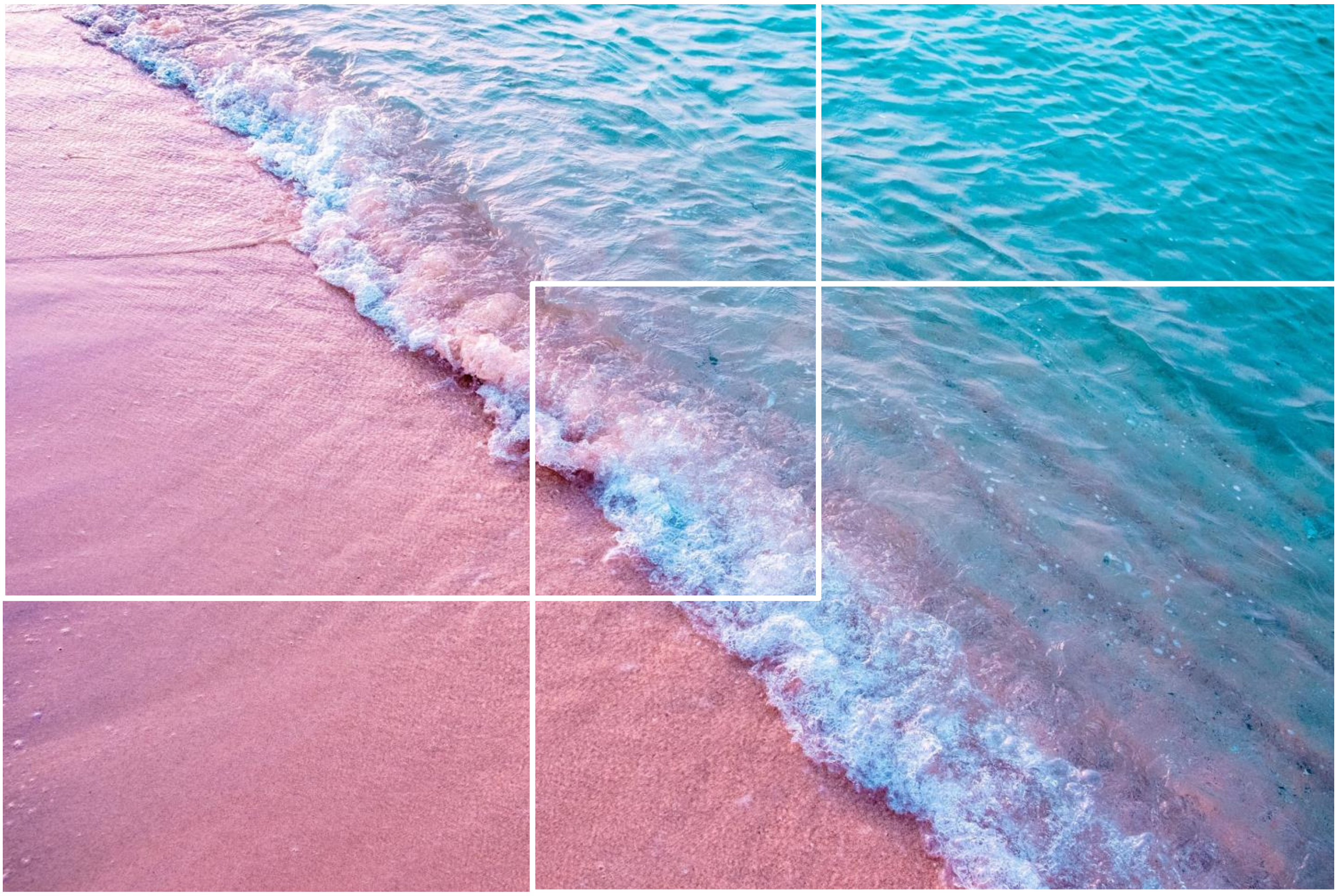

Namibian Marine Phosphate (Pty) Ltd

Submitted to: Namibian Marine Phosphate (Pty) Ltd
Attention: Mr Chris Jordinson
Private Bag 5018
7 Auob Street, Meersig
Walvis Bay
Namibia

REPORT:

ESIA REPORT FOR THE PROPOSED SANDPIPER MARINE PHOSPHATE PROJECT WITHIN ML 170, OFFSHORE, NAMIBIA.

PROJECT NUMBER:	ECC-133-377-REP-03-D
REPORT VERSION:	REV 01
DATE:	OCTOBER 2022

Prepared by: ECC ENVIRONMENTAL COMPLIANCE CONSULTANCY

TITLE AND APPROVAL PAGE

Project Name:	ESIA report for the proposed Sandpiper Marine Phosphate Project within ML 170, offshore, Namibia.
Client Company Name:	Namibian Marine Phosphate (Pty) Ltd
Client Representatives:	Mr Chris Jordinson and Mr Michael Woodborne
Ministry Reference:	APP-003397
Authors:	Carlene Baufeldt, Jessica Bezuidenhout and Monique Jarrett
Status of Report:	Final for Government Submission
Project Number:	ECC-133-377-REP-03-D
Date of issue:	October 2022
Review Period	N/A

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DISCLAIMER

Environmental Compliance Consultancy (ECC) (Reg. No. CC 2013/11401) has prepared this report on behalf of the Proponent. This report has been authored by employees of ECC, who have no material interest in the outcome of this report, nor do any of the ECC team have any interest that could be reasonably regarded as being capable of affecting their independence in the preparation of this report. ECC is independent from the Proponent and has no vested or financial interest in the Sandpiper Project, except for fair remuneration for professional fees rendered which are based upon agreed commercial rates. Payment of these fees is in no way contingent on the results of this report or the assessment, or a record of decision issued by Government. No member or employee of ECC is, or is intending to be, a director, officer, or any other direct employee of the Proponent. No member or employee of ECC has, or has had, any shareholding in the Sandpiper Project. Any personal views or opinions expressed by the writer may not necessarily reflect the views or opinions of Environmental Compliance Consultancy or its client.

Please note at ECC we care about lessening our footprint on the environment; therefore, we encourage that all documents are printed double sided.

EXECUTIVE SUMMARY

Environmental Compliance Consultancy (ECC) has been appointed as the environmental assessment practitioner (EAP) by Namibian Marine Phosphate (Pty) Ltd (referred to as the Proponent or NMP herein) to manage the application process for an environmental clearance certificate and to conduct an environmental and social impact assessment (ESIA) for mining of phosphate, within mining licence 170 (ML 170). The area is located off the Namibian coast 120 km to the southwest of the of Walvis Bay (-24° 19' 59.99" S: 13° 53' 20" E). The eastern boundary of the mining licence is located approximately 40 km off the coast (directly west of Conception Bay). The proposed Sandpiper Marine Phosphate Project (SP1) is located within ML 170 (see Figure 4).

Mining activities will be undertaken within the initial target area (SP1) within ML 170 (Figure 4). The mining operation will entail dredging and recovery of marine phosphate sediments using a trailing suction hopper dredger (TSHD) from water depths between 190 m to 250 m. The scale of the Sandpiper Project within the SP1 target area will involve mining a total area of 34 km^2 over a period of 20-years at an average of 1.7 km^2 annually. The annual mining area equates to 0.08% of ML 170. The total 20-year mining area equates to less than 2% of ML 170 and less than 0.0003% of the seabed within Namibia's exclusive economic zone. Within this exclusive economic zone, the project would coexist with existing marine diamond mining, fishing, tourism, and the oil and gas industry, operations of a significantly larger scale. The other sites SP2 and SP3 also contain phosphate resources and may be considered at a later stage (refer Figure 4).

In terms of the Namibian Environmental Management Act, No. 7 of 2007 and its regulations, the Ministry of Mines and Energy (MME) is the competent authority for the proposed Project. Mining operations trigger listed activities in terms of the Act, and as such, requires an environmental clearance certificate.

SCREENING PHASE

Previously the Proponent had undergone an environmental impact assessment that was submitted to the competent authority, the Ministry of Environment, Forestry and Tourism (MEFT) and the Ministry of Fisheries and Marine Resources (MFMR) in 2012. Subsequent to that assessment, further verification studies were requested by the Ministry of Fisheries and Marine Resources (MFMR) in consultation with the Environmental Commissioner, which were completed in 2014. Further respective engagement and workshops with the respective line ministries took place in 2016 and 2018, whereby further scientific environmental baseline and socio-economic assessments were conducted and finalised in 2020. On conclusion of the legal action initiated in 2016, the High Court ruled in 2021 that NMP's Mining Licence ML 170 remains valid and that NMP is required to obtain a valid environmental clearance certificate in order to undertake the proposed mining activities within ML 170. Accordingly, NMP has taken the necessary steps to re-submit an environmental clearance certificate application for ML 170.

All previous data and scientific reports were utilised during the screening phase to determine the potential environmental and social impacts of the Project, which are listed below:

- Potential effects on the marine benthic fauna
- Potential impairment of food chain functionality
- Potential creation of new habitat colonized by as yet unknown fauna
- Potential modification to the water column, primarily turbidity
- Reduction in light penetration caused by localized surface turbidity plume
- Change in, i.e., oxygen levels related to sediment releases into water column
- Possible release of hydrogen sulphide into the water column
- Potential removal of typical spawning substrate for fish
- Potential removal of foraging substrate for fish
- Potential interference with fish behaviour
- Associated implications for the commercial fishing industry
- Potential to increase the marine traffic in the vicinity of Walvis Bay
- Potential job creation and skills development due to the proposed project
- Potential social upliftment benefits for local and regional communities
- Potential influx of people moving to the Walvis Bay areas
- Potential social nuisances
- Potential value for development of a new mining sector and phosphate-based industry
- Potential regional and national economic benefits
- Potential role in regard to national policies and objectives for Blue Economy
- Development and Marine Spatial Planning.

SCOPING PHASE

The objective of the scoping phase was to obtain a thorough understanding of the biophysical and socioeconomic environment in which the Project is located, using existing baseline and specialist studies. It also provided an opportunity for the public to have input into the scope of the assessment. The technical inputs combined with the inputs from the I&APs during the previous engagements led to the development of the Terms of Reference (ToR) for the assessment phase.

The following was considered during the preparation of the scoping report:

- Desktop and literature research
- Specialist studies available from between 2012 to 2020
- Peer review reports
- Available survey data
- Specialist baseline studies, including:
  - Marine ecology
  - Marine water quality
  - Benthos

- Jellyfish
- Geology and history of the deposit (verification study)
- Water column and sedimentary environment (verification study)
- Fisheries and biodiversity (verification study)
- Plume dispersion modelling (supplementary studies)
- Sediment toxicity (supplementary studies)
- Noise baseline (supplementary studies)
- Socio-economic baseline (supplementary studies)
- Independent external review reports
- Independent peer review reports.

TERMS OF REFERENCE

The ToR within the scoping report proposed for the assessment phase and covered the following:

- Water column, water quality, sediments and benthos assessment
    - Seabed physiography
    - Sediment plume dispersion modelling
    - Current velocity and water mass characteristics
        - Dissolved oxygen
    - Sediments characteristics and chemistry
        - Particulate organic matter concentrations
        - Inorganic nutrient levels
        - Oxidative state
        - Heavy metal concentrations
        - Hydrogen sulphide
    - Sediment toxicity
    - Plankton
        - Phytoplankton
        - Zooplankton
    - Benthos
        - Thiobacteria
        - Meiofauna
        - Epifauna
        - Macrobenthos
    - Depositional history of phosphate deposits
- Fisheries, Mammals and Seabirds assessment
    - Biodiversity study
    - Ecosystem impact modelling
    - Biomass and stock estimates (hake/Monk)
    - Reproductive dynamics, recruitment and stock dynamics
    - Jellyfish

    - Mammals and seabirds
    - Noise.
- Social and socio-economic impact assessment.

Additionally, the scoping report defines the impact methodology that was adopted for the impact assessment phase of the ESIA, this is included in Chapter 6 of this report. The methodology was adopted from the previous assessments conducted in 2012 and 2014 respectively for the marine environment and to be applied to the updated specialist impact assessments to be completed in the assessment phase of this application. A scoring system has been applied for the updated impact assessment Chapter to appropriately evaluate the sensitive receptors, where feasible. A hierarchical decision-making process is followed, to prevent or eliminate, prevent, reduce or offset, mitigate or manage potential impacts. The scoping report and provisional environmental management plan (EMP) was provided to the public for a 14-day period of review (22 April to 6 May 2022) prior to submission to the competent authority, including MEFT and MFMR on the 03 June 2022.

ASSESSMENT PHASE

The next stage of the process was to conduct the impact assessment which included updated specialist impact assessments as well as relevant amendments to the EMP.

All I&AP comments on the scoping report, were responded to, through providing an explanation or further information in the response table, which was attached as an addendum report to the final scoping report submitted to the competent authority.

Once finalised, prior to formal submission, the final ESIA report and appendices, including relevant specialist reports, will be made available to all registered I&AP's and stakeholders for comment.

The final ESIA report and appendices will then be formally submitted to the Environmental Commissioner as well as the competent authority, being the MME and, then to the MEFT as well as MFMR as part of the application for an environmental clearance certificate for the Sandpiper Marine Phosphate Project. The phases of the ESIA are provided in Figure 1.

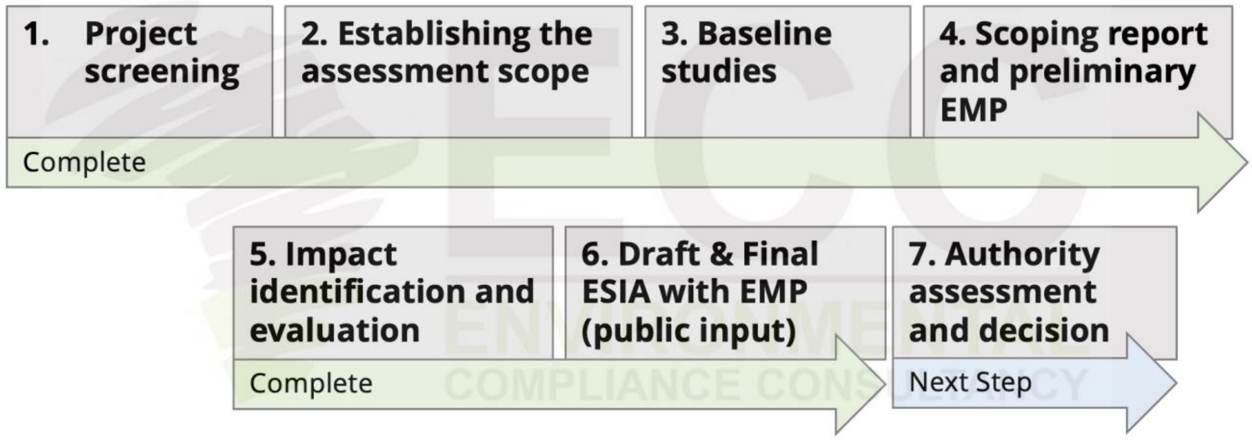

Figure 1 – Simplified Namibian ESIA process noting the Sandpiper Marine Phosphate Project progress

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ABBREVIATIONS

ABBREVIATIONS	DESCRIPTION
µPa	pascal
3D	three dimensional
AIDS	acquired immunodeficiency syndrome
AVS	acid volatile sulphide
Bq	becquerel
Bq/g	becquerel per gram
Bq/kg^{-1}	becquerel per kilogram as per activity concentration
BCLME	Benguela Large Marine Ecosystem
BID	background information document
Bn	billion
BOQ's	bills of quantity
C	carbon
CA	Competent Authority - Government Ministry that assists the MEFT in assessing a project and issuing a record of decision
CAPEX	capital expenditure
CIA	cumulative impact assessment
cm/s	centimetres per second
CNFA	Confederation of Namibian Fishing Association
COM	Chamber of Mines
CSIR	Council for Scientific and Industrial Research
DAPR	direct application phosphate rock
dB	decibels
DEA	Directorate of Environmental Affairs
DFS	definitive feasibility study
E	east
EC	Environmental Commissioner
ECC	Environmental Compliance Consultancy
ECC	environmental clearance certificate
ECD	early childhood development
EEZ	exclusive economic zone
EIA	environmental impact assessment
EMA	Environmental Management Act, No.7 of 2007
EMP	environmental management plan
EPL	exclusive prospecting licence
ESIA	environmental and social impact assessment
FEED	front end engineering design
GDP	gross domestic produce

ABBREVIATIONS	DESCRIPTION
GVA	gross value added
H2S	hydrogen sulphide
Ha	hectares
HIV	human immunodeficiency viruses
Hz	hertz
IAEA	International Atomic Energy Act
IALA	the convention on the international organization for marine aids to navigation
I&APs	interested and affected parties
IFC	International Finance Corporation
JDN	Jan De Nul Group
Kg	kilograms
LFP	lithium ferro (iron) phosphate
m	metres
Ma	miocene age
MARPOL	International Convention for the Prevention of Pollution from Ships
MEFT	Ministry of Environment, Forestry and Tourism
MFMR	Ministry of Fisheries and Marine Resources
mg/l	milligrams per litre
MHSS	Ministry of Health and Social Services
ML	mining licence
mm	millimetres
mm/year	millimetres per year
MME	Ministry of Mines and Energy
mMOL/kg	millimole per kilogram
Mt	metric ton
mv	motor vessel
MWT	Ministry of Works and Transport
N	nitrogen
NamDeb	Namdeb Diamond Corporation (Pty) Ltd including subsidiary Debmarine Namibia (Pty) Ltd
Namport	Namibia Ports Authority
NCE	Namibia Chamber of Environment
NDP 5	national development plan 5
NEWS	Namibia Environment and Wildlife Society
NGO	Non-Government Organisation
NMP	Namibian Marine Phosphate (Pty) Ltd
NNE	north-north-east
NPC	national population census

ABBREVIATIONS	DESCRIPTION
NTU	nephelometric turbidity unit
NUI	Namibia Uranium Institute
O	oxygen
ORP	oxidation reduction potential
P2O5	phosphorous pentoxide
POM	Particulate organic matter
RO	Reverse osmosis
S	south
SADC	Southern African Development Community
SADCO	Southern Africa Data Centre for Oceanography
SAEIA	Southern African Environmental Impact Assessment
SEMP	strategic environmental management plan
SEM	scanning electron microscopy
SME's	small and medium enterprises
SO2−4	sulphate
SP1	initial target area
SSP	single super phosphate
SSW	South - southwest
STPM	suction tube position monitoring
SW	southwest
TB	tuberculosis
ToR	Terms of Reference
TSHD	trailing suction hopper dredger
UNAM	University of Namibia
USA	United States of America
WINSN	workload indicators of staffing need
Wt.	weight
XRD	x-ray diffraction
ZOI	zone of influence

1 INTRODUCTION

1.1 COMPANY BACKGROUND

Environmental Compliance Consultancy (ECC) has been appointed as the environmental assessment practitioner (EAP) by Namibian Marine Phosphate (Pty) Ltd (referred to as the Proponent or NMP herein) to manage the application process for an environmental clearance certificate and to conduct an environmental and social impact assessment (ESIA) for mining of phosphate, within mining licence 170 (ML 170). The area is located off the Namibian coast 120 km to the southwest of the of Walvis Bay (-24° 19' 59.99" S: 13° 53' 20" E). The eastern boundary of the mining licence is located approximately 40 km off the coast (directly west of Conception Bay). The proposed Sandpiper Marine Phosphate Project (SP1) is located within mining licence ML 170 (see Figure 2).

Mining activities will be undertaken within the initial target area (SP1) within ML 170 (Figure 2). The mining operation will entail dredging and recovery of marine phosphate sediments using a trailing suction hopper dredger (TSHD) from water depths between 190 m to 250 m. The scale of the Sandpiper Project within the SP1 target area will involve mining a total area of 34 km^2 over a period of 20-years at an average of 1.7 km^2 annually. The annual mining area equates to 0.08% of ML 170. The total 20-year mining area equates to less than 2% of ML 170 and less than 0.0003% of the seabed within Namibia's exclusive economic zone which falls under the countries mineral and environmental management legislation, in accordance with the provision of the United Nations Convention on Law of the Sea (UNCLOS). Within this exclusive economic zone, the project would coexist with existing marine diamond mining, fishing, tourism, and the oil and gas industry, operations of a significantly larger scale. The other sites SP2 and SP3 also contain phosphate resources and may be considered at a later stage (Refer Figure 2).

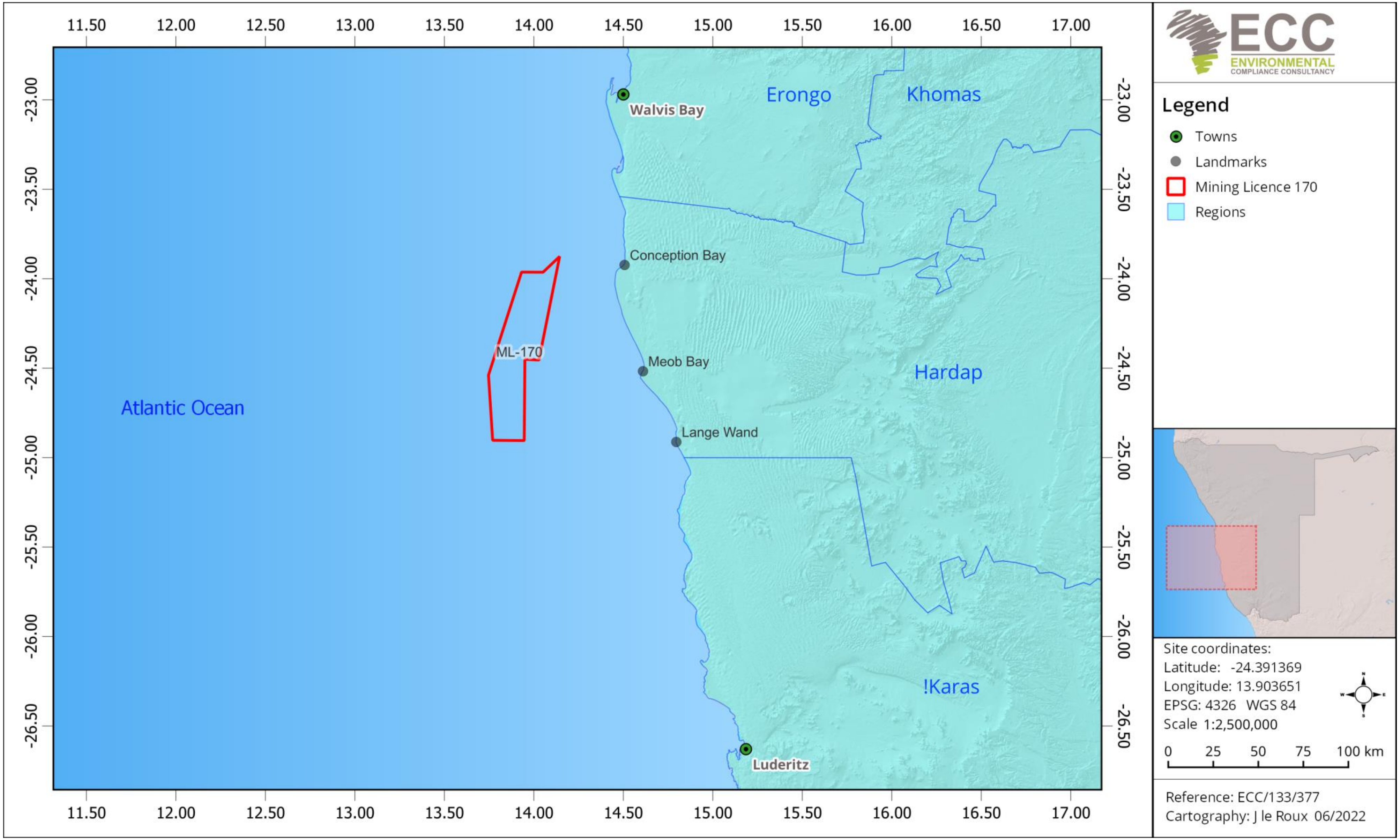


Figure 2 - Locality map of the Sandpiper Marine Phosphate Project on ML 170

1.2 Purpose of the assessment report

An environmental and social impact assessment (ESIA) has commenced in compliance with the requirements of the Environmental Management Act, 2007 and its regulations. This report presents the findings of the ESIA process. In addition to describing the prescribed ESIA process, the report describes the baseline biophysical and socioeconomic environments, provides a project description, outlines the terms of reference for the assessment phase, and presents a preliminary environmental management plan (EMP). The scope of the assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment, obtained through a desktop review, available site-specific literature, monitoring data, and site reports.

The scoping report and appendices was submitted to the public for review from 22 April to 6 May 2022. This stage provided an opportunity for registered interested and affected parties (I&APs) to provide input, comments, and suggestions on the proposed Project and in so doing, guide the impact assessment phase (Appendix B – Public consultation document
). The final scoping report, inclusive of the public comments, was be submitted to the Ministry of Mines and Energy (MME) as the competent authority for the Project on the 8 June 2022. Thereafter, it was submitted by MME to the Environmental Commissioner, Ministry of Environment, Forestry, and Tourism (MEFT) - Directorate of Environmental Affairs (DEA) for a record of decision on the scoping report. Approval of the scoping report was received via MEFT portal (8 June 2022) and via a formal letter from the Office of the Environmental Commissioner (30 August 2022). This approval was the initiation of the impact assessment and this report is the result of that process.

1.3 The proponent of the proposed project

Namibian Marine Phosphate (Pty) Ltd (NMP) is the Proponent for the proposed Project. The Proponent holds the rights to ML 170 located 120 km off the coast to the southwest of Walvis Bay.

NMP was formed in 2008 as a joint venture company for the development of a marine phosphate resource contained within three primary EPLs, namely 3414, 3415 and 3323. NMP also holds another 3 EPL's (4009, 4010, and 4059) with the potential to host resource in the same region.

NMP is a Namibian registered company with two primary shareholders namely Mawarid Mining LLC (Oman registered) holding 85% as the funding shareholder and Havana Investments (Pty) Ltd (Namibian registered) holding 15%. Table 1 provides the company representative and contact details of the Proponent.

Table 1 - Proponent's details

Company Representative:	Contact Details:
Namibian Marine Phosphate (Pty) Ltd Mr Chris Jordinson (Corporate contact person)	7 Auob Street, Meersig Walvis Bay Namibia Private Bag 5018 Tel: +264 85 580 0013 Email: info-namphos@namphos.com

1.4 ENVIRONMENTAL AND SOCIAL ASSESSMENT PRACTITIONER

Environmental Compliance Consultancy (ECC) (Reg. No. CC 2013/11401) has prepared this report and the EMP on behalf of the Proponent.

This report was authored by employees of ECC, who have no material interest in the outcome of this report, nor do any of the ECC team have any interest that could be reasonably regarded as being capable of affecting their independence in the preparation of this report. ECC is independent of the Proponent and has no vested or financial interest in the Project, except for fair remuneration for professional fees rendered based upon agreed commercial rates. Payment of these fees is in no way contingent on the results of this report or the assessment, or a record of decision issued by the Government. No member or employee of ECC is, or is intending to be, a director, officer, or any other direct employee of Namibia Marine Phosphate. No member or employee of ECC has, or has had, any shareholding in Namibia Marine Phosphate.

All compliance and regulatory requirements regarding this report should be forwarded by email or posted to the following address:

Environmental Compliance Consultancy
PO Box 91193, Klein Windhoek, Namibia
Tel: +264 81 669 7608
Email: info@eccenvironmental.com

1.5 ENVIRONMENTAL REQUIREMENTS

The Environmental Management Act, 2007 and its regulations, stipulate that an environmental clearance certificate is required before undertaking any of the listed activities that are identified in the Act and its regulations. Potential listed activities triggered by the Project are provided in Table 2.

Table 2 – Activities potentially triggered by the NMP project

Source: Environmental Management Act, 2007, and its regulations

Listed activity	As defined by the regulations of the Act	Relevance to the project
Mining and quarrying activities	(3.1) The construction of facilities for any process or activities which require a licence, right, or other forms of authorization, and the renewal of a licence, right, or other forms of authorization, in terms of the Minerals (Prospecting and Mining Act), 1992. (3.2) Other forms of mining or extraction of any natural resources whether regulated by law or not. (3.3) Resource extraction, manipulation, conservation, and related activities.	− Mining is the primary listed activity that will be undertaken in mining licence ML 170 under the provisions of the Minerals (Prospecting and Mining) Act 33 of 1992. − The Minerals Act (1992) defines mining activities under the lawful ownership of a mining licence. − The primary activity to be undertaken is the mining or dredging of phosphatic sediments within ML 170. − The phosphatic sediment will be extracted in ML 170 using deep water dredging techniques and will then be transported to Walvis Bay for discharge and processing at an onshore facility. The onshore beneficiation operations, including transportation and discharge of the phosphate ore mined in ML 170 form a separate component of the project and will be the subject of a separate environmental and social impact assessment and in turn application for an environmental clearance certificate.
Hazardous substance treatment, handling and storage	(9.1) The manufacturing, storage, handling, or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974. (9.2) Any process or activity which requires a permit, licence, or another form of authorization, or the modification of or	− The Proponent will ensure that the dredging company contracted to conduct the dredging operations are compliant with the provisions of International Convention for the Prevention of Pollution from Ships (MARPOL) and will verify that the vessel holds valid and applicable permits

Listed activity	As defined by the regulations of the Act	Relevance to the project
	changes to existing facilities for any process or activity which requires amendment of an existing permit, licence or authorization or which requires a new permit, licence or authorization in terms of a governing the generation or release of emissions, pollution, effluent or waste. (9.4) The storage and handling of dangerous goods, including petrol, diesel, liquid petroleum gas, or paraffin, in containers with a combined capacity of more than 30 cubic meters at any one location.	associated with the prevention of pollution of hazardous substances, if applicable. – The dredge vessel will hold a supply of fuel in the vessel's fuel tanks in accordance with standard international marine practice. Refuelling will be conducted in the Port of Walvis Bay.

2 APPROACH TO THE ASSESSMENT

2.1 PURPOSE AND SCOPE OF THE ASSESSMENT

The aim of this assessment is to determine which impacts are likely to be significant; to scope the available data and identify any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

2.2 THE ASSESSMENT PROCESS

The ESIA methodology applied to this assessment is compliant with Namibia's EMA 2007 which is applicable to all marine areas located within Namibia's Territorial Waters and Exclusive Economic Zone (EEZ) (Territorial Sea and Exclusive Economic Zone of Namibia Act 3 of 1990). The EISA methodology has been developed using the International Finance Corporation (IFC) standards and models performance Standard 1: 'Assessment and management of environmental and social risks and impacts' (International Finance Corporation, 2012 and 2017) as a guideline, as well as Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia 2008); international and national best practice guidelines and ECC combined relevant ESIA experience.

Furthermore, this assessment was undertaken for the Proponent in accordance with Namibian legal requirements.

This assessment is a formal process whereby the potential effects that the Sandpiper Project will have on the biophysical, social and economic environments are identified, assessed and reported, so that the significance of potential impacts can be taken into account when considering a record of decision for the proposed Sandpiper Project.

Final mitigation measures and recommendations are based on the cumulative experience of the consulting team and the client, taking into consideration the potential environmental and social impacts. The process followed, through the assessment, is illustrated in Figure 3 and is detailed further in the following Sections.

1. Project screening

Complete

The first stages in the ESIA process are to undertake a screening exercise to determine whether the Project triggers listed activities under the Environmental Management Act, 2007, and its regulations.

The screening phase of the Project is a preliminary analysis, in order to determine ways in which the Project might interact with the biophysical, social, and economic environments.

Stakeholder engagement:

- Registration of the project
- Preparation of the BID

2. Establishing the assessment scope

Complete

Where an ESIA is required, the second stage is to scope the assessment. The main aim of this stage is to determine which impacts are likely to be significant; to scope the available data and any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

The scope of this assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment. Feedback from consultation with the public and the Proponent informs this process. The following environmental and social topics were scoped into the assessment, as there was the potential for significant impacts to occur. Impacts that are identified as potentially significant during the screening and scoping phase are taken forward for further assessment in the ESIA process. These are:

BIOPHYSICAL ENVIRONMENT

- Biogeochemistry;
  Effects of disturbances to the seabed for benthos
  Sediment plume and dispersion modelling
  Sediment toxicity
  Underwater noise
  CO_2 fluxes
- Biodiversity;
  Mammals
  Fisheries
  Seabirds

SOCIAL ENVIRONMENT

- Socio-economic

3. Baseline studies

Complete

A robust baseline is required, in order to provide a reference point against which any future changes associated with a Project can be assessed, and to allow suitable mitigation and monitoring to be identified.

The project area has been studied extensively from 2011 – 2020 utilising various specialist works, with an original impact assessment conducted in 2011/2012. Verification studies were conducted in 2013/2014 with supplementary studies conducted in 2020. This literature was available to be referenced. The Project site-specific area has been studied as part of the ESIA process for both the ML170 area and target mining area of SP-1 and the following has been conducted as part of this assessment:

- Desktop studies
- Consultation with stakeholders
- Specialist studies

The environmental and social baselines are provided in the scoping study.

4. Draft scoping report and EMP

Complete

The scoping report documents the findings of the current process and provides stakeholders with an opportunity to comment and continue the consultation that forms part of the environmental assessment. The EMP provides measures to manage the environmental and social impacts of the proposed Project, and outlines the specific roles and responsibilities required in order to fulfil the management plan.

This scoping report focuses on describing the ESIA process, project description, baseline description and Terms of Reference for the assessment phase.

This report was issued to stakeholders and I&APs for consultation, for a period of 14 days, meeting the mandatory requirement as set out in the Environmental Management Act, Act 7 of 2007. The aim of this stage is to ensure that all stakeholders and I&APs have an opportunity to provide comments on the assessment process and to register their concerns, if any.

5. Impact identification and evaluation

Complete

The key stage of the ESIA process is the impact identification and evaluation stage. This stage is the process of bringing together Project characteristics with the baseline environmental characteristics and ensuring that all potentially significant environmental and social impacts are identified and assessed. It is an iterative process that commences at Project inception and ends with the final design and Project implementation. The impact identification and evaluation stages will be updated in the assessment phase.

The final design of the proposed Project will be assessed, along with alternatives that were considered during the design process in accordance with the Environmental Management Act, No 7 of 2007. Section 6 in this report sets out the assessment methodology to be used to assess the Project against the environmental and social baselines that would be affected.

6. Final EIA and EMP

This Stage

All comments received during the I&AP public review period will be collated in an addendum report, which will accompany this scoping report when submitted to the MEFT: DEA. All comments will be responded to, either through providing an explanation or further information in the response table, or by signposting where information exists, or where new information has been included in the ESIA report or appendices. Comments will be considered and where they are deemed to be material to the decision-making, or might enhance the ESIA, they will be incorporated.

The final ESIA report, appendices and the addendum report will be available to all stakeholders and all I&APs will be informed of its availability for review period of 14 days.

The ESIA report, appendices and addendum will be formally submitted to the competent authority (MME), the MEFT: DEA and MFMR as part of the application for an environmental clearance certificate.

7. Authority assessment and decision

Next Step

The Environmental Commissioner, in consultation with other relevant authorities, will assess if the findings of the ESIA presented in the report are acceptable. If deemed acceptable, the Environmental Commissioner will revert to the Proponent with a record of decision and recommendations.

8. Monitoring and auditing

Future Stage

In addition to the EMP being implemented by the Proponent, a monitoring strategy and audit procedure will be determined by the Proponent and competent authority. This will ensure key environmental receptors are monitored over time to establish any significant changes from the baseline environmental conditions, caused by Project activities

Figure 3 - ESIA process and stages complete

2.3 STUDY AREA

This ESIA study area has been defined according to the geographic scope of the receiving environment and potential impacts that could arise because of the Sandpiper Project. The receiving environment is a summary term for the biophysical and socioeconomic environment that is described in the baseline Chapter. The study area is presented in Figure 4.

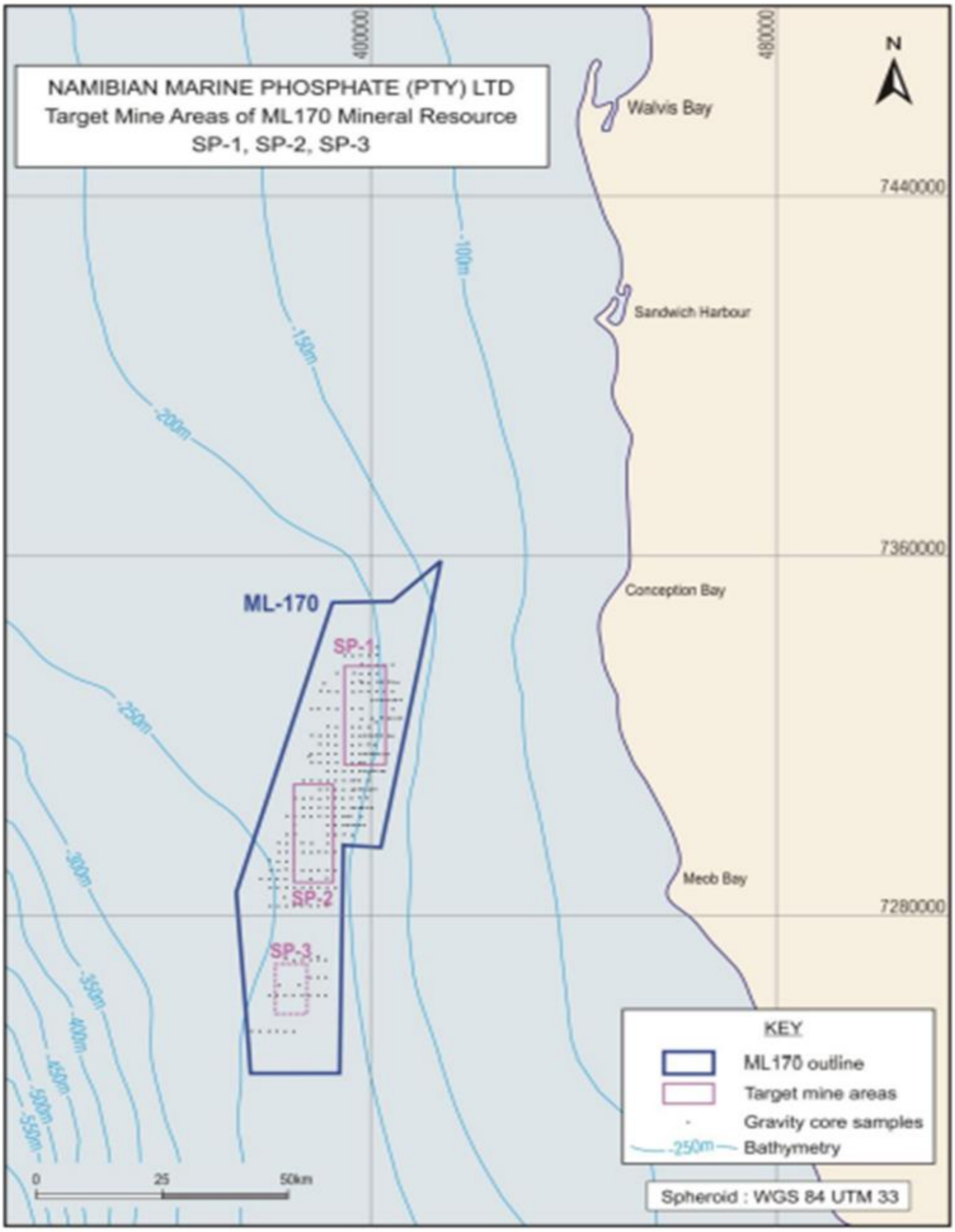


Figure 4 - ESIA study area

2.4 PUBLIC CONSULTATION

Public participation and consultation are a requirement stipulated in the Environmental Impact Assessment Regulations (Regulations 21 and 23) of the EMA, 2007 for a project undertaking a listed activity and requires an environmental clearance certificate.

Consultation is a compulsory and critical component of the ESIA process for achieving transparent decision-making and can provide many benefits. Consultation is ongoing during the ESIA process. The objectives of the public participation and consultation process are to:

- Provide information on the Sandpiper Project, introducing the overall project concept and planning in the form of a background information document (BID)
- Determine the relevant government, regional and local regulating authorities
- Listen to and understand community issues, record concerns and questions
- Explain the process of the ESIA and timeframes involved and establish a platform for ongoing consultation.

Public consultation for the Sandpiper Project commenced on 27 January 2022 when pre-consultation letters were distributed to focus groups and identified key stakeholders and interested and affected parties.

Adverts for public meetings held in Windhoek and Walvis Bay were placed in local newspapers and the notification of the assessment in terms Regulation 21 of the Act was placed in the following newspapers on the 27 January and 3 February 2022 in the following newspapers:

- The Republikein
- The Namibian Sun
- Allgemeine Zeitung.

Public meetings and various focus group meetings were also held between the Proponent and stakeholders. A focus group session was held between the Walvis Bay Salt Works, the Proponent and the EAP (ECC) via zoom on 4 February 2022 and another focus meeting was held with the MFMR at NatMIRC on 11 February 2022. Two public meetings were also held; one in Windhoek at the Scientific Society on 9 February 2022 and another one was held in Walvis Bay at the Walvis Bay Town Hall on 11 February 2022. An additional community engagement information meeting was held with Walvis Bay residents on the 19 October 2022 in Kuisebmond. Information booklets were distributed at the meeting and at the municaplouty buildings in Kuisebmond and Narraville, respectively. Proof of these stakeholder engagements can be found in Appendix B.

2.4.1 IDENTIFICATION OF KEY STAKEHOLDER AND INTERESTED OR AFFECTED PARTIES

A stakeholder mapping exercise was undertaken to identify individuals or groups of stakeholders, and the method in which they will be engaged during the ESIA process.

Stakeholders were approached through direct communication (letters and phone calls), the national press, or directly by email. A summarised list of stakeholders for this project is given below:

- The general public with an interest in the Sandpiper Project
- Ministry of Environment, Forestry and Tourism (MEFT)
- Ministry of Mines and Energy (MME)
- Ministry of Fisheries and Marine Resources
- Ministry of Works and Transport (MWT)
- Erongo Regional Council
- Walvis Bay Municipality
- Swakopmund Municipality
- Fishing unions such as the Confederation of Namibian Fishing Association (CNFA)
- Directorate of Maritime Affairs in the MWTC
- Walvis Bay Salt Holdings
- Namibia Ports Authority (Namport)
- Chamber of Mines (COM)
- Namibia Chamber of Environment (NCE)
- Namibia Uranium Institute (NUI)
- NGO's such as Namibia Environment & Wildlife Society (NEWS)
- The Dolphin Project
- Swakopmund Scientific society
- Mine Workers Union
- LL Namibia Phosphate (Pty) Ltd
- Wet Landed Horse Mackerel Association.

The records of the public consultation process in the form of a summary report are provided in Appendix B – Public consultation document
and provides a list of interested and affected parties (I&APs'), evidence of consultation, including notes of public meetings, advertisements in national newspapers, and a summary of the comments or questions raised by the public.

The draft scoping report was submitted to the competent authority, and all interested and affected parties for their review on 22 April 2022. The public review period was open for a period of 14 days from 22 April 2022 to 6 May 2022. All comments received were recorded, analysed, and incorporated into the summary report as an addendum to the scoping report as presented in Appendix C – I & APs comments consolidation
The final scoping report was then submitted to the competent authorities and I&APs for their records.

The draft ESIA report was submitted to the competent authority, and all interested and affected parties for their review on 5 September 2022. The public review period was open for a period of 15 days from 5 September 2022 to 20 September 2022. All comments received were recorded, analysed, and incorporated into the summary report as an addendum to the scoping report as presented in Appendix C – I & APs comments consolidation

2.4.2 SUMMARY OF ISSUES RAISED

Matters raised by registered I&APs in relevant stakeholder consultations and the public meetings in Windhoek and Walvis Bay are relevant for the nature, location and scale of project, and these are summarised as follows:

- Potential effects on the marine benthic fauna
- Potential impairment of food chain functionality
- Potential creation of new habitat colonized by as yet unknown fauna
- Potential modification to the water column, primarily turbidity
- Reduction in light penetration caused by localized surface turbidity plume
- Change in, e.g., oxygen levels related to sediment releases into water column
- Possible release of hydrogen sulphide into the water column
- Potential removal of typical spawning substrate for fish
- Potential removal of foraging substrate for fish
- Potential interference with fish behaviour
- Associated implications for the commercial fishing industry
- Potential to increase the marine traffic in the vicinity of Walvis Bay
- Potential job creation and skills development due to the Sandpiper Project
- Potential social upliftment benefits for local and regional communities
- Potential influx of people moving to the Walvis Bay areas
- Potential social nuisances
- Potential value for development of a new mining sector and phosphate-based industry
- Potential regional and national economic benefits.

3 REVIEW OF THE LEGAL ENVIRONMENT

This Chapter outlines the regulatory framework applicable to the proposed Project. As stated in Section 1, an environmental clearance certificate is required for any activity listed in the Government Notice No. 29 of 2012 of the EMA. The Sandpiper Project is located outside of any marine protected or heritage listed areas.

A thorough review of relevant legislation has been conducted for the Sandpiper Project and is outlined in the tables listed below and in the following Sections:

- Table 3 identifies relevant legal requirements specific to the Sandpiper Project (Section 3.1)
- Table 4 provides the national policies and plan (Section 3.2)
- Table 5 specifies permits relevant for the Sandpiper Project (Section 3.2)
- Table 6 identifies the international policies and plans relevant to the Sandpiper Project (Section 3.3).

3.1 NATIONAL REGULATORY FRAMEWORK

Table 3 - Details of the regulatory framework as it applied to the Sandpiper Project

National regulatory framework	Summary	Applicability to the Sandpiper Project
Constitution of the Republic of Namibia (1990)	The constitution defines the country's position in relation to sustainable development and environmental management. The constitution refers that the State shall actively promote and maintain the welfare of the people by adopting policies aimed at the following: "Maintenance of ecosystems, essential ecological processes and biological diversity of Namibia, and the utilisation of living, natural resources on a sustainable basis for the benefit of all Namibians, both present, and future."	The Proponent is committed to the sustainable use of the environment, and has aligned its corporate mission, vision, and objectives within the ambit of the Constitution of the Republic of Namibia (1990).
Territorial Sea and Exclusive Economic Zone Act No.3 of 1990	To determine and define the territorial sea, internal waters, exclusive economic zone and continental shelf of Namibia and activities associated herewith. The continental shelf is defined as State land and the Exclusive Economic Zone (EEZ) extends to 200 nautical miles offshore (370.4 km). Under the provisions of the United Nations Convention for Law of the Seas (UNCLOS), Namibian legislation regulates the activities of proposed exploration and mining projects that fall within these areas and not international guidelines or standards.	The Sandpiper Project falls within the continental shelf of Namibia and in the EEZ zone.

National regulatory framework	Summary	Applicability to the Sandpiper Project
	As defined under this Act (Section 4) Within the exclusive economic zone - (a) any law of Namibia which relates to the exploitation, exploration, conservation or management of the natural resources of the sea, whether living or non-living, shall apply; (b) Namibia shall have the right to exercise any powers which it may consider necessary to prevent the contravention of any law relating to the natural resources of the sea	
Minerals (Prospecting and Mining) Act No. 33 of 1992	The Act provides for the granting of various licences related to mining and exploration. Section 50 (i) requires: “An environmental impact assessment indicating the extent of any pollution of the environment before any prospecting operations or mining operations are being carried out, and an estimate of any pollution, if any, likely to be caused by such prospecting operations or mining operations.” The Act sets out the requirements associated with licence terms and conditions, such that the holder of a mineral licence shall comply with. The Act also contains relevant provisions for pollution control related to mining activities and land access agreements and provides provisions that mineral licence holders are liable for any damage to land, water, plant, or animal life, caused by spilling or pollution, and must take all such steps as may be necessary to remedy such spilling, pollution, loss, or damage, at its own costs.	Mining Licence ML 170 was issued to the Proponent in July 2011 and is valid for a period of 20-years. The proposed mining activity in ML 170 requires an EIA to be carried out, as it triggers listed activities as defined in Government notice 29 in the Environmental Management Act 2007. Mining activities in ML 170 shall not commence until an Environmental Clearance Certificate has been issued in accordance with the provisions of the Environmental Management Act 2007. The Sandpiper Project shall be compliant with Section 76 of the Act with regard to records, maps, plans and financial statements, information, reports and returns submitted.

National regulatory framework	Summary	Applicability to the Sandpiper Project
Environmental Management Act, 2007 (Act No. 7 of 2007) and its regulations (2012), including the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011)	The Act aims to promote sustainable management of the environment and the use of natural resources. The Act requires certain activities to obtain an environmental clearance certificate prior to project development. The Act states that an EIA should be undertaken and submitted as part of the environmental clearance certificate application process for listed activities. The MEFT is responsible for the protection and management of Namibia's natural environment. The Department of Environmental Affairs, under the MEFT, is responsible for the administration of the EIA process.	This environmental and social impact assessment report documents the findings of the scoping and impact assessment phase of the environmental assessment undertaken for the proposed Sandpiper Project. The process will be undertaken in line with the requirements under the Act and its regulations. Mining activities in ML 170 shall not commence until an Environmental Clearance Certificate has been issued in accordance with the provisions of the Environmental Management Act 2007.
Marine Resources Act, 2000 (Act 27 of 2000)	The Act provides for the conservation of the marine ecosystem and the responsible utilization, conservation, protection and promotion of marine resources on a sustainable basis; for that purpose, to provide for the exercise of control over marine resources; and to provide for matters connected therewith.	The Proponent is committed to the conservation of the marine ecosystem and has taken steps to ensure that it uses a method of mining (dredging) that has been appropriately tried and/or tested in order to contribute the least amount of disruption to the marine environment.
The Namibian Ports Authority Act, 1994 (Act 2 of 1994)	The Act provides for the establishment of the Namibian Ports Authority to undertake the management and control of ports and lighthouses in Namibia, and the provisions of facilities and services related thereto. The Act gives provisions for licence to undertake activities in any port (including entry to a port).	During Sandpiper Project related construction, mobilisation and operations, any vessel(s) entering Namport waters will comply with all nautical safety requirements and will obtain relevant permission or licences where required.

National regulatory framework	Summary	Applicability to the Sandpiper Project
Hazardous Substances Ordinance, No. 14 of 1974	This Ordinance provides for the control of toxic substances and can be applied in conjunction with the Atmospheric Pollution Prevention Ordinance, No. 11 of 1976. This applies to the manufacture, sale, use, disposal, and dumping of hazardous substances, as well as their import and export.	The planned Sandpiper Project will involve the handling and onboard storage of hazardous substances such as fuels, reagents, and industrial chemicals. The Proponent and appointed international dredging contractor shall ensure safe handling, transfer, storage, and disposal protocols are developed, implemented, and audited throughout its operations in accordance with all relevant National and International maritime practices and regulations The Proponent is obliged to ensure that all permits under this Ordinance are obtained prior to Sandpiper Project commencement.
Labour Act, No. 11 of 2007	The Labour Act, No. 11 of 2007 (Regulations relating to the Occupational Health & Safety provisions of Employees at Work, promulgated in terms of Section 101 of the Labour Act, No. 6 of 1992 - GN156, GG 1617 of 1 August 1997)	The Sandpiper Project shall adhere to all labour provisions and guidelines, as enshrined in the Labour Act. The Sandpiper Project shall also develop and implement a comprehensive occupational health and safety plan to ensure adequate protection for its personnel throughout the Sandpiper Project lifecycle.
The Merchant Shipping Act, No.73 of 1991	This Act regulates all shipping activities and includes the following matters: registration and licensing of ship(s), safety of ships and life at sea, safety of navigation and collisions, accidents at sea and limitation of liability.	These matters are applicable to the proposed dredging activities on ML 170 and the navigation to and from the Port of Walvis Bay.

National regulatory framework	Summary	Applicability to the Sandpiper Project
Prevention and Combating of Pollution of Sea by Oil Amendment Act, No. 24 of 1991	The primary focus of this amendment Act deals with fines that may be imposed in respect of offences regarding pollution from ships at sea.	The dredger will operate in strict accordance with all National and International regulations governing the management and prevention of pollution of the sea by Oil or any other substances.
National Monuments Act, No. 28 of 1969	This Act regulates the disturbance of shipwrecks and archaeological deposits. If such finds are found, it details reporting requirements and further action to be taken by the Proponent.	NMP will adhere to the requirements of the Act if chance finds are discovered during marine operational activities.
Maritime Notice No. 4 of 1994	Provides rules and procedures for collecting non-mineralised waste from vessels in Namibian waters.	The dredger will have permanent staff to operate the vessel and provide support activities, therefore waste produced on board will be managed in strict accordance with the provisions of MARPOL and this Maritime Notice.
Petroleum Products and Energy Amendment Act, No.3 of 2000	Provides provision for the Minister to regulate the cleaning up of petroleum product spills, leaks and related incidents. The Proponent is required to carry all costs associated with such incidents.	The dredger has the potential to cause petroleum product spills or related incidents. The Proponent and appointed dredging contractor shall ensure that all necessary hazard management, mitigation, and recovery procedures as well as relevant marine and environmental insurance covers are in place and maintained throughout operations.

3.2 NATIONAL POLICIES AND PLANS

Table 4 – Namibian national policies and plans applicable to the Sandpiper Project

Policy or plan	Description	Relevance to the Sandpiper Project
Vision 2030	Vision 2030 sets out the nation's development targets and strategies to achieve its national objectives. Vision 2030 states that the overall goal is to improve the quality of life of the Namibian people aligned with the developed world.	The proposed Sandpiper Project shall aim to meet the objectives of Vision 2030 and shall contribute to the overall development of the country through continued employment opportunities and ongoing contributions to the gross domestic product (GDP).
Fifth National Development Plan (NDP5)	The NDP5 is the fifth in a series of seven five-year national development plans that outline the objectives and aspirations of Namibia's long-term vision. The NDP5 pillars are economic progression, social transformation, environmental sustainability, and good governance.	The planned Sandpiper Project supports meeting the objectives of the NDP5 through creating opportunities for continued employment.
The Harambee Prosperity Plan ii (2021 – 2025)	Second Pillar: Economic advancement – ensuring increasing productivity of priority key sectors (including mining) and the development of additional engines of growth, such as new employment opportunities.	The Sandpiper Project will contribute to the continued advancement of the mining industry and create an additional employment generation engine within the regional and national landscape.
Namibia's Green Plan, 1992	Namibian has developed a 12-point plan for integrated sustainable environmental management to ensure a safe and healthy environment and to maintain a viable economy. Clause 2 (f) makes specific mention to guidelines related to Mining and Sustainable Development.	Guidelines as best practise to be adhered too during operational activities.

Policy or plan	Description	Relevance to the Sandpiper Project
The Protocol on Fisheries for the Southern African Development Community (SADC), 2001	The goal of the strategy is to promote the sustainable use of living aquatic resources and ecosystems. Namibian has endorsed this protocol, which is based on 31 Articles. The specific policy objectives are to promote effective management of fish stocks, protect and preserve fish resources, promote aquaculture and mariculture development and promote trade in fish.	Compliance with the provisions of the Environmental Management Act 2007 by the proponent ensures alignment with this policy. The planned Sandpiper Project conforms to the Policy, which has been considered through the ESIA process and the production of this report ML 170 overlaps partly with certain commercial fisheries where bottom trawling activities have historically taken place in the deeper parts of ML 170. However, the current 20-year target mining area represents less than 2% of the total ML 170 area and is located at the eastern margin of ML 170. The impact assessment process has taken the scale of the proposed operations and the specific potential impacts into account with various specialist studies from 2012 to 2022.
Pollution Control and Waste Management Bill (draft), 1999	This draft Act aims to promote sustainable development by regulating the discharge of pollutants into the air, land and sea. Additionally, to ensure Namibia has an integrated waste management approach and complies with international legislation.	Vessel operations will be undertaken in accordance with the provisions of MARPOL. NMP to take note of the draft bill that requirements are adhered to with regards to containment of pollutants of the dredger activities.
Minerals Policy	The Minerals Policy was adopted in 2002 and sets guiding principles and direction for the development of the Namibian mining sector, while communicating the values of the Namibian people.	The planned Sandpiper Project conforms to the Policy, which has been considered through the ESIA process and the production of this report.

Policy or plan	Description	Relevance to the Sandpiper Project
	The policy strives to create an enabling environment for local and foreign investments in the mining sector and seeks to maximise the benefits for the Namibian people from the mining sector, while encouraging local participation. The objectives of the Minerals Policy are in line with the objectives of the Fifth National Development Plan that include reduction of poverty, employment creation, and economic empowerment in Namibia.	The Proponent intends to continue to support local spending and procurement. The Sandpiper Project will comply with the general guidelines of the Policy through the adoption of various legal mechanisms to manage all aspects of the environment effectively and sustainably from the start. The ESIA is one such mechanism to ensure environmental integrity throughout the planned Sandpiper Project's lifecycle.
The Green Paper for the Coastal Policy of Namibia	The Green Paper provides an outline of the key findings of a long-term study on the conservation and management of the Namibian coast. It sets out the coastal policy and the vision for the coast, as well as principals, goals and objectives for coastal governance. It also presents the options for institutional and legal arrangements towards implementing the emerging Namibia Coastal Policy options for coastal governance in Namibia.	The principles of Integrated Coastal Zone Management will be used as guidance in the ESIA and have been considered and included where applicable in the EMP.
National Marine Pollution Contingency Plan	A coordinated and integrated system for preparing and responding to ship-sourced pollution incidents, setting out and defining Namibia's oil and hazardous and noxious substances (HNS or chemicals) pollution preparedness and response system	The measures set out in the Contingency Plan to prevent marine pollution incidents have been considered and included where applicable in the EMP.
Draft Sustainable Blue Economy Policy	Namibia's Sustainable Blue Economic Policy is based on the three interconnected pillars of sustainable ecosystem	The proponent is committed to supporting the principles and pillars of the Blue Economy Policy

Policy or plan	Description	Relevance to the Sandpiper Project
	management: environmental protection, economic sustainability and social equity. The policy attempts to indicate and reflect the need to update approach towards marine and aquatic ecosystem management. This policy is currently in a draft phase and has not yet been gazetted.	which have been considered and will be included where applicable in the EMP once the Blue Economy Policy document has been finalised and gazetted.
Marine Spatial Planning (and Draft Central Marine Spatial Plan)	Marine Spatial Planning (MSP) is being implemented under provisions of NDP5 and Blue Economy Policy. It is a participative decision-making process and management system that guides and prioritises where and when human activities occur in marine spaces, providing for comprehensive, integrated, and complimentary planning and management across all sectors and for all ocean uses in order to enable sustainable ocean development and to resolve potential conflicts in the marine space. This strategy guides the work of the Namibian Marine Spatial Planning (MSP) Working Group in establishing and implementing MSP in Namibia and developing the first marine spatial plan. This document is currently in a draft phase and has not been gazetted.	The Proponent is committed to promoting sustainable ocean development and applying the MSP objectives as set out in the implementation and Draft Central Marine Spatial Plan of this initiative which forms part of the Blue Economy Policy. Relevant aspects have been considered and will be included where applicable in the EMP once the Central Marine Spatial Plan has been finalised and gazetted.

Table 5 - Specific permits and licence requirements for the Sandpiper Project

Permit or licence	Act or Regulation	Related activities requiring a permit	Relevant Authority
Environmental clearance certificate	Environmental Management Act, No 7 of 2007	Required for all listed activities shown in Table 2. Requires issuance of Environmental Clearance Certificate by the Environmental Commissioner.	Ministry of Environment, Forestry and Tourism (MEFT)
Mining Licence	Section 90 (2) (A) of the Minerals Act, No.33 of 1992	Mining Licence ML170 was granted on 13 July 2011 by the Ministry of Mines and Energy, Namibia. Mining operations may not commence without a valid environmental clearance certificate.	Ministry of Mines and Energy (MME)

3.3 INTERNATIONAL CONVENTIONS

Table 6 - International policies and plans applicable to the Sandpiper Project

Policy or plan	Description	Relevance to the Sandpiper Project
Convention for the Prevention of Pollution from Ships (MARPOL) – 73/78	MARPOL is one of the most important international conventions that is endorsed to prevent or minimize pollution at sea. Its main objective is to 'to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances.' Discharges relate to sewage, non-mineralised waste, oil, hazardous substances and atmospheric emissions.	As of July 2019, Namibia was at an advanced stage of ratifying and becoming a party to MARPOL, Annex VI – air pollution. Cabinet in principle approved that Namibia accedes to the MARPOL convention to ensure its compliance as a member of the international community to protect the tenets of protecting the marine ecosystem as provided for under the constitution (2019 Statement by Information Minister Hon Stanley Simataa). Namibia is now a confirmed signatory and the guidelines to the prevention of pollution from ships are relevant to the Proponent and will be applied by the appointed international dredging contractor.
United Nations Law of the Sea Convention (UNCLOS), 1982	The UNCLOS provides an international legal framework to govern the seas and oceans of the world. Namibia as the designated State is required to administer exploitation, protection and preservation of the marine environment and natural resources on the Namibian Continental Shelf and Exclusive Economic Zone by enforcing the State's specific regulatory requirements for preventing pollution and damage to marine resources.	The Proponent adheres to the required Namibian legislation to comply with UNCLOS requirements.

Policy or plan	Description	Relevance to the Sandpiper Project
Convention on the Control of Transboundary Movements of hazardous Wastes and their Disposal, 1994 (Basel Convention)	This convention controls the cross-border movement of hazardous wastes but does not address radioactive contaminated waste. Within Namibia, the Ministry of Environment, Forestry and Tourism is legally responsible to handle these applications and issue permits.	It is not envisaged that any hazardous waste will be produced by the dredging operations or will be required to be disposed of or moved across the Namibian border.
Convention of Biological Diversity Rio de Janeiro, 1992	Namibia is a signatory on this convention and is obliged under international law to adopt the objectives and obligations of this convention through her national legislation with regards to biodiversity to maintain ecosystems, ecological processes and biodiversity for the benefit of present and future generations (Article 95(I)). Currently Namibia's second national biodiversity strategy and action plan (2013-2022) has been developed to address short comings with specific goals and targets, including reference to the mining sector.	The Proponent adheres to the required Namibian legislation to comply with CBD requirements.
United Nations Framework Convention on Climate Change (UNFCCC), 1992	This objective of the convention is to reduce and stabilize greenhouse gases at an atmosphere level to reduce impacts on climate systems, to allow ecosystems time to adapt to these changes, reduce food shortages and that economies can develop in sustainable manners.	The Proponent adheres to the required Namibian legislation to comply with the requirements to reduce greenhouse gases during operational activities.

Policy or plan	Description	Relevance to the Sandpiper Project
The Stockholm Declaration on the Human Environment, Stockholm 1972	Namibia has adopted the declaration in 1996 with the following Principle 21 and 22 most relevant to the proposed Sandpiper Project. Namibia has the right to explore her own resources but to ensure that there is effective policies and controls in place to regulate these activities as to not cause detrimental harm to the environment. Whereby environmental damage has occurred in areas of her jurisdiction, compensation must be provided for victims of pollution or environmental degradation.	The Proponent adheres to the required Namibian legislation to comply with these requirements.

4 PROJECT DESCRIPTION

4.1 NEED FOR THE PROJECT

Phosphate deposits contain phosphorus which is a vital element for growth in plants, animals and humans. There is no artificial substitute for phosphorous for this purpose. It is therefore an essential element used in the production of fertiliser and animal feed to promote and sustain health and growth. More recently, phosphorus has proven to have significant technical and environmental benefits if used as an alternative to metals such as cobalt to produce lithium iron phosphate batteries in the green energy and electric vehicle sectors.

With one of the world's largest undeveloped phosphate resources, establishing a phosphate based industry could position Namibia to meet the future global demand for phosphate to establish a phosphate based industry that can help to support production of agricultural products (fertilizers and animal feed), as well as the requirements for the development of green energy and electric vehicle battery markets as shown in Figure 5. The Proponent would be one company operating as a provider of primary products within this new phosphate based industry in which an independent economic study has shown to have the potential to contribute up to 9% to Namibia's GDP and create over 50,000 direct and indirect induced jobs.

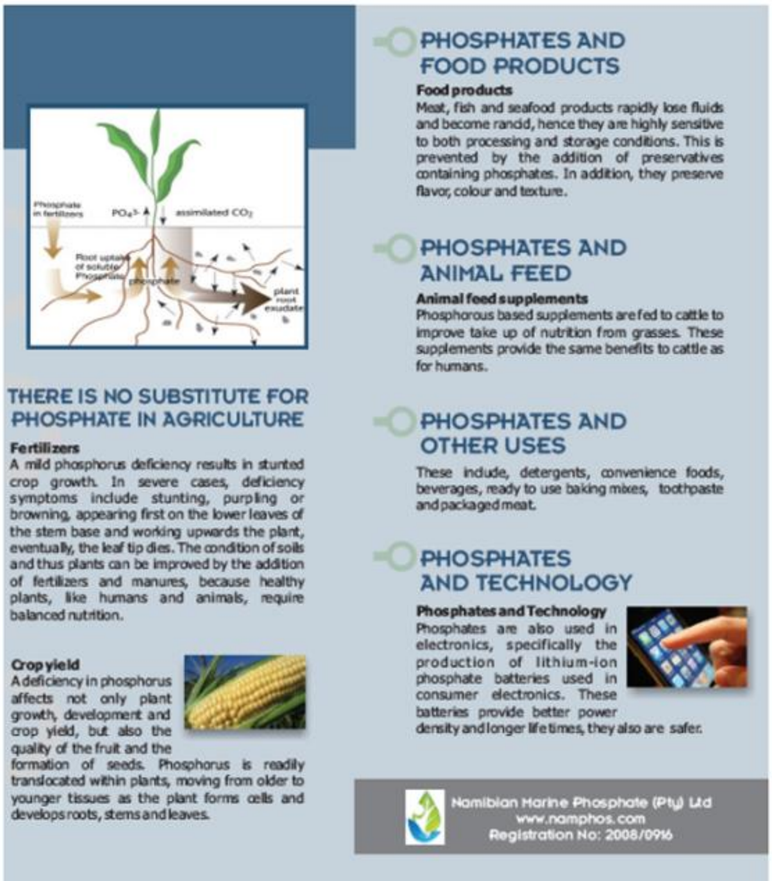


Figure 5 - Uses of phosphate in agriculture (NMP brochure) (Source: www.namphos.com)

Figure 6 – Phosphate industry development phases for the manufacturing of various phosphate products.

When farming for crops, fertilizer is applied to improve the crop yield per hectare, which is now a well-accepted practice with sound scientific support; and phosphate is also critical for plant and animal growth. Despite having one of the largest known phosphate resources in the world, Namibia still imports the majority of the fertilizer products needed to underpin its agricultural industry. Most of which comes from South African manufacturers. For example, a N$19.8 million contract to supply and import fertilizer was awarded to South African company Kynoch by the AgriBusDev Agency in Namibia (Article, Mar 30, 2020, Observer National). Additionally, due to the high import costs of fertilizer products, the per capita fertilizer consumption in Namibia is low as compared to other countries that have developed phosphate mineral resources such as South Africa, Egypt and Morocco as shown in Figure 7. Typically, the large proportion of subsistence farmers in Namibia cannot afford commercial fertilizers.

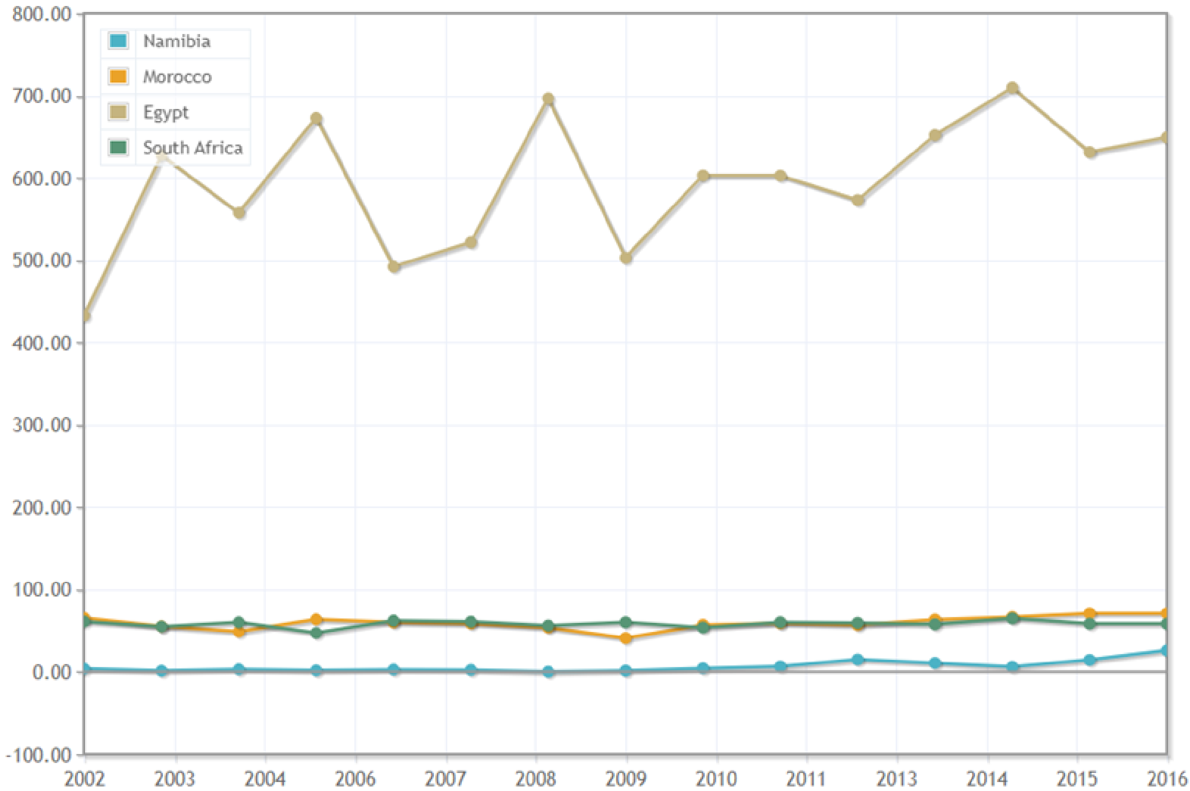


Figure 7 - Fertilizer consumption 2002 – 2016 (kg/ha of arable land) (Source: World Bank, World Development Indicators, January 2020)

The Proponent intends to pursue mining activities with the aim of producing a beneficiated phosphate concentrate product from these new mining prospects. This new mining project will enable production of phosphate concentrate in Namibia that can be used both as a direct application phosphate and as the primary product for producing fertilisers and animal feed. The definitive feasibility study (Bateman Advanced Technologies Ltd., 2013) for the Sandpiper Project completed by the Proponent, as well as an independent economic study on the potential development of a phosphate based industry in Namibia shows that development of this new mine could have a positive impact on the country's local and national economy in the areas of job creation, industrialisation and revenue generation. The 2013 definitive feasibility study concluded that the Sandpiper Project was technically, economically and environmentally feasible.

