ALCATEL SUBMARINE NETWORKS (ASN)
EQUIANO SUBMARINE FIBRE OPTIC CABLE SYSTEM TO BE LANDED AT SWAKOPMUND, NAMIBIA

PARATUS TELECOMMUNICATIONS (PTY) LTD
(LANDING PARTNER)

DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT

EIA REFERENCE: APP-002171

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Compiled for

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DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT DISTRIBUTION

The Draft Scoping Report is distributed for public review to key stakeholders for a period of 14 days.

The Draft Scoping Report is also available on Geo Pollution Technologies web site (http://www.thenamib.com/projects/projects.html).

PREFACE

The proposed Equiano Cable System requires approval from the Ministry of Environment, Forestry and Tourism (MEFT). In this context, ACER (Africa) Environmental Consultants (ACER) and Geo Pollution Technologies (Geo) has been appointed by ASN to take responsibility for the application for environmental authorisation for the construction of the Equiano Cable System on behalf of the Namibian landing partner Paratus Telecommunications (Pty) Ltd (Paratus).

This Draft Environmental Impact Assessment Report (DEIAR) has been compiled in accordance with the Environmental Assessment Policy of 1995, the Environmental Management Act (Act 7 of 2007) and the Environmental Impact Assessment (EIA) Regulations of Government Notice 28, 29, and 30 promulgated on 6 February 2012. The activities required for the construction of the proposed subsea cable requires an Environmental Clearance Certificate from the competent authority, namely MEFT. On completion of the Draft Environmental Impact Assessment Report (DEIAR) process, a Final Environmental Impact Assessment Report will be submitted to the MEFT to take an informed decision as to whether the project may proceed on social, economic and environmental grounds.

EXECUTIVE SUMMARY

Introduction

Submarine telecommunication cables are important for international telecommunication networks as they transport almost 100% of the transoceanic Internet traffic throughout the world. It is widely recognised that access to affordable international bandwidth is key to economic development in every country. As such, the improvement in Africa's information technology infrastructure via telecommunication cables will remove one of the current key inhibitors to development in Africa and support economic growth and opportunities on the continent.

Alcatel Submarine Networks (ASN) was appointed to execute the installation of a new subsea telecommunications cable system, the Equiano Cable System, which will connect Africa with Europe. It will be located along the West Coast of Africa, between Portugal and South Africa. Branching units along the cable will in turn connect it to African countries, including Namibia, to increase and improve connectivity in Africa. There will be one Namibian landing at Swakopmund, where it will be operated by the Namibian landing partner Paratus Telecommunications (Pty) Ltd.

In support to this initiative, ASN has appointed ACER (Africa) Environmental Consultants (ACER) as the Environmental Assessment Practitioner (EAP) to take responsibility for the EA requirements, including identifying environmental aspects relevant to the proposed telecommunications infrastructure and construction of the Equiano Cable System. ACER has in turn partnered with Geo Pollution Technologies a local Namibian environmental consultancy to assist with the drafting of this report and to assist with public consultation in Namibia.

Scope of Work

The main Equiano Cable System trunk will be located approximately 200 to 500 km from the shoreline in international waters. Branch cables will run from the main trunk to the shoreline through territorial waters to the landing site in each country. The final route of the marine portion of the cable will be identified based on a combination of engineering, environmental and economic factors; however, the general alignment of the Equiano Cable System will follow the WACS cable alignment which was installed in 2010.

Project Activities

The proposed Equiano branch to Swakopmund will include the installation and operation of the following project components:

- Laying of the cable in the offshore environment on the ocean bed, including cable burial to a water depth of 1,500 m.
- Within the shallow water environment, the cable will be buried in sediment wherever possible and the route will be adjusted to avoid obvious visible rock. The aim is to bury the cable to a depth of 1 m where possible.
- Excavations within the intertidal zone to bury the cable before it being anchored into the Beach Manhole (BMH) which will be constructed directly inland of the beach at the preferred landing point.
- On the beach the cable will be buried to a depth of 2 meters, substrate permitting.
- Construction of a BMH at the preferred landing point. The BMH will be constructed underground and will have the following dimensions: length (approximately 4.0 m); breadth (approximately 2.0 m) and depth (approximately 2.0 m).
- Installation of the onshore cable section between the BMH and the preferred Cable Landing Station (CLS)
- Construction of a Cable Landing Station near the (Hage Heights WACS Co-location Facility) which is currently operated by Telecom Namibia. The terrestrial cable will be installed

underground by trenching. Typically, the trench required for cable burial will be 1 m in depth and have a width of approximately 0.5 - 0.7 m depending on the excavator bucket width.

Legal Requirements

There are many legal requirements (National, Provincial and Local Government spheres) to which the project proponent must adhere for the proposed Equiano Cable System. A review of this legislation and guidelines applicable to the proposed project are provided in Chapter 3 of this report.

The proposed Equiano Cable System requires an environmental clearance certificate from the Ministry of Environment, Forestry and Tourism (MEFT).

In addition to the environmental authorisation, the following permissions and licences will be or are likely to be required:

No.	Permit	Title	Description
1	Environmental Clearance Certificate	Ministry of Environment, Forestry and Tourism (MEFT)	Environmental Clearance Certificate as stipulated in the (Environmental Management Act, 2007). Based on findings during the screening exercise it is ACER teams opinion that the certificate will be issued following a Scoping process and will not require a full EIA
2	Heritage Permits (Terrestrial)	Ministry of Education, Arts and Culture/National Heritage Council of Namibia	Onshore heritages resources in project's area of influence (unlikely to be required)
3	Heritage Permits (Offshore)	Ministry of Education, Arts and Culture/National Heritage Council of Namibia	Offshore heritage resources in project's area of influence (unlikely to be required)
4	Protected Tree and Plant Permits	Ministry of Agriculture, Water and Forestry/Directorate of Forestry	Based on observations on site and along the proposed fronthaul alignments, no protected plant and tree permits will be required
5	Maritime Permits	Ministry of Works and Transport/Directorate of Maritime Affairs	Based on discussions with MoWT, no permits are required for the installation of the Equiano Cable
6	Land Use Permits	Ministry of Land Reform	The portion of the beach south of Platz am Meer shopping mall (preferred landing site) is state property and an application needs to be made to the state for the landing of the cable at this site
7	Building Permits	Municipality of Swakopmund	A wayleave from the municipality will be required for land-based installations and construction
8	Sea Floor Lease Agreement	Office of the President	Based on information obtained from the WACS cable installation, it was determined that a lease agreement for the use of the seafloor must be concluded. This lease agreement must be signed by His Excellency the President of Namibia

Need and Desirability

Submarine telecommunication cables are essential for international telecommunications as they currently transport almost 100% of transoceanic Internet traffic throughout the world. It is widely recognised that access to affordable international bandwidth is key to unlocking economic development in every country.

Today, Africa relies primarily on satellites with few marine cables to provide its international communications. Improvement in Africa's information technology infrastructure via telecommunication cables will remove one of the current key inhibitors to development in Africa and support economic growth and opportunities on the continent. Installation of the proposed Equiano Cable System will facilitate more affordable and effective transport of voice, data, Internet and television services. Furthermore, the cable will support the objectives set out by the New Partnership for Africa's Development (NEPAD).

By supplying increased bandwidth, the proposed Equiano Cable System will support the following primary NEPAD objectives:

- To eradicate poverty in Africa and to place African countries both individually and collectively on a path of sustainable growth and development to thereby halt the marginalisation of Africa in the globalisation process.

Telecommunications is one of the fastest growing sectors of Namibian's economy which has been driven by rapid growth in the number of mobile phone users and their need for broadband connectivity.

Site Alternatives
Alternatives are different means of achieving the purpose and need of a proposed development and include alternative sites, layouts or designs, technologies and the "no development" or "no go" alternative.

Two potential landing alternatives were considered for the Equiano Cable System at Swakopmund:

- The **Paddock Gardens landing point**, which is located on the beach immediately south of the 'Platz am Meer Waterfront Shopping Mall' (Preferred Alternative).
- The **Baobab Avenue landing point**, which is approximately 5 km north of Swakopmund's town centre within a new residential suburb currently under construction.

During screening undertaken by ACER/Geo, information contained in the Equiano Cable System Segment 24: Namibia Swakopmund Site Visit Report compiled by Pelagian (PL-SVR-102 Site Visit v0.1 05 Sep 2019) was consulted extensively as the project details and proposed alignments are clearly defined in this report. Therefore, the descriptions of the proposed landing alternatives in this report are sourced from the Pelagian report.

Of these two beach landing alternatives and associated cable alignments to the proposed CLS site, the preferred landing point for the Equiano Cable System is the **Paddock Gardens landing point** as the beach profile at the Baobab Avenue landing point proved unsuitable for the landing of a marine telecommunications cable. A detailed description of the preferred landing point is provided in Chapter 6 of this Report.

Technical Description
The section of the Equiano Cable system which forms part of this impact assessment includes the section of cable from where it enters Namibia's Exclusive Economic Zone (EEZ) (200 nautical miles from the sea shore) through Namibia's Territorial Waters (TW) (12 nautical miles from the sea shore) and onto land until it reaches the proposed landing location and CLS at Swakopmund.

The Equiano Cable System comprises the following project components from where it enters Namibia's EEZ until it reaches the CLS site in Swakopmund:

- Marine Fibre Optic Cable (marine environment to the Beach Manhole).

- Beach Manhole (BMH) located at Swakopmund Paddock Gardens.
- Terrestrial Fibre Optic Cable from the BMH to the CLS at Hage Heights Swakopmund.

A detailed description of the various project components and the proposed construction methods to be utilised to implement the proposed development are provided in Chapter 6 of this report.

Details of the Public Participation Process

The public participation process has been designed to comply with the requirements of the EMA EIA 2012 Regulations. The process is described in Chapter 7 of this report. Once the Draft Environmental Impact Assessment Report has been submitted for authority and public review, key stakeholders will be consulted with independently to ensure that their concerns and issues were captured and addressed in the Final Scoping Report, which will be submitted to the MEFT for decision making.

Issues raised by I&APs to date have been considered and incorporated into the Comments and Responses Report, provided in Appendix 2.

Description of the Environment

The climate of the Namibian coastline is classified as hyper-arid with typically low, unpredictable winter rains and strong predominantly southerly or south-westerly winds with thick fog occurring on average between 50-75 days per year, is quite dense and appears as a thick bank hugging the shore and may reduce visibility to less than 300 m. The coastline of Namibia is arid in nature with beach sediments along the coastline that originate from wind-blown sediments and coastal dune systems.

The Equiano Cable Route crosses the Namib Flyway Ecologically or Biologically Significant Areas (EBSA). The principal objective of the EBSAs are the identification of features of higher ecological value that may require enhanced conservation and management measures. This EBSA includes six terrestrial Important Bird Areas (IBAs), and two proposed marine IBAs. The area also encompasses key spawning and nursery areas of various fish species, including sardine and anchovy, which are important forage fish for a range of marine predators. The area is highly relevant in terms of its importance for life-history stages of species, threatened, endangered or declining species and/or habitats, and biological productivity. The Namib Flyway area also hosts several 'Near threatened' and 'Vulnerable' fish species and is considered an important foraging area for leatherback turtles from both the nesting grounds in Brazil and KwaZulu-Natal in South Africa. The Namib Flyway also includes three 'Endangered' habitat types that are not impacted on the Equiano Marine System.

Namibia has one of the most productive fishing grounds in the world, based on the Benguela Current System. Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, line fish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay and surrounds. Other users of the offshore areas (including the commercial fishing are the oil and gas licence holders and marine mining (diamonds and marine phosphates) concession holders. Interest in mariculture (marine aquaculture) has increased in Namibia recently and is being conducted at an increasing scale in Walvis Bay. Guano platforms occur north of the cable landing site at Swakopmund, in Walvis Bay and at Cape Cross. Swakopmund is well known for its eco-tourism activities both onshore and offshore.

The proposed cable landing site is at Swakopmund, a large city positioned almost centrally along the Namibian coastline, where the cable landing is located just south of a small coastal breakwater harbour. This breakwater has interrupted the transport of sediment since its construction and is now considered a disturbed coastal environment.

As the project area is located with the Swakopmund Municipality within a serviced and developed urban area, the biodiversity in the immediate vicinity of the project area has been significantly impacted on by human activities with no flora or fauna of significance for consideration.

The COVID-19 pandemic has had a negative effect on the Swakopmund community due to the travel restrictions impacting on tourism generating income, with this sector experiencing an almost complete collapse for the first three quarters of 2020. According to the census data of 2011, it is estimated that the Erongo region, of which Swakopmund is a constituency, has a literacy rate of 97%, with services such as water, electricity and sanitation considered to be accessible to the majority of its inhabitants.

Based on documentary records the heritage specialist reported that the possibility of underwater heritage of importance within the area to be affected is not expected. The unconsolidated beach sand had no indications of archaeological remains, and from the BMH the route proceeds along land surfaces that have been extensively modified for purposes of development. He concluded that indications of archaeological or palaeontological remains were not observed.

Environmental Issues and Potential Impacts
The issues identified have been formulated as seven key questions within which potential impacts are identified and described further in Chapter 9:

- ❑ What are the potential social and socio-economic impacts associated with the construction and operation of the proposed Equiano Cable System?
- ❑ What impact will the construction and operation of the proposed Equiano Cable System have on the terrestrial environment (flora and fauna)?
- ❑ What impact will the construction and operation of the Equiano Cable System have on the fishing industry?
- ❑ What will the potential impact of the Equino System have on the Marine Benthic Environment based on the alignment selected.?
- ❑ What impact will the construction and operation of the Equiano) Cable System have on the beach and dune cordon at Swakopmund?
- ❑ What impact will the construction of Equiano Cable System have on cultural and heritage resources, including any paleontological resources (if any are identified during the study)?
- ❑ What cumulative impacts will the construction of the Equiano Cable System have?

These issues have been investigated to inform decision-making and to enable the relevant parties to proactively address any impacts if they do occur. The no-development option has also be considered and assessed as part of these issues in Chapter 10.

The specialist studies commissioned are listed below:

- ❑ Flora Specialist Study
- ❑ Fauna Specialist Study
- ❑ Beach and Coastal Dune Specialist Study
- ❑ Social Impact Assessment
- ❑ Fisheries Specialist Study
- ❑ Marine Ecology Specialist Study
- ❑ Archaeological and Heritage Specialist Study

The mitigation measures recommended by the specialists and EAP are provided in the Environmental Management Plan (EMP) attached as Appendix 5.

The nature of the impact, its intensity, duration, and extent including the significance of the impact before and after mitigation, are summarised in the table below:

Description of Impact	Nature of Impact	Intensity	Duration	Extent	Significance without Mitigation	Significance with Mitigation
Impact on terrestrial flora (Construction Phase)	Negative	Low	Short-term	Site-specific	Low	Low (-)
Contamination of soils through construction related pollutants	Negative	Low	Short-term	Site-specific	Low	Very Low (-)
Impact on terrestrial fauna: habitat destruction and disturbance, including waste/pollution and bird collisions, and illegal wildlife trade (indirect impact) (Construction and Operational Phase)	Negative	Low	Short-term (construction)	Site-specific	Low	Very Low (-)
Impact on beach and dune morphology (Construction Phase and Operational Phase)	Negative	Medium	Short-Term (construction) Long-term (operational related to cable repair)	Site-Specific	Low	Very Low (-)
Public nuisance such as dust, noise and service disruption	Negative	Medium	Short-Term (construction) Long-term (operational related to cable repair)	Site-Specific	Low	Very Low (-)
Temporary employment creation (Construction Phase and Operational Phase)	Positive	Medium	Short-Term (construction) Long-term (operational related to cable repair)	Local	Low (-)	Medium (+)
Improved bandwidth & telecommunications capacity in Namibia (Operational Phase)	Positive	High	Long - Term	National	High (-)	High (+)
Impact on the fishing industry (Construction and Operational Phase, (including cumulative impact)	Negative (construction) Negative (operation)	Low (construction) Medium (operational)	Short-term (construction) Long-Term (operational)	Regional Regional	Low (construction) Medium-Low (operational)	Low (-) (construction) Medium-Low (-) (operational)
Impacts of multi-beam and sub-bottom profiling sonar on marine fauna (pre-construction)	Negative (pre-construction)	Low	Short-term	Site-specific	Very Low	Very Low (-)
Disturbance and destruction of sandy beach biota during trench excavation and subsea cable installation (construction and operation in event of cable repair)	Negative	Medium	Short-term	Site-specific	Low	Low (-)
Disturbance and destruction of nearshore biota in unconsolidated sediments during trench excavation and cable installation (construction and	Negative	Medium	Short-term	Site-specific	Low	Low (-)

Description of Impact	Nature of Impact	Intensity	Duration	Extent	Significance without Mitigation	Significance with Mitigation
operation in event of cable repair)						
Disturbance and avoidance behaviour of surf-zone fish communities, shore birds and marine mammals through coastal construction noise and offshore cable installation noise (construction and operation in event of cable repair)	Negative	Low	Short-term	Site-specific	Very Low	Very Low (-)
Behavioural changes and masking of biologically significant sounds in marine fauna due to noise from cable installation operations (construction and operation in event of cable repair)	Negative	Low	Short-term	Site-specific	Very Low	Very Low (-)
Disturbance and destruction of subtidal sandy biota during cable laying (construction and operation in event of cable repair)	Negative	Medium	Medium to Long-term/ Permanent	Site-specific	Low	Low (-)
Reduced physiological functioning or marine organisms due to increased turbidity in surf-zone as a result of excavations and mobilising of sediments (construction and operation in event of cable repair)	Negative	Low	Short-term	Site-specific	Very Low	Very Low (-)
Physical presence of the subsea cable (Operational Phase)	Negative	Medium	Continuous	Site-specific	Low	Low (-)
Impact on the marine ecology caused by pollution and accidental spills (Construction and Operational Phase)	Negative	Medium	Short-Term	Local	Medium	Low (-)
Cumulative effects on the marine ecology (Operational Phase)	Negative	Low	Long - Term	Local	Low	Low (-)
Cumulative impact of climate change on the beach environment from erosion	Negative	Low	Long - Term	Local	Medium	Low (-)
Impact on marine and terrestrial heritage resources	No direct, indirect or cumulative impacts identified by the specialist (Kinahan, 2020)					

Based on the impact rating process detailed in this report and summarised above it is evident that most of the negative impacts vary from low to very low, except for the impact on the fishing industry rated as medium-low, with no impacts identified by the heritage specialist. Positive impacts are related to employment creation, economic spin offs and the provision of high-speed data and improved band width with increased telecommunications capacity in Namibia. The “no-go” alternative would mean that there would be no Equiano Cable System installed, and no increase in capacity in internet band width in a time of the COVID-19 pandemic when this is an essential service necessary to facilitate remote working, education on line, and growth in the Namibian economy, including that of partner (land-locked) countries.

Concluding Remarks

The EAP is of the opinion that due environmental process has been followed during the undertaking of this detailed scoping impact assessment process and report. Following the comment period for this report the issues raised by stakeholders, together with those of technical specialists and the regulatory authorities, will be captured into a Final Report, which will be submitted to the Ministry of Environment, Forestry and Tourism (MEFT) for decision making.

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DEFINITIONS

Alternatives - In relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to –
i. The property on which or location where it is proposed to undertake the activity;
ii. The type of activity to be undertaken;
iii. The design or layout of the activity;
iv. The technology to be used in the activity, and;
v. The operational aspects of the activity.

Baseline - Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.

Benthic - Referring to organisms living in, or on, the sediments of aquatic habitats (lakes, rivers, ponds, etc.).

Biodiversity - The diversity, or variety, of plants, animals and other living things in a particular area or region. It encompasses habitat diversity, species diversity and genetic diversity.

Community - Those people who may be impacted upon by the construction and operation of the project. This includes neighbouring landowners, local communities and other occasional users of the area.

Construction Phase - The stage of project development comprising site preparation as well as all construction activities associated with the development.

Consultation - A process for the exchange of views, concerns and proposals about a project through meaningful discussions and the open sharing of information.

Critical Biodiversity Area - Areas of the landscape that must be conserved in a natural or near-natural state in order for the continued existence and functioning of species and ecosystems and the delivery of ecosystem services.

Cumulative Impacts - Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.

Ecosystem - A community of plants, animals and organisms interacting with each other and with the non-living (physical and chemical) components of their environment.

Endemic - Plant or animals species found only within a specific place, and has same the same meaning as indigenous.

Environment - The surroundings within which humans exist and that are made up of
i. The land, water and atmosphere of the earth;
ii. Micro-organisms, plant and animal life;
iii. Any Part or combination of (i) and (ii) and the interrelationships among and between them; and
iv. The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing.

Environmental Assessment Practitioner (EAP) – The person responsible for planning, management and co-ordination of environmental impact assessment, strategic environmental assessments, environmental management plans or any other appropriate environmental instrument introduced through regulations.

Environmental Compliance Certificate – the certificate of approval from the relevant designated organ of state as described in the EIA Regulations (2012).

Environmental Impact Assessment (EIA) – In relation to an application to which scoping must be applied, means the process of collecting, organizing, analysing, interpreting and communicating information that is relevant to the consideration of that application. This process necessitates the compilation of an Environmental Impact Report, which describes the process of examining the environmental effects of a proposed development, the anticipated impacts and proposed mitigatory measures.

Environmental Impact Report (EIR) - A report assessing the potential significant impacts as identified during the Scoping phase.

Environmental Management Plan (EMP) - A management programme designed specifically to introduce the mitigation measures proposed in the Reports and contained in the Conditions of Approval in the Environmental Authorisation.

Epifauna - Organisms, which live at or on the sediment surface being either attached (sessile) or capable of movement.

Gross Domestic Product (GDP) by region - represents the value of all goods and services produced within a region, over a period of one year, plus taxes minus subsidies.

Habitat - The place where a population (*.e.g.,* animal, plant, micro-organism) lives and its surroundings, both living and non-living.

Hazardous waste – means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical, or toxicological characteristics of the waste, have a detrimental impact on health and the environment.

Hydrocarbons – Oils used in machinery as lubricants, including diesel and petrol used as fuel.

Impact - A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.

Infauna - Animals of any size living within the marine sediment. They move freely through interstitial spaces between sedimentary particles or they build burrows or tubes.

Interested and Affected Party (I&AP) – Any individual, group, organization or associations which are interested in or affected by an activity as well as any organ of state that may have jurisdiction over any aspect of the activity.

Marine environment - Marine environment includes estuaries, coastal marine and nearshore zones, and open-ocean-deep-sea regions.

Marine Protected Area (MPA) is an area of coastline or ocean that is specially protected for the benefit of people and nature

EIA Regulations - The Environmental Impact Assessment Regulations means the regulations made under section 56 of the Environmental Management Act, 2007 (Act No. 7 of 2007).

No-Go Alternative – The option of not proceeding with the activity, implying a continuation of the current situation / status quo

Public Participation Process (PPP) - A process in which potential Interested and Affected Parties are given an opportunity to comment on, or raise issues relevant to, specific matters.

Recruitment - The replenishment or addition of individuals of an animal or plant population through reproduction, dispersion and migration

Registered Interested and Affected Party (I&AP) – All persons who, as a consequence of the Public Participation Process conducted in respect of an application, have submitted written comments or attended meeting with the applicant or environmental assessment practitioner (EAP); all persons who have requested the applicant or the EAP in writing, for their names to be placed on the register and all organs of state which have jurisdiction in respect of the activity to which the application relates.

Scoping process - A procedure for determining the extent of and approach to an EIA, used to focus the EIA to ensure that only the significant issues and reasonable alternatives are examined in detail

Scoping Report - The report describing the issues identified during the scoping process.

Sediment - Unconsolidated mineral and organic particulate material that settles to the bottom of aquatic environment.

Significant impact - Means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

Spatial Development Framework (SDF) - A document required by legislation and essential in providing conservation and development guidelines for an urban area, which is situated in an environmentally sensitive area and for which major expansion is expected in the foreseeable future.

Specialist study - A study into a particular aspect of the environment, undertaken by an expert in that discipline.

Species - A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group.

Stakeholder Engagement - The process of engagement between stakeholders (the proponent, authorities and IAPs) during the planning, assessment, implementation and/or management of proposals or activities.

Stakeholders - All parties affected by and/or able to influence a project, often those in a position of authority and/or representing others.

Subtidal - The zone below the low-tide level, *i.e.,* it is never exposed at low tide.

Sustainable development - Sustainable development is generally defined as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. NEMA defines sustainable development as the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations.

Surf-zone - Also referred to as the 'breaker zone' where water depths are less than half the wavelength of the incoming waves with the result that the orbital pattern of the waves collapses and breakers are formed

Turbidity - Measure of the light-scattering properties of a volume of water, usually measured in nephelometric turbidity units.