Establishing a fertilizer industry would enable an increase of in-country agricultural productivity and allow Namibia to become an exporter of phosphate and fertilizer, helping the world achieve food security. In fact, the Sandpiper Project's phosphate concentrate has been assessed by institutions internationally as being commercially viable and cost-effective for use as:

- A direct application fertilizer
- Single super phosphate
- A blend to more expensive forms of fertilizer
- A component of Lithium Ferro Phosphate batteries.

4.1.1 PHOSPHATE FOR THE ELECTRIC VEHICLE MARKET

The shift from coal and gas power to wind and solar power, in combination with the shift from combustion vehicles to electric vehicles, is driving the new demand for minerals, particularly copper, nickel and cobalt. Phosphate is a key component in lithium ferro phosphate (LFP) batteries, which are required for electric vehicles. The use of phosphates is also expected to lessen the use of cobalt and, therefore, reduce both the cost and environmental concerns of LFP batteries. According to estimates, electric vehicles are expected to make up over half of all passenger vehicle sales by 2040 with many governments committing to support the production of electric vehicles in a bid to decrease their dependency on oil and gas. The largest minerals importer, China, has, for example, set a goal by 2025 whereby electronic vehicles are to make up 20% of new car sales.

NMP is in the process of studying the LFP battery market to understand if, along with other applications NMP has already identified for the Namphos Concentrate (e.g., direct application, single super phosphate and blend for phosphoric acid production), there is a position for the Namphos Concentrate in the LFP battery market.

4.1.2 NAMIBIA ECONOMY AND NEED FOR NEW MINING INDUSTRY DEVELOPMENT

Namibia's economy is heavily dependent on the extraction and processing of minerals and products for export. Mining accounts for about 12.5% of the country's GDP but provides more than 50% of foreign exchange earnings.

Marine phosphate mining and processing will not only create new mining operations, such as NMP's Sandpiper Project but can also provide Namibia with the phosphate concentrate required to develop a fully integrated fertilizer industry that has the potential to contribute significant social and economic benefits for Namibia while addressing key issues such as job creation and poverty eradication. Additionally, the Project will contribute to an increase in shipment consignments from the Port of Walvis Bay.

Development of new primary and secondary industries in the mining sector is now, more than ever, a vital consideration in the drive to support sustained growth of the Namibian economy and its national socio-economic upliftment goals. Such as those outlined in the Harambee Prosperity Plan and the National Development Plan 5 (NDP 5).

An independent analysis of the economic benefits that could accrue to Namibia from opening the country to an incipient phosphate based industry was completed by Stratecon (2018) and circulated within Government, noted that:

- Countries that have abundant phosphate rock reserves (E.g., USA, Morocco, Egypt, Jordan) have benefited with employment in the tens of thousands and had significant contributions to GDP from phosphate mining and beneficiation

- Namibia could benefit from its phosphate resource, just as it has benefited other countries with similar resources
- Setup of the industry would occur over time in discrete steps comprising:
  - Dredging and basic beneficiation to produce phosphate concentrate
  - Establishment of phosphate processing and product manufacturing factories to produce primary fertiliser products such as phosphoric acid, single super phosphate, dicalcium phosphate, triple super phosphate
  - Marketing and sale of fertiliser products
  - Possibility for future production of advanced levels of beneficiation and products contingent on related developments in the Namibian economy.

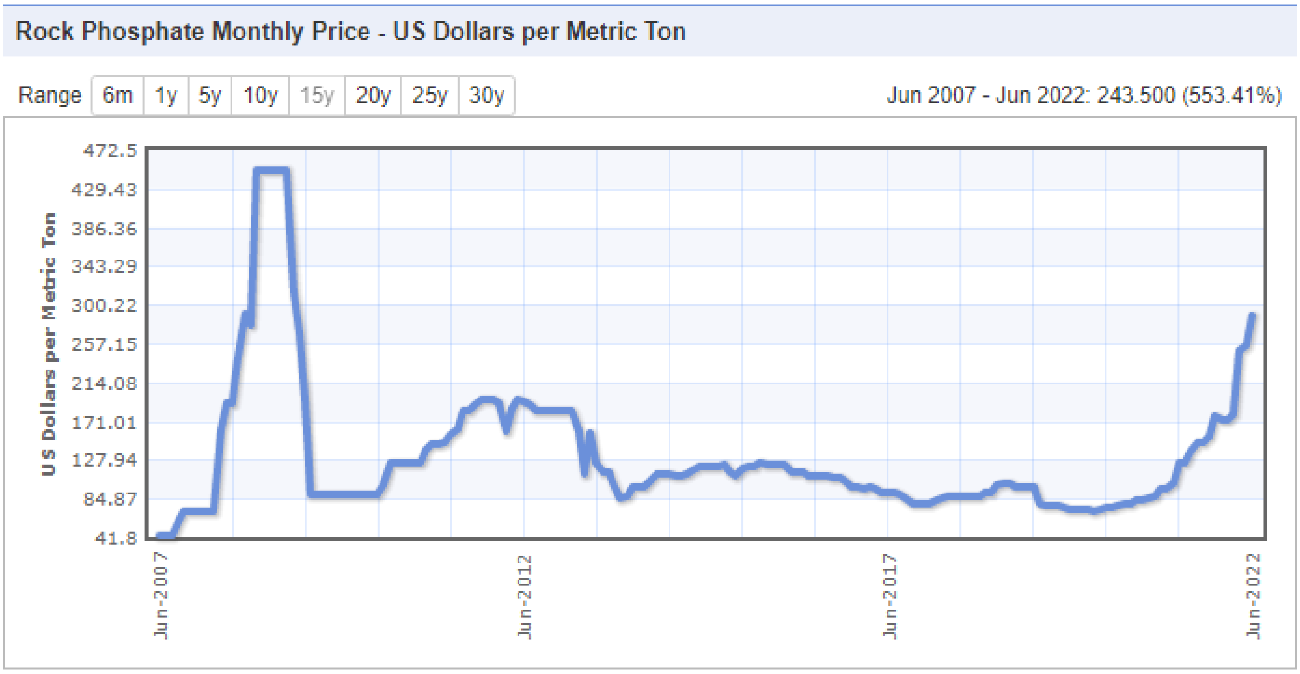
4.2 Background of the Sandpiper Project

4.2.1 PHOSPHATE IN NAMIBIA – PROJECT BACKGROUND AND ECONOMIC VIABILITY

Phosphates in the marine environment were first discovered and regionally mapped on the Namibian shelf in the late 1960s and 1970's, with subsequent exploratory work undertaken by the South African mining company Gencor Ltd and others in the 1990s and 2000's. The phosphate deposit off Walvis Bay was termed "Sandpiper Deposit" by Gencor, and that name has been retained. Phosphate deposits (of various type and grade) are known to be widely distributed on the Namibian continental shelf.

In the 1990s the Sandpiper Deposit was considered sub-economic based on price levels for rock phosphate concentrate (1991: US$ 42.50 tonne). From 2007 the value of phosphate rock concentrate (32%P_2O_5 70% BPL contract f.a.s. Casablanca) increased rapidly from US$ 80.00 per tonne, peaking at US$ 430.00 per tonne in August –September 2008, resulting in a re-rating of the economic viability of the Sandpiper deposit in Namibia and others worldwide. The 2008 pricing peak has since retracted to more consistent and sustainable price levels, despite cyclic fluctuations.

The current rock phosphate price has risen from US$172/t in February 2022 to US$ 287.5/t in June 2022 as a result of recent global events and is now at its highest level since 2009 and well above the 10 -year high in 2012 of US$197/t (Phosphate rock ((Morocco)), 70% BPL, contract, f.a.s. ((Casablanca)), as shown in Figure 8. The price has increased by 73% since March 2020, when the Covid-19 Pandemic became a world reality.



Description: Phosphate rock (Morocco), 70% BPL, contract, f.a.s. Casablanca

Unit: US Dollars per Metric Ton

Figure 8 - Morocco Phosphate Rock Price as of June 2022 (Rock Phosphate Monthly Price - US Dollar per Mectric Ton, 2022)

4.2.2 SANDPIPER PROJECT AND EXPLORATION HISTORY

Commencing in 2006, comprehensive exploration and resource or reserve development programs were completed in selected target areas and comprising geological, geophysical and analytical surveys and studies which resulted in the delineation and classification of ore reserves and resources suitable to support long term mining operations. The exploration program confirmed the Sandpiper Project has:

- Ore reserves (proven and probable) of 132.76 Mt at 20.41% P_2O_5
- Indicated mineral resource inventory of 80Mt at 19.8% P2O5
- Inferred mineral resource of 1.61 billion tons at 18.9% P2O5
- Estimated at a 15% cut off grade.

As such, the Sandpiper Project represents a potentially world class phosphate deposit with an initial mineral reserve and resource base of adequate size and average grade required to support the development of a long-term viable mining operation.

On 13th July 2011 a 20-year mining licence, ML 170, was granted over the whole of EPL 3414 and portions of EPL's 3415 and 3323. ML 170 covers an area of 2,233 km^2. The ML170 is located approximately 120km SW of Walvis Bay, in the vicinity of Meob and Conception Bay, Namibia along with the other exploration licenses held by NMP as shown in Figure 9.

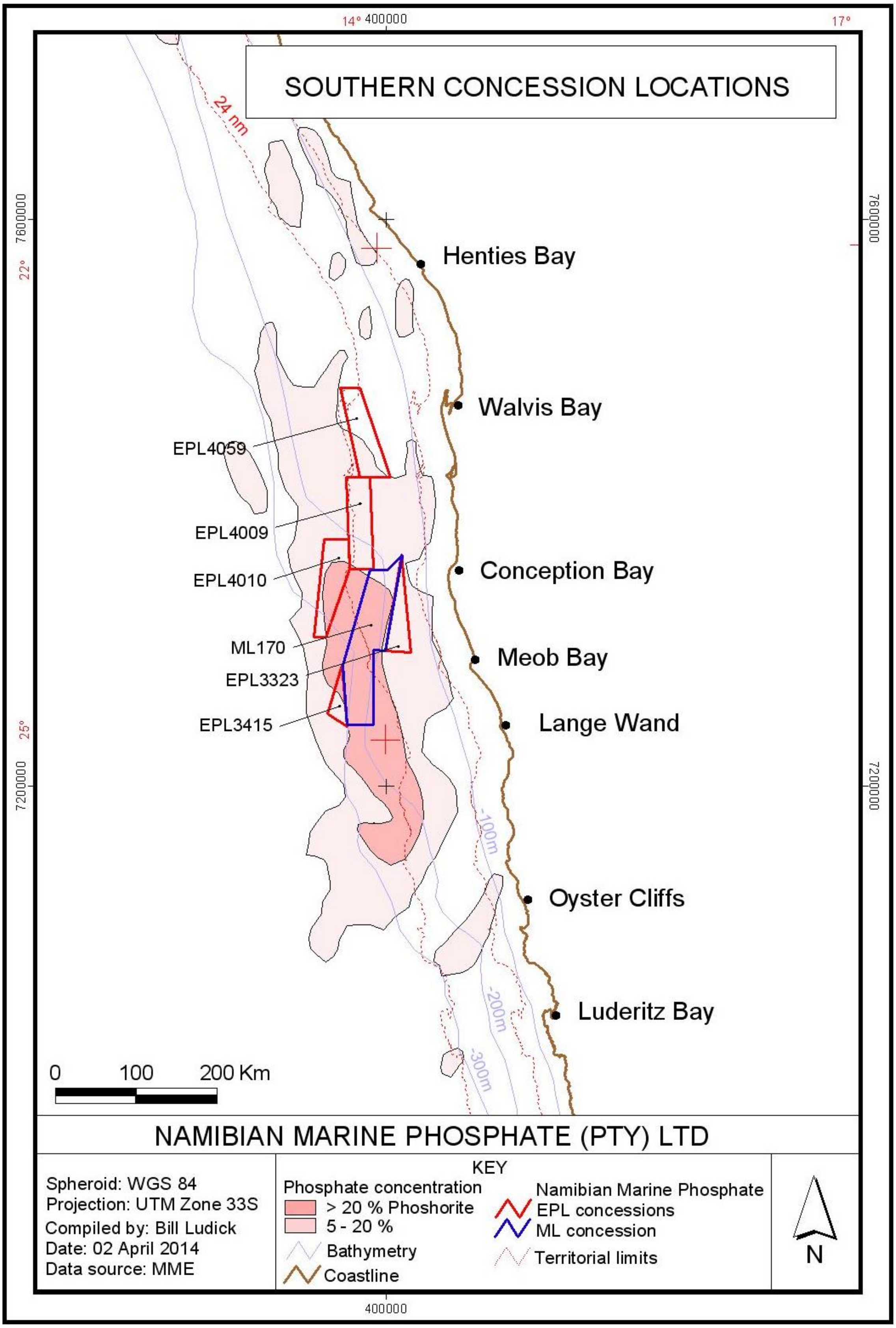


Figure 9 – Shows exploration and mining mineral tenements held by NMP on award of ML 170

A definitive feasibility study (DFS), completed by NMP for the Sandpiper Project in 2012 and updated in 2013 (Bateman Advanced Technologies Ltd., 2013), concluded that the Sandpiper Project is technically, economically and environmentally feasible. Based on a commercially viable cut-off grade of 15% P_2O_5, the DFS indicated there is sufficient phosphate resource within ML 170 to sustain mining operations and benefits for future Namibian generations for more than 100 years.

Environmental studies and stakeholder consultations have also been undertaken at various intervals commencing in 2010, including studies and stakeholder engagements completed in 2011, 2012, 2013, 2014, 2016, 2018 and 2020, respectively.

4.3 GEOLOGY AND MINERALISATION

The phosphate deposits are characterized by their spatial continuity (especially in an SSW - NNE direction) and general uniformity in grade. The variations in thickness are generally the product of thicker accumulation of sediment in very shallow palaeo-topographic depressions in the underlying clay surface.

The age and origin of the phosphorite deposits of ML 170 has been determined by analysis of sediment cores combined with strontium-36 isotope dating. These deposits formed over millions of years, initially by marine algae growing in the highly productive surface waters, dying and sinking to the seafloor where the organic phosphorus contained in the algal cells was incorporated into the mineral carbonate fluorapatite or francolite. Phosphorite grains were concentrated through repeated erosion of the sediment through wave and current activity during sea level lows. The repeated formation and reworking of these deposits have led to a highly enriched phosphorite deposit occurring in areas of the uppermost 2m of the present-day seabed on the Namibian continental shelf and particularly in ML 170. The basal phosphorite muddy sand varies from 0.5 m to 1.5m in thickness.

The phosphorite grains formed predominantly during the early Pleistocene (2.6 to 1 Ma) and the deposit formed during the early to middle Pleistocene (2.6 to 0.126 Ma). This is overlain by increasingly shelly phosphorite sand of variably 0.5 m to 1.5 m thickness, containing 65 to 86 wt.% sand and 4-5 wt.% mud.

The phosphorite is diluted by shell fragments, particular the upper layer. The upper sediment profile displays multiple erosional surfaces formed during sea-level low stands that occurred during the various glacial maxima since 1 Ma. These findings are new to science and provide a robust understanding of the origins and age of the Sandpiper phosphate deposit.

4.3.1 STRATIGRAPHY

The stratigraphy throughout the Sandpiper Project area has been ascertained from gravity cores (with a restricted maximum penetration potential of up to ~ 3m) and older (Gencor) vibrocores (with a penetration of up to 6m). The phosphatic horizon, which overlies a grey-green footwall clay of Miocene age, is subdivided into two distinct layers; an upper (layer 1) 0.1 m to 1.0 m thick Miocene shelly phosphorite demonstrating a downward fining sequence and a lower (layer 2) 0.05 m to > 2.0 m Miocene thick clayey phosphorite.

Phosphorite Horizon:

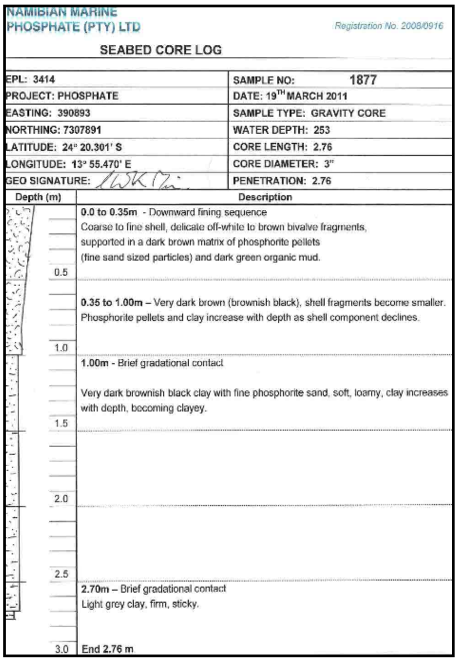
Layer 1: An upper 0.1 m to 1.0 m thick shelly phosphorite identified as Miocene in age and demonstrating a downward fining sequence. This consists of a coarse broken shell bed that contains delicate off-white to brown bivalves and occasional turritella shells supported in a very dark brown (blackish) matrix of phosphorite pellets (fine sand sized particles) and dark green organic mud. Shell fragments become smaller and the phosphorite pellet component and clay increase with depth until the horizon becomes mostly a fine phosphorite sand with a small clay content. This horizon passes gradationally into layer 2.

Layer 2: A lower 0.05 m to > 2.0 m thick clayey phosphorite identified as Miocene in age. This consists of a very dark brown (blackish), soft, sticky, clayey, fine phosphorite sand, which usually becomes more clayey with depth (there are exceptions where the clay content can decrease with depth). The phosphorite content is usually highest in this part of the sequence although in some areas clay predominates. Commonly brown porous bone fragments (often vertebrae) appear towards, or at the base of the horizon.

Clay Horizon (footwall)

The phosphorite horizon has a sharp bioturbated contact with an underlying Miocene marine footwall clay which gravity coring has penetrated to a maximum of 2 m. This contact represents a sedimentary hiatus. This zone is a pale grey to dark olive green-grey, firm, sticky clay with coarse burrows in the top 15 cm filled with sediment from the layer above.

Typical sedimentary sequence of the deposit is shown in Figure 10, with core 1877 showing both layers 1 and 2 of the deposit and core 1939, showing only Layer 1.



NAMIBIAN MARINE PHOSPHATE (PTY) LTD — Registration No. 2008/0916

SEABED CORE LOG

EPL: 3414	SAMPLE NO: 1877
PROJECT: PHOSPHATE	DATE: 19TH MARCH 2011
EASTING: 390893	SAMPLE TYPE: GRAVITY CORE
NORTHING: 7307891	WATER DEPTH: 253
LATITUDE: 24° 20.301' S	CORE LENGTH: 2.76
LONGITUDE: 13° 55.470' E	CORE DIAMETER: 3"
GEO SIGNATURE:	PENETRATION: 2.76

Depth (m)	Description
0.5	**0.0 to 0.35m** - Downward fining sequence Coarse to fine shell, delicate off-white to brown bivalve fragments, supported in a dark brown matrix of phosphorite pellets (fine sand sized particles) and dark green organic mud.
1.0	**0.35 to 1.00m** – Very dark brown (brownish black), shell fragments become smaller. Phosphorite pellets and clay increase with depth as shell component declines.
1.5	**1.00m** - Brief gradational contact Very dark brownish black clay with fine phosphorite sand, soft, loamy, clay increases with depth, becoming clayey.
2.0	
2.5	
3.0	**2.70m** – Brief gradational contact Light grey clay, firm, sticky. End 2.76 m

Core log No. 1877	0 to 0.65m	0.45 to 1.14m

0.97 to 1.62m	1.41 to 2.05m	1.89 to 2.56m	2.10 to 2.76m

Figure 10 - Typical sedimentary sequence of the deposits with core 1877 showing both layers 1 and 2 of the deposit

The photograph and core log (sample 1877) collected from 235 m water depth in ML 170, shows layer 1, which is a shell rich phosphate rich mud 0.35 m thick, with approximately 60% phosphate, 20% shell and 20% mud. Layer 1 continues to 1.0 m; it shows decreasing abundance of shell fragments with depth. Layer 2 is typically 80% phosphate and 20% mud (shell is absent in this layer throughout the deposit) is well represented in this core, (1.0 m to 2.70 m). Layer 2 of the deposit sits on a footwall of bioturbated clay. These burrows are typically filled with phosphate rich mud.

4.3.2 NATURE OF THE PHOSPHATE MATERIAL

The phosphatic material within the sediment predominantly comprises unconsolidated fine sand sized phosphorite ooliths and pellets, falling in the 100 to 500 micron grain size range (mostly 150 microns to 250 microns). These pellets are formed of concentric phosphate layers and predominantly comprise calcium carbonate and phosphate (P_2O_5). They can also contain quartz grains, ilmenite and sulphides.

The phosphorite pellets form a matrix with organic rich mud and supports a downward fining and declining bed of coarse to fine shell fragments (bivalves and foraminifera) in the winnowed upper part of the deposit. The lower part of the deposit is shell free and clay rich in the matrix.

Using x-ray diffraction (XRD) and scanning electron microscopy (SEM) techniques it was confirmed that the phosphatic mineral is primarily francolite, a high carbonate apatite. Its formation was likely through chemical precipitation of dissolved phosphorous in a layered pattern to form mini nodules. Pyrite is evident in the layers, suggesting that it precipitated simultaneously with the nodule in an anaerobic environment. The francolite particles rarely occur without pyrite inclusions. Other inclusions of very fine ilmenite, quartz, mica and plagioclase are evident in the nodules.

Grades for individual samples rarely exceed 23% P_2O_5 and the majority lie between 17 and 21% P_2O_5. Average layer grades are typically 19 to 20% P_2O_5 for the lower layer (2) and 18 to 19% for the upper layer (1).

The phosphate-enriched sediments and the defined mineral resources and reserves are located throughout the entire mining licence area. Within the ML 170 area, three initial target dredging areas have been identified namely SP1, SP2 and SP3.

The 20-year mine plan covering 34 km^2 is located in target area SP1 (176 km^2) which lies in water depths of 190 m to 225 m. The other target sites SP2 and SP3 also contain phosphate resources and may be considered at a later stage, at which time the requisite additional environmental evaluations will be made in accordance with the Environmental Management Act, No. 7 of 2007 shown in Figure 11.

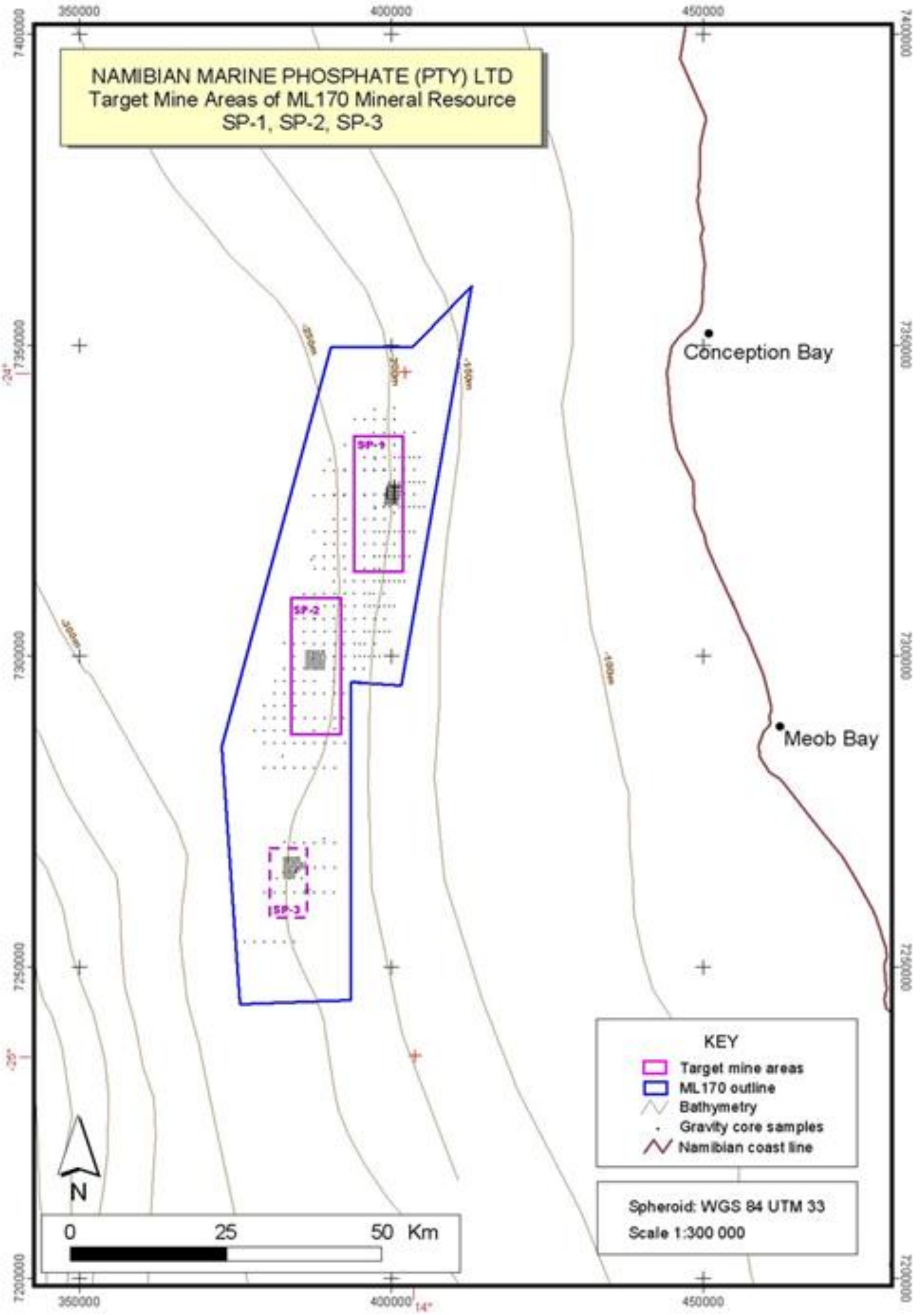


Figure 11 - Distribution of target dredging areas

4.4 SANDPIPER PROJECT LAYOUT

The Sandpiper Project comprises two separate but contingent primary activities which will be dealt with under two separate ESIA processes namely:

- Marine activities – includes all proposed activities to be undertaken in the ML 170 area (located offshore and 120 km SW of Walvis Bay) per the conditions issued by the Ministry of Mines and Energy and incorporating phosphate sediment recovery (dredging) and transport to the coast off Walvis Bay.
- Land/Terrestrial activities (future activity covered in a separate environmental clearance application) – includes the proposed processing activities onshore in Walvis Bay comprising treatment/beneficiation of the material recovered, incorporating slurry transfer pipeline to pump the material onshore from the dredger, ore discharge and screening material, the processing of the phosphate slurry to produce the export product 'rock phosphate concentrate' and the associated infrastructural requirements.

Note: Rock phosphate is an industry term used to refer to land-based phosphate deposits which typically occur in a hard rock form. The term is applied to the Sandpiper Project; however, the Namibian marine phosphate occurs in the seabed sediments as a fine black sand which forms the final concentrate product – referred to as "rock phosphate".

A trailing suction hopper dredger (TSHD) will be used to recover approximately 5.5 million tons of sediment to produce 3 million tons of phosphate concentrate at 27 to 28% P_2O_5 annually over the course of the remaining granted mine licence period.

The overall process for recovery and beneficiation of the marine phosphate will involve several steps shown in Figure 12.

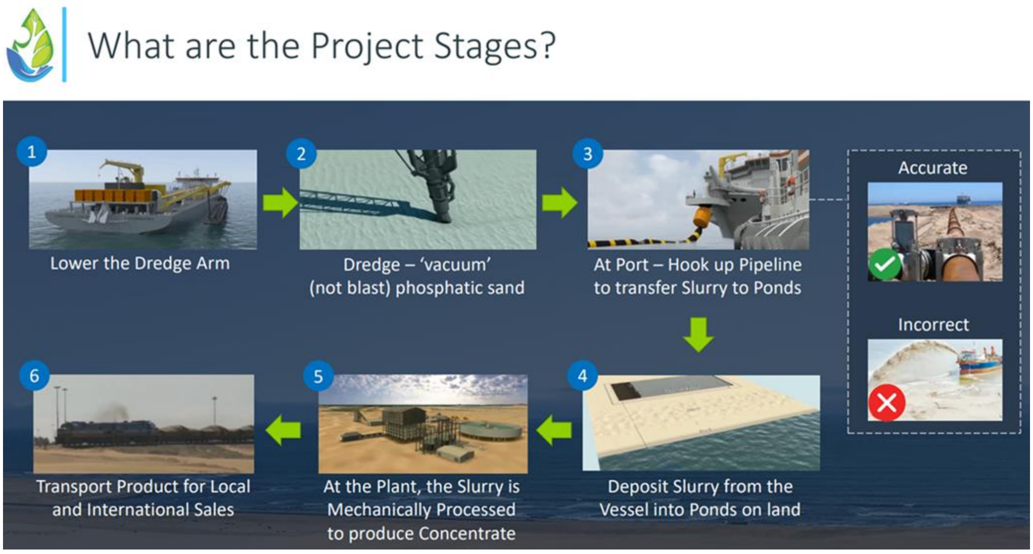


Figure 12 - Overall process for recovery and beneficiation of the marine phosphate

4.4.1 MARINE BASED SANDPIPER PROJECT COMPONENET

4.4.1.1 Dredging and transport

The ore is dredged from the ocean floor in ML 170 and stored in the hopper of the dredger, a special purpose ship designed for conducting dredging operations internationally. A specially designed dredging arm is to be used to reach the seabed at the required depth of 190 m to 225 m.

Seabed dredging is a process that is used globally and has a common set of impacts on the seabed regardless of the purpose for which is it used. Primary examples of seabed dredging operations include:

- Aggregate mining
- Shore and beach replenishment
- Harbour and channel clearing
- Marine diamond mining.

The dredger then travels to Walvis Bay to berth at an appropriate facility to discharge the phosphate ore ashore as cargo.

4.4.2 LAND BASED SANDPIPER PROJECT COMPONENT (WALVIS BAY) OPERATIONAL CYCLE

The Section below describes the shore-based beneficiation process which forms the Land component of the Sandpiper Project that will be carried out after phosphate has been dredged from the seabed floor and delivered to the proposed shore-based facility. This Section is for information purposes only and will not form part of the current impact assessment report.

4.4.2.1 Ore handling

Ore is discharged from the dredger via a fixed slurry pipeline feeding into a storage facility (buffer pond) to be constructed within the North Port Bulk Terminal area (site allocation pending). The excess sea water pumped ashore will be conditioned to prescribed parameters and then returned from the buffer pond back to the sea.

4.4.2.2 Beneficiation

The beneficiation process utilizes sea water for processing and comprises effectively a sieving and sizing operation to separate coarse (shell) and fine (mud) fractions from the sand fraction which contains the phosphate. Ore is reclaimed as slurry from the buffer pond either by dredging or sluicing and the shell grit is screened out before it is pumped via a pipeline to the process plant site (site allocation pending) to be located close to the buffer pond. At the Walvis Bay Process Plant site, the ore slurry is de-slimed and attritioned (or polished) and the waste gangue material is rejected by gravity separation. Slimes and gravity tails are thickened using polymer flocculant and pumped into a tailings dam to be located near the processing plant (site allocation pending). Fundamentally, the entire process is a mechanical process, with no chemicals used other than the bio-degradable flocculant used in the tailings dam.

If a market can be found for the shell grit it will be stockpiled and sold, alternately ground and incorporated in the tailings for storage. Excess sea water from the process is pumped back to the buffer pond site and re-used or discharged back into the sea. Clean water is required to wash the last vestige of salt water from the filtered concentrate. Options for the supply of the fresh water, including reverse osmosis are under investigation by Lithon mining engineers. The spent wash water is sent back to the buffer pond with the excess process water. The process explained above is shown in Figure 13.

Figure 13 - Beneficiation process

4.4.2.3 Phosphate concentrate product handling

After upgrading the resulting concentrate to 27 to 28% P_2O_5 (phosphate), it is filtered, washed, dried and stockpiled for sale in a covered stockpile, as shown in Figure 14. The Phosphate concentrate product is then delivered to the Walvis North Port Bulk Terminal at Walvis Bay for shipping and distribution to the national, regional, and international markets.

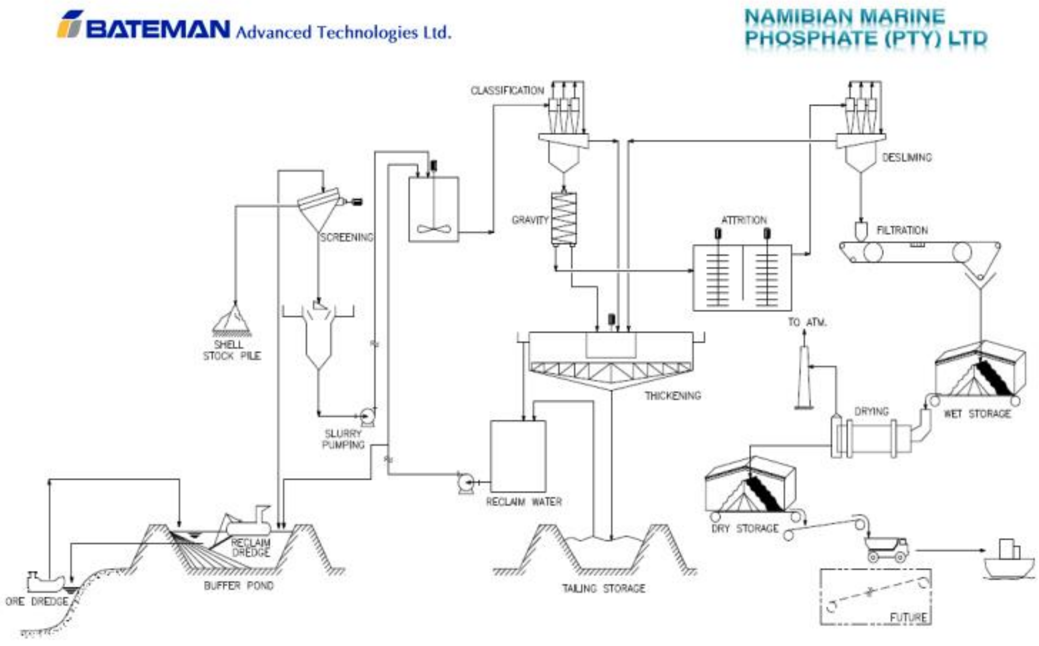


Figure 14 - Simplified concentrate production flow sheet (Source: Bateman Advanced Technologies Ltd.)

4.4.2.4 Product marketing and manufacturing

The citric acid and formic acid solubility of the phosphate concentrate is very high, compared with global results, indicating that the concentrate is suitable for direct application phosphate rock (DAPR). Bench-scale scoping tests to make single super phosphate (SSP) and phosphoric acid were promising. A detailed marketing survey was carried out on the global phosphates market with emphasis on phosphate rock and the specifications, markets and shipping for NMP phosphate concentrate.

4.4.3 SANDPIPER PROJECT LAYOUT OPTIONS FOR SHORE BASED COMPONENT

From 2012 to present date, there have been significant infrastructural and commercial developments at the Port of Walvis Bay that have enabled a significant adjustment to the options for project developmental plans and specifically the location of the proposed land-based operations, including the ore handling and discharge as well as onshore processing and product handling facilities.

These developments as shown in Figure 15 include:

1. Expansion of the Walvis Bay Port facilities including the new North Port, SADC Gateway Development for bulk cargo handling and the Oil Terminal, including a new allocation and transfer of land to Namport
2. Zoning and development of a new heavy industrial zone near the Walvis Bay airport by the Municipality of Walvis Bay
3. Walvis Bay Industrial Development Initiative.

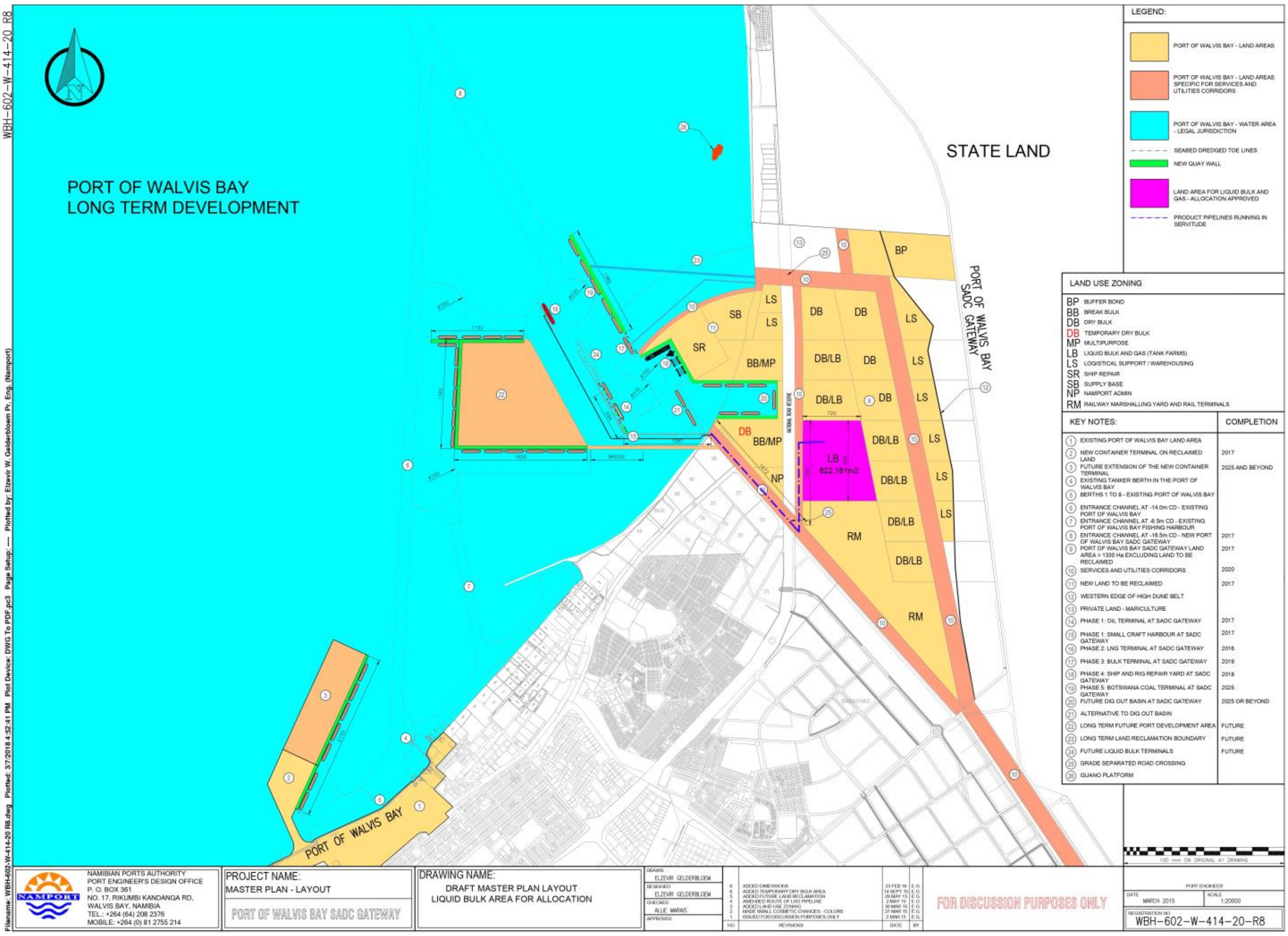


Figure 15 – Developments in Walvis Bay and related implications for Sandpiper land-based component

Port access for the dredger to enter the Port of Walvis Bay, SADC gateway bulk terminal to offload the dredged material, utilizing the newly dredged access channel is now a viable option.

Therefore, the Sandpiper Project development and layout plan for the land-based component of the Sandpiper Project can now be re-considered and substantially revised with opportunity for significant improvement over the original plan proposed in 2012.

Once the permitting for the marine component of the Sandpiper Project has been approved, site selection and land allocation application can be completed in consultation with the relevant authorities including Namport and Municipality of Walvis Bay and the Ministry of Works and Transport.

The ESIA and ECC application for the land component of the Sandpiper Project will be based on the revised Sandpiper Project development layout plan once land allocations have been approved as shown in Figure 16.

Figure 16 - ESIA and ECC application process needed for land component of a project to begin

Permitting for both the marine and land components of the Sandpiper Project is required in order to secure the funding required to commence with the 24-month plant and site construction phase of the Sandpiper Project development. Operations can then commence with employment and full-scale production.

4.5 INVESTMENT, REVENUES AND EMPLOYMENT

4.5.1 INVESTMENT AND REVENUE

Capital Expenditure (CAPEX) associated costs:

- The revised Sandpiper Project CAPEX (capital cost) is estimated at US$323.1M. A front-end engineering design (FEED) was carried out as part of the 2012/13 definitive feasibility study. The purpose of the FEED was to provide sufficient engineering detail to permit a realistic estimate of the required investment to be prepared.
- This involved extension of the budget pricing for the equipment and for the construction work activities, preparation of packages for construction work execution and requesting offers for the construction works based on the prepared bills of quantity (BOQ's) in all the engineering disciplines.

At a project level, if it were to be implemented, NMP's Sandpiper Project will:

- Employ over 600 Namibians (directly and indirectly) for construction and operations in Walvis Bay
- Create opportunities for SMEs and other economic sectors
- Spend an estimated N$ 1 billion on civil and local infrastructure
- Require a capital investment of N$ 5.2 billion for the development
- Expect an annual revenue of N$ 4.2 billion
- Contribute direct taxes of N$ 650 million/year
- Contribute royalties of N$ 78 million/year.

4.5.2 EMPLOYMENT

The development of the Sandpiper Project will bring much-needed investment and job opportunities to Namibia and more particularly the Erongo Region, supporting both Vision 2030 and Harambee policies as outlined in Section 3.2.

Sandpiper Project development and operations will employ over 600 Namibians (directly and indirectly) for construction and operations in Walvis Bay.

Additionally, the appointed dredging contractor, Jan De Nul, will establish an operations support base in Walvis Bay which will create further direct, indirect and induces employment opportunities in Walvis Bay area and regionally.

According to the Chamber of Mines Namibia's 2019 analysis, for every 1 new job created in the mining industry, 7 additional new jobs are created indirectly in the economy, forecasting that 600 direct and indirect jobs of the Sandpiper Project will create a further 4,200 jobs in the broader economy.

The production of phosphate concentrate product in Namibia at a project scale, creates the opportunity for further capital investments to enable further beneficiation and industrial development opportunities, at a much larger scale

An industry-based socio-economic study (Stratecon, 2018) around establishing a phosphate industry, circulated within Government, independently demonstrates that the potential economic benefits of establishing a phosphate-based industry alongside the existing marine diamond mining and fishing industries, if developed back in 2012, could by 2016 have:

- Created total jobs of 51,593 (direct, indirect and induced)
- Contributed N$14.7 Bn to the Gross Domestic Product
- Contributed N$11.3 Bn to Gross National Income
- Contributed N$18.7 Bn in Export Revenue.

4.6 TARGET MINING AREA AND MINE PLAN

4.6.1 OREBODY AND TARGET MINING AREA SP-1 WITHIN ML 170

The primary target dredge site for the 20-year licence period is SP1 (176 km^2) which lies in water depths of 200 m to 225 m.

The initial target mining area is defined based on the initial maximum water depth for the JDN dredging contract proposal, which is initially restricted to operations in water depth of up to 225 m. JDN consider access to 250 m water depth as easily achievable with some additional engineering. The grade in the initial target mining area is expected to range between 17% and 22% P2O5, refer to Figure 17.

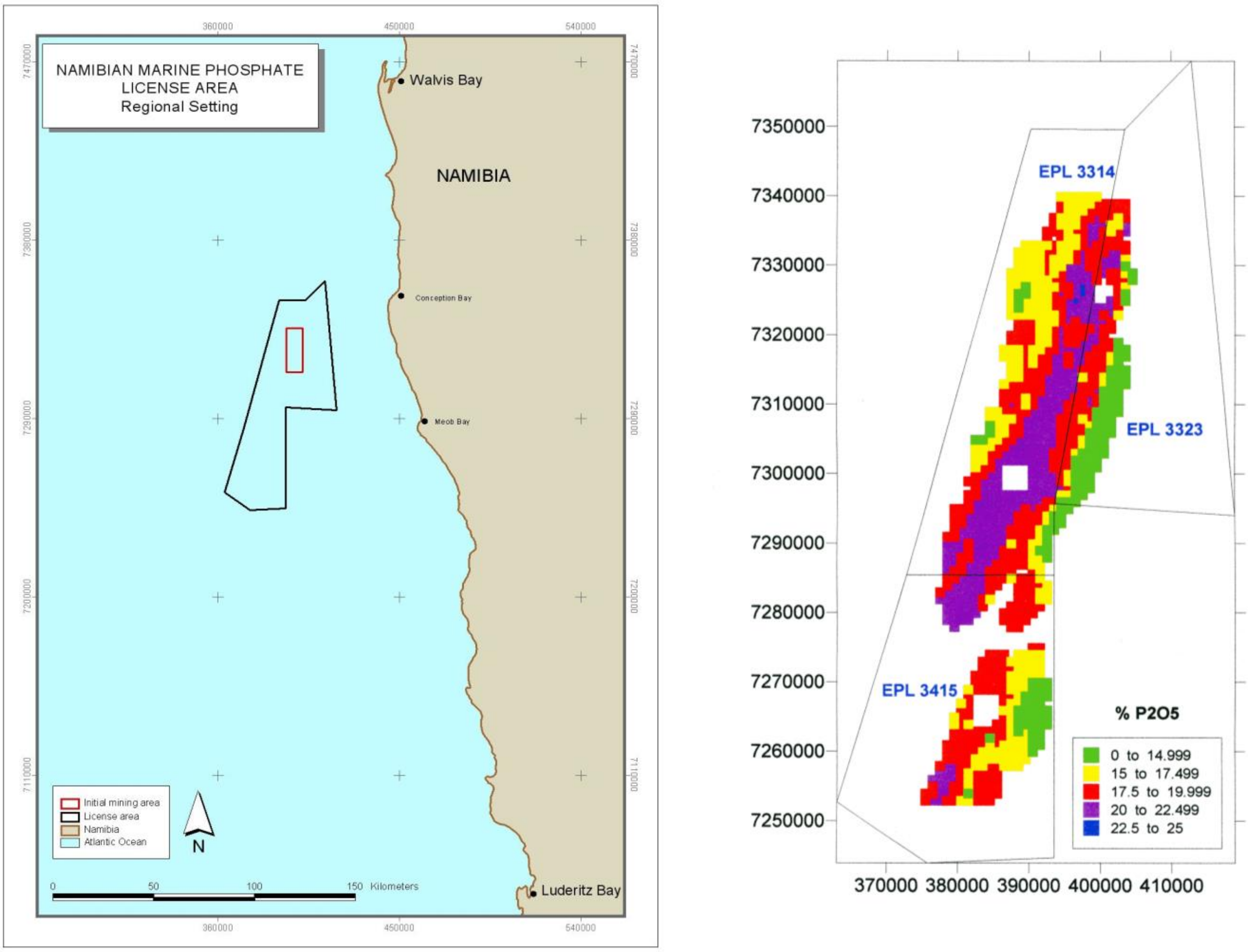


Figure 17 - Resource area and initial mining area

Details of the SP1 target mining area are provided in Table 7 below as follows:

Table 7 - Details of the SP1 target mining area

Detail	Sandpiper - SP1 Target Area
Boundary coordinates (Lat - Long) of the target mining areas	A: 24° 05' 24.500'' S 13° 57' 25.716'' E
	B: 24° 05' 26.359'' S 14° 02' 09.025'' E
	C: 24° 17' 21.597'' S 14° 02' 03.644'' E
	D: 24° 17' 19.720'' S 13° 57' 19.895'' E
Approx. width - km	8
Approx. length - km	22
Area (km2)	176
Thickness Avg - m	1.69
Thickness Max - m1	2.5
Thickness Min (m)	0.50
Water depth range - m	190 - 235
Deposit > 3 m2	Non

4.6.2 20-YEAR MINE PLAN

The scale of the 20-year dredge mine plan area is primarily controlled by the annual export/sales requirement of 3 million tonnes of 'rock phosphate'.

The Sandpiper Project 20-year mine plan covers a total area of 34 km^2 and is located withing the SP1 target mining area. It is planned to ramp up the production of concentrate from 1 million tonnes per year in Year 1, and 2 million and 3 million tonnes per year in years 2 and 3 respectively.

In each year of the 20-year mine plan, the actual area that needs to be dredged to meet the commercial production target of 3 million tonnes of rock phosphate at 27 to 28% P_2O_5 concentrate depends on the thickness of the deposit, the grade and the mining/dredging rate.

[1] Not all cores terminated on footwall, these figures may change with further exploration.

[2] Depths in excess of 3 m are to be further evaluated with vibracoring sampling equipment.

For the initial 20-year mine plan the operating parameters for the annual dredging operations are as follows:

- Average sediment thickness to be dredged is 2.3 m
- Average area to be dredged is 1.7 km^2/year
- Average operating water depth is 215 m (ranging from 201 m to 224 m over the 20-year period).

The detailed 20-year mine plan for the in SP1 target mining area in ML 170 is shown in Figure 18.

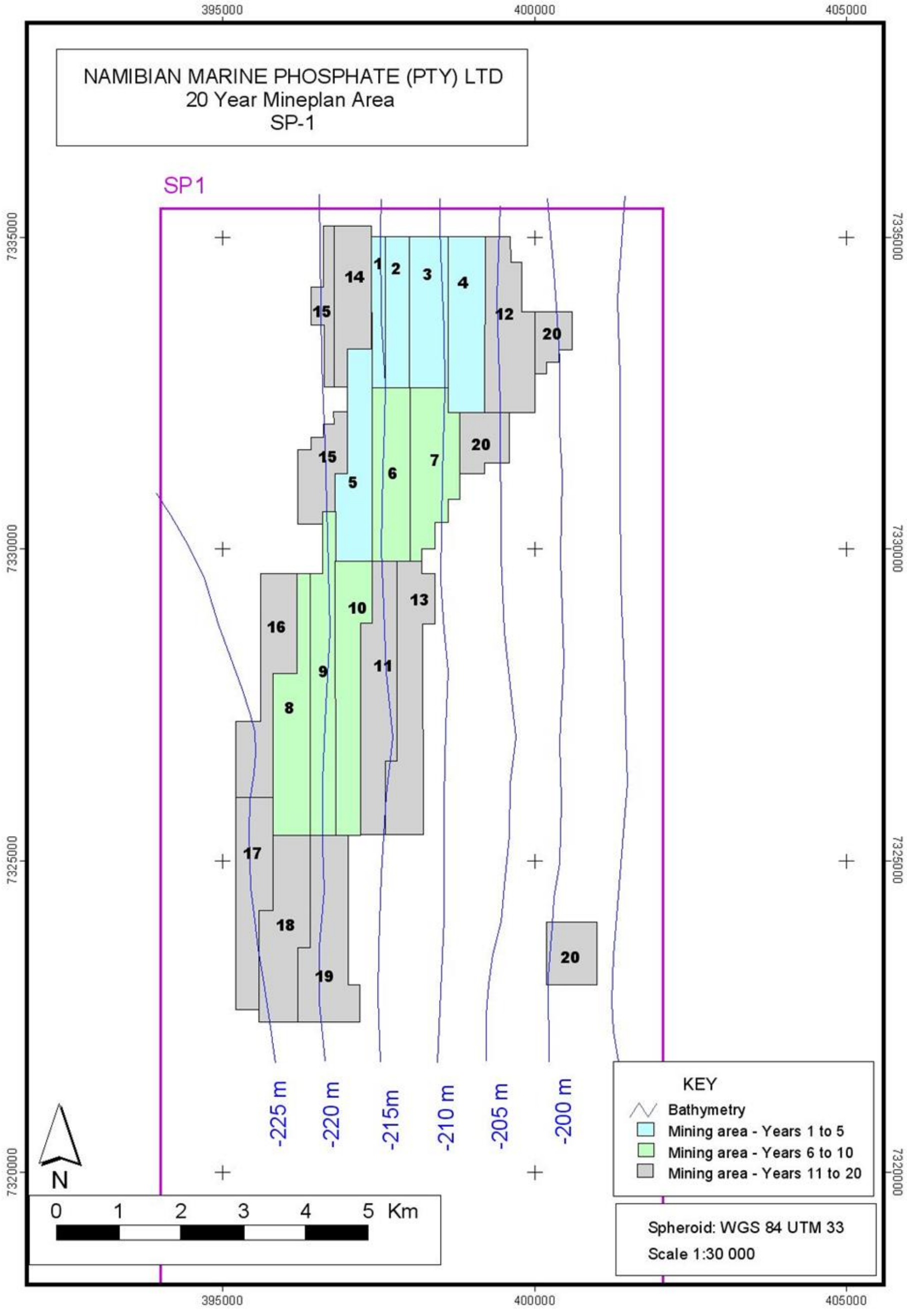


Figure 18 - 20-year mine plan for the in SP1 target mining area in ML 170

The deposit has a resource which can sustain continued production for over 100 years at the proposed rate, although the current plan is for a 20-year mine-life, related to the term of the mining licence.

4.6.3 SCALE OF OPERATIONS

The mining licence area is 25.2 km wide and 115 km long. ML 170 is 2,233 km^2 in extent, representing approximately 2% of the Namibian continental shelf area (110 000 km^2)

Within ML 170 and within SP-1, the total area of the 20-year mine plan represents 1.5% of the total ML 170 licence area and less than 3/100ths of 1 percent (0.03%) of the Continental shelf Area off Namibia.

The average yearly dredged area of 1.7 km^2 represents 8/100ths of 1% (0.08%) of the total ML 170 area and less than 2/1000th of a percent (0.002%) of the total continental shelf area off Namibia. As such annual mining operations will occupy a very small area within the mining licences and will not present any substantial or continuous operational impacts to commercial fisheries or other marine activities being undertaken within the boundaries of ML 170.

Table 8 provides an overview of the 20-year mine plan and annual dredged mine area in size (km^2) and percentage (%), compared to SP1, ML 170 and the Namibian continental shelf.

Table 8 - The proportions of the Namibian continental shelf, ML 170 and SP1 affected by the proposed dredging for the Project

	Continental Shelf	ML170	SP-1	**20 Year Mine Plan**	**Annual Dredged Mined Area**
Area (Km^2)	110,000	2,233	176	34	**1.7**
% SP1 Area			100%	19.32%	0.966%
% ML170 Area		100%	7.88%	**1.52%**	**0.076%**
% Continental Shelf Area	100%	2.03%	0.16%	**0.03%**	**0.002%**

4.7 MINING METHOD AND EQUIPMENT

In the last two decades the expansion of the global economy and increase in the world's population has compelled the dredging industry to adapt its fleet by building new vessels with increased transport capacity, installed power and dredging production. The dredging contractor Jan De Nul Group (JDN) has been the forerunner in satisfying these demands with its new trailing suction hopper dredgers (TSHD).

In June 2011 NMP and JDN entered into an agreement for design and operations for mining of phosphate-rich deposits off the coast of Walvis Bay, Namibia, based on the production of 3.0 Mtpa phosphate concentrate. The approach involved the utilization of an extended suction pipe, related equipment and modifications to the trailing suction head dredge (TSHD) cristobal colon. JDN has many years of experience in dredging work and the development of dredging technology, including amongst others considerable experience with sea conditions in Namibia and knowledge of the nature of the dredged material.

Current dredging technology allows recovery from depths of up to 165 m. Dredging contractors, Jan de Nul, estimate that a purpose-built extended dredging arm, requiring limited modification of their largest dredge, the Cristobal Colon, will allow recovery from 225 m depth with a 3 m wide dredge head (Figure 19). Alternate technology under development by JDN will in due course enable recovery from even greater depths.

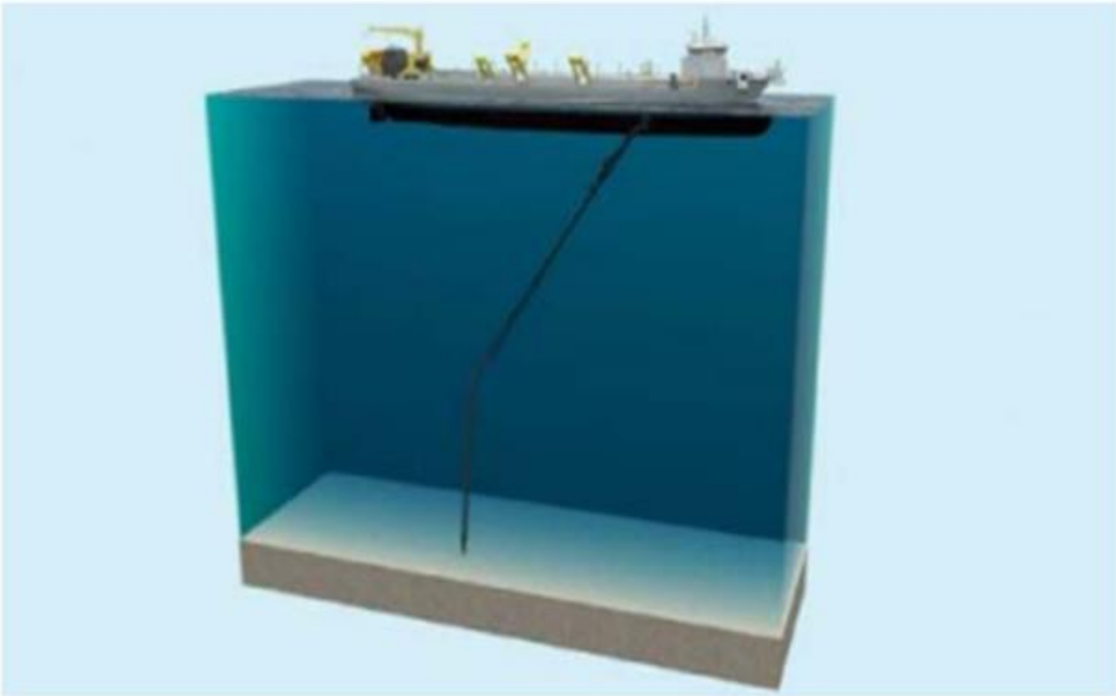


Figure 19 - Schematic of extended dredging arm (source: JDN)

The dredge vessel will recover sediments from individual continuous lanes within the target mine area initially from within the Sandpiper-1 (SP1). The length of each lane (cut) is 4 km and width of 600 m. This lane length may vary in orientation as determined from geotechnical feedback information obtained during the dredging process and or as established from ongoing resource development exploration. Dredging will predominantly take place in a north – south (or south – north) direction e.g., aligned with the predominant swell and wind direction.

In the initial 4 km cut, the dredger will steam at 1 knot, which results in the seabed engaged dredge head excavating to a depth of 0.75 m below seabed with the 3 m wide dredge head. In order to fill one hopper (vessel) load, 4 parallel adjacent or near adjacent cuts within the mine area are dredged and the vessel will cover approximately 4 km during this period. Subsequent cuts within the same lane will be made, so that the full vertical extent of the deposit can be extracted. By varying the speed of the vessel, the depth of cut can be increased (shallower cut) or decreased (deeper cut, to a maximum of 0.75 m). The vessel will continue to dredge vertically within the particular lane to a point just above the footwall clays. Depending on the location within the deposits, these footwall clays may be located at depths from 1 m to 3 m or more below the original seabed level. The intention is not to cut (dredge) into the footwall clay, but to rather leave a residual thickness of marine sediments over the footwall. This thickness will vary but is envisaged to be between 10 and 15% of the original volume of target sediment layer(s). This will remain in situ on completion of recovery. The depth of recovery during dredging will be managed through positional software integrated with the hydraulic winch systems that control the position of the dredge arm and the location drag head. This residual sediment remaining above the footwall clay will be present as an uneven 'hummocked' surface.

4.7.1 DREDGING CONTROL

Dredging control for the vessel is typically maintained by means of the following systems and equipment:

- A positioning system
- A dredging computer
- A suction tube position monitoring system (STPM)
- A dynamic tracking computer.

4.7.1.1 Positioning system

Dredging control is based upon a vessel positioning system. The Z or vertical co-ordinate of the ship is obtained from swell and tidal data from a prediction model based on historical data. The positioning computer determines the actual ship and draghead position as co-ordinates and presents the results, relative to the area to be dredged on navigational displays. These position results are derived by calculation from the X, Y and Z inputs from the suction tube position monitoring system (STPM) system as described below and the ship's bearing provided by the gyrocompass.

The positioning computer also determines the actual vertical offset of the drag head as compared to the target dredge depth. Information outputs from the computer include:

- Plots of dredged tracks
- Position of vessel and drag head visualized on screen on a background of bathymetric data
- Obstacles and buoys
- The display is in plain view with a differential colour chart showing the amount still to be dredged, together with a longitudinal and cross profile of the trench marking seabed level and target level
- Changes in X and Y co-ordinates as input to the dynamic tracking system.

4.7.1.2 Dredging control computer

The dredging control computer enables all the dredging processes such as the dredging level of the drag head, pump settings and 'lean water' to be controlled. The interface between the positioning computer and the dredging control computer enables control of the dredging process to pre-defined levels of input to the system from pre-dredge survey information and pipe profile design requirements.

4.7.1.3 Suction tube position monitoring system

The STPM is a system comprising a system of pressure and angle transducers, which allows the determination of the drag head position relative to the ship. This makes relative X, Y and Z co-ordinates of the drag head available to the positioning system and dredging computers.

4.7.1.4 Dynamic tracking

This system can automatically control the vessel's track and therefore the drag head's horizontal position by compensating for wind and current effects on the ship. It achieves such control by automatically adjusting rudder direction, propellers and bow thrusters.

4.7.1.5 Progress monitoring

During the process of line cut dredging, the progress is monitored on board by means of the dredging control systems and the multibeam or survey results. The dredging control system allows for the actual drag head depth and the target depth at the drag head position to be compared online and the difference displayed.

4.7.1.6 Survey

The survey procedures ensure that the survey methods used comply with the specifications and that surveys are carried out in an accurate and efficient manner. The procedures cover all survey works.

4.7.1.7 Equipment

The dredger is equipped with a multibeam echo sounder. This allows online surveys without the need of a separate survey vessel within the mining area. Alternatively, should the circumstances make surveying from the dredger less favourable, a separate survey vessel can be mobilized.

4.7.2 DREDGE CYCLE

Dredging operations in ML 170 are not conducted on a continuous 24/7 basis, as is the standard practice for marine diamond mining. The proposed dredging operations will be conducted on a cyclic basis, with an average of 2.85 dredge cycles per week.

The actual loading time (dredging onsite in ML 170) represents only 38% of the vessel operational time as shown in Table 9.

Table 9 - Details of the dredge cycle

Dredging cycle times	Minutes	Hours
Loading	798	13.30
Turning	199	3.32
Sailing time, loaded unrestricted	353	5.88
Sailing time, loaded restricted	0	0.00
Accelerate / slow down	20	0.33
Connect to pipeline	40	0.67
Discharge to shore	360	6.00
Disconnect from pipeline	20	0.33
Sailing time, unloaded unrestricted	316	5.26
Sailing time, loaded restricted	0	0.00
Total cycle time	2,106	35.10
Loading proportion of total dredging cycle		38%

Source: modified from JDN (2013)

4.8 MINE WASTE

4.8.1 DREDGE VOLUMES, PRODUCTION AND SEDIMENT DISCHARGE

It is planned to ramp up the production of concentrate from 1 million tpa in year 1, to 2 million tpa in year 2, to 3 million tpa in year 3. During the entire dredging cycle, there are no additives or precondition processes other than overflow of fines. The mass balance of the ramp up to full production capacity over 3 years is presented in Table 10.

Table 10 - Mass balance of the ramp-up to full production capacity

MASS BALANCE			
Dredge capacity (m3)	37,750	37,750	37,750
Dredge capacity planned (m3)	30,000	30,000	30,000
Dredge volume per week (m3)	90,000	90,000	90,000
Dredge volume per year (m3)	1,260,000	2,430,000	3,600,000
Dredge wet tonnes per year (t)	2,646,000	5,103,000	7,560,000
Dredge dry tonnes per year (t)	2,142,000	4,131,000	6,120,000
Processing yield per year with 40% reduction + 10% dredge loss (t)	**1,071,000**	**2,065,500**	**3,060,000**

4.8.2 DISCHARGE OF FINE SEDIMENTS

The overflow funnel(s) on the JDN dredger are vertically mounted tubes inside the hopper well that are used to drain off (through the keel) excess water inside the hopper well allowing the hopper load to be maximized. The anti-turbidity valve or "green valve" is a hydraulically controlled valve mounted inside the overflow funnel(s). This valve drastically reduces the turbidity generated by the overflow water drained through the overflow funnels. It smothers the mixture flow through the overflow funnel. As a result, the water level inside the overflow funnel will be kept high and the mixture will "fall" from a lesser height. This will ensure that less air gets mixed into the overflow and hence the flow will not have a tendency to rise up next to or behind the vessel. Without the use of this green valve the finer particles in the overflow mixture are churned up by the vessel's propellers and hence create those infamous turbid clouds behind the trailer dredger.

4.9 SUPPORT SERVICES

For the operations in ML 170 being the marine component of the Sandpiper Project, the requirement for shore-based support services will be primarily for the dredging contractor, Jan De Nul to support and maintain operations of the dredging vessel. JDN intend to establish their own operations support office in Walvis Bay to oversee these requirements, support services they may require are likely to include:

- Supply boat and crew
- Victuals for supply boat and dredge vessel
- Bunkering for dredge vessel and support vessel
- Accommodation
- Mechanical and electrical engineering support services.

4.10 UTILITIES

For onsite operations in ML 170, the dredging vessel is self-supporting, having access to utilities and support services to replenish requirements during the regular return trips to port of Walvis Bay.

4.10.1 POWER

All of the power required for operation of the dredging system and the vessel is generated onboard the dredge vessel, which is equipped with main engines, MAN B&W, 48-60, 4-stroke, 16 cyl's and generates total power of 41,650 kW.

4.10.2 WATER

Fresh water required for onsite operations is generated by RO systems (reverse osmosis) on board the vessel and or taken onboard when in port of Walvis Bay and stored in dedicated freshwater tanks.

4.10.3 SEWERAGE AND GENERAL WASTE

All waste produced will be contained within the vessel and will be managed in accordance with the International Convention for the Prevention of Pollution from Ships (MARPOL) requirements to which Namibia is at an advanced signatory stage.

4.10.4 OTHER

The Proponent will ensure that the dredging company contracted to conduct the dredging operations are compliant with the provisions of MARPOL and will verify that the vessel holds valid and applicable permits associated with the prevention of pollution of hazardous substances, if applicable.

The dredge vessel will hold supply of fuel in the vessel's fuel tanks in accordance with standard international marine practice. Refuelling will be conducted in the Port of Walvis Bay.

4.11 REHABILITATION

Rehabilitation of the dredged areas within the 20-year mine plan will be conducted in accordance with the substantial provisions of the environmental management plan.

To aid functional recovery of seabed benthos, operational procedures for dredging will include provisions:

- To leave a residual thickness of marine sediments over the footwall representing between 10 and 15% of the original volume of target sediment layer(s). This will remain in situ on completion of recovery. This residual sediment remaining above the footwall clay will be present as an uneven 'hummocked' surface.
- To leave lanes of undisturbed sediment to support infill and recolonisation of benthos.