Visibility - The area from which the project components would actually be visible and depends upon topography, vegetation cover, built structures and distance.

Visual Character - The elements that make up the landscape including geology, vegetation and land-use of the area.

Visual Quality - The experience of the environment with its particular natural and cultural attributes.

Visual Receptors - Individuals, groups or communities who are subject to the visual influence of a particular project.

ABBREVIATIONS AND ACRONYMS

ACER	ACER (Africa) Environmental Consultants
ASN	Alcatel Submarine Networks
BID	Background Information Document
BMH	Beach Manhole
CA	Competent Authority
CLS	Cable Landing Station
CPTs	Cone Penetrometer Tests
CRR	Comments and Responses Report
DEIAR	Draft Environmental Impact Assessment Report
EAP	Environmental Assessment Practitioner
EBSA	Ecologically or Biologically Significant Areas
EIS	Ecological Importance and Sensitivity
EMP	Environmental Management Plan
EEZ	Exclusive Economic Zone
FEIAR	Final Environmental Impact Assessment Report
Geo	Geo Pollution Technologies
GPS	Global Positioning System
HDPE	High-density polyethylene
I&APs	Interested and Affected Parties
LWM	Low Water Mark
MEFT	Ministry of the Environment, Forestry and Tourism
MPA	Marine Protected Area
MBES	Multi-beam echo sounder
NEPAD	New Partnership for Africa's Development
Nm	Nautical Miles
PES	Present Ecological State
PLGR	Pre-Lay Grapnel Run
TW	Territorial Waters
UNCLOS	United Nations Convention on the Laws of the Sea
WACS	West Africa Cable System
WD	Water Depth

AUTHORS

The authors of this Draft Environmental Impact Assessment Report are Mr G. Churchill, Ms J. Barnard and Dr R-D Heinsohn (ACER (Africa) Environmental Consultants), with local support provided by Dr A. Faul and Ms Q Bosman (Geo Pollution Technologies) based in Windhoek.

An external review was conducted by ASN.

Adherence to Regulatory Requirements as per the EIA Regulations

Regulation 8: Scoping Report content	Section in Report
a) the curriculum vitae of the EAP who prepared the report;	Appendix 3
b) a description of the proposed activity;	Chapter 5
c) a description of the site on which the activity is to be undertaken and the location of the activity on the site;	Chapter 5 and 6 Figures 1, 4 and 6
d) a description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed listed activity;	Chapter 8
e) an identification of laws and guidelines that have been considered in the preparation of the scoping report;	Chapter 3
f) details of the public consultation process conducted in terms of regulation 7(1) in connection with the application, including – i. the steps that were taken to notify potentially interested and affected parties of the proposed application; ii. proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given; iii. a list of all persons, organisations and organs of state that were registered in terms of regulation 22 as interested and affected parties in relation to the application; and iv. a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;	Chapter 7
g) a description of the need and desirability of the proposed listed activity and any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives have on the environment and on the community that may be affected by the activity;	Chapter 4
h) a description and assessment of the significance of any significant effects, including cumulative effects, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the proposed listed activity;	Chapter 10
i) terms of reference for the detailed assessment; and	Chapter 9
j) a draft management plan, which includes - (aa) information on any proposed management, mitigation, protection or remedial measures to be undertaken to address the effects on the environment that have been identified including objectives in respect of the rehabilitation of the environment and closure; (bb) as far as is reasonably practicable, measures to rehabilitate the environment affected by the undertaking of the activity or specified activity to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development; and (cc) a description of the manner in which the applicant intends to modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation remedy the cause of pollution or degradation and migration of pollutants.	Appendix 5

1 INTRODUCTION

1.1 Background

Submarine telecommunication cables are important for international telecommunication networks; they transport almost 100% of transoceanic Internet traffic throughout the world (https://www.iscpc.org/). It is widely recognised that access to affordable international bandwidth is key to unlocking economic development in every country. Today, Africa still relies primarily on satellites with only few submarine cables to provide its international communications. Communication via submarine telecommunication cables generally allows for lower cost, better performance, and greater capacity (throughput) than that available via satellite. Improvement in Africa's information technology infrastructure via telecommunication cables will remove one of the current key inhibitors to development in Africa and support economic growth and opportunities on the continent.

The International Cable Protection Committee (ICPC) represents 97% of the world's subsea telecom cables (https://www.iscpc.org/). A report prepared by the environmental advisor of the ICPC, Dr Mike Claire entitled: "Submarine Cable Protection and the Environment: A Bi-Annual Update" (30 September 2020) addresses the role of submarine cables in a post-COVID-19 world, where submarine telecommunications cables are an enabler for changing people's behaviour away from hydrocarbons and climate impacting sources. Lessons learned from the lockdown will inform how businesses operate in future— leading to an increase in virtual, online meetings compared to those requiring long haul flights, and increased home-working— all of which will help in lowering greenhouse gas emissions. The ICPC estimates that internet traffic increased between 25% and 50% between November 2019 and the early stages of lockdown in April 2020, and this will likely continue as we adapt to the "new-normal". Zoom Video. Communications revenue for the quarter ending July 31, 2020 saw a 355% increase compared to the previous year. This is just one indication of the increased video conferencing occurring as a result of widespread remote work, remote education, and remote personal video communication.

Alcatel Submarine Networks (ASN) was appointed to execute the installation of a new subsea telecommunications cable system, the Equiano Cable System, which will connect Africa with Europe. It will be located along the West Coast of Africa, between Portugal and South Africa. Branching units along the cable will in turn connect it to African countries, including Namibia, to increase and improve connectivity in Africa (Figure 1). There will be one Namibian landing at Swakopmund, where it will be operated by the Namibian landing partner Paratus Telecommunications (Pty) Ltd.

The subsea fibre optic cable system consists of a main trunk running offshore from the shoreline in international waters. Branch cables to the South African landing points will run from the main trunk to the shoreline through Namibia's Exclusive Economic Zone (EEZ) and territorial waters to the selected landing site at Swakopmund.

ACER (Africa) Environmental Consultants (ACER) has been contracted by ASN to prepare a Environmental Impact Assessment Report for the Equiano Cable System landing point in Swakopmund on the coast of Namibia and incorporates the main Cable System trunk line from where it enters Namibia's EEZ from to Swakopmund.

The environmental assessment is required as per the Namibian Environmental Management Act No. 7 of 2007 (EMA), and EIA Regulations (2012).

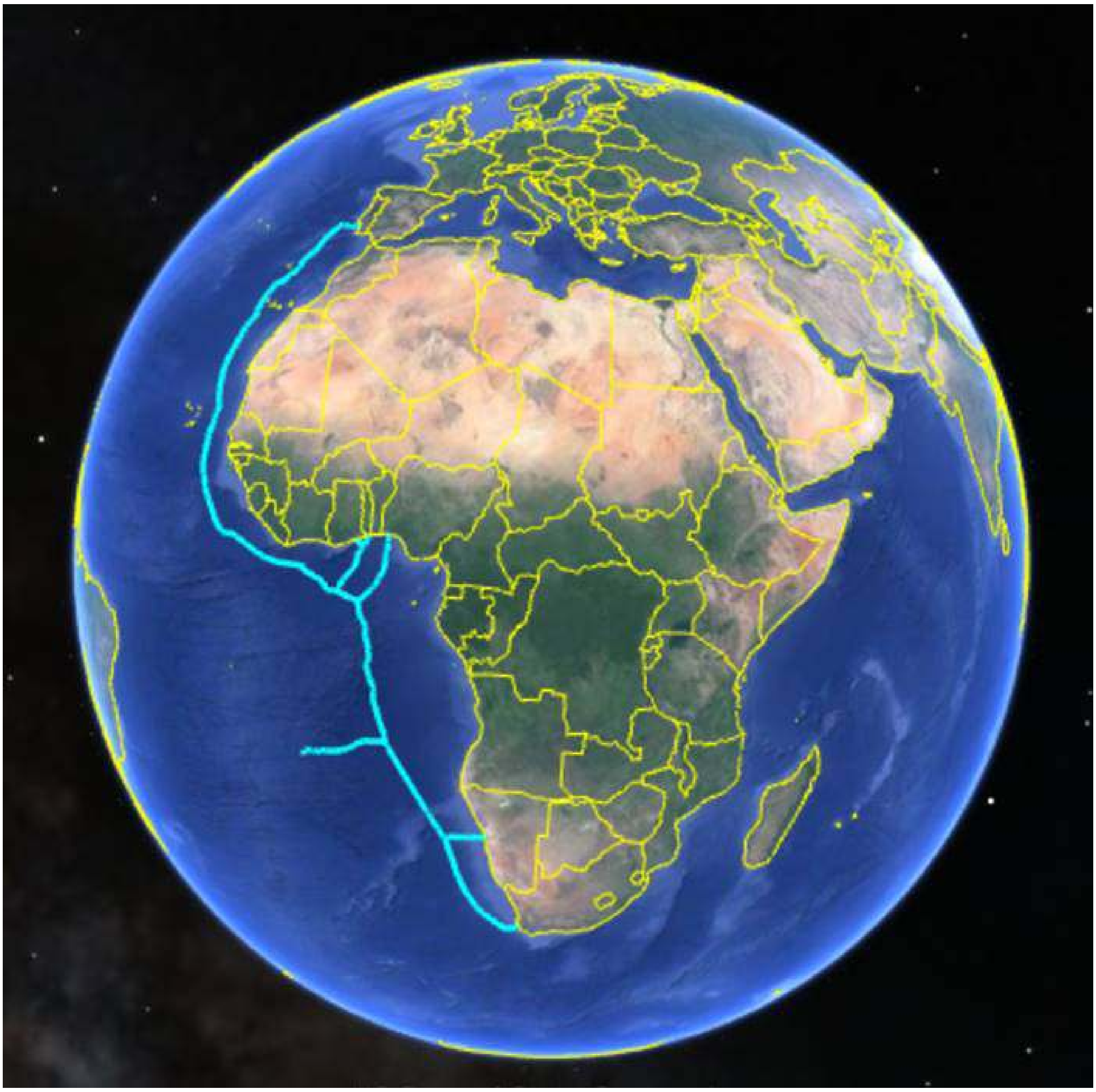


Figure 1 Equiano System Overview

1.2 Qualifications and experience of the Environmental Assessment Practitioner

ACER (Africa) Environmental Consultants (ACER) is a well-established company with wide ranging expertise in environmental management and assessment processes. ACER has twice won the IAIAsa National Premium Award for excellence in environmental management and assessment in South Africa. The qualifications and experience of the primary assessors and report compilers are listed in Table 1 and curriculum vitae are provided in Appendix 3. For this assessment ACER has partnered with Geo Pollution Technologies a locally based environmental consultancy agency based in Namibia.

Table 1 Qualifications and experience of the Environmental Assessment Practitioner (EAP) Team

EAP	Academic Qualification	Relevant Work Experience
Dr André Faul EAP based in Windhoek (from Geo Pollution Technologies (Pty) Ltd)	PhD	8 years' experience in environmental management and impact assessments of over 140 EIAs in various sectors in Namibia, such as harbour expansions, petroleum industry, irrigation schemes, township establishment, power generation and transmission. Before joining the environmental assessment profession, he worked for 12 years in the Environmental Section of the Department of Biological Sciences at the University of Namibia, as a technician and then as a lecturer in biological and ecological sciences.
Ms Quzette Bosman Social Specialist (from Geo Pollution Technologies (Pty) Ltd)	BA (Hons)	14 years' experience in the Impact Assessment Industry, working as an Environmental Assessment Practitioner and Social Assessment practitioner mainly as per the National Environmental Legislation sets for South Africa and Namibia
Dr Dieter Heinsohn (EAP and Co-author)	PhD	28 years' experience in environmental management and impact assessments. He is registered in South Africa with the South African Council for Natural Scientific Professions (SACNASP) in the field of environmental science (Registration No. 400442/04) and the Environmental Assessment Practitioners Association of South Africa (EAPASA) (Registration No.2019/963)
Mr Giles Churchill (EAP and Co-author)	MSc	13 years' experience in environmental management, impact assessments and the monitoring of compliance with specifications contained in Environmental Management Programmes (EMPr's). He is registered in South Africa with the SACNASP in the field of environmental science (Registration No 116348) and EAPASA (Registration No.2019/1687)
Jenny Barnard (EAP and Co-author)	MSc	28 years' experience in environmental management, impact assessments and the monitoring of compliance with specifications contained in Environmental Management Programmes (EMPr's). She is registered in South Africa with the SACNASP as a Professional Natural Scientist (Registration No.400197/09) and EAPASA (Registration No.2020/2492).

1.3 Environmental assessment requirements and process

The proposed installation and operation of the Submarine Cable triggers listed activities in terms of the Environmental Management Act No. 7 of 2007 (Government Notice (GN) No. 232) and the Environmental Impact Assessment Regulations of 6 February 2012 (GN No. 28-30 of 2012) that may not be undertaken without an Environmental Clearance Certificate (ECC). Refer to Table 2.

The Namibian environmental impact assessment process is illustrated in Figure 2 as sourced from the Ministry of Environment, Forestry and Tourism's website (http://www.met.gov.na/services/environmental-impact-assessment-/233/).

The Terms of Reference (TORs) for this Environmental Impact Assessment study is in accordance with the Environmental Management Act 7 of 2007 and the Environmental Management Act Regulations. The contents of the Scoping Report are as per Section 8 (a - j) of the Regulations. The legislated contents of the Report are listed in the table above on page xxiii, and the process is illustrated in Figure 2.

The overall aim is to obtain an Environmental Clearance Certificate (ECC) in order for the project to be implemented. It considers all other relevant local, national and international laws. These guidelines are aimed to focus on issues of greater environmental concerns and to develop mitigation measures to ensure effective environmental management.

The Terms of Reference of this Environmental Impact Assessment Report includes the following:

- A comprehensive description of the proposed Project.
- Identification of relevant legislation and guidelines for the project.
- Identification of potential environmental (physical, biological and social) conditions of the project location, including conducting an environmental impact risk assessment.
- Notification of Interested and Affected Parties (I&APs) and relevant authorities about the proposed project to enable their participation and contribution.
- Development of an Environmental Management Plan (EMP) that would be a legal guideline for the environmental protection by the project.

In terms of the Namibian Environmental Management Act (Act 7 of 2007) and EIA Regulations (2012) and environmental best practise, the potential impacts of the project on the environment (social, economic and biophysical) must be considered, investigated and assessed prior to implementation.

Given that the project triggers listed activities in these regulations (Table 2), the application requires an impact assessment process as outlined in the EIA Regulations (2012). The activities are listed under Government Notice 29 of 2012 (contained in GG 4878) under the Annexure to these Regulations[1]. The category "Infrastructure" is applicable, as detailed in Table 2 below.

Table 2 List of activities triggered in the EIA Regulations (2012)

Activity	Description
10.1 The construction of – e) any structure below the high water mark of the sea;	The installation of the Equiano Cable system will take at sea and on the beach at the landing site below the high water mark of the sea.
10.1 The construction of – (g) communication networks including towers, telecommunication and marine telecommunication lines and cables;	The Equiano Cable System requires the construction of marine telecommunication cables.

1 https://laws.parliament.na/cms_documents/2011---environmental-impact-assessment-regulations--fdbe98c372.pdf

ACER will fulfil the role and responsibilities of the Environmental Assessment Practitioner (EAP) to undertake the EIA and the associated public participation process, and to submit the required application and supporting documentation for consideration and decision-making.

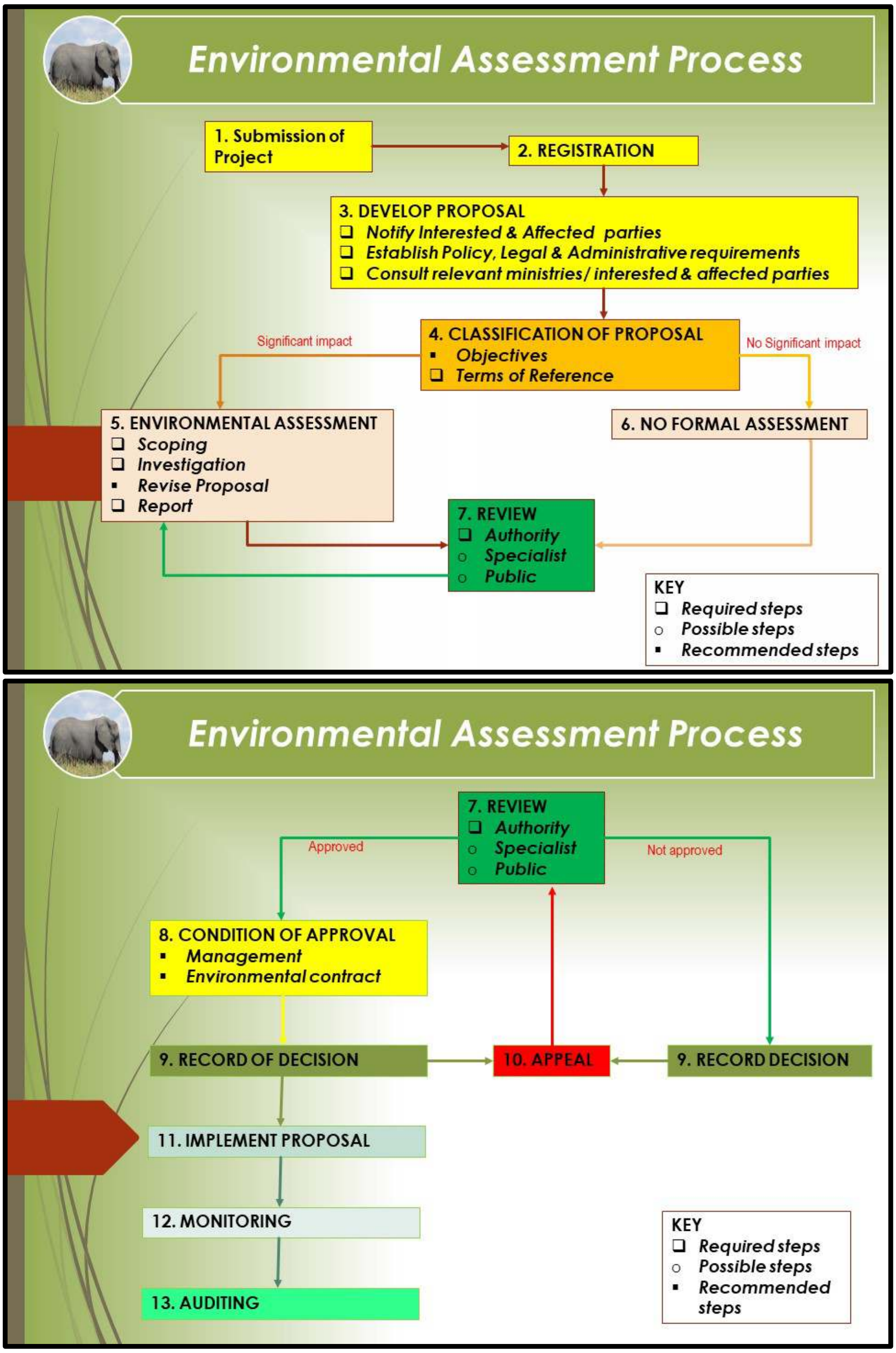


Figure 2 The EIA Process
(Source: http://www.met.gov.na/services/environmental-impact-assessment-/233/)

1.4 Project Timeline

Key activities and anticipated timeframes for the scoping and environmental impact assessment process are shown in Table 3 below. This programme takes into account the technical and public participation processes, and interaction between them.

Table 3 Timeline of the Environmental Assessment Process

Activity	Timeline
Project Screening	November 2019
Newspaper Advertisements and Site Notices	September 2020
Public Consultation	September – October 2020
Comments and Responses Report	November 2020
Specialist Study Investigations	June to November 2020
Preparation of Draft Environmental Impact Assessment Report (DEIAR) and Environmental Management Plan (EMP)	November & December 2020
Public Consultation on DEIAR and Draft EMP	January 2021
Preparation of Final Environmental Impact Assessment Report (FEAR) and Final Environmental Management Plan (EMP)	February 2021
Submit FEIAR and Final EMP to the Competent Authority (MEFT) for decision making	February 2021

2 ENVIRONMENTAL IMPACT METHODOLOGY

Scoping is a process designed to define the limits of the assessment, to identify and elicit inputs from Interested and Affected Parties (I&APs), and to define an assessment framework with the purpose of focusing the scope of the assessment, thereby ensuring a focus on key issues and associated impacts. The sustainability framework (Figure 3) within which environmental aspects arising from or influencing the proposed project (and its alternatives) are considered, has been undertaken using the following philosophy:

- The concept of sustainability, which considers the inter-related dimensions of the environment, viz. the social, economic and biophysical dimensions, underpinned by a system of sound governance through the legal/statutory requirements of Namibia (in particular, EMA).
- The principles of EMA are listed in Chapter 4 where the Need and Desirability of the Equiano Cable System is assessed in more detail.

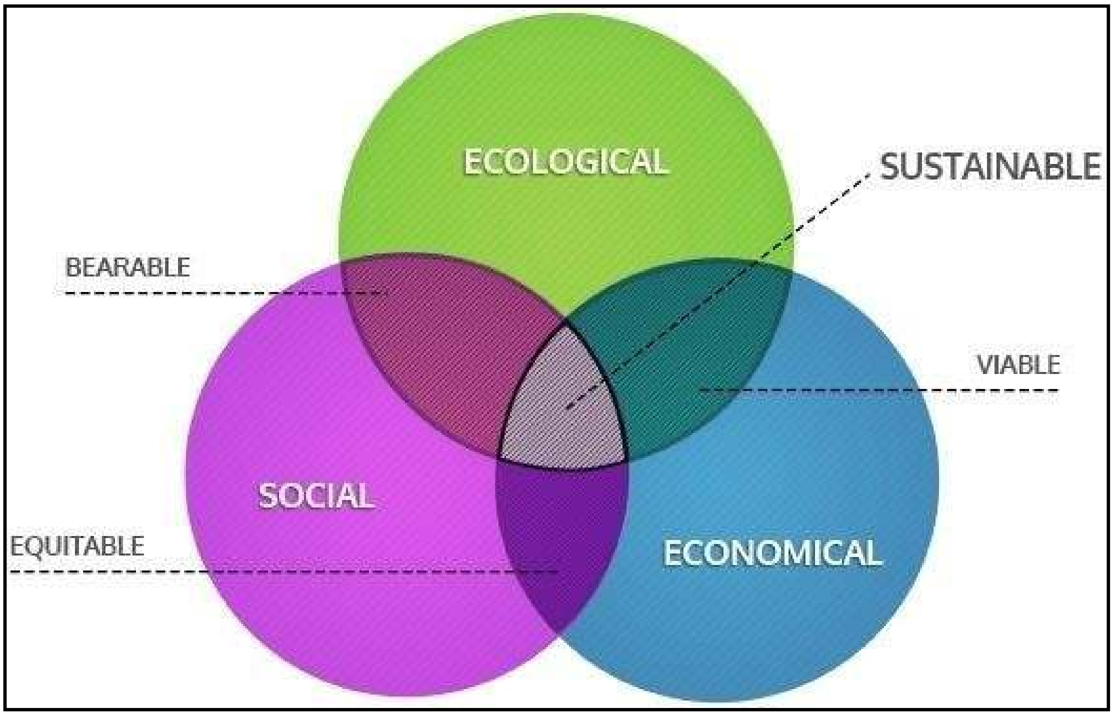


Figure 3 Assessment framework based on the concept of sustainability

Issues and impacts were identified by way of interlinked technical and public participation processes (Chapter 7 details the public participation process). Information gathering focused on gaining an understanding of the interactions between the different dimensions of the environment in order to identify potentially significant issues and impacts. This involved site visits, reference to existing documentation and maps, liaison with the project proponent and technical team, the commissioning of specialist assessments, as well as consideration and incorporation of the issues raised during the initial consultation process with authorities. Information has been collated, integrated, and evaluated, and potentially significant issues and impacts identified and assessed in terms of their significance.

This Draft Environmental Impact Assessment Report contains appendices that present the following information:

- Appendix 1: Public Participation Documentation.
- Appendix 2: Issues and Response Report.
- Appendix 3: CV of EAPs
- Appendix 4: Specialist Studies
- Appendix 5: Environmental Management Plan
- Appendix 6: Supporting Maps

The Draft Environmental Impact Assessment Report is being made available to Interested and Affected Parties (I&APs) between the 25 January – 15 February 2021 (over 21 calendar days) to review and provide comments on the document. Following the period of public review, the Draft Report will be updated and finalised into the Final Environmental Impact Assessment Report which will be submitted to the Ministry of Environment, Forestry and Tourism for decision making.