Recovery of the seabed over time ranging from 2 to 16 years has been demonstrated and reported in monitoring studies conducted by Namdeb (DebMarine Namibia) over the past 20-years in their Namibian offshore mining licences.

5 ENVIRONMENT AND SOCIAL BASELINE

5.1 BASELINE DATA COLLECTION

Initial environmental baseline and specialist studies relevant to the Sandpiper Project commenced in 2010 and formed part of the 2012 environmental impact assessment (EIA) conducted for ML 170.

Following further consultation with key stakeholders the 2012 EIA baseline data and assessed impacts were further expanded, assessed, and verified to increased levels of confidence based on the results of a comprehensive 2 year program of in situ sampling, data analysis and specialist studies completed in 2013/2014 on the primary target dredge site SP1 in mining licence 170 (EIA Verification Study). The 2014 EIA verification study included participation of representatives from UNAM as independent observers of the program operations. The EIA verification program was finalised in close consultation with the Ministry of Fisheries and Marine Resources as well as Ministry of Mines and Energy and Ministry of Environment Forestry and Tourism. Representatives from MFMR participated in the fisheries component of the EIA verification study. The specialist studies and results included in the 2014 EIA verification work program were submitted for review by an external peer review panel of international experts with relevant experience.

In 2018, on instruction of the Minister of Environment, Forestry and Tourism (MEFT), the Environmental Commissioner (EC) completed a further round of public consultation to review the 2012 EIA and 2014 EIA verification study and then appointed independent external consultants to review submissions and to provide relevant recommendations on the outcome of the process. Based on the external reviewers' recommendations for further supplementary studies to be completed and submitted to the EC, the Proponent undertook additional specialist studies based on in-situ samples and data. These supplementary studies were completed in 2020.

As an outcome of these various assessments, the baseline knowledge and data for the receiving environment has been substantially expanded with the inputs from the wide range of comprehensive specialist studies which are further discussed as part of this environmental and social impact assessment process.

This Section sets out the biophysical and socio-economic environments of the receiving environment in which the Sandpiper Project is situated.

5.1.1 SPECIALIST STUDIES

The specialist studies outlined in Table 11 were commissioned and completed (2012, 2014, 2020), to determine the current state of the baseline environments.

Table 11 - Specialist studies conducted for the ESIA

Study area	Purpose	Contributing Specialists/Organisation
Marine Ecology	– Assess impacts on fishing operations that could have a potential impact on the fishing sector – Identify and assess potential impacts on ecologically important demersal and pelagic fish species – Impacts on recruitment of key commercial fish stocks – Impacts on species diversity – Impacts on seabirds and marine mammals	Mr D Japp, Capricorn Fisheries Monitoring cc, Dr Melanie Smith, Dr Tony Robinson, Dr Carola Kirchner, Dr Jeremy David
Marine Water Quality	– Changes to marine water quality impacting organisms and benthos – Water column and sediments alterations impacting organisms and benthos – Deterioration in water quality from discharges to sea of wastes – Alien marine species influence on indigenous species and aquaculture – Nutrient availability and phytoplankton growth – Trace metals impacts on organisms and filter/feeding benthos	Dr R Carter, Lwandle Technologies Pty Ltd, Dr Sue Lane, Eric Koch, Carrie Pretorius
Benthos	– Loss of benthic biota due to upper sediment removal during dredging activities – Direct and indirect impacts on biota in larger ML – Alterations to local near bottom hydrographical conditions – Impacts on large sulphur-oxidising bacteria – Increasing anoxic conditions in sediment	Dr N Stefanni, Stefanni Marine Environmental Consultants cc, Dr Robin Carter, Lwandle Technologies

Study area	Purpose	Contributing Specialists/Organisation
	– Smothering effects during dredging operations on biota – Potential effects of Algal blooms	
Jelly Fish	– Blockages on vessel water sea intake – Potential mortalities to jelly fish due to hydrogen sulphide releases – Potential mortalities to jelly fish due to tailings plume – Jelly fish population dynamics as a result of substrate alterations of the seabed floor	Prof M Gibbons, University of Western Cape
Geology and History of Deposit (Verification studies 2014)	– Preliminary Model for the Origin and Age of the Sandpiper Deposit – A review of offshore phosphorite deposits on the Namibian margin	Dr JS Compton, University of Cape Town
Water Column and Sedimentary Environment (Verification studies 2014)	– Gather data in the target mine area on currents, water column characteristics and sediment properties – Toxicology risk of heavy metals	Dr Robin Carter, Lwandle Technologies (Pty) Ltd, Metocean Services
	– The utility of hydrodynamic and biogeochemical numerical modelling of dredge plumes to better inform the assessment of potential water column and benthic impacts	Dr Roy Van Ballengooyen, CSIR, South Africa
	– Determination of bacterial genera involved in sulphur-oxidisation and sulphur-reduction (thiobacteria)	Dr Bronwyn Kirby, University of Western Cape, Next Generation Sequencing Facility
	– Meiofaunal Analysis of Namibian Offshore Sediments	Dr S Forster, UK, Pgysilia
	– Conduct the identification and analysis of the benthic macrofauna communities – Review confidence levels for original assessment outcomes based on additional sampling and empirical data assessment	Dr Nina Steffani Stefanni Marine Environmental Consultants

Study area	Purpose	Contributing Specialists/Organisation
	– Epifauna survey – Biomass compositions – Comparisons to other trawling surveys – Environmental drivers such as jellyfish	Dr Tim McKlurg, KZN Coastal Impact Consultants. Dr Melanie Smith, Capfish, Dr Mark Gibbons, University of Western Cape
	– Plankton which includes phytoplankton, zooplankton and ichthyoplankton	Dr Robin Carter, Lwandle Technologies (Pty) Ltd
	– Seabed Physiography and habitat, Geophysical survey and mapping SP1	Gordon Rigg, Marine Data Consultants.
Fisheries and Biodiversity (Verification studies 2014)	– Survey of fish, mammals and seabirds – Assessment of fisheries biomass and stock assessment (Hake and Monk) – Assessment of ecosystem impacts – Assessment of recruitment – Biodiversity assessment	Capricorn Fisheries Monitoring cc, Dr Dave Japp, Dr Melanie Smith
	– Biomass and stock estimates of hake and monk	Dr James Gaylard Capricorn Fisheries Monitoring cc
	– Ecosystem Impacts related to dredging of phosphates offshore through ecosystem modelling	Dr Kevern Cochran Capricorn Fisheries Monitoring cc
	– Fish reproduction dynamics and stock distribution of hake, monkfish, horse mackerel and sardine	Dr Hilka Ndjauala, University of Namibia Capricorn Fisheries Monitoring cc
	– Assessment focus on pelagic fish species, demersal fish species and west coast rock lobster in the following study areas – Spawning activity – Ichthyoplankton drift routes – Recruitment of Namibian marine fauna	Capricorn Fisheries Monitoring cc and related sub-consultants listed above.
Plume Dispersion Modelling (Supplementary Studies 2020)	– Ocean current and plume dispersion modelling with sensitive receptors included	HR Wallingford, UK
Mine Area Sediment Toxicity	– Sediment Toxicity test work of the ore body	Dr Robin Carter, Lwandle Marine Environmental Services

Study area	Purpose	Contributing Specialists/Organisation
(Supplementary Studies 2020)		
Noise (Supplementary Studies 2020)	– TSHD sound measurements – Noise modelling below and above ground	Jan De Nul N.V.
Socio-Economic Study	– Economic Assessment of the Development of a Phosphate Based Industry in Namibia	Stratecon Applied Economic Research
Socio-Economic (Supplementary Studies 2020)	– Socio-economic assessment dredging works	Jan De Nul N.V.

5.2 MARINE ENVIRONMENT

The mining licence area ML 170 is located within the Northern Benguela upwelling system of the Benguela Large Marine Ecosystem (BCLME). The Benguela current is very nutrient rich and supports a variety of sea life. The current licence area overlaps in some places towards the southwestern end of the ML 170, with fish trawling operations, which operate in water depths from 200 m to 600 m. The main shipping lanes for Southern Africa lie seawards (west) of the Mining Licence however shipping activities could occur within ML 170 and between ML 170 and the coastline. Various mineral licences are located immediately adjacent to the Sandpiper Project (ML 170), with granted and or pending Exclusive Prospecting Licence (EPL) types including precious stones, semi-precious stones, industrial minerals and precious minerals Figure 20. Adjacent EPL's 4009, 4010, 3323 and 3415 are also held by NMP.

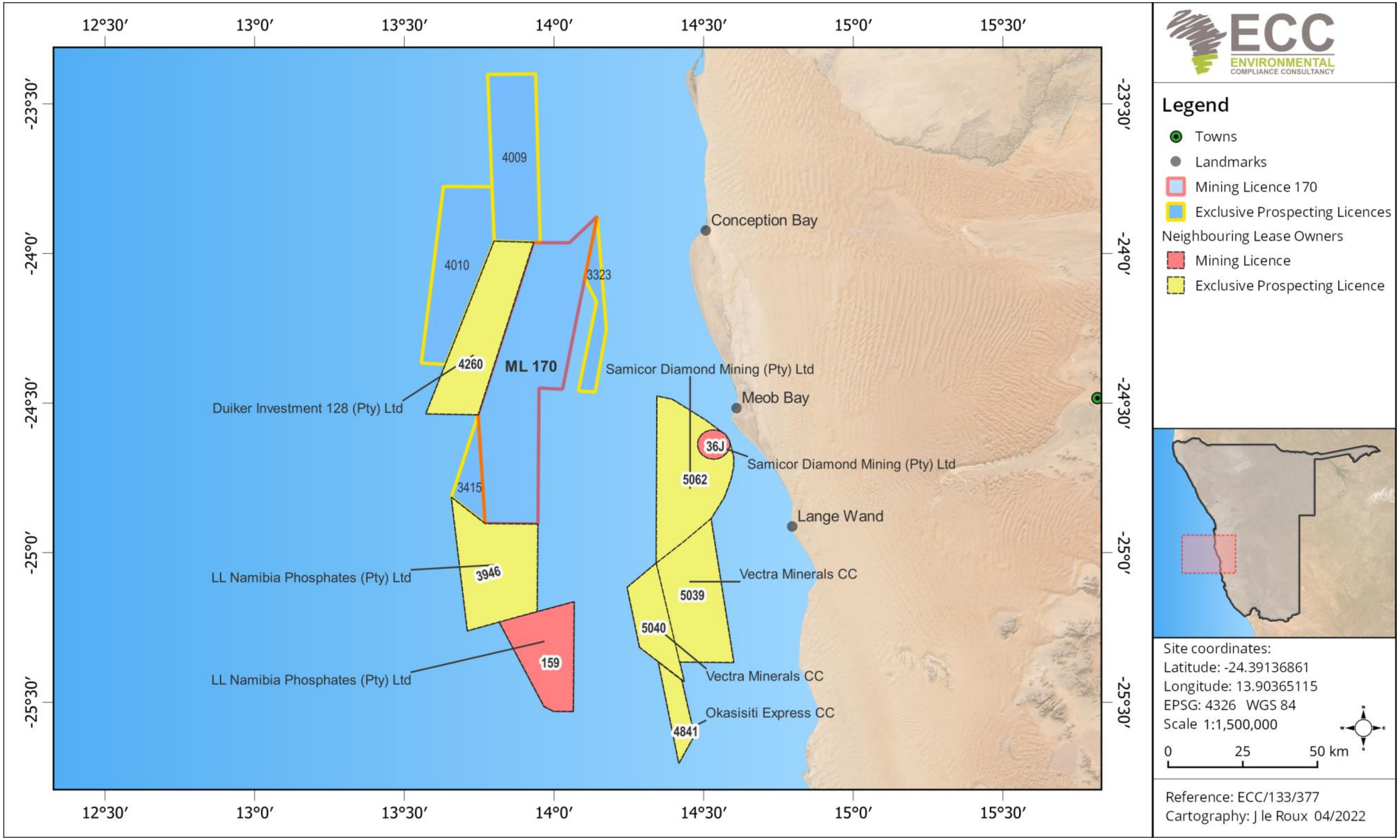


Figure 20 - Adjacent concession holders to ML 170

5.3 GEOLOGICAL SETTING

The local geology has been explained in detail in the original 2012 ESIA report (J Midgley and Associates, 2014) and genesis of the phosphate deposits is further summarised in Chapter 4 of this report from the specialist geological study conducted by Prof. John Compton, University of Cape Town, as included in the 2014 EIA verification study (J Midgley and Associates, 2014). The reader is referred to Section 4 for details of the geological information.

Three broad physical types of Phosphorite have been identified on the Namibian continental shelf and are geographically distinct, these phosphorites are found in the form of either sand, rock phosphorite or concretionary (nodular) phosphorite (Rodgers & Bremner, 1991). The phosphorite sand is divided further into either pelletal phosphorite and glauconitized pelletal phosphorite. Both varieties are located on the continental shelf in water and have been radiometrically dated as Miocene in age. The phosphorite sand of Miocene age (2.38 Ma) on the middle continental shelf is the target mineral deposit of the Sandpiper Project. Major sea levels changes also played an important role in the regional geology of the shelf dynamics (J Midgley and Associates, 2014).

The Sandpiper Project site ML 170 is located in water depths ranging from 150 m in the east to 350 m in the west. The initial target mining area SP1 is located in water depths of 190 m to 250 m. The middle shelf at 200 m is mainly made up of pelletal phosphatic sediment and glauconitized pelletal sediment which occurs predominantly to the north of Walvis Bay. The pelletal deposit is mixed with gravel (molluscan shells) and mud (biogenic and terrigenous). The enriched part of the phosphorite deposit lies largely within ML 170 between Conception and Spencer Bay as shown in Figure 21 (J Midgley and Associates, 2014).

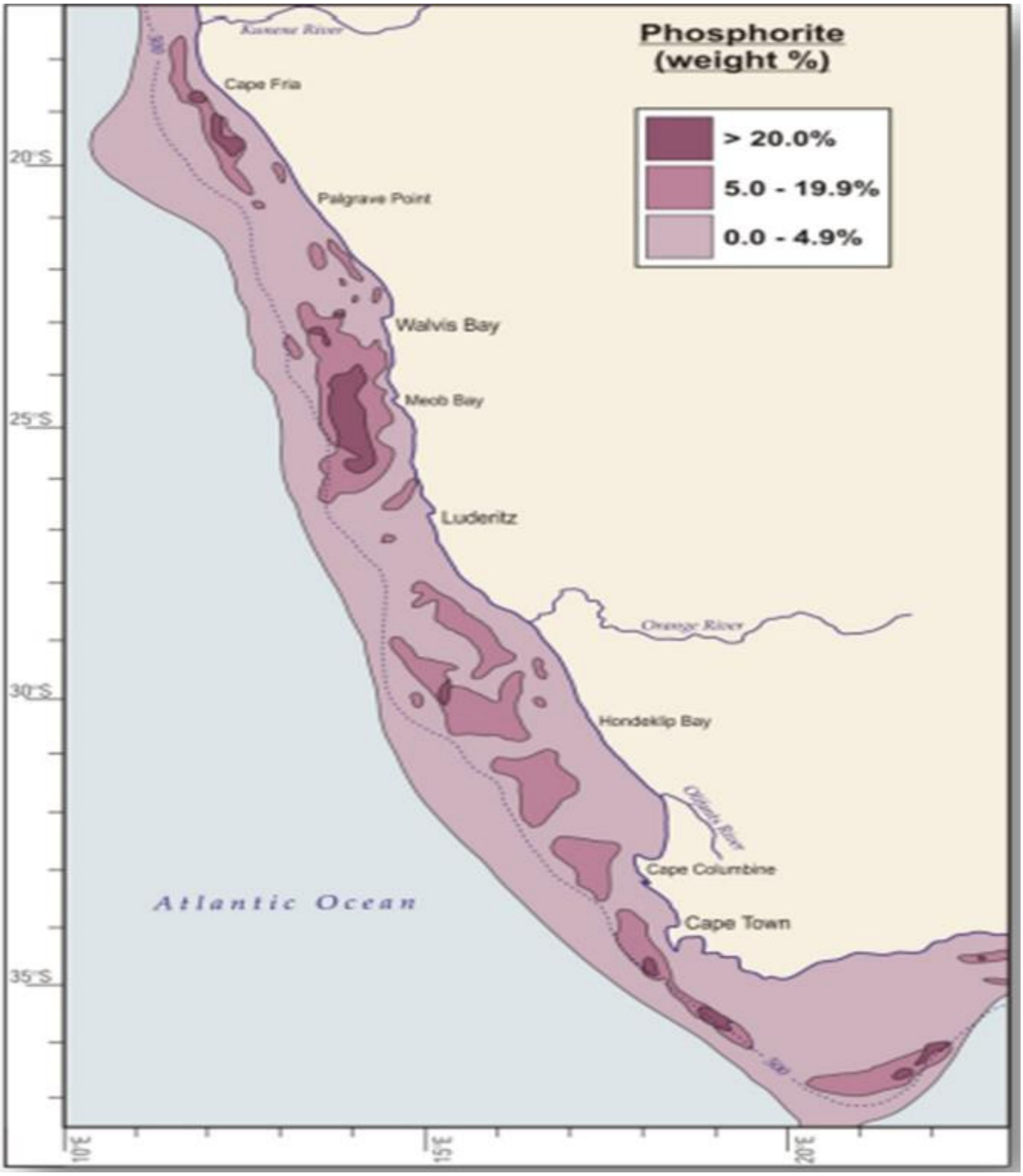


Figure 21 - The abundance of phosphate on the middle to outer shelf (in J Midgley and Associates, 2014)

The detailed geological study by Prof. J, Compton (Compton, 2014) (J Midgley and Associates, 2014) as presented in the 2014 EIA verification study included determination of the origin and age of the marine phosphorite deposits in the Sandpiper Project area ML 170. This was done by analysing the sediment cores combined with strontium-36 isotope dating. The findings from this study confirm that the deposits formed during the early to middle pleistocene period (2.6 to 0.126 million years ago (Ma)), therefore after the miocene age.

These deposits were initially formed by marine algae growing in highly productive surface waters, whereby the dying and sinking action to the seafloor allowed for the organic phosphorus in the algal cells to be incorporated into the mineral carbonate fluorapatite or francolite. These phosphorite grains were concentrated through repeat erosion of the sediment by wave and current action during low sea levels. The phosphorite grains formed predominantly during the early pleistocene (2.6 to 1.26 million years ago (Ma)).

The stratigraphy of the deposits in ML 170 typically comprise a basal phosphorite muddy sand that varies from 0.5 m to 1.5 m in thickness. This is overlain by increasingly shelly phosphorite sand of variably 0.5 m to 1.5 m thickness, containing 65 to 86wt.% sand and 4-5 wt.% mud. The phosphorite is diluted by shell fragments, particular the upper layer. The upper sediment profile displays multiple erosional surfaces formed during sea-level low stands that occurred during the various glacial maxima since 1 Ma (Compton, 2014) (J Midgley and Associates, 2014).

5.4 TOPOGRAPHY

The seabed on the middle continental shelf in the project area is typically flat, sediment covered and featureless, with a gradual slope to the west as evidenced by the generally evenly spaced bathymetric contours presented in regional and local studies and navigational charts.

The geophysical survey data gathered during the 2014 EIA verification study conclusively demonstrated a flat, smooth seafloor with a homogeneous surficial sediment cover across the northern part of SP1 and including the proposed 20-year mine plan area with the SP1 target mining zone as shown in Figure 22. Data mapping and interpretation confirmed no protruding obstacles (rocks and reefs) or biological features (cold water corals etc) were observed (J Midgley and Associates, 2014).

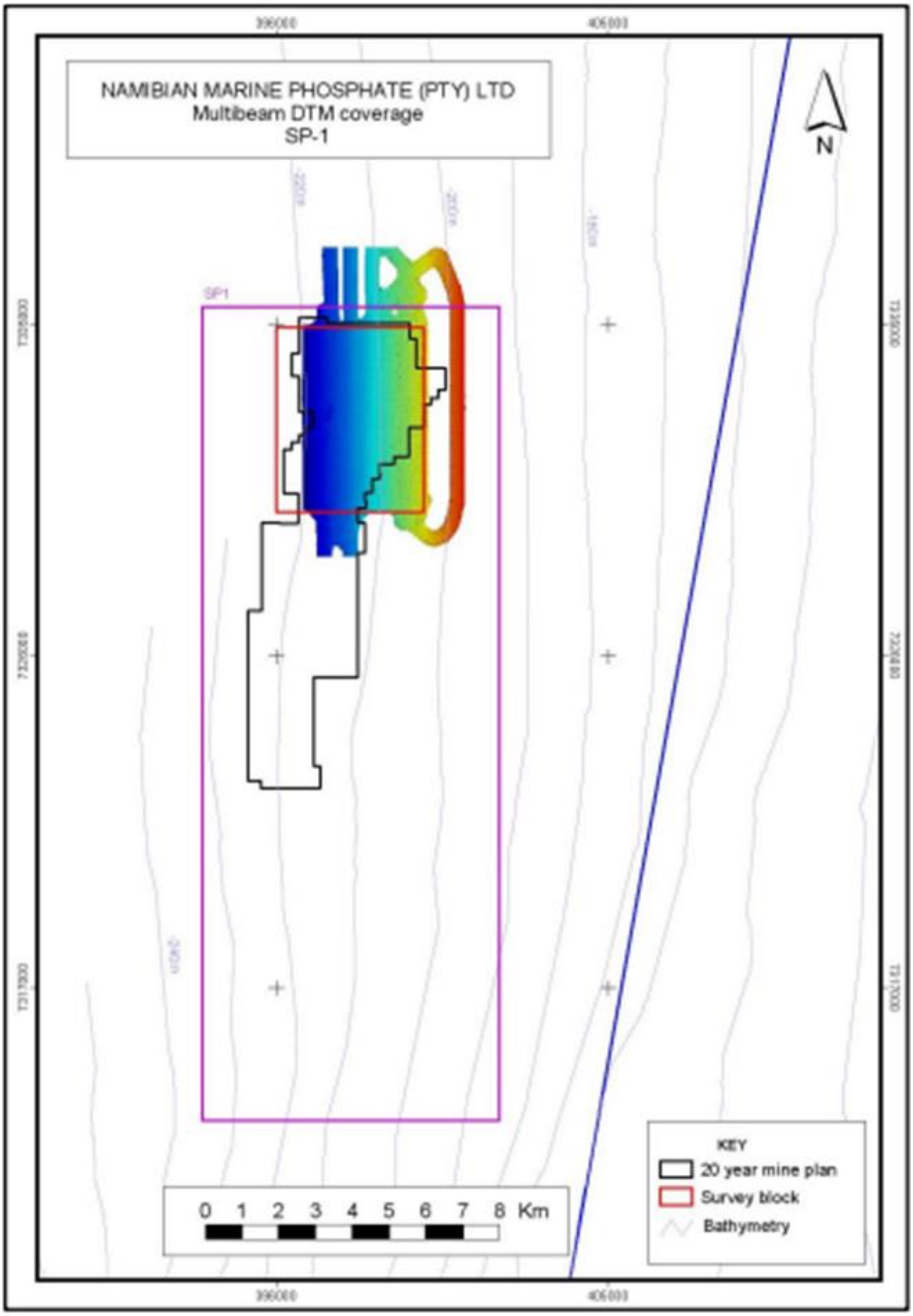


Figure 22 – Multibeam survey coverage of seafloor topography of SP1 and 20-year mine plan area (J Midgley and Associates, 2014)

5.5 SHIPPING INTERACTIONS, NAVIGATION, TRANSPORT AND DREDGER OPERATIONS

5.5.1 INTERACTIONS WITH COMMERCIAL VESSEL TRAFFIC

The main shipping lanes off the Namibian coast for Southern Africa lie seawards of the mining licence area. It is therefore a possibility that sea traffic could frequent the Sandpiper Project site. It is however envisaged that the dredger will only interact with sea traffic when travelling between ML 170 and Walvis Bay. When operational in the Sandpiper Project area (ML 170) the dredging contractor will provide advance notice to the Namibian Maritime Authority and Ports of Walvis Bay and Lüderitz per required operating procedures and protocols. The authorities in turn will issue relevant notices to mariners. The dredger will also display all relevant maritime signals while on station.

5.5.2 INTERACTIONS WITH FISHING VESSELS

Interactions with fishing vessels while the dredger is onsite in ML 170 are possible and the dredger has restricted movement when operational as shown in Figure 23. Therefore, before dredging activities take place in SP1, a notice to mariners of the exact location of dredging will be advertised and marked on hydrographic charts. The 20-year mining area within SP1 comprises a total of 34 km^2 and the average annual mining area of 1.7 km^2/year represents an insignificant footprint in comparison to the total annual Namibian bottom trawl area and commercial catch (primarily monkfish) operations, since data from Ministry of Fisheries and Marine Resources (MFMR) and related specialist studies show that historically minimal bottom trawling activity has been undertaken in the area (J Midgley and Associates, 2014). MFMR data shows that during 2005 to 2010 there was no monk or hake bottom trawling within SP1 (J Midgley and Associates, 2014). More recent data from updated specialist studies by Robin Carter and Dave Japp have been used as part of the current assessment (See appendix E and F).

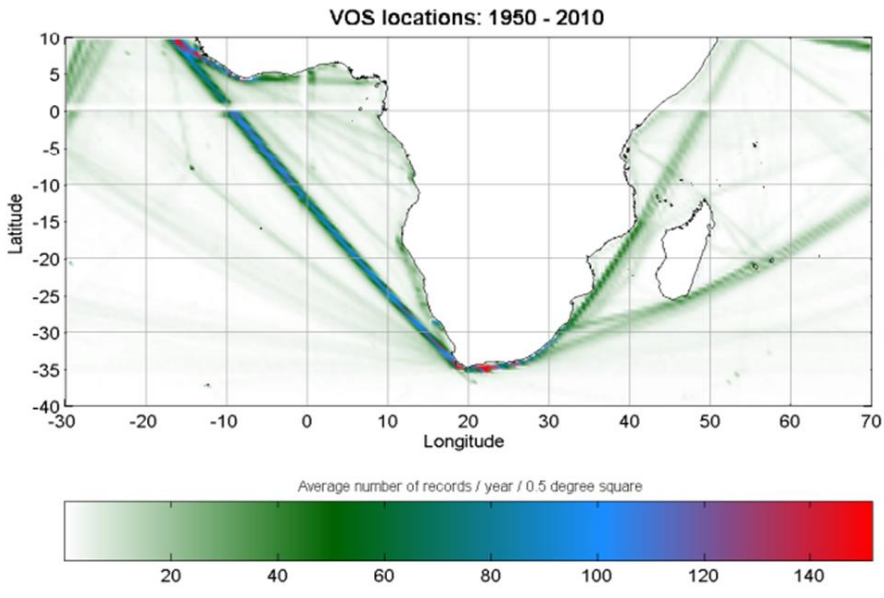


Figure 23 - Shipping routes off the west coast of Southern Africa

5.5.3 NAVIGATION

The coast of Namibia is dominated by a fog belt, which is a navigational hazard for sea and air operations. On average 50 fog days a year are experienced from Elizabeth Bay to Sandwich Harbour. The fog belt extends from the coast to 35 km offshore (Olivier, 1992 and 1995).

Buoyage in Namibian waters follows the Convention on the International Organization of Marine Aids to Navigation (IALA convention) for region A, which are guidelines to be followed by vessels. Apart from satellite navigation systems, Decca navigation is also provided for. Maritime radio services for emergency (channel 16) services, weather bulletins and navigation warnings are provided by Walvis Bay radio call sign ZSV (J Midgley and Associates, 2014).

Transportation access to the Sandpiper Project site is mainly via sea with the dredger. Fly in and fly out opportunities are possible with a helicopter from major harbour towns, such as Walvis Bay, Lüderitz and Cape Town. The dredger will mainly move between ML 170 and the port of Walvis Bay.

5.5.4 OPERATIONAL DISCHARGE FROM THE DREDGER

The dredger will be MARPOL compliant in terms of all operational emissions and non-dredging related discharges from the vessel. Emissions will be recorded and reported on annually. The individual and cumulative impact is to be assessed and expected to be minimal.

5.5.5 SEDIMENT PLUME MODELLING

Findings from an independent review and updated assessment in 2014 conducted by CSIR on the dredge plume characterisation indicate that there is a possibility that the plume dimensions (1500 m long by 800 m wide with suspended sediment concentrations ranging between 20 mg/l to 100 mg/l) may exceed the dimensions reported on in the 2012 ESIA by Lwandle (2013) (2 to 5 times larger). However, the implications for a cumulative impact to occur was assessed and confirmed to be low. It was recommended that an additional and comprehensive plume model be constructed for validation prior to commencement of the proposed commercial dredging operations (base case) and verified during dredging (operational case), as part of the monitoring commitments in order to predict and monitor sediment plume dispersion behaviour, including extent and duration of the sediment discharge.

Subsequently, following recommendations put forward to the Environmental Commissioner in 2018, in 2020 a comprehensive ocean current and sediment plume dispersion modelling study of the proposed 20-year dredging operations within SP1 was conducted by UK based hydrodynamic modelling specialist company HR Wallingford.

Further findings from this study are discussed in the Section below. Sensitive receptors identified during public consultation in 2012 and 2018 were included in the plume modelling as defined in Section 5.8.7.

The study made use of site-specific measurements of water currents and available data to model water and sediment flows in the mining area using three-dimension (3D) technology. The dredger process was analysed in order to make reasonable estimates of the size and rates of sediment released from dredging operations. These inputs were used in the dispersion model to predict the extent of suspended sediments and subsequent deposition from dredging above background levels. These models will be refined with time when additional baseline data becomes available.

5.6.1.1 Zone of Influence (ZOI) from dredging

The zone of influence (ZOI) is the zone or area within which the dredging will lead to changes above background levels in suspended sediment concentrations or to deposition of sediments on the seabed, which are not negligible and the significance of which require an environmental assessment.

The ZOI of the dredging operation is defined as a combination of the suspended sediment footprint (the area in which either the peak concentration increases of more than 7.6 mg/l or mean concentration increases of more than 1 mg/l) and the deposition footprint (the area of fine sediment deposition of more than 5 mm) occur at any time over the course of the 20-year mining period (HR Wallingford, 2020).

HR Wallingford (2020) note that the ZOI does not imply that there will be an actual ecological impact within the ZOI area. The ZOI identifies that there are physical changes to suspended sediment concentration and to the seabed substrate above levels which could be immediately associated with negligible impact. Whether such changes could potentially cause significant adverse impact will depend on the precise nature of the changes and the nature and distribution of the ecological receptors present in the ZOI.

As such these changes cannot immediately be dismissed as insignificant without appropriate assessment, which will be conducted as part of the current process.

Outside the ZOI however, any changes can be considered as insignificant, and it can be concluded that there is no environmental impact.

For the dredging activity in the mine plan area (34 km^2) within ML 170, the overall ZOI for the total 20-year dredging operations extends over an area of 513 km^2 which lies predominantly within the boundaries of ML 170, and which extends only up to 11 km^2 outside of ML 170.

5.6.1.2 Comparison of ZOI and extent of the sediment plume at any given moment

It must be emphasised that the overall ZOI represent the area within which non-negligible changes in suspended sediment and or deposition above background levels are predicted to occur at any time within the proposed 20-year period of mining. However, at any given moment within the 20-year period, the actual sediment plume represents a much smaller area than the total ZOI.

The sediment plume from the active dredging operation in a dredge cycle typically only covers an area of between 1 km^2 to 5 km^2 at any one time and occurs at different levels in the water column over time. As such the plume does not exist at all depths of the water column at the same time.

The ZOI is well separated from the coast and does not influence sensitive receptors in the region of Walvis Bay (HR Wallingford, 2020).

The conclusion drawn was that at any time during the 20-years of mining activity, the plume represents a much smaller area than the ZOI. The ZOI for a single dredging operation extends up to 5 km^2 outside of the 20-year mining plan area. On average the typical extent of the plume during active operations is less than 1% of the ZOI at any given time.

5.6.1.3 Fine Sediment deposition

With regards to the footprint sediment deposition over 20-years, the area is similar to (but slightly smaller than) the overall ZOI. An average sediment deposition of 0.07 m is predicted over the whole ZOI over 20-years. Whilst the predicted deposition rates appear unlikely to cause an ecological effect, the seabed area experiencing >0.1 m deposition above background rates is likely to change to a predominantly silty substrate. However, as dredging occurs, the effects of bioturbation (reworking of surface sediments by animal activity such as burrowing, ingestion and defecation) will also be occurring during the dredging operation and likely to result in gradual mixing of the upper and lower sediment layers over time to varying degrees, depending on sediment deposition rates.

5.6.1.4 Suspended Sediment Concentration

The extents of predicted increases in suspended sediment concentration vary with the position of the dredging operation but as a whole the suspended sediment footprint associated with the 20-year mining area is predicted to extend up to 23 km north, 8 km east, 12 km south and 4 km west during the 20-year mining plan area in SP1. The predicted peak increases in plume concentration outside of the 20-year mine plan area is less than 50 mg/l above background.

Mean increases in suspended sediment concentrations above background are predicted to be below 5 mg/l except at the surface within 100 m horizontally of the dredging operation.

Time series analysis at locations sited 2 km from the boundary of the 20-year mine plan area shows that the predicted increase in surface concentrations of suspended sediments above background, outside of the 20-year mine plan area, do not exceed the acute concentration threshold of ecological effects of 7.6 mg/l. The mid depth concentrations and near bed concentrations increases above background exceed this threshold for 4% of the time or less.

5.6.1.5 Single dredge cycle

The ZOI parameters do not provide an indication of the general behaviours and vertical progress of the sediment plume through the water column. A summary of the plume behaviour over an individual dredging cycle is shown in Figure 24, as defined in the results of the plume modelling.

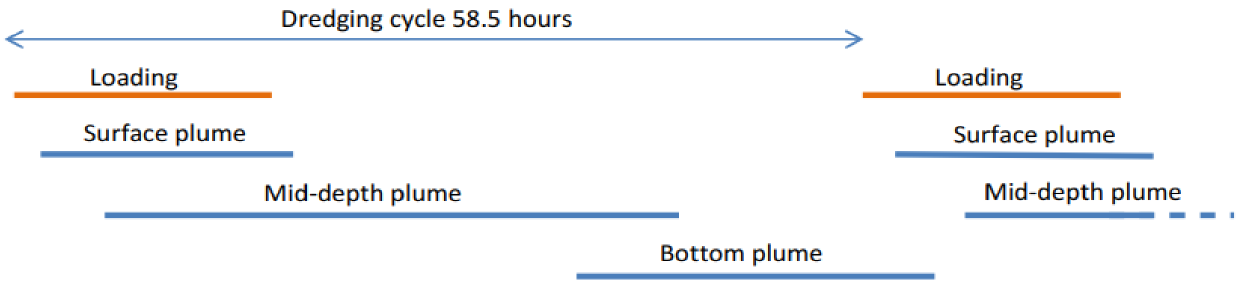


Figure 24 - Summary of plume behaviour over an individual dredge cycle

This is further described below:

- Loading takes 18 hours (hrs)
- The surface plume (defined by sediment concentration increases above background of greater than 7.6 mg/l) is present for up to 3 hrs following cessation of dredging
- The mid-depth plume is present for 25 hrs to 30 hrs following cessation of dredging
- The bottom plume is present for 17.5 hrs to 30 hrs but appears >20 hrs after dredging ceases
- The next period of loading starts, and the surface plume becomes apparent before the bottom plume disappears
- There is therefore no time when there is no plume present, either at the surface, mid-depth or bottom of the water column
- Plumes are present (to some extent) in the bottom/mid-depth/surface for (on average) 41%/73%/34% of the time, respectively
- Deposition over an individual cycle (58.5 hrs) is predicted to be 0.3 mm or less.

5.6 BIOPHYSICAL ENVIRONMENTAL BASELINE

The Namibian coastline is dominated and influenced greatly by the Benguela upwelling system. Namibia and the west coast of South Africa forms part of the eastern boundary to the Benguela Current Large Marine Ecosystem (BCLME), which lies between 15 to 37°S and 0 to 26°E (Shillington et al., 2006). The surface currents of the Benguela are generally equatorward, with strong coastal upwelling cells and equatorward shelf edge jets. Subsurface currents on the continental shelf, especially below 100 m depth are constantly poleward (Shillington et al., 2006). Upwelling intensity varies and is not uniform due to short term and seasonal differences in wind regime and coastal topography. The upwelling is associated with cool nutrient rich waters that are projected equatorward along the Namibian continental shelf generated by Ekman transport. This is one of the reasons the Namibian coastline is one of the richest fishing grounds internationally.

Hydrological data collected during the 2014 verification survey indicated a well-mixed layer of South Atlantic Central Water, with typical winter values for temperature and salinity and low oxygen levels near the seafloor. More recent data from updated specialist studies by Robin Carter and Dave Japp have been used as part of the current assessment (See appendix E and F).

5.6.1 WATER COLUMN AND SEDIMENTS

5.6.1.1 Currents

Measured currents in the target mining area (SP1) reflect consistent northwest (equatorward) flow in the near surface depths. At mid depth, currents switch between northwest and southward (poleward) flow. Near the seabed there is a period of continual poleward flow, followed by switching between poleward and equatorward flows (Shillington et al., 2006) At the time of the 2012 ESIA, mid-depth time series were not available and the results from the 2014 verification study depict new data for the region. (Shillington et al., 2006) reported that the seabed current velocities are <10 cm/s, however in 2014 velocities of 30 cm/s were recorded at the mooring, implying significant turbulence at the seafloor with implications for natural sediment dispersal and impacts on local benthos. The recorded data was also used to validate the oceanographic circulation and current models developed by HR Wallingford for conducting the sediment plume dispersion studies for the 20-year mine plan (total area 34 km^2) for the proposed dredging operations in SP1 (ML 170).

5.6.1.2 Current velocity

The 2014 verification study data concluded that most of the variability in velocity occurred in longer period (>3 day) fluctuations, with inertial and tidal periods also of importance. During the 2012 assessment, lunar tides were assumed to be the probable mechanism preventing accumulation of pelagically produced particulate matter (POM) in mid-shelf sediments immediately offshore of the mud belt. With this mechanism excluded, the ambient current velocities measured are sufficient to exert bottom shear stress forces well in excess of those required to suspend finer sedimenting particles, thereby preventing its accumulation in the survey area.

5.6.1.3 Water Mass Characteristics

The characteristics present in the study area represent oxygen depleted, saline South Atlantic Central Water flowing south, in the poleward undercurrent from the Angola gyre. Additionally, less saline, relatively oxic Eastern South Atlantic Central Water from the Cape Basin was also present. Figure 25provides a visual representation of the surface ocean currents described. The influence of the latter on the ventilation of bottom water in the area is evident from the temperature, salinity and dissolved oxygen time series measurements that were made (J Midgley and Associates, 2014)

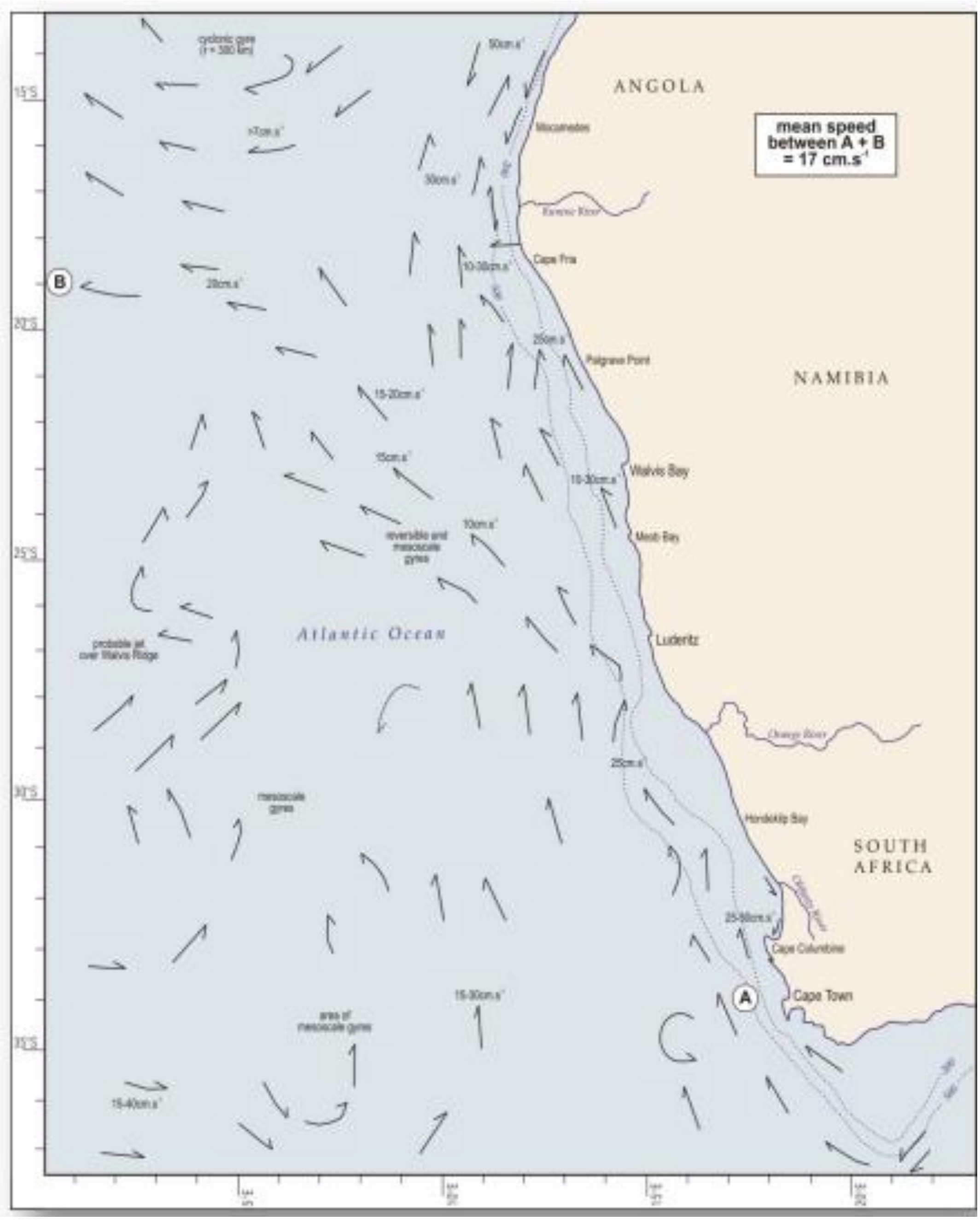


Figure 25 - Surface currents off the west coast of Southern Africa (Shannon, 1986)

5.6.1.4 Dissolved Oxygen Concentrations

Results during the 2014 survey showed that the upper mixed water layer was normoxic. This entails that the water is air-saturated and has a partial pressure of oxygen in the normal expected range. Dissolved oxygen concentrations are shown to decrease in depth and at the sub-thermocline these concentrations measured at 0.5 mg/l. The seabed displayed very low oxygen concentrations, demonstrating periods of hypoxia, which only increased during ventilation events (1/10 mg/l).

5.6.1.5 Turbidity

Turbidity throughout the water column and on the seabed floor during the survey period in the assumed benthic boundary layer was typically low (1 NTU). No clear association exists between recorded turbidity events, current speed, and direction. Thus, these measurements support the conclusions for the 2012 ESIA that observed turbidity events occur as a result of the near shore biogenic mud belt being advected past ML 170 towards the outer continental shelf and slope.

5.6.1.6 Sediment Composition

Surficial sediments are found to be silty, whilst underlying sediments are primarily silt. Evidence of clay was only found in low proportions (<8%) in the deeper sediments. Surficial and upper sediment layers were found to have low porosity, which entails that the sediment is firmly packed, with low pore water volumes and abundant shell material. These features make the sediment body resistant to re-suspension. These conclusions are aligned with the 2012 ESIA that local turbidity generation is a rate event.

5.6.1.7 Particulate Organic Matter (POM)

The average particulate organic matter (POM) concentrations in the sediments of SP1 were recorded to be 7.4 % during the field re-surveys in 2014. This is a higher percentage than the 6.9 % recorded in the 2012 ESIA. Carbon to Nitrogen ratios (C: N) in the POM were 11:4 in the surficial layers and 19:8 in the underlying sediments. These ratios are indicative of refractory organic matter (J Midgley and Associates, 2014).

5.6.1.8 Inorganic Nutrient Concentration

Concentrations in the sediment pore water shows evidence of enriched phosphorous when compared to the overlaying water column. There is also a noted deviation from the classical Redfield Ratio for nitrogen (Carbon: Nitrogen: Phosphorus 106:16:1). The higher phosphorus level concentration is attributed to enrichment from the pelleted phosphate ore body (J Midgley and Associates, 2014). The pore water volumes are low as a result of low sediment porosity. Therefore, significant alterations to upper water column Redfield ratios through translocation of pore water to the surface is not expected to occur (J Midgley and Associates, 2014).

5.6.1.9 Sediment Oxidative State

The findings from the 2012 ESIA and 2014 EIA verification draw to similar conclusions that sediments in ML 170 were hypoxic and thus yield low sulphide fluxes. In order to measure oxidative state of sediments, measurements are taken of oxidation reduction potential (ORP), nitrate-nitrogen and acid volatile sulphide (AVS). ORP was recorded as moderately high (>0 ± 100mv) throughout all sediment core samples, which implies that sediment samples are hypoxic. The presence of nitrate-nitrogen in the sediment pore water supports as when exposed to anoxic conditions, the chemical state changes to ammonia. AVS was below detection levels in the surficial sediments and averaged <2mMol/kg in the subsurface layers. The absence of AVS is consistent with hypoxia, as free sulphide is oxidized to sulphate (SO_4^{2-}) in the presence of oxygen.

5.6.1.10 Dissolved Heavy Metal and Heavy Metal Concentrations

Findings of the 2014 EIA verification found that dissolved heavy metal concentrations in the water column were insignificant and close to or below detection levels. Nutrient concentrations were found to be similar to regional measurements and the Redfield ratio (Molar N:O) averaged slightly higher at 17:71. This could be a result of minor nitrate-nitrogen enrichment. These findings support the conclusions in the 2012 ESIA that the water quality is close to or at its natural state in the Sandpiper Project area.

High concentrations of heavy metals (arsenic, cadmium, chromium, copper and nickel) are found in the surficial and subsurface sediments. This is a common feature of sediments that occur at various locations withing the BCLME. The 2012 ESIA predicted high concentrations of cadmium and nickel. Elutriation studies in the 2014 EIA verification for assessment of the bioavailability of these metals in the dissolved phase showed that they do not present a toxicity risk in situ or following physical disturbance in this phase.

The sediments on the Namibian continental shelf are characterised by elevated cadmium concentrations. It is suspected that resident demersal fish, such as hake and monkfish, would have elevated cadmium concentrations in their livers. Therefore, dredging operations would not have an effect on these species.

It is concluded that trophic transfers of heavy metals associated with dredging sediment plumes would include the ingestion by planktonic copepods. However due to rates of digestion being longer than gut passage time, the metals will be lost in faecal pellets. This sinking rate of the pellets is high and the metals will be returned rapidly to the sea floor (hrs to days).

In order to gain more confidence in the results obtained from earlier studies, toxicity testing was further carried out on the proposed mine sediments in 2020 (Lwandle Marine Envrionmental Services, 2020) Sediment samples used for testing were the available core samples from the proposed mining area and the study focused on surficial layers of these cores. It is noted that the

EMP will include a programme of core sampling and analyses to refresh the overall environmental baseline reference dataset before the commencement of mining which will include monitoring to assess toxicity levels at deeper sediment profiles across the planned mining area.

Nine core samples were subsampled at 5 cm to 15 cm core depths and sediments extracted for analysis. The toxicity testing measured acute and chronic effects on sea urchin fertilisation success and larval development. The toxicity test results are consistent with data collected during the 2014 EIA verification studies, an increase in heavy metal contamination is not likely through direct exposure or through ingestion.

Whilst surficial and subsurface sediments in the proposed dredging area support naturally higher concentrations of heavy metals such as arsenic, cadmium, chromium, copper and nickel, the bioavailability impact is considered not significant, as confirmed during elutriation test work completed in 2014. Therefore, even though the natural concentrations exceed the sediment quality guidelines for the region, the low release of metals in the dissolved phase does not pose a toxicity risk in this phase or in situ following physical disturbance.

With regards to demersal fish, the transfer of heavy metals is low, as these contaminates are reduced ay a primary consumer level. With regards to benthic species, the proposed mining operations will not increase additional exposure above what naturally occurs and therefore bioaccumulation potential is low.

The contamination of heavy metals of the sediment plume is thus not considered to have a significant impact on marine species in the water column when the increase in suspended sediment concentrations above background fall below the value of 7.6 mg/l.

More recent data from updated specialist studies by Robin Carter and Dave Japp have used as part of the current assessment. (See Appendices E and F).

5.6.2 NOISE IMPACTS

A literature-based assessment of the potential impacts of sound from dredging vessels on a variety of species showed that sound levels in all cases are well below those known to cause damage to marine life (J Midgley and Associates, 2014). In 2020 a supplementary study on trailing suction hopper dredger (TSHD) sound measurements were carried out by international dredging company Jan De Nul N.V.

Sound waves associated with the TSHD dredger are similar to that of a merchant vessel, with dominant sounds emitted from the main engine (500Hz) and propeller (300Hz), respectively. Higher frequencies are associated with draghead or soil interaction, hydraulic transport, hopper loading, and these frequencies are faster diminished.

Under water sound limits are internationally imposed to prevent potential damage to marine mammals and fish hearing organs. Such damages are noted to occur at sounds above 150 dB re 1μPa for defined range and continuous exposure periods, with avoidance responses triggered from 100dB re 1μPa. Currently, international and national noise limits set for dredging operations is limited. Using information from other studies including the Jan De Nul dredging vessel fleet and literature reviews, conclusions are drawn on the preferred acceptable range. The source level for a TSHD in operation is 180-190 dB re 1μPa at 1m (Jan De Nul Group, 2020). Figure 26 below summarizes the measurements of the Jan De Nul fleet and clarifies what can be found in literature, that the 150 dB contour range is less than 100m around the vessel (Jan De Nul Group, 2020). Shown in Figure 27 the propagation of underwater sound over a larger range is modelled for a TSHD dredger known as the Gerardus Mercator (Jan De Nul Group, 2020).

Due to the significant variability of ocean water properties and related aspects that influence the transmission of sounds from a specific source, no further meaningful studies for sound profiling of SP1 can be carried out until the intended dredger is on site.

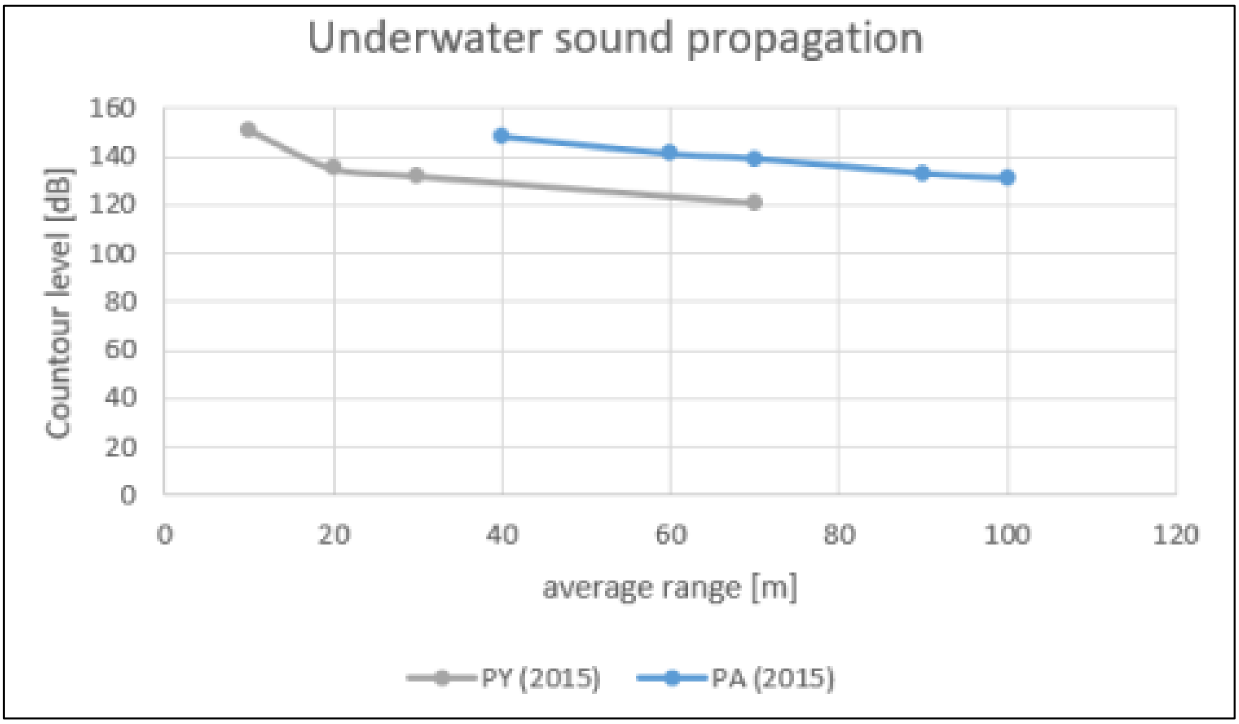


Figure 26 - Measured underwater sound from Jan De Nul fleet (Jan De Nul Group, 2020)

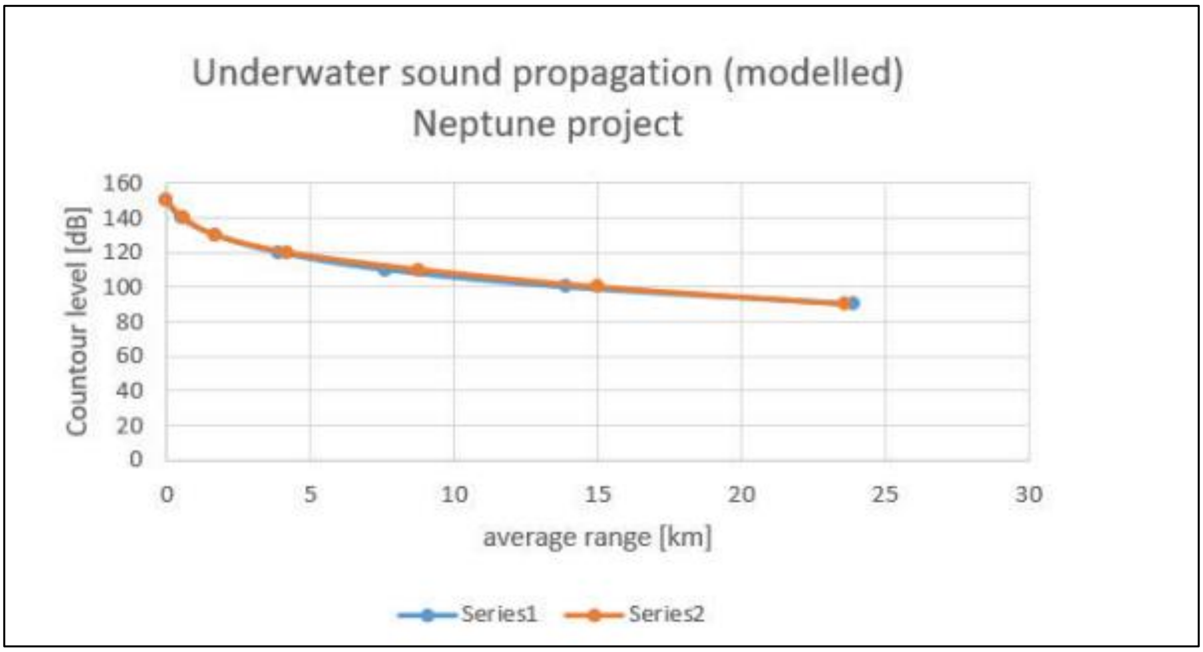


Figure 27 - Modelled underwater sound for TSHD Gerardus Mercator (GM) (Jan De Nul Group, 2020)

Above ground limits are imposed when working in close vicinity of tourist or residential areas. No measures are required for dredgers. The source level for a TSHD in operation is 80 dB to 90 dB re 1µPa at 1m (Jan De Nul, 2020). Figure 28 demonstrates measurements done around the JDN dredger fleet.

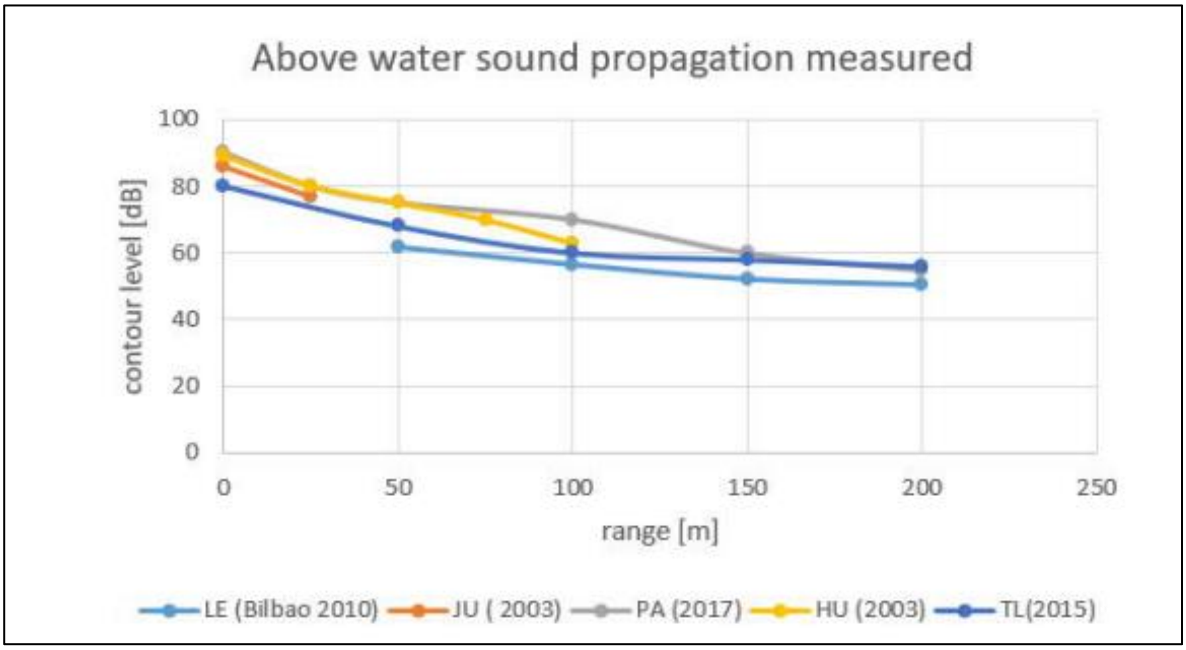


Figure 28 - Above water measurement of sound JDN dredger fleet (5 dredger total) (Jan De Nul Group, 2020)

More recent data from updated specialist studies by Robin Carter and Dave Japp have used as part of the current assessment. (See Appendices E and F).

5.7 METEOROLOGY AND CLIMATE

The meteorological conditions experienced along the Namibian coastline are controlled by the South African anticyclone, the Benguela current, associated upwelling and the divergence of the south-east trade winds as shown in Figure 29. The semi-permanent temperature inversion layer caused by the warm/dry air mass overlapping the cool air mass above the Atlantic Ocean allows for the regular formation of fog and low status clouds. Utilising seasonal and average wind rose data of the Licence Area from voluntary observing ships (Southern Africa Data Centre for Oceanography (SADCO)) over the last 51 year period (1960 to 2011) demonstrates the predominate winds from the south/southeast and are generally stronger in the spring and summer months for offshore winds. Nearshore wind data displays a predominantly strong southern component. There are however minor seasonal changes between southerly and south easterly winds. During the winter months, strong easterly winds from the Namib desert can carry aerosol plumes of sand and dust up to 150 km offshore.

Fog is one of the most distinctive features on the Namibian coastline and can reach up to 35 km offshore (20 nautical miles) which can have an effect on dredger discharge operations from a safety risk perspective. Fog is usually quite dense and reduces visibility intensely. The coast between Walvis Bay and Lüderitz experiences between 50 to 100 fog days a year, with the highest frequency found between Walvis Bay and Swakopmund (±30 km belt). Fog precipitation regularly exceeds rainfall and is considered more reliable moisture for the Namib desert. Fog precipitation averages 34 mm/year at the coast, whereby Swakopmund measured a high of 130 mm in 1958 as shown in Figure 30.

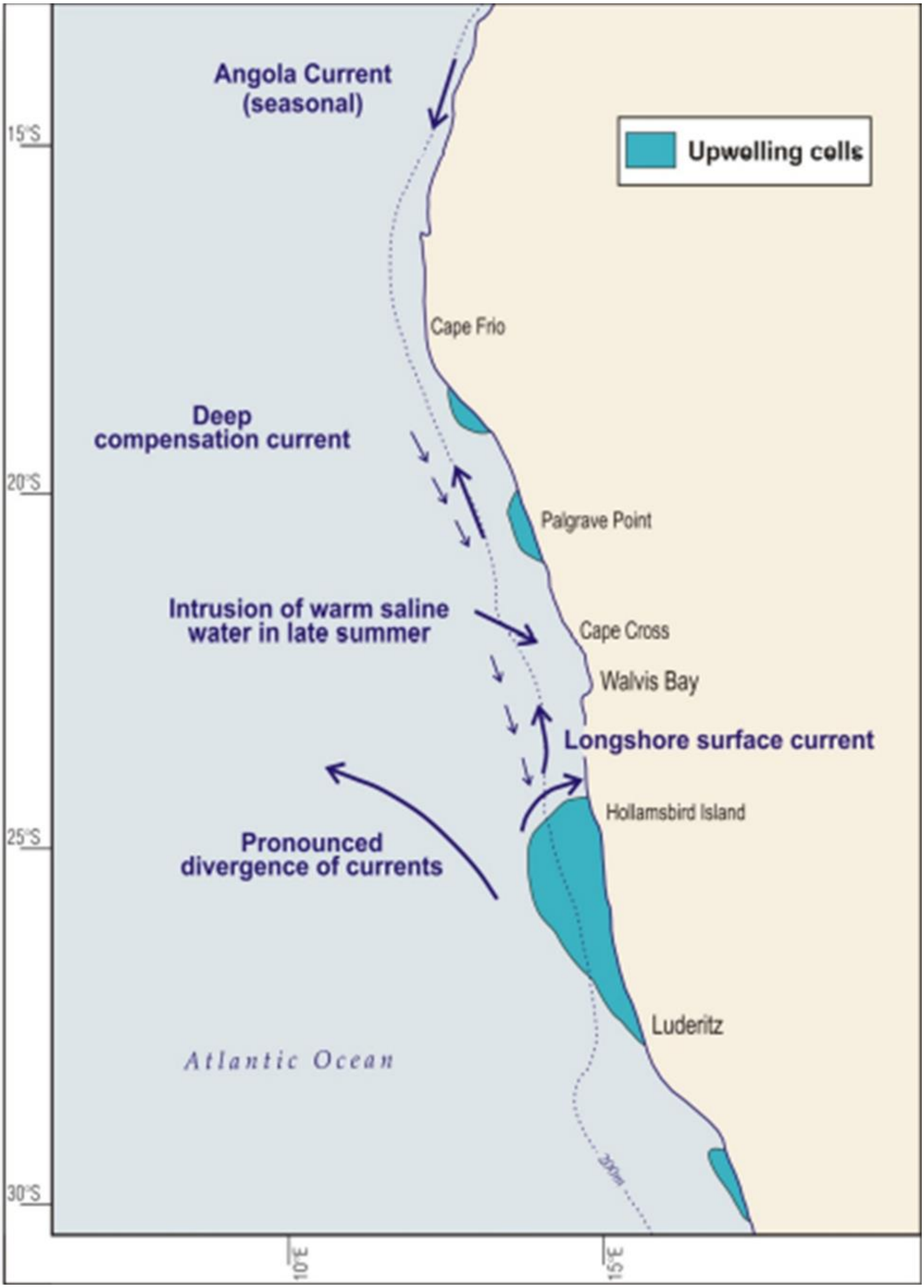


Figure 29 - Upwelling centres on the west coast of Namibia and Angola, with a schematic of currents (Shannon, 1986).