In addition to the requirement for the Environmental Impact Assessment Regulations (2012) a review of all legislation, including policies and guidelines, applicable to the proposed Equiano Cable System has been undertaken in order to establish what other licences and permits are applicable to the project. Findings from this review of applicable legislation and the required licence and permits are included in Chapter 3 of this Report.

3 LEGAL ASPECTS

3.1 Applicable legislation

The Government of Namibia is committed to sustainable development. Article 95(1) of the Constitution of Namibia states that:- "The State shall actively promote and maintain the welfare of the people by adopting policies aimed at … The maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future…"

The commitment of the Government of Namibia to environmental protection, socio-economic and sustainable development are expressed and articulated in the Vision 2030 and at the medium term, included in the National Development Plan. In 2007, the Government of Namibia enacted the Environmental Management Act (Act 7 of 2007), referred to as EMA, with the objective to prevent and mitigate the significant effects of activities on the environment by:

- Ensuring that the significant effects of activities on the environment are considered in time and carefully.
- Ensuring that there are opportunities for timeous participation of interested and affected parties throughout the assessment process.
- Ensuring that the findings of an assessment are taken into account before any decision is made in respect of activities.

Some of the key legislation that is applicable to this project is provided in Table 4, with Table 5 detailing the relevant Namibian Policies, and Table 6 relevant multilateral environmental agreements.

Table 4 Applicable Namibian Legislation

Law	Key Aspects
The Namibian Constitution	❑ Promote the welfare of people ❑ Incorporates a high level of environmental protection ❑ Incorporates international agreements as part of Namibian law
Communications Act Act No. 8 of 2009, Government Notice No. 226	❑ Provide for the regulation of telecommunications services and networks, broadcasting, postal services and the use and allocation of radio spectrum; for that purpose the establishment of an independent Communications Regulatory Authority of Namibia; to make provision for its powers and functions; the granting of special rights to telecommunications licensees
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232	❑ Defines the environment ❑ Promote sustainable management of the environment and the use of natural resources ❑ Provide a process of assessment and control of activities with possible significant effects on the environment
Environmental Management Act Regulations Government Notice No. 28-30 of 2012	❑ Commencement of the Environmental Management Act ❑ List activities that requires an environmental clearance certificate ❑ Provide Environmental Impact Assessment Regulations
Territorial Sea and Exclusive Economic Zone of Namibia Act Act No. 3 of 1990, Government Notice No. 28	❑ Determines and define the territorial sea, internal waters, exclusive economic zone and continental shelf of Namibia

Law	Key Aspects
Marine Resources Act Act No. 27 of 2000, Government Notice No. 292	❑ Prevents the discharge of anything that may be injurious to marine resources or may disturb ecological balance in any area of the sea or which may detrimentally affect the marketability of marine resources, or which may hinder their harvesting ❑ Regulates the conservation of marine resources and ecosystems ❑ Regulates the protection of the Namibian islands' Marine Protected Area
The Water Act Act No. 54 of 1956, Government Gazette No. 2015	❑ Remains in force until the new Water Resources Management Act comes into force ❑ Defines the interests of the state in protecting water resources ❑ Controls the disposal of effluent ❑ Numerous amendments
Water Resources Management Act **Act 24 of 2004**	❑ This Act provides a framework for managing water resources based on the principles of integrated water resources management. ❑ It provides for the management, development, protection, conservation and use of water resources. In terms of the Act "water source" is defined as "water from a watercourse, an aquifer or the sea, and includes meteoric[2] water" while "water resource" includes a "watercourse, an aquifer and the sea and meteoric water". Relevant principles of the Act include, inter alia: ❑ Equitable access for all people to safe drinking water is an essential basic human right to support a healthy productive life; ❑ Harmonisation of human water needs with the requirements of environmental ecosystems and the species that depend on them, while recognising that the water resource quality for those ecosystems must be maintained; ❑ Promotion of the sustainable development of water resources based on an integrated water resources management plan which incorporates social, technical, economic, and environmental issues; ❑ Development of the most cost effective solutions, including conservation measures, to infrastructure for the provision of water; and ❑ Promotion of water awareness and the participation of persons having interest in the decision-making process should form an integral part of any water resource development initiative.
Water Resources Management Act Act No. 11 of 2013, Government Notice No. 284	❑ Provide for management, protection, development, use and conservation of water resources ❑ Prevention of water pollution and assignment of liability ❑ Not in force yet
Local Authorities Act Act No. 23 of 1992, Government Notice No. 116	❑ Define the powers, duties and functions of local authority councils ❑ Regulates discharges into sewers
Regional Councils Act Act No. 22 of 1992, Government Notice No. 115	❑ Sets out the powers, duties, functions, rights and obligations of Regional Councils. ❑ Provides the legal basis for the drawing up of Regional Development Plans.
The Namibian Ports Authority Act[3] Act No. 2 of 1994, Government Notice No. 30	❑ Provide for the establishment of the Namibian Ports Authority and its functions ❑ Responsible to protect the environment within its areas of jurisdiction

2 Meteoric water is groundwater derived from precipitation (atmosphere) and reaches the zone of saturation by infiltration and percolation (source: https://glossary.ametsoc.org/wiki/Meteoric_water).
3 This Act will be applicable for any ships making call to Port.

Law	Key Aspects
Public Health Act Act No. 36 of 1919 Government Gazette Extraordinary No. 979	❑ Provides for the protection of health of all people
Public and Environmental Health Act Act No. 1 of 2015, Government Notice No. 86	❑ Provides a framework for a structured more uniform public and environmental health system, and for incidental matters ❑ Deals with Integrated Waste Management including waste collection disposal and recycling; waste generation and storage; and sanitation
Immigration Control Act Act No. 7 of 1993, Government Notice No. 690	❑ Regulate and control the entry of persons into, and their residence in, Namibia
Labour Act Act No 11 of 2007, Government Notice No. 236 of 2007	❑ Provides for Labour Law and the protection and safety of employees ❑ Labour Act, 1992: Regulations relating to the health and safety of employees at work (Government Notice No. 156 of 1997)
National Heritage Act Act No. 27 of 2004, Government Notice No. 287	❑ Provide for the protection and conservation of places and objects of heritage significance and the registration of such places and objects; ❑ Establish the National Heritage Council ❑ Establish a National Heritage Register
Pollution Control and Waste Management Bill (draft document)	❑ Not in force yet ❑ Provides for prevention and control of pollution and waste ❑ Provides for procedures to be followed for licence applications.
Prevention and Combating of Pollution of the Sea by Oil Act Act No. 6 of 1981, Government Notice No. 342	❑ Provides for the prevention of pollution of the sea where oil is being or is likely to be discharged
Prevention and Combating of Pollution of the Sea by Oil Amendment Act Act No. 24 of 1991, Government Notice No. 150	❑ Amends the Prevention and Combating of Pollution of the Sea by Oil Act of 1981 to be more relevant to Namibia after independence.
Dumping at Sea Control Act Act No. 73 of 1980, Government Notice No. 1149	❑ Provides for the control of dumping of substances in the sea. ❑ Provides for permits to be issued to allow dumping at sea of scheduled substances
Marine Traffic Act **Act No. 2 of 1981,** Government Notice No. 282	❑ Regulates marine traffic in Namibia
Road Traffic and Transport Act Act No. 52 of 1999, Government Notice No. 282	❑ Provides for the control of traffic on public roads and the regulations pertaining to road transport.
Road Traffic and Transport Regulations Government Notice No. 53 of 2001	❑ Prohibits the transport of goods which are not safely contained within the body of the vehicle; or securely fastened to that vehicle, and which are not properly protected from being dislodged or spilled from that vehicle.
Hazardous Substance Ordinance 14 of 1974 Government Notice No. 151	❑ provide for the control of substances which may cause injury or ill-health to or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure thereby in certain circumstances, and for the control of certain electronic products; ❑ to provide for the division of such substances or products into groups in relation to the degree of danger; ❑ to provide for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances and products; and to provide for matters connected therewith.
Atmospheric Pollution prevention Ordinance 11 of 1976 Government Notice No. 239	❑ Provide for the prevention of the pollution of the atmosphere
Sea-shore Ordinance 37 of 1958 Government Notice No. 142	❑ Provides for the determination of the position of the high-water mark.

Table 5 Namibian Policies of relevance

Policy	Description
Namibia's 5th National Development Plan (NDP5) 2017/18 – 2021/22	The purpose of the NDP5 is to set out a roadmap for achieving rapid industrialisation while adhering to the four integrated pillars of sustainable development, these being: economic progression; social transformation; environmental sustainability; and good governance. Economic progression aims at achieving inclusive, sustainable and equitable growth for the Namibian society, which aspires to change form a input-dependent economy based on primary industries, to a knowledge based economy. This is to be achieved through structural transformation through value addition, and expansion and modernisation of physical infrastructure, through strengthening export capacity and grater regional integration with supportive financial infrastructure. The Equiano Cable System will help grow the Namibian economy, and its design and implementation are based on environmentally sustainably principles.
The National Policy on Coastal Management for Namibia (2013)	The policy aims to "provide a framework to strengthen governance in Namibia's coastal areas to realise long-term national goals defined in Vision 2030 and the more specific targets of National Development Plans, namely sustainable economic growth, employment creation and reduced inequalities in income". One of the objectives of the policy is to provide a foundation for improving the quality of life of coastal communities while doing so responsibly.
The Integrated Coastal Management Bill (2014)	Once enacted the bill aims to establish a system of integrated coastal management in Namibia in order to promote the conservation of the coastal environment, maintaining the natural attributes of the coastal landscapes and seascapes, and ensuring the sustainable development and use of the natural resources within the coastal zone that is also socially, economically and ecologically justifiable. To define the rights and duties in relation to coastal areas; to determine the responsibility of the organs of state in relation to the coastal areas; to control pollution in the coastal zone, development of the coastal environment and other adverse effects on the coastal environment; to give effect to Namibia's international obligations in relation to coastal matters; and to provide for related matters connected therewith.
The Namibian Vision 2030	The principles that underpin Vision 2030[4], a policy framework for Namibia's long-term national development, comprise the following: ❑ Good governance; ❑ Partnership; ❑ Capacity enhancement; ❑ Comparative advantage; ❑ Sustainable development; ❑ Economic growth; ❑ National sovereignty and human integrity; ❑ Environment; and ❑ Peace and security. Vision 2030 states that natural environments are disappearing quickly. Consequently the solitude, silence and natural beauty that many areas in Namibia provide are becoming sought after commodities and must be regarded as valuable natural assets. Vision 2030 emphasises the importance of promoting healthy living which includes that the majority of Namibians are provided with safe drinking water. The importance of developing wealth, livelihood and the economy is also emphasised by Vision 2030. This includes infrastructure provision like transport, communication, water and electricity.
National Climate Change Strategy & Action Plan 2013 – 2020 (NCCPSAP)	The NCCSAP aims to build Namibia's adaptive and mitigative capacities by identifying potential adaptation options and, where development actions also have mitigation benefits, committing to pursue these opportunities to bring the country on to a low-carbon development pathway. The NCCSAP clarifies

4 Derived from Namibia's Green Plan drafted by MET in 1992 and followed by the sequence of National Development Plans.

	national goals and objectives regarding climate change, and lays out a plan for implementing, reporting and monitoring a series of priority activities in pursuit of this aim. Furthermore, it will enable Namibia to be a more active participant in the global effort to combat climate change. The goal is further facilitate building the adaptive capacity of Namibia to increase climate change resilience and to optimize mitigation opportunities toward a sustainable development path, guided by the National Climate Change Policy (2011) as included below.
National Policy on Climate Change for Namibia - 2011	The National Policy on Climate Change pursues constitutional obligations of the Government of the Republic of Namibia, namely for "the state to promote the welfare of its people and protection of Namibia's environment for both present and future generation." The policy outlines a coherent, transparent and inclusive framework on climate risk management in accordance with Namibia's national development agenda, legal framework, and in recognition of environmental constraints and vulnerability. Similarly, the policy takes cognizance of Namibia comparative advantages with regard to the abundant potential for renewable energy exploitation. The goal of the National Policy on Climate Change is to contribute to the attainment of sustainable development in line with Namibia's Vision 2030 through strengthening of national capacities to reduce climate change risk and build resilience for any climate change shocks.

Table 6 Relevant multilateral environmental agreements for Namibia

Agreement	Key Aspects
Stockholm Declaration on the Human Environment, Stockholm 1972	❑ Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment.
UN Convention for the Prevention of Marine Pollution from Land-based Sources	❑ Concerns itself with the protection of marine fauna and flora by preventing marine pollution from land-based sources. ❑ Contracted parties, are committed to take all possible steps to prevent pollution of the sea as well as the direct or indirect introduction of substances or energy by humans into the marine environment resulting in such adverse effects as harm to living resources and to marine ecosystems, hazards to human health, damage to services/ facilities or interference with other legitimate uses of the area.
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	❑ Dealing with the prevention of pollution of the sea by oil, sewage and garbage from ships.
United Nations Convention on the Law of the Sea (UNCLOS)	❑ Namibia is obligated to protect and preserve the marine environment. ❑ Includes the prevention, reduction and control of pollution of the marine environment. Under this convention Namibia claims rights within a 12 nautical mile (Nm) territorial water and a 200 Nm Exclusive Economic Zone (EEZ). Article 79 of UNCLOS[5], in particular, concerns the installation of "submarine cables and pipelines on the continental shelf" and specifies the following: ❑ All States are entitled to lay submarine cables and pipelines on the continental shelf, in accordance with the provisions of this article as follows: ▪ Subject to its right to take reasonable measures for the exploration of the continental shelf, the exploitation of its

5 Source: http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf

	natural resources and the prevention, reduction and control of pollution from pipelines. ▪ The coastal State may not impede the laying or maintenance of such cables or pipelines. ▪ The delineation of the course for the laying of such pipelines on the continental shelf is subject to the consent of the coastal State. ▪ Nothing affects the right of the coastal State to establish conditions for cables or pipelines entering its territory or territorial sea, or its jurisdiction over cables and pipelines constructed or used in connection with the exploration of its continental shelf or exploitation of its resources or the operations of artificial islands, installations and structures under its jurisdiction. ▪ When laying submarine cables or pipelines, due regard shall be taken of cables or pipelines already in position. In particular, possibilities of repairing existing cables or pipelines shall not be prejudiced.
Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London Convention, 1972)	❑ Aims at controlling and preventing marine pollution and contains guidelines for dredged material known as the Dredged Material Assessment Framework (DMAF). ❑ Provides guidelines for dredging and disposal operations to minimize environmental damage
Convention Concerning the Protection of the World's Cultural and Natural Heritage	❑ The objective is that effective and active measures are taken for the protection, conservation and presentation of the cultural and natural heritage.
Convention on Biological Diversity, Rio de Janeiro, 1992	❑ Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity.
Benguela Current Convention of 2013	❑ The Convention is a formal treaty between the governments of Angola, Namibia and South Africa that sets out the countries' intention "to promote a coordinated regional approach to the long-term conservation, protection, rehabilitation, enhancement and sustainable use of the Benguela Current Large Marine Ecosystem, to provide economic, environmental and social benefits.
Abidjan Convention of 1981	❑ The Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region ❑ Provides an overarching legal framework for all marine-related programmes in West, Central and Southern Africa.
National Marine Pollution Contingency Plan of 2017	❑ Coordinated and integrated national system for dealing with oil spills in Namibian waters.

3.2 Additional national planning legislation

Additional planning legislation considered include:

- ❑ Harambee Prosperity Plan.
- ❑ 5th National Development Plan (NDP5).

The Harambee Prosperity Plan (HPP) is a targeted action plan to accelerate development in clearly defined priority areas, which lay the basis for attaining prosperity in Namibia. The plan does not replace, but complements the long-term goal of the National Development Plans (NDPs) and Vision 2030. The rationale behind the HPP is to introduce an element of flexibility in the Namibian planning system by fast tracking development in areas where progress is insufficient. It also incorporates new development opportunities and aims to address challenges that have emerged after the formulation of NDPs. It is the purpose of NDP5 to set out a roadmap for achieving envisioned rapid industrialization while adhering to the four integrated pillars of sustainable development as outlined below:

- Economic Progression
- Social Transformation
- Environmental Sustainability
- Good Governance.

3.3 Permits and Licenses Required

Based on the outcomes from screening, the following associated permits/approvals are likely to be required for the proposed landing of the Equiano Cable in Swakopmund (summarised in Table 7):

Ministry of Works and Transport (MoWT) – Directorate of Maritime Affairs
No permits are required from the Ministry of Works and Transport (MoWT). However, the following information would be required by them prior to cable installation:

- Details of the project and vessel.
- The coordinates and area where the vessel will operate, along with dates on when the vessel will be where.
- The name, flag and call sign of the vessel, all ship particulars.

This information will then be used to issue a marine navigational warning to ensure other vessels stay clear and do not interfere with the project.

Ministry of Mines and Energy (MME)
No permits will be required from the Ministry of Mines and Energy (MME); however, they should be consulted and informed about the project. It is the MME's responsibility to then notify the MoWT about the project from where Maritime Affairs broadcasts the details to other vessels to inform them of the ship location and planned works.

Ministry of Fisheries and Marine Resources (MFMR)
No permits will be required from the Ministry of Fisheries and Marine Resources (MFMR). The ministry must be consulted during scoping and be kept informed of the proposed project prior to installation commencing.

Office of the President
Based on information obtained from the WACS cable installation, it was determined that a lease agreement for the use of the seafloor must be concluded. This lease agreement must be signed by His Excellency the President of Namibia.

Ministry of Information & Communication Technology (MITC)
Based on informal engagements with the Ministry of Information & Communication Technology (MITC), no permits will be required from them.

Ministry of Education, Arts and Culture (MoEAC)/National Heritage Council of Namibia
If heritage resources are encountered during construction and installation of the Equiano Cable System, heritage permits may be required from the Ministry of Education, Arts and Culture (MoEAC)/National Heritage Council for the removal, disturbance and destruction of heritage resources. From discussions within the project team, it is unlikely that heritage permits will be

required for this development although it is recommended that a heritage assessment be undertaken during scoping to confirm this.

Ministry of Land Reform (MLR)
Permits may be required for the changing of land use from the Ministry of Land Reform (MLR). Given that the land-based components of the Equiano Cable System are located within the town of Swakopmund, it is unlikely that a change of land use permits will be required for the proposed development.

The portion of the beach south of Platz am Meer shopping mall (preferred landing site) is state property and an application needs to be made to the state for the landing of the cable at this site. This application can be made at the MLR. Through informal discussions, it is likely that this application can be processed within 30-60 days.

Swakopmund Municipality
A meeting was held with the Swakopmund Municipality to discuss the proposed Equiano Cable landing in Swakopmund and the landing alternatives under consideration. The Swakopmund Municipality indicated that the following would be required for project implementation:

- The proponent should apply for a wayleave from the municipality. Information required for the wayleave application includes the following:
  - The municipality needs to know exactly where the cable is proposed to land in Swakopmund.
  - The municipality needs to know the proposed cable alignment from the BMH to the CLS.
  - The municipality needs to know what land based activities are going to be performed during project implementation to ensure that the proposed locations are suitable for the installation of the Equiano Cable.

- The municipality indicated that the wayleave application should be in the form of a formal letter directed to the Swakopmund Municipality. The letter should contain all details on the landing location and alternatives, what land based infrastructure will be constructed if required, i.e. manholes or chambers, server rooms and exact locations of these.

The following Table 7 provides a summary of the permissions and licences that are likely to be required:

Table 7 Permissions and Licenses required

No.	Permit	Title	Description
1	Environmental Clearance Certificate	Ministry of Environment, Forestry and Tourism (MEFT)	Environmental Clearance Certificate as stipulated in the (Environmental Management Act, 2007). Based on findings during the screening exercise it is ACER's opinion that the certificate will be issued following a Scoping process and will not require a full EIA
2	Heritage Permits (Terrestrial)	Ministry of Education, Arts and Culture/National Heritage Council of Namibia	Onshore heritages resources in project's area of influence (unlikely to be required)
3	Heritage Permits (Offshore)	Ministry of Education, Arts and Culture/National Heritage Council of Namibia	Offshore heritage resources in project's area of influence (unlikely to be required)
4	Protected Tree and Plant Permits	Ministry of Agriculture, Water and Forestry/Directorate of Forestry	Based on observations on site and along the proposed fronthaul alignments, no protected plant and tree permits will be required
5	Maritime Permits	Ministry of Works and Transport/Directorate of Maritime Affairs	Based on discussions with MoWT, no permits are required for the installation of the Equiano Cable
6	Land Use Permits	Ministry of Land Reform	The portion of the beach south of Platz am Meer shopping mall (preferred landing site) is state property and an application needs to be made to the state for the landing of the cable at this site
7	Building Permits	Municipality of Swakopmund	A wayleave from the municipality will be required for land-based installations and construction
8	Sea Floor Lease Agreement	Office of the President	Based on information obtained from the WACS cable installation, it was determined that a lease agreement for the use of the seafloor must be concluded. This lease agreement must be signed by His Excellency the President of Namibia

3.4 Summary

In summary, Paratus has a number of legal obligations in terms of legislation, the pertinent obligations being:

- An obligation to undertake an EIA for the activities that fall within the scope of an impact assessment as defined in the EIA Regulations (2012).
- An obligation to obtain permits in terms of other relevant environmental legislation (for example, heritage, water and biodiversity).
- Adherence to the principles of sustainability and duty of care.

4 NEED AND DESIRABILITY

4.1 Overview

Submarine telecommunication cables are important for international telecommunication networks as they transport almost 100% of transoceanic Internet traffic throughout the world (www.iscpc.org). It is widely recognised that access to affordable international bandwidth is key to economic development in every country. Today, Africa relies primarily on satellites with few submarine cables to provide its international communications. Communication via submarine telecommunication cables generally allows for lower cost, better performance, and greater capacity (throughput) than that available via satellite.

Improvement in Africa's information technology infrastructure via telecommunication cables will remove one of the current key inhibitors to overall development in Africa and support economic growth and opportunities on the continent.

Paratus proposes installing a submarine telecommunications cable, referred to as the Equiano Cable System, to link …Namibia and South Africa with key international telecommunication hubs in Europe. In doing so, the company will facilitate more affordable and effective transport of voice, data, Internet and television services. Furthermore, the cable will support the objectives set out by the New Partnership for Africa's Development (NEPAD), and provide a means of fulfilling the Namibian Government's requirements in terms of its 2030 Vision regarding the importance of developing wealth, livelihood and the economy through improved telecommunications.

By supplying increased bandwidths, the proposed Equiano Cable System will support the following primary NEPAD objectives:

- To eradicate poverty in Africa and to place African countries both individually and collectively on a path of sustainable growth and development to thereby halt the marginalisation of Africa in the globalisation process.

At the core of the NEPAD process is its African ownership, which must be retained and strongly promoted, so as to meet the legitimate aspirations of the African people. (http://www.dirco.gov.za/au.nepad/nepad_overview.htm)

By supplying increased bandwidths, the proposed Equiano Cable System will support the NEPAD objective to eradicate poverty in Africa and to place African countries both individually and collectively on a path of sustainable growth and development; thereby halting Africa's marginalisation in the globalisation process. Telecommunications are one of the fastest growing sectors of southern Africa's economy, which has been driven by rapid growth in the number of mobile phone users and their need for broadband connectivity. The proposed Equiano Cable System will provide an opportunity to facilitate the growth of telecommunications infrastructure in Namibia and promote sustainable growth and development at a time when internet connectivity is essential for working and education.

5 PROJECT DESCRIPTION

This chapter describes the infrastructure and operational aspects of the Equiano Cable System. The aim of this chapter is to enable readers to gain a better understanding of how the cable system will be installed and maintained in order to understand the possible impacts the development may have on the receiving environment.

5.1 General description

The main Equiano cable trunk will be located approximately 200 to 500 km from the shoreline in international waters and will run down the West Coast of Africa as shown in Figure 1 (generally parallel to the coastline) and approach Namibian coastal waters from the north (i.e. international waters). From the main cable, branches will run through exclusive economic zones and territorial waters to the landing sites in each country. The proposed alignment through the Exclusive Economic Zone (EEZ) of 200 nautical miles and the Namibian Territorial Wates of 12 nautical miles with the landing site in Swakopmund, is shown in Figure 4.

The Equiano Cable System will enter Namibian Territorial Waters approximately 22 km from the seashore (12 Nm). The exact position of the final section of the cable has been identified based on a combination of engineering, environmental and economic factors and will require offshore and nearshore surveying of the seabed; however, the general alignment for this landing of the Equiano Cable System will follow the WACS cable general alignment to Swakopmund, which was installed in 2012.

The proposed Equiano branch to Swakopmund will include the installation and operation of the following project components:

- Laying of the cable in the deep-water environment (deeper than 1,500 m Water Depth (WD)), the cable will be placed directly on the sea floor and not require any cable burial.
- Within the shallow water environment, the cable will be buried in sediment wherever possible and the route will be adjusted to avoid obvious visible rock. The aim is to bury the cable to a depth of 1 m where possible.
- Excavations within the intertidal zone to bury the cable before being anchored into the Beach Manhole (BMH) which will be constructed directly inland of the beach at the preferred landing point.
- Installation of a sea earth system (System Earth) on the beach.
- On the beach the cable will be buried to a depth of 2 meters, substrate permitting.
- Construction of a BMH at the preferred landing point. The BMH will be constructed underground and will have the following dimensions: length (approximately 4.0 m); breadth (approximately 2.0 m) and depth (approximately 2.0 m).
- Installation of the onshore cable section between the BMH and the preferred Cable Landing Station (CLS) located near the Hage Heights WACS Co-location Facility which is currently operated by Telecom Namibia. The cable will be installed underground by trenching. Typically, the trench required for cable burial will be 1 m in depth and have a width of approximately 0.5 - 0.7 m depending on the excavator bucket width.

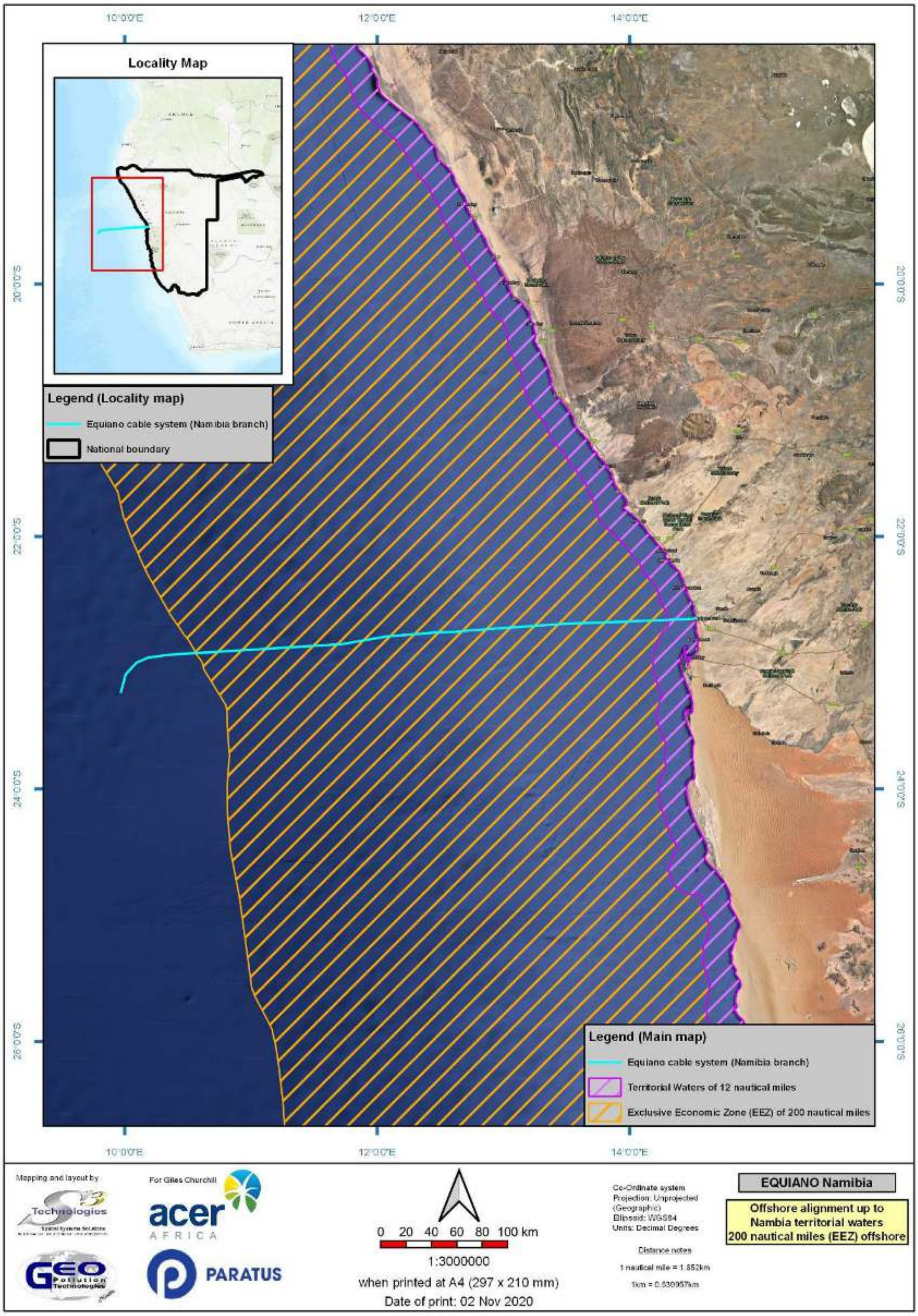


Figure 4 **Offshore alignment showing location of Equiano Cable system in relation to the landing in Swakopmund and Namibian territorial waters and EEZ (200 nautical miles) offshore**

5.2 Marine components and installation methods

5.2.1 Marine Fibre Optic Cable

Offshore, the cable is laid by a purpose-built cable-laying ship. Consistent with industry practice, the unarmoured cable (Plate 1 & 2) will rest on the seabed in water depths greater than 1,500 m, where the risk of inadvertent damage from human activities is negligible.

As the cable route changes direction to approach the coastline of Swakopmund, the cable will be buried beneath the sandy seabed of these shallower marine waters. This is typically achieved with the use of a specially designed plough which is submerged onto the seabed by the cable laying ship. The cable is then fed from the ship to the plough which effectively buries the cable to a depth of approximately 1.0 metres. This burial is intended to provide protection to the cable from the hazards posed by ships' anchors, fishing trawls/lines and the like.

The diameters of the marine fibre optic cables range in size from 17 mm diameter (cables installed at a water depth of between 7,000 – 1,500 m) to 37.5 mm diameter (double armoured cable which is installed in shallow water depths.

5.2.2 Repeaters and Branching Units

Repeaters

Repeaters are optical amplifiers that are installed along the length of the cable and are used to extend the reach of optical communications links by overcoming loss due to attenuation of the optical fibre (Plate 3). Repeaters will be installed at specific distances along the route making up the cable system. Repeaters are designed to function continuously without maintenance for 25 years in depths of up to 8,000 m with no degradation in mechanical, electrical and optical performance. This requires among other a controlled ambient internal climate and a durable enclosure.

Internal atmosphere is controlled to 20% relative humidity over the operating temperature range by the hydrogen getters[6] and moisture absorbing desiccants. The controlled internal gas atmosphere is suitable for maintaining the life expectations of all internal components.

The main structural component of the repeater housing is a monobloc tubular case fabricated from high tensile steel. The bulkhead and composite gland assembly provide full protection against water and gas ingress, either directly from the surrounding sea or from axial cable leakage due to a cable break close to the repeater.

The repeater housing is protected against corrosion with an organic electrically insulating barrier coating with additional mechanical reinforcement. This prevents seawater contact with the repeater housing steel surface and eliminates risk of metal wastage and galvanic corrosion and magneto-hydrodynamic effects that could generate hydrogen.

6 A "getter" is a deposit of reactive material placed inside a vacuum system to maintaining the vacuum. Gas molecules striking the getter material combine with it chemically or by absorption, and the gas is removed from the evacuated space.

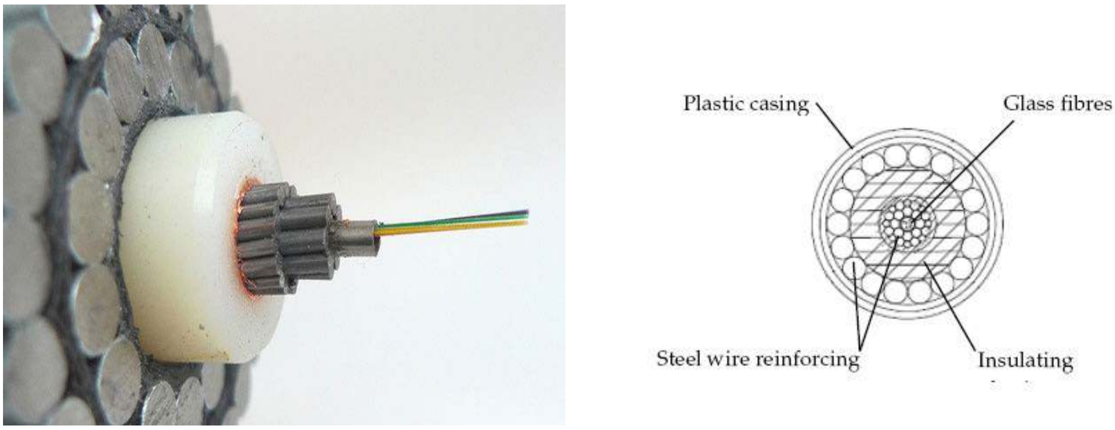


Plate 1 Cross section of a typical marine telecommunications cable

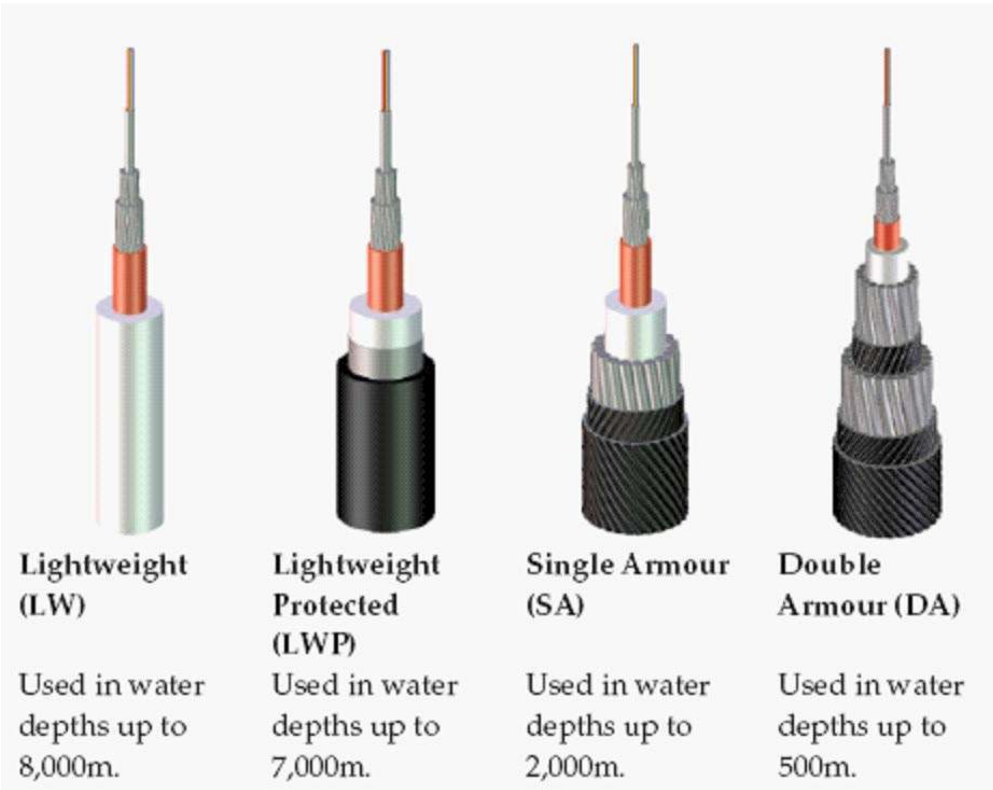


Plate 2 Cable armouring and operational depths

Repeaters are electrically powered. Voltage insulation is maintained between the internal unit and the repeater housing by two insulation paths: the polyethylene liner and the power conductor feeding through the gland assembly.

The repeaters will have the following specifications:

- The diameter of the rigid sea-case (white tube section in the photo) is approximately 270mm.
- The length of the sea-case section of the repeater is approximately 980mm.
- The total length of repeater is approximately 3,900 mm to 4,240 mm depending on cable coupling.
- The spacing between repeaters is approximately 75 km to 83 km varying with the route plan.

Plate 3 Repeater

5.2.4 Physical characteristics of fibre optic cables

External chemical properties of the cable

The external protection of the cable comprises a naturally occurring bitumen (asphalt) as a compound to adhere the outer polypropylene housing to the armour wires on the armoured shallow water cables. No form of additive to prevent bio-degradation or anti-fouling is used in the cable's outermost layers. The other cable components in contact with the sea are the galvanized steel armour wires and the polyethylene sheath, which also contain no additives harmful to marine life (Heath; 2001).

Electrical Current

According to Heath (2001), optical fibre cables carry a constant dc[7] current of 1.6 Amps to feed power to the underwater repeaters. This current is fed along the copper clad steel inner conductor and depending on the length of the cable span it may require several thousands of volts to maintain it. In very approximate terms the cable resistance is about 1 Ohm per kilometre and the repeaters, spaced at 50 km, drop about 30 volts each. Therefore, a cable spanning 4,000 km would have about 80 repeaters and require a power feed voltage of about 6,500 volts. It is normal practice to apply half this voltage at positive polarity to one end of the system and

7 Dc is direct current: the one directional or unidirectional flow electric charge

half the voltage at negative polarity to the other end to establish a zero voltage point midway along the cable span. This reduces the level of voltage stress on the cable and repeaters.

There is no external electric field associated with the power on the inner conductor. The ratio of the conductivity of the polyethylene insulation to that of seawater means that the electric field remains only within the cable insulation.

Electromagnetic Fields (EMFs)
Electromagnetic fields (EMFs) are generated by current flow passing through cables and can be divided into electric fields (called E-fields, measured in volts per metre, V m^{-1}) and magnetic fields (called B-fields, measured in µT) (Taormina *et al*., 2018). The dc current in the inner conductor does set up a stationary magnetic field in the form of concentric rings emanating from the cable. The magnetizing force produced by this field diminishes with increasing radius from the cable. EMF's are generally effectively confined inside cables by armouring (Taormina et al., 2018). As referenced from Heath (2001), for a cable carrying 1.6 amps this means that the magnetic flux density due to the cable at a distance 1 metre away is 0.32 micro Tesla. This is two orders of magnitude lower than the vertical component of the earth's magnetic field on the West Coast of the United States, which is about 43 micro Tesla. This means that marine life forms would need to approach to within less than half an inch of the cable to detect its magnetic field above that of the earth.

Audible sound and frequency association with "toning"
Audible sound lies in the range 15 to 40,000 Hertz and neither coaxial nor optical cables emit this range, or any other frequencies, during their normal operation. During the laying of the cable it can, on occasion, vibrate as a result of regular vortex shedding as it descends the water column. This is a low frequency phenomenon, at approximately 10 Hertz, is short lived and ceases when the cable comes to rest on the bottom.

The injection of a low frequency electrical signal from the land station is known as "toning". Toning is undertaken as an aid to cable location in the event of a fault on the cable or where other marine work is being conducted, which involves keeping a safe distance from the working cable. Toning works on the principle of a coaxial transmission line, formed by the inner conductor of the cable and the external armouring, providing a circuit for a low frequency signal.

At low frequency, a current applied to the inner conductor will propagate along the line, with its return path provided by a combination of the steel armour wires and the surrounding seawater. It is the proportion of current in the seawater, which enables electrodes trailed from a ship to detect the cable by locating the maximum level of the tone. During toning the level of the signal injected is usually around 160 mA at 25 Hz as the threshold level of detection on the ship electrodes is normally around 20 mA. The attenuation of the cables at low frequency is such that the tone injected at the terminal should be detectable across the length of the cable.

Toning is undertaken infrequently and is only really required prior to or during a repair operation on the cable. Toning is also undertaken during the installation of new cables, which have to cross or come close to the existing working cables. To increase safety margins in this situation, it helps the new installer to know the precise whereabouts of existing cables, which are mostly buried on the shelf area. Although toning is less effective in buried cables, it is much more reliable than visual or magnetometer detection in shallow water regions.

Toning has been used for many years on telegraph, coaxial, and optical fibre submarine cables throughout the world. From video evidence of ROV's tracking toned cables, the short-term presence of a low frequency, low level electric field in seawater does not appear to have any influence on the behaviour of fish.

5.2.5 Marine Fibre Optic Cable Installation

Prior to the installation of the Equiano Cable System taking place, the following offshore marine investigations have been performed by ASN to install the cable system.

Cable Route Survey
The proposed cable routes was surveyed by the project team to identify whether or not the substrate and topography of the ocean floor are suitable for the installation of the Equiano Cable System. The survey conducted by FUGRO (2019) included the following activities:

- A geophysical survey of the deep water, shallow water, and inshore sections of each proposed cable route. This will include the establishment of bathymetric corridor widths of 500 m (inshore and up to a depth of 500 m). In deeper water this corridor will extend up to three times the water depth centred on the proposed cable route.
- Conducting a side scan sonar and survey of a 500 m corridor width (inshore and up to a depth of 500 m) centred along the proposed cable route.
- Bottom samples taken at an average 10 km spacing in shallow water (less than 500 m in depth).
- The cable route will be surveyed using multi-beam echo sounder (MBES) Swath Bathymetry systems. The MBES equipment is integrated with the surface navigation equipment (GPS).
- Bathymetric data will be processed using the onboard workstation with specialised software to verify the coverage and accuracy of the collected bathymetry data and to provide colour contour charts. These charts will be used to review the proposed route and where necessary plan offset lines.
- In the shallow water sections, an integrated Side Scan Sonar and a Sub-bottom Profiler will be used. These will be housed in a device which will be towed behind a boat in order to get to an optimum position close to the seabed. The position of this towed device will be tracked acoustically using an ultra-short base line (USBL) tracking system.
- A burial assessment survey will be undertaken from the shoreline up to a depth of 1,500 m to test the suitability of the substrate for cable burial. The survey will include Cone Penetrometer Tests (CPTs) with an average of 1 CPT taken at 4 km intervals in planned burial areas.
- Sediment samples (in support of the sonar imaging and sub-bottom profiling) will be collected along the shallow water and inshore routes utilising gravity coring, or grab sampling devices.
- The landing sites for all cable segments will be positioned utilising Global Positioning System (GPS) and topographic surveying practices. (The in-shore survey vessels will use a GPS navigation system).
- At each landing site, the survey of the shore approaches will be supported where appropriate by a diver/swim team equipped with both video camera and bar probes. Any obstructions, potential hazards or engineering constraints to the submarine cable will be located and fully documented.

Cable Route Clearance Operations
Prior to the installation of the Equiano Cable System, route clearance operations will be conducted along those sections of the route where burial is to be performed to ensure that, as far as practically possible, the burial operation will not be hindered by out of service cables or discarded fishing gear. This route clearance operation is typically called the Pre-Lay Grapnel Run (PLGR). The objective of the PLGR operation is the clearance of any seabed debris, for example wires or hawsers, fishing equipment etc., which may have been deposited along the route.

PLGR is undertaken by dragging grapnels (Plate 4) behind a ship along the proposed cable route in order to clear the route of debris. Different types of grapnels can be used depending on the seabed conditions (Gillford in rockier areas and Rennies and Flat Fish in softer sandy sediments). The PLGR operations are normally carried out by a vessel specifically fitted out with winches and grapnels, and capable of sustaining good slow speed positional control. The vessel will be equipped with navigation and positioning system to the same specification as the main lay vessel. Alternatively, the main lay vessel will be used.

Any debris recovered during these operations will be discharged ashore on completion of the operations and disposed in accordance with local regulations. If any debris cannot be recovered, then a local re-route of the Equiano Cable System will be planned to avoid the debris.

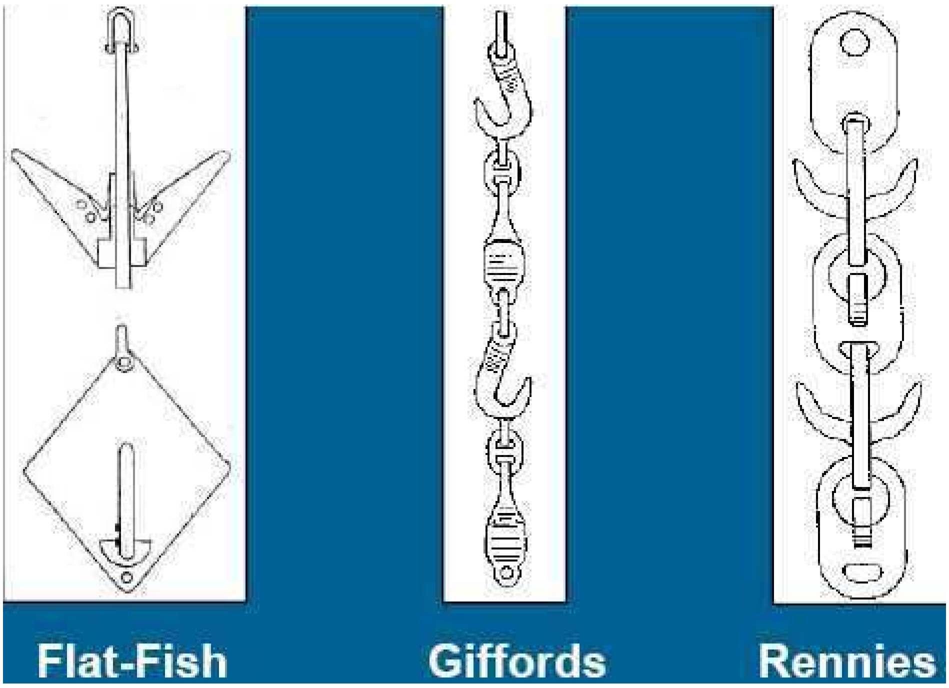


Plate 4 Types of grapnels used to clear the cable route of debris

Installation of the marine telecommunications cable

The Equiano Cable System will be installed using a purpose-built cable ship fully equipped with all the necessary equipment, tools and facilities to safely handle and install, join, test, and power the submerged plant, including simultaneous lay and plough burial. The vessel will have sufficient power and dynamic positioning capability to carry out the installation in the expected weather and current conditions. During cable laying an automatic log of all critical operational parameters will be kept including navigational data, speed, tension, slack, cable counter and plough data.

Surface Laying Operations

Surface laying implies that the cable will be laid on the surface of the seabed. The objective is to install the cable as close as possible to the planned route with the correct amount of cable slack to enable the cable to conform to the contours of the seabed without loops or suspensions.

Plough Burial Operations

The cable will be buried to a target depth as defined in the burial plan, and as determined by the cable route and burial assessment surveys. Burial depth will be controlled by adjusting the height of the plough's front skids. The depth of burial achieved will be continuously recorded by the plough and logged with the ship's data. In areas where plough burial is planned, the cable will be buried to a target depth of up to 1 m (Plate 5). The footprint of the cable trench is generally less than a 1 m in width with the plough skids having a width of less than 6 m.

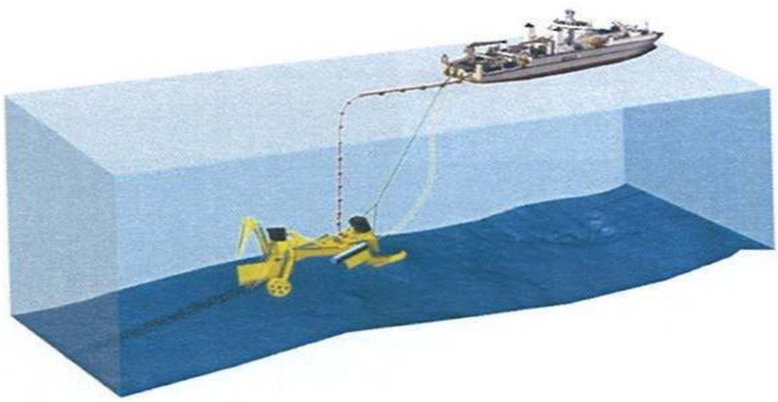


Plate 5 Sea plough to be used to bury the cable along sections of the cable alignment where conditions permit burial

Crossing of existing submarine cables and pipelines

For cable route planning, ASN uses the Global Marine Cable Database augmented by ASN's own internal databases and Admiralty Charts (UKHO, 2019) to identify all known existing and proposed telecommunication and power cable systems that will be crossed by the Equiano Cable System. Where existing cables are crossed, the industry norm is to ensure that the crossing is undertaken using a similar type cable, i.e., an armoured cable crosses an armoured cable or an un-armoured cable crosses an un-armoured cable. Where seabed conditions allow, post lay cable burial using a Remote Operated Vehicle (ROV) can be performed to afford additional protection to the cables at the crossing point.