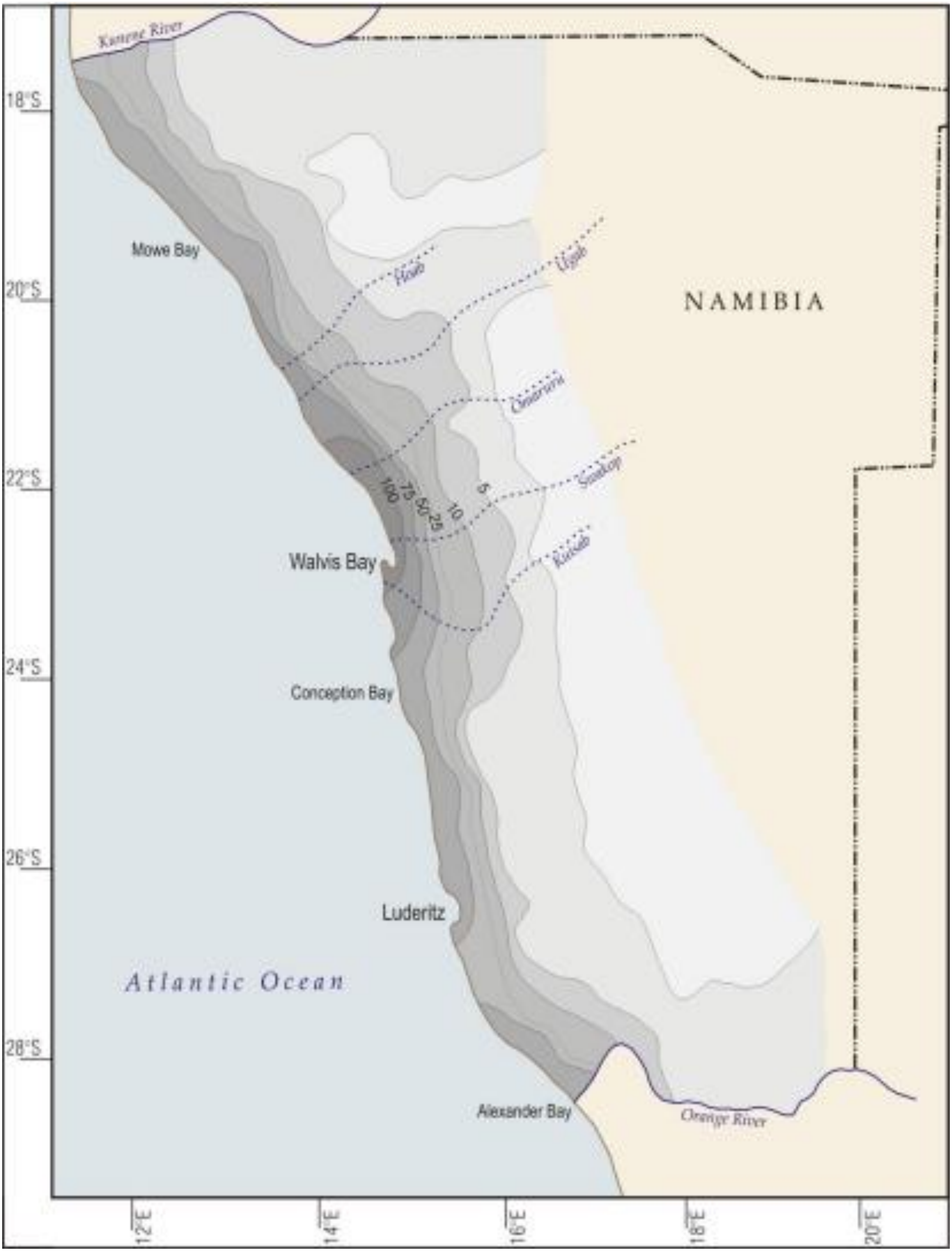


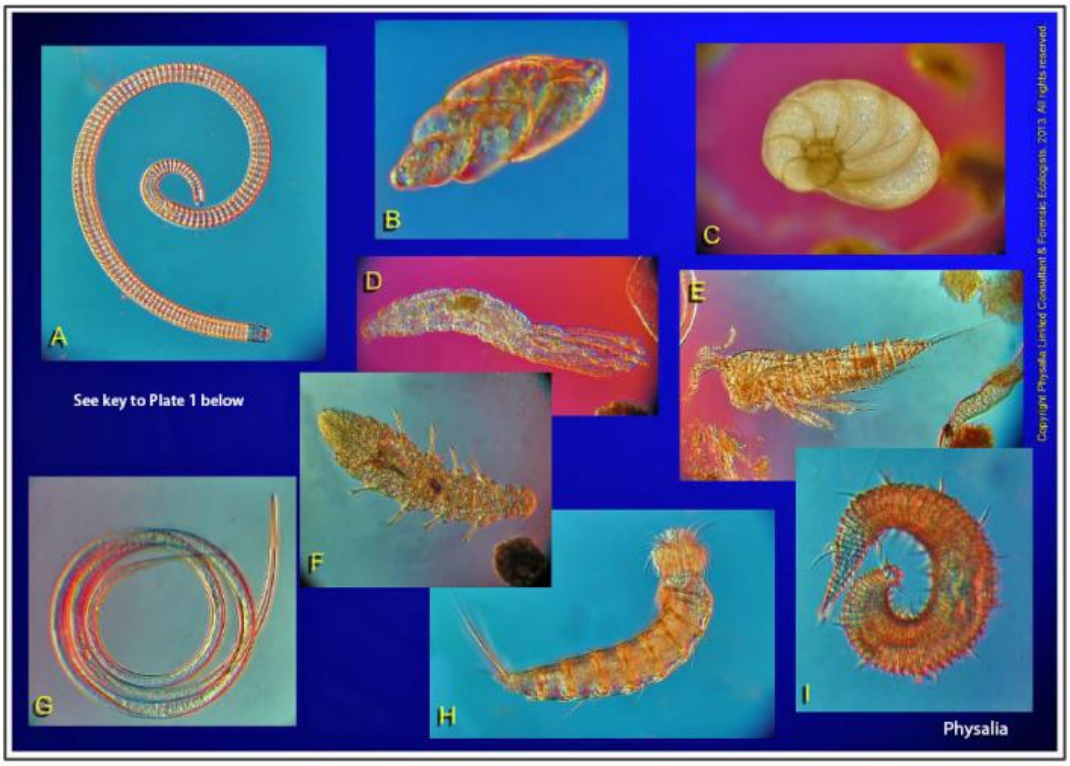
Figure 30 - 1984 Fog day frequency using Meteosat Images (Olivier, 1995)

5.8 BIODIVERSITY BASELINE

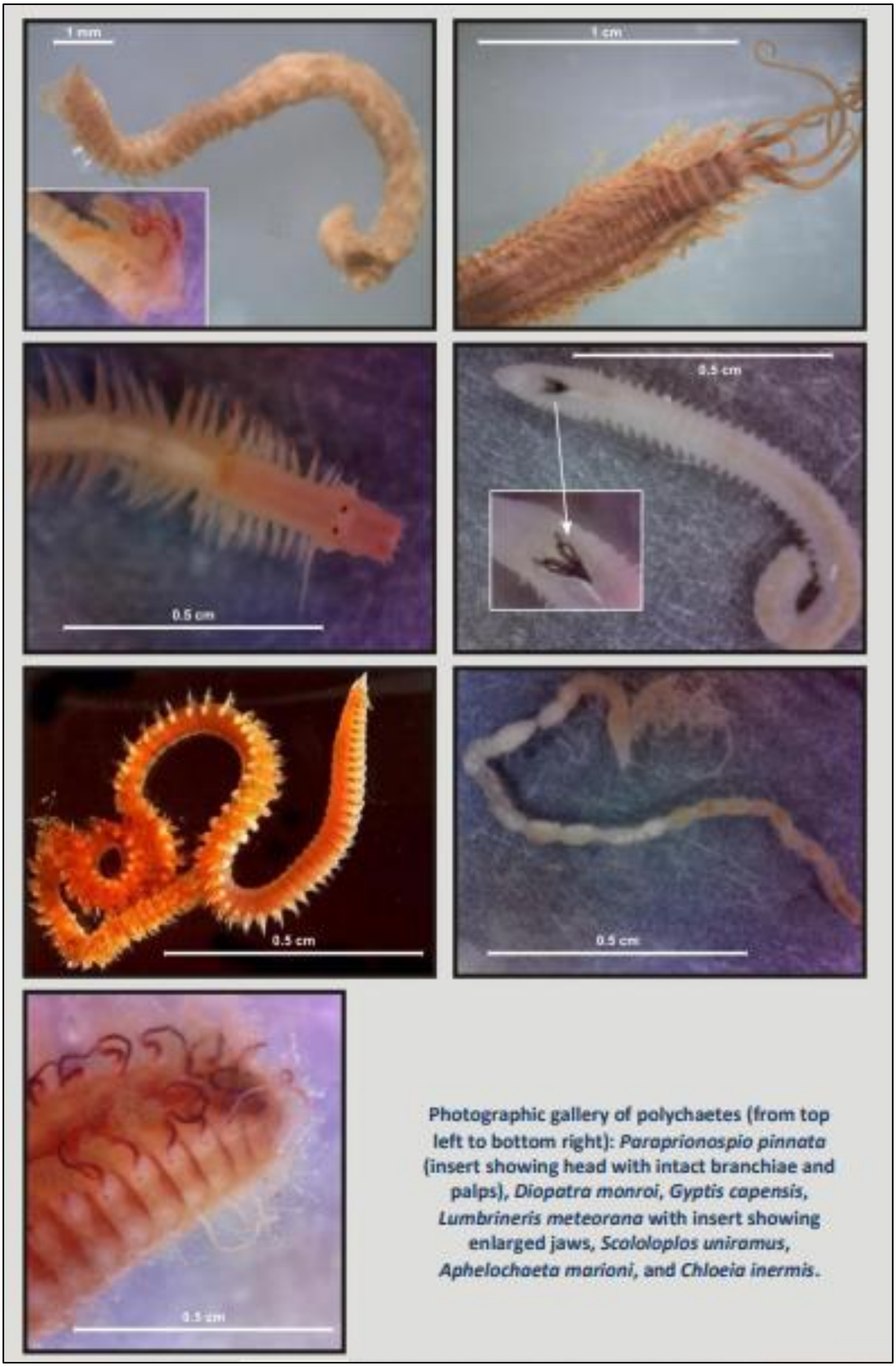
5.8.1 BENTHIC MEIOFAUNA AND MACROFAUNA

Benthic meiofauna and macrofauna are both found to be abundant in the surficial sediments in the Sandpiper Project area shown in Figure 31. Their presence is consistent with hypoxic sediment environments. The relative abundance of benthic macrofauna in the >1 000 µm size class indicates that this condition is persistent as (Para) Prionospio, which forms a large proportion of the fauna, has a life cycle of 1 to 2 years and Diopatra sp. may be as long-lived (Stefanni, 2014). The species abundance is consistent with a stable sedimentary environment The seasonal changes in the oxygen content in the overlaying water body will not greatly influence the benthic fauna. The macrofauna of ML 170 has a much larger geographical distribution and has been recorded on the continental shelf elsewhere along the Namibian and South African west coast.

The homogeneity of the meiofauna and macrofauna assemblages reflects the homogeneous nature of the seafloor in SP1.



A: The nematode worm ***Ceremonema*** sp.; ***B:*** The ***Bolivinitid type*** foraminiferan; ***C:***, The planospiral foraminiferan of the family Elphidiidae; ***D*** and ***F***: Juvenile/neochaete polychaete annelid worms; ***E***: Harpacticoid copepod; ***G***: The nematode ***Halalaimus*** sp; ***H***: A member of the phylum Kinorhyncha; ***I***: ***Quadricoma*** sp.



Photographic gallery of polychaetes (from top left to bottom right): *Paraprionospio pinnata* (insert showing head with intact branchiae and palps), *Diopatra monroi*, *Gyptis capensis*, *Lumbrineris meteorana* with insert showing enlarged jaws, *Scoloplos uniramus*, *Aphelochaeta marioni*, and *Chloeia inermis*.

Photographic gallery of crustaceans, molluscs, and other taxa (from top left to bottom right): The amphipod *Gammaropsis* sp., shrimp *Pasiphaea* sp., isopod *Arcturella lineata*, amphipod *Grandidierella lutosa*, sea pen (Veretillidae), sea squirt (Ascidicea, *Molgula* ? sp.), and the bivalves *Tellina gilchristi* and Dosinia ? sp.

Figure 31 - Benthic meiofauna and macrofauna samples taken during 2014 field survey (J Midgley and Associates, 2014).

5.8.2 THIOBACTERIA

During field surveys in 2014 of the sampled bacterial assemblages of thiobacteria, it was observed that the large sulphide bacteria, namely from the genera Thiomargarita, Beggiatoa and Thioploca, were absent. These bacteria play significant roles in the oxidisation of H2S. Smaller forms including Thiobacillus spp with relatively lower growth yields were present. Therefore, it can be concluded that sulphide fluxes are assumed to be low.

5.8.3 PLANKTON

The Atlantic oceanographic environment off the Namibian coastline is dynamic and influenced mainly by the Benguela current upwelling system. This system supports a rich ecosystem with a high abundance of phytoplankton, zooplankton and ichthyoplankton species. Within the Lüderitz upwelling cell, the species abundance is low however, abundance in species increases between the transitional zone of the southern and northern regions of the Benguela ecosystem, which is located north of ML 170. Additionally, species abundance decreases further offshore which is important since the proposed dredging site is located 60 km offshore. The plankton species present in the vicinity of the ML 170 area are commonly found in the region.

5.8.3.1 Phytoplankton

Phytoplankton communities in the Sandpiper Project area are dominated by diatoms and the majority of these species are found in the global oceans. Diatoms occur primarily inshore, with biomass decreasing offshore. These species found within ML 170 are therefore common and occur in decreased abundance when compared inshore.

5.8.3.2 Zooplankton

Zooplankton communities in the central Namibian waters are dominated by copepods. These species are common and not unique to the Sandpiper Project area. Zooplankton is found further offshore than phytoplankton, whereby species abundance peaks on the shelf-break at depths of approximately 200 m. The proposed dredging activity of the Sandpiper Project is located in water depths of 200 m to 225 m, and therefore an increased abundance of zooplankton will be present (Japp, 2012).

5.8.3.3 Ichthyoplankton

Central Namibian waters support several commercial fisheries. Species of sardine, anchovy, hake and horse mackerel are of particular importance. The ichthyoplankton of these species plays an important role in recruitment, which is important for the fishing industry. Generally, fish off the Namibian coast spawn in inshore waters north of Walvis Bay. Based on assessment of the available information, the proposed 20-year mining area in SP-1 is not located within any important spawning or nursery grounds for the commercially fished monk and hake fisheries (Japp, 2012).

Although the central Namibian waters are productive and support large communities of plankton, the proposed dredging site does not occur within any identifiably important area for phytoplankton, zooplankton or ichthyoplankton growth and development (Japp, 2012).

5.8.4 FISH, SEABIRDS AND MAMMALS

The 2014 verification survey component for fish, fisheries and biodiversity consisted of a; i) review of ecosystem modelling and its application to ML 170 and ii) a monk trawl survey. These studies were conducted to further enhance the findings from the 2021 EIA and the subsequent results will be discussed in the Sections below.

5.8.4.1 Ecosystem impact modelling

The review of the possible ecosystem impacts of dredging (up to 3 km^2 annually and 60 km^2 for the 20-year mining lease period) within the broader northern Benguela system concluded that the combination of the high uncertainty typically associated with projections by ecosystem models and the extremely small area that will be affected by the proposed dredging annually and cumulatively over 20-years means that it is unlikely that ecosystem modelling would be able to resolve and expose any unexpected or highly significant threats that have not already been considered and evaluated in the other specialist studies (Midgley 2014). Therefore, significant impacts on the ecosystem are unlikely.

5.8.4.2 Fisheries – biomass, recruitment and spawning

Conclusions drawn from the biodiversity survey are consistent with the 2012 ESIA assumptions and findings as well as the 2014 EIA Verification findings regarding the size distribution of the main commercial fish species (monk and hake) most likely to be impacted on. No evidence could be found of unique spawning and recruitment characteristics in the mining licence area. Juvenile and pre-recruiting Cape hake is found in abundance. No irregularities were found between proportions of juveniles and sex ratios (male and females), making the dredge area not unique.

With regards to monkfish, the verification survey provided evidence of a mix of juveniles, adults and pre-recruiting fish. Due to the survey team using monk-directed gear with a cod-end liner (20 mm mesh) to retain as much as possible, the proportion of juvenile fish caught was higher than would be expected for equivalent Biomass assessments completed by MFMR (J Midgley and Associates, 2014).

Both the field survey outputs and the biomass estimates for SP1 confirm that the dredging activity is likely to have only a very small impact relative to the overall abundance of the monk and hake stocks in Namibian waters (J Midgley and Associates, 2014). The impact in SP1 on monk reproduction and the recruitment will also be minimal.

Sole abundance was recorded as low during the survey. Additionally, predominantly large sole was caught. This further suggests that the SP1 area and adjacent grounds are unlikely to be a significant recruiting area for sole.

The verification surveys for the fish, mammals and seabirds confirmed the core assumptions of the 2012 ESIA, confidence levels of the impact assessments are now reported as high (J Midgley and Associates, 2014).

5.8.4.3 Biodiversity Trawl Survey

The biodiversity survey spanned a total of eight days in June 2014 in the Sandpiper Project area and was conducted under specifications set by MFMR and with participation of 2 members MFMR onboard the survey vessel. A commercial monkfish trawler was used, sampling 24 stations at depths greater than 200 m. The aim of the survey was to provide biodiversity baseline data.

A total of 14 fish species, including two squid species (*Todarodes angolensis* and *Todaropsis sagittatus*) and one shark (*Hexanchus griseus*) was identified. Cape hake dominated the catch, amounting to 40% of the total fish weight. This was followed by monkfish at 35%, rat tail (*Coelorinchus simorynchus*) at 14%, West Coast sole at 3%, bearded goby at 2% and horse mackerel at 0.4%. Cape hake, monkfish and gobies were found in most of the trawls and little variation was noted throughout the survey area showed in Figure 32. In general fish diversity was lower than reported in the 2012 ESIA. The most probable reason is that the survey gear used in 2012 varied in type (hake, monk, midwater, purse seine). As a result of using dedicated monk trawl gear, no conclusions can be made regarding the availability and abundance of non-demersal species (horse mackerel, sardine, mesopelagics and gobies).

The fauna recorded in the 2014 verification survey were notably less abundant than reported in the 2012 ESIA. Fifteen species of seabird, 45% were White-chinned Petrel (*Procellaria aequinoactialis*), 20% Subantarctic Skua (*Catharacta antarctica*) and 12% Black-browed Albatross (*Thalassarche melanophrys*) as shown in Figure 33. Only two species of marine mammals were observed during the survey, the Cape fur seal (*Arctocephalus pusillus pusillus*) and the dusky dolphin (*Lagenorhynchus obscurus*) as shown in Figure 34. With respect to demersal fish species mammals and seabirds, no unique features were noted, and the results are consistent with the initial assessment in the 2012 ESIA that the abundance of certain species will vary.

No mesopelagic species were recorded in the trawl catches. Lantern fish are expected in the mid-water; however, the trawling gear would not have targeted these species.

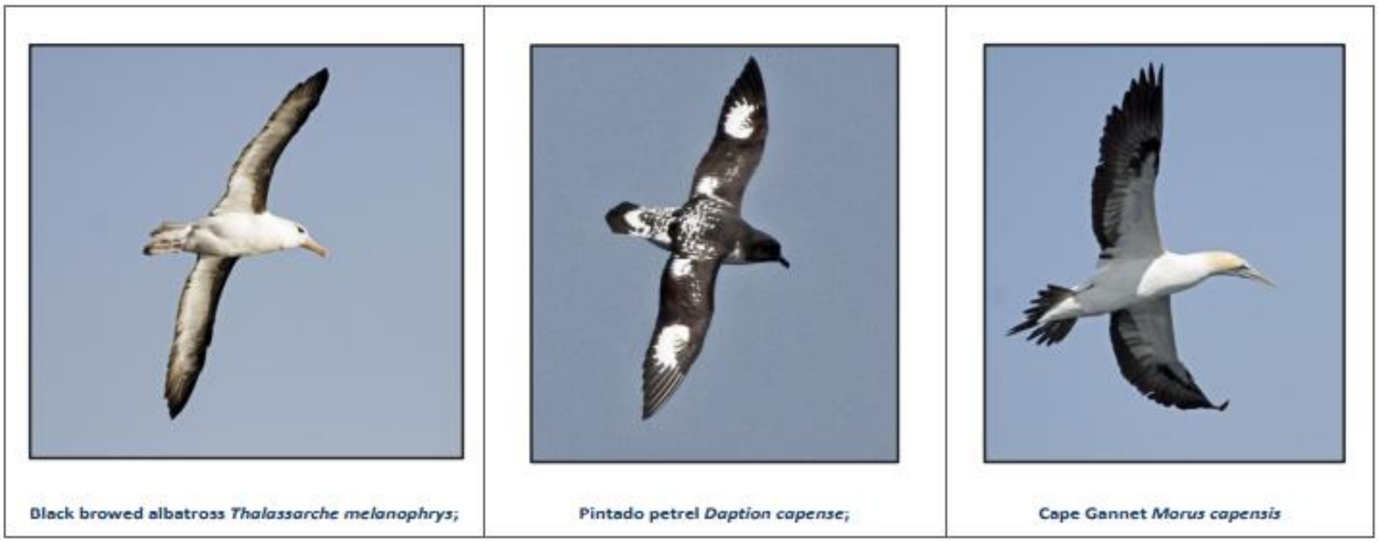
Trawl catches between night and day varied as expected due to the normal diurnal behavioural patterns with regards to fish and crustaceans.

Fourteen taxa of epifauna were collected by the bottom trawl, which included; crabs, ascidians (sea squirts), brown sponges, sea pens, mantis shrimps, starfish and whelks shown in Figure 35 and Figure 36. The colonial ascidian (*Molgula* sp.) was recorded as the most dominant bottom living organism, contributing up to 60% of the epifauna catch weight. This was followed by the pennate sea pens (family Veretellidae) at 37%. Both groups were found widely distributed over the survey area. Overall, the high abundance of ascidians was notable. Their abundance may in part be due to the historically very low density of trawling of the region and in particular in the Sandpiper Project area as shown in Figure 37.

Jellyfish, particularly *Chrysaora fulgidia* were also abundant in all trawl catches.

More recent data from updated specialist studies by Robin Carter and Dave Japp have used as part of the current assessment. (See appendix E and F).

Figure 32 - Fish, shark and squid species collected during the survey (J Midgley and Associates, 2014)



Black browed albatross *Thalassarche melanophrys*; | Pintado petrel *Daption capense*; | Cape Gannet *Morus capensis*

Figure 33 - Avifauna species observed during the survey (J Midgley and Associates, 2014)

Figure 34 - Dusky dolphin (*Lagenorhynchus obscurus*) observed during the survey (J Midgley and Associates, 2014)

Figure 35 - Epibenthic fauna collected include: 1. Odontaster australis; 2 Astropecten (aboral view); 3 Astropecten (oral view); 4 Molgula; 5 Proferia (J Midgley and Associates, 2014)

Epibenthic fauna: 1 *Bathynectes piperitus*; 2 *Solenocera africana*; 3 *Pterygosquilla armata capensis*; 4 Veretellidae; 5 *Callianassa australis*.

Figure 36 - Epibenthic fauna collected include: 1 *Bathynectes piperitus*; 2 *Solenocera africana*; 3 *Pterygosquilla armata capensis*; 4 Veretellidae; 5 *Callianassa australis* (J Midgley and Associates, 2014)

Figure 37 - Trawl contents showing a high abundance of spherical *Molgula* sp (family Ascidiacea) (J Midgley and Associates, 2014)

5.9 SOCIAL AND SOCIO-ECONOMIC BASELINE

The 2012 and 2014 ESIA reviewed the social and socio-economic environment for the proposed Sandpiper Project, in which associated impacts and key sensitivities were identified. Therefore, a summary of this review will be provided in this Chapter. However more recent data for the Erongo and Walvis Bay coastal region will be sourced from Geological Survey of Namibia's Strategic Environmental Management Plan (SEMP) report(s) and the 2011 National Population Census (NPC). A recent pilot census was conducted in 2021, however this data is not yet available from the National Statistics Agency.

A supplementary socio-economic study was conducted in 2020 by Jan De Nul N.V. and the marine component of this study will be further elaborated on in this Chapter. Additionally, an industry-based study was carried out in 2018 by Stratecon Applied Economic Research to conduct an economic assessment of the development of a phosphate-based industry in Namibia. Further details on the conclusion of this study will also be discussed.

The Namibian Government aims to encourage local and foreign investment, promote job creation, alleviate poverty and income inequality. The establishment of Namibia's first marine phosphate mining project will have positive short, medium and long term socio-economic impacts for Namibia. At full production of 3.0 Mtpa, it is expected that Namibia will be amongst the top ten world producers of phosphate.

One of the main positive contributors and tangible impacts of the dredging operations will be the employment opportunities created for the local communities. These are both direct and indirect such as material supplies, catering, training, education etc. The skill sets created in the community will remain after the Sandpiper Project has closed. Local purchasing in relation to the Sandpiper Project will also improve the local economy.

5.9.1 POPULATION AND GROWTH RATE

In 1991 the Erongo Region had a population of 55,470, in 2001 this increased to an estimated 107,663 and in 2011 this increased to 150,809 (Government of Namibia, 2011) as shown in Figure 38. The percentage increase from 2001 to 2011 is recorded as 40.1%. Therefore, an estimated 50 000 increase per decade is noted. The first main population increase in 1994 was noted due to the inclusion of Walvis Bay into Namibia from South Africa. The increase between 2001 and 2011 can be attributed to the increase in industrialisation in the coastal towns and the uranium rush. The Erongo Region is the seventh most populated region in the country (Government of Namibia, 2011). If the main urban towns and city populations are reviewed, Walvis Bay (62,096) and Swakopmund (44,725) are the third and fourth highest respectively. Persons per km^2 are calculated to be 2.4.

The growth rate in the Erongo increased from 1.3% in 2001 to 3.4% in 2011, with more males residing in the Erongo than females, with a difference of over 10 000. This status has remained relatively the same for both 2001 and 2011. This is mainly attributed to job availability in the industrialised market at the coast, whereby traditionally certain skill sets were not associated to be 'female jobs'. The Erongo Region is recorded to have had the highest growth rate than any other region between 2001 and 2011.

The Khomas and Erongo regions have also experienced the highest statistics with regards to inward migration at above 40% between 2001 and 2011.

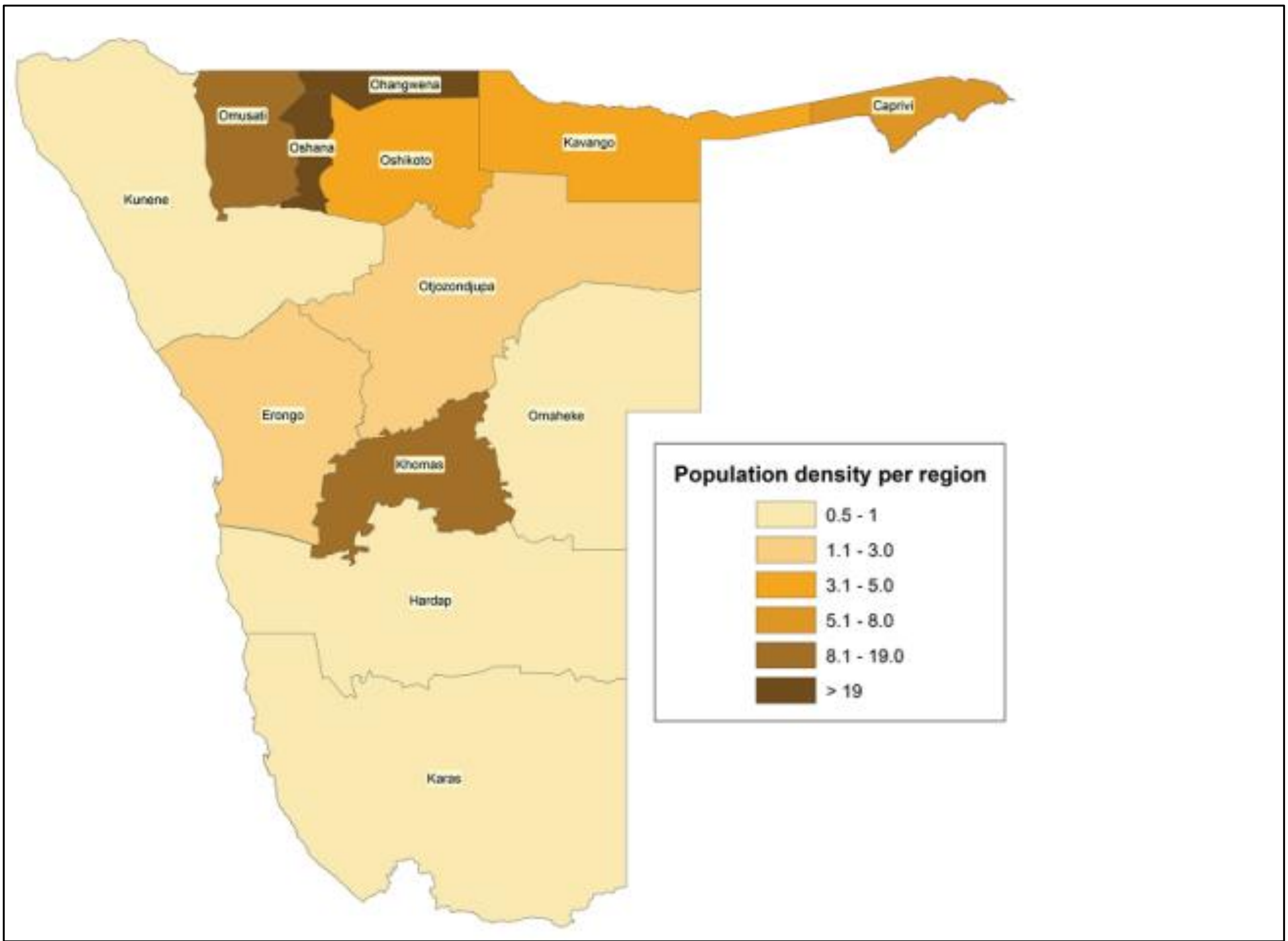


Figure 38 - Population density recorded per region (Government of Namibia, 2011)

5.9.2 POVERTY AND UNEMPLOYMENT

Urbanisation in the Erongo Region is noted to have increased between 2001 and 2011 from 80% to 87.4%. The unemployment rate in the Erongo Region decreased between 2001 (34%) and 2011 (30%). However, overall, the unemployment rate in the country increased from 28% in 2014 to 33% in 2018. See Table 12 depicting urban population changes per main coastal town.

Table 12 - Urban population by census year for the Erongo Region main coastal towns

Town	2011	2001	Difference	Percentage Change
Walvis Bay	– 62 096	– 43 611	– 18 485	– 42.4
Swakopmund	– 44 725	– 23 808	– 20 917	– 87.9
Henties Bay	– 4 720	– 3 285	– 1 435	– 43.7
Arandis	– 5 214	– 3 974	– 1 240	– 31.2

The 2011 census determined that for the Namibian economically active population, 63% aged 15 years and above were employed, whilst 37% were unemployed. There were only slight differences between urban and rural areas. In the Erongo, 22.9% of the unemployed workforce was actively looking for jobs, with more females (29.7%) actively looking than males (17.5%). The latter is in fact the lowest country wide for the inactive male workforce.

As per information received from the Namibian Chamber of Mines and SEMP Report, the mining industry provided 9,045 permanent and 498 temporary jobs in 2018. Additionally, 6,681 individuals were subcontracted. Currently approximately 1.5% of Namibia's workforce is employed in the mining sector.

The COVID-19 pandemic has also had a negative effect on the economy and the livelihoods of individuals across the various sectors. Due to the stringent lockdown events that occurred in 2021 in Namibia, many people lost their jobs and had to seek alternative work or assistance. Namibia and her economy are still recovering from this as the pandemic is ongoing.

5.9.3 ECONOMIC ENVIRONMENT

Currently the main economic drivers of Walvis Bay and Swakopmund town are fishing, tourism, manufacturing, mining and the harbour. Of these industries, the fishing industry is perceived by certain groups to be affected by the proposed Sandpiper Project.

There are two main noted categories of fishing; pelagic and demersal. Pelagic fish are found near the upper layers of the open sea, whilst demersal fish are found on or near the seabed. Both types of fish are caught north and south of Walvis Bay and quotas per catch per day are allocated and monitored from the Ministry of Fisheries and Marine Resources.

Demersal fish are caught by bottom trawling on the seabed on the Namibian continental shelf at water depths ranging from 200 m to 600 m in parts of the Sandpiper Project area (ML 170) and surrounding areas, bottom trawling operations are undertaken at water depths of 200 m to 350 m. However as discussed earlier in this Chapter from the scientific field surveys, at the scale of the proposed dredging operations, the operational and cumulative impacts and influences on the fishing industry are considered to be minimal.

The development of the proposed Sandpiper Project will contribute towards the NamPort expansion and bulk terminal development. NMP will move an estimated ~8.0 Mtpa (~5.0 Mtpa import and ~3.0 Mtpa export) of cargo through the port which will contribute to investment in Walvis Bay and the planned Walvis Bay development corridor.

5.9.4 HEALTH AND DISEASE

Currently the Namibian public health system experiences various short falls, which is a national issue. This was further exacerbated with the influence of the COVID-19 pandemic in 2021. There are three different types of health services available in Namibia; public, private and not-for-profit (NGO). Currently only 15% of the population can afford private healthcare and certain services are only available at these facilities.

The Ministry of Health and Social Services (MHSS) formulated a strategy including planned targets to be achieved by 2022. The implementation of this strategy depends on the availability of resources. The Ministry reconfirmed its commitment in 2018/2019 to capacity building and skills development of health workers to provide quality essential services.

What is evident from the 2019 MHSS statistics reviewed for the Erongo for the ambulance availability, number of registered healthcare facilities and the number of registered health care professionals is that these targets have not been met. The vessel will have onboard its own medical facility and officers who are trained in first aid. In the event of an emergency involving serious injury or illness NMP's emergency response procedures include provision for assessment and airlift to a hospital by medivac. Emergency response plans are integrated with details of onshore local medical facilities and medivac capabilities prior to commencement of operations.

In 2015 the MHSS conducted an exercise known as the Workload Indicators of Staffing Need (WISN). This exercise would determine the number of health care professional required per region according to national practice standards. The exercise focused on four categories of health workers that the MHSS determined as the most critical.

Table 13 summarised the WISN results for the Erongo, compared to the SEMP targets. Additionally, the table shows target ratios of health care professionals versus actual numbers in 2015, assuming a population of 175,750 residing in the Erongo. Currently the Erongo is not meeting the required figures or ratios.

Table 13 - Public health care professionals in the Erongo region (WISN and SEMP) (SEMP, 2018/2019)

	Doctor		Dentist		Pharmacist		Pharmacist assistant		Registered nurse		Enrolled nurse	
Health District	Actual	Required	Actual	Required	Actual	Required	Actual	Required	Actual	Required	Actual	Required
Omaruru district	3	4.6	0	0.8	0	2.8	1	2.5	0	33	0	30
Swakopmund district	5	14	2	1	0	4.3	4	6.7	49	64	27	43
Usakos district	2	4.7	0	2	0	2.8	1	4.2	24	36	16	30
Walvis Bay district	4	14	3	1	0	4.5	2	9.3	12	89	9	69
Total	**14**	**37**	**5**	**5**	**0**	**14**	**8**	**23**	**85**	**223**	**52**	**172**
Target ratio per 1000	1:1000		1:2000		1:2000		1:2000		2.5:1000		2.5:1000	
Actual ratio per 1000	1:12550		1:35150		None		1:22000		1:2070		1:3380	

Walvis Bay currently has the highest rate of tuberculosis (TB) infections in Namibia. This was also the first town during the COVID-19 pandemic where cluster infections were occurring. This can be seen as contributions from the international harbour, various trucking companies and overcrowding in townships, whereby airborne diseases travel faster. The 2016 Ministry of Health Centennial Surveillance Survey confirmed Walvis Bay had a HIV/AIDS prevalence rate estimated at 17.6% and Swakopmund of 18.6%. The national prevalence rate average stands at 17.2%. Both Swakopmund and Walvis Bay are above the national average; however, Walvis Bay has shown a noted decrease from previous surveys (29% in 2009) and Swakopmund has shown a significant increase from the 2015 survey (10.5%). National for urban areas, the age group 45 to 49 group had the highest prevalence rate, whereby in rural areas the age group 35 to 39 had the highest prevalence rate.

5.9.5 SOCIO-ECONOMIC ENVIRONMENT

Early childhood development (ECD) programmes are crucial for children to develop the necessary skills to further their future educational and career pathways. The 2011 census concluded that of the total children recorded between the ages of 0 to 4 years (283 501), only 13% attending ECD programmes country wide. Accesses to these ECD centres in urban areas were higher than in rural areas. At a regional level, a higher proportion of children attended ECD programmes in Erongo (24.2%). It can be concluded that the mining industry has played a role to better these facilities as part of its educational and community outreach programmes (2018-2019 SEMP report).

The 2011 NCP survey revealed that the literacy rate in Namibia for the population 5 years and above was 85.3%. The rate was marginally higher for men (85.4%) than for women (85.1%). Furthermore, literacy rates were higher in urban (93%) than in rural (79%) areas (Government of Namibia, 2011). The literacy rate in the Erongo was recorded at 94.3%, with females (94.5%) slightly more literate than males (94.2%). The Erongo has the second highest literacy rate behind the Khomas Region.

The 2011 national adult literacy rate (15 years and above) was 89%, with no major difference between males and females. The adult literacy rate in urban areas stood at 96% compared to 83% in rural areas (Government of Namibia, 2011). The adult literacy rate in the Erongo was 96.7%, with females (96.9%) slightly more literate than males (96.4%).

The 2011 literacy rate for youth (15 to 24 years) in Namibia was 94%, with higher proportions of women (95.3%) being literate than men (92.5%). The rate was again higher in urban (98%) than rural areas (92%) (Government of Namibia, 2011). The Erongo youth literacy rate was recorded to be 98.1%, with females (98.7%) more literate than males (97.6%).

The 2011 school enrolment rate for the school going population (5 to 24 years) was not high at 56%. However, the primary school enrolment rate for the Erongo was high (91.2%) with more primary school going females (92%) over males (90.5%).

The learner to teacher ratio for the Erongo in 2020 and 2019 was determined as 27 learners per teacher. This is slightly higher than the national average of 26 learners per teacher. No improvements have therefore been noted in the Erongo (SEMP, 2019).

With regards to persons living with a disability (physical or mental), the Erongo Region displayed the lowest percentage when compared to other regions (2.5%). The difference between female (2.4%) to male (2.6%) disability ratio was low. Of the disabled group, 36.3% are not able to engage in any learning or economic activity. This is one of the lowest percentages per region.

The labour participation rate for the economically active population in the Erongo (78.8%) was relatively high when compared to the average national percentage (64%) and other regional percentages (Government of Namibia, 2011). In the Erongo, a higher percentage of males (82.4%) are active than females (74.7%).

At a project level, the following socio-economic contributions are expected to occur when both the marine and terrestrial land components can commence:

- Over 600 Namibians will acquire jobs, directly or indirectly, with the construction and operational activities in Walvis Bay (land-based operations)
- Opportunities will be created for SMEs and other economic sectors
- N$ 1 billion is estimated to be spent on civil and local infrastructure
- Contribution of N$650 million/year in direct taxes
- Contribution of royalties of N$78 million/year
- Expected annual revenue of N$4.2 billion.

The following information at a developed fertilizer industry level was predicted by Stratecon (2018) of the contribution of the phosphate industry to Namibia from zero contribution in 2010 to 2016:

- 4.3% Namibian GDP in 2012 and to 9% by 2016
- 1.9% mining GVA in 2012 and to 4.2% by 2016
- 18% manufacturing GVA in 2012 and 45.7% by 2016
- 2.7% employment in 2012 and 7.6% by 2016
- Additionally, increased productivity in subsistence farming would have added 3.8% to agriculture GVA in 2012 and 5.2% by 2016.

Figure 39 and Figure 40 provides an overview of the phosphate industry contribution to the GDP and employment, respectively, as predicted by Stratecon (2018).

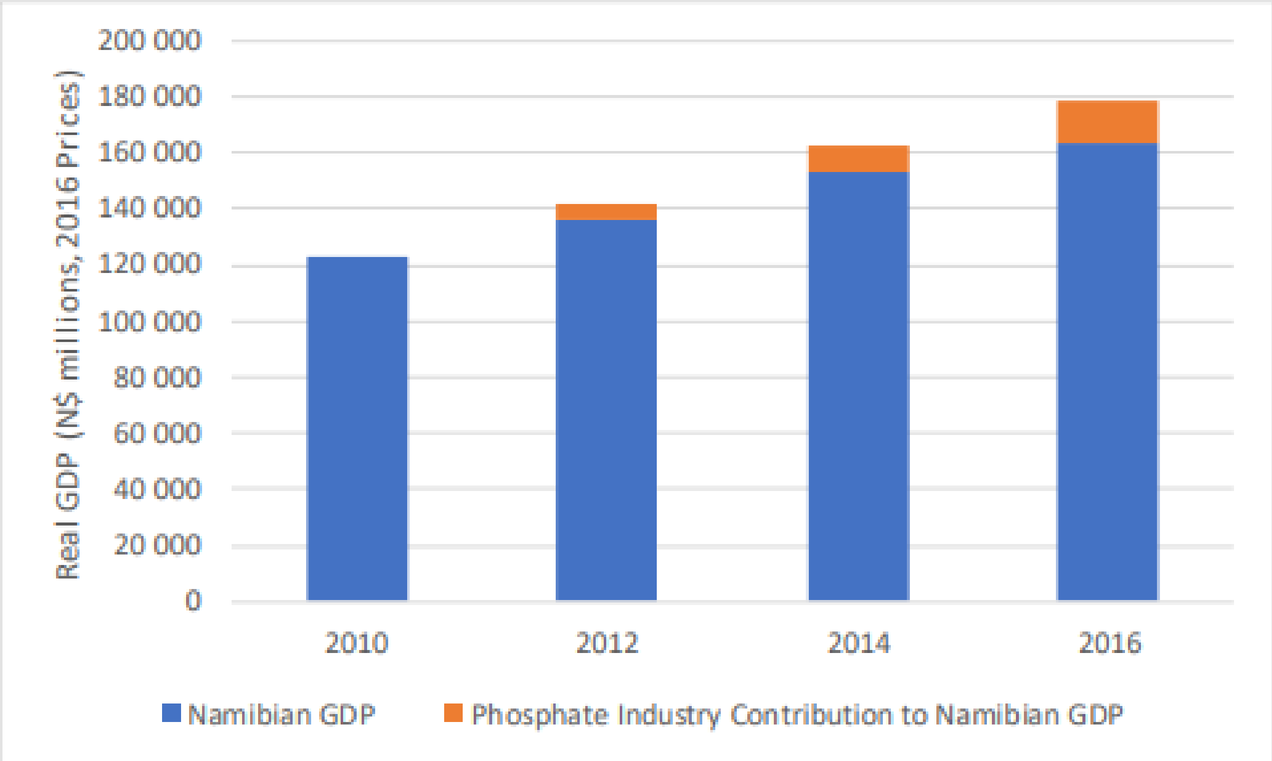


Figure 39 - Phosphate industry contribution to the GDP (Stratecon, 2018)

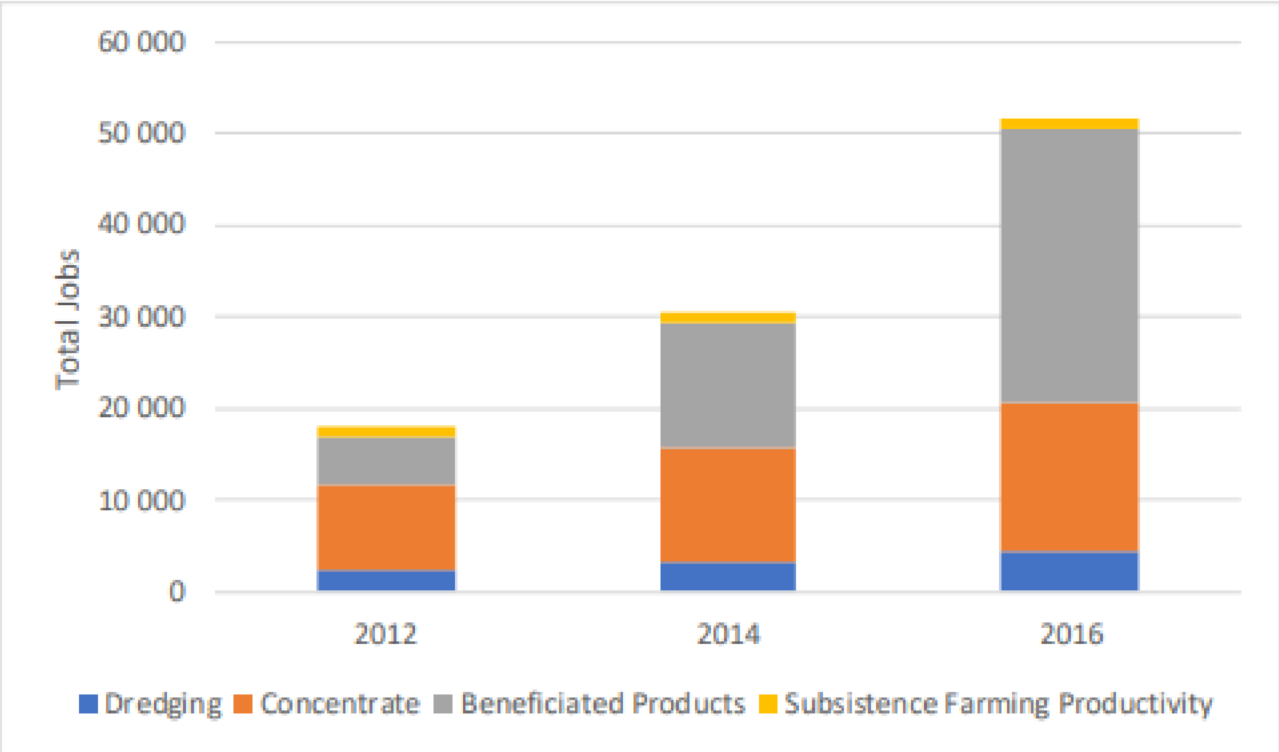


Figure 40 - Employment potential (Stratecon, 2018)

5.9.6 SOCIO-ECONOMIC INDICATORS

Table 14 below describes the socio-economic indicators as determined by the 2020 Jan De Vul study.

Table 14 - Socio-economic indicators assessed and defined

Indicator	Description
Local employees and sub-contractors	– Payment of salaries and benefits – Programmes relating to skills development and training/education – Workplace safety employed
Local Economy	– Local purchasing of goods and services within the project context. – Purchasing of goods and services outside the project context (tourism, living expenses etc.) – Social programmes and community upliftment. – Revenue for government through income tax, levies, other taxes, royalties profit taxes. – Profits retained and distributed to local shareholders.

The Sandpiper Project estimates that over 72 employees will be employed for land and sea-based operations, with 40 crew members working at sea. Employees will be skilled labour and receive an expected salary above the national average wage. Year 1 is expected to be a 3 month operation, year 2 a 6 month operation, year 3 and going forward is expected to be a 9 month operation. Man, hrs will therefore differ per year. If skill sets are not readily available in Walvis Bay, specific training programmes will be established to build up this capacity.

The overall conclusion from the Stratecon (2018) study found that to commence with the Namibian phosphate industry would have a major positive impact on the country. It could potentially increase GDP by 9%, generate over 50 000 jobs from a fully integrated fertilizer industry and increase employment levels to 7.6% to 2016. The phosphate industry would help the country achieve both general and specific Vision 2030 and Harambee policy goals.

5.9.7 KEY SENSITIVE RECEPTORS

The key sensitivities were identified, and impacts assessed in the 2012 and 2014 ESIA and therefore will not be repeated for this report but rather summarised below.

Positive influences associated are job creation, skills transfer, improvements in the local and national economy (GDP).

Some potential negative influences associated are inward migration, spread of illness and disease and influences on fishing trawling activities.

Additional key sensitivities were identified during the public participation process and have been addressed in the 2020 supplementary studies covering the following areas:

- Fish spawning areas
- Trawling protected juvenile zones
- Hake and monk commercial fishing grounds
- Mariculture and Saltworks operations water intake.

A Map depicting commercial fishing zones (as sensitivity receptors) in relation to ML 170 is also shown in Figure 41.

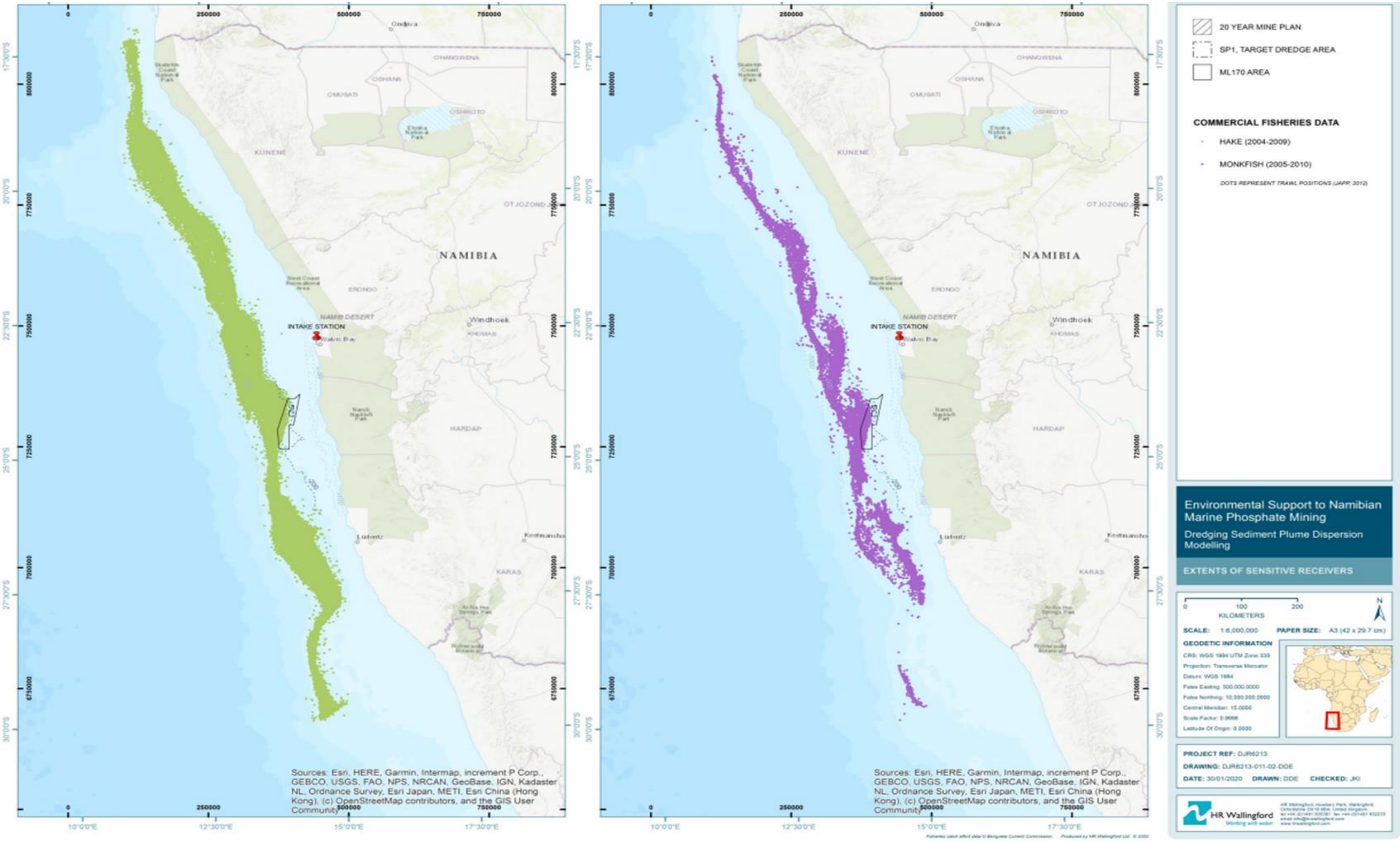


Figure 41 - Map depicting commercial fishing zones (as sensitivity receptors) in relation to ML 170 (HR Wallingford, 2020)

6 IMPACT IDENTIFICATION & EVALUATION METHODOLOGY

6.1 INTRODUCTION

Chapter 2 provides an overview of the approach used in this ESIA process and details each of the steps undertaken to date. Predication and evaluation of impacts is a key step in the ESIA process. This Chapter outlines the methods followed, to identify and evaluate the impacts arising from the proposed Sandpiper Project. The findings of the assessment are presented in Chapter 7.

This Chapter provides comprehensive details of the following:

- The assessment guidance used to assess impacts
- The limitations, uncertainties and assumptions with regards to the assessment methodology
- How impacts are identified and evaluated and how the level of significance is derived
- How mitigation is applied in the assessment and how additional mitigation will be identified
- The cumulative impact assessment (CIA) method used.

The aims of this assessment process will be to determine which impacts are likely to be significant; to scope the available data and identify any gaps that need to be filled; to determine the spatial and temporal scope, to identify and describe the assessment methodology.

The scope of the assessment will be determined through undertaking a preliminary assessment of the proposed Sandpiper Project against the receiving environment. This will include a desktop review incorporating the available site-specific data, pertinent Project-specific literature and required specialist studies.

6.2 ASSESSMENT GUIDANCE

The following principal documents were used to inform the assessment method:

- Methodology utilised in initial 2012 environmental impact assessment and the 2014 verification assessment (J Midgley and Associates, 2014) for the biophysical environment
- Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008) and best practice
- International Finance Corporation (IFC) standards and models, in particular performance standard 1: 'Assessment and management of environmental and social risks and impacts' (International Finance Coorporation, 2021) for the social environment
- International Finance Corporation Cumulative Impact Assessment (CIA) and Management Good Practice Handbook (International Finance Corporation, 2013)for the social environment and overall cumulative impacts, where applicable.

Note that international guidelines related to deep sea mining are directed towards the seabed mining of deep-sea minerals comprising polymetallic sulphides, cobalt rich crusts, manganese nodules that occur in specific deep-water environments (1,000 m to 6,000 m depth) and are not considered applicable to the proposed Sandpiper Project.

The proposed Sandpiper Project is located on the Namibian continental shelf in water depths of less than 300m and which is deemed national jurisdiction falling within the Namibian Exclusive Economic Zone (EEZ) which extends to 200 nautical miles (370.4 km) offshore. This is consistent with the definitions and provisions of the Territorial Sea and Exclusive Economic Zone of Namibia Act, Act 3 of 1990, whereby international laws are not applicable, and Proponents are required to comply with the required Namibian regulations. Reference to Section 4 (3) (a) (b) of the Act therefore applies viz:

‘(3) Within the exclusive economic zone –

(a) any law of Namibia which relates to the exploitation, exploration, conservation or management of the natural resources of the sea, whether living or non-living, shall apply and

(b) Namibia shall have the right to exercise any powers which it may consider necessary to prevent the contravention of any law relating to the natural resources of the sea.

6.3 Limitations, uncertainties and assumptions

The following limitations and uncertainties associated with the assessment methodology will be considered in the assessment phase:

- Topic specific assessment guidance has not been developed in Namibia. The definitions identified are in line with commonly applied impact criteria used in Southern Africa, recognised internationally and best practice.
- Guidance for cumulative impacts has not been developed in Namibia but a single accepted state of global practice has been applied.
- Determining the sensitivity of biological receptors to direct physical disturbance, e.g., seabed excavation, noise, and indirect effects from temporary modifications in the abiotic environment, e.g., increased water column turbidity, will be done per sub-discipline. Metrics employed can include proportions of known habitats for species and/or communities affected, their vulnerability to disturbance, and recovery potential from this. In cases where this is not feasible for either or both biodiversity attributes and ecosystem service(s) the receptor sensitivity will be excluded when scoring significance of the impact.

6.4 Assessment methodology

In order to ensure consistency in the approach in the evaluation of impacts from the 2012 and 2014 specialist’s studies, the same methodology will be utilised and will form the basis for this ESIA process of the biophysical environment. The aforementioned methodology was verified and approved by the CSIR for both the 2012 EIA and the 2014 verification studies. Independent reviews were undertaken by UNAM as well as an independent peer review panel. Additionally, the appointed external reviewers (e.g., SAEIA) approved the methodology for both the 2012 and 2014 studies. To improve the robustness and confidence in the rating of significance of impacts, ECC will utilise best practice through application of a rating scale for probability to determine a score for significance of the impact to the receptor. IFC standards as modified by ECC will be utilised to rate the impacts for the social baseline.

The following describes the methods used to determine significance rating of impacts identified in the specialist's studies for the biophysical environment:

- Description of impact – reviews the type of effect that a proposed activity will have on the environment
- What will be affected
- How it will be affected
- Points 1 to 3 above are to be considered/evaluated in the context of the following impacts criteria:
    - Extent
    - Duration
    - Probability
    - Intensity or magnitude.

These impact criteria are to be applied as prescribed in Table 15.

Table 15 - Impact criteria

Impact Criteria						
Extent	Dredge Area Per vessel cycle e.g., ~66 000 m2 or 6.6 ha	Annual Mining Area Up to 3 km2	Specific Mine Site (SP1 or SP2) each if 22x8 km or 176 km2	Local 25-50 km or 2000 km2 – 8 000 km2	Regional 50-100 km or 8 000 km2 – 30 000 km2	National 100 km to EEZ (200 nautical miles) 100 to 370 km or >30 000 km2
Duration	Very Short Term 3 days	Short Term 3 days – 1 year	Medium Term 1 – 5 years	Long Term 5 – 20-years	Permanent >20-years (life of mine)	
Intensity/ Magnitude	No lasting effect	Minor effects	Moderate effects	Serious effects		

Impact Criteria				
	No environmental functions and processes are affected	The environment functions but in a modified manner	Environmental functions and processes are altered to such an extent that they temporarily cease	Environmental functions and processes are altered to such an extent that they permanently cease
Probability	Improbable <5%	Possible 5% - 50%	Probable 50% - 90%	Highly probable/Definite 90% - 100%

The status of the impacts and degrees of confidence with respect to the assessment of the significance are stated below as follows:

- **Status of the impact**: a description as to whether the impact is positive (a benefit), negative (a cost) or neutral
- **Degree of confidence in predictions**: based on the availability of information and specialist knowledge. This has been assessed as high, medium or low.

Based on the above considerations, a score is provided (1-100) that is linked to the significance of the impact. This score is tabled in a matrix (4x3) whereby the specialist provides an overall evaluation of the significance of the potential impact based on the sensitivity of the receptor, if applicable.

6.5 Mitigation

Mitigation comprises a hierarchy of measures ranging from preventing environmental impacts by avoidance, to measures that provide opportunities for environmental enhancement. The mitigation hierarchy is: avoidance; reduction at source; reduction at receptor level; repairing and correcting; compensation; remediation; and enhancement.

Mitigation measures can be split into three distinct categories, broadly defined as:

1. Actions undertaken by the ESIA process that influence the design process, through implementing design measures that would entirely avoid or eliminate an impact or modifying the design through the inclusion of environmental features to reduce the magnitude of change. These are considered as embedded mitigation.
2. Standard practices and other best practice measures for avoiding and minimising environmental impacts. These are considered as good practice measures.

3. Specified additional measures or follow-up action to be implemented, to further reduce adverse impacts that remain after the incorporation of embedded mitigation. These are considered as additional mitigation.

The ESIA is an iterative process whereby the outcomes of the environmental assessments inform the Sandpiper Project.

The provisional EMP attached in Appendix A provides an outline of the good practice measures and specified additional measures or follow-up actions to be undertaken. The project EMP will be finalised on completion of the impact assessment process and included in the final ESIA report.

Embedded mitigation and good practice mitigation will be taken into account in the assessment process. Additional mitigation measures will be identified for inclusion in the EMP when the significance of impact requires it and causes the impact to be further reduced. Where additional mitigation is identified, a final assessment of the significance of impacts (residual impacts) will be carried out, taking into consideration the additional mitigation measures.

7 IMPACT ASSESSMENT FINDINGS AND MITIGATION

This impact assessment was completed taking into consideration the input received from stakeholders and those individuals/groups who registered as interested and affected parties during the 2022 public participation phase. Specialist studies that had previously been conducted for the 2012 EIA and 2014 verification study were reviewed and reassessed based on the input from the public participation phase. Additionally new specialist studies between 2018 to 2022 were also assessed. As part of the final impact assessment, a final environmental management plan (EMP) was produced to manage residual impacts that cannot be mitigated through the project.

This Chapter presents the findings of the ESIA for the proposed Project as per the ESIA process, scope and methodology set out in Chapters 2 and 6. The aim of this ESIA report is to focus on the significant impacts that may arise as a result of the proposed Project. This Chapter therefore considers the significant impacts and or those that may have specific interest to the community and stakeholders. A summary of impacts that are not considered significant is discussed in Section 7.1.

For each potential significant or sensitive impact, a summary is provided which includes the activity that would cause an impact; the potential impacts; embedded or best practice mitigation (stated where required / available); the sensitivity of receptor that would be impacted; the severity, duration, and probability of impacts; the degree of confidence in the predictions by the specialists; the significance of impacts before mitigation and after mitigation measures are applied.

During the original EIA assessment in 2012, the social assessment was not comprehensively conducted, however this has been addressed in the 2022 assessment report. Therefore, no reference will be made to the 2012 assessment and all potential socio-economic and socio impacts are now assessed and discussed in detail in this 2022 assessment report.

The structure of the assessment Chapter as per the main impacts assessed are as follows:

1. The marine environment: water column and sediments (7.4)
2. The marine environment: benthic macrofauna (7.5)
3. The marine environment: biotic (7.6 and 7.7)
4. Socio-economic: economic (7.8)
5. Socio-economic: socio (7.9)
6. Cumulative impacts (7.10).

7.1 LIMITATIONS, UNCERTAINTIES AND ASSUMPTIONS

The following assumptions and uncertainties identified during the assessment process include the following:

- Various specialist reports have been developed and provided for in this assessment dating from 2012 to 2022. In all instances, the specialists appointed to conduct these studies have substantial direct experience and expertise related to the Benguela Current Large Marine Ecosystem and Namibia in particular. Where specific data to assess an impact is not available/presented in these reports, various alternative sources have been used to derive the most accurate conclusion to assess the significance of the impact (example: internet sources, personal communications from professional specialist opinion, monitoring reports from other marine based mining companies).
- The environmental and social baseline presented in Chapter 5 has been used in the assessment, based on the previous 2012 EIA and 2014 verification assessments and supplementary studies conducted between 2018 to 2021. Updated baseline information for 2022 is discussed in the impact assessment Chapter (Chapter 7).
- The project description in Chapter 4 has been applied to the assessment. Any changes to the mining methodology and 20-year mine plan scale may alter the assessment findings. If this occurs, the assessment will need to be revisited and further assessment work may be required.
- The methodology adopted for the biophysical assessment is based off international best practise for the marine environment, as discussed in Chapter 6. Therefore, an exact standard has not been used.
- The land-based component does not form part of the marine assessment and will be conducted after environmental clearance certificate has been issued. No land-based impacts have been discussed in this Chapter.
- A rapid CIA has been undertaken due to quantitative information not being available for all potential impacts assessed. Where quantitative information is available, this has been presented.

7.2 IMPACTS NOT CONSIDERED AS SIGNIFICANT

As a result of an iterative project evolution process, mitigation has been incorporated and embedded into the project plan and processes thereby designing out potential environmental and social impacts or reducing the potential impact so that it is not considered significant. The EMP provides best practice measures, management and monitoring for identified impacts. Impacts that have been assessed as not being significant are summarised in Table 16 and are not discussed further, unless otherwise indicated.

Table 16 – Summary of impacts not assessed as being significant

Environment or social topic	Potential impact	Summary of assessment findings
Air quality	Air pollution from the vessel to the atmosphere and people Air pollution from hydrogen sulphide releases	– Pollutants from vessels is regulated under the MARPOL convention and all ships are required to adhere to strict pollution prevention control measures. The project will employ a MARPOL compliant vessel for the project and therefore potential air pollution from the vessel is considered low. – MARPOL requirements will be adhered too. – Mitigation measures are incorporated in the EMP. – The potential for hydrogen sulphide release is discussed under the water column specialist studies.
Cultural heritage	There is potential to uncover chance finds (e.g., shipwrecks) during dredging operations	– In the unlikely event that the proposed Project dredging activities identify such objects the chance find process will be followed with mitigation measures incorporated in the EMP.

7.3 THE MARINE ENVIRONMENT: HYDRODYNAMICS AND WATER QUALITY

The overall methodology approach to the assessment was described in Chapter 6 in detail, with reference to the previous 2012 and 2014 methodology utilised. In order to enhance the confidence of the water column and sediments and benthic macrofauna assessments, and assess potential impacts on a finer scale, the scale of change/extent was reviewed and amended and is further described in the table below (Table 17). Note the scale of change/extent differs from the original assessment with the differentiation between the 20-year mining plan site (34 km^2) and the specific target mining areas (176 km^2) impacts. The impacts are activity based and assessed in line with the annual mining plan and/or the 20-year mining plan. The target mine area for this assessment is specifically SP1.

All 2014 methodology further reported on in this Chapter is as stated in Chapter 6, no changes to the methodology were made.

Table 17 – Scale of change/extent utilised for water column and sediments, and benthic macrofauna assessments

Scale of change/extent	Description
Single dredge cycle area	0.02 – 0.04 km^2 per vessel cycle (i.e., 2 – 4 ha)
Annual mining area	Up to 2.5 km^2 (average 1.7 km^2/year)
Specific 20-year mine plan site (in SP1)	34 km^2
Target mining areas	SP1, SP2, SP3 each 176 km^2
Local	25-50 km or 2000 km^2 – 8 000 km^2
Regional	50-100 km or 8 000 km^2 – 30 000 km^2
National	100 km to EEZ (200 nautical miles) 100 to 370 km or >30 000 km^2

7.4 THE MARINE ENVIRONMENT: WATER COLUMN AND SEDIMENTS IMPACTS

Water column and sediments impacts include the consequences of vessel operations, fine sediment discharge and seabed dredging on the marine environment. The significant impacts or impacts that have specific interest to stakeholders, before mitigation, are summarised in Figure **42** for illustrative purposes only. Details related to each specific impact is discussed further in this Section.

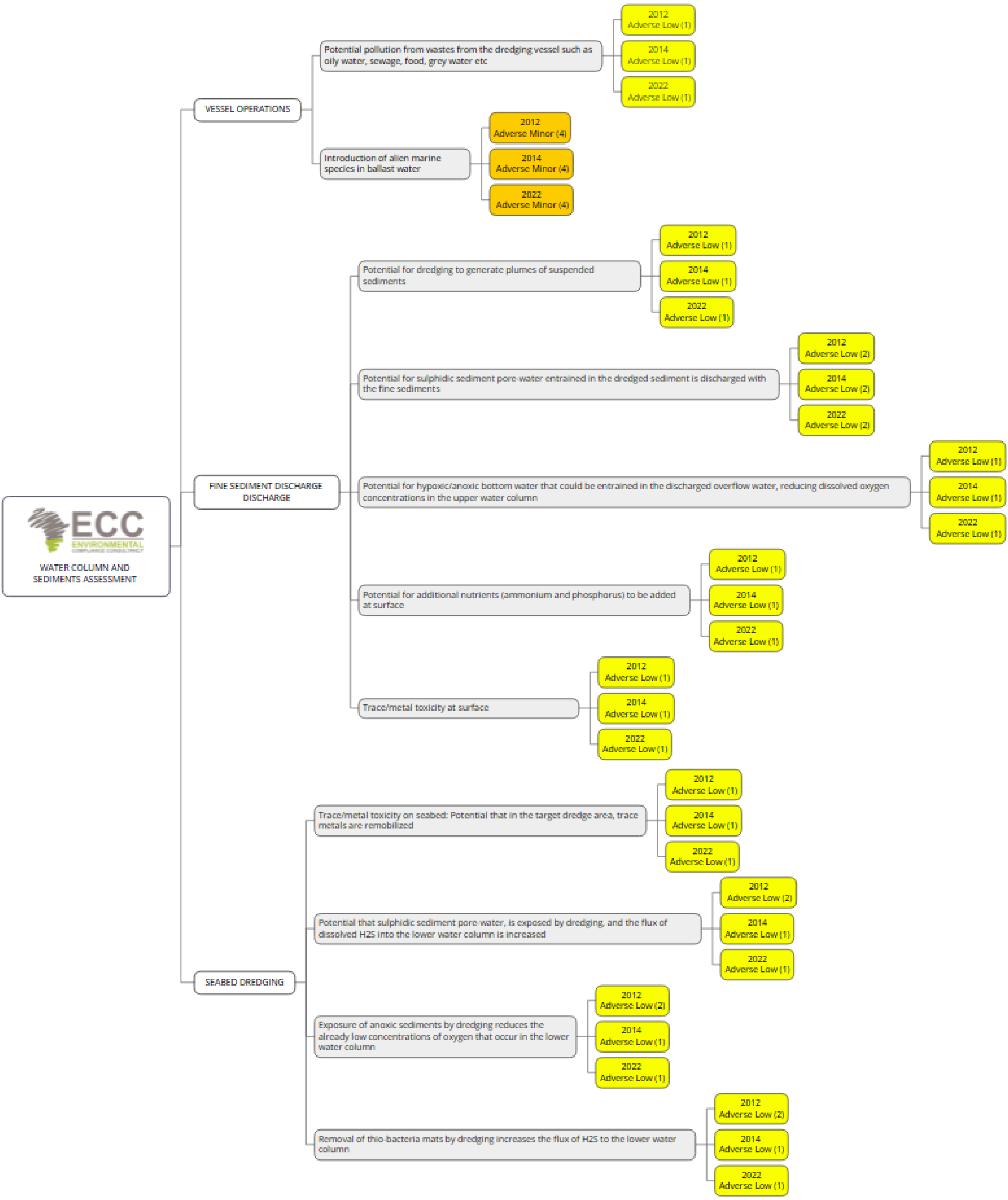


Figure 42 – Potential impacts to water column and sediments

7.4.1 IMPACTS FROM VESSEL OPERATIONS

The potential impacts from vessel operations were assessed in the 2012 EIA assessment and subsequent 2014 verification assessment, as there has not been a change to the project design since this assessment the results remains valid. With consideration of the supplementary specialist studies on sediment plume dispersion and toxicity completed in 2020. These impacts have been assessed again in 2022, scored and are described in this Section below.

The preferred dredging operator for this project, Jan De Nul Group (JDN), has extensive experience in conducting dredging operations internationally in strict compliance with all international regulations and standards. Jan De Nul Group sets itself ambitious sustainability goals. Their Code Zero awareness programme brings together all of their sustainable initiatives. With respect to waste management, JDN looks for circular solutions and ways to reduce our waste. Furthermore, the waste management on board all of their vessels is in accordance with the International Convention for the Prevention of Pollution from Ships (MARPOL). These regulations prescribe how our crew should collect, store, process and discharge waste on board a vessel.

7.4.1.1 Potential deterioration in water quality from liquid discharges to sea of vessel wastes

Discharges at sea from dredge vessel operations (other than dredging discharge water) may occur under normal ship operations under either approved protocols and prescribed procedures and/or by accident. Examples of wastes from the dredger may include oily water, macerated sewage or food and grey water. As per the MARPOL convention, all vessels need to comply to certain prescribed protocols for waste disposal at sea to ensure pollution is prevented or limited in the water column. This includes requirements for disposal limits, monitoring and record management of waste disposed of at sea. The vessel operations could have an adverse impact; however, this will be restricted to the dredge site during vessel operations and the duration is considered short term. The probability of the impact occurring, is possible. The receptor assessed is the marine water column, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change is expected to have no lasting effects. The significance of the impact is determined as low, and the confidence level of the impact result remains high. Mitigation required includes ensuring that the vessel discharge/retention systems are in good working condition and do not malfunction and the waste management procedures and protocols are strictly applied. These measures have been incorporated in the EMP.

7.4.1.2 Alien marine species in ballast water

Ballast water is one of the main transporters of marine alien and/or invasive species from one location to another internationally. It is expected that the vessel will travel unladen to the Walvis Bay or the mining area, from a foreign port when transiting into Namibia and from the SP1 area to and from the port of Walvis Bay during annual dredging campaigns in SP1. Sea water is generally used as ballast water, entering and exiting the onboard ballast tanks, to ensure the ship is level during sailing. Ships are required to have procedures in place to manage their ballast water and prevent introduction of alien and/or invasive species. Vessel operations could therefore have an adverse impact nationally, that could be permanent if contaminated bilge or ballast water is discharged accidentally or in breach of either the international or Namibian regulations. The receptor assessed is the marine ecology and biodiversity and the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as medium.

The magnitude of change associated with the introduction of alien invasive species could be determined as having a serious effect as they could impact indigenous species. The probability of the impact occurring is possible, however it is managed in accordance with strict international and national shipping protocols and therefore the overall significance of the impact is determined as minor. The confidence level of the impact result remains high. Mitigation required compliance with the International Maritime Organization (IMO) guidelines on ballast water management (IMO Resolution A. 868 (2), 1997) as well as all relevant Namibian regulations and has been incorporated into the EMP.

7.4.2 SUMMARY OF IMPACTS FROM VESSEL OPERATIONS

Table 18 provides an overview of the impact assessment outcomes for vessel operations[3].

Table 18 – Impact assessment for vessel operations

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations – vessel general	Marine water column	Potential deterioration in water quality from discharges to sea of wastes such as oily water, sewage,	Adverse Dredge area Very short term	Low	No lasting effects	Adverse Low (1)

[3] References made to vessel, dredger and dredger vessel are the same

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		food, grey water, from the dredging vessel				
Operations – ballast water	Marine ecology and biodiversity	Alien marine species may displace indigenous species and reduce indigenous biodiversity and/or affect aquaculture and/or aquaculture products.	Adverse National Permanent	Medium	Serious effects	Adverse Minor (4)

7.4.2.1 Dredging generates plumes of suspended sediments

Specialist studies on the fine sediment plume dispersion and potential impacts of suspended sediments from the dredging operation were conducted for the 2012 assessment and the 2014 verification study. Supplementary specialist studies by international experts in the field of sediment plume dispersion modelling have been conducted in 2020 which have been considered as further information to re-assess impacts.

Dredging induced discharge of suspended fine sediments could generate turbidity plumes that can potentially adversely affect organisms in the water column, including phytoplankton, zooplankton, crustacea, molluscs and fish. The toxicity threshold applied in the 2012 EIA phase was a TSS concentration of 20 mg/l persisting for >3 days (Carter in Midgley, 2012). This has been revised and reduced in the 2022 assessment (Carter & Steffani, 2021) to a more conservative threshold of 7.6 mg/l persisting for 72 hrs based on species sensitivity distributions to TSS (Smit et al., 2008). Further, sediment plume behaviour put forward in the 2014 EIA verification study was based on available data on regional currents and comparative measured and modelled marine diamond mining sediment discharge plumes in ~100 m water depth.

As part of the supplementary studies conducted from 2018, the international expert group HR Wallingford conducted detailed ocean current and plume dispersion modelling (HR Wallingford, 2020) of dredge plume behaviour in the 20-year mine plan area based on their existing comprehensive regional and local metocean data bases, in-situ measurements of sediment properties as well as water column and bottom currents in the 20-year target mining area (2014 verification assessment) along with the technical details on the proposed dredging programme production rates and equipment specifications provided by the dredging contractor (JDN). Process design scenarios modelled included operations with and without an environmental valve and the primary dredge discharge located at -15m depth (i.e., keel level of the dredger). The environmental valve reduces air bubbles from the dredger discharge and therefore plume buoyancy, further reducing the extent and sediment concentration in the fine sediment discharge plume. Consequently, more of the discharged fine sediment plume then behaves in dynamic mode to approximately 50 m depth and then enters the passive mixing mode. This increases dilution and minimises plume dimensions and effects in the upper water column such as light attenuation affecting phytoplankton photosynthesis.

Based on the acute effect threshold (TSS SSD HC5 value of 7.6 mg/l, protective of 95% of the taxa tested) HR Wallingford defined a zone of influence (ZOI) for the sediment plume for a single dredging cycle as well as for the overall footprint for all individual dredge plumes that would be generated over the cumulative period of 20-years for operations, within the defined mine plan area.

The ZOI is therefore a zone or area within which the dredging will lead to changes above background levels in suspended sediment concentrations or to deposition of sediments on the seabed, which are not negligible and the significance of which require an environmental assessment.

The ZOI of the dredging operation is defined as a combination of the suspended sediment footprint (the area in which either the peak concentration increases of more than 7.6 mg/l or mean concentration increases of more than 1 mg/l) and the deposition footprint (the area of fine sediment deposition of more than 5 mm) may have occurred at any time and location over the course of the 20-year mining period (HR Wallingford, 2020).

HR Wallingford (2020) note that the ZOI does not imply that there will be an actual ecological impact within the ZOI area. The ZOI identifies that there are physical changes to suspended sediment concentration and to the seabed substrate above levels which could be immediately associated with negligible impact. Whether such changes could potentially cause significant adverse impact will depend on the precise nature of the changes and the nature and distribution of the ecological receptors present in the ZOI.

As such these changes cannot immediately be dismissed as insignificant without appropriate assessment, which will be conducted as part of the current process.

Outside the ZOI however, any changes can be considered as insignificant, and it can be concluded that there is no environmental impact.

For the dredging activity in the mine plan area (34 km^2) within ML 170, the overall ZOI for the total 20-year dredging operations extends over an area of 513 km^2 which lies predominantly within the boundaries of ML 170, and which extends only up to 11 km outside of ML 170

For a single dredging cycle, which has an average duration of 16 hrs onsite, the sediment plume ZOI ranges from 1 km^2 to 5 km^2 from the dredger (refer to Figure 43 and Figure 44) for further details). Average sediment concentration increases across the modelled domain were predicted to be limited to <5 mg/l except for within 100 m of the dredger where the mean increase can be up to 18 mg/l. Durations of exposures to elevated suspended sediment concentrations above the HC5 threshold at locations 2 km distant from the border of the 20-year mining area were predicted as zero for the surface layer and 15 hrs in the mid- and bottom depth layers. Exposure durations within the immediate dredging area could be 30 hrs, well within the usual toxicity test durations (Carter & Stefanni, 2021).

The individual sediment plumes at any one time could have an impact, but it will be limited to operations at a specific site within the specific 20-year mine plan site (SP1) and as modelled by the ZOI. The duration of the impact will be short term, as the plume will disperse within 72 hrs and dredging operations onsite are not continuous. The probability of the impact occurring is possible. The receptor assessed is the marine water column and organisms, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change is no lasting effect. The confidence level remains high and the significance of the impact low, consistent with prior assessment outcomes. Relevant mitigation measures are incorporated in the EMP.

Additionally, the potential operational mitigation measure of discharging the fine sediment plume at or near the seabed was considered. Dredging contractor JDN has advised that such measured are not routinely done for any of their international coastal dredging projects (JDN personal comms, 2022). For the current operational depths (200 m to 225 m) in ML 170, while it would be technically feasible, there is no clear evidence that it would have any substantial environmental benefits, considering that the current assessed impacts significance is low for plume dispersion and sedimentation and operational mitigation measures for fine sediment discharge are already being applied (environmental valve and discharge at -15 m depth).

During dredging, there will be repeat traverses over the defined dredging lanes in order to mine to the required depth of sediment below seabed (leaving ~30 cm above the footwall) in the mine plan area. If fine sediment discharge is released at the seabed during the traverses, an amount of the fine sediment discharged would then fall back into the active dredge lanes and will need to be double handled and removed during the next traverse. Ore recovery efficiency would possibly be affected and reduced which would result in increased onsite dredging time and related fine sediment discharge. Comparisons when using an environmental valve of surface (40 m to 50 m depth), mid depth and bottom turbidity distributions against no valve, indicates an improvement in total suspended solids (TSS) concentrations in the surface layers to <7.6 mg/l but no or little change in the subsurface layers (HR Wallingford, 2020). This is beneficial as the 1 % light depth would be around -50 m at this sediment concentration, therefore negative effects of reduced light levels on phytoplankton production should be mostly avoided. Also, as there is little or no change in the near seabed TSS load, it can be assumed that the sediment deposition would be similar between the valve and no-valve scenarios which, according to modelling, is predicted to be 0.3 mm or less per dredge cycle.

This is a factor of 20 below the HL_5 threshold of effects on marine benthos reported by Smit et al. (2008). Note that the environmental valve is recommended as a mitigation measure during mining operations. Whether such deposition patterns would occur with a near-seabed discharge is uncertain, as behavioural aspects of the discharge in terms of jet momentum, dynamic plume collapse, associated mixing with the receiving water body along with possible turbidity flows and local currents will affect deposition rates and distributions. This may result in considerably higher instantaneous sediment deposition thickness in places, possibly approaching centimetres, with correspondingly higher risks of negative effects on benthic macrofauna as Smit et al (2008) determined a median hazardous effect level (HL_{50}) of 5.4 cm for instantaneous burial on benthos.

Therefore, the environmental benefit of a near seabed fine sediment discharge is moot and will most likely not warrant the linked cost and potential operational risks and uncertainties (Carter personal comms, 2022).

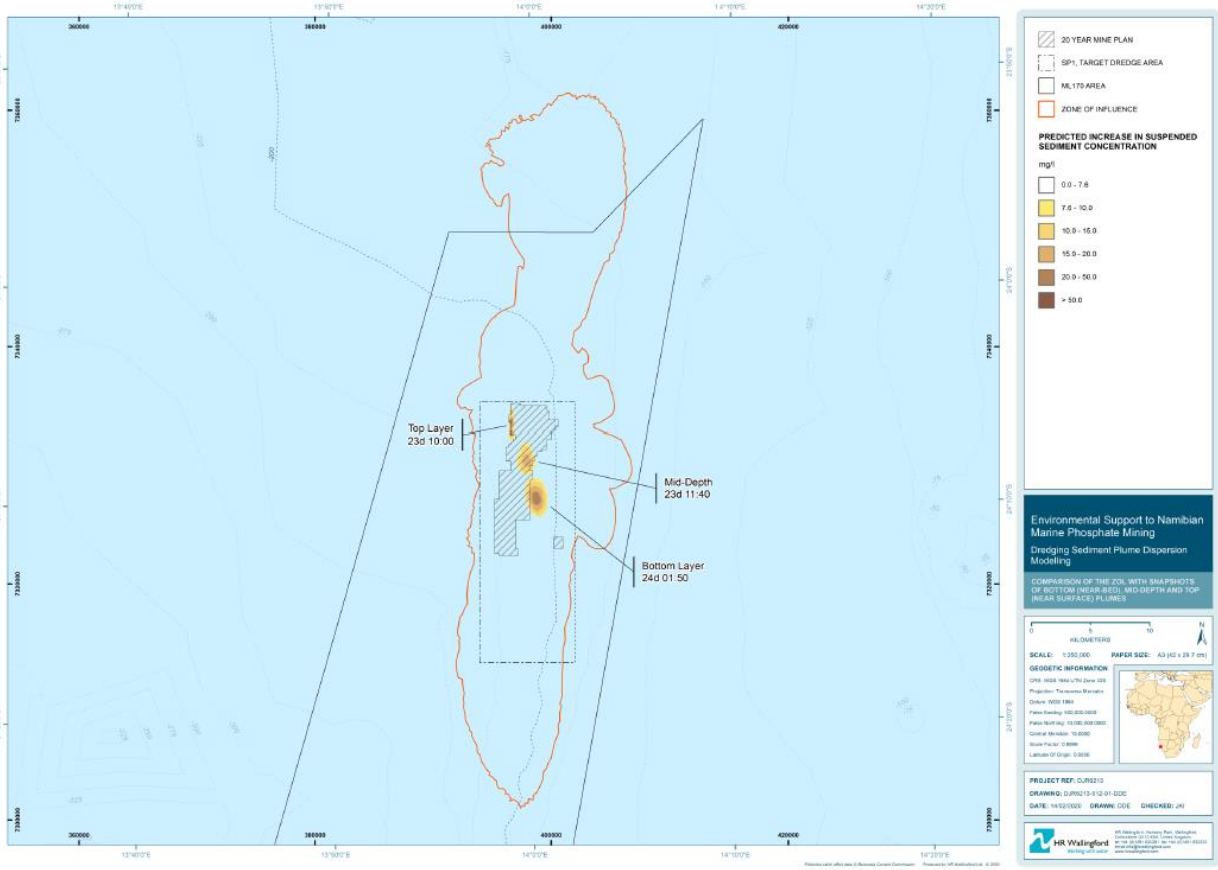


Figure 43 – Comparison of the 20-year cumulative ZOI with snapshots of bottom (near-bed), mid-depth and top (near-surface) plumes from a single dredging cycle simulation at a local scale (HR Wallingford, 2020)

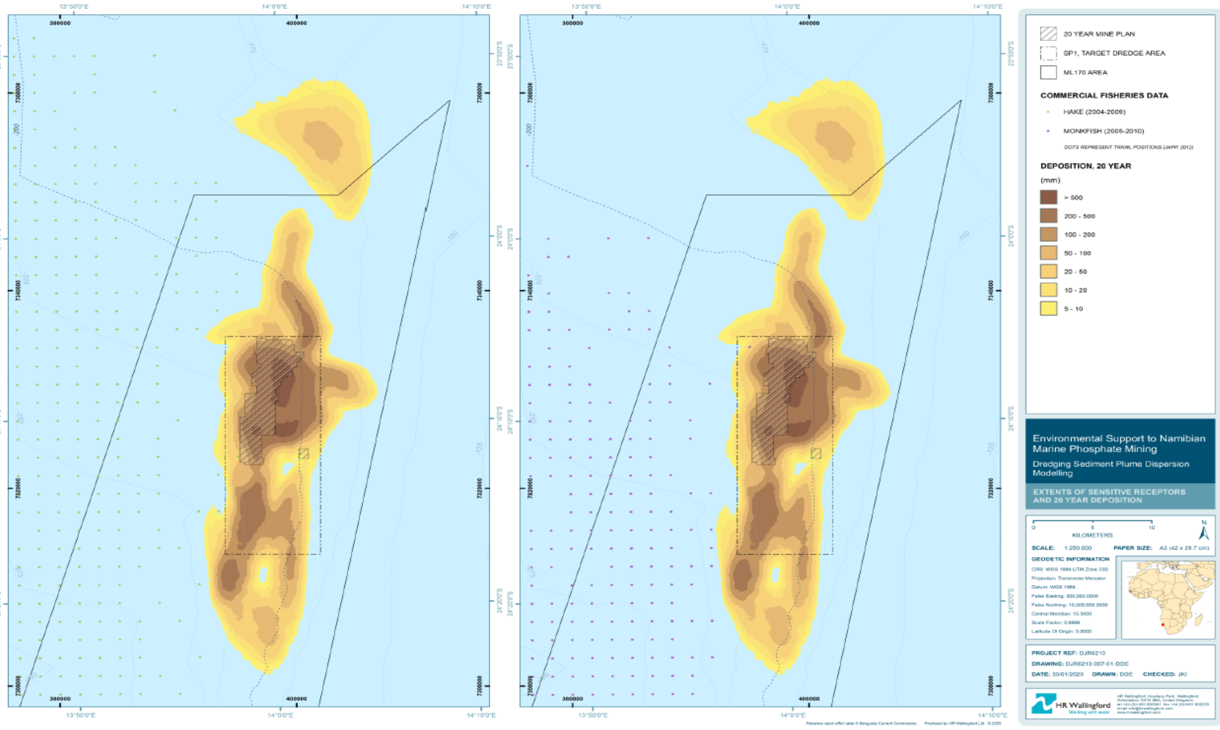


Figure 44 – Cumulative extent of predicted sediment deposition (mm) over the 20-year life of mine, along with historic records of hake and monkfish catches at a local scale (HR Wallingford, 2020)

7.4.2.2 Sulphidic sediment pore-water entrained in the dredged sediment is discharged with the over-spill

During the 2014 verification assessment, this impact was re-evaluated, and proxy measurements were taken of the mine site sediment properties (both surficial and sub-surface), to confirm the 2012 EIA assessment findings. Acid volatile sulphide (AVS) concentrations in the sediments was used as a proxy for H_2S production and sulphate reduction. The confidence level in the results changed from medium to high as the results showed that the probability of the presence of appreciable concentrations of H_2S in the sediments is low and therefore pyrite sulphide will have low solubility. This conclusion was reached as results showed that 'evaluations of potential sulphide generation from oxidation of iron pyrite following translocation of seabed sediments to the upper water column in the dredging process indicate that negligible amounts will be liberated and that associated effects on dissolved oxygen concentrations will be minimal. The latter is due to elemental sulphur being the end-point of the oxidation of sulphide as opposed to sulphate' (Carter in Midgley, 2014).

The potential for sulphidic sediment pore-water entrained in the dredged sediment may have an adverse impact but this impact will be in the dredge area and the duration is short term. The probability of the impact occurring is possible. The sensitivity value of the organisms in the water column in considered medium. The magnitude of change is described as minor effects. The significance of the impact is low and therefore no further mitigation is required.

7.4.2.3 Hypoxic/anoxic bottom water is entrained in the discharged dredging overflow water so reducing dissolved oxygen concentrations in the upper water column

This impact assesses the potential changes to the biogeochemical properties of the surface water in the water column due to potential impacts of lowered oxygen levels as a result of the quality of the dredging discharge water. The Section below describes the associated scoring of the impact from the 2014 assessment outcomes. The 2012 assessment concluded the following: 'in a worst-case scenario approximately 31 680 m^3 of anoxic water may be discharged along a 4 km long dredge path during dredging. This will be mixed into approximately 5x106 m^3 of normal oxic water. Mixing factors are therefore <1%; and dissolved oxygen concentration reductions will be negligible (< 0.1 ml/ℓ)' (Carter in Midgley, 2012).

The status of the impact may be adverse; however, it will be restricted to the dredge area and duration will be short term. The probability of the impact occurring is improbable. The receptor assessed is the marine water column organisms, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change is determined to have no lasting effect. The confidence level remains high. The significance of the impact is therefore low. No further mitigation measures are required.

7.4.2.4 Nutrients (ammonium and phosphorus) added at surface promote phytoplankton growth

This impact was re-evaluated during the 2014 verification assessment as the 2012 assessment conclusions for this impact was determined based on publicly available data without field measurements being available for nutrient specific data. Since then, measurements that were taken of the sediment properties in the proposed dredge site showed that subsurface sediment pore water contained moderate nitrate-nitrogen concentrations but high phosphate-phosphorous concentrations. Additionally, the pore water showed a considerate departure from the water column Redfield ratio observed in the survey area (8.2 vs 17.7). Refer to Chapter 5 on further information related to the Redfield ratio. The measured moisture content of the sediment was low, indicating that the affected pore water volume is also low (~35 litres/m^3 sediment). Therefore, dilution in the dredged sediment slurry and with surface waters after discharge from the dredger will limit nutrient enrichment and elevated phytoplankton production (Carter in Midgely, 2014). The magnitude of change remains valid as no lasting effect, as silicate is probably the limiting nutrient for diatoms and the amount of nutrients transferred to the euphotic zone will be low due to low pore water volumes. The confidence level of the impact outcome changed from medium to high as the mine site sediment pore water volumes were confirmed through physical data, as low.

This fine sediment discharge from the dredger may have an adverse impact but this will be restricted to the dredge area and the duration is considered to be short term. The probability of the impact occurring is possible. The receptor assessed is the marine water column organisms, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change remains no lasting effect. The confidence level is high. The significance of the impact is low. Relevant mitigation measures are incorporated in the EMP.

7.4.2.5 Trace/metal toxicity at surface

This specific impact relates to potential changes in biogeochemical properties of the surface water as a result of a potential increase in levels of heavy metals from the hopper discharge water. The potential mobilization of toxins in the water column was re-assessed during the verification assessment in 2014, as heavy metal elutriation measurements were able to be conducted on the sediment samples retrieved from the mine target dredge site. It was determined that the mine area heavy metals have low solubility and bioavailability and that trophic transfers are attenuated at primary consumer level i.e., zooplankton (Carter in Midgley, 2014). The confidence level thus increased from medium to high and the impact remained low.

This Section below details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

As part of the supplementary studies conducted from 2018, in 2020 toxicity tests measuring acute and chronic effects on sea urchin fertilisation success rates and larval development in elutriates from the mine area surficial sediments previously sampled by gravity corer were conducted. The methods applied followed those of the USA EPA (US EPA, 2000) and the results are reported in (Lwandle Technologies Pty Ltd, 2020). The elutriation tests showed similar dissolved trace metal concentrations to those determined on fresher core material collected in the 2014 verification assessment. In both cases the proportion of metals entering the dissolved phase and therefore being bioavailable was low average values on both sets of material.

In the suite of trace metals examined in the elutriation testing arsenic showed the highest solubility, although this was very modest at <1 % of the mass processed (Lwandle Technologies, 2014). Arsenic is an abundant element in the marine environment ranked 22nd in terms of abundance, primarily occurring in the inorganic forms of arsenite (As (III)) and arsenate (As (V)), the latter being the dominant form in oxic water and the former being more important in reduced, hypoxic/anoxic environments (Neff, 1997). The average sediment bound total arsenic concentration determined in the verification survey (Lwandle Technologies,2014) was 49 µg/g whilst that in the water column was 3.21 µg/L. These are close to the estimated world average in marine sediments of 40 µg/g and 3 µg/L in coastal seawater reported in Neff (1997).

The pathway of arsenic from the dissolved phase into higher trophic levels in the euphotic zone of the water column is predominantly via uptake and production of organoarsenicals in phytoplankton, and transfers to zooplankton and their predation by fish. Phytoplankton take up arsenate, and within their cells reduce this to arsenite, with biotransformation through methylation to organoarsenicals, primarily dimethylarsinous and monoethylarsinous acids. Arsenite and organoarsenicals are readily excreted back to the water column when phosphorous is non-limiting for phytoplankton growth, as is generally the situation in the Benguela Current system, where the arsenite is rapidly oxidised to arsenate (Neff, 19978; Rahman et al, 2012). The minimal dissolution of arsenic from marine sediments during dredging as predicted from elutriation testing is unlikely to materially affect apparent ambient concentrations and bioaccumulation from these.

The impact to be assessed relates to the transfer of potential toxicity to the upper water column by fine sediment discharge during ore recovery which may have an impact and the exposed biota may suffer acute (lethal) or chronic (sub-lethal) effects with associated negative effects on ecological functionality. Toxicity effects may be exerted on biota within the fine sediment plume path as it mixes with the host water body. Any deleterious effects are predicted to be limited to the dredge sediment plume, be short term as effects will be exerted within the lifetime of the plume, while the intensity of effects would be minor.

The trace metal elutriation measurements conducted in the toxicity study (2020) are consistent with those of the 2014 verification assessment. The toxicity test results indicate no acute effects, consistent with the apparent low solubility of metals and, for divalent metals, the minor excess of AVS over SEM (ratio <1). The conducted toxicity measurements support the impact assessments of trace-metal toxicity in the sea surface layers due to disturbances during dredging for phosphate ore. Further, possible toxicity effects of pore water total ammonia should be unlikely due to high dilutions in the dredging process.

The 2022 ESIA assessment outcomes are further detailed in the Section below.

The mobilization of toxins from the hopper overspill could be possible and have an adverse impact on the marine benthic communities but this impact will be for a single dredge cycle area and the duration will be short term. The plume duration is shorter than the exposure time required for biota to be directly affected by toxicity concentrations. The receptor assessed is the marine water column organisms, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change is determined as minor effects. The degree of confidence remains high. The significance of the impact is determined as low.

7.4.3 SUMMARY OF IMPACTS FROM THE FINE SEDIMENT DISCHARGE

Table 19 provides an overview of the impact assessment outcomes for fine sediment discharge.[4]

Table 19 – Potential impacts assessed for fine sediment discharge

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations – hopper fine sediment discharge	Marine water column organisms Crustacea Molluscs Fish	Dredging generates plumes of suspended sediments that adversely affect organisms in the water column.	Adverse Specific 20-year mine plan site (SP1) Very short term	Low	No lasting effect	Adverse Low (1)
Operations – fine sediment discharge	Marine water column organisms	Sulphidic sediment pore-water entrained in the dredged sediment is discharged with the over-spill water thereby affecting organisms in the water column.	Adverse Dredge area Short term	Medium	Minor effects	Adverse Low (2)

[4] In the previous assessments this was stated as hopper overspill discharge.

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations – fine sediment discharge	Marine water column organisms	Hypoxic/anoxic bottom water is entrained in the discharged overflow water so reducing dissolved oxygen concentrations in the upper water column where it can affect organisms.	Adverse Dredge area Very short term	Low	No lasting effects	Adverse Low (1)
Operations – fine sediment discharge	Marine water column organisms	Increased availability of nutrients (ammonium and phosphorus) promotes phytoplankton growth. Following senescence, the phytoplankton will add to the particulate organic matter flux to the seabed	Adverse Dredge area Short term	Low	No lasting effects	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		eventually further reducing dissolved oxygen concentrations through remineralisation.				
Mining - mobilisation of toxins	Marine water column organisms	Trace metals (e.g., cadmium and nickel) bound in the dredged sediment are discharged with the over spill water thereby affecting organisms in the water column.	Adverse Single dredge cycle area Short term	Low	Minor effects	Adverse Low (1)

7.4.3.1 Trace/metal toxicity on seabed - target dredge area trace metals are remobilized

This specific impact relates to potential changes in biogeochemical properties of the bottom waters as a result of a potential mobilization of heavy metals from the sediment during seabed dredging. Toxins could become bioavailable and have negative effects on benthos. The exposure of potential toxic sediments on the seabed by ore removal during ore recovery may have an impact. The exposed biota may suffer acute (lethal) or chronic (sub-lethal) effects with associated negative effects on ecological functionality.

The potential mobilization of toxins in the water column and bioavailability potential was re-assessed during the verification assessment in 2014, as heavy metal elutriation measurements were able to be conducted on the sediment samples retrieved from the mine target dredge site. It was determined that the mine area heavy metals have low solubility and bioavailability and that dredging should not increase exposures (Carter in Midgley, 2014). The confidence level thus increased from medium to high and the impact remained low.

As part of the supplementary studies conducted from 2018, in 2020 toxicity tests measuring acute and chronic effects on sea urchin fertilisation success rates and larval development in elutriates from mine area surficial sediments previously sampled by gravity corer were conducted.

The methods applied for the toxicity test work followed those of the USA EPA (US EPA, 2000) and the results are reported in (Lwandle Technologies Pty Ltd, 2020). The elutriation tests showed similar dissolved trace metal concentrations to those determined on fresher core material collected in the 2014 verification assessment. In both cases the proportion of metals entering the dissolved phase and therefore being bioavailable was low average values on both sets of material.

Consistent with the low trace metal concentrations liberated by elutriation from surficial sediments the toxicity testing conducted did not show any acute level toxicity in sea urchin fertilisation success or the chronic level toxicity larval development test measured after 72 hrs of exposure to elutriates. The respective performance levels as a percentage of the controls were 97.58 % fertilisation success and 94.2 8% nondeformation of larvae. Toxicity effect levels exceeding -10 % of that in control tests are considered indicative of toxicity.

The Section below details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

The dredging may increase bioavailability of trace metals in the target ore body through promoting dissolution from the solid phase during turbulent mixing in dredging. Toxicity effects may be exerted on biota within the fine sediment plume path as it mixes with the host water body. Any deleterious effects are predicted to be limited to the dredge sediment plume as per the annual mining area, be short term as effects will be exerted within the lifetime of the plume, while the intensity of effects would be minor.

The trace metal elutriation measurements conducted in the toxicity study (2020) are consistent with those of the 2014 verification assessment. The toxicity test results indicate no acute effects, consistent with the apparent low solubility of metals and, for divalent metals, the minor excess of AVS over SEM (ratio <1). The conducted toxicity measurements support the impact assessments of trace-metal toxicity in the sea surface layers due to disturbances during dredging for phosphate ore. Further, possible toxicity effects of pore water total ammonia should be unlikely due to high dilutions in the dredging process.

The 2022 ESIA assessment outcomes are further detailed in the Section below.

The mobilization of toxins from seabed dredging activities could be possible and may have an adverse impact on the marine benthic communities, but this impact will be for the annual area and the duration will be short term. Bioavailability will reduce with time as heavy metals become bound into the sediments again. The receptor assessed is the marine water column organisms, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change is determined as minor effects. The toxicity risk is from cadmium and or nickel, and concentrations are below the probable effects level (Carter in Midgley, 2014). The degree of confidence remains high. The significance of the impact is determined as low.

Further the potential for the radioactive mineral uranium and its associated radionuclides to be dispersed in the water column from the sediment was assessed. The total uranium concentration in the ore sediment was quantified during the test work for the Sandpiper Project as part of the pre-feasibility study (Bateman, 2011) and defined. The natural uranium content is determined to be low (~100 ppm), which is in line with other mined phosphate sedimentary deposits globally. Currently there is very little international and local information and studies available on marine radioactivity levels and their potential impacts on marine organisms. Additionally, currently there is no known expertise in this field in Southern Africa. Furthermore, there is no evidence in available published literature of any known detrimental effects on demersal fish as yet recorded from radioactive components being released into the water column as a result of trawling activities, which dominate the Namibian EEZ. However, it is acknowledged that radioactive elements exist in the seabed and uranium, thorium and their associated radionuclides will be included as variables in the baseline monitoring required in the EMP for the sediments and water column.

7.4.3.2 Sulphidic sediment pore-water is exposed by dredging, and the flux of dissolved H_2S into the lower water column is increased

This impact addresses the potential changes to biogeochemical properties of bottom waters as a potential consequence of releasing hydrogen sulphide from the seabed during dredging activities. During the 2012 assessment, it was predicted that there is low H_2S in the target dredge area sediments. During the 2014 verification assessment, in field measurements and proxy measurements were taken to confirm this from the mine site sediment properties.

The results from core samples collected over 26 sites across SP1 and approximately 1 km to 2 km to the east and west of SP1 concluded that at the time of the measurement of proxy variables, all measurements show that H_2S concentrations in the pore water were low. The measurements included indicators of the presence or absence of H_2S, through AVS, POM C/N, sediment pore water nitrate-nitrogen and sediment oxidation/reduction potential (ORP). Measured pore water volumes were also low, a variable likely to be stable over time in the subsurface sediments, and therefore even if H_2S concentrations were relatively high the mass flux to the adjacent water body would be low. Consequently, effects on resident biota would also be low (Carter in Midgely, 2014). The differences noted from the 2012 and 2014 assessment were as follows; the extent remained in the dredge area, the magnitude of change was reduced from moderate to minor effects and the confidence level increased from medium to high. In the 2022 assessment (Carter and Steffani, 2021) it is noted that the verification survey in conjunction with biogeochemical inputs by Monteiro (in litt. In Lwandle Technologies, 2014) concluded that the proposed mine area in SP1 does not show the characteristics of the mud belt and the SO_4 reduction and therefore HS^- flux from the sediments would be minimal. This supports the conclusion that environmental risks of mining by dredging would be physical as opposed to biogeochemical.

H_2S could have an adverse impact on the water column and benthos, however this impact will be in the dredge area and the duration for medium term. This is because pulses of H_2S escaping from the trench walls will be extremely short term with toxicity effects on benthos being experienced over benthos life cycles (Carter in Midgley, 2012). The probability of the impact occurring is possible. The receptor assessed is the marine water column organisms, the sensitivity of the receptor to accommodate changes associated with this potential impact is determined as low. The magnitude of change is minor effects on the benthos. The significance of the impact is low. No further mitigation is proposed.

7.4.3.3 Exposure of anoxic sediments by dredging reduces the already low concentrations of oxygen that occur in the lower water column

This impact was reassessed in 2014 during the verification assessment due to the availability of measurements of sediment properties and physical observations from the grab (surficial) and gravity core (subsurface) layer samples taken of the mine target site. The presence of anoxic sediments in the dredge area was not apparent from the available samples or indicated in the sediment properties measurements (Carter in Midgley, 2014). Additionally, the presence of large epibenthic organisms observed during the verification trawl survey in and adjacent to the mine target site indicate the absence of anoxic sediments (Japp in Midgley 2014). Therefore, the risk of reducing oxygen concentrations in the lower water column and potential effects on biota are considered unlikely. The magnitude of change was reduced from minor to negligible as the sediment properties revealed hypoxic conditions. The confidence level remained high.

Seabed dredging could have an adverse impact, the extent of the impact will be in the annual dredging area and the duration is medium term. It is expected that oxygen distributions that existed prior to dredging would re-establish themselves with time, and the effects on benthos will diminish. The probability of the impact occurring is possible. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change will have no lasting effect. The significance of the impact is low. The confidence level remains high. No further mitigation is proposed.

7.4.3.4 Removal of thio-bacteria mats by dredging increases the flux of H_2S to the lower water column

This impact assesses the potential changes to biogeochemical properties of bottom waters as a potential consequence removing thio-bacteria mats from the seabed during dredging activities. During the 2012 EIA assessment, it was predicted that there is low H_2S in the target dredge area sediments. During the 2014 verification assessment. A study analysing 8 samples spread across the mining target area in SP1 and 1 site each to the west and east of SP1, detected several sulphur-oxidising bacterial species including *Thiobacillus thioooxidans*, *Thiobacillus ferrooxidans*, *Thiobacillus denitrifican*s cluster and several *Acidothiobacillus* species (Kirby, 2014). Neither the giant *Thiomargarita namibiensis* nor *Beggiatoa* species were recorded. In general, sulphur reducing bacteria were slightly more common than sulphur oxidising bacteria, the latter ranging from <3800 to 8.9x10^5 per gram of soil. Measurements of proxy variables within the sediments in the target dredge area estimated that concentrations and thus possible fluxes of H_2S in sediment pore water is low. Additional evidence in support of this is the absence of large sulphate oxidising bacteria from the survey area during the period of the thiobacteria verification survey conducted in July/August 2014. Furthermore, evaluation of pyrite-S mobilisation from sediments indicate that this is low. Therefore, H_2S fluxes to the lower water column are considered to be negligible and the absence of large sulphur oxidising bacteria, due to either natural causes or disruption from dredging, would have little effect on these (Carter in Midgely, 2014).

The magnitude of change was reduced from minor to negligible. The confidence level increased from medium to high as the mine site sediment property data indicate low H_2S presence and release from iron pyrites should be low.

The current assessment (Carter and Steffani, 2021) notes that although the 2014 verification assessment supports the conjecture made in the benthic study that mats of the large sulphur-oxidising bacteria (i.e., *Thiomargarita namibiensis* and *Beggiatoa*) in the mining target area may be low to absent, the study is based on a relatively small number of samples and conclusion should therefore be drawn with caution. The presence or absence of bacterial mats also do not signify the same for *Beggiatoa* as they can exist deep below the sediment surface (Priesler et al., 2007). On the other hand, it does not provide a reliable reason to amend the significant rating.

Dredging could have an adverse impact, that will be restricted to the dredge area and the duration is long term. The establishment of a significant H_2S flux would require significant POM flux; only then could the thio-bacteria return. The probability of the impact occurring is possible as thio-bacterial mats have been observed at depth ranges similar to the proposed dredging areas so despite predicted low H_2S flux rates there can be a net supply of this compound to the lower water column until re-establishment of these thio-bacterial mats. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change is no lasting effect. The significance of the impact is low. The confidence level is high. No further mitigation is proposed.

7.4.3.5 Summary of impacts from seabed dredging

Table 20 refers to the impact assessment outcomes for seabed dredging on the water column.

Table 20 – Impact assessment for seabed dredging

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining - mobilisation of toxins	Marine benthic communities	Trace metals held within the target dredge area sediments are remobilized; they become bio-available through exposure to the overlying water during dredging with deleterious effects on filter and/or deposit feeding benthos.	Adverse Annual mining area Short term	Low	Minor effects	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations – seabed dredging	Marine benthic communities	Sulphidic sediment pore-water is exposed by dredging, and the flux of dissolved H_2S into the lower water column is increased, so affecting benthos.	Adverse Dredge area Medium term	Low	Moderate effects	Adverse Low (1)
Operations – seabed dredging	Marine benthic communities	Exposure of anoxic sediments by dredging reduces the already low concentrations of oxygen that occur in the lower water column so affecting resident biota, primarily benthos.	Adverse Annual mining area Medium term	Low	No lasting effects	Adverse Low (1)
Operations – seabed dredging	Marine benthic communities	Removal of thio-bacteria mats by dredging increases the flux of H_2S to the	Adverse Dredge area Long term	Low	No lasting effect	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		lower water column.				

7.5 THE MARINE ENVIRONMENT: BENTHIC MACROFAUNA IMPACTS

Benthic macrofauna impacts include the consequences of seabed dredging on the marine environment, namely benthic communities. The significant impacts or impacts that have specific interest to stakeholders, before mitigation, are summarised in Figure 45 for illustrative purposes only. All previous impacts detailed in the 2012 and 2014 assessments, were re-assessed in 2022. Details related to each specific impact is discussed further in this Section.

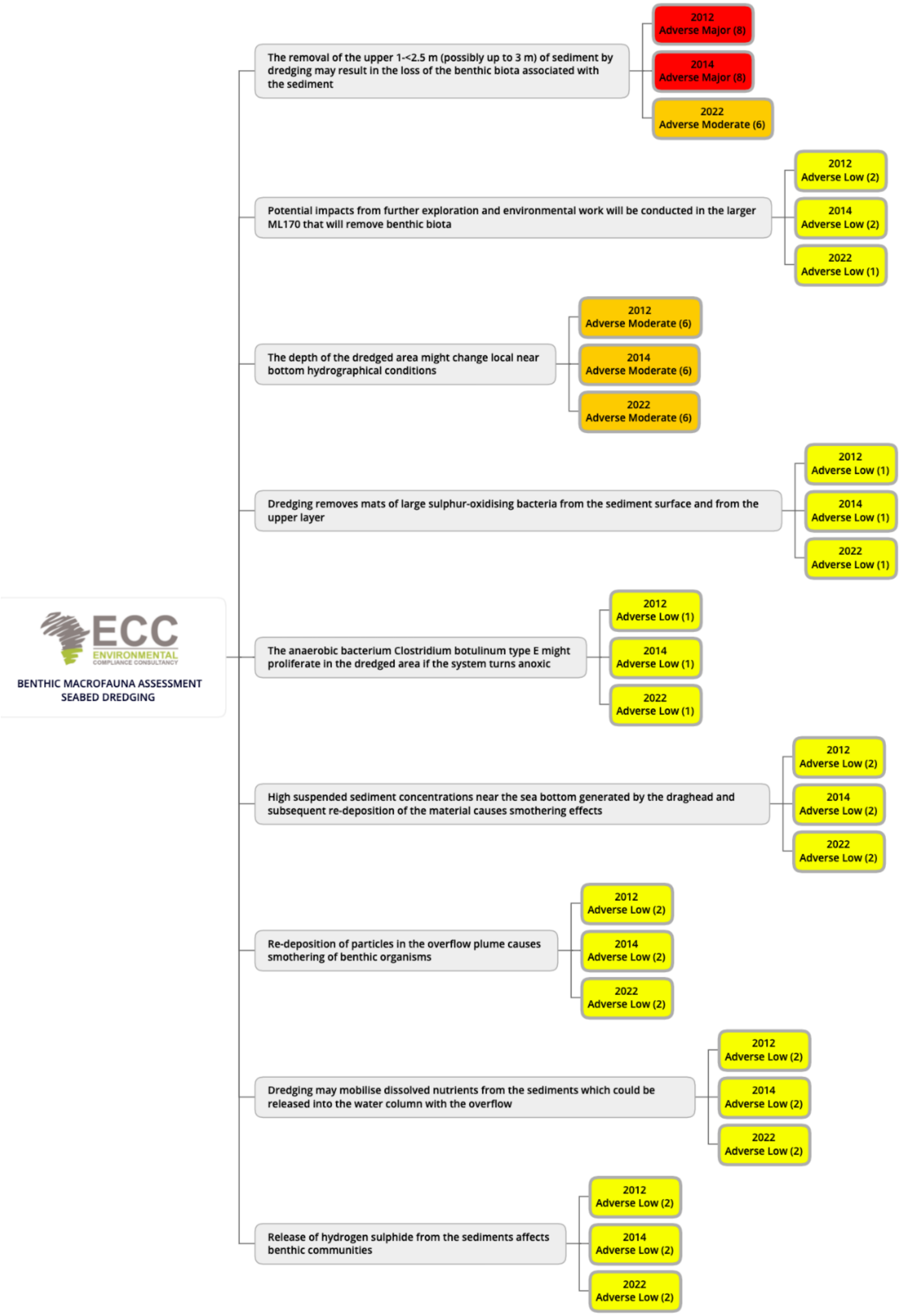


Figure 45 – Benthic macrofauna impacts

7.5.1 IMPACTS FROM SEABED DREDGING ON BENTHIC MACROFAUNA

All associated seabed dredging operational impacts (nine) on benthic macrofauna that were assessed in 2012 EIA and 2014 EIA verification assessment, have been re-assessed in 2022 with the inclusion of the additional scientific information and data from subsequent supplementary studies that were conducted in 2020.

7.5.1.1 The removal of the upper 1-<2.5 m (possibly up to 3 m) of sediment by dredging will result in the loss of the benthic biota associated with the sediment

The 2012 assessment outcome was based on regional benthic sampling data from 3 areas (SP1, SP2 and SP3) in ML 170 supported with data from MFMR and publicly available data. The 2014 EIA verification assessment included a dedicated benthic survey comprising *in situ* sediment samples and oceanographic measurements taken from 26 stations in SP1 that were, to confirm some of the assumptions upon which the 2012 assessment was based. Most macrofaunal species that were noted in the 2013/2014 benthic sampling program were also found in the 2010 baseline, with only six 'new' species recorded in the 2014 verification assessment. In the meiofauna study 135 nematode and 36 harpacticoid copepod taxa were recorded. Nematode species richness values of up to 42 species per sample were found with densities of up to 30,400 nematodes per litre sediment. These numbers are comparable to other offshore seabed sites at similar water depth.

The 2014 increased the confidence of the original assessments and confirmed the following; low dissolved bottom water conditions are not anoxic and no significant amounts of $H2S^-$ flux from the sediments. The 2014 verification study further confirmed that the significance rating to be medium, as the residual layer will be removed is colonised by benthic organisms, but the communities will be able to re-establish, however the rate and composition of the recovering benthic communities composition may differ. The 2022 assessment reviews these findings, taking into consideration the current and sediment plume modelling study conducted by HR Wallingford (2020).

This Section below details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

The exposed sediments in the dredged area can be expected to differ from the original surficial deposits after upper sediment removal, and sediment refill rates at this depth are likely to be slow. Colonising assemblages may differ from those present prior to the dredging activity. The loss of the benthic community is restricted to the dredged-out areas (maximum of 2.5 km^2 and average of 1.7 km^2 per annum), but the recovery to the original community is likely to take longer than the life of mine (permanent (~20-years life of mine) or may even not be achieved in a meaningful timescale. However, recovery to pre-mining conditions is commonly defined as the recolonization of previously mined areas by marine faunal communities to the point that they can be considered to have an ecological function equivalent to those that exist in comparable undisturbed reference sites. This is deemed to be achieved when the communities have, after a number of years, reached a similarity to the undisturbed sites of at least 80 % (MacDonald, L. and Erickson, W., 1994; Newell, R., Seiderer, L. and Hitchcock, D., 1998). This similarity is based on a combination of univariate (abundance, biomass, diversity, species richness) and multivariate (species composition based on abundance, biomass, and functional traits) indices. Such an approach has also been adopted by the Debmarine Namibia (DBMN) Marine Scientific Advisory Committee (MSAC) and is applied in their diamond mining monitoring program (Risk Based Solutions (RBS), 2021).

Long-term benthic monitoring carried out by De Beers Marine (DBM) provides a good record of mining-related impacts and subsequent recovery of benthic marine habitats and associated macrofaunal communities. Monitoring in a diamond mining licence area on the South African side of the Orange River has been undertaken since 2003 and mining in this area occurred from 2007. The latest 2018 survey suggests that recovery at the mined sites is very close to complete and shows that recovery period seems to be in excess of 10 years (Risk-Based Solution (RBS), 2021). From the DMBN benthic monitoring studies conducted in the Namibian Mining Licence Area Atlantic 1 MLA, it can be gleaned that rates of recovery can vary. Impact sites have been mined in 2012, 2014, 2016, and 2018. The monitoring studies found that in terms of univariate measures (abundance, biomass, and species richness) some mined sites showed clear lasting impacts of mining, while others showed little evidence of mining related impacts, or had even reached pre-mining conditions although they had been mined within the last four years (Risk-Based Solutions (RBS), 2021). In terms of species composition and biological traits, multivariate analyses differences between mined and unmined sites were recorded for sites that had been recently mined. Recovery rates seem to be closely linked to sediment refill rates as those mined sites closer to the Orange River mouth showed earlier signs of recovery compared to those further away. Further reference can be made to the Environmental Management Programme Report for Namdeb’s ML 45 (Elizabeth Bay) by Pisces Environmental Services (Pty) Ltd (2018), whereby a marine monitoring programme of benthic macrofaunal communities has been in effect since 2008 as part of mid-water operations.

Colonisation of the newly exposed surface can start soon after cessation of dredging. The main pathway of colonisation is through settlement and recruitment processes from the meroplankton but can also take place by passive translocation of animals during storms or sediment sliding from nearby unaffected areas, and the active immigration of mobile species. Opportunistic species, characterised by being small, mobile, highly reproductive, and fast growing, are typically dominating the first successional stage(s). Long-lived species, however, need longer to re-establish the natural age and size structure of the population.

The HR Wallingford 2020 Plume dispersion modelling study indicates that sediment re-deposition can progressively attain a thickness of up to 200->500 mm in the mined area over the 20-year-life of mine (HR Wallingford, 2020), which would provide some measure of refilling into the dredged areas and may facilitate recolonization. However, it is predicted that sediments in the dredged area are likely to change to a predominantly silty substrate from silty sand, leading to a possibly different functional benthic community composition than at pre-dredge conditions.

Recovery to functionally similar communities that provide similar ecosystem services as the original communities might, however, occur sooner (i.e., > 10 years, long term) based on available data for benthic recovery from marine diamond mining operations. Significance rating remains medium from the previous assessments and a conservative approach is appropriate to predicted recovery times.

The removal of the upper layer of sediment may have an adverse impact, that will be limited to the annual mining area and the duration will be long term to permanent, depending on whether functional or complete recovery is attained. Note: A recovery to pre-mining conditions is commonly defined as the recolonization of previously mined areas by marine faunal communities to the point that they can be considered to have an ecological function equivalent to those that exist in comparable undisturbed reference sites. This is deemed to be achieved when the communities have, after a number of years, reached a similarity to the undisturbed sites of at least 80% (MacDonald, L. and Erickson, W., 1994; Newell, R., Seiderer, L. and Hitchcock, D., 1998). The probability of the impact occurring is high probable/definite as this upper layer is required to be removed to mine for phosphate from the seabed. The sensitivity of the benthos will be medium and the magnitude of change serious effects, as communities will re-establish and function, but the assemblages might differ. The level of confidence remains high. The significance of the impact is moderate. Take note that the significance of the impact has decreased from the 2012 and 2014 assessments, after applying the quantitative scoring methodology as described in Chapter 6 for the previous assessments (major to moderate). This is possible to due to confidence in the assessment outcomes, professional opinion, approach to the methodology, in which the scale of extent was refined. In the 2012 and 2014 assessments, the impact was assessed on a larger scale (specific mine site i.e., SP1) and in the 2022 assessment the impact is assessed based on the annual mining area (up to 2.5 km^2 (average 1.7 km^2/year)).

Mitigation summary:

- As per the recommendations in the benthic study, mitigation measures are to leave behind a residual sediment layer of at least 30 cm of the original deposit thickness to cover the clay footwall and leave undredged corridors adjacent to dredged areas. A small-scale physical disturbance experiment simulating mining of phosphate deposits at the Chatham Rise in New Zealand, indicates that undisturbed areas near mined areas, despite being subjected to some level of sedimentation, may act as a critical source of colonising fauna (Murray, 2021). This highlights the importance of leaving unmined patches of seabed adjacent to or within targeted areas, to aid the recovery of macrofaunal communities through migration of adult mobile organisms from these areas (see also (Powilleit, Kleine and Leuchs, 2006; McLaverty et al., 2020).
- The benthic monitoring programme in the EMP will be reinforced with adequate reference sites to make before/after comparisons and recovery rate estimates robust. Results of predicted dredge plume fines sedimentation patterns in the hydrodynamic modelling study (HR Wallingford, 2020) will be used in allocations of reference and impact sample sites.
- Given the relocation of reference sites and the fact that the initial baseline surveys were conducted in 2013, the current baseline survey data should be refreshed prior to commencement of dredging in the 24 to 36 month period after award of an environmental clearance certificate for the project. In this survey, benthos sampling should focus on macrofauna but the sampling of the larger mobile epifauna and small commercially non-targeted fish species should be included.
- Regular macrofauna and meiofauna monitoring surveys of all selected sites should be carried out over the life of mine and if necessary, beyond to determine the time of recovery once dredging has ceased (Carter & Steffani, 2021).

7.5.1.2 Further exploration and environmental work will be conducted in the larger ML170 that will remove benthic biota

This impact addresses the potential for continued exploration and resource development work in ML 170 (through use of gravity cores, vibrocores, grab samples and bulk samples) to have a negative impact on marine benthic communities. The footprint of the exploration sampling activities was determined as extremely small with a limited to zero potential impact. This Section details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

The total area disturbed by the exploration tools, even after extensive exploration campaigns, will be very small, with the largest individual grab size at 1.5 m^2. Recovery is predicted to be fast (short term) due to slumping of material from the sides and migration of benthic fauna from undisturbed adjacent areas. Significance rating therefore remains low and no amendments required to previous findings or provisions of the EMP.

The exploration activities may have an adverse impact but this will be limited to the size of a single sample (grab/core) which will be extremely small in terms of area disturbed and the duration will be short term. The probability of the impact occurring is probable as exploration activities are expected to take place. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change will have no lasting effect. The confidence level remains high and the significance of the impact is low. No further mitigation measures are required.

7.5.1.3 The depth of the dredged area might change local near bottom hydrographical conditions

This impact assesses the potential that seabed topographic changes resulting from seabed dredging operations may change local near bottom hydrographical conditions and that could result in an uneven slightly 'hummocked' surface. This may sufficiently alter seafloor topography to slow down or change currents over deeper tracks, thereby possibly acting as traps for finer sediments and particulate organic matter (POM). This could lead to high rates of decomposing organic matter and possible development of anoxic conditions and elevated H_2S concentrations in the affected areas.

The 2012 assessment showed a medium confidence in the conclusions drawn, based on the available data for the target dredge mine site which was then followed up with in-situ samples and current metering data collected at the target mine site during the 2014 verification assessment which then confirmed the assumptions and findings from the 2012 assessment (Steffani in Midgley, 2012). The findings confirmed in 2014 are that the high natural near bottom current speeds are sufficient enough to exert shear stress forces that would prevent accumulation of fine sediment particulate matter. The outcomes of the original assessments in 2012 and backed up with in-current data in 2014 remained valid with a change in confidence level from moderate to high.

Due to the availability of additional comprehensive modelling studies conducted by HR Wallingford (2020) on ocean currents which were verified using the current data recorded on the mine site in 2014 for validation purposes and used to define the sediment plume dispersion patters for the mine target area, this impact was re-evaluated for the current 2022 assessment. This Section details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

The dredging of the target area will probably result in an uneven slightly 'hummocked' surface. This may sufficiently alter seafloor topography to slow down/change currents over deeper tracks, thereby possibly acting as traps for finer sediments and particulate organic matter (POM). This could lead to local concentrations of decomposing organic matter and possible development of anoxic conditions and elevated H_2S concentrations in the affected areas. The impact should be limited to the deeper trenches of the dredged area (maximum of 2.5 km^2 per annum) but can be permanent (>20-years) as sediment refill rates are expected to be low. Localised effects are moderate to serious as anoxic conditions are deadly for most benthic communities, but large sulphur-oxidising bacteria can thrive under these conditions. Significance rating is medium, as per the previous assessment outcomes.

If POM settles into the deeper trenches due to altered current speed, it would be restricted to surficial layers of the sediment and not be buried at least for decades (unless it is being covered by fines settling from the hopper overflow plume). The POM is mainly refractory material imported from the inner continental shelf productive area and would be mostly deposited in hypoxic and/or oligoxic conditions allowing oxic remineralisation. Thus, generation of anoxic conditions post mining should be unusual. In addition, the plume dispersion modelling study predicts that sediment re-deposition rates can attain 200 mm to >500 mm in the mined area over the 20-year-life of mine (HR Wallingford, 2020) thereby mitigating the potential for altered current speed over time.

Seabed dredging may have an adverse impact on the changes to seabed topography, that will be limited to the specific 20-year mine plan site (in SP1) and the duration is permanent. The probability of the impact occurring is probably. The value of the sensitivity of the benthic communities is medium. The magnitude of change is serious effects due to the potential for anoxic conditions. The significance of the impact is moderate.

The significance rating for the current assessment remains the same as noted from the previous assessments. The impact area is the only noted change as the area of disturbance is redefined, based on the boundary of the 20-year mine plan area, to an influence of 34 km^2 and not 176 km^2 as was used previously for evaluation purposes. Mining will not be carried out in the whole of the SP1 area, only in the 20-year mine plan area that lies within SP1. Relevant mitigation measures are incorporated in the EMP.

7.5.1.4 Dredging removes mats of large sulphur-oxidising bacteria from the sediment surface and from the upper layer

This impact addresses the potential for seabed dredging to remove mats of large sulphur-oxidising bacteria from the sediment surface and from the upper layer. These bacteria are important in oxidising the toxic H_2S, thereby reducing its diffusion into the water column and the prevention of anoxic conditions for the benthic communities.

The outcomes of the 2012 assessment showed a medium confidence in the conclusions drawn, based on available benthic sampling information from the target dredge mine site as well as public available data and published literature. During the 2014 verification assessment, surveys were conducted whereby target mining area samples were collected and analysed, and results verified the findings from the 2012 assessment (Steffani in Midgley, 2012). These findings are that the following large sulphur bacteria are absent from the target dredge site (SP1): *Thiomargarita*, *Beggiatoa* and *Thioploca*. During sampling of the bacterial assemblages, sulphide fluxes were considered to be most likely low, as these aforementioned bacteria play an important role in H_2S oxidisation to prevent anoxic conditions. Smaller forms of sulphur bacteria were present (e.g., *Thiobacillus* species), with lower growth yields. This indicates that low concentrations of sulphide were present in the samples.

This impact was re-evaluated for the 2022 assessment and the Section below details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

The removal of sulphur-oxidising bacteria would be limited to the dredge area (34 km^2 for life of mine (20-years)). The recovery of bacterial mats will likely be medium to long term as it depends on the development of anoxic conditions in the sediment and subsequent sufficient H_2S concentrations. Removal of the sediment also removes H_2S and fluxes from the dredge area and are thus not expected unless there is sufficient particulate organic matter deposition and anoxic conditions are generated through anaerobic remineralisation. If this happens, the bacterial mats are likely to return. Significance rating is low as concentrations of large sulphur bacteria are assumed to be low or absent, as per the previous assessment's outcomes.

Seabed dredging may remove bacterial mats, this will be restricted to the specific 20-year mine plan site (SP1) and will be long term for the duration of mining activities. The probability of the impact occurring is improbable, due to low or absent concentrations of the large sulphur bacteria from the dredge target mine site. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change is moderate effects. The confidence level remains high. The significance of the impact is low.

7.5.1.5 The anaerobic bacterium Clostridium botulinum type E might proliferate in the dredged area if the system turns anoxic

This impact addresses the potential that the anaerobic bacterium *Clostridium botulinum* type E might proliferate in the dredge area if the system turns anoxic as a consequence of seabed dredging activities. In turn this would potentially pose a health risk to humans and marine organisms if it were to enter the food chain. In the 2012 assessment it was concluded, with medium confidence, that the proliferation of the bacteria is assumed to be a rare probability.

Literature reviews were conducted based on northern hemisphere data as currently no record of in situ contamination of fish populations by *C. botulinum* has been reported in southern African fish populations. The distribution of this bacteria is limited to deeper saline waters and the proliferation of this bacteria is linked to extreme events such as H_2S eruptions. This impact was re-evaluated for the 2022 assessment. The Section below details the 2021/2022 specialist assessment outcomes (Carter & Steffani, 2021).

They note that the anaerobic bacterium Clostridium botulinum type E might proliferate in the dredged area if the system turns anoxic and may then pose a health risk to humans and wildlife when entering the food chain. The impact is restricted to the mine site (maximum of 2.5 km^2 per annum, 1.7 km^2 on average) and short term. If the system turns anoxic this will be of long term or permanent duration, but *C. botulinum proliferation* is linked to periodic massive die-offs of fish and other aquatic organisms, that might occur during extreme events such as H_2S eruptions. Once bacteria proliferate, they may enter the food chain by ingestion of contaminated sediments from the dredge area, and the effects of botulism are serious (botulism caused by the bacteria can be lethal to human and wildlife). However, in-situ contamination of fish populations by the bacterium has not been reported for southern African fish populations, and literature data suggest that the distribution of the bacteria is generally limited in deeper saline waters.

Significance rating is low as proliferation of bacteria is assumed to be a rare probability.

An extensive literature search could not find any reported evidence of in-situ outbreaks of *C. botulinum* contamination in southern African water and/or fish populations.

Seabed dredging could have an adverse impact, this will be restricted to the annual mining area and be short term. The probability of the impact occurring is improbable. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change can be serious effects if the bacterium enters the food chain. The confidence level is high. The significance of the impact is low. Therefore, no amendments from the previous assessment outcomes are noted. No further mitigation measures are required.

7.5.1.6 High suspended sediment concentrations near the seabed generated by the draghead and subsequent re-deposition of the material causes smothering effects

This impact addressed the potential adverse effects on benthos from seabed sediment plumes generated by the dredge head during dredging activities. The 2012 assessment (Steffani in Midgely, 2012) assessed the significance of the impact occurring as low, based off of studies conducted by the preferred dredging contractor Jan De Nul Group on draghead plumes. The 2014 verification assessment found the 2012 assessment and findings remained valid.

This impact was reassessed by Carter and Steffani (2021) in light of the supplementary studies on plume generation and dispersion completed in 2020 by HR Wallingford. The Section below details the specialist's current 2022 assessment outcomes.

Suspended sediment concentrations generated at the point of dredging tend to decline as the sediments become coarser and usually decrease rapidly with distance from the dredger. The size fractions of greatest consequence are the silts, muds and clays (<63 µm) as these create the highest level of turbidity. The sediments in the target area are dominated by medium to fine sand and the mud fraction (<63 micron) contributes 0% to surficial sediment composition (Lwandle Technologies, 2014). Modelling and experiments conducted (Jones et al., 2017; HR Wallingford (2020); Purkiani, K., Gillard, B., Paul, A., 2021) indicate that dredge head plumes in silty sand may have suspended sediment concentrations of 1mg/l and that these will be confined to the lower 10 m of the water column within the dredge area.

Sediment re-deposition from the drag head is expected to be very localized. The mining area is subjected to natural turbidity events, which seem to pass over the mining area without settling due to high bottom shear stress, and the addition of fine particles suspended by the drag head to these is negligible.

The sediment plume could have an adverse impact; however, the impact is very localized to a single dredge cycle area and the duration is very short term. The effects will only be relevant along a narrow strip around the outer edge of the dredge site since any re-deposition inside the dredged area will have no impact as the benthos are removed. The sediment plume duration is for 72 hrs maximum. The probability of the impact occurring is highly probable. The sensitivity of the receptor is low as the benthos will be removed during dredging activities. The magnitude of change is minor effects. The level of confidence is now determined as high. The significance of the impact is determined as low, as per previous assessment outcomes.

7.5.1.7 Re-deposition of particles in the fine sediment plume causes smothering of benthic organisms

This impact addresses the potential for fines from the TSHD discharge plume to be deposited in areas located outside of the immediate dredging area, therefore impacting benthos (smothering) on a larger scale. At the time of the 2012 EIA, plume dispersion models specific to this Project were not available. The outcomes of the 2012 assessment showed a medium confidence in the conclusions drawn on the size and extent of the sediment plume and related fine sediment deposition, based on assessment of the based on available information on sedimentation rates from an equivalent study conducted in shallower waters, with different hydrographical conditions, off the southern Namibian coast. The 2014 verification assessment reviewed the 2012 assessment outcomes utilising updated modelling by the Council for Scientific and Industrial Research (CSIR), that predicted sedimentation rates to be low, for the extent to probably be regional but for a very short term that will have minor effects (benthos in immediate vicinity affected) and thus significance rating was low. The 2014 assessment indicates that it is possible that the actual plume dimensions assumed in the 2012 assessment may be exceeded (2 to 5 times larger). It was considered that the plume extent may increase from the immediate dredge area to possibly affecting the annual mining area but not extending outside of SP1 mining target area. The implication from this change in the assessment did l not influence the findings of the 2014 assessments and therefore the 2012 assessments remained unchanged.

As part of the supplementary studies conducted from 2018, an international expert group HR Wallingford conducted detailed ocean current and plume dispersion modelling (HR Wallingford, 2020) of dredge plume behaviour in the 20-year mine plan area based on their existing comprehensive regional and local metocean data bases, *in situ* measurements of sediment properties as well as water column and bottom currents in the 20-year target mining area (2014 verification assessment) along with the technical details on the proposed dredging programme production rates and equipment specifications provided by the dredging contractor (JDN).

This impact was re-evaluated for the current 2022 assessment in due to the availability of these additional modelling studies conducted on ocean currents and sediment plumes for the mine target area by HR Wallingford (2020).

This Section below details the updated 2022 specialist assessment outcomes (Carter & Steffani, 2021).

The effect of burial by sediments on benthic animals depends on several factors including thickness of deposits, rate of deposition, nature (grain size) of the deposits and species-specific traits (e.g., mobile or sessile biota). Species with burying behaviour may experience little or no effect, while sedentary animals are more sensitive. The development of marine species sensitivity distributions (SSDs) for the burial by sediment based on effect levels published for 32 species (molluscs, crustaceans and polychaetes) determined a 50 % hazardous level (HL50, i.e., 50% of animals are negatively affected by the burial) of 54 mm and a 5% hazardous level (HL5) of 6.3 mm (Smit, et al., 2008). If deposition is slow or occurs in pulses (as is the case for the proposed Project, modelled deposition rates being ≤0.3 mm per dredging cycle), (non-sessile) species have time to escape burial and can move upwards with a rate equal to the deposition rate (Bolam, 2011).

According to the plume dispersion model (HR Wallingford, 2020) the cumulative zone of influence (ZOI) from the fine sediment discharge plume for the 20-year mining period extends over an area of 513 km^2 outside of the mining target area in SP1. The total area outside the mining area affected by a re-deposition of >5 mm is 412 km^2, of which an area of 151 km^2 is predicted to experience an overall deposition thickness of f >10 cm, which would well trigger the SSD HL50 of 54 mm (Smit et al., 2008).

However, these ZOIs for plume dispersion and re-deposition are calculated taking the entire life of mine (20-years) into consideration (cumulative effect). while plume dispersion and re-deposition for a single 16 hour dredging period in each 59 hour dredging operational cycle on the other hand extend 1 km^2 to 5 km^2 outside the mining plan area and the corresponding thickness for deposition of sediment is predicted to result in 0.3 mm deposition, well below the HL5 (6.3 mm) which is protective of 95 % of the taxa tested.

Following deposition some of the very fine fraction may be resuspended in the continental shelf wide benthic boundary nepheloid layer and transported offshore beyond the continental shelf break for deposition as described in Inthorn et al (2006). Any possible contribution to this from the spatially restricted area of dredged fine sediment deposition should be proportionally infinitesimally small. The extent is local. For an individual dredge cycle (58.5 hrs being 16 hrs active dredging and remainder of time dredger is offsite), the impact is short term. Benthic biota in the immediate vicinity of the dredge area may be affected by smothering, elsewhere sedimentation rates are expected to be very low.

In summary, the sediment plume could have an adverse impact, the extent will be local and for a very short term (per dredge cycle). The probability of the impact occurring is probable. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change is minor effects. The confidence in the results is high. The significance of the impact is low as per the previous assessment's outcomes.

7.5.1.8 Dredging may mobilise dissolved nutrients from the sediments which could be released into the water column

This impact addresses the potential for dissolved nutrients to be mobilized during dredging operations from the dredger discharge. The increased nutrient level may result in extensive phytoplankton blooms, which upon death cause aggravated decomposition rates leading to anoxic conditions at the seafloor. The outcomes of the 2012 assessment showed a medium confidence in the conclusions drawn based on the available from the target dredge mine site, published literature and publicly available data from relevant authorities. During the 2014 verification assessment, *in situ* sediment core and grab samples were collected to a depth of up to 2 m below seabed at 26 stations across the mining target area in SP1 and analysed at

CSIR laboratories in Cape Town (Stellenbosch). The results verified the assumptions and findings from the 2012 assessment (Steffani in Midgley, 2012). This impact was reassessed by Carter and Steffani (2021) and the Section below details the 2022 assessment outcomes.

At the seabed, there are moderately high nutrient levels in the dredge area sediments (moderate nitrate-nitrogen and high phosphate-phosphorus concentrations) but generally low pore water volumes (~35 litres/m^3 sediment) that could release nutrients when disturbed. The Redfield ratio measured was 8.2 vs 17.7 and the measured moisture content of the sediment was low. Therefore, nutrient loading to the euphotic zone through dredging will be unlikely. On completion of the 2014 verification assessment, the confidence level for this impact assessment was increased to high and remains unchanged for the current 2022 assessment.

Dredging hopper discharge could have an impact by increasing nutrient levels that in turn result in extensive phytoplankton blooms, which upon death cause aggravated decomposition rates leading to anoxic conditions at the seafloor. The effects are local as the released nutrients will spread with the fine sediment discharge plume and are expected to be very short term as the fine sediment discharge plumes will only be generated during dredging which occurs within a 37-hour dredge cycle for approximately 16 hrs. The magnitude of change is minor effects as dissolved nutrient concentrations in the target areas are expected to be relatively low. The probability of the impact taking place is possible. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. Significance rating is low as per the previous assessment outcomes.

7.5.1.9 Release of hydrogen sulphide from the sediments affects benthic communities

The outcomes of the 2012 assessment showed a medium confidence in the conclusions drawn, as the assessment was based on the sediment sampling information available from the target dredge mine site, published literature and from publicly available data. The 2014 verification survey sediment-sampling regime covered a total of 26 verification sites, which extended across SP1 and approximately 1-2 km to the west and east of SP1 (Lwandle Technologies, 2014). As a proxy for potential HS^- fluxes from the sediment, acid volatile sulphides (AVS) and oxidation reduction potential (ORP) were measured from superficial sediments (day grab) and from subsurface sediments down to 2.2 m (gravity core). The results of the 2014 assessment verified the assumptions and findings from the 2012 assessment (Steffani in Midgley, 2012) that there are low dissolved bottom water conditions that are not anoxic and the fluxes of H_2S in sediment pore water is low. Additional evidence in support of this is the absence of large sulphate oxidising bacteria from the survey area during the period of the thiobacteria verification survey conducted in July/August 2014. Furthermore, evaluation of pyrite-S mobilisation from sediments indicate that this is low. Therefore, H_2S fluxes to the lower water column are considered to be negligible and the absence of large sulphur oxidising bacteria, due to either natural causes or disruption from dredging, would have little effect on these (Carter in Midgely, 2014). The significance rating remains low.

This impact was reassessed by Carter and Steffani (2021) and the Section below details the 2022 specialist assessment outcomes.

Literature data suggest that hydrogen sulphide concentrations in the near-bottom waters, pore waters and in the upper sediment layers in the target areas are very low, but it cannot be excluded as deeper sediment layers may contain hydrogen sulphide. If hydrogen sulphide is present, it is presumably sucked up with the sediments and residual hydrogen sulphide at the seafloor will be minimal.

During the verification study, AVS was undetectable in the surficial sediments and there were very low AVS concentrations in the underlying sediments, which predicts low to zero flux of HS^- into the benthic boundary layer. Furthermore, elevated nitrate concentrations at the base of the water column and in the sediment pore-water supports the contention that HS^- flux is low as the two compounds cannot coexist.

The verification survey in conjunction with biogeochemical inputs by Monteiro (in literature in Lwandle Technologies, 2014) concluded that the proposed mine area in SP1 does not show the characteristics of the mud belt and the SO_4 reduction and therefore HS^- flux from the sediments would be minimal. This supports the conclusion of the 2012 EIA that environmental risks of mining by dredging would be mainly physical as opposed to biogeochemical.

Dredging could release hydrogen sulphide from the sediments and the impact would be local as the released hydrogen sulphide may spread along the sea bottom affecting undredged areas and the associated biotic life. The duration will be short term as the spread of hydrogen sulphide across the seafloor will be very short term and the compound will eventually mix with oxic seawater and be oxidised to sulphate. The probability of the impact occurring is probable. The sensitivity of the receptor to accommodate changes associated with this potential impact was determined as low. The magnitude of change is moderate effects as hydrogen sulphide is very toxic and can kill many animals in its path. The confidence level remains high. The significance rating is low.

7.5.2 SUMMARY OF IMPACTS FROM SEABED DREDGING ON BENTHOS

Table 21 provides an overview of the impact assessment outcomes for seabed dredging on benthic communities.