If the Equiano Cable System requires a pipeline crossing, ASN recommends the application of Uraduct (or similar product) (Plate 6) to the cable at the point of contact with the pipeline.

URADUCT is a protection system designed and developed to protect subsea fiber optic cables, power cables, umbilicals, flexible flowlines, rigid flowlines, hoses and bundled products from abrasion and impact. Generally, the length of URADUCT required for a pipeline crossing is 50 m each side of the crossing or quarter the water depth either side of the crossing. Mattressing[8] can also be used when crossing pipelines; however, this is not considered necessary for standard pipeline crossings but may be installed in special circumstances at the request of the pipeline operator.

It must be noted that no pipeline crossings are expected for the landing of the Equiano Cable System in Namibia.

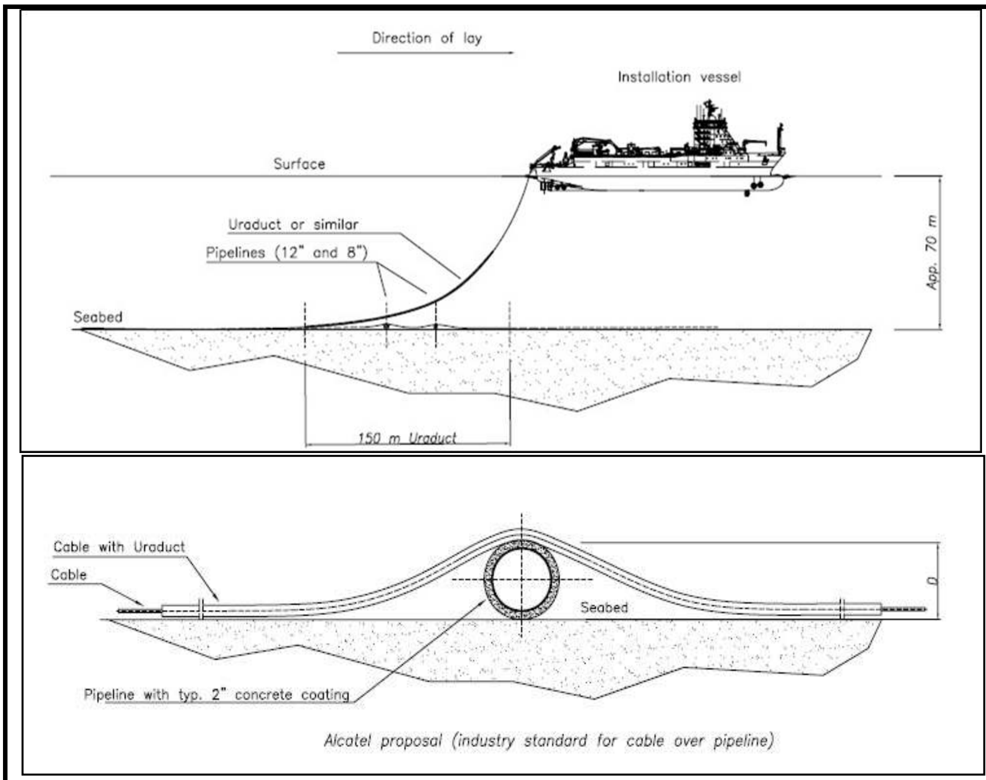


Plate 6 Example of a cable crossing using URADUCT or similar product (Source: ASN REH, 2019)

Shore End Operations

Shore end operations refer to the installation of the cable through the shallow water near shore, through the intertidal zone and up onto the beach (Plates 7 and 8). All shore end landings will be performed directly from the main cable installation vessel except where shallow water conditions require the use of a small shallow draft vessel or barges, usually mobilised specifically for the task, and equipped with cable tanks, cable engines, cable handling gear and a suitable cable burial device.

During cable landing in Swakopmund, the following activities will be performed by the appointed contractor:

8 Generally, mattresses are made of high strength concrete segments linked together with a network of high strength polypropylene ropes to form a continuous flexible concrete barrier which is used to separate structures ensuring the protection of infrastructure.

- Preparation of a detailed operational plan based on the findings of the survey, with site visits as necessary.
- Provision of an advance party to establish the beach equipment and to prepare the beach, cordon off a working area to protect the public, etc.
- The marking of any existing in-service cables at the shore end location (with the assistance of the cable owners).
- Performance of the installation of the shore end section of the sea cable and support of the cable vessel activity.
- Installation of cable slack at the beach, as required.
- Installation of a cable loop in the beach manhole to facilitate re-terminations.
- Securing the cable in the beach manhole by means of an armour wire anchor clamp.
- Burial of the cable from the Beach Manhole to the Low Water Mark (LWM) to a depth of 2 m (or to bedrock, if reached sooner).
- This may also include installation and burial of the sea earth plate and earth cable (System Earth).
- All digging will start the day before the planned cable landing.
- Reinstatement of the beach to the required standards.
- All testing, reporting, and accurate as-built records.
- Articulated pipe, where required across the beach up to the Beach Manhole, will be fixed to the beach manhole outside wall by means of a flange adapter.

Plate 7 Landing of the cable on shore. Similar works will be undertaken for the landing of the Equiano Cable System

In the near shore zone (generally in waters less than 9 m in depth) external protective measures such as articulated split pipes will be installed around the Equiano Cable to guard against cable damage due to the following:

- Surf zone wave action.
- Small vessel anchoring.
- Nearshore currents and tidal ebb and flow.

Using articulated pipe in the near shore environment increases cable protection against chafing by providing an additional physical barrier of protection against external forces. Articulated pipe (Plate 9) is usually made of cast iron and the additional weight it provides to the cable aids in stabilising the cable and in maintaining cable burial depth where that is possible. Standard practice is to apply articulated pipe to beyond the surf zone, however, at landings where burial may prove difficult, articulated pipe can be extended further offshore.

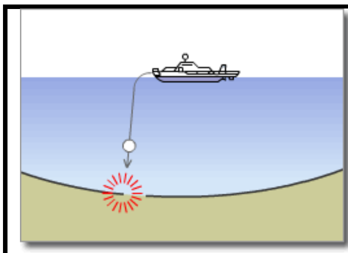
Plate 8 Bringing the cable to shore from the cable laying vessel. Cable is buoyed off and pulled to shore with smaller vessels.

Plate 9 Articulated pipe sections which are installed around the cable in shallow water to offer additional protection.

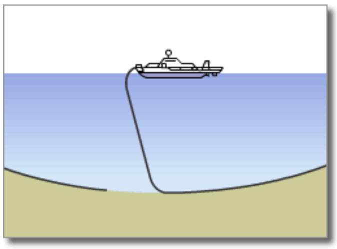
5.2.6 Post construction maintenance of the cable

Once installed, marine telecommunications cables generally require little to no maintenance if the cable is not damaged by natural disasters (underwater landslides, earthquakes, etc.) or through human activities (fishing trawlers, anchors, etc.). If the cable is damaged, a cable repair ship is dispatched to repair the cable fault (Plate 10), which usually entails the following:

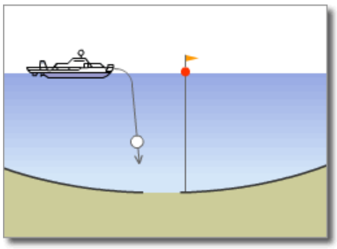
- Localization of the cable failure point and recovery of the failed cable section onto the ship.
- Cutting and removal of the cable failure section and then joining the recovered cable to the new section on board the ship.
- Testing of the cable followed by reburial of the cable on the exact same alignment.

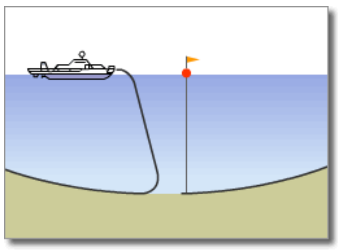


The cable ship is navigated to the location by a Differential GPS (DGPS). Once the fault is located, a cable cutting tool attached to the rope is paid out to the seabed. This tool and grapnel (Cable Catch) are then used to hook the cable before cutting the cable.

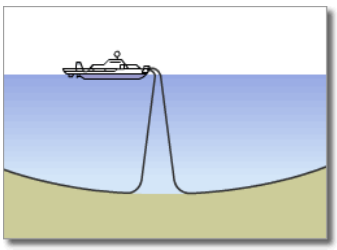


Once cut, the cable is recovered to the ship (Cable Recovery). Once on board the cable is tested to find the fault and that section of cable is removed. The cable is then waterproofed and dropped back to the sea floor attached to a buoy.





The same procedure is then carried out on the other section of cable still on the sea floor.



Once both sides of the fault have been repaired, the cables are once again bought up to the ship where a new section of cable is joined to the cable sections. Once completed the cable is placed back onto its original alignment and if necessary reburied.

Plate 10 Protocol for repairing cable faults to marine telecommunications cables (Source: http://www.k-kcs.co.jp/english/solutionRepairingMethod.html)

5.2.7 Cables in Operation – Life Cycle Analysis

A life cycle analysis study suggests that over a typical operational lifetime of 25 years (manufacture-to-decommissioning)[9] the main environmental impacts of a cable system are carbon emissions emanating from power consumption at the terminal station (chiefly related to air conditioning and powering of the terminal equipment); and b) vessel transits for cable maintenance.

"The results show that the use and maintenance phase clearly dominates all impact categories at an average of 66 percent (Donovan, 2009). By comparison, the raw materials and design and manufacturing phases account for, on average, only 6 percent of the total potential impact. This clearly highlights that the greatest impact over the life cycle of a submarine cable system comes from the use and maintenance activities. Namely, electricity use at the terminal to power the terminal equipment and the combustion of marine fuel during cable maintenance with purpose-built ships."

5.3 Terrestrial components and installation methods

5.3.1 Overview

Refer to Figure 5 which provides the terrestrial location of the Equiano Cable System from the landing at the beach just south of two breakwaters constructed to create a small 'harbour' feature 3 km north of Swakopmund's town centre, to the Beach Manhole, the haul route and location of the Cable Landing Station as further described below.

5.3.2 Beach Manhole

A schematic drawing of the BMH is provided in Figure 6. Once the fibre optic cable has made landfall and been buried through the beach section of the route, the cable will be anchored at the proposed Paratus Beach Manhole (BMH) at the preferred landing site at Paddock Gardens as shown in Figure 5.

The typical trench dimensions for cable burial under natural ground and under roadway are illustrated in Figure 7.

5.3.3 Construction Programme

It is anticipated that construction of all infrastructure required for the landing of the Equiano Cable System will not take longer than 3-4 months to complete including the offshore cable installation.

5.3.4 Project implementation

The landing of the cable is entirely dependent on receiving an Environmental Clearance Certificate from the MEFT. Only once the environmental authorisation process is nearing its completion will the project proponent be able to realistically set dates for project implementation. ASN is hoping to have the Equiano Cable System installed and operational by 2022.

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9 Donavan, 2009. "Twenty thousand leagues under the sea: A life cycle assessment of fibre optic submarine cable systems".

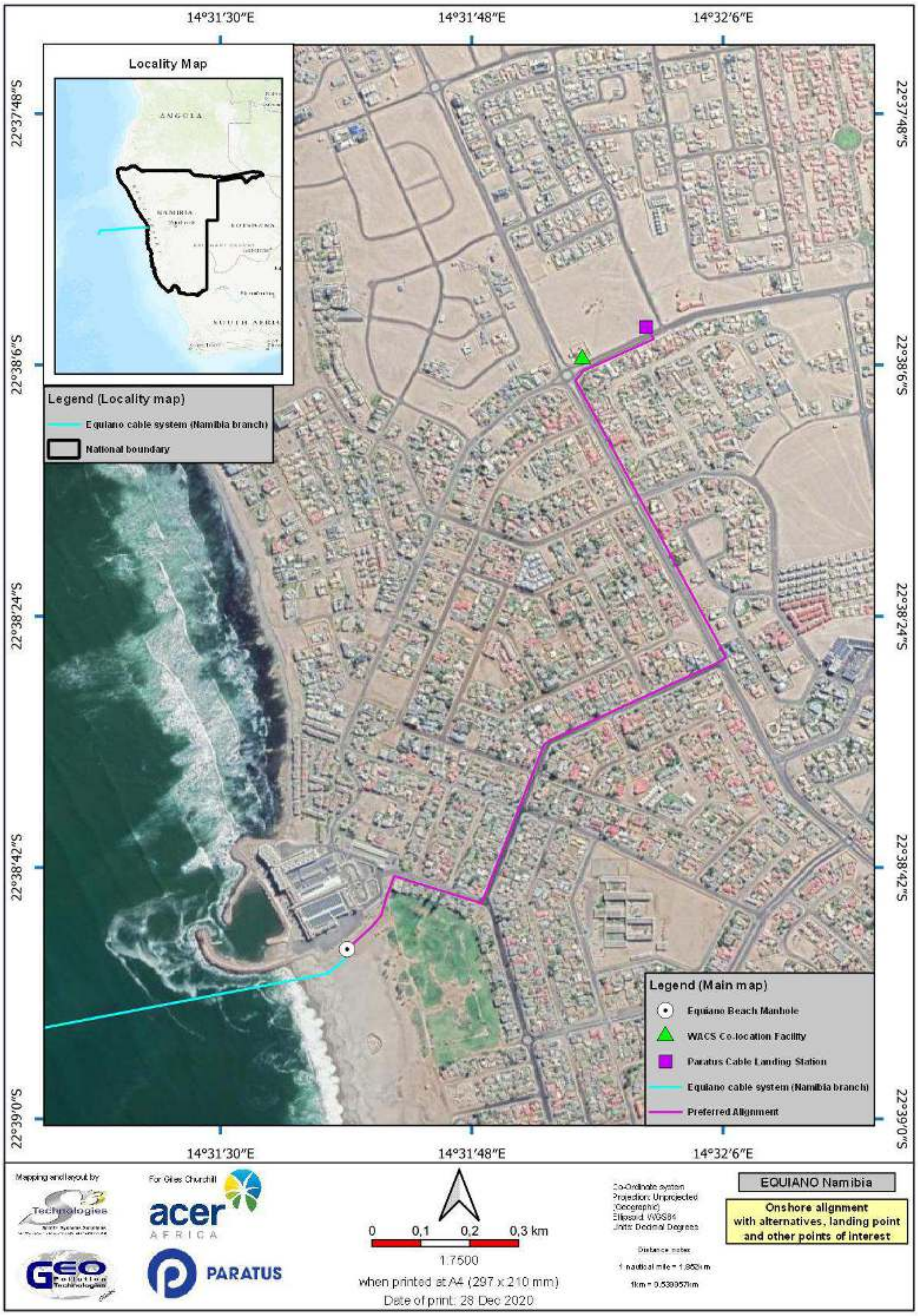
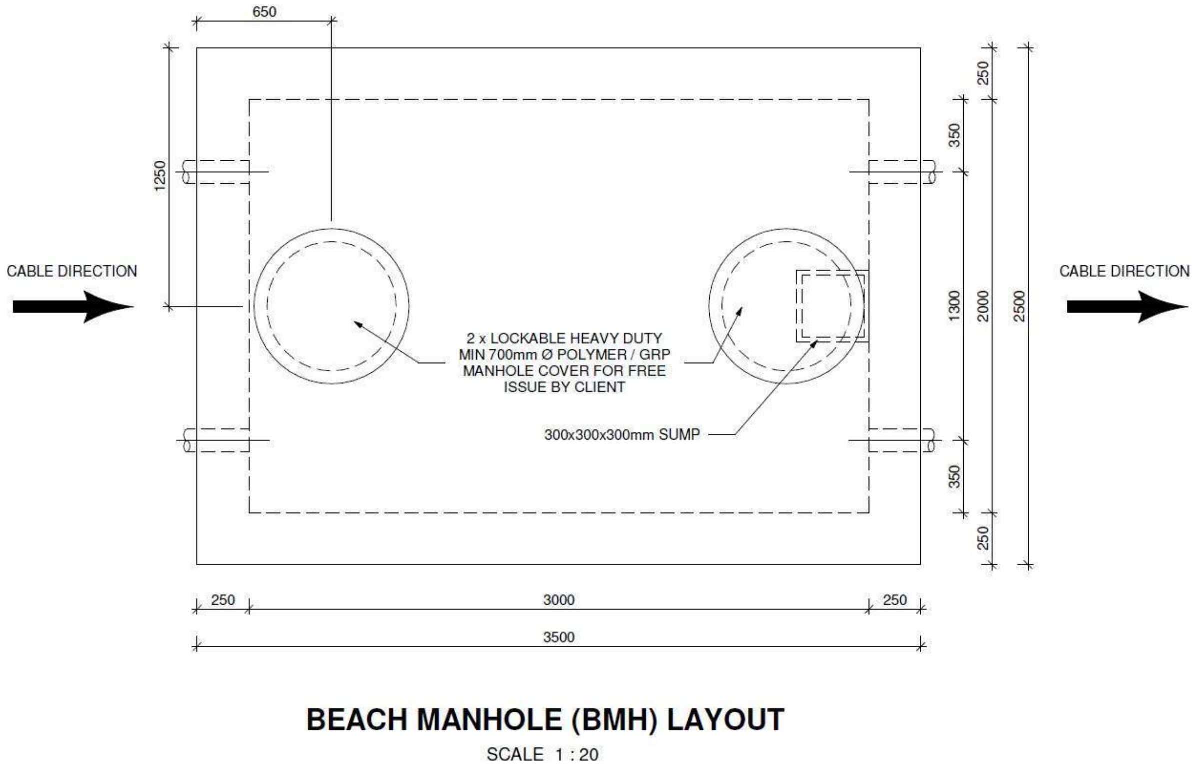


Figure 5 Location of landing at the proposed Beach Manhole at Swakopmund and haul route to the Paratus Cable Landing Station at Hage Heights Co-location



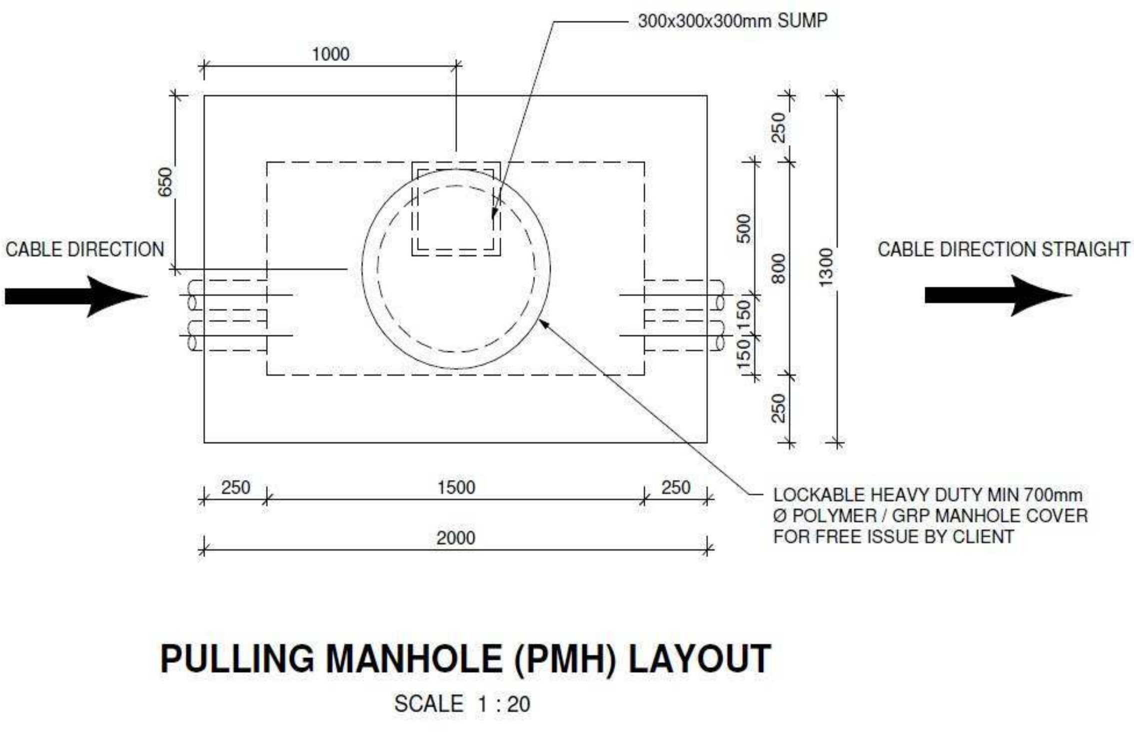


Figure 6 Plans for the Beach Manhole
(Sourced from Paratus)

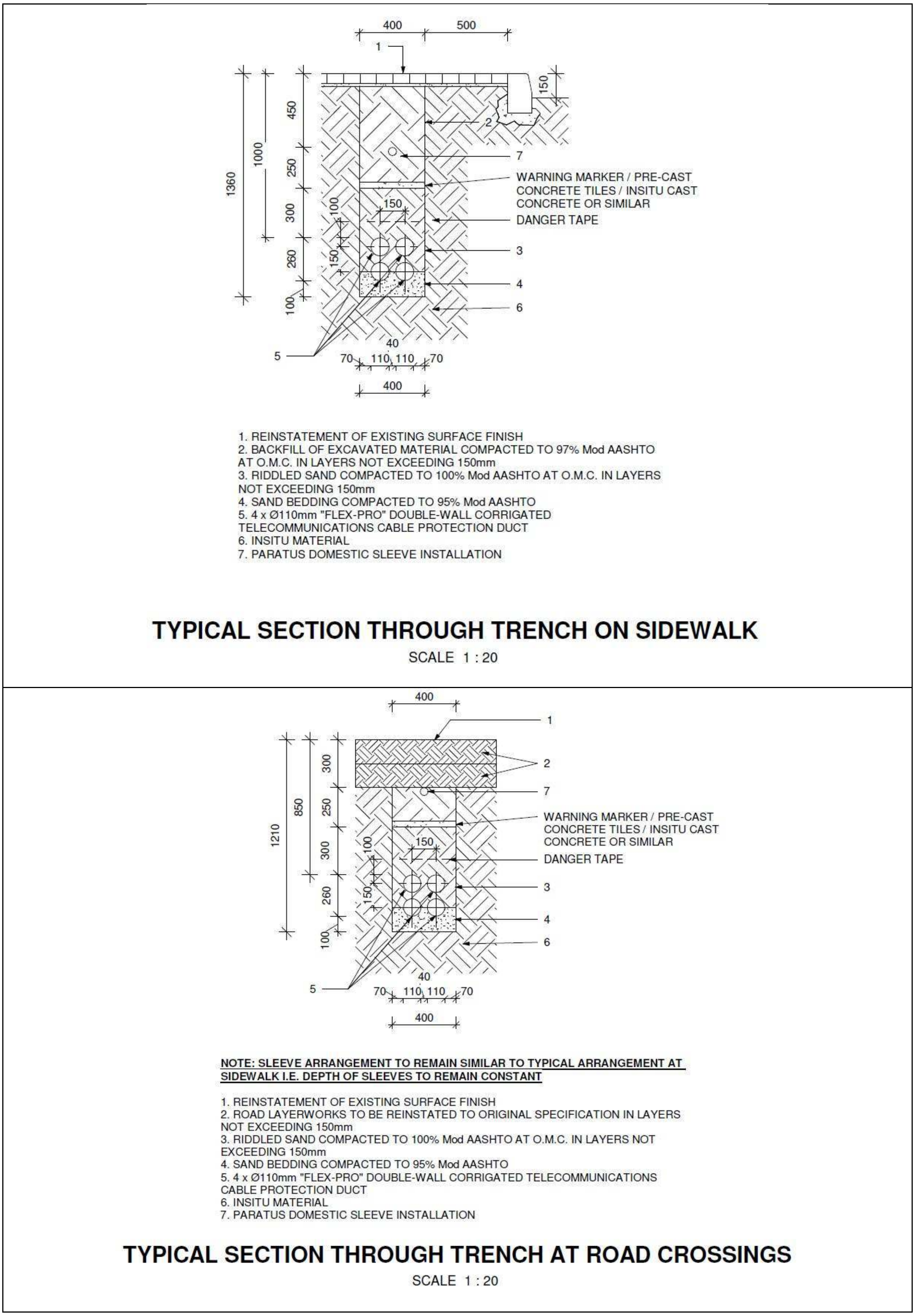


Figure 7 Trench dimensions for cable burial under natural ground and roadway
(Sourced from Paratus)

5.4 Existing services and project implementation

During construction and installation of the Equiano Cable System on land the following services will be utilised by the appointed service providers. Refer to the letter of approval for way leave included in Appendix 1, from the Swakopmund Municipality dated 7 October 2020, which provides details on the conditions to be adhered to for the trenching activities during construction.