Table 21 – Impact assessment for seabed dredging on benthos

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining – phosphate ore recovery by dredging	Marine benthic communities	The removal of the upper 1-<2.5 m (possibly up to 3 m) of sediment by dredging will result in the loss of the benthic biota associated with the sediment	Adverse Annual mining area Permanent (functional recovery 10-20-years – long term)	Medium	Serious effects	Adverse Moderate (6)
Mining – seabed dredging	Marine benthic communities	Further exploration and environmental work (gravity cores, vibrocores and grabs) will be conducted in the larger ML170 that will remove benthic biota.	Adverse Single dredge cycle area Short term	Low	No lasting effect	Adverse Low (1)
Mining – seabed dredging	Seabed surface Marine benthic communities	Seabed topographic changes affect change local near bottom hydrographical conditions and probably result in an uneven slightly	Adverse Specific 20-year mine plan site (in SP1) Permanent	Medium	Moderate to serious effects	Adverse Moderate (6)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		'hummocked' surface.				
Mining – seabed dredging	Marine benthic communities	Dredging can remove mats of large sulphur-oxidising bacteria from the sediment surface and from the upper layer.	Adverse Specific 20-year mine plan site (in SP1) Long term	Low	Moderate effects	Adverse Low (1)
Mining – Seabed dredging	Marine communities Public consuming seafood	The anaerobic bacterium *Clostridium botulinum* type E might proliferate in the dredged area if the system turns anoxic	Adverse Annual mining area Short term	Low	Serious effects	Adverse Low (1)
Mining – seabed plumes generated at the drag head	Marine benthic communities	High suspended sediment concentrations near the seabed generated by the drag head and subsequent re-deposition of the material causes smothering effects on the benthos.	Adverse Single dredge cycle area Very short term	Low	Minor effects	Adverse Low (2)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining - sedimentation from the dredger fine Sediment plumes during seabed dredging	Marine benthic communities	Re-deposition of particles/ fine material from the TSHD discharge plume causes smothering of benthic organisms.	Adverse Local Very short term	Low	Minor effects	Adverse Low (2)
Mining – seabed dredging	Marine benthic communities	Dredging may mobilise dissolved nutrients from the sediments, which could be released into the water column with the discharge This could result in phytoplankton blooms, leading to anoxic conditions at the seafloor.	Adverse Local Very short term	Low	Minor effects	Adverse Low (2)
Mining – sulphide releases from seabed dredging	Marine benthic communities	Release of hydrogen sulphide from the sediments due to dredging may occur, which can affect benthic communities.	Adverse Local Short term	Low	Moderate effects	Adverse Low (2)

7.6 THE MARINE ENVIRONMENT: BIOTIC

The overall methodology approach to the assessment was described in Chapter 6 in detail, with reference to the previous 2012 and 2014 methodology utilised. In order to enhance the confidence of the fisheries, mammals and seabirds' assessments, and assess potential impacts on a finer scale, the scale of change/extent was reviewed and amended and is further described in the table below (Table 22). Note the scale of change/extent differs from the original assessment, whereby the impacts have been refined and zoned, based on the defined 20-year mine plan area in ML 170 as well as recent information available for the assessment from the Ministry of Fisheries and Marine Resources and the transboundary survey undertaken through the FAO/NORAD programme (Boyer et al., 2019). While the original assessment considered the whole of ML 170 and applied zones for the assessment referenced to the borders of the whole ML 170, this revision now focuses on the area to be exploited within ML 170, which is only in the SP1 target mining area incorporating the 20-year mine plan, covering an approximate annual dredge area of 1.7 km^2 and a cumulative planned total of 34 km^2 over the 20-year life of mine. Therefore, impacts for the 2022 assessment are able to be assessed on a smaller scale as per the annual mining plan for the designed 20-years life of mine. This adjustment is appropriate as mining operations are not conducted over the whole of the ML 170 at any one time. The annual mining area equates to 0.08 % of the MLA and the 20-year mining area to less than 2 %, which is about 0. 0003 % of the seabed within Namibia's exclusive economic zone.

All 2014 methodology further reported on in this Chapter for jellyfish, is as stated in Chapter 6, no changes were made.

Table 22 – Scale of change/extent utilised for fish, mammals and seabirds' assessments

Scale of change/extent	Description
Zone 1	Area of direct impact (20-year plan) within SP1
Zone 2: Local	Indirect and induced effects (within 25 km of mined area), (area of biodiversity / ecosystem effects)
Zone 3: Regional	Perceived effect (concerns) (within 50 km) (area of biodiversity / ecosystem effects) + cumulative effects
Zone 4: National	>50 km to EEZ includes + cumulative effects

7.6.1 THE MARINE ENVIRONMENT: FISHERIES, MAMMALS AND SEABIRDS' IMPACTS

Fish, mammals and seabirds' impacts include the consequences of seabed dredging on the marine environment and these communities. The significant impacts or impacts that have specific interest to stakeholders, before mitigation, are summarised in Figure 46 for illustrative purposes only. All previous impacts detailed in the 2012 and 2014 assessments, were re-assessed in 2022. Details related to each specific impact is discussed further in this Section.

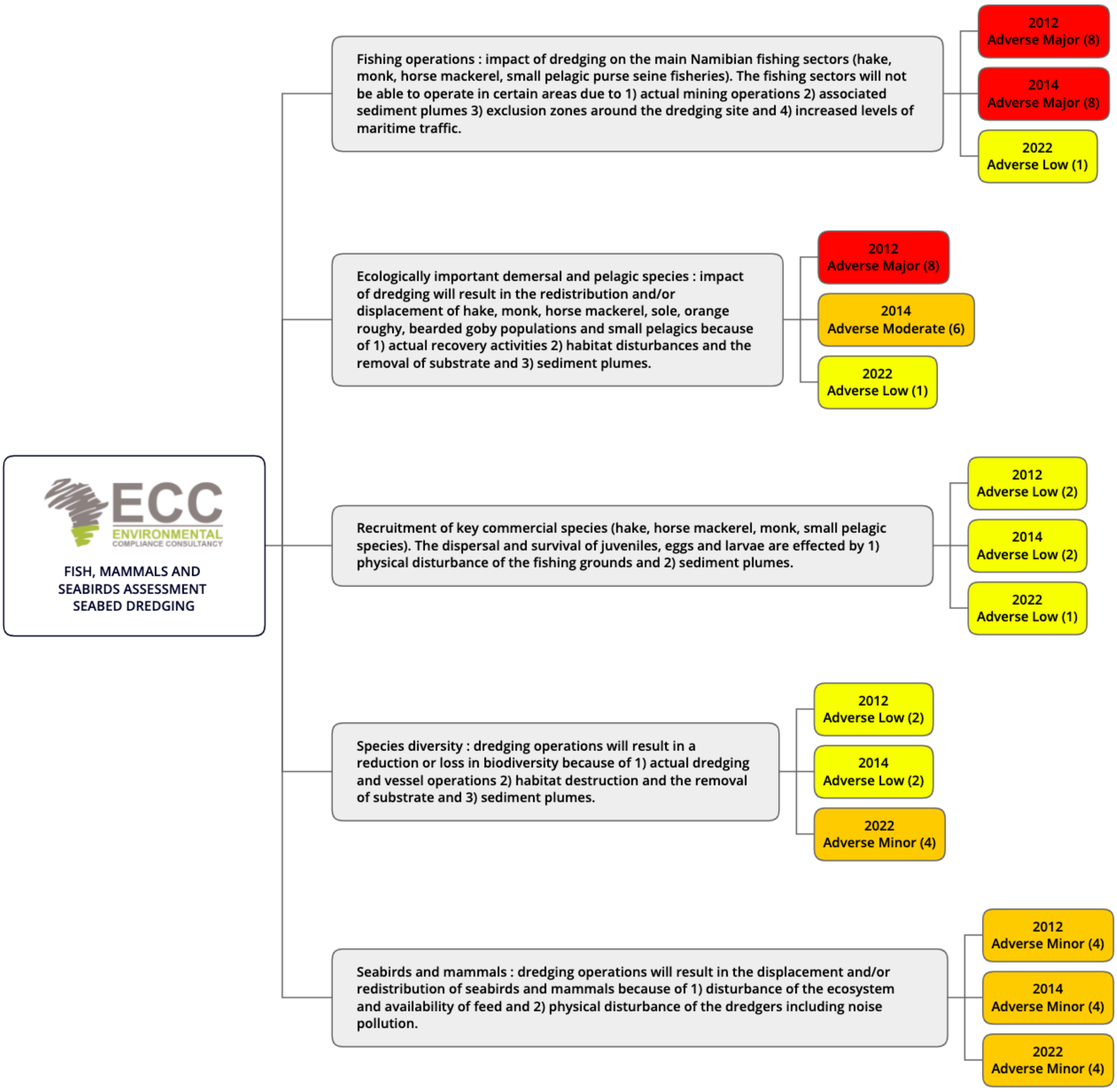


Figure 46 – Fish, mammals and seabirds' impacts

7.6.2 FISHERIES IMPACTS

The fisheries component of this assessment reviews impacts 1 – 3, as recorded in the previous 2012 EIA and 2014 verification assessments (Japp in Midlgey, 2012 & 2014). These impacts include the following study areas: impacts of mining on commercial fisheries, commercial fish species and on the recruitment of commercially important species. All associated potential impacts were assessed in 2012 and reassessed in 2014 during the verification programme, whereby comprehensive infield surveys and specialist studies were conducted.

As part of this current (2022) assessment report, the appointed specialists FOSS cc (Japp 2022) has re-assessed fish and fisheries impacts accordingly, per species. These impacts will be further discussed in the Sections below and the aggregated impact significance score will be used as the final outcome of each impact.

7.6.2.1 Fishing operations: impact of dredging on the main Namibian fishing sectors (hake, monk, horse mackerel, small pelagic purse seine fisheries). The fishing sectors will not be able to operate in certain areas due to 1) actual mining operations 2) associated sediment plumes 3) exclusion zones around the dredging site and 4) increased levels of maritime traffic.

The potential impacts of dredging activities on commercial fisheries are described below. The commercial fisheries assessed includes; hake (wet fish trawl, freezer trawl, longline), monk and sole trawl, horse mackerel (midwater trawl, purse seine), small pelagic purse seine (sardine and anchovy), orange roughy trawl, meso-pelagic/snoek and other migratory (snoek), large pelagic tunas, crustaceans (rock lobster and deep water crab), line fish and mariculture. The aggregated impact significance score will be used as the final outcome of the impact, as per Table 27.

<u>2012/2014 Assessment</u>

During the original 2012 assessment, the confidence level of the outcomes of the assessment was confirmed to be high, as good quantitative, historical and current fisheries data was used for the assessment.

Conclusions drawn from the 2012 assessment which considered the whole area of ML 170 (2,233 km^2) are listed as the following (Japp in Midgley, 2012):

- Historical hake trawl catch was 0.86 % (about 1 %) of total hake trawl effort within ML 170
- For historic monk fish trawl, 6.34 % of the catches were taken in ML 170 and 4.93 % of the effort was spent in ML 170
- The hake longline catch distribution is similar to the trawl in that in ML 170 the fishery overlaps on the fringes of their catch distribution profile
- The demersal longline fishery should therefore only be impacted on the southwestern portion of ML 170
- The horse mackerel fishery operates further north of ML 170 and only a small proportion of fishing occurs within the ML 170
- The current small pelagic fishing grounds do not overlap with ML 170, although historically the range of the sardine and anchovy resource did overlap with ML 170.

The verification assessment in 2014 included consideration of both the ML 170 and the much smaller SP1 area within ML170. The verifications assessment comprised a comprehensive set of specialist studies on key aspects including assessment of biomass, reproductive dynamics, ecosystem impacts and biodiversity which further showed that the actual biomass of commercial fish in the proposed dredging area is extremely low in SP1 and ML 170. All conclusions listed above were thus verified from the biomass and stock assessment study and through the biodiversity survey analysis. Therefore, it was concluded that catches (and effort) in ML 170, including SP1, represents a very small proportion of the entire Namibian EZZ (Japp in Midgley, 2014).

Conclusions drawn from the 2014 assessment are listed as the following (Japp in Midgley, 2014):

- SP1 area within ML 170 contained less than 1.6 % of the Namibian biomass for *M. capensis*, 0.2 % for *M. paradoxus* and less than 2 % for *L. vomerinus*. This suggests that only a small proportion of the biomass will be recruiting to the fishery from inside ML 170 and therefore the overall impact on these fisheries is likely to be minimal.
- The biomass of hake and monk in the SP1 is extremely small (0.14 % for *M. capensis* and 0.8 % for monk).
- During the biodiversity survey only 143 horse mackerel individuals were measures and recorded, amounting to 0.005 % of the total fish catch.
- No small pelagics (sardine, anchovy and red eye) were caught during the survey because the bottom trawl gear provided is not designed to catch these species.

One of the primary issues of concern for the fishing industry in regard to operational impact related to the fact that the assessment zoning applied for the 2012 and 2014 assessments was referenced to the borders of the whole ML 170.It was concluded therefore that fishing access would be severely impacted by restrictions extending to the whole of the MLA and up to 25 km from the dredging location. The significance of the impact was stated by the specialist (Japp, 2012 & 2014) as medium before mitigation (low – medium after mitigation), however once the assessment methodology was applied and a score was provided, the significance outcome changed to major before mitigation (medium after mitigation). However, this is not the case as operations will not be conducted over the whole of the ML 170 but instead will impact a very small percentage of the total ML 170 area. Dredging operations will only be undertaken in the 20-year mine plan covering a total area of 34 km^2 in which annual dredging operations cover an average area of 1.7 km^2 per year. The annual mining area equates to 0.08 % of the MLA and the 20-year mining area to less than 2 % which is about 0. 0003% of the seabed within Namibia’s exclusive economic zone.

Consequently, the perceived and actual operational impacts and restrictions on commercial fisheries operating in and around ML170 are therefore significantly less than was originally assumed by the fishing industry.

Accordingly, the current 2022 assessment now appropriately addresses the scale of impacts related to the dredging operations related to the annual and 20-year cumulative mine plan area located within ML 170 itself.

2022 Assessment

As stated in Section 7.5.2, the impact of the mining/dredging operations in ML 170 on commercial fisheries was reassessed in 2022, based on the 20-year mine plan area in SP1 and has been updated with the more recent available catch data (2016 – 2021) from MFMR including data for wet landed horse mackerel fisheries, and the 2019 transboundary survey conducted by FAO/NORMAD.

For the assessment, the percentage catch or effort in the primary commercial fisheries in each zone was calculated relative to the total catch (national/EEZ). All fisheries catch and effort data on an annual basis was considered. Additionally, data was combined for periods where averages had no material effect on the outcomes. There are noted cases where the available fisheries data differed in character. Catch or effort was selected that best represented each fishery sector. Table 32 below refers to the 2012 assessment summary information and Table 24 to the new consolidated information for the 2022 assessment.

Table 23 – Commercial fisheries data showing percentage catches per impact zone (Japp in Midgley, 2012)

Dataset	Dates	Species (percentage of 100 km buffer zone)	Mla (sp1, sp2, sp3)	Mine site <25 km	Local 25 – 50 km	Regional 50 – 100 km	National >100 km zone 5
Hake commercial trawl data	2004 - 2009	Hakes	Yes	28.69	20.21	51.10	5.03*
Hake commercial longline data	2006 – 2010	Hakes	No	31.49	21.11	47.4	No data
Horse mackerel commercial mid-water trawl data	1997 – 2011	Horse mackerel	Yes	18.15	24.50	57.36	1.08*
Monk commercial trawl data	2005 – 2010	Monk	Yes	46.17	18.57	35.26	13.08*
		Anchovy	No	1.67	42.28	56.06	No data

Dataset	Dates	Species (percentage of 100 km buffer zone)	Mla (sp1, sp2, sp3)	Mine site <25 km	Local 25 – 50 km	Regional 50 – 100 km	National >100 km zone 5
Small pelagics commercial data	2000 - 2011	Sardine	No	17.44	29.17	53.39	No data
		Round herring	No	1.82	23.67	74.52	No data

Table 24 – Summary table of recent primary commercial fishery data used in the assessment of fishery impacts (Japp, 2022)

		ZONE 1: 20-year MINE SITE SP1		ZONE 2: LOCAL <25 KM		ZONE 3: REGIONAL <50 KM		ZONE 4: NATIONAL <50 KM	
Year	**Hake wet**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
2016	12 936	0	0.00	0	0.00	52	0.40	12 884	99.60
2017	10 754	0	0.00	3	0.03	47	0.44	10 710	99.59
2018	3 057	0	0.00	0	0.00	10	0.33	3 047	99.67
3 year average	8 916	0	0.00	1	0.01	36	0.39	8 880	99.62
Year	**Hake freezer (t)**	**Catch**	**%**	**Catch**	**%**	**Catch**	**%**	**Catch**	**%**
2016	104 234	0	0.00	4 005	3.84	7 564	7.26	92 665	88.90
2017	124 179	0	0.00	1 730	1.39	8 125	6.54	114 324	92.06
2018	107 369	0	0.00	2 285	2.13	6 263	5.83	98 821	92.04
3 year average	111 927	0	0.00	2 673	2.45	7 317	6.54	101 937	91.00
Year	**Hake LL sets**	**No. Sets**	**%**	**No. Sets**	**%**	**No. Sets**	**%**	**No. Sets**	**%**
2016	1 242	0	0.00	5	0.40	55	4.43	1 182	95.17
2017	1 536	0	0.00	10	0.65	131	8.53	1 395	90.82
2018	1 787	0	0.00	12	0.67	99	5.54	1 676	93.79
3 year average	1 522	0	0.00	9	0.58	95	6.17	1 418	93.26
Year	**Monk catch (t)**	**Catch**	**%**	**Catch**	**%**	**Catch**	**%**	**Catch**	**%**
2016	16 177	0	0.00	1 646	10.17	2 389	14.77	12 142	75.06
2017	13 930	0	0.00	2 360	16.94	3 492	25.07	8 078	57.99
2018	14 789	0	0.00	2 016	13.63	3 545	23.97	9 228	62.40

		ZONE 1: 20-year MINE SITE SP1		ZONE 2: LOCAL <25 KM		ZONE 3: REGIONAL <50 KM		ZONE 4: NATIONAL <50 KM	
2019	13 993	0	0.00	2 349	16.78	3 364	24.04	8 280	59.17
4 year average	14 722	0	0.00	2 093	14.38	3 198	21.96	9 432	63.65
Year	**Midwater**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
2014	7 664	0	0.00	0	0.00	0	0.00	7 664	100.00
2015	8 724	5	0.06	18	0.21	113	1.30	8 588	98.44
2016	9 019	2	0.02	2	0.02	24	0.27	8 991	99.69
3 year average	8 469	2	0.03	7	0.08	46	0.52	8 414	99.38
Year	**Small pelagic (PS)**	**No. Shots**	**%**	**No. Shots**	**%**	**No. Shots**	**%**	**No. Shots**	**%**
2014	450	0	0.00	1	0.22	1	0.22	448	99.56
2015	267	0	0.00	0	0.00	0	0.00	267	100.00
2016	43	0	0.00	1	2.33	2	4.65	40	93.02
2017	48	0	0.00	0	0.00	2	4.17	46	95.83
4 year average	202	0	0.00	1	0.64	1	2.26	200	97.10
Year	**HM P Seine**	**No. Shots**	**%**	**No. Shots**	**%**	**No. Shots**	**%**	**No. Shots**	**%**
2015	132	0	0.00	0	0.00	0	0.00	132	100.00
2016	109	0	0.00	0	0.00	1	0.92	108	99.08
2017	153	0	0.00	0	0.00	0	0.00	153	100.00
2018	102	0	0.00	0	0.00	0	0.00	102	100.00
2019	663	0	0.00	0	0.00	0	0.00	663	100.00
2020	697	11	1.58	18	2.58	28	4.02	640	91.82
2021	570	3	0.53	12	2.11	15	2.63	540	94.74
7 year average	347	2	0.30	4	0.67	6	1.08	334	97.95

For the current assessment, Japp (2022) used spatial analysis to estimate the proportion of fished ground likely to fall within each defined zone centred on the 20-year mine plan area in SP1, as described in Section 7.5.2. See Figure 78 to Figure 50 of the comparative spatial maps for hake, monk, horse mackerel and small pelagics. The red dot in the figures marks the approximate location of the 20-year mining area (within SP1).

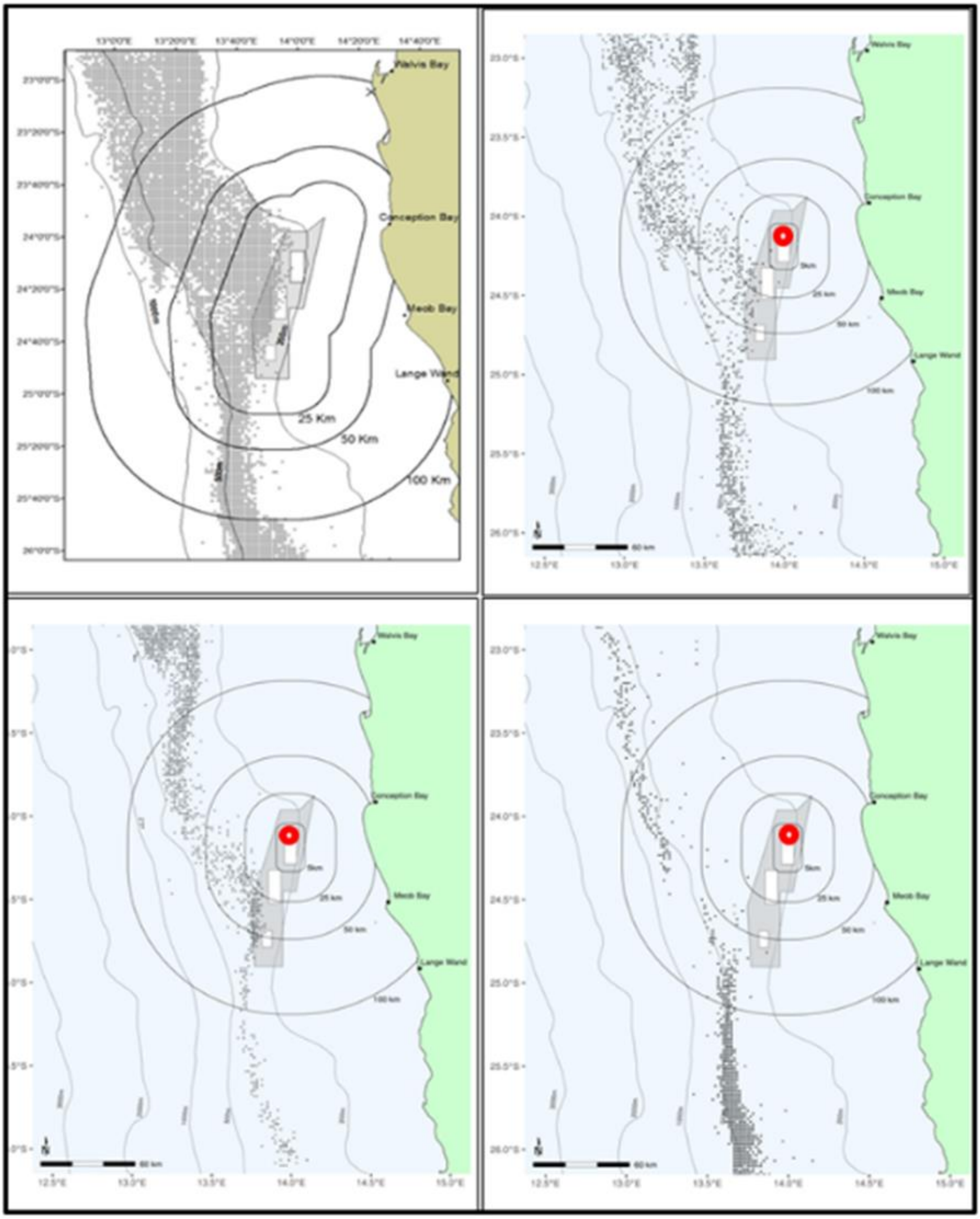


Figure 47 – Hake commercial data 2004 – 2009 (top left); hake wet fish data 2016 – 2018 (top right); hake freezer data 2016 - 2018 (bottom left) and hake longline data 2016 - 2018 (bottom right). Each black dot represents the position per trawl or set.

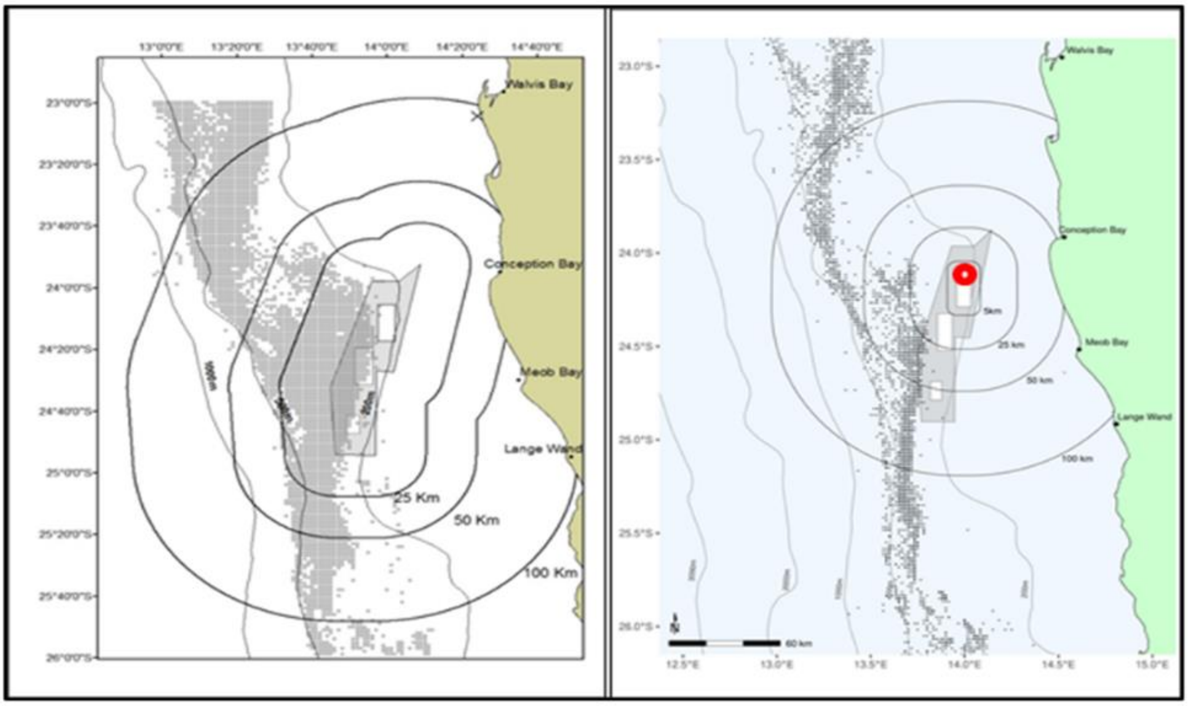


Figure 48 – Monk commercial data 2005 – 2010 (left) and 2016 – 2019 (right), Black dots represent the position per trawl.

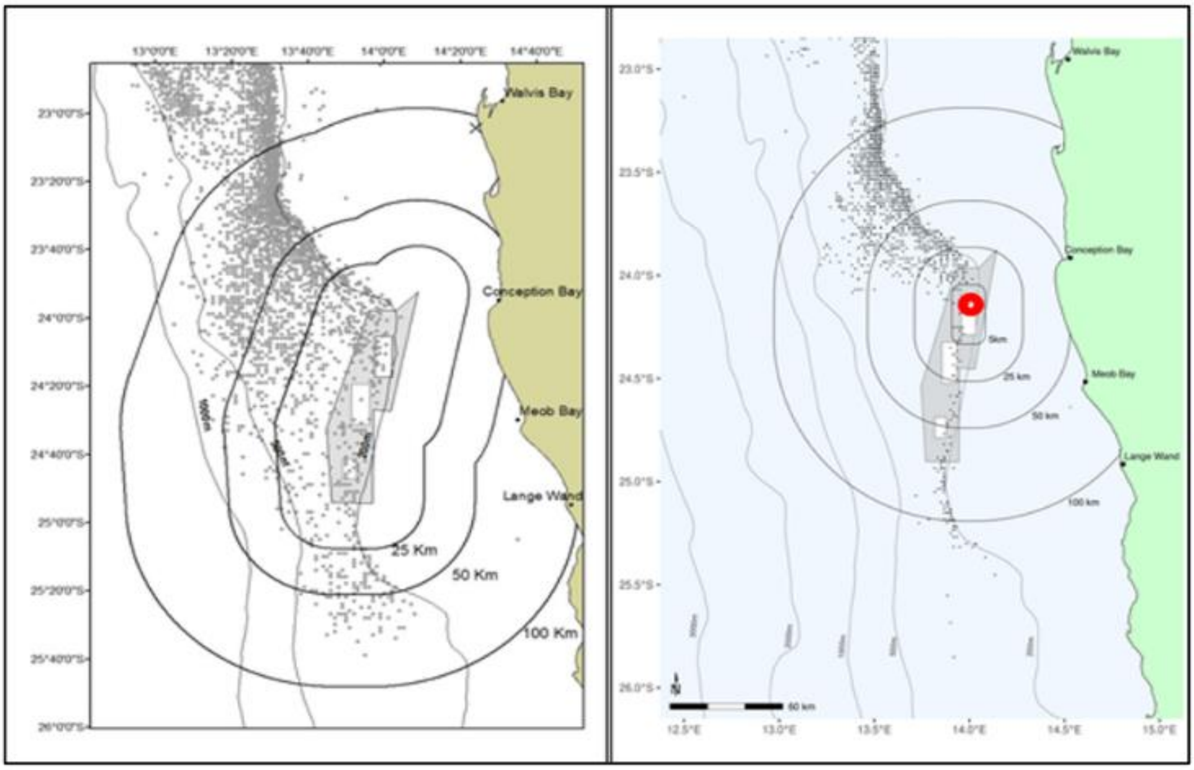


Figure 49 – Horse mackerel commercial data 1997 – 2011 (left) and 2016 – 2019 (right), Black dots represent the position of the last trawl per day.

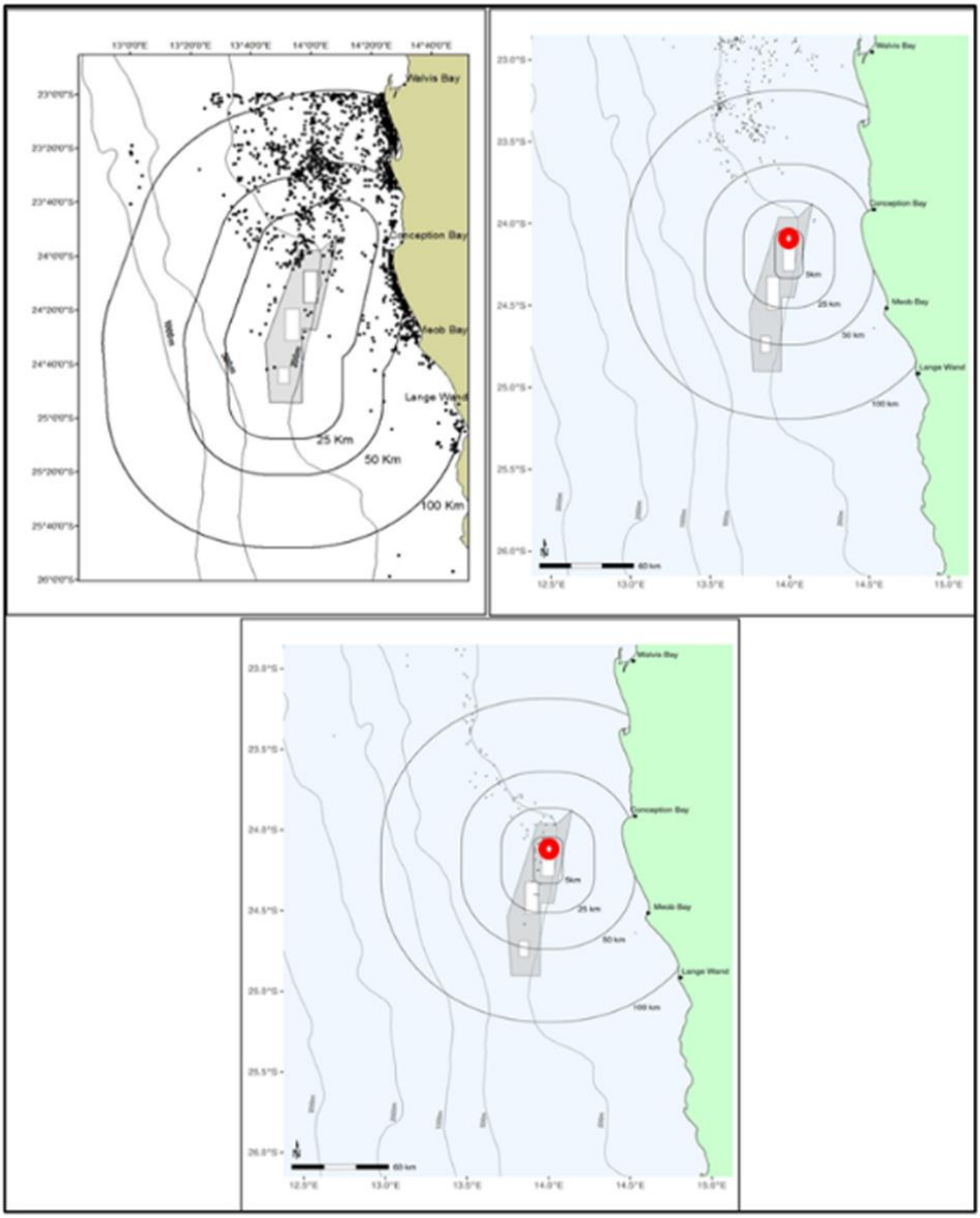


Figure 50 – Small pelagic (anchovy, sardine and round herring) commercial data 2000 - 2011 (top left) and 2016 – 2019 (top right); horse mackerel data 2018 – 2021 (bottom). Black dots represent the position per trawl.

Direct impacts on other fisheries described for deep water trawl, crustaceans, linefish and mariculture are not deemed likely.

For hake fisheries, the following is concluded for the potential impacts within Zone 1 (Japp, 2022):

- From the data collected and reviewed, there is no evidence of historical fishing in Zone 1, only marginal hake effort in Zone 2
- The majority of hake effort occurs in Zone 3 and beyond, particularly in deeper water
- The impact is expected to be long term for the duration of 20-year mine plan and restricted to Zone 1, with minimal extent into the other zones
- Impacts are possible on wet fish trawl but improbable on freezer trawl and hake longline
- Impact status is neutral apart from wet fish trawl, where this is adverse/negative
- The magnitude of change is no lasting effects
- Confidence level for the assessment is high and medium for wet fish trawl, due to some data uncertainties
- Therefore, overall potential impacts (direct) of seabed dredging are expected to be minimal on hake fisheries operations, the sensitivity of hake fishery to adapt to effects of mining are low and the significance of the impact for all hake sectors is low.

For monk fishery, the following is concluded for the potential impacts within Zone 1 (Japp, 2022):

- From the data collected and reviewed, there is no evidence of historical fishing in Zone 1, with an average of 14.38 % in adjacent Zone 2.
- The majority of monk effort occurs in Zone 3 and beyond, particularly in deeper water where fishing effort increases.
- The impact is expected to be long term for the duration of life of mine and restricted to Zone 1, with minimal extent to Zone 2.
- The probability of the impact occurring is possible, adverse/negative and with a medium level of confidence.
- The magnitude of change is minor effects.
- Dredging impacts will not impact fishing operations and the proximity to the mining site is deemed to not have any direct impacts. Therefore, minimal direct impacts will occur on monk fishery, the sensitivity of monk fishery to adapt to changes is medium and the significance of the impact is determined as low (minor).

For horse mackerel midwater trawl, the following is concluded for the potential impacts on this fishery (Japp, 2022):

- From the data collected and reviewed, there is no evidence of historical fishing in Zone 1 (0.03 %), this increases to 0.08 % in Zone 2
- Over 99 % of midwater effort occurs in Zone 4, northwards of SP1
- The impact is expected to be long term for the duration (20-year mine plan), with minimal extent from Zone 2 and beyond
- The probability of the impact occurring is possible, adverse/negative and with a high level of confidence
- The magnitude of change is no lasting effect
- Dredging impacts will not impact fishing operations and the proximity to the mining site is not deemed to have any direct impacts
- The plume effect is likely of limited effect though the 20-year cumulative ZOI shows it is anticipated to extend both to the north and south of SP1 in some areas fished for horse mackerel in waters deeper than 200m
- Therefore, minimal direct impacts will occur on horse mackerel midwater trawl fishery from seabed dredging operations, the sensitivity of horse mackerel midwater trawl fishery to adapt to changes is low and the significance of the impact is determined as low (minor).

For small pelagic purse seine horse mackerel-directed, the following is concluded for the potential impacts on this fishery (Japp, 2022):

- From the data collected and reviewed, there is no evidence of historical fishing in Zone 1 (0.3 %), this increases to 0.67 % in Zone 2
- Over 98 % of horse mackerel purse seine effort occurs in Zone 4, northwards of SP1 (similar to horse mackerel mid water trawl)
- The impact is expected to be long term for the duration of 20-year mine plan, with minimal extent from Zone 2 and beyond
- The magnitude of change is minor effects
- The probability of the impact occurring is possible, adverse/negative and with a medium level of confidence
- Dredging impacts will not impact fishing operations and the proximity to the mining site is not deemed to have any direct impacts
- The plume effect is localised and likely of limited effect though the 20-year cumulative ZOI shows it is anticipated to extend both north and south of SP1wards in some areas fished for horse mackerel in waters deeper than 200 m
- Therefore, minimal direct impacts will occur on this horse mackerel fishery, the sensitivity of horse mackerel purse seine fishery to adapt to changes is low and the significance of the impact is determined as low.

For small pelagic purse seine (fishery inactive), the following is concluded for the potential impacts on this fishery (Japp, 2022):

- From the data collected and reviewed, there is no evidence of historical fishing in Zone 1 and this increases to 0.64 % in Zone 2
- Over 99 % of small pelagic effort occurs in Zone 4
- The impact is expected to be long term for the duration of 20-year mine plan, restricted to Zone 1
- The magnitude of change is no lasting effects
- The probability of the impact occurring is improbable, neutral and with a high level of confidence
- Seabed dredging impacts (direct) will not impact the small pelagic sector operations
- The sensitivity of small pelagic sector to adapt to changes is low and the significance of the impact is determined as low.

For crustacean's fisheries (deep water trawl sector) the following is concluded for the potential impacts on this fishery (Japp, 2022):

- From the data collected and reviewed, there is no evidence of historical fishing in Zone 1 or Zone 2
- The impact is expected to be long term for the duration of 20-year mine plan, restricted to Zone 1
- The magnitude of change is no lasting effects
- The probability of the impact occurring is improbable, neutral and with a high level of confidence
- Dredging impacts will not impact the crustacean's fisheries operations
- The sensitivity of crustacean's fisheries to adapt to changes is low and the significance of the impact is determined as low.

For orange roughy trawl, (Japp 2022) notes that this species of fish is only found in deeper waters, well outside of ML 170 (see Figure 16 in the Section below) and that no impact on the ecosystem is expected. However, for the purposes of the impact assessment scoring, Japp (2022) included this species in the overall assessment table utilising the prescribed scoring criteria. The potential impacts on this fishery are described below:

- The impact is expected to be long term for the duration of 20-year mine plan, restricted to Zone 1. (Note: this species is not present in ML170)
- The magnitude of change is no lasting effects
- The probability is therefore improbable, with high confidence and an overall neutral impact
- The sensitivity of orange roughy trawl fisheries to adapt to changes is low and the significance of the impact is determined as low.

For meso-pelagic, snoek and other migratory (snoek) fisheries, the following is concluded for the potential impacts of seabed dredging on this fishery (Japp, 2022):

- From the data collected and reviewed, there is no historical fishing effort in Zone 1 for these sectors
- Meso-pelagic species occur mostly in deeper waters than 200 m, though some seasonal effort directed at snoek is possible (though unlikely at the distance of the SP1 offshore)
- The impact is expected to be long term for the duration of 20-year mine plan, restricted to Zone 1
- The magnitude of change is no lasting effects
- The probability is therefore possible, with medium confidence and an overall neutral impact
- The sensitivity of meso-pelagic, snoek and other migratory (snoek) fisheries to adapt to changes is low and the significance of the impact is determined as low.

For large pelagic tunas, Japp 2022) notes that this species of fish is only found in deeper waters, well outside of ML 170 (see Figure 16 in the Section below) and that no impact on the ecosystem is expected. However, for the purposes of the impact assessment scoring, Japp (2022) included this species in the overall assessment table utilising the prescribed scoring criteria. The potential impacts on this fishery are described below:

- The impact is expected to be long term for the duration of 20-year mine plan, restricted to Zone 1
- The magnitude of change is no lasting effects
- The probability is therefore improbable, with high confidence and an overall neutral impact
- The sensitivity of large pelagic tuna fisheries to adapt to changes is low and the significance of the impact is determined as low.

For linefish and mariculture sectors, the following is concluded for the potential impacts (Japp, 2022):

- From the data collected and reviewed, there is no historical fishing effort or mariculture in Zone 1 for these sectors
- The proximity of mariculture (in Walvis Bay area) extends further than 100 km from the mine site
- The operational distance from ports negates any likelihood of impacts on linefish operations
- Plume dispersion modelling (Wallingford, 2020) shows the mariculture areas in Walvis Bay lie well beyond the defined cumulative zone of influence from dredging operations

- For both sectors, the impact is expected to be long term for the duration of 20-year mine plan, restricted to Zone 1
- The magnitude of change is no lasting effects
- The probability is improbable, with a high confidence and an overall neutral impact
- The sensitivity of these sectors to adapt to changes is low and the significance of the impact is determined as low.

The general conclusion from the 2022 assessment is as follows (Japp, 2022):

- In general, for all fisheries operations the likely direct impacts of seabed dredging are deemed low
- The conclusion on significance of the impacts and outcomes of the various fisheries sectors does not differ significantly from the previous 2012 and 2014 assessments
- Of all the receptors considered, the following is noted:
    - Only hake trawl, horse mackerel midwater trawl, horse mackerel purse seine and monk trawl are the sectors that will be potentially directly impacted by mining activities over the 20-year life of mine. This impact is only expected at the actual mining location during operations over the 20-year period.
    - From Zones 2 to 4, the proportion of fishing that may be indirectly impacted on will vary with distance from the actual mining area.
    - With respect to demersal and pelagic fish sectors, the dredge overspill plume impacts will likely be low or minimal and localised, provided that plumes are limited to the mining or immediate operational area.
    - Due to the current along the Namibian shelf it is possible, but unlikely, that the impact of the operations (plume effect) might be transported into part of the fishing areas for hake, horse mackerel, sardine and monk.

Therefore, in summary based on the collective assessment of the sensitivity of all receptors considered in the impact assessment table (Japp, 2022), dredging operations could have an overall adverse to neutral impact on commercial fisheries but this will be restricted to Zone 1 and for the duration of mining activities (20-years life of mine). The probability of the impacts occurring are improbable to possible. The magnitude of change is no lasting effects on the different sectors. The sensitivity of the different receptors to adapt to mining activities potential impacts is low. The overall confidence level in the outcomes is high. The overall significance of the impact is determined as low. Relative mitigation measures are further elaborated on in the EMP.

7.6.2.2 Ecologically important demersal and pelagic species: impact of dredging will result in the redistribution and/or displacement of hake, monk, horse mackerel, sole, orange roughy, bearded goby populations and small pelagics because of 1) actual recovery activities 2) habitat disturbances and the removal of substrate and 3) sediment plumes.

Potential impacts will be further discussed in the Section below and the aggregated impact significance score will be used as the final outcome of the impact, as per Table 34.

<u>2012/2014 Assessment</u>

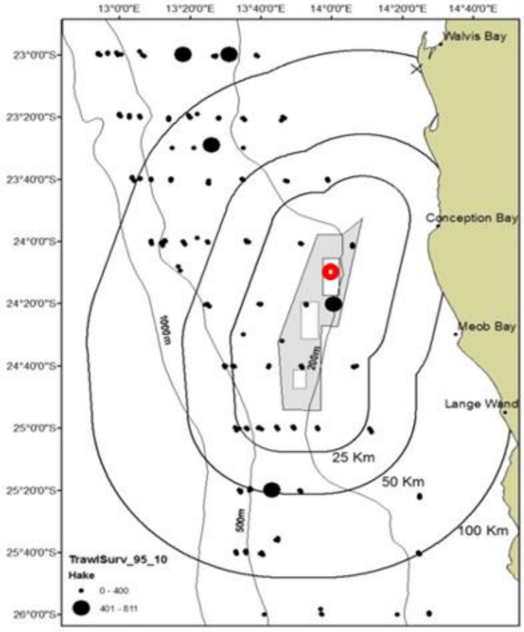
The 2012 assessment confidence level for all assumptions and conclusions was low to medium, as the data available for fish ecology was limited at the time of the assessment. During the 2014 verification assessment, data was utilised from various sources including; *in situ* data from the biodiversity survey (Japp in Midgley, 2014), biomass and stock assessment (Gaylard, 2013) and a professional opinion on the ecosystem impact from phosphate mining (Cochrane, 2014). The confidence level therefore increased to high in the outcome of the results of the assessment. The only changes from the 2012 to 2014 assessment were the impact scale of extent, which was assessed in 2012 based on ML 170 and was refined to the specific mine site (SP1) in 2014, therefore the impact size was reduced. The 2014 assessment concluded that demersal and pelagic fish species could be displaced from SP1 extending to the mining licence boundary and the impact would decrease further away from the mining activities. The 2014 assessment confirmed that the actual biomass of the main commercial fisheries affected (hake and monk) by proposed seabed dredging in SP1 is proportionally very low and will have moderate effects. This concurs with the 2012 assessment that only a small fraction of the commercial fish populations inhabits ML 170 and populations would recover or settle in these areas after mining operations ceases. Recovery of habitat may take longer for monk and sole to recover, due to their preference for a muddy substrate. Therefore, the duration of the impact was considered permanent but the fish populations will recover in the long term.

<u>2022 Assessment</u>

For the 2022 assessment by Japp (2022), available biomass and stock assessment survey data (Table 25) were analysed by visually examining in frequency distribution maps (Figure 51 to Figure 62). To determine the likelihood of mining impacting each species, the distribution and abundance of each species was assessed relative to their proximity to the 20-year mining area (SP1). The black dots in the figures represent the cumulative weight per station. The red dot represents the mining area within SP1. Additionally recent MFMR and independent trawl survey data has also been used. Note the scale differs from the 2012 assessment, whereby the impact was assessed based on the entire ML 170 and the impact is now assessed based on SP1 mining area.

Table 25 – Visual assessment of the potential impacts of phosphate mining on ecologically important fish species

Dataset	Dates	Species	Occurrence in Zone 1	Likelihood of being impacted on in Zone 1
Hake survey data	1995 – 2010 2019 - 2020	Horse mackerel	Yes	Unlikely
		Snoek (*Thyrsites atun*)	Unknown	Unlikely
		Goby (*Sufflogobius bibarbatus*)	Yes	Possible
		Monk	Yes	Probable
		Hake	Yes	Possible
		Sole (*Austroglossus microlepis*)	Yes	Probable
Monk survey data	2007 - 2010	Monk	Yes	Probable
		Goby	Yes	Unlikely
		Orange roughy (*Hoplostethus atlanticus*)	No	Unlikely
		Sole	Yes	Probable
Small pelagic survey data	2002 - 2011	Horse mackerel, anchovy, sardine and round herring	Yes	Unlikely
Hake, monk and small pelagics survey data combined	1995 - 2011	All species counted per sample station	Yes	Yes



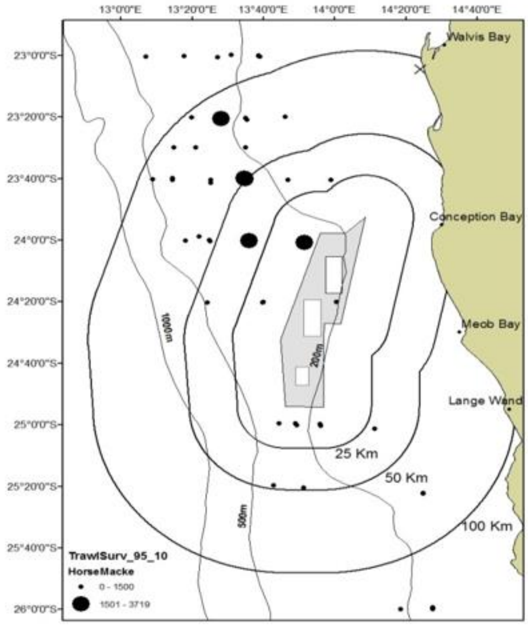
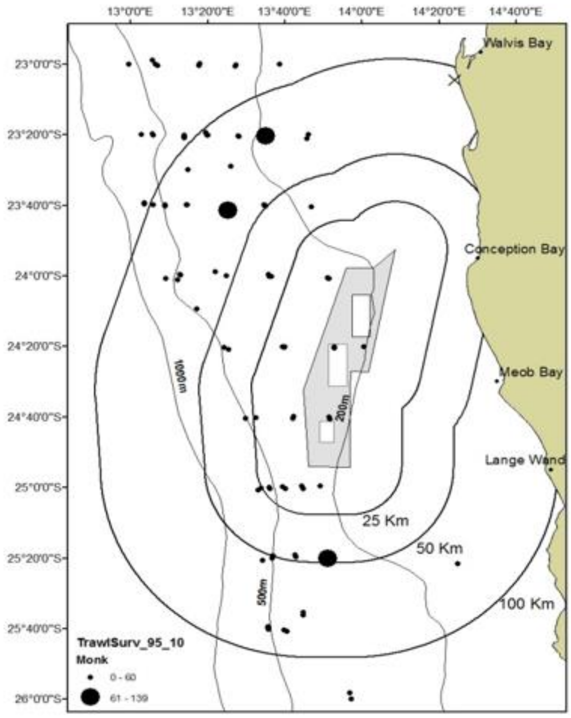


Figure 51 – (left) Distribution of hake from the hake-survey data (1995-2010) (n=678)
Figure 52 – (right) Distribution of horse mackerel from the hake-survey data (1995-2010) (n=78)



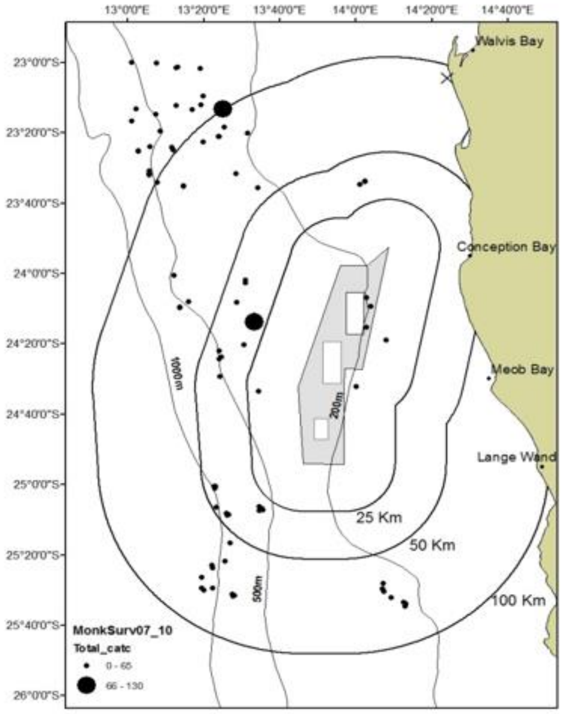
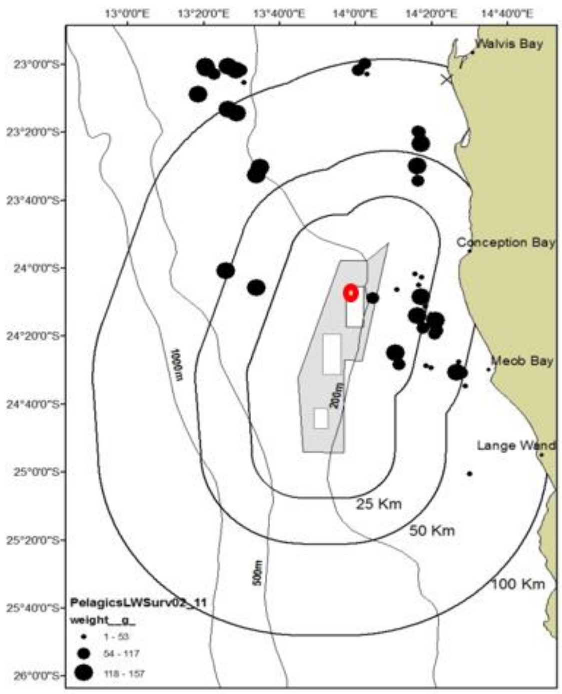


Figure 53 – (left) Distribution of monk from the hake-survey data (1995-2010) (n=134)
Figure 54 – (right) Distribution of monk from the monk-survey data (2007-2010) (n=100)



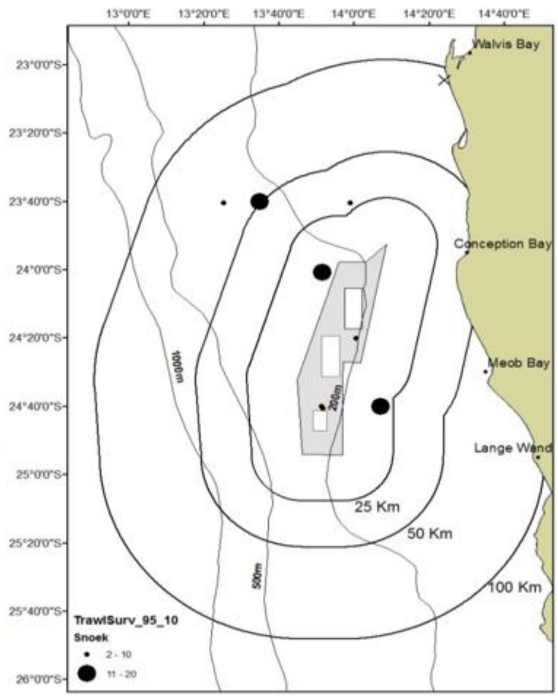
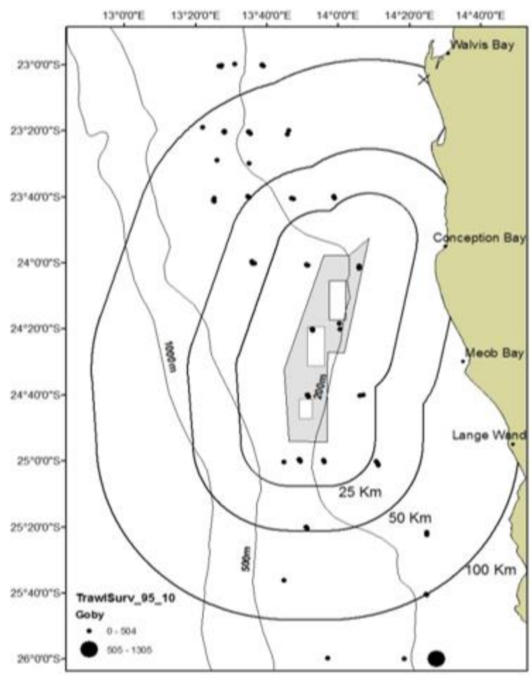


Figure 55 – (left) Distribution of pelagic (anchovy, sardine and round herring) weights from pelagic-survey data (2002-2011) (n=2557)
Figure 56 – (right) Total catch per station for snoek from hake-survey data (1997-2010) (n=8)



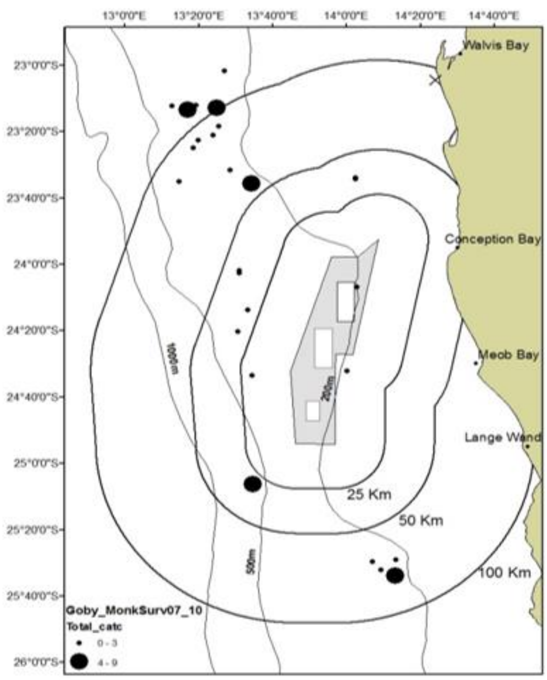
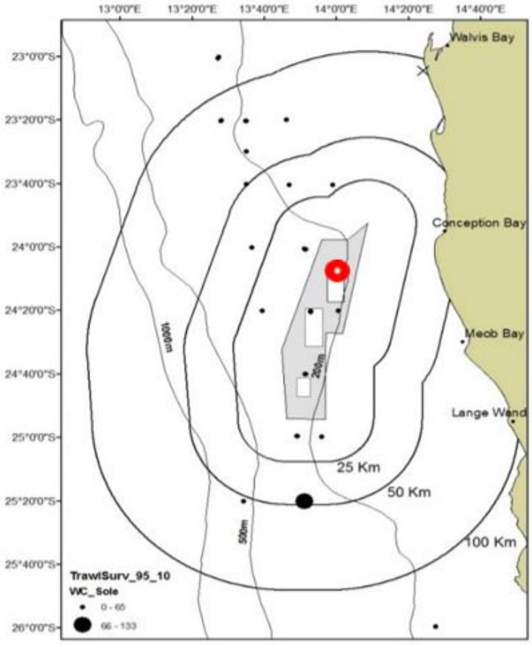


Figure 57 – (left) Distribution of goby from the hake-survey data (1995-2010) (n=93)
Figure 58 – (right) Distribution of goby from the hake-survey data (2007-2010) (n=24



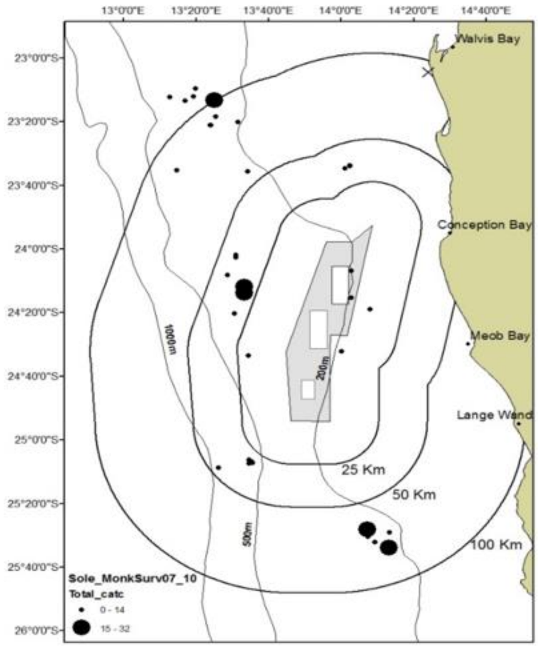
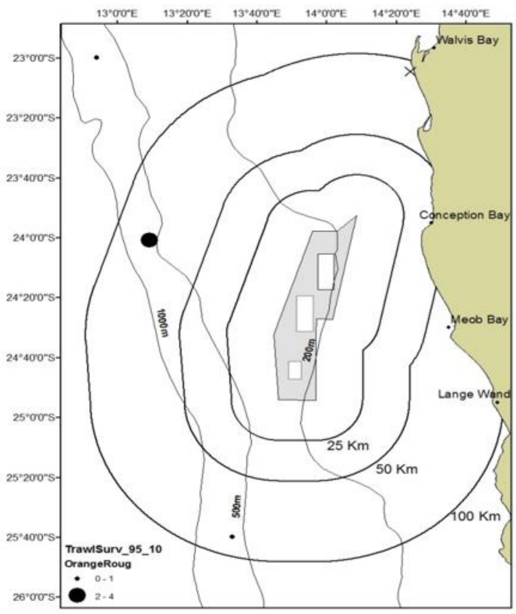


Figure 59 – (left) Total catch per station from west coast sole from the hake-survey data (1997-2010) (n=48)

Figure 60 – (right) Total catch per station from west coast sole from the monk-survey data (1997-2010) (n=42)



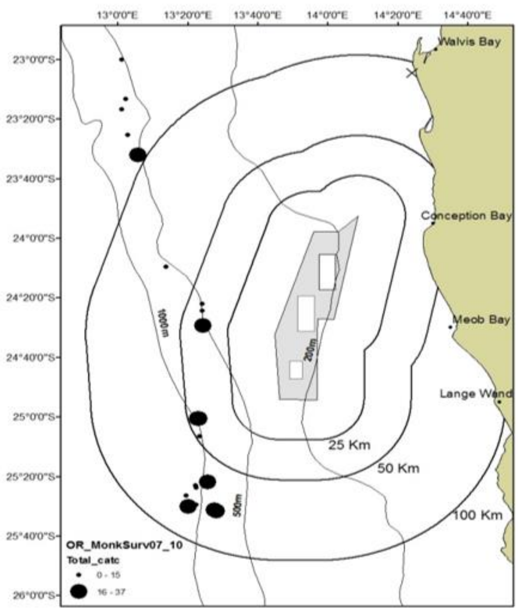


Figure 61 – (left) Distribution of orange roughy from the hake-survey data (1995-2010) (n=4)

Figure 62 – (right) Distribution of orange roughy from the monk-survey data (2007-2010) (n=29)

The most recent independent trawl survey data available shows that species caught at stations in proximity of SP1, do not differ significantly from those species recorded in the 2014 verification assessment (Japp in Midgley, 2014).

The following is concluded based on the 2022 assessment by Japp, for the potential impacts of seabed dredging on the abundance and distribution of the main commercial fish species.

Hake:

- Shallow water is the dominant hake species found throughout ML 170. It is assumed that the abundance in ML 170 and the surrounding areas, including SP1, is fairly uniform, with higher levels of hake abundance in deeper waters.
- Mining at the specific site (Zone 1) in SP1 cis expected to impact on hake, however due to their mobility, hake will avoid this area and most likely result in displacement of hake into adjacent areas. Mortality is considered unlikely. Therefore, from an ecosystem perspective these will only have localised impacts.
- Substrate disturbance could result in minor loss of food for hake, as hake mostly predate on other fish species and squid.

Horse mackerel:

- The abundance of horse mackerel is low in ML 170. Abundance is expected to increase north and west of the mine site.
- Horse mackerel are highly mobile and are expected to displace outside of the dredge mining area.
- Mortality is not expected and the impact on the ecosystem is depicted as low.

Monk and sole:

- Monk is found throughout ML 170 and adjacent areas and distributions are fairly uniform
- Monkfish are considered aggressive ambush predators and are found mostly on flat muddy surfaces/substrate
- Monk are not highly mobile fish and have patchy localised distribution patterns
- Due to these characteristics, monk is more vulnerable to mortality due to direct physical impacts from dredging
- This could potentially have a localised impact on the trophic ecology, but this is relatively small due to the dredge site mining area and impacts are considered moderate
- The removal of the preferred substrate for monk is expected to be long term for the duration of mining activities and will impact the availability of monk in and adjacent to the dredge sites

- Sole are sedentary species that prefer muddy surfaces/substrate and feed mainly on polychaetes and other worms found in this substrate
- Their distribution is broad, occurring within Zone 1 and extending to Zone 2
- Therefore, dredging could have a significant localised impact on sole abundance that results in direct mortality and some displacement is expected to adjacent areas from SP1
- The removal of the preferred substrate for monk is expected to be long term for the duration of mining activities due to removal of the preferred substrate.

<u>Pelagic species:</u>
The potential impacts and effects from the sediment dredge plume is discussed in more detail in Carter & Stefanni (2021) and during these assessment Sections of this Chapter (water column, sediments and benthos impacts). HR Wallingford (2020) defined a 20-year suspended sediment plume zone of influence (ZOI) that encompassed the SP1 mine area, for the actual dredging events this zone is more localised (1 km^2 to 5 km^2). The cumulative ZOI is the area within which a suspended sediment concentration above 7.6 mg/L may occur within the water column during dredging operations at any location and time over the 20-year modelled period. Carter and Steffani (2021) further noted that plume effects associated with deposition of fines from the dredging operation is expected to be minimal, concluding that for an individual dredge cycle, the impact is expected to be short term. Benthic biota in the immediate dredge area may be affected but the sedimentation rates are low at a further scale from the dredge site. Small pelagic fish (filter feeders) might be intermittently disturbed by dredging directly (possible gill clogging) or indirectly (food web if mortality occurs), and trophic cascade effects are possible (changes to feeding behaviour).

The sediment dispersion ZOI defined by HRW Figure 44) shows that the dredging plume impacts are contained largely within the boundaries of ML 170 at depths of greater than 150 m.

Japp (2022) concluded therefore that as long as dredging impacts are not transported inshore where the majority of pelagic spawning occurs, the impacts on small pelagic fish species is considered low:

- The abundance of pelagic species is low in ML 170, with high availability of these species in Zone 2.
- However, small pelagics are likely to be found in ML 170 but the impact from dredging and resultant plumes is not considered to have significant impacts on the resource and ecosystem associated with these species, as a whole.
- Surveys suggest that goby are distributed throughout ML 170 and will occur within SP1.

- During the 2014 biodiversity survey, gobies were caught at every station. Goby only appeared in small amounts in the relevant survey data.
- Goby have been identified as having a key trophic role in the ecosystem and are mobile species that can be displaced. They are also noted to extent throughout the Namibian coastal ecosystem.
- Therefore, mortality is expected to occur during dredging at the dredge site.
- The displacement and mortality of this species could have a moderate impact on the whole ecosystem in ML 170 only.

<u>Snoek:</u>

- Snoek is found in and adjacent to ML 170
- They are a highly mobile species and therefore found seasonally and in high abundance during these times
- Snoek is expected to avoid dredging areas when active in ML 170 and SP1
- This displacement is not expected to have significant impacts on the ecology in ML 170 and adjacent zones.

<u>Orange roughy:</u>

- These species are found in deeper waters and well outside of ML 170
- No impact on the ecosystem is expected.

Based on the above assessment outcomes (Japp, 2022), the overall assessment of the impacts is that seabed dredging could have an impact on ecologically important demersal and pelagic fish species (hake monk, horse mackerel, sole and small pelagic species). Therefore, the proposed dredging operations in SP1 will result in redistribution and/or displacement of these species as a result of i) actual mining activities 2) habitat disturbances and 3) sediment plumes (turbidity). However, this impact is expected to be adverse for hake, monk and sole and neutral for the other fish species. The potential impact is expected to be long term for the duration of mining activities (20-years) and will be restricted to Zone 1 with minimal extent. The probability of the impact occurring is improbable for all species (<5 %), apart from monk which is possible (5–50 %). The sensitivity of all fish species to adapt to seabed dredging effects is low, apart from monk, which is medium. The magnitude of change is no lasting effects for all species, apart from monk, which is minor effects. The confidence level is high for all fish species, apart from monk, which is medium. This is due to data availability as the number of monk surveys is fewer than for the other main commercial species. All individual fish species significance rating is low, apart from monk which is minor. The overall significance of the impact is deemed low. Therefore, the impact as a result of mortality is expected to be proportionately minimal relative to total biomass of the main commercial species.

As discussed at the beginning of this Section, the scale was refined from the 2012 and 2014 assessments, whereby the impact zone was reduced in size from the MLA to the actual dredging area, and additionally updated survey data was made available, therefore the significance of the impact has reduced in weight from the previous assessments and the outcomes are quantitatively assessed and determined as low.

7.6.2.3 Recruitment of key commercial species (hake, horse mackerel, monk, small pelagic species). The dispersal and survival of juveniles, eggs and larvae are effected by 1) physical disturbance of the fishing grounds and 2) sediment plumes.

Recruitment can be influenced by many factors and will not remain constant each year. Recruitment is identified as the mechanism by which most fish species breed, spawn, migrate and become available for exploitation (Japp, 2022). It is recognised that the main commercial fisheries, in particular hake and horse mackerel are of significant socio-economic importance.

Potential impacts will be further discussed in the Section below and the aggregated impact significance score will be used as the final outcome of the impact, as per Table 27.

There are various key factors to consider for recruitment in the Namibian context, Japp (2022) has considered the following:

- Since independence in 1990, Namibia launched a stock rebuilding process. This has had positive outcomes as resource have improve, stocks appeared to have stabilised and management strengthened, particularly for hake and horse mackerel fisheries.
- A 200 m depth restriction was introduced, as part of the resource stranger with an aim to protect juvenile fish and associated habitat.
- In the main fisheries (e.g., hake) there are management measures that aim to minimise, for example, impacts on juvenile mortality. Such measures include depth separation of fleets (wet and freezer) and mesh size.
- Independent surveys do focus on commercial sizes, which is mainly <32 cm total length for hake.

During the 2014 verification survey (Smith and Japp, 2014), the Proponent had requested specific MFMR survey vessels with standardised gear, which was not made available. A monk-directed vessel was thus used, utilising monk fishing gear with a cod-end liner. This ensured the best possible capture of benthic and other species to facilitate likely species breakdown. The 2014 survey operated 24/7, to ensure that the different groups of species was captured and species that migrate off the sea floor or are only found in the water column (e.g., hake and hake juveniles). The results of the 2014 are discussed further below and compared with the recent results made available for the 2022 assessment. It is noted that trawl and gear types can have material differences (Japp, 2022).