5.4.1 Water

Water for construction purposes will be sourced from the closest municipal supply point and tankered to site when required. Water use during construction is however very limited and confined to the concrete works required for the construction of the BMH and cable sleeve.

5.4.2 Sewage

During construction and installation of the Equiano Cable System on land, chemical toilets will be provided for construction workers. These chemical toilets will be routinely serviced by the appointed service providers and all waste will be disposed at a licensed waste treatment works within the area. Given the short construction period associated with this project, the impact associated with sewage is not expected to pose any significant risk.

5.4.3 Storm water

The proposed development should not have any impact on storm water once construction is completed. During construction, however, the appointed contractor will take cognisance that the Swakopmund Municipality has storm water structures within the project area and these structures will be avoided during construction.

While trenching of the cable alignment is underway, stockpiles of soil will be located outside any storm water drains to prevent the wash away of material and siltation of downstream habitats.

5.4.4 Waste streams

During the construction and installation of the terrestrial section of the Equiano Cable System, little waste is expected to be generated on site and waste will be limited to litter, spoil from the trenching operations (where rubble or buried waste is unearthed) and material off cuts. It is envisaged that a skip will be hired for the duration of the construction period where all construction related waste will be stored and then disposed by an appointed service provider.

5.4.5 Decommissioning

Submarine Cables are designed to have a life-span of 25 years. Currently most of the installed cables are operating beyond this and decommissioning of the Equiano Cable System soon is unlikely given the current growth in the telecommunications sector within Namibia. When, decommissioning takes place, all activities would be subject to legislation relevant at the time.

6 PROJECT ALTERNATIVES

Alternatives are different means of achieving the purpose and need of a proposed development and include alternative sites, layouts or designs, technologies and the “no development” or “no go” alternative. This chapter describes the various alternatives **assessed for the** proposed installation and operation of the Equiano Cable System.

During project screening an alternative landing site called the Baobab Avenue landing point was assessed. This landing point is approximately 5 km north of Swakopmund’s town centre within a new residential suburb currently under construction. The beach at the proposed landing point is approximately 25 m wide and has a relatively steep slope falling 4 m across the beach. During the site visits undertaken by Pelagian in September 2019 and the ACER team in October 2019 the beach profile had shifted significantly and the municipality has confirmed through discussions that the beach has retreated by approximately 40 m over the last 10 years. This dramatic change in beach profile made this landing alternative not a viable alternative for cable burial and the risks posed to the cable through exposure and breaking.

As such, there is only one potential shore landing point under consideration for the Equiano Cable System located at the Paddock Gardens landing point at Swakopmund as shown in Figure 5 above.

6.1 Equiano Cable Preferred and Only Alternative Landing Site

6.1.1 Location

The Preferred and Only Alternative Landing site as shown in Figure 5 is located at:

- The **Paddock Gardens landing point**, which is located on the beach immediately south of the ‘Platz am Meer Waterfront Shopping Mall’.
- Co-ordinates are: S 22°38'47.76 and E 14°31'39.06.

The Paddock Gardens landing point is located on the beach immediately south of the ‘Platz am Meer Waterfront Shopping Mall’, Vineta North and is approximately 3 km north of Swakopmund’s town centre. The ‘Platz am Meer Waterfront’ development is a mix of seafront apartments, food and fashion retailers and high-end restaurants.

The proposed landing point is located to the south of two breakwaters, which were constructed to create a small ‘harbour’ feature (Figure 8). These breakwaters have resulted in an accretionary beach environment to the south of the harbour where sediment is deposited on the beach through disruptions of the longshore drift along the beach. Consequently, the beach at the proposed landing point is much wider and has more sand than neighbouring beaches and currently is approximately 200 metres wide.

An area, currently delineated as ‘public open space’ by the Swakopmund Municipality, south-east of the existing car parking area at the Platz am Meer Waterfront Shopping Mall, has been selected as the Paddock Gardens BMH position. The position of the BMH was selected as access to the beach is relatively simple from the parking area and fronthaul would also avoid the Paddock gardens located directly inland from the proposed BMH position (Figures 9 and 10).

Figure 8 Paddock Gardens landing point

Figure 9 Paddock Gardens Beach Manhole position

Figure 10 View of the propoed route to the BMH south of the mall at Swakoomund and Paddock Garden inland of the BMH

Directly inland from the beach is Paddock Gardens, which is a communal park area with walkways and benches. These are maintained by a local trust; a joint project of the local community and the Swakopmund Municipality (Plate 11).

Plate 11 Paddock Gardens

The Paddock Gardens Landing Site and BHM has been selected as the preferred and only landing alternative based on the following factors:

- No environmental red flags or fatal flaws[10] were identified at the proposed Paddock Gardens landing site which could preclude this landing alternative from being selected.
- Beach profile.
  The Paddock Gardens beach is wide and appears to be getting wider due to sediment deposition as a result of disruptions to longshore drift caused by the construction of the harbour breakwaters to the north. This has the following environmental benefits in terms of landing the Equiano Cable System at this location:
  - Once the cable is buried it is unlikely that it will become exposed in the future due to the deposition of material on the beach. This will reduce environmental impacts associated with maintenance and reburial operations on the beach during operation.
  - The proposed landing point is directly south of the harbour breakwater on a relatively disturbed section of beach.
- Location of the Beach Manhole.
  The proposed location of the BMH is directly to the south of the parking area behind the ‘Platz am Meer Waterfront Complex’. Access to the site is simple and will not result in a significant amount of disturbance to the beach environment.

10 A red flag indicates a severe impact or an impact that will be difficult (and probably expensive) to mitigate. Red flag issues and associated potential impacts require detailed specialist investigations. A fatal flaw indicates that the alternative should be precluded from further consideration.

- Paddock Gardens
  Some impact on the Paddock Gardens park directly inland from the beach is expected. However, these impacts are not considered significant because the gardens do not constitute “natural” indigenous vegetation and the proposed alignment of the terrestrial cable passes only through the northern-most section of the park along the existing walkway. The following management actions are recommended prior to construction commencing:
  - The custodians of Paddock Gardens (local municipality and community forum) must be consulted prior to construction to agree on the following:
    - The construction footprint.
    - The scheduling of construction and manner in which construction will take place.
    - The level of rehabilitation required and expected condition of the site post construction. This may involve some type of maintenance agreement between the cable operators and the custodians of Paddock Gardens.

6.1.2 BMH at Paddock Gardens to CLS at Hage Heights

From the proposed BMH at the Paddock Gardens landing point, the terrestrial cable alignment to the Hage Heights WACS Co-location Facility site runs through residential areas which have significantly transformed the natural environment. No environmental red flags or fatal flaws were identified along the proposed cable alignment which could preclude the installation of the Equiano Cable System.

The preferred alignment of the terrestrial cable from the BMH to the Hage Heights WACS Co-location Facility Co-location site is illustrated in Figure 5 and Plate 12 and is described hereunder:

- From the BMH through Paddock Gardens until reaching Albatross Avenue.
- The cable then turns right and runs along Albatross Avenue until reaching Fischreiherstrasse Street where it turns left.
- The cable then follows Fischreiherstrasse Street until it reaches Dr Schwietering Street where it then turns left to run along Dr Schwietering Street until reaching Tsavorite Street where it turns right running past the Hage Heights Telkom Namibia CLS to the proposed site for the Equiano CLS.

The following factors were identified during screening which need to be noted during project planning and implementation:

- Fischreiherstrasse Street is a paved road which will require the removal of paving for cable laying and then the reinstatement of the road paving.
- Fischreiherstrasse Street and Dr Schwietering Street are relatively busy roads and sufficient warning must be given to the Swakopmund Municipality to effect road closures and to notify surrounding residents of planned construction works.

6.1.3 Paratus Cable Landing Station near the WACS Hage Heights WACS Co-location Facility

The preferred and only cable landing station alternative is located near the WACS Hage Heights WACS Co-location Facility.

Alignment through Paddock Gardens

Alignment from Paddock Gardens to Albatross Avenue

Fischreiher Street

Corner of Fischreiher and Dr Schwietering Street

Dr Schwietering Street

Telkom Namibia Hage Heights WACS Co-location Facility

Plate 12 Fronthaul route from Paddock Gardens BMH to the Hage Heights WACS Co-location Facility Site

6.2 Marine cable alignment alternatives

The main cable trunk will be located approximately 200 to 500 km from the shoreline in International Waters. From the main cable, branches will run from the main trunk line through territorial waters to the landing site in each country.

The route of the marine portion of the cable entering Namibian waters has been identified based on a combination of engineering, environmental and economic factors. The marine cable alignment through the EEZ to Namibia's territorial waters is shown in Figures 4 and 11, with the marine cable route alignment landing at Swakopmund Paddock Gardens beach as shown in Figure 5 above.

The survey of the proposed marine alignment conducted by FUGRO in 2019 did not identify any fatal flaws along the alignment which could prevent the implementation of the project based on seabed topography and characteristics. It must be noted that the Equiano Cable System will require the crossing of 3 in-service cables (WACS SEG 1C (3.1); SAT 3 SEG 1; ACE) and 1 out-of-service cable (Telegraph) in deep waters.

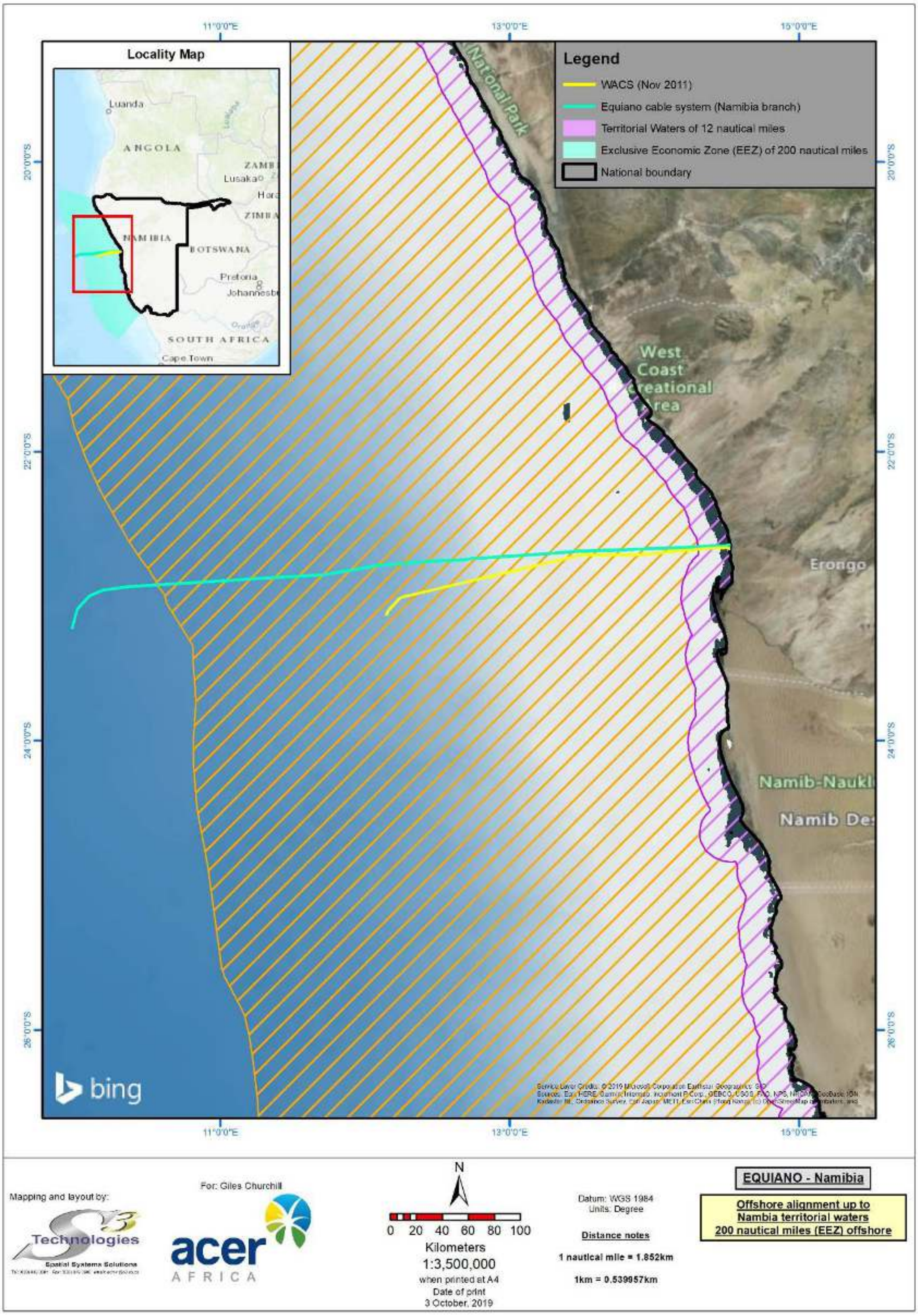


Figure 11 Equiano Marine Cable System Alignment on the Namibian coast through the EEZ and Namibia's Territorial Waters to the landing point at Swakopmund

6.3 Technology Alternatives

Although there are a number of available telecommunication mechanisms used worldwide the scale of customer demand and expectation of ever faster data transfer have made many of these inadequate or obsolete. Radio has largely been phased out due to restricted bandwidth and poor data transmission. Currently, Africa relies primarily on satellites with few submarine cables to provide its international communications. Satellite and microwave transmissions are unable to offer the capacity required for Namibia and other African countries to remain part of the global community in terms of communication services.

Fibre optic networks are able to transmit sufficiently high volumes of voice and data traffic, with higher security, reliability and at a low cost. This is the current preferred technology for meeting demand for data and voice transmission on a global scale and is one of the main reasons why the Equiano Cable System is based on a fibre optic network.

6.4 Operational Alternatives

The timing from a tourism and recreational perspective of the construction required on the beach, will need to be taken into consideration as soon as the project's timing is determined.

Operational alternatives are also applicable to the seasonal timing of the offshore installation of the Equiano Cable System related to seasonal whale migration patterns.

6.5 No-Go Alternative

In the context of the proposed development, the No-Go alternative would mean that installing the proposed Equiano Cable System at Swakopmund would not take place . Although impacts on the marine and terrestrial environment would be avoided entirely, submarine telecommunication cables are important for international telecommunication networks and it is widely recognised that access to affordable international bandwidth is key to economic development in every country.

Africa relies primarily on satellites with few submarine cables to provide its international communications. Communication via submarine telecommunication cables generally allows for lower cost, better performance, and greater capacity (throughput) than that available via satellite. If the No-Go alternative is selected, Paratus and Namibia will be missing out on an opportunity to unlock economic development within the country. In addition, should the No-Go alternative be selected it would mean that Paratus will not be able to operate an international fibre-optic bandwidth and they will be unable to facilitate more affordable and effective transport of voice, data, Internet and television services to Namibia's population.

6.6 Other considerations

6.6.1 Community safety

The main safety issues during project implementation of the proposed Cable System are that construction activities may pose a safety risk to local residents and visitors to the beach as there will be working machinery and open trenches associated with the construction of the proposed project. Mitigation measures have been included in the EMP to manage these safety risks including:

- ❑ Construction vehicles must obey regulated speed limits, lights will be switched on at all times and no large vehicles will use the roads at dawn, dusk, at night or in heavy mist conditions to reduce the risk of accidents with other vehicles and pedestrians.
- ❑ Deliveries of materials and large components will be scheduled for times that fall within, or outside of the school day, and not in the early morning or mid-afternoon when there are school children using the access roads.
- ❑ All trenches must be dug with digging, placement of infrastructure and backfilling taking place on a progressive basis to limit the amount of open trench on site.
- ❑ All trenches must be suitably barricaded to prevent access by surrounding residents or children.

6.6.2 Sustainable management and natural resources

Over recent years, private sector finance for infrastructure projects, both in the developed and developing world, has increased in importance. This has exposed financial institutions to increasing pressure from Non-Governmental Organisations (NGOs) for their involvement in a variety of controversial projects and the need for greater transparency, accountability and tighter standards in the operations of commercial banking. Stemming from these demands and concerns is a set of standards known as the Equator Principles, which are based on the International Finance Corporation (IFC) performance standards on social and environmental sustainability, and on the World Bank Group's Environmental, Health and Safety General Guidelines. The Equator Principles promote socially responsible conduct and sound environmental practices in relation to project financing initiatives.

The single most important factor in reducing the environmental (and social) impacts of marine telecommunications infrastructure projects is good site selection and the ease at which marine telecommunications cable can tie into the existing land based telecommunications network (distance from landing site to the Cable Landing Station and existing network). The best option is, as much as possible, to avoid negative impacts on the environment from the outset, thereby minimising the amount of environmental mitigation measures required.

6.6.3 Cumulative Impacts

A cumulative impact is an incremental impact upon the environment that results from the impact of a proposed action when added to past, existing and reasonably foreseeable future actions. Cumulative effects can be both positive and negative.

The construction of the Equiano Cable System will add to any cumulative impacts already likely to occur from a wide range of development interventions, i.e. increased employment, increased investment, etc. The aim of this section is to focus on the key cumulative impacts raised as concerns by stakeholders and identified by the specialists, as well as those associated with the project that may trigger different development pathways.

In this regard, a key cumulative impact has been identified to date which will require further investigation, viz. the combined impact of current and future marine telecommunication cable systems on the deep-sea trawling industry and the offshore Oil & Gas Sector.

As referenced from the National Policy on Climate Change (MET; 2011), the predicted consequences of climate change of interest to the Equiano Cable System landing at Swakopmund off the coast of Namibia are:

- Sea level rise, which is expected to increase by 18-59c m over the 20th century. Climate change induced sea level rise is expected to cause (i) increased coastal erosion, (ii) flooding, inundation and displacement of coastal wetlands and lowlands (iii) impairment of water quality in freshwater aquifers and estuaries due to increased salt intrusion and (iv) reduced protection from extreme storm and flood events with accompanying damage to infrastructure and displacement of communities.
- Namibia's marine fisheries (of direct relevance to the Namibian fisheries industry and indirect relevance to the Equiano Cable system) are predicted to be impacted on by possible changes from climate change to the nutrient-rich upwelling of the Benguela Current system, caused by future changes in wind distribution and intensity suppressing the upwelling, causing the accumulation of oxygen poor water near the sea-bed impacting negatively on marine life.

Cumulative impacts associated with climate change such as the increase in severity and occurrence of storm events and the predicted rise in sea-level will be included in the management and mitigation component of the EMP to monitor for erosion of the beach environment.

7 PUBLIC PARTICIPATION PROCESS

The public participation process that includes a 21 day comment period has been designed to comply with the requirements of the EIA Regulations (2012) of the EMA. The important elements relating to the public participation process that are required by the Regulations are the following:

- The manner in which I&APs were notified of the application for environmental authorisation. This includes on-site notice boards, giving written notice to landowners, letters, Background Information Documents (BID) and advertisements in the media (Section …)
- Opening and maintaining a register containing the names and addresses of I&APs. These include all persons who have submitted comments, attended meetings, and are organs of State who have jurisdiction in the assessment process, and all those who have requested that they be placed on the register as registered I&APs (Section …).
- Registered I&APs are entitled to comment, in writing, on all written submissions made to the competent authority by the applicant or the Environmental Assessment Practitioner managing the application, and to bring to the attention of the competent authority any issues, which that party believes may be of significance when the application is considered for authorisation (Section …).
- The comments of registered I&APs must be recorded and included in the reports submitted to the competent authority (Section …).

The objectives of public participation are to provide sufficient and accessible information to I&APs in an objective manner to assist them to:

- Identify issues of concern and provide suggestions for enhanced benefits and alternatives.
- Contribute local knowledge and experience.
- Verify that their issues have been considered, either by the EIA Specialist Studies, or elsewhere.
- Comment on the findings of the report including the measures that have been proposed to enhance positive impacts and reduce or avoid negative ones.

Public participation incorporated the following activities as part of the **project notification phase**:

Press Notices

Press notices were placed in two national newspapers for two consecutive weeks. Notices appeared in Die Republikein and The Namibian Sun on 18 and 23 September 2020 (Appendix 1. The notices appeared in the press during the time that Namibian Safety Regulations (as per the National Covid-19 pandemic response) were in force. To accommodate news dissemination, both publishing houses made their publications available online.Therefore the notices appeared freely on the internet as well as per the conventional, commercially available printed media.

Site Notices

Site notices were erected on site on and were still present at the time of the compilation of this report. Site notices were erected at the preferred BMH site at the CLS site and an additional notice was erected at the Platz Am Meer Mall (Appendix 1).

Stakeholders Database

During the initiation phase of the public consultation process, IAPs were made aware of their rights to provide input into the assessment process through registering on the project and providing comments and concerns. This invitation appeared on all the notices as mentioned above. Combining the registered parties with those already identified to be IAPs cumulated in the stakeholder list for the project. All parties on this list received and will continually receive information about the ECC application as well as an opportunity to comment on this report.

Stakeholder Notification Letters

Key stakeholders and other I&APs, who include local, provincial and national government authorities, local businesses, environmental interest groups, affected landowners/users and neighbours were identified and their contact details incorporated in a project database during the project notification phase.

The direct mailing list for this EIA consists of individuals and organisations from both within the project area and beyond. A copy of the stakeholder database is provided in Appendix 1.

Conventional methods of neighbour notification involves the physical delivery of notification letters to property owners. This project however, had to conduct project notification during the Covid-19 pandemic. Therefore, conventional methods of neighbour notification could not be executed. To ensure all stakeholders were identified the project team engaged with various departments (GIS and Administration) of the Swakopmund Municipality, to obtain contact details of the property owners along all proposed alternatives. These landowners were then contacted telephonically and electronically. Notification letters were sent via email to minimise personal contact as per the safety regulations related to Covid-19. Where no electronic means could be established the landowners received a hand delivered notification letter. A database of all electronically notified persons was drawn up while a record for the hand delivered notifications was kept. A list of the IAPs to which a notification letter and information were sent is attached in Appendix 1.

Among the property owners were the Swakopmund Municipality and the current President of Namibia, Hage Geingob. Additional Ministries which were notified includes the Ministry of Works and Transport, Directorate of Maritime Affairs, as well as the Ministry of Fisheries and Marine Resources. The information sent to identified persons aimed at informing them about the proposed project as well as inviting them to provide their comments and concerns.

Background Information Document

Background information documents were provided to various IAPs (Appendix 1) during the project initiation process. This document provided an overview and non-technical summary of the proposed development and act as an easy reference to proposed project information.

Comments and Responses Report

All the comments and concerns received during the notification period of the project has been captured in a comments and responses table as attached in Appendix 2. The main issues of concerns have been summarised below.

- ❑ Construction concerns related to the laying of the cable including:
  - Utility damage,
  - Pavement and foundation damage,
  - Legality of sidewalk disturbance.
- ❑ Any possible connection with regards to 5G was noted as undesirable.
- ❑ Employment requirements (Namibian).

This report will be updated to include any additional inputs from I&APs that may be received as the EIA process proceeds and will be included in the final report submitted to MEFT for decision making.

8 DESCRIPTION OF THE RECEIVING ENVIRONMENT

This section describes relevant characteristics of the receiving environment that may affect or be affected by the proposed Equiano Cable System development and associated infrastructure. The aim of this chapter is to enable the reader to understand the receiving environment in the context of the proposed development.

8.1 Marine and Offshore Environment

At each landing country associated with the Equiano Cable System as shown in Figure 1, the proposed fibre-optic cable will transit coastal waters and be brought on shore using industry-standard installation methodologies. When selecting the route alignment for the Equiano Cable System, the following criteria were taken into account by the engineering team in order to find the most practical and cost-effective alignments:

- The placing of the cable close to and along existing alignments of submarine telecommunications cables entering Namibia's coastal waters.
- Identification of a suitable landing beach that minimises on-shore environmental and infrastructure constraints and enables the cable to be linked to the proposed or existing cable station.

Refer to Figures 4 and 11 which show the offshore alignment.

8.1.1 Marine Protected Areas and Ecologically or Biologically Significant Areas

Marine Protected Area
The Namibian Islands' Marine Protected Area (NIMPA) was officially launched on 2 July 2009 under the Namibian Marine Resources Act (No. 29 of 1992 and No. 27 of 2000) (Pulfrich, 2020). The MPA lies far south and outside the Equiano Cable System route (Pulfrich, 2020). Refer to Figure 12.