Concerns have been noted that productivity of hake may be underestimated due to age interpretation. Work done by Namibian scientists in this regard is highly regarded but not particularly relevant with regards to recruitment. The relevancy and importance for these assessments is the seasonal movement of juvenile hake and that there is evidence that the central Namibian shelf (assumed <200 m) is a key area for juvenile hake, particularly those 2-3 years that recruit to the fishery (Japp, 2022). The species in particular of concern is Cape Hake (shallow water hake) and not deepwater hake, as these juveniles are difficult to identify. Genetic evidence suggests that Namibian and South African shallow hake stocks are separate. Genetic evidence for deepwater hake is less certain. The mixing and recruitment of juvenile hake between these two species is not clear (Japp, 2022).

In consideration of the re-assessment of this impact, the above information is significant and recruitment impacts are deemed important. Namibian stock assessment for hake model and consider recruitment, however it is analysed based off of annual survey data and might not fully capture the annual hake migratory cycle. The MFMR hake 2020 state of stocks report depicts the significance of juvenile shallow water hake biomass in the 100 m to 200 m depth zone and a biomass that approximates between 10 to 30.1 tonnes per nm^2, refer to Figure 63 (MFMR Hake SOS report, 2020). Namibian scientists do consider and apply recruitment indices when assessing annual stocks as shown in Figure 64 (MFMR Hake SOS report, 2020).

With regards to the assessment of potential impacts of seabed dredging on commercial fish species, the broad understanding of recruitment is critical and the assessment of scale is important. Hake recruitment work undertaken in Namibia, as with global assessment methodologies, may be influenced by high variability as a result of various factors, in particular environmental variability and mortality associated with fishing itself (Japp, 2022)

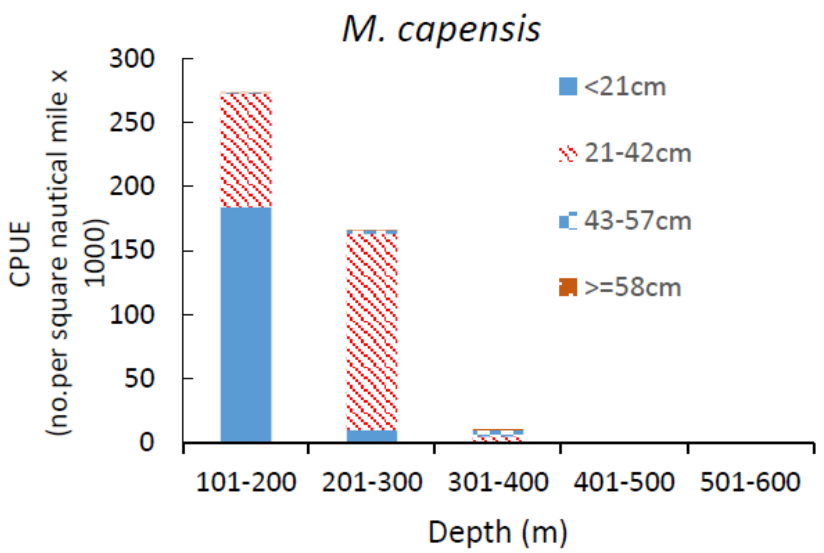


Figure 63 – Average catch rates of the two hake species by size groups in relation to depth during the 2020 survey (MFMR Hake SOS report, 2020).

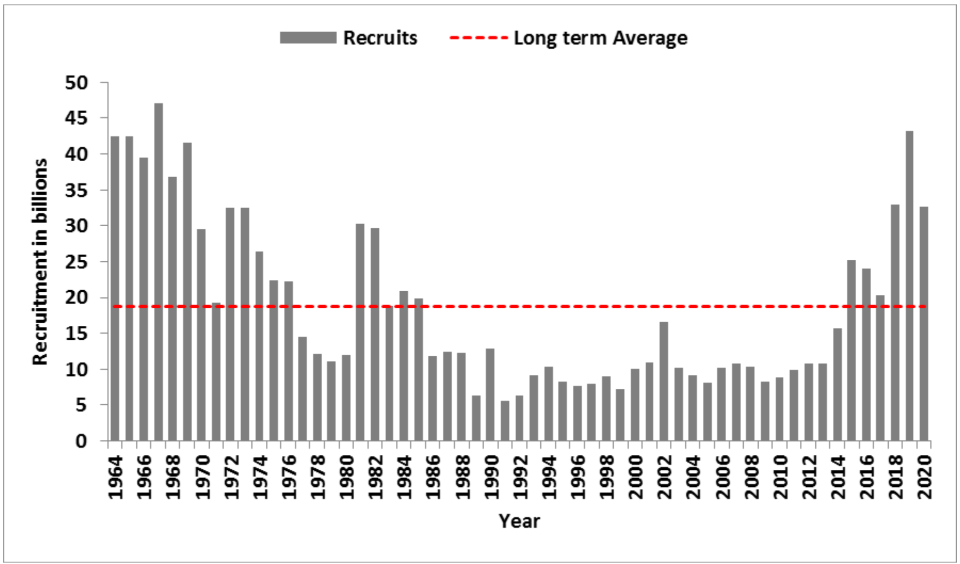


Figure 64 – Model estimated recruitment (numbers) from 1964-2020 (a), Beverton and Holt recruitment curve fit onto the estimated recruitment values (MFMR Hake SOS report, 2020).

<u>2012/2014 Assessment</u>

The 2012 assessment outcomes of the potential impacts of dredging on recruitment of key commercial species confidence level was low to medium as assumptions were based off of limited available data at the time of the assessment (Table 26).

To this end, during the 2014 verification assessment (Smith and Japp, 2014), a specific independent recruitment study was undertaken by a Namibian fishery scientist aimed at supporting the original 2012 assessments (Ndajula, 2014).

The comprehensive fish reproductive and stock dynamics study undertaken included the *in situ* size structure data from the biodiversity survey undertaken. No major changes to the 2012 impact assessment occurred as a result of new available information.

The outcomes of these assessments in 2014 are further described below.

According to Gaylard (2013), ML 170 contains less than 1.6 % of the Namibian biomass for *M. capensis* (hake species). When only SP1 is considered, this is further reduced to 0.14 %. No notable departure from these percentages is estimated for recruits of spawning adults. The 23°S to 26°S is a known breeding ground for *M. capensis*¸ containing a large number of juveniles, however the majority of the juveniles are at depths less than 200 m (SP1 lies between 225 m to 200 m). *M. paradox* (hake species) adults are not commonly found in depths less than 300 m and younger fish are found manly south of 26°S. Therefore, SP1 and ML 170 have little interaction with this species (<25 % of biomass in ML 170).

For monkfish, ML 170 contributes to approximately 2 % of the overall biomass. The mature stock is noted to lie in deeper water and further south. Monk fish recruits are more common in ML 170 thank hake, with 7 % of recruits estimated to occur in ML 170. The main contribution to recruitment is between the 250 m to 300 m depth range and not in SP1 (200 m to 225 m). SP1 is estimated to contribute to 0.2 % if recruitment to monk.

Ndajula (2014) observed that multiple cohorts in both the spatial and temporal analysis suggests that factors other than habitat preference are responsible for the distribution of Namibian marine species. Additionally, no significant spawning areas were observed, specifically in SP1. Data from cohort indicators in the study showed that whilst that are certain dynamics relating to stock structure, the growth is generally poorly defined. SP1 has no special biological reproductive characteristics for the main commercial specials when compared to the rest of the Namibian coastal waters.

During the 2014 assessment, the biodiversity survey assessed and measured the length and maturity stages of hake and monkfish. The mean length was 26 cm and 29 cm for hake and monk, respectively. A large proportion of the hake catch was mature, whilst the monk catch was immature. Hake are mobile and expected to be displaced at the dredging area but mortality will be limited. Data from the survey further suggested that spawning hake are not commonly found in ML 170 and are located generally in areas north of ML 170. Hake recruitment is not expected to be impacted on significantly. Juvenile monk were found throughout the survey area. Therefore, it is expected that the local impact on juvenile monk due to dredging will be high (mortalities). However, the mining area is small in comparison to the overall monk distribution. The total impacts on recruitment of monk are expected to be low.

The updated 2014 assessment concluded that:

- Impacts on recruitment are limited to the mining license area and possibly up to 25 km from the impact zone (pre-recruits confirmed for hake, monk and sole fisheries).
- The impact is expected to occur for the duration of the 20-year mine plan and ecosystems will recover progressively.
- Minor effects are predicted as a small fraction of juveniles, eggs and larvae occur in ML 170, when compared regionally.
- The probability of the impact occurring for monk is higher than the other species, as monk recruits make up and 7 % of the overall biomass in ML 170 and 0.2 % in SP1.

- For the other species the probability of an impact is improbable. Therefore, the impact is expected to be neutral for all species, apart from monk, where it is adverse.
- The overall significance of the impact is low.

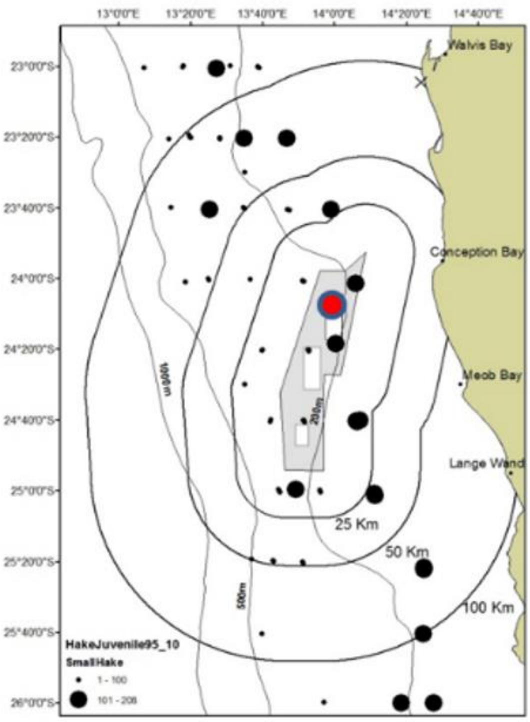
2022 Assessment

For the 2022 assessment (Japp 2022), it was determined to re-evaluate the potential effects of mining on recruitment, as within the Namibian context, this impact is of concern for the potential impacts on commercial fishery of these species stock (e.g., hake and horse mackerel). Japp (2022) notes that “The evidence used in the initial impact assessment (2012 and 2014 EIA verification) considered many different data sets – egg and larval studies etc and was cognisant of this complexity. Using “zones” as done in this assessment, while not definitive, does help in understanding scale effects. The current 20-year mining plan (in 200 m to 225 m water depth) focuses on a very small area of the Namibian waters and is also largely constrained to the proximity of the 200 m depth contour, which is outside of the area deemed important for recruitment. While mortality may occur of different species through the dredging process, the relatively small area affected, and also the likely extent of the biomass impacted (see Gaylard report), demonstrably supports this assessment and the ratings given”.

Table 26 – Survey data used in the assessment of the potential impacts of dredging on fish recruitment for available species recorded/observed.

Dataset	Dates	Species (percentage of 100km buffer zone)	ML 170 (SP1, SP2 and SP3)
Hake length-frequency survey data	1995-2010	Horse mackerel juveniles (<21cm)	No
		Hake juveniles (<21cm)	Yes
		Monk juveniles (<21cm)	Yes
Pelagic length-frequency survey data	2002-2011	Horse mackerel, anchovy, sardine and round herring juveniles (<8cm)	No
Hake maturity survey data	1995-2010	Hake stage 4 (spawning stage)	Yes
Pelagic egg and larvae from Spanish survey data		Anchovy eggs and larvae	No
		Sardine eggs and larvae	No
	1999 - 2005	Sardine eggs	No

Dataset	Dates	Species (percentage of 100km buffer zone)	ML 170 (SP1, SP2 and SP3)
Pelagic egg and Larvae from Nansen survey data		Horse mackerel eggs and larvae	No
Pelagic egg from SWAPELS survey data	1978-1985	Sardine	No
		Anchovy eggs	No



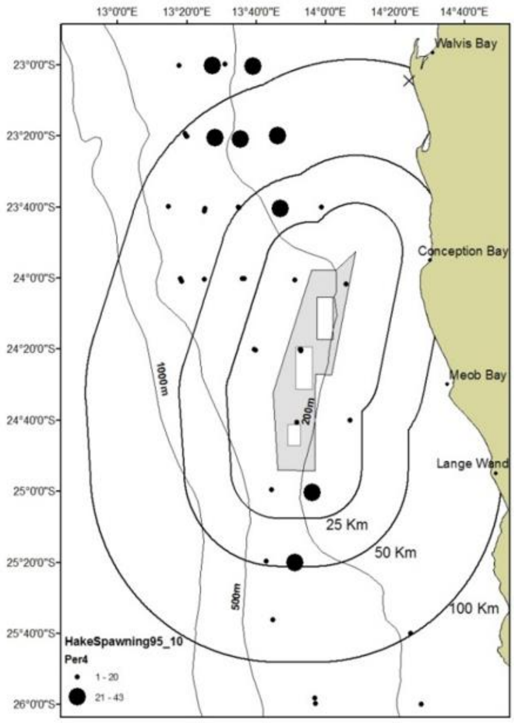
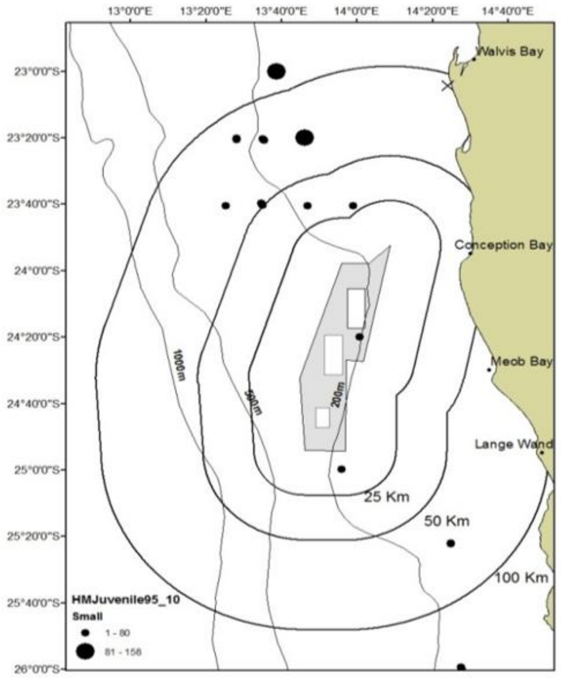


Figure 65 – (left) Hake juvenile numbers (<25cm) from length frequency from the hake-survey data (1995-2010) (n=6649)

Figure 66 – (right) Hake stage 4 represented as a percentage of the total number of all stages per station from the hake-survey data (1995-2010) (n=8769)



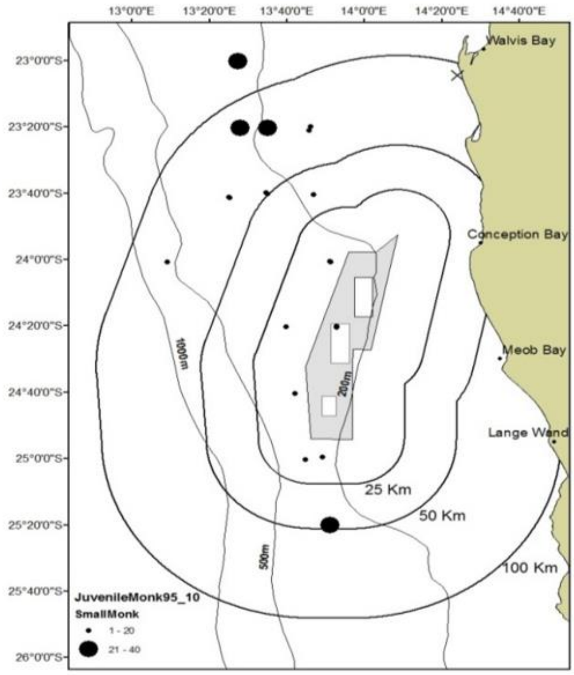
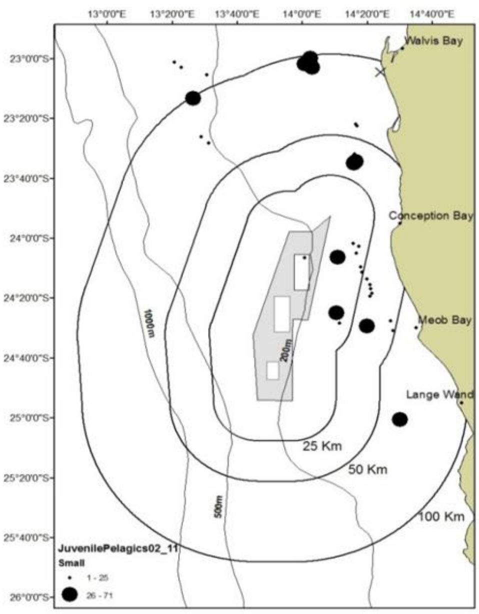


Figure 67 – (left) Horse mackerel juvenile numbers (<21cm) from the hake-survey data (1995-2010) (n=1368)

Figure 68 – (right) Juvenile monk (<21 cm) from the hake-survey data (1995-2010) represented as numbers per station (n=263)



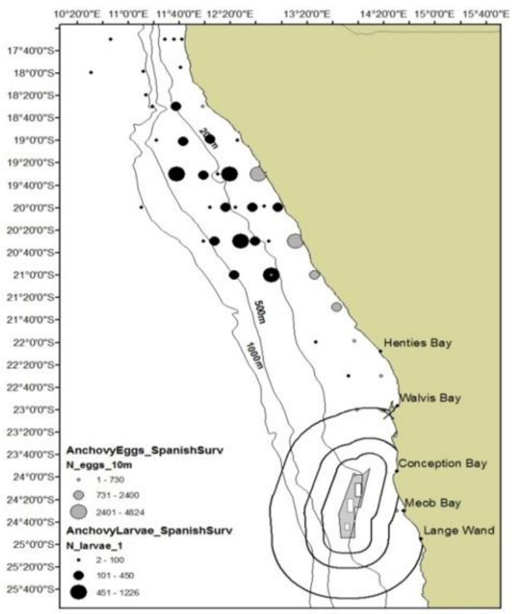
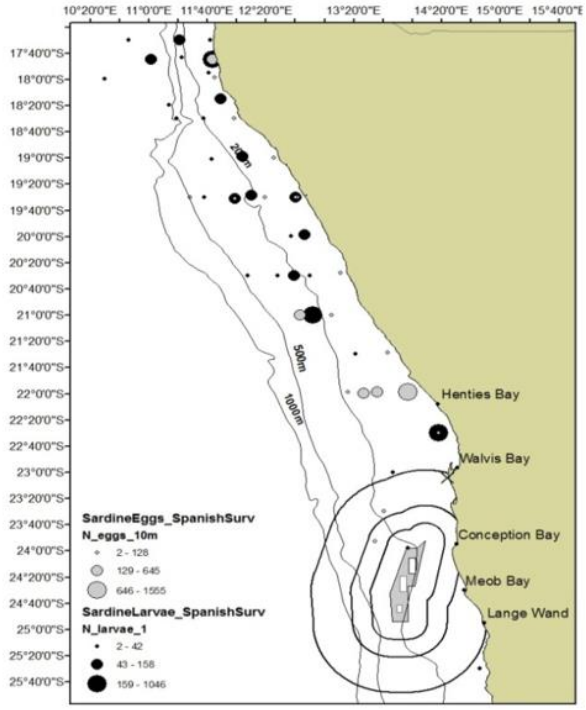


Figure 69 – (left) Pelagic (anchovy, sardine and herring) juveniles' numbers (< 8cm) from pelagic-surveys (2002-2011) (n=10714)

Figure 70 – (right) Distribution of anchovy eggs (grey) and Larvae (black) from Spanish survey data (n=333)



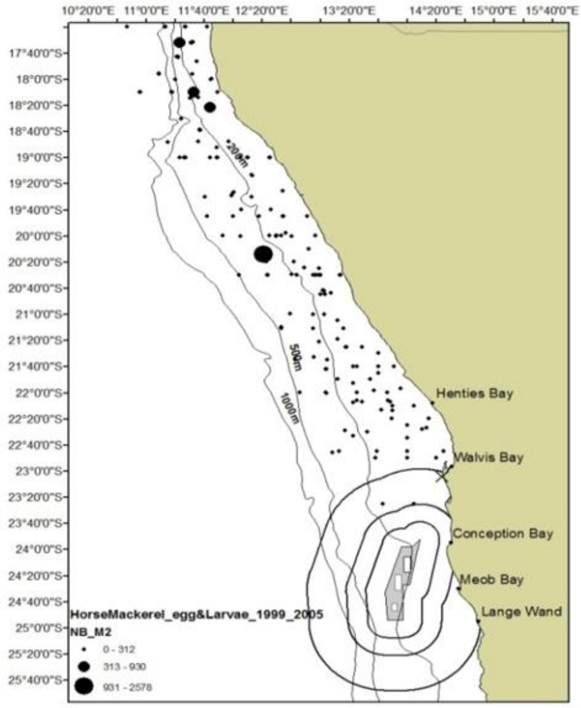
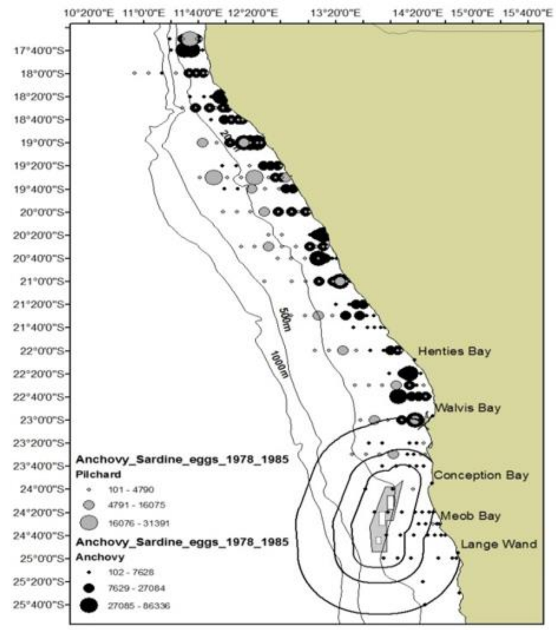


Figure 71 – (left) Distribution of sardine eggs (grey) and larvae (black) from Spanish survey data (n=333)

Figure 72 – (right) Distribution of horse mackerel eggs and larvae from Nansen survey data (1999-2005) (n=2811)



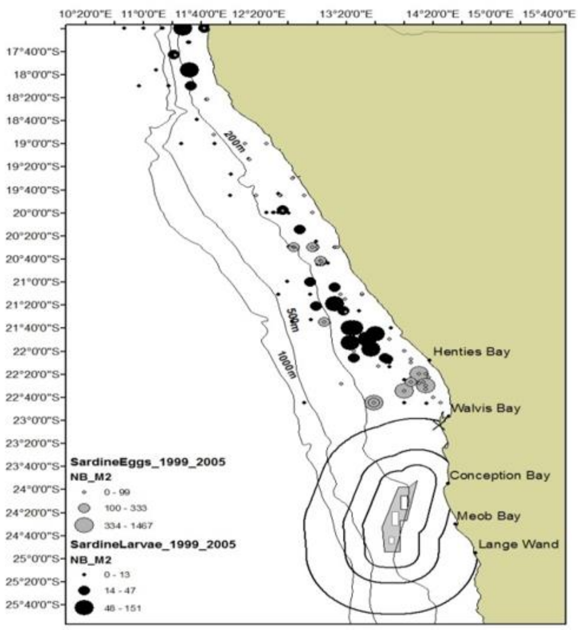


Figure 73 – (left) Distribution of sardine (grey) and anchovy (black) eggs from SWAPELS survey data (1978-1985) (n=265)

Figure 74 – (right) Distribution of sardine eggs (grey) and larvae (black) from Nansen survey data (1999 – 2005) (n=2811)

The following conclusions from the 2022 assessment (Japp, 2022) are summarised in the Section below per species or fishery sector. Further reference can be made to Figure 65 - Figure 74.

Hake:

- The distribution of juvenile hake (<25 cm) occurs throughout the Namibian waters and mostly in waters shallower than the 200 m bathy-contour. This is typical for juvenile hake that recruit in shallower water and migrate to deeper water with age.
- Juvenile hake are specifically found in the northern part of ML 170, near SP1.
- Juvenile hake are expected to be displaced from the dredging area but their mobility should limit the potential for mortality,
- The distribution of stage 4 adult hake is an indicator that fish are spawning. The data indicates that spawning hake are not commonly found in ML 170 and are generally located in areas north of ML 170 well away from the mining site.
- Hake recruitment is therefore not expected to be impacted significantly.

Horse mackerel:

- Horse mackerel juveniles are not found in high abundance in and around ML 170, this is even less so for the mining area in SP1. This species occurs mostly northwards of Zone 1.
- Horse mackerel eggs and larvae are predominantly found north of ML 170.
- The potential impact in recruitment on this species is determined to be low or negligible.

Monk:

- Juvenile monkfish (<21 cm) are located throughout ML 170 but not in high abundance.
- The potential direct impact on juvenile monk from dredging is deemed as high (mortality) but only localised in the mine site within SP1 (Zone 1).
- However, the data suggests the extent of the mining area is small compared to the total biomass of monkfish in Namibian waters, therefore recruitment effects are deemed to be low.

Small pelagic:

- The known distribution patterns of small pelagic juveniles suggests that they are predominantly found landwards of the mine site in SP1, therefore in shallower waters
- Egg and larval surveys suggest that spawning occurs north of Zone 1 which includes the mine site in SP1
- Further historical data suggests also that spawning occurs north of Walvis Bay and well away from the mine site

- There is some historical evidence however of sardine and anchovy eggs found in small number south of Walvis Bay and broadly across ML 170
- It is concluded that mining in SP1 (Zone 1) is therefore unlikely to significantly impact recruitment of small pelagic fish species
- However due to the depleted small pelagic stock in Namibian waters, any minor disturbance could disrupt spawning and raise the impact implications from low to moderate.

The overall potential impacts on recruitment of hake, monkfish, horse mackerel and sardine from dredging operations could occur, however it is determined that these impacts will remain neutral. Potential impacts will be long term, for the duration of life of mine (20-years) and be restricted to Zone 1, with a possible extent to Zone 2 for monkfish. The probability of the impact occurring is possible for hake and monk and improbable for horse mackerel and sardine. The sensitivity of the recruitment of hake, horse mackerel and sardine are low to dredging, whilst for monkfish it is medium. The magnitude of change is no lasting effects for hake, horse mackerel and sardine and minor effects for monkfish. For hake and horse mackerel the confidence level is high in the assessment and for sardine and monk, this is medium. The significance of the impact is low for hake, horse mackerel and sardine and minor for monkfish. The overall aggregated significance of the impact is low. This current assessment validates further the outcomes of the 2012 and 2014 assessment (low).

7.6.2.4 Summary of impacts from seabed dredging on fisheries

Table 27 provides an overview of the impact assessment outcomes of seabed dredging on fisheries.

Table 27 – Impact assessment for seabed dredging on fisheries

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining – seabed dredging	Fishing industry, operations and grounds	Fishing operations: impact of dredging on the main Namibian fishing sectors (hake, monk, horse	Adverse -neutral Zone 1 Long term	Low	No lasting effect	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		mackerel, small pelagic purse seine fisheries). The fishing sectors will not be able to operate in certain areas due to 1) actual mining operations 2) associated sediment plumes 3) exclusion zones around the dredging site and 4) increased levels of maritime traffic.				
Mining – seabed dredging	Fishing industry, operations and grounds	Ecologically important demersal and pelagic species: impact of dredging will result in the redistribution and/or displacement of hake, monk, horse	Adverse - neutral Zone 1 Long term	Low	No lasting effect	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		mackerel, sole, orange roughy, bearded goby populations and small pelagics because of 1) actual recovery activities 2) habitat disturbances and the removal of substrate and 3) sediment plumes.				
Mining – seabed dredging	Fishing industry, operations and grounds	Recruitment of key commercial species (hake, horse mackerel, monk, small pelagic species). The dispersal and survival of juveniles, eggs and larvae are effected by 1) physical disturbance	Neutral Zone 1 Long term	Low	No lasting effect	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		of the fishing grounds and 2) sediment plumes.				

7.6.3 BIODIVERSITY IMPACTS

This impact focuses on the potential impacts of mining on marine biodiversity. As noted by Japp (2022) the living marine resources of Namibia are relatively well-known and by definition marine biodiversity is the degree of variation of marine life forms within a given ecosystem (Japp 2022). It is a measure of the health of the ecosystem and changes in marine biodiversity are directly caused by exploitation, pollution, and habitat destruction or indirectly through climate change and related perturbations of ocean biogeochemistry (Worn et al. 2006). Unique or keystone species are important for the ecosystems to function in which they occur. If the aforementioned species (e.g., goby) is permanently lost, this could cause a collapse of that ecosystem. Therefore, when the biodiversity of an ecosystem is assessed, essentially the health of an ecosystem is assessed. Impacts that could potentially directly alter ecosystems include pollution, habitat destruction and exploitation. Marine ecosystems can also be indirectly impacted through climate change and changes to the water column biogeochemistry (Work et al., 2006). Seabed mining therefore could have an impact on species diversity.

The Namibian living marine resources are generally well known, however the biodiversity within the Benguela ecosystem is not well documented.

The associated potential impact of dredging in ML 170 was assessed in 2012 and reassessed in 2014 during the verification programme, whereby an infield biodiversity survey was conducted.

As part of this assessment report, the appointed specialist Japp (2022) has comprehensively re-assessed the potential impacts on marine biodiversity accordingly, per species. These impacts will be further discussed in the Section below and the aggregated impact significance score will be used as the final outcome of the impact, as per Table 28.

This Section below describes the potential impacts on marine fish species, with consideration for benthos, which is mainly described in Section 7.2.4 as assessed by Carter and Steffani (2021).

7.6.3.1 Species diversity: dredging operations will result in a reduction or loss in biodiversity because of 1) actual dredging and vessel operations 2) habitat destruction and the removal of substrate and 3) sediment plumes.

2012/2014 Assessments

The 2012 assessment concluded at a low to medium confidence level, that the significance of the impact from seabed dredging would be low for fish species (Japp in Midlgey, 2012) and benthic communities (Steffani in Midgley, 2012). During the 2014 verification assessment, a biodiversity survey was conducted and *in-situ* data was collected from SP1 and surrounding areas within ML 170. A total of 32 species (fish and epifauna species) was identified during the survey and no unique species were found during the survey. The 2014 verification assessment concluded that the diversity of fish and epifauna in and adjacent to SP1 is comparatively low in terms of the Benguela ecosystem in Namibia, at a high confidence level, confirming the findings of the 2012 assessment with an increased level of confidence (Japp in Midlgey, 2014). The increase in confidence level related also to considering the scale of impacts more appropriately for the the specific mining target mining area (SP1), located within ML 170.

2022 Assessment

The potential impacts of seabed dredging on the biodiversity of demersal fish species and the substrate/habitat flora and fauna and overspill discharge on pelagic fish species, has now been re-assessed in 2022 incorporating additional updated and recent data from routine stock assessment trawl surveys conducted by MFMR (2016 to 2021) and NORAD (2019), respectively. Data on biodiversity in Benguela ecosystem is not well documented although there are on-going initiatives to study biodiversity through the Benguela Current Commission. As a proxy for biodiversity Japp (2022) used the number of species recorded in all independent surveys to gauge the relative number of species (predominantly fish) expected in and around the Zone 1 20-year mine plan area within ML170 (Note in the 2012 and 2014 Assessments, Zone 1 as defined as the whole of ML170.) Results were also compared with the data from the 2014 Verification biodiversity survey conducted in SP1. Japp (2022) notes this data should form a baseline to monitor changes in the fauna diversity in the proximity of the mining area(s). Biodiversity impacts were separated broadly into three groups, namely a) demersal fish and b) habitat flora and fauna (due to dredging itself) and c) pelagic species (due to fine sediments discharge / plume effects) for purposes of the current assessment impact scoring.

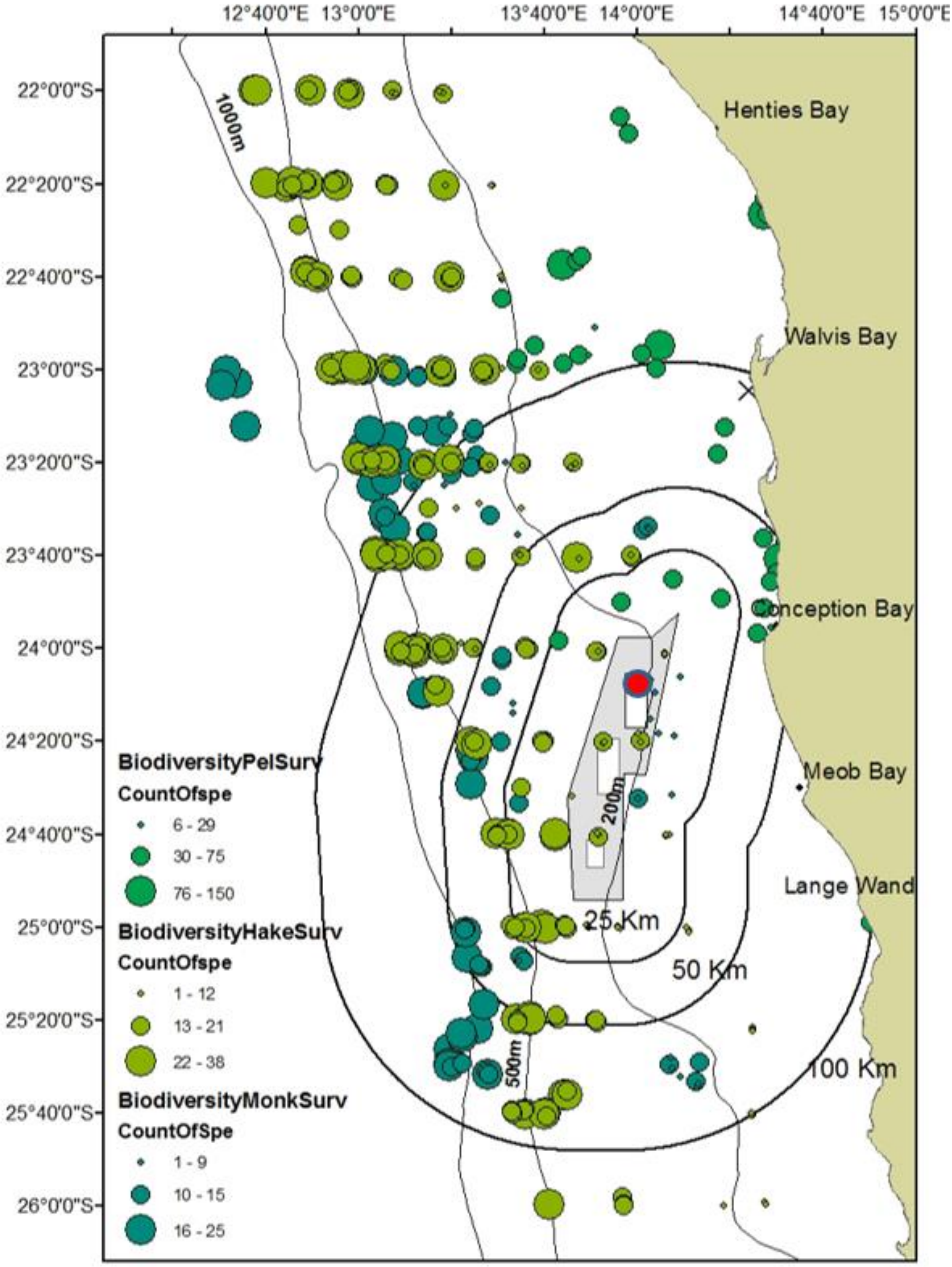


Figure 75 – Dots represent the number of species counted per coordinate (lat/long) from the hake-survey data, monk-survey data and small pelagic-survey n=9116 (red dot approximates the 20-year mine area) (Japp, 2022)

Figure 75 provides an overview of current available survey data from the hake, monk and small pelagic research cruises, that are shown to be spatially separated by survey type and station. Specifically, within ML 170, the number of stations sampled is relatively low and none are present in SP1 when compared to stations in deeper water towards the continental shelf edge. Nevertheless, Japp (2022) concluded that the diversity of primarily fish fauna in and immediately adjacent to Zone 1 is comparatively low. It must however be noted that the assessment does indicate that approximately 40 different fish species have been recorded in or adjacent to the intended mining area and that these species (i.e., fish biodiversity) will in some way be impacted by the mining operation although the extent of these impacts is difficult to judge (Japp, 2022). Note the potential impacts on benthic marine species is mainly covered under Section 7.4.2 (Carter & Steffani, 2021) in this Chapter.

As an outcome, Japp (2022) notes that the aggregated assessment for all three groups, keeping in mind the relative scale of the operations. The aggregated impact significance score for the above assessments was used to define the final outcome of the impact, which is summarised as follows:

Mining/dredging activities could have an adverse impact on biodiversity and the impact is deemed to be regional as, although the seabed dredging is only expected to have localised effects from Zone 1 and extending possibly into Zone 2. The impact is expected to be long term for the duration of mining activities (20-years) but shorter in places as the dredger moves away from mined areas. For demersal and pelagic species, the impacts are deemed possible and for habitat-associated species the probability is high, as habitats will be physically disturbed by seabed dredging. Overall, the sensitivity value on biodiversity is medium as dredging will alter the seabed, with a low sensitivity for pelagic species as they do not reside on or close to the benthic zone but can be found in the water column Section where the sediment plume will be released. Overall and for pelagic species, the magnitude of change is expected to be minor effects, taking the scale of the operation into account. Demersal species will be able to repopulate over time and therefore no lasting effects is expected. For habitat associated fauna and flora, the magnitude of change is expected to be moderate if applied to the specific mine site. Recovery of biodiversity in the specific mining area once mining has stopped is likely to be slow and will follow a natural process of ecological succession that is dependent upon the rate of recover of the substrate. The confidence level is medium for fish species and high for habitat associated species. Through continuous monitoring programmes and surveys required during operations, additional information within SP1 will be obtained and will enhance the biodiversity programme and outcomes of this study. Overall, the significance of the impact is determined as minor.

This outcome is still a relatively low score, as per the previous assessment's conclusions, however the impacts has now been quantified as per amended methodology adopted for this

ESIA. No additional physical mitigation measures are currently possible, noting that the planned operations are scheduled to be cyclic, not continuous on a weekly basis and that regular surveys of species biodiversity are to be undertaken through EMP monitoring programmes that have been incorporated into the EMP.

The impact on species diversity is not expected to influence project design provided the current area limitations are maintained. Expansion of dredging in SP1 or SP2/3 without baseline monitoring of biodiversity and controls must be a prerequisite to the commencement of mining in these areas (Japp, 2022).

7.6.3.2 Summary of impacts from seabed dredging on biodiversity

Table 28 provides an overview of the impact assessment outcomes of seabed dredging on biodiversity.

Table 28 – Impact assessment for seabed dredging on biodiversity

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining – seabed dredging	Marine fish species Marine benthic communities	Species diversity: dredging operations will result in a reduction or loss in biodiversity because of 1) actual dredging and vessel operations 2) habitat destruction and the removal of substrate and 3)	Adverse Zone 3: Regional Long term	Medium	Minor effects	Adverse Minor (4)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		sediment plumes.				

7.6.4 MARINE MAMMALS AND SEABIRDS' IMPACTS

This impact focuses on the potential impacts of the proposed dredging operations on marine mammals (including seals), turtles and seabirds.

The associated potential impact was assessed in 2012 and reassessed in 2014 during the verification programme, whereby infield surveys were conducted (Japp in Midgley 2012 and 2014).

As part of this current assessment report, the appointed specialist Japp (2022) has expanded the baseline information and re-assessed the potential impacts accordingly, per species group. Additionally, Carter & Steffani (2021) have assessed the potential impacts of noise in their specialist study for this assessment, which includes new quantitative noise generation and attenuation data for dredge vessels operated by the dredging contractor JDN. These impacts will be further discussed in the Section below and the aggregated impact significance score in Table 29 will be used as the final outcome of the impact.

7.6.4.1 Seabirds and Mammals: dredging operations will result in the displacement and/or redistribution of seabirds and mammals because of 1) disturbance of the ecosystem and availability of feed and 2) physical disturbance of the dredgers including noise pollution.

<u>2012/2014 Assessments</u>

The results of the 2012 assessment referenced the entire Namibian coastline for the majority of bird and mammal species and conclusions were presented with medium confidence in the absence of site specific data from within ML 170. During the EIA verification study assessments in 2013 and 2014 both benthic and biodiversity surveys were conducted during which seabird and mammal observations and spatial information was collected from SP1 and adjacent areas inside ML 170. During these verification surveys, 16 different species of seabirds were identified (three were albatrosses) and two species of mammals were recorded (Cape fur seal and dusky dolphin). The data showed no variation from the 2012 assessment and confidence level was increased from medium in 2013 to high for the 2014 assessment that the impacts were considered to be of minor significance and expected to be limited to the active dredging area and immediate surroundings (500 m from the dredging location).

<u>2022 Assessment</u>

The Namibian coast supports large populations of seabirds. Detailed scrutiny of the published literature has revealed that no important seabird breeding or foraging areas fall within the vicinity of Conception Bay (which is located on the Namibian coast in the vicinity of ML170) (Japp 2022).

Namibian marine mammals are considered a marginal component part of the broader southern Atlantic marine mammal community and includes three species of seals and approximately 40 species of whales and dolphins (Griffin, 1998 in Japp 2022). There has been a noted northerly shift in breeding seal populations in the last decade, which is potential linked to a geographical redistribution of prey (Kirkman et al., 2007). Baleen whales are considered seasonal visitors, however some species may support resident populations (Griffen, 1998). Most whale species which were once exploited remain very rare within the Namibian waters, (Bianchi et al., 1999). Although once considered to have been totally eradicated by overexploitation, since 1996 sightings of mother and calf pairs of southern right whales sighted between Conception Bay and the Orange River indicate the presence of a breeding population. Other baleen whales known to occur along the Namibian coastline include pygmy right whales, fin whales, minke whales and humpback whales. Additionally toothed whales are recorded to occasionally visit Namibian coastal waters as include sperm whale, killer whales and longfinned pilot whales. A number of dolphin species, most notably the dusky dolphin, bottlenose dolphin and Heavisides dolphin are year round residents along the Namibian coast (Griffin, 1998).

The location of SP1 (Zone 1) is located in the mid-shelf along the 200 m bathy-contour. SP1's location and distance from the shoreline allows for coastal and oceanic seabird activity, large migratory whales activity and localised distributions of smaller marine mammals (Japp, 2022).

As the actual dynamics of these species are difficult to gauge relative to the mining location, it must be assumed that most, if not all species are expected to be found in the proximity of the mine site. Marine mammals are naturally inquisitive and the dredging activity will attract smaller marine mammals, however the larger migratory mammals (e.g., baleen whales) are expected to avoid these areas of high activity and poor visibility due to water quality (e.g., sediment plume). Impacts on birds and marine mammals will nevertheless be limited to the actual mining site and immediate areas (500 m around the dredging location).

Due to the increase in substrate disturbance, this could result in higher biological activity and increased particulate matter in the water column and at the surface, which would attract birds to these areas. Additionally, lighting could also attract seabirds, particularly nocturnal birds to the dredger vessel.

The effects of sound, particularly below water, are also considered as part of the assessed impact, particularly for whales, dolphins, seals and even to an extent, fish. Noise associated impacts could displace and/or redistribute marine mammals and seabirds. Japp (2022) notes that this impact on mammals in particular, is considered relatively benign and references the assessments conducted by JDN (in Carter 2022) as mentioned above in Section 7.6.4, concluding that sound frequencies and amplitudes generated from their operational TSHD fleet are like those of vessels of comparative size and are likely to only transit through the active dredging area in ML 170. The sound levels are in all cases far below those which would or could pose any threat of injury to marine life. Noise from shipping is not to be confused with the well-known damaging effects of activities such as pile driving and most effects concern short, perhaps medium-term behavioural reactions and masking of low-frequency calls in baleen whales and seals (Todd, 2015).

However potential short/medium term effects on changes in behaviour could occur for baleen whales and seals as low-frequency calls could be masked during dredging activities (Japp, 2022).

Measured underwater sound (SPL) source levels for an operating TSHD in the Jan De Nul fleet are 180-190 dB re 1 μPa at 1m, dominant sources are main engine (500 Hz) and propeller (300 Hz). Carter and Steffani (2021) further concluded that modelling indicates that attenuation to 100 dB re 1 μPa at 1m will be attained at an average range of 15 km while received sound levels ≥130 dB will be restricted to within a radius of 2 km to 3 km from the operating dredger. Sound receptors in the operations area will be mainly cetaceans, seals, and fish. Temporary (hearing) threshold shift (TTS) in cetaceans and seals are reported as being 175 dB re 1μPa at 1 m SPL received level and above. Mortality can be caused in fishes at SPL >207 dB re 1μPa at 1m for fish with swim bladders and >213 for fish without bladders, TTS thresholds are ≥186 dB; mortality in fish eggs and larvae can occurs after exposure to 207 dB. Mortality or potentially mortal injury to sea turtles can follow exposures to similarly high SPLs. Given the dredger sound source level (above) such effects are unlikely. Received sound level thresholds causing moderate behavioural shifts for baleen and odontocete cetaceans and seals range from 130 to 180 dB re 1μPa at 1 m. Modelled sound attenuation for the TSHD Gerardus Mercator provided by Jan de Nul (Jan De Nul N.V., 2020) indicate that received sound levels >130 dB will be restricted to within a radius of 2-3 km from the operating dredger while sound levels >150 dB will be restricted to within 100 m.

Direct noise measurements will only be possible when the dredger is operating and therefore onsite sound measurements and modelling is a requirement of the EMP and has been included as such.

The impact of dredging on seabirds, marine mammals (including seals) and turtles is assessed as outlined below.

Dredging vessel activities through general disturbance and noise could have an adverse impact on marine mammals, seals, turtles and seabirds. The impact will be for a long duration for all groups (20-years of life of mine) and reduced in places when dredging activities shift to new areas in the mining plan. The impacts are deemed regional for all four groups (within 50 km from the dredge site plus cumulative effects), however sound impacts are more likely extending to the specific mine site only (SP1). The probability of the impact occurring is possible for mammals, seabirds and turtles and improbable for seals. The sensitivity of mammals (including seals) for noise is expected to be medium. The sensitivity of seabirds and turtles in relation to general marine vessel operations disturbance is medium and low for seals. The magnitude of change for mammals and seals is expected to have no lasting effects, whereas for seabirds and turtles, minor effects are expected. The level of confidence in the results is high for seals and medium for mammals, seabirds and turtles. The overall significance of the impact is determined as minor. Standard mitigation measures can be implemented to reduce impacts associated with sound and light and are incorporated in the EMP.

7.6.4.2 Summary of impacts from seabed dredging on mammals, seals, turtles and seabirds

Table 29 provides an overview of the impact assessment outcomes for seabed dredging on mammals, seals, turtles and seabirds.

Table 29 – Impact assessment for seabed dredging on mammals, turtles and seabirds

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining – seabed dredging	Marine mammals Marine avifauna Marine ecology and biodiversity	Species diversity: dredging operations will result in a reduction or loss in biodiversity because of 1) actual dredging and vessel	Adverse Zone 3: Regional Long term	Medium	No lasting effect – minor effects	Adverse Minor (4)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		operations 2) habitat destruction and the removal of substrate and 3) sediment plumes.				

7.7 THE MARINE ENVIRONMENT: JELLYFISH IMPACTS

Jellyfish impacts include the consequences of seabed dredging on this species. The significant impacts, or impacts that have specific interest to stakeholders, before mitigation, are summarised in Figure 76 for illustrative purposes only. The re-assessment conducted in 2022 of the impacts, mirrored the outcomes of the 2014 assessment and were appropriately scored as per the methodology described in Chapter 6. Details related to each specific impact is discussed further in this Section.

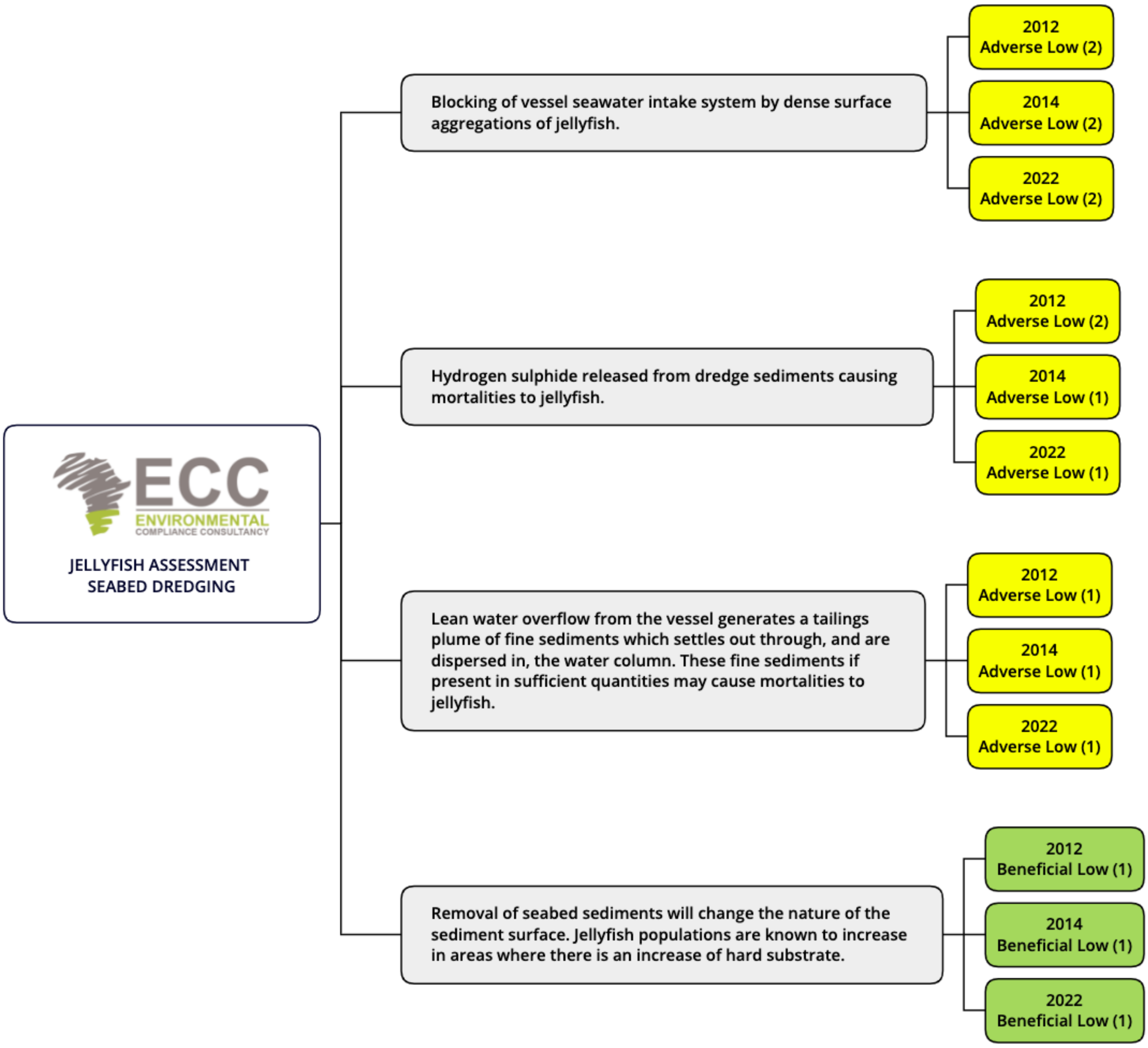


Figure 76 – Jellyfish impacts

7.7.1 IMPACTS FROM SEABED DREDGING ON JELLYFISH

Jellyfish are an important food source for various species and account for up to 70% of the diet of bearded gobies. All associated seabed dredging operational impacts (four) on jellyfish assessed in 2012 was reviewed and reassessed in 2014. All associated impacts significance was rated low in 2012, re-confirmed in 2014 and in this assessment. For the purposes of this assessment, these impacts were scored as per Chapter 6 methodology to qualitatively re-confirm the conclusions drawn from the previous specialist studies conducted and is further discussed in the Sections below.

7.7.1.1 Blocking of vessel seawater intake system by dense surface aggregations of jellyfish

Jellyfish have been known to block seawater intake systems when accumulated in large volumes at sea water surfaces. Incoming seawater cools the engine of the vessel and therefore any blockage of the intake water system could cause engines to overheat and fail. Mitigation measures are therefore required to avoid this from occurring, and have been included in the EMP, and standard dredging vessel operating procedures.

The 2012 assessment concluded that jellyfish can be found throughout the water column and more than 50 % of their biomass is found in the upper 50 m of the water column (Flynn et al., in press). Jellyfish therefore could block the seawater cooling intake of the dredging vessel if dense aggregations occur. The extent will however be limited to where the vessel is operating at the time (dredge event) and occur for a very short duration (a few hrs). The probability of the event occurring is high probable, particularly for the late winter/early spring months when jellyfish populations are more abundant. The magnitude of change is no lasting effect, as the impact will involve a low volume of jellyfish and more adverse impacts could occur for the vessel if not mitigated. The value of sensitivity for jellyfish is therefore determined as low. The confidence level remains high. The significance of the impact is low. No change required for the 2014 assessment and therefore the original 2012 assessment outcomes remain valid.

7.7.1.2 Hydrogen sulphide released from dredge sediments causing mortalities to jellyfish

This impact assesses the potential of H_2S released from the sediments during dredging operations to cause mortalities to jellyfish. During the 2012 assessment, assumptions were drawn based on available publications that the H_2S concentrations are low for the water column and sediments and benthic macrofauna assessments in SP1. These assumptions were confirmed during the 2014 verification assessment when dredge target area sediments were further analysed and proxy variable measurements confirmed the limited presence of

H_2S concentrations present in the samples. Additionally, there is currently no information available on the tolerance of jellyfish to hydrogen sulphide and more research is required on this. However due to the low presence of H_2S in SP1, no further assessment is required. It can however not be entirely eliminated that jellyfish will not be poisoned by H_2S if fluxes occur.

The 2014 assessment therefore concluded that H_2S fluxes as a result of dredging activities could have an adverse impact on jellyfish, this impact will be restricted to the dredge area and by for a very short term duration (hrs – related to the pulse releases of H_2S). The probability of the impact occurring is possible (5 to 50 %) and no longer probable (50 to 90 %), as per the 2012 assessment. The sensitivity of the receptor is low, as H_2S concentrations are low in SP1 target area. The magnitude of change is no lasting effects (however individuals may be effected) and no longer minor effects, as per the 2012 assessment. The confidence level remains high. The significance of the impact is low. No mitigation is further required.

7.7.1.3 Lean water overflow from the vessel generates a tailings plume of fine sediments which settle out through and are dispersed in the water column. These fine sediments if present in sufficient quantities may cause mortalities to jellyfish.

This impact assesses the potential for jellyfish to be adversely affected by the sediment plume that will be generated during dredging operations. During the 2012 assessment, it was concluded that the impact of the fines from the sediment plume in the water column on jellyfish is dependent on the number of animals present during dredging activities in the SP1 and mining licence areas. The fines could settle on the jellyfish, however as jellyfish have no specialised respiratory surfaces that could be blocked, they will be able to continue swimming and rid themselves of the particles. Particles could be ingested but this is considered unlikely (Japp in Midlgey, 2012). However, no research has been conducted in this area to date.

The extent was redefined in the 2014 verification assessment from mine site to dredge event, as the cut length of the sediment plume will be 4 km and not 22 km, as originally assessed. The maximum concentrations of sediments in the sediment plume are envisaged to be <50 mg/l but most of the plume area will have total suspended sediment concentrations <10 mg/l above background (1 mg/l to 4 mg/l), these are regarded as low.

Therefore, the sediment plume could have an adverse impact on jellyfish, but this is restricted to a dredge event and will be for a very short term (dredging cycle). The probability of the impact occurring is improbable as jellyfish are not likely to ingest fines. Conversely, jellyfish are also known to be attracted to the sediment plume that is discharged overboard on diamond mining vessels and aggregate in sufficient numbers which can cause blockages to the sea water cooling intakes on the vessel. The value of sensitivity of the receptor is determined as low as mortalities are not expected. The magnitude of change is minor effects and the jellyfish will still be able to function normally. The significance of the impact is rated as low, as per the 2012 assessment outcomes. No further mitigation is required. The confidence level remains low as further research is required on this area.

7.7.1.4 Removal of seabed sediments will change the nature of the sediment surface. Jellyfish populations are known to increase in areas where there is an increase of hard substrate.

Jellyfish populations are known to increase in areas where there is an increase of hard substrate (Example: where rock, concrete or iron structures are erected, such as a jetty). Although the dredging operation will leave behind a residual sediment layer of at least 30 cm above the overlying clay footwall and slivers of undisturbed seabed, and the fact that no hard rock layers have been mapped or encountered in any of the surveys completed for the project, the removal of the upper layers of sediment (relatively soft) could leave behind a relatively hard clay footwall surface in places, which may potentially provide such a hard surface,. This impact, although not anticipated as part of the operational dredging plan, therefore assesses the potential for jellyfish populations to increase in relation to the exposure of a hard or relatively hard substrate. Whilst jellyfish in the water column will not be affected, the exposed harder substrate could be suitable for polyp attachment. However other polyp species require a sediment free surface to establish properly. Therefore, this will most likely not occur due to the tailings plume fall out during dredging activities and due to the sedimentation of the photic zone production (Japp in Midgley, 2012). No re-assessment was required during the 2014 assessment and the 2012 conclusions remain valid.

Therefore, seabed dredging could have a positive impact on jellyfish populations within the annual mining licence area but this will be for a very short term (dredge cycle). The probability of the impact occurring is improbable due to the continuous release of tailings material. The value of sensitivity of the receptor is determined as low and the magnitude of change as minor effects, as not changes are predicted for jellyfish populations. The confidence of the assessment outcome is high as slivers of undisturbed ground will be left *in situ*, as well as a covering of sediments over the harder (relatively) clay footwall. The significance of the impact is therefore a beneficial low, with a potential for negative impacts on fisheries if jellyfish populations increase. No mitigation is required; if between 10 to 15 % of the original thickness of the sediment is not recovered, there will sufficient soft substrata to preclude polyp settlement (Japp in Midgley, 2012).

7.7.2 SUMMARY OF IMPACTS FROM SEABED DREDGING ON JELLYFISH

Table 30 provides an overview of the impact assessment outcomes of seabed dredging on jellyfish.

Table 30 – Impact assessment for seabed dredging on jellyfish

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining – seabed dredging	Jellyfish	Blocking of vessel seawater intake system by dense surface aggregations of jellyfish. This incoming seawater is used to cool the vessel's engines and any blockage of the intake system could cause the engines to overheat and fail.	Adverse Dredge area Very short term	Low	No lasting effect	Adverse Low (2)
		Hydrogen sulphide released from dredge sediments causing mortalities to jellyfish.	Adverse Dredge area Very short term	Low	No lasting effect	Adverse Low (1)
		Lean water overflow from the vessel generates a	Adverse Dredge area	Low	Minor effects	Adverse Low (1)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		tailings plume of fine sediments which settle out through and are dispersed in the water column. These fine sediments if present in sufficient quantities may cause mortalities to jellyfish.	Very short term			
		Removal of seabed sediments will change the nature of the sediment surface. Jellyfish populations are known to increase in areas where there is an increase of hard substrate.	Beneficial Annual mining area Very short term	Minor effects	Low	Beneficial Low (1)

7.8 SOCIO ECONOMIC ENVIRONMENT: ECONOMIC

The term socio economic impact assessment embraces both social impacts and economic impacts. Economic impacts include issues such as employment, changes in economic activity such as fishing and tourism, and increased expenditure. The significant economic impacts or impacts that have specific interest to the community and stakeholders, before mitigation, are summarised in Figure 77 for illustrative purposes only. Details related to each specific impact is discussed further in this Section. Take note that the socio-economic impacts assessed in this Chapter are related directly to the offshore marine operations component in ML 170. The overall socio-economic impacts of the Project will be reassessed as part of the land-based component and the full scale of potential impacts will be determined thereafter (for example the total figures related to job creation and skills development will increase in numbers).

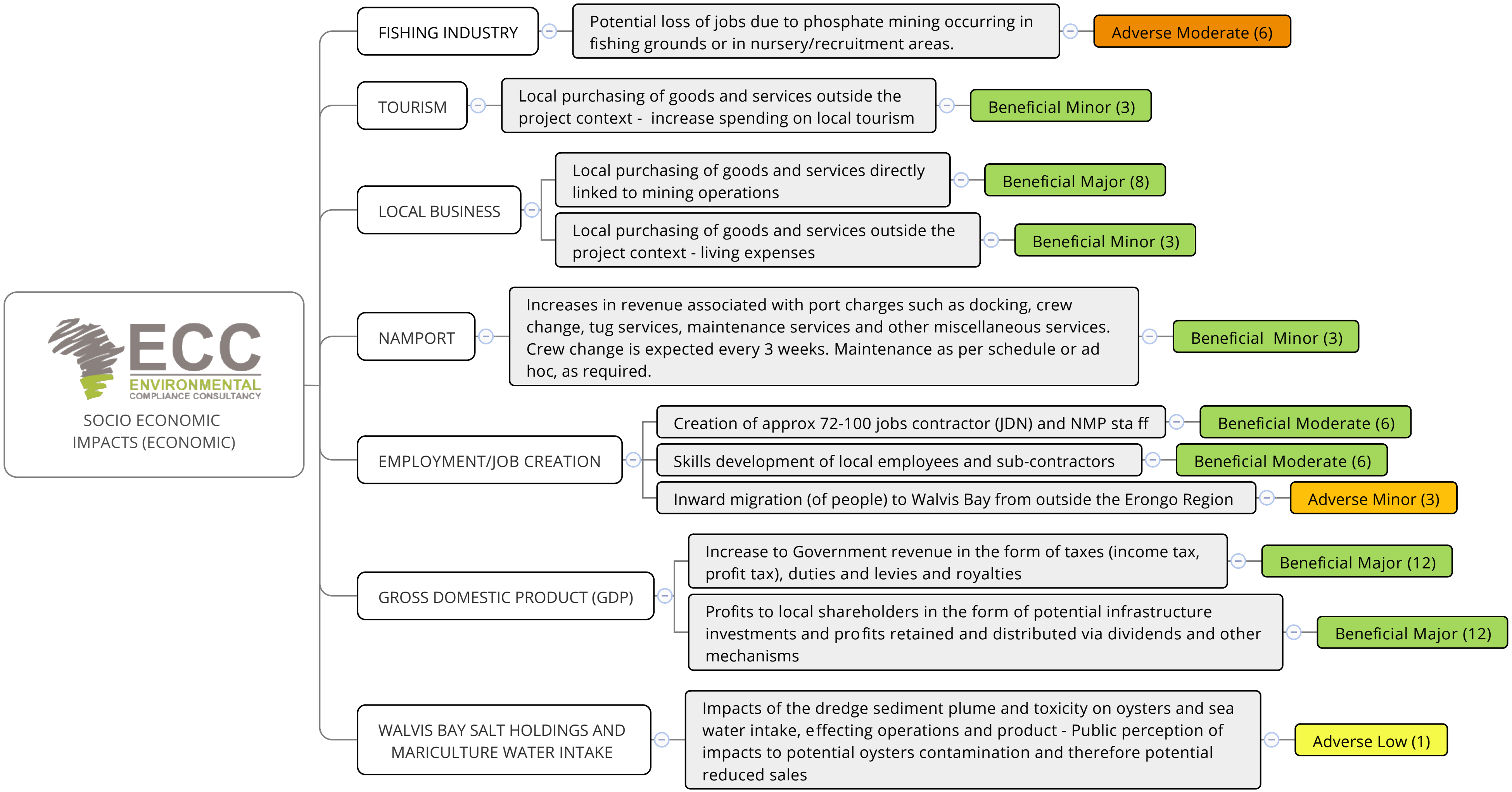


Figure 77 – Economic impacts

7.8.1 IMPACTS TO FISHING INDUSTRY

The commercial fishing industry is a very important industry in Walvis Bay and Namibia as a whole and is one of a number of industries that supports the local economy. The fishing industry is considered the third largest economic sector after mining and agriculture and contributes an estimated 6.6 % to the Namibian GDP. The fishing industry has been established for over 50 years and is one of the largest employers alongside the mining industry in the Erongo Region. It is estimated that the fishing industry employs directly 14 000 workers between onshore processing and vessel operations (Source: The Confederation of Namibian Fishing Association, CNFA).

The two main categories of fishing are for pelagic and demersal fish. Pelagic fish include pilchards, anchovy, juvenile horse mackerel, tuna and sardines. Demersal fish include hake, monk and horse mackerel. Hake and horse mackerel are currently the two main fishing sectors within the industry. Due to the fluctuations in fish stocks, employment opportunities in the industry could change as a result thereof and not from additional industries.

The mining industry in Namibia in comparison is the leading economic sector and accounts to an estimated 10% of Namibia's GDP. At current it is estimated that the mining industry in Namibia employees directly 14,591 workers (Source: Namibian Chamber of Mines, https://chamberofmines.org.na/).

The mining and fishing industries, particularly seabed diamond mining and fish trawling activities, have coexisted for a number of years in the Namibian waters. This Section discusses the potential impact of a possible loss of jobs due to phosphate mining occurring or coinciding in commercial fishing grounds and/or in nursery/recruitment areas. Additionally, toxicity concerns from turbidity plumes are included in this assessment.

Additional specialist studies have been undertaken in 2019/2020 to review the previous water column, benthos and fisheries specialist work conducted in 2012 and 2014, to add confidence to the results that impacts will be minimal on the fishing industry (refer to Sections 7.4 and 7.5.1).

The dredging activities are constrained to an area of 34 km^2 within ML 170, although the scale of the proposed operations represents a fractional portion of the Namibian continental shelf area, nevertheless the proposed activities within this area will have a direct but proportionately limited impact on the fishing industry as the probability of these industries interacting is definite; however, it is considered that the nature of the impact will only be for the duration of the 20-year LOM plan for SP1 (long term) and partially reversible. The fishing industry is considered of medium sensitivity due to value at a regional scale of where ML 170 is located. The magnitude of change is considered low/minor as the mining activities in SP1 only slightly overlap with commercial fishing grounds and the turbidity plume's zone of influence is restricted to the SP1 and MLA boundaries. The overall significance of the impact on the fishing industry is considered to have a moderate impact as outlined in Table 31. The key outcomes of the various studies completed are that the fishing industry will be able to coexist with the phosphate industry.

7.8.1.1 Summary of impacts on the fishing industry

Table 31 provides an overview of the impact assessment outcomes for potential impacts on the fishing industry.

Table 31 - Impact assessment for the fishing industry

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations	The fishing industry Community	Loss of jobs due to phosphate mining occurring in fishing grounds or in nursery/recruitment areas. Additionally, toxicity concerns are included.	Adverse Direct Regional Long term Partly reversible	Medium	Low/minor	Adverse Moderate (6)

7.8.2 IMPACTS TO TOURISM

Tourism is an important industry in the Erongo Region and in particular, the town of Walvis Bay. Therefore, tourism actively supports the local economy. There are various tourist activities and attractions that draw visitors to Walvis Bay (e.g., birding, lagoon, harbour tours, catamaran tours etc.). NMP's operational activities are not expected to impact tourism negatively, as operational mining activities are located offshore. The impacts on tourism as a result of the proposed Project is detailed in this Section below.

The crew on the dredging vessel will be operating on a three week on and off cycle. Therefore, there is a high probability that during the off cycle, staff based in Walvis Bay will be able to spend time at their leisure on recreational activities, which include various tourism company activities. Therefore, this impact will have an indirect impact on the tourism industry, long term for the duration of the project and partly irreversible. The spending would not only occur within Walvis Bay but at a regional scale in other towns, such as Swakopmund. The tourism market in Walvis Bay is of low sensitivity, as the additional income provided to the local business and economy from the operational staff will occur on an ad hoc basis. The magnitude of change is considered moderate as spending on the tourism industry is expected to take place on a regular basis. The probability is considered definite as spending will take place. The overall significance of the impact is expected to be minor, but beneficial. No mitigation measures are required to be implemented.

7.8.2.1 *Summary of impacts on tourism*

Table 32 provides an overview of the impact assessment outcomes for potential impacts on the tourism industry.

Table 32 – Impact assessment for the tourism industry

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations – off cycle	Local tourism Local economy	Purchasing of goods and services outside the project context such as spending on local tourism when not on the dredger/vessel (off cycle).	Beneficial Indirect Regional Long term Partly reversible	Low	Moderate	Beneficial Minor (3)

7.8.3 IMPACTS TO LOCAL BUSINESSES

The operational offshore mining activities will require onshore support by local business. This will be in the form of direct and indirect impacts on the local economy. The impacts on local business are further discussed in the Sections below.

7.8.3.1 *Direct impacts - local purchasing of goods and services directly linked to the vessel/dredging operations.*

Each campaign at sea will required basic needs and services to sustain staff for a period of three weeks. This includes items such as drinking water, food, basic amenities, sanitation, chemicals, fuel and power requirements. Additionally sub-contractors will be contracted to assist with operational needs, such as managing the dredging equipment workshop and acquiring dredging supplies. Other examples include maintenance requirements for the vessel, refuse removal, vessel hygiene cleaning. Additionally local purchasing includes accounting for the support staff on land, such an office expenditures and fuel. A total of

US$ 4,865,457 p.a. (~NAD 80 766 586.20 at current exchange rate) local purchases and subcontracting is expected to be generated from the project in the first year, mounting to US$ 14,569,370 p.a.r (~NAD 241 851 542) of local purchases and subcontracting in year 3 and beyond (JDN, 2020).

Therefore, this impact will be direct, long term for the duration of the project and partly reversible. Local business and economy will be supported, however this could extend to a national scale if services or goods are not directly available in Walvis Bay (e.g., parts to be sourced from Windhoek). The value of the sensitivity is expected to be medium and the magnitude of change expected to be high, as the businesses will be engaged and supported for the duration of the project (20-years). The overall significance of the impact is expected to be beneficial major. No mitigation measures are required to be implemented.

7.8.3.2 Indirect impacts - purchasing of goods and services outside the project context such as living expenses of expat staff when not on the vessel/dredger (off cycle).

The staff on the vessel will be on a three week on and off cycle. Therefore, during the off cycle, expat staff will be based at times in Walvis Bay. Currently it is expected that 56 expats will be employed on the Project. Therefore, they will contribute to the local economy by spending on local goods and services and accommodation required for this period. This will result in local spending of US$167,738 p.a. (~NAD 2 784 450.80) in the first year of operations and mounting to US$503, 215 p.a. (~NAD 8 353 369) in year 3 and beyond (JDN 2020).

This impact will be indirect, long term for the duration of the project and party reversible. Local business could benefit at a regional scale as spending is expected to occur outside the local scope of Walvis Bay. The probability of this impact occurring is expected to be highly probably as expat staff will not immediately return to their country of residence or may decide to remain the entire off cycle in Namibia. The value of sensitivity is expected to be low and magnitude of change moderate, as local spending of the local economy will take place during the off cycles. The overall significance of the impact is expected to be a beneficial minor. No mitigation measures are required to be implemented.

7.8.3.3 Summary of impacts on local business and economy

Table 33 provides an overview of the impact assessment outcomes for potential impacts on local business and the economy.

Table 33 – Impact assessment for direct and indirect spending on local business

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations	Local businesses Sub-contractors	Local purchasing of goods and services directly linked to the vessel/dredging operations. This includes sub-contracting work and local spending.	Beneficial Direct National Long term Partly reversible	Medium	High/major	Beneficial Major (8)
Operations	Local businesses	Purchasing of goods and services outside the project context such as living expenses of expat staff when not on the vessel/dredger (off cycle).	Beneficial Indirect Regional Long term Partly reversible	Low	Moderate	Beneficial Minor (3)

7.8.4 IMPACTS TO NAMPORT

The majority of the impacts associated with NamPort form part of the land-based assessment (including export) and will not be discussed here. For the marine component, the dredger will dock on a regular basis (estimated to sail 221 days of the year back and forth from SP1 to the offloading site/buffer pond and when required for crew change at the port and/or maintenance every 3 weeks), therefore requiring port services for crew transfers and/or vessel repairs. Port tariffs/charges will need to be paid to NamPort to dock and make use of their services. VAT is payable of 15% on all services as per the VAT Act of 2000 (NamPort 2022/2023 tariff booklet) and is discussed further in Section 7.8.6. The mining operations will increase maritime shipping activities in and out of the port. NamPort have recently completed the expansion of the harbour.

Tug and piloting fees will not always be applicable to be paid. As agreed with NamPort, the vessel will get clearance from the NamPort captain to enter and leave without assistance, which is a general internal practice for dredging vessels.

Table 34 below provides a high-level overview of fees due to NamPort when making use of the harbour facilities, based off of the JDN fleet Cristobal Colon (deadweight 78,500 t, length 223 m, breadth 41 m). Take note that two additional support vessels from part of the fleet during port activities.

Table 34 – NamPort services and tariffs (2022/2023 booklet)

Service	Requirement	Tariff (NAD)
Port dues	– All vessels basic charge per 100 gross tonnage or part thereof per call – Plus, per 100 gross tonnage or part thereof per 6hour period or part	– 181.00 – 18.00
Light dues	– Vessels at anchor, per 100 gross tonnes or part thereof per 6 hour period or part thereof, within the first 24 hrs – All other ships: First 12 calls: per 100 GT per vessel call, per service – Thereafter: per 100 GT per call	– 29.00 – 114.00 – 33.00
Berth dues	– Vessels are exempted when changing crews for a period of 12 hrs, thereafter full tariffs are paid. If berthing has to be shared, 50% only liable to pay. – Per 100 gross tonnes or part thereof per 6 hour period or part thereof – Small craft harbour per 30 minutes or part thereof – Permanent mooring buoy per 100 gross tonnes or part thereof per 12 hour period or part thereof	– 58.00 – 255.00 – 115.00
Tug services	Ordinary – Per gross tonnes (78 500) – Or part thereof above 30 000 Miscellaneous – Launch – Tug service per size – 25% surcharge outside of normal ordinary working hrs on weekdays, Saturdays, Sundays and public holidays. Additional charges are also depicted in the T&Cs.	– 40 299.00 – 35.00 – 2 354.00 – Between 5 197.00 – 18 951.00
Berthing services	– Per gross tonne range 70 001 – 80 000 (78 500)	– 11 559.00

Service	Requirement	Tariff (NAD)
Piloting services	– Per gross tonne range 70 001 – 80 000 (78 500)	– 28 603.00
Channel levy	– Per meter of vessels length or part thereof for vessels entering/leaving the port for the reasons other than cargo working (less than 15m exempted).	– 18.00
Basic services	– Fresh water supplied per vessel – Electricity max charge per vessel – Removal of refuse basic charge – Removal of refuse per load for vessels 50m and longer	– 264.00 – 4 343.00 – 709.00 – 750.00
Overtime and stand by charge (60 min)	– Overtime per gang, per hour or part thereof – During ordinary working hrs – Outside normal working hrs	– 2050.00 – 563.00 – 1436.00
Access/entry permits	– Vehicle entry permit transporting passengers per vehicle trip per day – Port access cards per year	– 110.00 – 155.00
Other services	– Example crane hire, diving, security services, fire services etc. ad hoc when required.	– NA

In terms of maintenance services, all repairs except dry-docking can be sourced locally (2012 EIA). These are as follows:

- Lifting services when the vessel is at the quay (crane fees etc included)
- Inspection diving for damage to propellers, hull, bottom doors, etc
- Welding and steel-working
- Electrical & hydraulic repairs
- Assistance on board during planned or unplanned repair: welders, technicians, labour.

The potential impact on NamPort operations is expected to be direct, long term for the duration of the Project (20-years) and reversible. NMP will be required to pay the associated tariffs to gain access to the harbour, to dock, conduct crew change and maintenance on the vessel. This activity is expected at minimum to take place once a month during the LOM and therefore the probability is definite of the impact occurring. Only NamPort and associated contractors will benefit therefore the impact is on a local scale. The value of the sensitivity is expected to be low as NamPort benefit from various shipping companies and not from NMP alone. The magnitude of change is moderate as tariffs are paid when the harbour services are required to be used, which is suspected to be monthly. The significance of the impact is therefore expected to be a beneficial minor. No mitigation measures are required to be implemented.

7.8.4.1 Summary of impacts on NamPort Walvis Bay harbour operations

Table 35 provides an overview of the impact assessment outcomes for potential impacts on NamPort harbour operations in Walvis Bay.

Table 35 – Impact assessment for NamPort operations

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations	NamPort	Tariffs/port charges associated with docking, crew change, tug services, maintenance services and other miscellaneous services.	Beneficial Direct Local Long term Reversible	Low	Moderate	Beneficial Minor (3)

7.8.5 IMPACT DUE TO EMPLOYMENT AND JOB CREATION

The below Section details the potential impacts on employment and job creation for the local communities through the offshore mining operations. As previously described in Chapter 5, the unemployment rate in Namibia continues to increase, standing at 33 % in 2018. This value has further increased as Namibia continues to recover from the consequences of the COVID-19 pandemic. The Erongo Region has the lowest unemployment rate in Namibia and further potential jobs, temporary or permanent, are welcomed for job seekers.

7.8.5.1 Job creation for approximately 72-100 jobs (vessel and land based support operations).

As per the current labour plan for operational activities, it is required for 40 local employees to operate on the vessel in shifts. The current plan is for three months in year 1, six months in year 2 and nine months from year 3 and beyond. Employees will be sourced locally but expats will be on the vessel as NMP plan to utilise Jan de Nul as the main contractor (not local). Foreign nationals are excluded in the above reported figures. Additionally land based staff will be required to work from the head office in Walvis Bay to support operational activities. This includes for example, financial staff, HSE staff, administrative staff, human relations staff, management, maintenance staff, etc. All staff hired will receive an income in the payment of salaries and monetary benefits linked to employment for NMP. This is expected for local employees to average at US$495,255 (~NAD 8 221 233 at current exchange rate) in the first year of operations and grow to US$1,484,764 (~NAD 24 647 082.40) from year three of operations and above (JDN 2020).

The potential impact on employment and job creation is direct, long term for the duration of mining (20-years) and reversible over time. Employees will be sourced from Walvis Bay as a first priority and therefore the impact is expected to be local. Due to the number of jobs that will be created only for mining operations, the value of sensitivity is expected to be low. This is expected to be between 72 to 100 employees. The magnitude is expected to be moderate, as monetary value linked to job creation of the 72 to 100 job seekers will be beneficial to the community for those associated families. The probability of the jobs being created is definite. Therefore, the significance of the impact is expected to be a beneficial minor. No mitigation measures are required to be implemented.

7.8.5.2 Skills development of local employees and sub-contractors where required as per their job expectations.

NMP has committed to sourcing local employment from Walvis Bay and developing the skill sets required to perform the various job requirements expected of those positions. Therefore, where skills are lacking, training will be provided by the Proponent. This includes training sub-contractors where required to perform operational activities. Therefore, it is highly probable that skills development and training will take place. The potential impact on skills development and training is expected to be direct, permanent and irreversible. The skill set developed can be used for future job opportunities in the local community and at a national level in Namibia at large. The magnitude of change is therefore expected to be high/major. The value of sensitivity is expected to be medium, as the employees and sub-contractors have gained new skills in the community at large. The training and skill set developed might however only be for specialised jobs, that are not readily available in Namibia. The significance of the impact is expected to be beneficial moderate. No mitigation measures are required to be implemented.

7.8.5.3 Inward migration to Walvis Bay

Inward migration is not easily manageable in a country with high employment rates. Job seekers will move from different parts of the country to a town or city if an opportunity arises. This in turn puts extra stress on a community and services from that municipality, town council or local authority. Often informal settlements are a result hereof in major towns and cities.

Due to the number of job seekers required to be employed (72 to 100) and the minimum requirements for employment (semi-skilled to skilled), inward migration is not expected to have too much of an adverse effect on the community of Walvis Bay. The impact is expected to be direct, medium term and partly reversible. Initially job seekers will move to Walvis Bay for the commencement of the project and thereafter will either return to their original destinations or find alternative jobs. The impact is therefore also expected to be on a local scale and it is definite that it will take place. The value of sensitivity is expected to be low, as communities will be able to function normally with the low expected influx of persons. The magnitude of change to the community and services is expected to be low/minor as they should not be adversely affected. The significance of the impact is expected to be minor. Mitigation measures are required but this cannot be a function of the Proponent and must be addressed on a regional scale by regional and local government.

7.8.5.4 Summary of impacts on employment and/or job creation

Table 36 provides an overview of the impact assessment outcomes for potential impacts on employment and/or job creation.

Table 36 – Impact assessment for employment/job creation opportunities

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Job creation - operations	Community Job seekers Local economy	Job creation for approximately 72-100 jobs (vessel and land based support operations).	Beneficial Direct Local Long term Reversible	Low	Moderate	Beneficial Minor (3)
Job creation - operations	Community Job seekers Local economy	Skills development of local employees and sub-contractors where required as per their job expectations.	Beneficial Direct National Permanent Irreversible	Medium	High/Major	Beneficial Moderate (6)
Influx of families	Community	Inward migration due to the project commencing of persons outside of the Erongo Region to Walvis	Adverse Direct Local Medium term Partly reversible	Low	Low/Minor	Adverse Minor (3)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
		Bay and Swakopmund.				

7.8.6 IMPACTS TO GROSS DOMESTIC PRODUCT (GDP)

Revenue for the Namibian government consists of income tax, profit tax, value added tax, withholding tax, duties and levies, royalties (in the case of mining projects) and other taxes. Profits to local shareholders are also expected in the form of potential infrastructure developments and profits retained and distributed via dividends and other mechanisms. Revenue and profits are expected to improve the local economy and the contribute towards the mining sectors positive impact on the Namibian gross domestic product (GDP). As per the JDN socio-economic report from 2020 with the available information to the contractor, it is expected that in the first year government revenue will amount to US$160,082$^+$ p.a. (~NAD 2 657 361.20) and by the third year and beyond to US$480,247$^+$ p.a. (~NAD 7 972 100.20). However, the financial model is continuously changing and will be finalised by the Proponent when operations ramp up. Currently mining contributes to 10 % of the GDP in Namibia. The impacts to the GDP are further described in the Section below.

7.8.6.1 Impacts on revenue for government

All revenue requirements are legally required to be paid by mining companies during operations and therefore the Proponent will contribute to the GDP in this manner and the probability is definite. Sales will be in US dollars and therefore in-turn this will be a positive contribution by bringing is USD into the country and will assist with balancing out of payments.

The impact is expected to be direct, long term for the duration of mining activities (20-years) and irreversible. Monies are paid to local business, regional and national government institutes. The value of sensitivity is high as the revenue income will contribute positively to the overall countries GDP. The magnitude of change is rated as high/major due to the contributions of this new sector within the mining industry. The significance of the impact is expected to be beneficial major.

7.8.6.2 Impacts on profits to local shareholders

It is expected that the Proponent will contribute to profits of local shareholders by infrastructure development and investment, and profits retained and distributed through dividends or other financial mechanisms. This in turn contributes to the local economy. The impact therefore may be direct, long term for the duration of mining activities (20-years) and irreversible. The probability is rated as definite. The value of sensitivity if rated as high due to the positive influence on local livelihoods. The magnitude of change is rated as high/major due to the positive impacts on the local economy. The significance of the impacts if therefore rated as beneficial major.

7.8.6.3 Summary of impacts on gross domestic product (GDP)

Table 37 provides an overview of the impact assessment outcomes for potential impacts on the gross domestic product (GDP).

Table 37 – Impact assessment for gross domestic product (GDP)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations	National and local government	Government revenue in the form of taxes (income tax, profit tax, value added tax), duties and levies and royalties.	Beneficial Direct National Long term Irreversible	High	High/Major	Beneficial Major (12)
Operations	Local shareholders Local economy	Profits to local shareholders in the form of potential infrastructure investments and profits retained and distributed via dividends and other mechanisms.	Beneficial Direct National Long term Irreversible	High	High/Major	Beneficial Major (12)

7.8.7 IMPACTS TO THE WALVIS BAY SALT HOLDINGS AND MARICULTURE WATER INTAKE

Walvis Bay Salt Holdings (WBHS) operations and seawater intake are currently located to the south of Walvis Bay and the NamPort harbour. As discussed in Chapter 5, the salt mines operations were identified as a potential sensitive receptor and included in the specialist study conducted by HR Wallingford in 2020. HR Wallingford conducted simulation modelling of dredge plume behaviour in the mine area based on the existing metocean knowledge, plus measurements on sediment properties from the mine site and technical details on proposed dredging programme, rates and equipment provided by the dredging contractor. Previous toxicity studies were additionally reviewed and simulated in this model. It was concluded that the WBSH key receptors lie well beyond the defined 20-year cumulative zone of influence of sediment plume dispersion for the proposed Sandpiper Project operations in ML170.

Therefore, the potential impacts of the dredge sediment plume and toxicity on the oysters and sea water intake, effecting operations and product, were assessed and further described in this Section below.

There is not an indication from the plume dispersion modelling that the mining operations will have an impact on the WBHS operations. The impacts are expected to be local and restricted to the mining licence area. There is a no to low probability of the effects of the plume reaching the WBHS operations. The value of sensitivity has been determined as low, as no adverse changes to the water column, seawater intake or influence on the oyster's productivity is expected. The magnitude of change is expected to be none/negligible. The significance of the impact is therefore determined to be low. No mitigation measures are required to be implemented.

7.8.7.1 Summary of impacts on Walvis Bay Salt Holdings and mariculture water intake

Table 38 provides an overview of the impact assessment outcomes for potential impacts on the Walvis Bay Salt Holdings and mariculture water intake.

Table 38 – Impact assessment for Walvis Bay Salt Holdings oyster operations and sea water intake

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations	Walvis Bay Salt Holdings	Impacts of the dredge sediment plume and toxicity on oysters and sea water intake, effecting operations and product.	Adverse Direct Local Short term Reversible	Low	None/negligible	Adverse Low (1)

7.9 SOCIO ECONOMIC ENVIRONMENT: SOCIAL

Social impacts include the consequences to local populations in terms of ways in which people live, work and interact. The significant social impacts or impacts that have specific interest to the community and stakeholders, before mitigation, are summarised in Figure 78 for illustrative purposes only. Details related to each specific impact is discussed further in this Section.

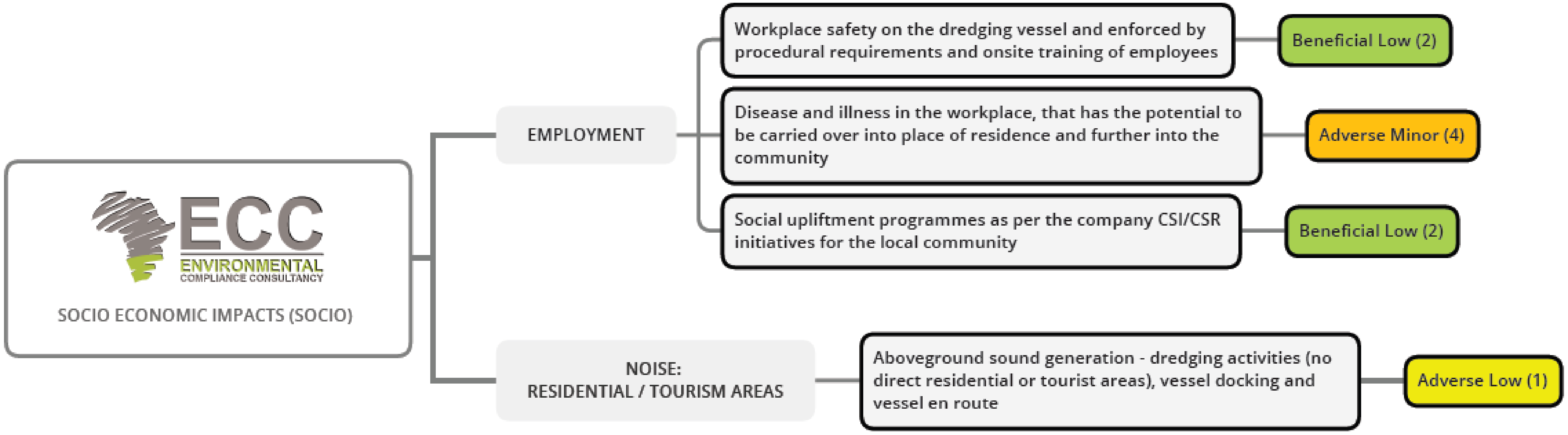


Figure 78 – Social impacts

7.9.1 IMPACTS TO EMPLOYMENT

In a mining environment, impacts associated with employment are not restricted to socio economic alone. The health and safely of employees need to be catered for, as injuries in the working environment could result in long term impacts on an employee that could negatively affect them as a future job seeker and in turn their families if they are the sole breadwinner (e.g., hand injury). Additionally, the spread of occupational diseases or other diseases, could be transferred into family homes and the local community.

Additionally, as part of the social commitments required from mining companies working in Namibia to give back to the communities, it is expected that a social uplift programme will be developed and implemented during operations.

The potential social impacts associated with employment were assessed and are further described in this Section below.

7.9.1.1 Workplace safety on the dredging vessel

Workplace safety on the dredging vessel is expected to be enforced by standard operating procedural requirements and all employees will received onsite induction and training in this regard. Training is expected to be conducted on an ongoing basis with employees and is not a once off. Injury statistics, incident corrective action and lessons learned forms part of the ongoing communication and training to reduce and/or prevent injuries and incidents. Therefore, the impact is expected to be direct, short term and partly reversible. Training will be received on the vessel and therefore the extent is determined as on-site. The probability is definite as health and safety requirements needs to be enforced as per the Labour Act, 1992 (Act No. 6 of 1992). The value of sensitivity is expected to be low. The magnitude of change is determined as moderate, as the training received can be carried over into future working opportunities. The overall significance of the impact is expected to be low, but beneficial. With regards to mitigation, the Proponent is expected to maintain and implement and effective health and safety programme on the vessel.

7.9.1.2 Disease and illness in the workplace

There is a potential for disease and illness originating on the vessel to be transferred into the local community. The vessel is restricted to personnel operating per work cycle, however employees involve local and expats, living and operating in close quarters to once another where disease and illness is quicker to spread. With the recent COVID-19 pandemic experienced, the consequences of transfer of infectious diseases cannot be ruled out. The impact could have an influence on the workforce and community which will be direct, long term for the duration of mining activities (20-years) and party reversible. The impact is expected to be local to the vessel operations and potentially extend into the local community. There is a medium probability/possibility that the impact could occur. The value of sensitivity is expected to be medium, as some support may be required post impact occurring (e.g., lung functionality post infection). The magnitude of change is expected to be high/major, especially in the case of the transfer of infectious diseases. The significance of the impact is however expected to be minor. Onsite mitigation programmes are required to be enforced.

7.9.1.3 Social upliftment programmes

Currently NMP plan to develop social upliftment programmes as per the company CSI/CSR initiatives to give back to the local community of Walvis Bay. The overall programme includes programmes related to healthcare, local economic development, charitable donations and other contributions to social causes. The impact is therefore expected to be direct, long term for the duration (20-years) of the project and irreversible. Changes introduced are expected to remain in the community for years to come after the project has ceased. The impact is expected to occur in Walvis Bay, therefore on a local scale. The probability of the impact occurring is definite. The value of sensitivity is low, as the community will be able to function normally with an improved lifestyle after the impact ceases. The magnitude of change is expected to be high/major due to the positive outcomes and changes to the quality of living in the community expected from these programmes. The overall significance of the impact is expected to me low but beneficial. In order to achieve the outcomes of the impact, the programmes must be implemented.

7.9.1.4 Summary of impacts on employment and the community during operations

Table 39 provides an overview of the impact assessment outcomes for potential impacts on employment and the community during oeprations

Table 39 – Impact assessment for employment

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations	Employees	Workplace safety on the dredging vessel and enforced by procedural requirements and onsite training on employees.	Beneficial Direct On-site Short term Partly reversible	Low	Moderate	Beneficial Low (2)
Operations	Employees Employee families	Disease and illness in the workplace, that	Adverse Direct Local	Medium	High/Major	Adverse Minor (4)

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
	Community Health care facilities	has the potential to be carried over into place of residence and further into the community.	Long term Partly Reversible			
Operations	Community Local economy Healthcare facilities Local business NGO	Social upliftment programmes as per the company CSI/CSR initiatives for the local community.	Beneficial Direct Local Long term Irreversible	Low	High/Major	Beneficial Low (2)

7.9.2 IMPACTS TO RESIDENTIAL/TOURISM AREAS: NOISE

Noise can be a nuisance to receptors and influence livelihoods. In this instance, above sound generation related to dredger vessels operations, such as vessel harbor operations and sailing was assessed for potential impacts on residential and tourism/recreational areas and will be described further in this Section. It must be noted however that vessel activities take place offshore, away from residential and tourism areas. The closest interaction to the local communities is when the vessel sails into the harbour and docks. However, NamPort have access restrictions in place and no residents reside in the harbour.

JDN conducted a noise assessment in 2020 to determine the potential impacts of aboveground noise generated from the dredger vessels, by utilising some of their fleet. This information was used to form part of this assessment. The impact could occur, and it is expected to be cumulative, temporary and reversible. The scale will be local as noise is restricted to where the vessel is operating. The probability of the impact occurring is highly probable as noise will be generated during vessel operational activities, namely dredging. The value of sensitivity is expected to be low. The magnitude of change is expected to be none/negligible as any adverse impacts will be low. The significance of the impact it determined be low. No further mitigation measures are required to be implemented.

7.9.2.1 Summary of impacts of noise to residential or tourism areas by aboveground sound generation of the dredger during operations

Table 40 provides an overview of the impact assessment outcomes for potential impacts of above ground noise on third party stakeholders.

Table 40 – Impact assessment for noise on third parties

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Operations - dredging and sailing	Community Tourism and recreational areas	Aboveground sound generation during dredging activities, vessel harbour activities and sailing.	Adverse Cumulative Local Temporary Reversible	Low	None/negligible	Adverse Low (1)

7.9.2.2 Radiation safety of workers in the marine environment

Radiation safety of workers is noted as an important potential impact that must be considered for assessment. Within the context of the marine environment and related operations, no direct contact is expected between employees on the vessel and the material in the hopper, thus the risk of accidental contact or exposure is not expected. Additionally, there are no known natural effects of radiation on the marine environment that are exposed to and reside in the sediments on a daily basis.

The radionuclide activity concentration (Bq/kg^{-1}) of the ore sampled in 2012 as part of the radiological specialist study conducted at the time (van Blerk, 2012), was compared to the International Atomic Energy Agency (IAEA) safety report (No.78) for Radiation Protection and Management of NORM Residues in the Phosphate Industry activity concentrations exempt for materials in transport and the Namibian Radiation Protection and Waste Disposal Regulations: Atomic Energy and Radiation Protection Act, No.5 of 2005, Schedule I. As per regulation 3, a licensee is exempted from the requirements of these regulations if the activity concentration level per radionuclide is below the required level as specified in Schedule I (Bq/g (column 2) or Bq (column 3)). Schedule I is adopted from the IAEA international requirements stated above. The results indicate that the activity concentration for the radionuclides measured and analysed from the ore are compliant with Schedule 1 activity level concentrations.

The radiation safety of the workforce will therefore be assessed as part of the land-based component ESIA and does not form part of this assessment.

7.10 Cumulative Impact Assessment – Further Considerations

The EIA regulations clearly states that cumulative impacts should be considered as part of the ESIA process for a proposed project. Good practice requires that, as a minimum, cumulative impacts are assessed during the ESIA process.

The cumulative impact assessment covers the following:

- Intra-project cumulative impacts: cumulative impacts can arise when a single resource or receptor is affected by more than one impact from the proposed project.
- Inter-project cumulative impacts: cumulative impacts may also arise as a result of the combination of two or more projects. A receptor could be impacted by similar types of impact from different developments, or a receptor could be impacted by different types of impact from different developments. This could occur at the same time or at different times.

This Section presents the CIA findings, which has been undertaken in line with the methodology summarised in Chapter 6 and Section 7.3. Information for the CIA assessment has been taken from the 2014 verification assessment and specialist reports where available. The impacts listed in the following Section were reassessed in 2022 from the 2014 assessment and will be further discussed below, as they do not relate specifically to the CIA criteria as differentiated above.

7.10.1.1 Mineral market constraints

The rate of supply of any commodity is controlled by the market demand for that specific commodity. The capacity of the market further dictates the supply of new material to that market. An oversupply of a commodity could force a reduction in the market price, which in turn will affect the economic viability of mines supplying that specific product. Therefore, there is a limit to the quantity of new material that can be supplied to the market from existing mine production or new mining development.

In the 1990s the Sandpiper deposit was considered sub-economic based on price levels for rock phosphate concentrate (1991: US$ 42.50 tonne). From 2007 the value of phosphate rock concentrate (32 % P_2O_5 70 % BPL contract f.a.s. Casablanca) increased rapidly from US$ 80.00 per tonne, peaking at US$ 430.00 per tonne in August – September 2008, resulting in a re-rating of the economic viability of the Sandpiper deposit in Namibia and others worldwide. The 2008 pricing peak has since retracted to more consistent and sustainable price levels, despite cyclic fluctuations. The current rock phosphate price is US$ 287/t (June 2022) (Phosphate rock ((Morocco)), 70 % BPL, contract, f.a.s. (Casablanca)), which is a direct result of higher fertilizer prices. The current price is reflected in the graph below (Figure 79), which depicts the phosphate rock price for the last 15 years:

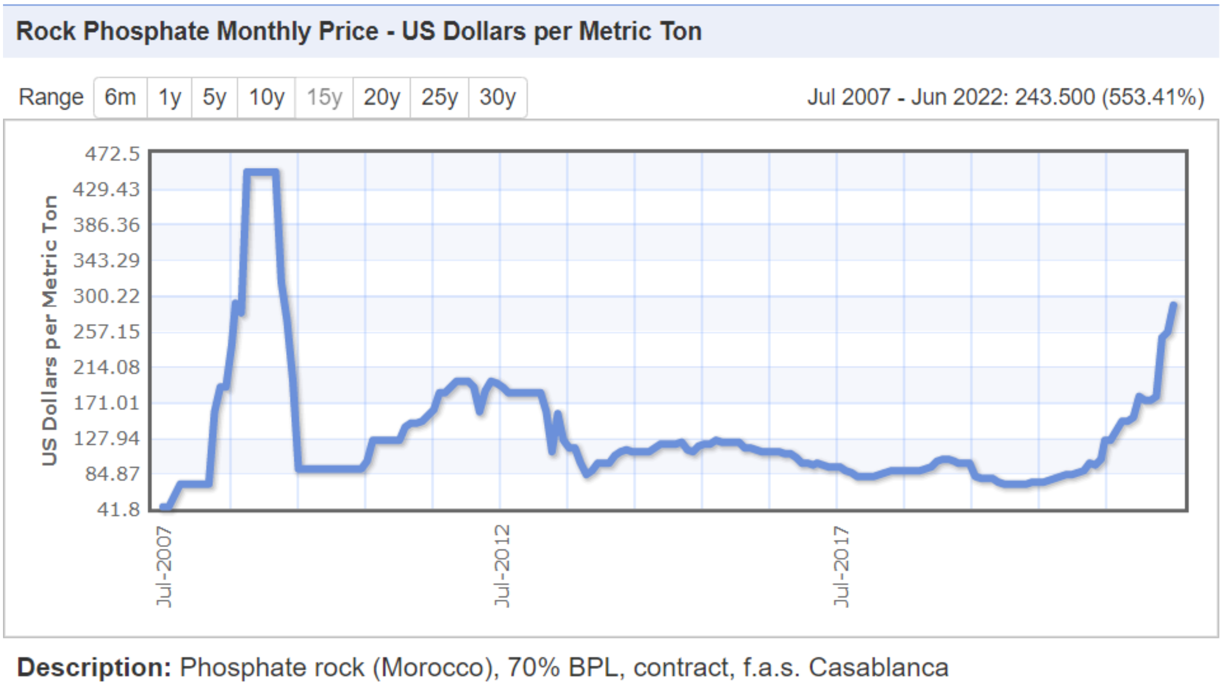


Figure 79 – Phosphate rock price as at June 2022
(Source: https://www.indexmundi.com/commodities/?commodity=rockphosphate&months=180).

The demand of the commodity will have an influence on sustainability within industry. The start-up of one or several marine phosphate mines will have socio-economic benefits, that will be on a national scale and for a long term duration. The impact is considered beneficial minor.

7.10.1.2 Existing legal controls

Through current legislation, the government of Namibia has a mandate to manage and regulate the scale and rate of development of various sectors within the mining industry. The authority to issue mining licences lies with the Ministry of Mines and Energy. The Minerals (Prospecting and Mining) Act, No.33 of 1992, also makes provision for the Minister to declare a moratorium on the issue of new mining licences and exclusive prospecting licences under certain conditions. This provision was invoked for EPLs by the Ministry in regard to the rapid development of the uranium industry in Namibia [2007]. In 2013 a moratorium on issuing environmental clearance certificates for bulk seabed mining of industrial minerals was proposed by the Minister of Fisheries and Marine Resources and supported by the Namibian Cabinet for an 18 month period, however this was never formally gazetted. This mortarium was lifted in 2015. The Minister can declare a moratorium should there be a requirement to do so. This impact will therefore be negative on socio-economic development within the country, that will be occur on a national scale. However, based on past occurrences, the duration will be for a medium term (1 to 5 years).

7.10.1.3 Disturbance of the Benguela benthic communities

This 2022 assessment has determined that dredging in SP1 (20-years LOM 34 km^2) will have a local impact on the benthic communities in the areas actually dredged. However, in terms of the benthic habitat in relation to ML 170 (2 233 km^2) and the broader mid-continental shelf (93 695 km^2) of Namibia, the effect of dredging in SP1 will be insignificant for the proposed 20-year dredging programme. However, since no data exists from the impacts of the fishing industry on the benthic communities affected by bottom trawling, the contribution of dredging in SP1 to the overall impact on the benthic environment and wider marine ecosystem can only be estimated, on the basis of relative national scale, to be insignificant. Therefore, the probability of this impact occurring in relation to scale is improbable. If an impact occurs it will be deemed adverse and permanent (refer to Carter & Stefanni, 2021).

7.10.1.4 Discharge of fine sediment to the water column

In the Namibian EEZ sediment plumes are generated in geographically widely separated areas on a range of spatial and temporal scales. Plume or suspended sediment-generating activities include maintenance and capital dredging at the ports of Walvis Bay and Lüderitz, coastal and deep water diamond mining (mostly south of the latitude of Lüderitz), the proposed phosphate ore dredging in SP1 and from the LL Phosphate project (ML 159) and, most extensively, from bottom trawling. The effects of trawl plume on the Namibian shelf have not been evaluated yet by the Ministry of Fisheries or Marine Resources or by the fishing sector. The study by HR Wallingford in 2020 determined the ZOI for mining activities in SP1 and determined that the ZO1 will be restricted to SP1 (176 km^2) and might extend to the ML 170 boundaries. Therefore, the impacts of fines generated in SP1 is small compared to the sediment plume activities by other third parties in the EZZ and therefore is concluded to have a small contribution to the overall cumulative impacts. Therefore, the probability of this impact occurring in relation to scale is improbable. If an impact occurs it will be deemed adverse and long term for the duration of mining activities (refer to Carter & Stefanni, 2021).

7.10.1.5 Shipping interactions - interactions with commercial vessel traffic

The mining licence area (ML 170) lies seawards of the main coastal shipping lane and to the east of the main Cape to Europe shipping routes. Thus, the dredger is only expected to interact with this traffic when travelling between the ML 170 and Walvis Bay. The vessel will be an insignificant addition to the overall shipping traffic, which would have increased in the last couple of years with the port expansion of Walvis Bay and with additional mining companies import and export activity at the coast (e.g., Husab Mine, Langer Heinrich Uranium, Uis Tine Mine). Therefore, it is the probability of interactions occurring with other marine vessels are possible. The potential impact is considered for the life of mine for SP1 (20-years), at a national level but the impact is neutral.

7.10.1.6 Shipping interactions - interactions with fishing vessels

The location of the SP1 target dredging area will be advertised by means of a Notice to Mariners and will be marked on hydrographic charts as to inform fishing and other vessels that the dredging vessel with restricted ability to manoeuvre, will be operating in the area. The specific 20-year mine plan site (in SP1 - 34 km^2), makes an insignificant contribution to the total annual Namibian bottom trawl catch, primarily of monkfish, since almost no bottom trawling is, or has been, undertaken in the area. During 2005 to 2021 there was no monk bottom trawling within SP1 (Japp, 2022). The dredging activity in SP1, therefore, will have an insignificant operational impact on bottom trawling activities. Similarly, activities are limited for horse mackerel mid-water trawl and purse seine, with the majority of fishing occurring in Zone 4, northwards of SP1, along the 200 m contour. Additionally, the dredger does not operate continuously, a current dredge cycle runs for 16 hrs to 20 hrs, therefore operating three times a week. Therefore, the probability of interactions with fishing vessels, their operations and thus grounds, is deemed to be limited however probable. The potential impact is considered for the life of mine for SP1 (20-years), at the specific 20-year mine plan site (in SP1) but the impact is neutral.

7.10.1.7 Shipping interactions - operational discharges from the dredger

The dredging vessel will be MARPOL compliant in terms of all operational emissions and discharges from the vessel. The vessel is expected to have a minimal individual impact and similarly will make a negligible contribution to the cumulative emissions and discharges from vessels currently operating in the Namibian EEZ. However, the EMP has made provision for the recording of emissions, which will be reported on annually to the required authorities. Emissions and discharges will occur and therefore the probability of the impact occurring is highly probable. The potential impact is considered for the life of mine for SP1 (20-years), at the specific 20-year mine plan site (in SP1) and the impact is adverse.

7.10.1.8 Summary of cumulative impacts assessed in 2014 and reassessed in 2022

Table 41 provides an overview of the impact assessment outcomes for re-assessed cumulative impacts.

Table 41 – Impact assessment summary for cumulative impacts assessed in 2014 and reassessed in 2022

Activity	Receptor/s	Impact	Nature of impact and probability	Impact rating
Mining	Socio economic	Mineral market constraints effecting industry	Benefit Long term National Possible	Beneficial minor

Activity	Receptor/s	Impact	Nature of impact and probability	Impact rating
		Existing legal controls effecting industry	Adverse Medium term National Possible	Minor
Marine vessel operations	Marine benthic communities	Disturbance of the Benguela benthic communities	Adverse Permanent National Improbable	Low
	Marine water column and sediments	Discharge of fine sediment to the water column in the Namibian EEZ context	Adverse Long term National Improbable	Low
	Marine vessels	Shipping interactions with commercial vessel traffic	Neutral Long term National Possible	Low
	Fishing industry, operations and grounds	Shipping interactions with fishing vessels, their operations and in fishing grounds	Neutral Long term Specific 20-year mine plan site (SP1) Probable	Low
	Marine communities	Shipping interactions - operational discharges from the dredger within the Namibian EEZ context	Adverse Long term Specific 20-year mine plan site (SP1) Highly probable	Minor

7.10.2 INTRA-PROJECT CUMULATIVE IMPACTS ASSESSMENT

7.10.2.1 CO_2 emissions from planned mining operations (dredging and sailing)

Carbon dioxide emissions at the sea surface can arise from mobilization of sea bottom rich CO_2 waters during dredging activities of the seabed. A simple observation-based model can be used to evaluate the change of partial pressure of CO_2 (pCO_2) from the bottom/interstitial waters to surface waters by analysing temperature. Temperature and CO_2 solubility changes from 11 °C at the seabed (NMP provided data) to two SST scenarios of 12 °C and 18 °C was assessed by Carter and Steffani (2021). These two likely extremes of surface warming increase pCO_2, which is instantaneously re-equilibrated with an atmospheric pCO_2 of 410 µatm. This loss of CO_2 during the equilibration constitutes potential emissions. It should also be noted that any contributions by benthic organic matter remineralization and carbonate dissolution to the CO_2 concentrations in bottom waters is already implicit in the concentrations of total dissolved CO_2 (CT) and total alkalinity (AT). Note that under the assumption that the pCO_2 equilibrates rapidly at the surface, the impact on ocean acidification from the translocation of bottom waters to the sea surface by the proposed dredging operations is predicted to be limited (Carter and Steffani, 2021).

There are very limited observations of the ocean carbonate system on the Namibian shelf and is a major gap in the otherwise adequate long-term observations in that coastal ecosystem. The known data sets are those collected in 1992 (Monteiro et al., 1996). It is considered that the use of this historical data set is appropriate and will have little or no bearing on the calculated fluxes.

Modelled results of the dredger indicate relatively small magnitudes of CO_2 emissions from the translocation of cool DIC rich bottom water to the warmer surface and comparable to emissions from 60 000 – 100 000 litres of petrol (30 – 50 % of the fuel load of a large passenger plane). The indicative annual estimate for the dredging process itself within ML 170 based on the targeted 5.5 million tonnes of dredged sediment, assuming sediment density of 1.8 tonnes/m^3 and CO_2 emissions of 3.2 kg/m_3 of dredged sediment (van der Belt, 2019), is 9 983 tonnes (Carter & Steffani, 2021).

Additionally, the dredger will also travel to and from the dredge site to the discharge location at Walvis Bay (buffer pond), therefore CO_2 emissions are expected. This is estimated to be a distance of ~240 km, approximately 221 times a year with an overall estimated distance of 53,040 km. The emission rate of 3.2 kg/m^3 has a sailing distance of 18.5 km per round trip factored in, therefore the net distance in terms of additional emissions is calculated at 48 952 km. CO_2 emissions for a large TSHD are ~0.42 tonnes/km (van der Belt, 2019) and emissions for this phase of the dredging operations are estimated at 20 560 tonnes. The indicative overall emissions for dredging within ML 170 and the delivery of product to the discharge site in Walvis Bay is thus 30,542 tonnes CO_2/year (Carter & Steffani, 2021).

Therefore, seabed dredging and sailing operations from the vessel could have a potential cumulative impact in the receiving environment at a regional scale. However, the duration of the impact is determined to be of a very short term (1-3 days) and should have a neutral impact on the water column and air quality. The probability of the impact occurring is possible (5 to 50 %). The magnitude of change is determined to be no lasting effect. The level of confidence in the results is high, however noted this is the first assessment conducted on CO_2 emissions during the project lifetime. The sensitivity of the water column and air quality in the surrounding environment is determined to be low. The overall significance of the impact is low for the annual emissions calculated. The recommended mitigation measure in the EMP is to include the annual CO_2 emission calculations for dredging and sailing with the land-based operations emissions inventory. This will provide the total of NMP emissions that may need to be offset for the entire value chain of the mining and beneficiation steps as these are developed and instituted (Carter & Steffani, 2021).

7.10.2.2 Summary of impacts CO_2 emissions during dredging and sailing

Table 42 provides an overview of the impact assessment outcomes for carbon dioxide emissions during dredging and sailing.

Table 42 – Impact assessment for CO_2 emissions

Activity	Receptor/s	Impact	Nature of impact	Value & sensitivity	Magnitude of change	Significance of impact
Mining operations – seabed dredging and sailing	Water column Air quality of the receiving environment	CO2 emissions from planned mining operations (dredging and sailing) impacting the near surface water quality and the air quality of the receiving environment	Neutral Regional Very short term	Low	No lasting effect	Adverse Low (1)

7.10.2.3 Conversion of an exclusive prospecting licence (EPL) to a mining licence (ML)

In order to apply for a mining licence, the economic viability of a project needs to be demonstrated. Fundamentally, the grade or concentration of the target mineral needs to be higher than the total cost of production, in order for a project to be economically viable.

Current feasibility studies indicate that *in situ* phosphate grades below 15 % P_2O_5 are unlikely to be viable. While phosphate occurs in a variety of forms (pelletal, concretionary, crusts) over the Namibian continental shelf, the areas with concentrations above 15 % are restricted to two main areas, the largest of which lies to the southwest of Walvis Bay off Meob Bay (Midgley, 2014).

Using the marine diamond industry by way of example, in the early to mid-1990s almost the entire continental shelf off Namibia was covered by EPLs issued for precious stones (diamonds), which resulted in issuing of approximately five mining licences in total. The situation remains similar for the 2022 assessment scenario. This is also dependent if there is an industry 'boom' due to commodity pricing or other phosphate project approvals. Therefore, the probability of an EPL to be converted to a ML is possible. Whilst this of course has socio economic benefits to the country, there are negative associated impacts on marine communities, that will need to be assessed on an individual basis per project. From a cumulative perspective, the impact is determined to be long term (5-20-years), on a national scale and neutral.

7.10.2.4 Two dredgers operating at the same time in SP1, impacts on benthos

All impacts have scored low for the fine sediment discharge and seabed dredging assessed against one active dredger. If more than one dredger was to operate at the same time in SP1, the sediment plume impacts will need to be re-evaluated. If more than one dredger is active in SP1, this might only change the scale of the annual mining plan and might not change the scale of the 20-year mine plan. However, this is dependent on the mine plan and two dredgers could cover the same scale for the annual mining plan. Therefore, impacts associated with benthos might not be influenced, apart from a larger sediment plume, potential larger zone of influence and possibly a quicker loss of benthic communities through sediment removal if mining was to occur in two separate areas at the same time. The current mine plan contemplates one TSHD, so currently this impact is deemed improbable. If the impact was to occur, it would be adverse, for a permanent duration due to loss of benthic communities and the scale would be for the target mining areas.

7.10.2.5 Two dredgers operating at the same time in SP1, impacts on the water column

All impacts have scored low for the fine sediment discharge and seabed dredging assessed against one active dredger. If more than one dredger was to operate at the same time in SP1, the sediment plume impacts will need to be re-evaluated. If more than one dredger is active in SP1, this might only change the scale of the annual mining plan and might not change the scale of the 20-year mine plan. However, this is dependent on the mine plan and two dredgers could cover the same scale for the annual mining plan. Therefore, impacts associated with the water column might not be influenced, apart from a larger sediment plume and potential larger zone of influence. All impacts have scored low for the fine sediment discharge and seabed dredging assessed against one active dredger. The current mine plan contemplates one TSHD, so currently this impact is deemed improbable. If the impact was to occur, it would be adverse, for a long term duration (20-years life of mine) and the scale would be for the target mining areas.

7.10.2.6 Two dredgers operating at the same time in SP1, impacts on fish, mammals, seabirds and jellyfish

As a result of the outcomes of the 2022 assessment, if more than one dredger is active in SP1, this might only change the scale of the annual mining plan and might not change the scale of the 20-year mine plan. Low to minor impacts are expected in SP1 (Zone 1) and therefore no additional impacts are expected for this cumulative impact. The probability of the impact occurring is improbable. If the impact was to occur, it would be adverse, for a long term duration (20-years life of mine) and the scale would be for the target mining areas.

7.10.2.7 Dredging in SP2 or SP3 at the same time as SP1 - disturbance to benthic environment

In order to properly evaluate the potential for cumulative impacts to occur as a result of more than one mining area being active at the same time is only possible if the scale of proposed disturbance is available and understood. There is currently no data provided to evaluate this effectively (i.e., mine plan). It is assumed that once the 20-year LOM is completed in SP1, the Proponent would have applied for an ECC to conduct mining activities in either SP2 or SP3. Therefore, if mining activities were to coincide, this would be towards the end of LOM of SP1 and natural restoration would have commenced and benthic communities would have started to re-establish in these areas. The probability of the impact occurring is possible. The impact is expected to be for medium term duration (1-5 years), on a local scale and adverse.

7.10.2.8 Dredging in SP2 or SP3 at the same time as SP1 - disturbance to the water column

In order to properly evaluate the potential for cumulative impacts to occur as a result of more than one mining area being active at the same time is only possible if the scale of proposed disturbance is available and understood. There is currently no data provided to evaluate this effectively (i.e., mine plan). It is assumed that once the 20-year LOM is completed in SP1, the Proponent would have applied for an ECC to conduct mining activities in either SP2 or SP3. Therefore, if mining activities were to coincide, this would be towards the end of LOM of SP1 and effects on the water column would need to be re-evaluated for the fines discharge namely. The probability of the impact occurring is possible. The impact is expected to be for medium term duration (1-5 years), on a local scale and adverse.

7.10.2.9 Dredging in SP2 or SP3 at the same time as SP1 - disturbance to the fish

In order to properly evaluate the potential for cumulative impacts to occur as a result of more than one mining area being active at the same time is only possible if the scale of proposed disturbance is available and understood. There is currently no data provided to evaluate this effectively (i.e., mine plan). It is assumed that once the 20-year LOM is completed in SP1, the Proponent would have applied for an ECC to conduct mining activities in either SP2 or SP3. Therefore, if mining activities were to coincide, this would be towards the end of LOM of SP1 and effects on fisheries and fish would need to be re-evaluated with updated available survey data. However, from the current 2022 assessment, this is not posed to have an impact on fisheries and potential impacts for monk and sole will need to be re-assessed due to their preference of muddy substrate. Additionally, fish would have been able to re-establish themselves in the restored areas within SP1. The probability of the impact occurring is possible. The impact is expected to be for medium term duration (1-5 years), on a local scale and adverse.

7.10.2.10 Dredging in SP2 or SP3 at the same time as SP1 - disturbance to the mammals and seabirds

In order to properly evaluate the potential for cumulative impacts to occur as a result of more than one mining area being active at the same time is only possible if the scale of proposed disturbance is available and understood. There is currently no data provided to evaluate this effectively (i.e., mine plan). It is assumed that once the 20-year LOM is completed in SP1, the Proponent would have applied for an ECC to conduct mining activities in either SP2 or SP3. Therefore, if mining activities were to coincide, this would be towards the end of LOM of SP1 and effects on mammals and seabirds, namely biodiversity, habitat displacement and noise, would need to be re-evaluated with updated available survey data. However, from the current 2022 assessment, this is not posed to have a significant impact on these receptors. It is expected that additional noise disturbance will lead to mammals avoiding ML 170 area. Overall, two vessels operating over large distances from each other should not have too much of an impact when compared to all activities within the EEZ and behavioural changes are often temporary. The probability of the impact occurring is possible. The impact is expected to be for medium term duration (1 to 5 yrs), on a local scale and adverse.

7.10.2.11 Dredging in SP2 or SP3 at the same time as SP1 - disturbance to jellyfish

In order to properly evaluate the potential for cumulative impacts to occur as a result of more than one mining area being active at the same time is only possible if the scale of proposed disturbance is available and understood. There is currently no data provided to evaluate this effectively (i.e., mine plan for SP2 or SP3). It is assumed that once the 20-year LOM is completed in SP1, the Proponent would have applied for an ECC to conduct mining activities in either SP2 or SP3. Therefore, if mining activities were to coincide, this would be towards the end of LOM of SP1 and effects on jellyfish as currently scored (low), cumulatively should not have a significant impact. The probability of the impact occurring is possible. The impact is expected to be for medium term duration (1-5 years), on a local scale and adverse.

7.10.2.12 Summary of intra-project cumulative impacts (7.6.2.3 – 7.6.2.12)

Table 43 provides an overview of the impact assessment outcomes for intra-project cumulative impacts.

Table 43 – Impact assessment for intra-project cumulative impacts

Activity	Receptor/s	Impact	Nature of impact and probability	Impact rating
Mining	Marine communities	Conversion of an EPL to a mining licence	Neutral Long term National	Low

Activity	Receptor/s	Impact	Nature of impact and probability	Impact rating
			Possible	
Marine vessel operations	Marine benthic communities	Two dredgers operating at the same time in SP1, impacts on benthos	Adverse Permanent Target mining areas Improbable	Low
	Marine water column and sediments	Two dredgers operating at the same time in SP1, impacts on the water column	Adverse Long term Target mining areas Improbable	Low
	Marine mammals and seabirds	Two dredgers operating at the same time in SP1, impacts on fish, mammals, seabirds and jellyfish	Adverse Long term Target mining areas Improbable	Low
	Marine benthic communities	Dredging in SP2 or SP3 at the same time as SP1, disturbance to benthic environment	Adverse Medium term Local Possible	Low
	Marine water column and sediments	Dredging in SP2 or SP3 at the same time as SP1, disturbance to the water column	Adverse Medium term Local Possible	Low
	Marine fish species	Dredging in SP2 or SP3 at the same time as SP1, disturbance to fish	Adverse Medium term Local Possible	Low
	Marine mammals and seabirds	Dredging in SP2 or SP3 at the same time as SP1, disturbance to mammals and seabirds	Adverse Medium term Local Possible	Low
	Marine jellyfish	Dredging in SP2 or SP3 at the same time as SP1, disturbance to jellyfish	Adverse Medium term Local Possible	Low

7.10.3 INTER-PROJECT CUMULATIVE IMPACT ASSESSMENT

7.10.3.1 Another phosphate offshore mining project commences – impacts on marine communities

Currently there are only two phosphate mining licences issued by MME. The project (ML 159) close to (185 km N and 80 km offshore) Lüderitz and south of ML 170 is currently not active. The company is LL Namibia Phosphates (Pty) Ltd (LLNP) and no mining activities are taking place. The last piece of information available was information shared from the mining expo in April 2016 and talk on the COM website from November 2016. Annual mining footprint is 4 km^2, slightly larger than NMP (2.5 km^2 max per year). Activities will also be by dredging. All baseline studies have been conducted for the original EIA application. Impacts currently analysed is similar to the approach by NMP for the original baseline studies. Therefore, it is possible for this mining operation to start up in the foreseeable future, pending ESIA processes and approvals. This could have adverse impacts on the environment, on a national scale and estimated for a long term duration (20-years).

7.10.3.2 Another phosphate offshore mining project – socio economic impacts

Currently there are only two phosphate mining licences issued by MME. The project (ML 159) close to (185 km N and 80 km offshore) Lüderitz and south of ML 170 is currently not active. The company is LL Namibia Phosphates (Pty) Ltd (LLNP) and no mining activities are taking place. The last piece of information available was information shared from the mining expo in April 2016 and talk on the COM website from November 2016. Annual mining footprint is 4 km^2, slightly larger than NMP (2.5 km^2 max per year). Activities will also be by dredging. All baseline studies have been conducted for the original EIA application. Impacts currently analysed is similar to the approach by NMP for the original baseline studies. Therefore, it is possible for this mining operation to start up in the foreseeable future, pending ESIA processes and approvals. This could have positive socio-economic impacts, on a national scale and estimated for a long term duration (20-years). The impact is determined as beneficial minor.

7.10.3.3 Trawling in ML 170 increases, impacts on benthos

Monk and hake include seabed trawling activities, whereby the other fisheries use different types of trawling (e.g., mid-water, demersal trawlers, purse seine). From the data made available for the assessment by Japp (2022), there is minimal evidence from the last 17 years that bottom trawling activities are active in SP1 (e.g., monk), with possible active trawling seawards on the edge of the mining licence boundary. Horse mackerel fishing has been commented on to be the up and coming sector within the fishing industry, from current data reviewed, the majority of midwater trawl occurs in Zone 4 (northwards of SP1). Over 98 % of horse mackerel purse seine effort occurs in Zone 4, northwards of SP1 (similar to horse mackerel mid water trawl). However trawling activities are noted in the ML, but on a very small scale. Most of this fishing occurs along the 200 m-contour line. Therefore, from the current available data, this does not seem probable. If the impact was to occur is would be adverse, for a long term (20-years) and on a national scale.

7.10.3.4 Trawling in ML 170 increases, impacts on the water column

Monk and hake include seabed trawling activities, whereby the other fisheries use different types of trawling (e.g., mid-water, demersal trawlers, purse seine). From the data made available for the assessment by Japp (2022), there is minimal evidence from the last 17 years that bottom trawling activities are active in SP1 (e.g., monk), with possible active trawling seawards on the edge of the mining licence boundary. Horse mackerel fishing has been commented on to be the up and coming sector within the fishing industry, from current data reviewed, the majority of midwater trawl occurs in Zone 4 (northwards of SP1). Over 98 % of horse mackerel purse seine effort occurs in Zone 4, northwards of SP1 (similar to horse mackerel mid water trawl). However trawling activities are noted in the ML, but on a very small scale. Most of this fishing occurs along the 200 m-contour line. Therefore, from the current available data, this does not seem probable. If the impact was to occur is would be adverse, for a long term (20-years) and on a national scale.

7.10.3.5 Summary of inter-project cumulative impacts

Table 44 provides an overview of the impact assessment outcomes for intra-project cumulative impacts.

Table 44 – Impact assessment for inter-project cumulative impacts

Activity	Receptor/s	Impact	Nature of impact and probability	Impact rating
Mining	Marine communities	Another phosphate offshore mining project commences and associated impacts on marine communities	Adverse Long term National Possible	Low
	Socio economic	Another phosphate offshore mining project commences and associated socio-economic impacts	Beneficial Long term National Possible	Beneficial minor
Fishing industry trawling	Marine benthic communities	Trawling in ML 170 increases and increases impacts on benthos	Adverse Long term Regional Improbable	Low
	Marine water column and sediments	Trawling in ML 170 increases and increases impacts on the marine water column	Adverse Long term Regional Improbable	Low

7.10.4 CONCLUSIONS OF THE CIA

The CIA has assessed the following:

- 2014 identified cumulative impacts
- Intra-project cumulative impacts: cumulative impacts that occur within the proposed Project
- Inter-project cumulative impacts; cumulative impacts that occur as a result of the proposed Project in combination with other projects, with a main focus on future projects.

The conclusions drawn from the CIA demonstrates that the proposed Sandpiper Project may contribute towards some cumulative impacts, both beneficial and adverse. The majority of impacts are recorded as low and two impacts are recorded as minor. Therefore, the proposed Project in a wider context, both temporally and spatially, is unlikely to contribute significantly to cumulative impacts and therefore the contribution is marginal compared to overall activities within the Namibian EEZ.

Recommendations have been identified for CO_2 emissions, that must be included in the future land-based component assessment for the Project and the updated EMP for that stage of further project development. It is also further advised in order to better understand cumulative impacts from the fishing industry on the overall Namibian EEZ, that assessments are conducted either by Government or the individual proponents.

8 CONCLUSION

A full and comprehensive environmental and social impact assessment (ESIA) has been undertaken for the Sandpiper Marine Phosphate Project. Potential impacts and aspects have been considered in the impact assessment and thoroughly investigated against planned marine activities. Previous assessment outcomes (2012 and 2014) have been considered in the 2022 assessment with the support of additional independent specialist studies and data. Further to the public consultations conducted 2011, 2012, 2014 and 2018, there has again been active public participation throughout the current 2022 ESIA process, with issues raised considered in this report for the decision making authority to make an informed decision about the outcomes of this impact assessment. All specialist input (2012 assessment, 2014 verification assessment, 2020/2021 supplementary studies and the 2022 assessment) has been included in this report and recommended mitigation measures have been incorporated into the proposed environmental management plan (EMP).

The scoping phase of the ESIA described the receiving environment. During the scoping phase the methodology for the assessment was reviewed and refined, in order to ensure the scale and extent was properly assessed. No new alternatives were considered for this Project, as the previous assessments incorporated changes to technologies in order to mitigate potential environmental impacts and for this project the mining activities will be restricted to SP1 in ML 170.

Table 45 summaries the assessed significant impacts after mitigation for the socio-economic environment. On a scale from 1 to 12, low to high, the beneficial (B) and negative (N) impact significance is stated.

Table 45 – Summary of socio-economic impacts assessed

Socio economic environment: Economic		Socio economic environment: Socio	
Fishing industry	N6	Employment – workplace safety	B2
Tourism	B3	Employment – disease and illness	N4
Local business - direct	B8	Employment – social upliftment programmes	B2
Local business - indirect	B3	Noise – residential/tourism areas	N1
NamPort	B3		
Employment – job creation	B3		
Employment – skills development	B6		
Employment – inward migration	N3		
Gross domestic product – government revenue	B12		
Gross domestic product – profits to local shareholders	B12		

Socio economic environment: Economic		Socio economic environment: Socio
Walvis Bay Salt Holdings and mariculture water intake	N1	

Table 46 summaries the assessed significant impacts after mitigation for the marine water column, sediments and benthic marcofauna environment. On a scale from 1 to 12, low to high, the beneficial (B) and negative (N) impact significance is stated.

Table 46 – Summary of water column, sediments and benthic macrofauna impacts assessed

Water column and sediments		Benthic macrofauna	
Vessel operations – pollution from waste	N1	Seabed dredging – removal of upper 1-<2.5m sediment	N6
Vessel operations – alien marine species	N4	Seabed dredging – exploration impacts	N1
Overspill discharge – sediment plume	N1	Seabed dredging – changes to local near bottom hydrographical conditions	N4
Overspill discharge – H_2S fluxes	N2	Seabed dredging – removal of large sulphur oxidising bacteria mats	N1
Overspill discharge – hypoxic/anoxic conditions bottom water impacting upper water column	N1	Seabed dredging – anaerobic bacterium *Clostridium botulinum* Type E proliferation	N1
Overspill discharge – nutrients added at surface	N1	Seabed dredging – draghead sediment plume	N2
Overspill discharge – trace/metal toxicity at surface	N1	Seabed dredging – re-deposition of fines from overflow plume	N2
Seabed dredging - trace/metal toxicity at seabed	N1	Seabed dredging – mobilisation of dissolved nutrients with overflow	N2
Seabed dredging – H_2S fluxes	N1	Seabed dredging – H_2S fluxes	N2
Seabed dredging – anoxic conditions in lower water column	N1		
Seabed dredging – removal of thio-bacteria mats	N1		

Table 47 summaries the assessed significant impacts after mitigation for the marine biotic environment. On a scale from 1 to 12, low to high, the beneficial (B) and negative (N) impact significance is stated.

Table 47 – Summary of fish, mammals, seabirds and jellyfish impacts assessed

Fish, mammals and seabirds		Jellyfish	
Seabed dredging – impact on main Namibian fishing sectors	N1	Seabed dredging – blocking of vessel water intake system	N2
Seabed dredging – impact on ecologically important demersal and pelagic fish species	N1	Seabed dredging – H_2S releases	N1
Seabed dredging – recruitment on key commercial fish species	N1	Seabed dredging – tailings plume	N1
Seabed dredging – impacts on biodiversity	N4	Seabed dredging – removal of seabed sediments alters the sediment surface	B1
Seabed dredging – impacts on seabirds, mammals (including seals) and turtles	N4		

Table 48 summaries the assessed significant impacts after mitigation for the marine cumulative impacts. Where able too, this has been scaled from 1 to 12, low to high, the beneficial (B) and negative (N) impact significance is stated. Where no scale could be appropriately applied, the impact rating is provided.

Table 48 – Summary of cumulative impacts assessed

Intra-project cumulative		Inter-project cumulative	
CO_2 emissions from planned mining operations (dredging and sailing) impacting the near surface water quality and the air quality of the receiving environment	N1	Another phosphate offshore mining project commences and associated impacts on marine communities	N low
Conversion of an EPL to a mining licence	N low	Another phosphate offshore mining project commences and associated socio-economic impacts	B minor
Two dredgers operating at the same time in SP1, impacts on benthos	N low	Trawling in ML 170 increases and increases impacts on benthos	N low
Two dredgers operating at the same time in SP1, impacts on the water column	N low	Trawling in ML 170 increases and increases impacts on the marine water column	N low

Intra-project cumulative		Inter-project cumulative	
Two dredgers operating at the same time in SP1, impacts on fish, mammals, seabirds and jellyfish	N low	**Other cumulative**	
Dredging in SP2 or SP3 at the same time as SP1, disturbance to benthic environment	N low	Mineral market constraints effecting industry	B minor
Dredging in SP2 or SP3 at the same time as SP1, disturbance to the water column	N low	Existing legal controls effecting industry	N minor
Dredging in SP2 or SP3 at the same time as SP1, disturbance to fish	N low	Disturbance of the Benguela benthic communities	N low
Dredging in SP2 or SP3 at the same time as SP1, disturbance to mammals and seabirds	N low	Discharge of fine sediment to the water column in the Namibian EEZ context	N low
Dredging in SP2 or SP3 at the same time as SP1, disturbance to jellyfish	N low	Shipping interactions with commercial vessel traffic	N low
		Shipping interactions with fishing vessels, their operations and in fishing grounds	N low
		Shipping interactions with fishing vessels, their operations and in fishing grounds	N minor

No adverse impacts remain high after mitigation and therefore all assessed impacts are within acceptable limits and can be managed effectively. Post mitigation two impacts were recorded as moderate impacts (6), which are socio economic impacts on the fishing industry and marine environment impacts due to seabed dredging removal of the upper surface of the sediment resulting in loss of benthic communities. It has been determined that the fishing industry will be able to coexist with the phosphate industry, however various mitigation measures to ensure a smooth transition and interaction between the industries and has been incorporated in the EMP. Mitigation for seabed removal includes leaving behind a residual sediment layer (30 cm) and leaving undredged corridors adjacent to the dredged areas. Additionally, monitoring programmes have been proposed to gather additional baseline information (e.g., benthos, radiation) and conduct repetitive surveys every 3 years during operations.

For the cumulative impacts, it is evident that the Sandpiper Project will not contribute significantly to overall activities within the Namibian EEZ. Recommendations have been identified for CO_2 emissions, that must be included in the future land-based component assessment for the Project and the updated EMP for that stage of further project development.

Additionally, an independent review was conducted based on the 2022 specialist studies provided (Carter & Steffani, 2021; Japp, 2022). by Dr Andrew Payne of A & B Word Ltd (UK) (Payne, 2022), an International marine and fisheries scientist consultant with more than 50 years of fisheries science, management advice, strategy and policy development in southern Africa and/or the UK Expert and member of MSc certification and surveillance audit panels for various fisheries worldwide, The review by Dr Payne concluded that all conclusions drawn from these assessments (Carter & Steffani, 2021; Japp, 2022) are considered to be factually well founded on reliable data and scientifically correct, noting also that no fault can be found with the assessment outcomes presented in these specialist impact assessments. Reference can be made to Appendix G for further details in this regard.

In closing, the ESIA report adequately outlines and captures the process of the impact assessment for the Sandpiper Project and recommended mitigation measures to reduce potential impacts. The EMP includes the required monitoring programmes to be implemented during the various mining stages. The 2022 ESIA assessment has reconfirmed the findings from the initial 2012 EIA and 2014 verification assessments, with improved confidence based off of the additional specialist studies completed. All stakeholders and registered interested and affected parties can now provide comments, if any, on the final ESIA and EMP reports directly to the office of the Environmental Commissioner as this final ESIA and EMP report will be submitted to the competent authorities for review and a record of decision.

8.1 FURTHER RECOMMENDATIONS – LAND BASED ASSESSMENT

The mining licence ML 170 is located in the ocean 160 km southwest of Walvis Bay. The law requires that an environmental clearance certificate must be issued for the mining licence ML 170, a) in compliance with the attached licence conditions and b) for authorization of any operations in the mining licence area. A valid and fully permitted mining licence is required to provide the security of tenure over the mineral rights and assets (reserves and resources) which is essential as a fundamental pre-requisite for securing the required capital investment for the project to progress to the next stage of development being the proposed onshore ore beneficiation facility and related supporting infrastructure. A separate environmental clearance certificate is required for the sites to be identified and allocated for the land-based beneficiation activities which, will include the ore processing and concentrate storage and handling facilities (buffer pond to final product). There can be no capital investment consideration for progressing the land-based component of the Project if there is no valid authorisation to conduct operations in the mining licence where the vessel and mineral deposits are located. Therefore, it is a requirement to have two separate ESIA processes. This process of staged environmental assessment and clearance for phases of a single project is not uncommon, falls within the provisions of EMA 2007 and has previously been applied in several other major projects in Namibia.

While separate ESIA processes will be undertaken for each of the marine- and land-based components, the common link between the two components of the Project is the phosphate ore. The following recommendations are of specific relevance to the land-based ESIA assessment:

- An in-depth radiation safety assessment of the operations, commencing from the drop off point at the buffer point from the dredger vessel to the shipment of the final product, is to be conducted.
- Carbon emissions inventory to be developed, taking the marine component into account
- Identification and agreement with NamPort and Walvis Bay authorities on the dedicated areas for storage, buffer pond, main processing plant, tailings storage facility and general services.
- Terrestrial ESIA process to be followed once suitable land sites have been identified and allocated through the required engagement with the relevant authorities.
- Update to the socio-economic baseline study to included land-based activities which will carry the largest contributions to the socio-economic aspects of the combined project.
- Development of a restoration and rehabilitation closure plan for the land-based beneficiation sites as per the draft Namibian mine closure framework.

9 REFERENCES

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APPENDIX A – ENVIRONMENTAL MANAGEMENT PLAN

APPENDIX B – PUBLIC CONSULTATION DOCUMENT

APPENDIX C – I & APS COMMENTS CONSOLIDATION

APPENDIX D – EAPS CVS

APPENDIX E – SPECIALIST STUDY BY ROBIN CARTER

APPENDIX F – SPECIALIST STUDY BY DAVE JAPP

APPENDIX G – INDEPENDENT REVIEW BY ANDY PAYNE

APPENDIX H – JDN SOCIO-ECONOMIC SPECIALIST STUDY

APPENDIX I – PLUME DISPERSION MODEL SUPPLEMENTARY STUDY

APPENDIX J – TOXICITY SUPPLEMENTARY STUDY

APPENDIX K – NOISE MODELLING SUPPLEMENTARY STUDY

APPENDIX L – PHOSPHATE INDUSTRY SOCIO-ECONOMIC SUPPLEMENTARY STUDY

APPENDIX M – SCOPING REPORT MEFT LETTER OF ACCEPTANCE

APPENDIX N – 2014 VERIFICATION STUDY

APPENDIX O – SPECIALISTS CVS