Ecologically or Biologically Significant Areas (EBSAs)
In the spatial marine biodiversity assessment undertaken for Namibia (Holness *et al*. 2014) various offshore and coastal areas were identified as being of high priority for place-based conservation measures. To achieve this, Ecologically or Biologically Significant Areas (EBSA) spanning the coastline between Angola and South Africa were proposed and written under the Convention of Biological Diversity (CBD). The principal objective of the EBSAs is the identification of features of higher ecological value that may require enhanced conservation and management measures.

Brief descriptions of these EBSAs referenced by Pulfrich (2020) from the EBSA-Portal (https://cmr.mandela.ac.za/EBSA-Portal/South-Africa), are provided below and illustrated in Figure 12:

- Two of the eight EBSAs identified off Namibia fall exclusively within Namibian national jurisdiction (Namib Flyway and Namibian Islands), while one is shared with Angola (Namibe) and two are shared with South Africa (Orange Shelf Edge and Orange Cone).
- The Benguela Upwelling System transboundary EBSA extends along the entire southern African West Coast from Cape Point to the Kunene River and includes a portion of the high seas beyond the Angolan EEZ This System is a transboundary EBSA, which makes it globally unique as the only cold-water upwelling system to be bounded in the north and south by warm-water current systems and is characterized by very high primary

production (Pulfrich, 2020). It includes important spawning and nursery areas for fish as well as foraging areas for threatened vertebrates, such as sea- and shorebirds, turtles, sharks, and marine mammals. Another key characteristic feature is the diatomaceous[11] mud-belt in the Northern Benguela, which supports regionally unique low-oxygen benthic communities that depend on sulphide oxidising bacteria.

- The Equiano Cable Route crosses the **Namib Flyway EBSA**, which extends from 18 km north of Cape Cross to 30 km south of Conception Bay, covering approximately 380 km of coastline bordering the Dorob National Park, Cape Cross Seal Reserve and the Namib-Naukluft Park.

  - The weak upwelling cell off Walvis Bay and the sheltered bays (Walvis Bay and Sandwich Harbour) and shallow waters featured in this EBSA (Cape Cross lagoons, Swakop River Mouth Lagoon, Walvis Bay Lagoon and Mile 4 salt works) lead to warmer waters and higher productivity. Two of Namibia's five Ramsar sites (Walvis Bay and Sandwich Harbour) are included, which are of international importance for resident bird species as well as resident and temporary marine mammals, and constitute key refueling and roosting habitats for many species of migrating waterbirds (Pulfrich, 2020)
  - This EBSA includes six terrestrial Important Bird Areas (IBAs), and two proposed marine IBAs as shown in Figure 13. The coastline includes mixed rocky and sandy shoreline, which together with the adjacent marine inshore environment supports resident, Palearctic, Oceanic and intra-African migrant bird species.
  - The area also encompasses key spawning and nursery areas of various fish species, including sardine and anchovy which are important forage fish for a range of marine predators. The area is highly relevant in terms of its importance for life-history stages of species, threatened, endangered or declining species and/or habitats, and biological productivity.
  - The Namib Flyway area also hosts several 'Near threatened' and 'Vulnerable' fish species and is considered an important foraging area for leatherback turtles from both the nesting grounds in Brazil and KwaZulu-Natal in South Africa.
  - The Namib Flyway also includes three 'Endangered' habitat types that are not impacted on the Equiano Marine System. These are the Central Namib Outer Shelf, Kuiseb Lagoon Coast and Kuiseb Mixed Shore, with the area being particularly important for Central Namib Outer Shelf and Kuiseb Lagoon Coast as shown in Figure 14.
  - Table 9 lists the Ecosystem threat status for marine and coastal habitat types off Central Namibia (adapted from Holness et al. 2014). Those habitats affected by the Equiano Cable System are shaded in light grey. The number refers to the numbers used in the legend of Figure 14.

No specific management actions have as yet been formulated for the EBSAs. Two biodiversity zones have however, recently been defined within each EBSA as part of the marine spatial planning process.

The management objective in the zones marked for 'Conservation' is "strict place-based biodiversity protection aimed at securing key biodiversity features in a natural or semi-natural state, or as near to this state as possible".

11 diatomaceous is a naturally occurring, soft, siliceous sedimentary rock that is crumbled into a fine white to off-white powder; (source: https://www.google.com/search?q=diatomaceous&oq=diatomaceous

The management objective in the zones marked for 'Impact Management' is "management of impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state"[12]

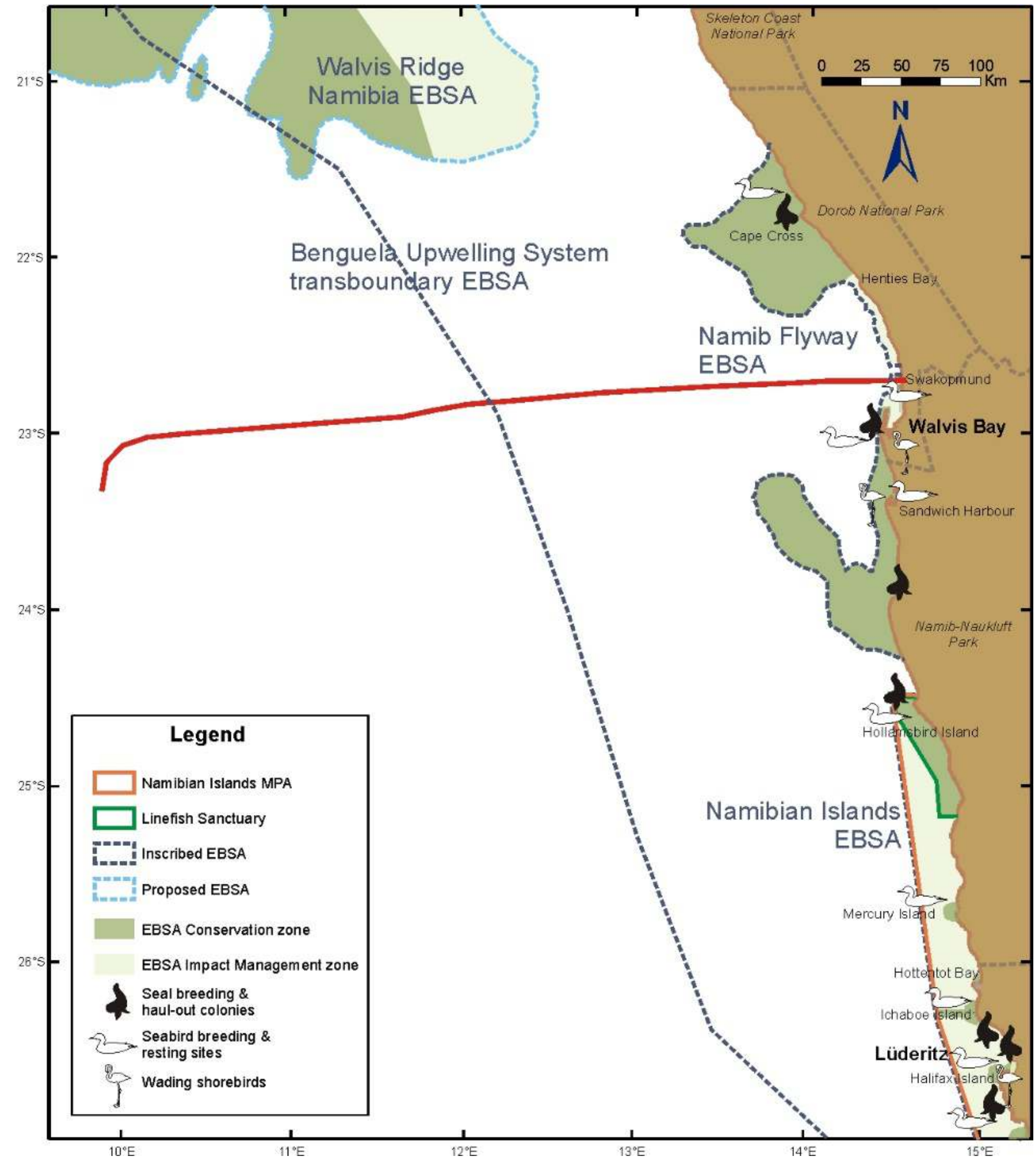


Figure 12 The Equiano Cable route (red line) in relation to the Namibian Islands Marine Protected Area, Ecologically and Biologically Significant Areas (EBSAs) and the marine spatial planning zones within these (referenced from Pulfrich, 2020)

12 https://cmr.mandela.ac.za/EBSA-Portal/Namibia/NA-EBSA-Status-Assessment-Management, accessed 5 June 2020 by Pulfrich (2020)

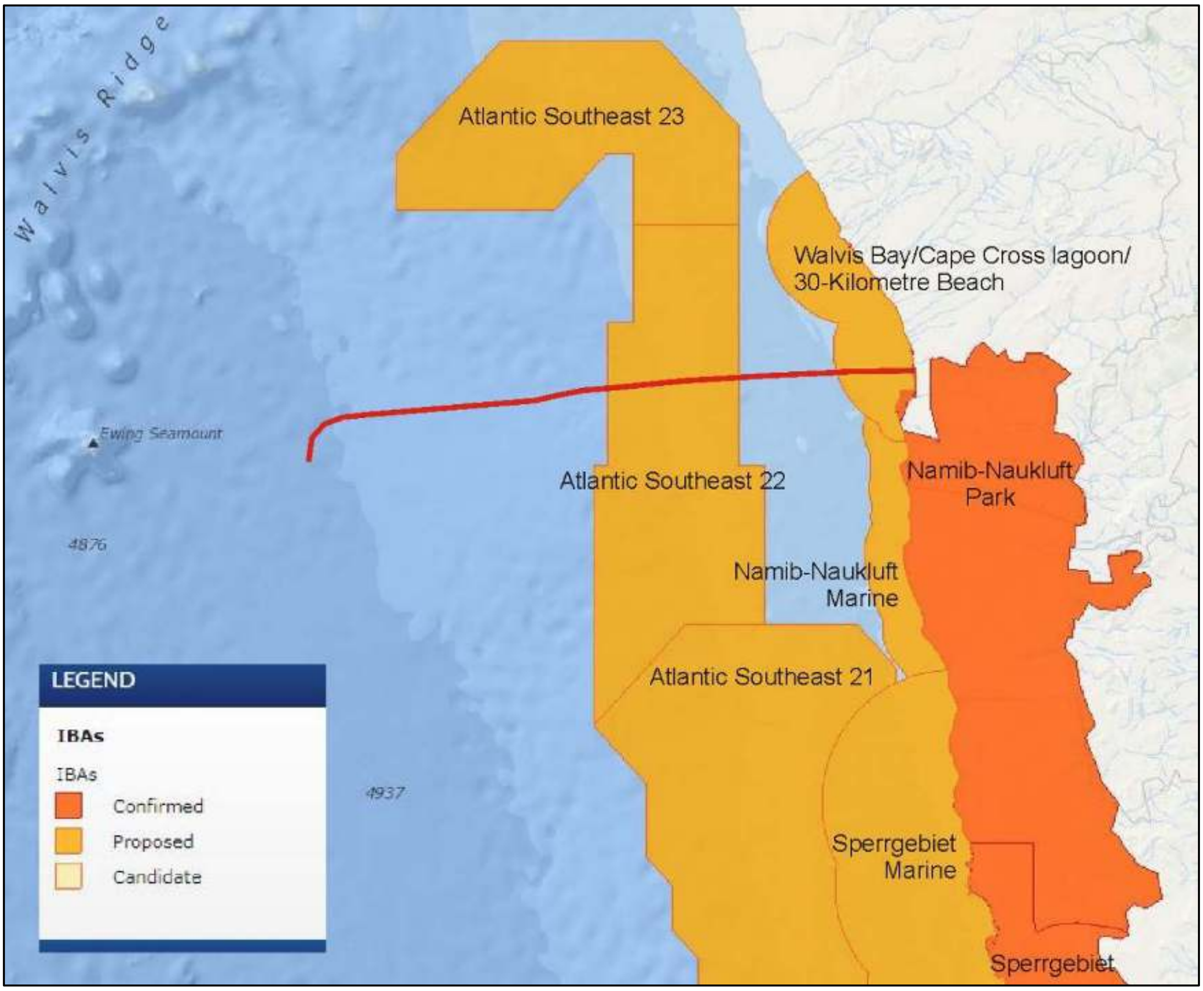


Figure 13 **The Equiano Cable route (red line) in relation to confirmed and proposed coastal and marine IBAs in central Namibia (Source: https://maps.birdlife.org/marineIBAs) as referenced from Pulfrich (2020)**

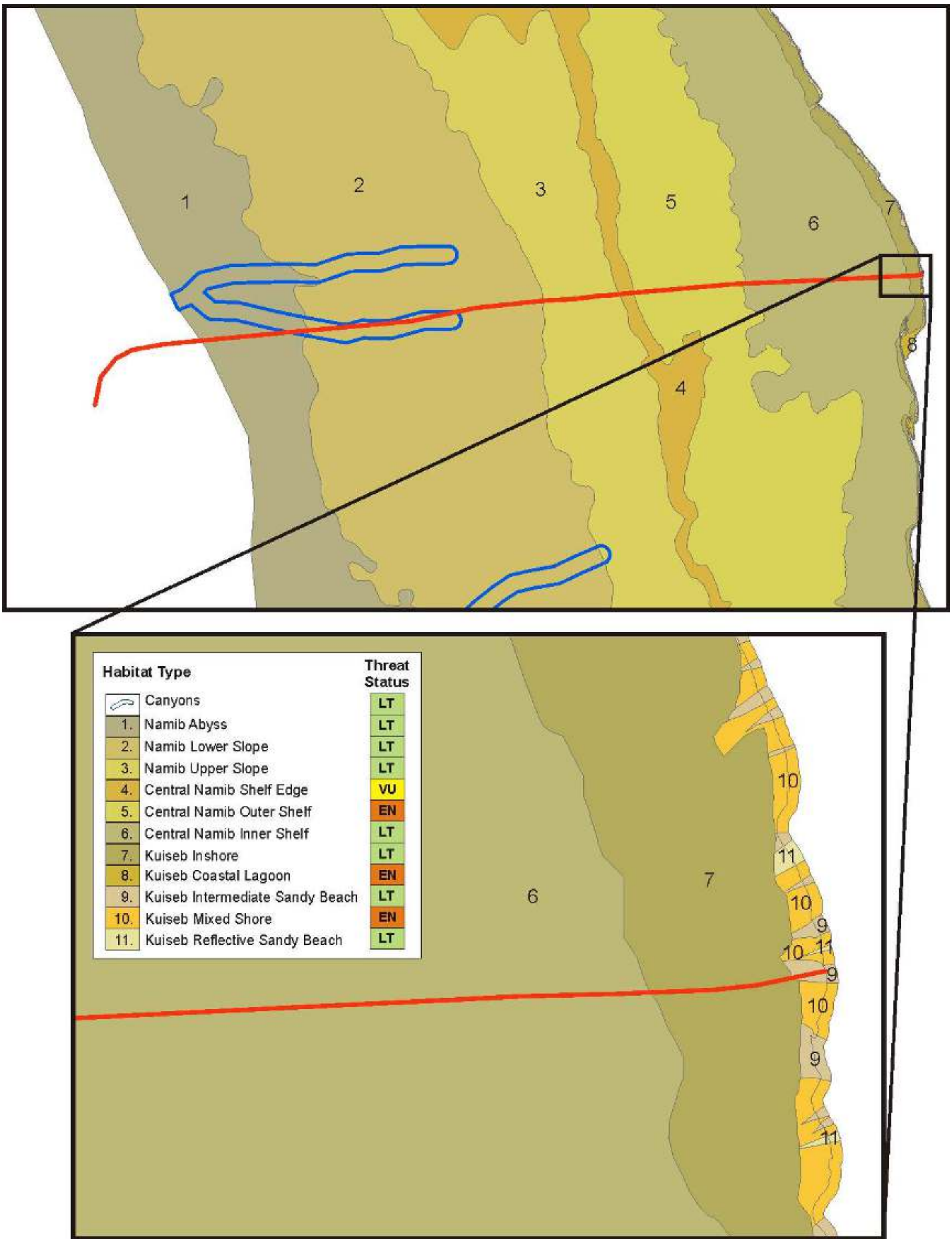


Figure 14 **The Equiano Cable route (red line) in relation to the distribution of Namibian benthic and coastal habitats. The positions of potential submarine canyons are also shown (blue lines) (adapted from Holness et al. 2014; as referenced from Pulfrich (2020). LT=Least Threatened; VU=Vulnerable; EN=Endangered.**

Table 9 Ecosystem threat status for marine and coastal habitat types off Central Namibia (adapted from Holness *et al.* 2014). Those habitats affected by the Equiano Cable System are shaded in light grey. The number refers to the numbers used in the legend of Figure 14.

No.	Habitat Type	Threat Status	Available Area (ha)
1	Namib Abyss	Least Threatened	80,093.8
2	Namib Lower Slope	Least Threatened	138,013.0
3	Namib Upper Slope	Least Threatened	59,066.3
4	Central Namib Shelf Edge	Vulnerable	32,745.5
5	Central Namib Outer Shelf	Endangered	40,939.6
6	Central Namib Inner Shelf	Least Threatened	38,243.7
7	Kuiseb Inshore	Least Threatened	2,911.1
8	Kuiseb Coastal Lagoon	Endangered	162.1
9	Kuiseb Intermediate Sandy Beach	Least Threatened	400.4
10	Kuiseb Mixed Shore	Endangered	63.6
11	Kuiseb Reflective Sandy Beach	Least Threatened	69.5

8.1.2 Geophysical Characteristics

Bathymetry

The continental shelf off Namibia varies in width. There is a double shelf break off Walvis Bay and Swakopmund with the inner and outer breaks beginning at depths of around 140 m and 400 m, respectively (Shannon & O'Toole, 1998).

The Equiano Subsea cable route survey conducted by FUGRO (2019) comprised an investigation of the bathymetry, seabed features, and shallow geology along the proposed route. In addition, a geotechnical sampling programme was undertaken to establish sediment types for correlation with geophysical data. This segment referred to as "Equiano Segment S24 BMH SWAKOPMUND to BU NAM" (FUGRO, 2019) covers deep water, shallow water and inshore (burial) and therefore comprised bathymetric investigations along the proposed route. The FUGRO (2019) report found that hazards or issues encountered were the following:

- Presence of hard rock, gravel beds and hard ground within target burial depth.
- Presence of sonar contacts, such as boulders, debris and sedimentary structures within the survey corridor. No ship wrecks were observed, as confirmed by the heritage specialist (Kinahan, 2020).
- Presence of in-service cables: 3 in deep water survey area.
- Presence of out-of-service cables: 1 in deep water survey.
- Indication of fishing activities, such as trawl scars.
- The route traverses hydrocarbon concessions: 4 blocks are crossed.
- Presence of adverse currents: moderate currents observed.

Based on results of the screening studies undertaken the following description of the bathymetry along the proposed Equiano Cable System has been compiled from where the cable enters the EEZ of Namibia until it makes land fall at Swakopmund. Much of the seabed along the alignment consists of silty clays (deep water) and silty sand and fine sand (shallower waters) as the cable approaches the coastline.

8.1.3 Biophysical Characteristics

Wind Patterns

Refer to Figure 15, which illustrates the seasonal wind roses at Walvis Bay. Gale force winds occur in all seasons and most frequently in Spring, lasting for 2-3 days for both south-southeast and north-northwest winds, not lasting longer than this is most cases. Winds occurring on the sea surface play a role in influencing the oceanography of the Benguela region (Pulfrich, 2020). Winds are directly along the coast as the arid coastal plans of the southern African West Coast acts as a thermal barrier (Pulfrich, 2020).

Large scale circulation and coastal currents

The Benguela Current strongly influences the Namibian coastline, where flows are mainly wind-forced and barotropic and fluctuate between poleward flow and flow towards the equator (Shillington et al. 1990; Nelson & Hutchings 1983). In the nearshore zone, strong wave activity from the south and southwest (generated by winds and waves in the South Atlantic and Southern Ocean) drives a northward long-shore current (Shillington *et al.* 1990), where unconsolidated sediments are transported along the coast in the northward littoral drift (Pulfrich, 2020).

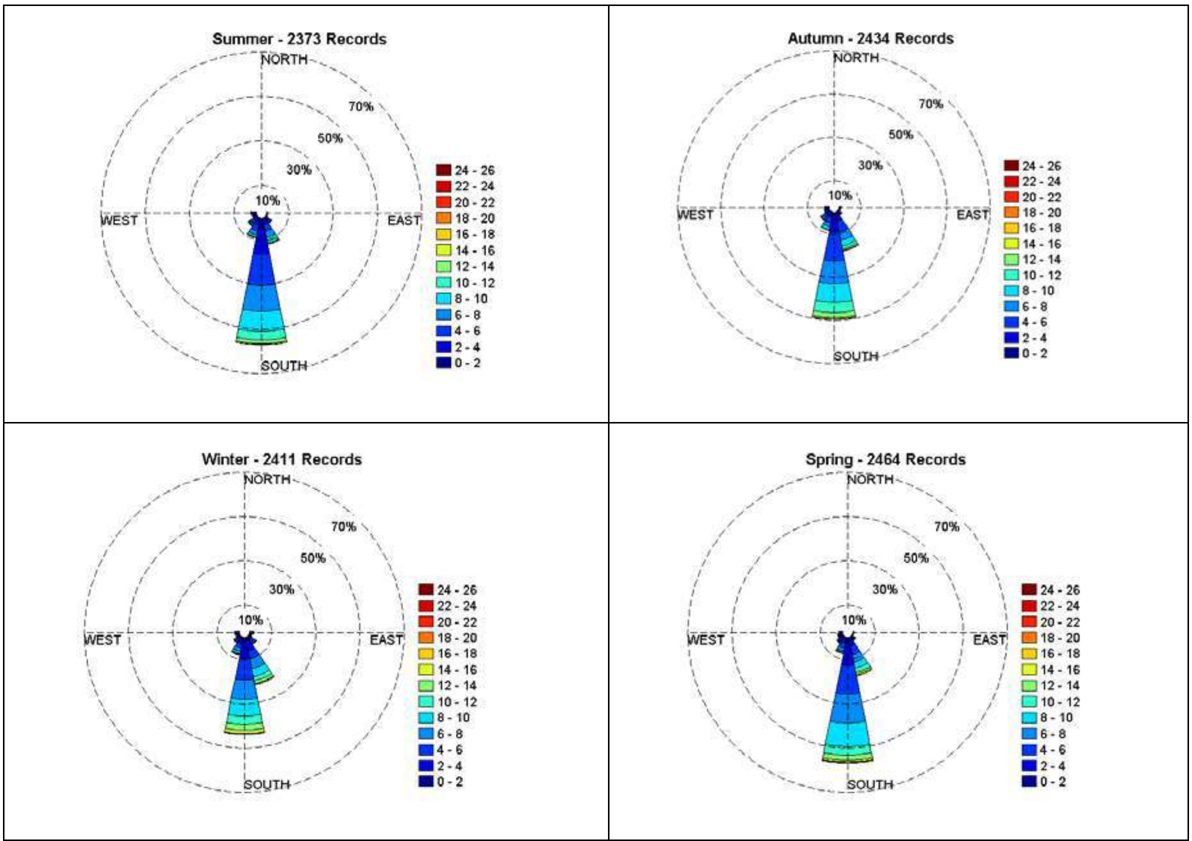
Waves and Tides

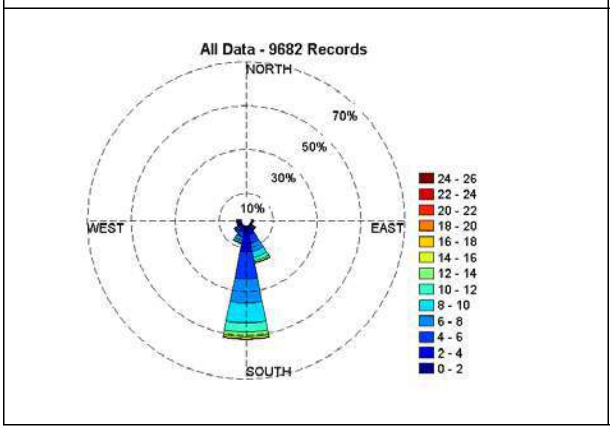
The Namibian coastline is classified as exposed, experiencing strong wave action, influenced by major swells generated in the Roaring Forties, as well as by significant sea waves generated locally by the continuous southerly winds (Pulfrich, 2020). The wave regime shows no strong seasonal variation apart from slight increases in swell in winter (Pulfrich, 2020). In general wave height decreases with water depth and distance longshore (Pulfrich, 2020). Tides in the study are regular and semi-diurnal, consistent with the rest of the southern African coast (Pulfrich, 2020).

Upwelling and Plankton Production

The west coast of Southern Africa is characterised by upwelling events where comparatively nutrient-poor surface waters are displaced by enriched deep water, supporting substantial seasonal primary phytoplankton production. The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman and Shannon, 1985).

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others).





Period	1960-01-07 to 2010-07-23
Station	VOS data
Position	22.0 - 23.9°S and 13.0 - 14.7°E
Sensor Height	0 m
Records	9682

Figure 15 Seasonal wind roses for the offshore Walvis Bay area (Source: Voluntary Observing Ship (VOS) data from the Southern Africa Data Centre for Oceanography (SADCO) referenced from Pulfrich (2020)

8.1.4 Marine biological environment

The coastal, wind-induced upwelling characterising the Namibian coastline, is the principle physical process which shapes the marine ecology of the southern Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions (Barnard 1998).

Sandy beaches dominate the coastline of central Namibia, with occasional small rocky outcrops. Marine ecosystems therefore comprise a limited range of habitats along this coastline that include:

- Sandy intertidal and subtidal substrates.
- Intertidal rocky shores and subtidal reefs.
- Water body.

The benthic communities within these habitats are generally found everywhere throughout the southern African West Coast region, consisting of many hundreds of species with considerable temporal and spatial variability. The biological communities 'typical' of each of these habitats are described in more detail in Pulfrich (2020) and briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the proposed project.

8.1.5 Marine Fauna

Fish Species

The marine environment off the south-western coast of Africa with its nutrient rich waters supports large populations of pelagic, mid-water and demersal fish species as well and high numbers of bird and mammalian predators (Hutchings *et al.,* 2009). Of particular relevance to the proposed Equiano Cable System are the fish stocks occurring within oceans surrounding the proposed cable route and the fishing industry which targets these fish species.

The three main Namibian commercial species (hake, sardine and horse mackerel) comprise the primary species of historical importance in Namibia. Other species of more recent importance include orange roughy, the deep-water crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna (Wilkinson, 2020). Note that these commercially fished species are not on the list of species of conservation concern as provided by Pulfrich in Table 10 below.

Table 10 Some of the more important linefish species likely to occur off Central Namibia, with the Global IUCN Conservation Status provided (Pulfrich, 2020)

Common Name	Species	IUCN Conservation Status
Teleosts		
Silver kob	*Argyrosomus inodorus*	Vulnerable
Elf	*Pomatomus saltatrix*	Vulnerable
West Coast steenbras	*Lithognathus aureti*	Near threatened
West coast dusky kob	*Argyrosomus coronus*	Data deficient
Chondrichthyans		
Bronze whaler	*Carcharhinus brachyurus*	Near threatened
Six gill shark	*Hexanchus griseus*	Near threatened
Spotted gullyshark	*Triakis megalopterus*	Near threatened
Smooth houndshark	*Mustelus*	Vulnerable
Broadnose seven-gill cow shark	*Heptranchias perlo*	Near threatened

Marine Mammals

Marine mammals occurring off the Namibian coastline include whales, dolphins and seals. The whale and dolphin fauna of Namibia comprises 33 species observed through historic sightings or strandings, or likely to be present based on habitat projections of known species. Their presence and seasonality are indicated in the tables included in Pulfrich (2020).

Apart from the resident species such as the endemic Heaviside's dolphin, bottlenose and dusky dolphins, Namibia's waters also host species that migrate between Antarctic feeding grounds and warmer low latitude breeding ground waters, as well as species with a circum-global distribution (Pulfrich, 2020). The project area lies close to the northern boundary of the cool Benguela ecosystem. Whales and dolphins associated with the Benguela ecosystem (e.g. dusky dolphins) and those associated with the warmer sub-tropical habitat off Angola are likely to be encountered in the area.

The likely presence and movement of marine fauna is of importance in understanding the impacts of the offshore cable laying operations of the Equiano Marine Cable System. Pulfrich (2020) provides the following information on whale occurrence:

- The most common species within the broader project area (in terms of likely encounter rate not total population sizes) are likely to be the Humpback whale and Pilot whale.
- The humpback and southern right whale are known to use feeding grounds around Cape Columbine in South Africa, with numbers there highest between September and February.
- Whaling data indicates that several other large whale species are also most abundant on the West Coast during these periods listed below:
  - Fin whales peak in May-July and October-November;
  - Sei whale numbers peak in May-June and again in August-October;
  - Bryde's whale numbers are likely to be highest in January-March in offshore areas;
  - Whale numbers on the shelf and in offshore waters are thus likely to be highest between October and February.

The blue whale is migratory, and considered 'Critically Endangered', and the sei and fin whales are listed as 'Endangered' in the IUCN Red Data book (Pulfrich, 2020). All whales and dolphins are given protection under the Namibian Law. The regulations under the Namibian Marine Resources Act, 2000 (No. 27 of 2000) states that no whales or dolphins may be harassed, killed or fished.

The Cape fur seal is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs, with currently half the Namibian seal population occurring in southern Namibia, and south of Lüderitz (Pulfrich, 2020). There is a controlled annual quota, determined by government policy, for the harvesting of Cape fur seals on the Namibian coastline (Pulfrich, 2020).

Humpback whale: migrate to breeding grounds off tropical west Africa, with regular sightings in Lüderitz area in spring and summer (Pulfrich, 2020)

Killer Whale: circum-global found all year round and found at all depths from coast to deep ocean (Pulfrich, 2020)

Plate 13 Selection of whale and dolphin (cetacean) species known to occur off the west coast of Namibia

Seabirds

Birds are common and important components of coastal ecosystems, being top predators both in near shore and intertidal environments. The distribution patterns of birds are also highly dependent on food availability and suitable nesting sites. Seabirds feed at sea and breed on land and are, therefore, important redistributors of nutrients within these environments.

The near shore environment of Southern Africa supports large numbers of both breeding and non-breeding seabirds. Breeding seabirds are spatially restricted by the availability of safe nesting sites such as islands and mainland cliffs, but non-breeding species can theoretically occur throughout the region. The distribution of sea birds is also highly dependent on food availability and, as such, the upwelling of nutrient water in the Benguela Current often results in large numbers of seabirds congregating around large shoals of fish such as pilchards and smaller pelagic shoaling fish.

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. In total, 11 species of seabirds are known to breed along the southern Namibian coast, restricted to areas where they are safe from predators (Pulfrich, 2020). Most breed on the islands off the southern coast of Namibia or on the man-made guano platforms in Walvis Bay, Swakopmund and Cape Cross. Cape Gannets are known to forage up to 140 km offshore (Dundee, 2006; Ludynia, 2007) and African penguins up to 60 km offshore.

Turtles

Five of the eight species of turtle worldwide occur off Namibia (Bianchi et al. 1999). Turtles that occasionally sighted off central Namibia, include the Leatherback Turtle (*Dermochelys* *coriacea*), known as the largest marine reptile. Observations of Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*) Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) turtles in the area are rare. Namibia is gaining recognition as a feeding area for leatherback turtles that are either migrating through the area or searching for food sources in Namibian waters (Pulfrich, 2020). The Leatherback is the only turtle likely to be encountered in the offshore waters of west South Africa. The Benguela ecosystem, especially the northern Benguela where jelly fish numbers are high, is increasingly being recognized as a potentially important feeding area for leatherback turtles.

Leatherback Turtles are listed as “Vulnerable” worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species) (Pulfrich, 2020). Loggerhead and Olive Ridley turtles are globally listed as ‘Vulnerable’ whereas Hawksbill are globally listed as ‘Critically Endangered’, and Green turtles as ‘Endangered’ (Pulfrich, 2020).

8.1.6 Offshore Fishing Industry

Namibia has one of the most productive fishing grounds in the world, based on the Benguela Current System (FAO, August 2015). Namibia is Africa’s fourth largest capture fisheries nation behind Morocco, South Africa and Mauritania, and 36th worldwide[13]. The fishing industry is a cornerstone of the Namibian economy, generating approximately N$10 billion in export revenue (2016) (Wilkinson, 2020). This is second most important forex earner after mining and provides approximately 16,800 direct jobs (Ministry of Fisheries and Marine Resources, 17 February 2017) of which 70% are in the hake sector (Wilkinson, 2020).

Namibia’s 200 nautical mile Exclusive Economic Zone (EEZ) supports approximately 20 different commercially exploited marine species. The three main Namibian commercial species (hake, sardine and horse mackerel) comprise the primary species of historical importance in Namibia. Other species of more recent importance include orange roughy, the deepwater crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna. The majority of sectors are considered by the Ministry of Fisheries and Marine Resources (MFMR) to be sustainably utilised (Wilkinson, 2020).

Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, line fish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay and surrounds.

Namibia has only two major fishing ports that facilitate the main commercial fishing operations from Walvis Bay and Lüderitz:

- The major port is Walvis Bay, located in central Namibia and it is from this port that most fishing vessels operate. Most of the fishing conducted from this port is, for economic and logistical reasons, due to its central locality can reach fishing grounds in the central and northern part of Namibia and to a lesser extent the southerly fishing grounds towards the South African border.
- Hake trawlers and longliners operate from Lüderitz, together with a small rock lobster fishery based in southern Namibian waters.

There are currently 116 Namibian-registered commercial fishing vessels:

13 Wikipedia, February 2017. https://en.wikipedia.org/wiki/Fishing_industry_by_country (cited by Wilkinson, 2020)

- The dominant fleet comprises demersal trawlers that include both large freezer vessels (up to 70 m in length), as well as a smaller fleet of monk trawlers. These vessels fish all year round, with the exception of a one month closed season in October and range the length of the Namibian EEZ. There is a 200 m fishing depth restriction (i.e. no bottom trawling permitted shallower than 200 m).
- The only other fleets of significance are the mid-water trawlers that target horse mackerel and the large pelagic tuna long-line vessels. These large midwater trawl vessels (mostly greater than 100 m in length) operate in the northern waters of Namibia and are restricted to fewer than 20 vessels.
- The large pelagic (tunas and shark) long-line vessels operate broadly in Namibian waters but operate mainly in the south near the South African border targeting the migrations of albacore and yellowfin tuna. The numbers of these vessels vary and is dependent on the seasonal availability of tuna and tuna-like species. The tuna pole (bait-boat) vessels are a small fleet and also increase in numbers depending on the number of licenses issued to South African boats. The tuna long-liners are also variable with the number of licenses issued to both Namibian flags and others (mostly Asian) fluctuating annually. The extent and number of these vessels is difficult to ascertain (as they are unpublished), although the actual numbers are limited and are less than the numbers of licensed Namibian boats.
- There are few known foreign fishing vessels licensed to fish in Namibian waters, although the majority of the current mid-water fleet have permits to fish under foreign flag registration, but as a rule all licensed fishers must reflag under Namibia. There is a possibility that licenses may have been issued to foreign tuna boats, although these would be few and they would be closely monitored by the Namibian compliance units and their Vessel Monitoring System (VMS).

8.1.7 Offshore Mining and Exploration Concessions Holders

Other users of the offshore areas (including the commercial fishing industry described above in Section 8.1.6) are the oil and gas licence holders and marine mining (diamonds and marine phosphates) concession holders. Refer to Figure 16 which provides a broad illustrative overview of the offshore users on the Namibian coastline (Pulfrich, 2020).

Offshore Mining Concessions

- The Namibian Minerals (Mining and Prospecting) Act (Act 33 of 1992) allows for various types of prospecting and mining licenses, issued by the Ministry of Mines and Energy, for both small-scale and formal activities.
- The current offshore marine mining concessions, established by the Ministry of Mines and Energy under the new mineral legislation, extend virtually the full length of country's coastline from the Orange River to the Kunene.
- The concessions are irregularly divided into Exclusive Prospecting Licenses (EPLs) and Mining License Areas (MLAs), in response to applications for specific areas. EPLs are dynamic, valid for three years only where license holders change regularly, often without having actively undertaken any prospecting or sampling operations in the concession before their leases expire.
- The marine diamond mining industry is dominated by a few major companies, notably Namdeb Holdings (Pty) Ltd (which operates most of the coastal mining areas), De Beers Marine Namibia (Pty) Ltd (which operates in the Atlantic 1 ML area offshore of Oranjemund), Samicor and Diamond Fields Namibia (Pty) Ltd. Current activities are all focused on the area south of Lüderitz and therefore not relevant to the Equiano Cable System offshore routing.
- In the early 2010s, the growing interest in the exploration of Namibian offshore phosphate resources, saw the application to dredge phosphate-rich sediments in ML-170 and ML-

159 south of Walvis Bay, also of no relevance to the Equiano Cable System offshore routing. Environmental resistance against the proposed mining resulted in a two-year moratorium on marine phosphate mining in Namibia being placed in September 2013. Continued resistance has resulted in the moratorium never being officially lifted.

- As with marine mining, the Namibian Petroleum (Exploration and Production) Act, 1991 (No. 2 of 1991) provides for the reconnaissance, exploration, production and disposal of petroleum within offshore license blocks issued by the Ministry of Mines and Energy. An exploration license is valid for a maximum period of 4 years, whereas a production license is valid for a maximum period of 25 years and may be renewed only once for a further period of 10 years. Numerous 3D seismic acquisition campaigns have been undertaken off central Namibia in the past 5 years, with applications for the drilling of exploration wells having been submitted.

Figure 16 indicates which mining licenses are active, and all are located to the south of the Equiano Cable System offshore routing. The FUGRO (2019) survey report provides a list of the Oil Concession Blocks (OCB) boundaries crossed by the proposed Equiano Cable System as shown in Table 11 below.

Table 11 List of oil Concession Block Boundaries (FUGRO, 2019)*

Segment	Country	Boundary	KP	Latitude	Longitude	Source
S24	Namibia	EXIT 2214A/ ENTER 2214B	2.921	22° 39.1393' S	014° 29.9996' E	RPL
S24	Namibia	EXIT 2214A/ ENTER 2213B	54.369	22° 40.3804' S	014° 00.0000' E	RPL
S24	Namibia	EXIT 2213B/ ENTER 2212B	157.303	22° 43.5154' S	013° 00.0000' E	RPL
S24	Namibia	EXIT 2212B/ ENTER 2211Ba	260.466	22° 48.2857' S	012° 00.0000' E	RPL
S24	Namibia	EXIT 2211Ba/ ENTER 2211Bb	312.325	22° 52.9828' S	011° 30.0000' E	RPL
S24	Namibia	EXIT 2211Bb/ ENTER 2210A	363.757	22°53.8226' S	010°59.9919' E	RPL
S24	Namibia	EXIT 2210A	408.407	22°55.4199' S	010°33.9348' E	RPL

* Note: RPL is Route Position List

From experience on other marine cable systems, ACER will engage with each of these concession holders at the onset of the environmental authorisation process and it is recommended that the Namibian landing partner engage directly with the concession holders to draw up a Memorandum of Understanding (MoU) which outlines the rights, obligations and roles and responsibilities of both parties in terms of the installation and operation of subsea infrastructure.

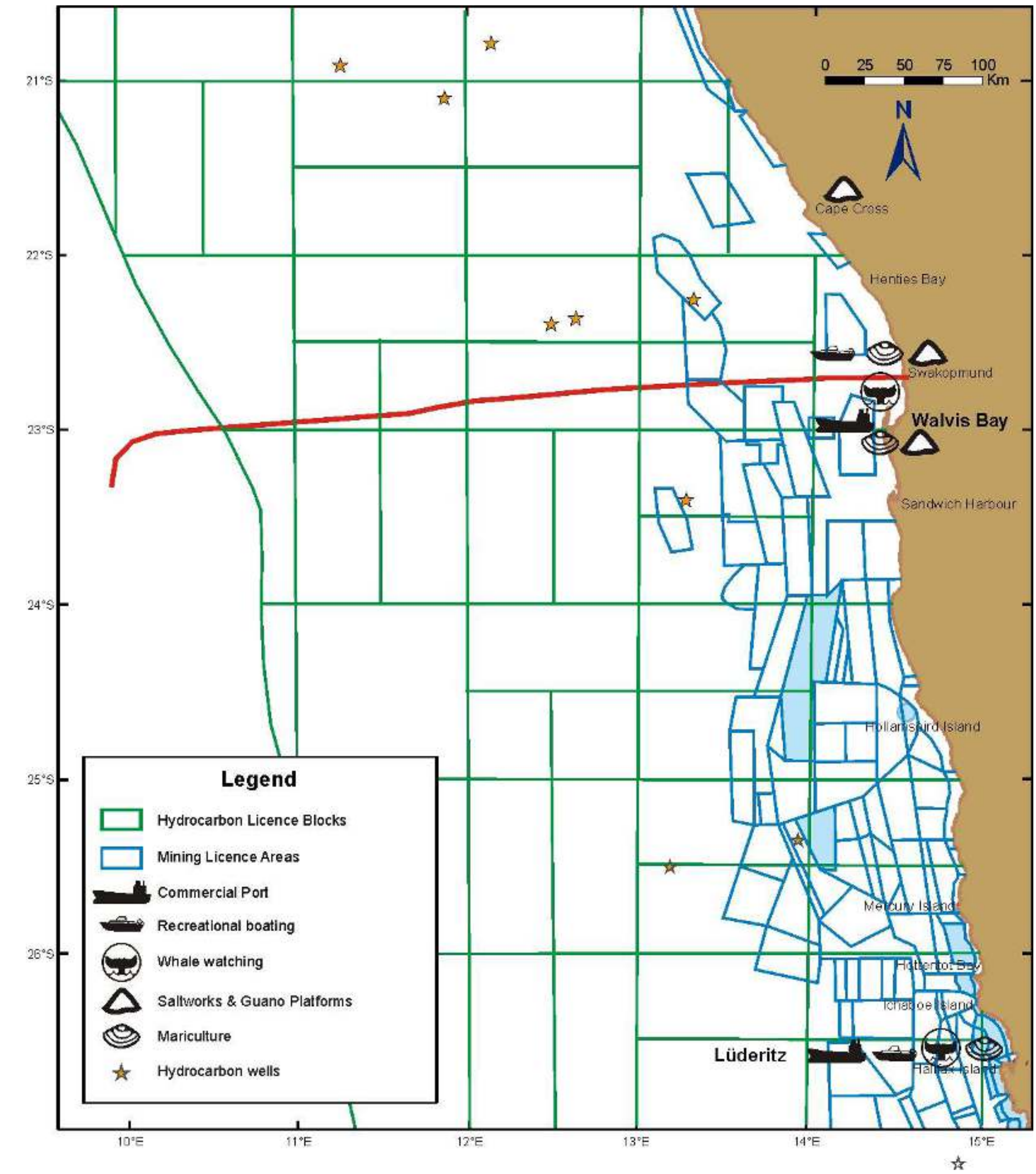


Figure 16 The Equiano Cable route (red line) in relation to the mining licence consessions (blue) and hydrocarbon licence blocks (green) off central Namibia. Active mining licences are shaded. (Referenced from Pulfrich, 2020)

8.1.8 Mariculture

Interest in mariculture (marine aquaculture) has increased in Namibia recently and is being conducted at an increasing scale in Walvis Bay (Pulfrich, 2020). A Strategic Environmental Assessment developed for the Erongo Region, indicated that suitable locations for sea-based and land-based aquaculture were limited and would primarily be associated with Walvis Bay and Swakopmund (Skov et al. 2008). Two plots between Walvis Bay and Swakopmund have been specifically zoned for land-based aquaculture developments that propose to produce shrimp, finfish and abalone. A further area to the north of Swakopmund (north of the Mile 4 Saltworks) was identified as a potential development area for land-based aquaculture.

In Walvis Bay, several companies are engaged in cultivation of Pacific oyster and European flat oyster in the shelter of Pelican Point, using suspended baskets on long lines in deeper areas and platforms in shallower depths. Oyster cultivation is also conducted in the feed-water ponds of the Walvis Bay and Swakopmund salt works.

None of the existing or currently proposed mariculture activities as identified by Pulfrich (2020) are located within the offshore or land-based components of the Equiano Cable System.

8.1.9 Ecotourism

The newly proclaimed Dorob National Park is renowned for its excellent angling with popular beach angling spots along the coast identified by their distance from Swakopmund (e.g. Mile 14, Mile 72 and Mile 108, at which campsites are located). Several skiboat operators from Swakopmund and Walvis Bay also offer guided angling tours. Specifically, shark angling tours targeting bronze whalers have become increasingly popular over the last ten years and have become an established part of the local coastal tourist industry (Holtzhausen & Camarada 2007).
Swakopmund is described as the coastal playground of Namibia and is attracting more international visitors. Although its environment is its greatest economic asset (Skov et al. 2008), the area has now also become world-famous for adventure seekers who visit the area for quad-biking, sand boarding, tandem skydiving, camel and horse trails, paragliding, hot air ballooning, leisure boating, kayaking, windsurfing and various beach activities, and bird watching.

There are ten whale-watching operators currently providing general nature trips that include sightings of dolphins and whales, as well as other marine life (e.g. fur seals, turtles and sunfish) out of both Walvis Bay and Swakopmund. Various operators in Walvis Bay also offer 4x4 excursions to the Sandwich Harbour area, which include the Walvis Bay Lagoon, the Saltpans, the Kuiseb River Delta, and the Sandwich Harbour Lagoon.

Marine ecotourism in the project area is therefore has become increasingly important, and offshore cable laying operations will need to be aware of any boating recreational activities that may be active in the area during cable laying.

8.1.10 Other Industrial Uses

Desalination Plants

- There is a Reverse Osmosis (RO) desalination plant 30 km north of Wlotzkasbaken that provides water for the Areva Resources Southern Africa mine, a Uranium mine 65 km north-east of Swakopmund.

- A further RO desalination plant was planned by NamWater at Mile 6 just north of Swakopmund, that provides water for the fast-growing Uranium Mining Industry.

Saltworks

- Namibia is the largest salt producer in sub-saharan Africa. Salt is the most important non-metallic minerals mined in Namibia, with the bulk of the salt output coming from the seawater evaporation pans at Walvis Bay and Swakopmund.
- The Swakopmund-based Salt Company (Pty) Ltd produces around 120,000 tons of edible salt annually[14]. The saltworks are situated about 7 km (4 miles) north of Swakopmund. The aquatic portion of the Swakopmund saltworks, 400 ha in size has been registered as a private nature reserve, where it provides ideal feeding grounds for thousands of wetland birds[15].
- The Walvis Bay Salt Refiners in Walvis Bay produce primarily chemical grade salt. This operation is one of the largest wind and solar evaporation facilities in Africa processing 24 million tons of sea water each year to produce more than 400,000 tons of high-quality salt. The ponds sustain a variety of wetland birds such as flamingos and other waders. Up to 120,000 birds at a time have been viewed at the salt field and more than 60 different species have been identified (Pulfrich, 2020).

Guano Operations

- Guano is valuable as an agricultural fertilizer.
- The man-made guano platforms at Walvis Bay, Swakopmund and Cape Cross are unique in the world, and guano has been scraped annually from them since the 1930s.
- The wooden platform between Swakopmund and Walvis Bay is located approximately 200 m offshore and has an area of 1.7 ha.
- A further two platforms of 4 ha each have been erected at the salt pans north of Swakopmund (as mentioned under Salt Pans above) and at Cape Cross.

The Desalination Plants, Salt Works and Guano Operations are not located in areas where the Equiano Cable System is to be routed offshore or onshore, posing no conflict of interest to the project.

8.1.11 Offshore marine telecommunications infrastructure

ASN is a member of the International Cable Protection Committee (ICPC) and as such they need to abide by a number of guidelines and standards to ensure that the new cable system does not negatively impact on existing marine telecommunications systems. ASN must abide by the conditions stipulated by the ICPC to ensure no negative impacts are experienced by existing marine cable operators such as the WACS cable system.

ASN will engage directly with the Office of the Presidency on behalf of Paratus to reach a formal agreement with regards to a lease agreement for the use of the sea floor for the installation and operation of the Equiano Cable System.

14 http://www.saltco.com/index.html referenced by Pulfrich (2020)
15 http://www.birdlife.org referenced by Pulfrich,(2020)

8.2 Beach and Terrestrial Environment

The final section of the Equiano Cable System which makes landfall in Swakopmund involves the installation of the cable through the intertidal zone, across the beach to the proposed BMH and then approximately 2.1 km of land cable to be placed in cable ducts to be constructed, until reaching the proposed CLS site at Hage Heights.

8.2.1 Conservation Areas and Ecoregions

The Namib Desert is believed to be the world's oldest desert and it has been arid for at least 55 million years (Barnard 1998). The Namib Desert ecoregion extends along the coastal plain of western Namibia, from the Uniab River in the north to the town of Luderitz in the south[16]. It extends inland from the Atlantic Coastline to the foot of the Namib Escarpment, a distance of between 80 and 200 km. The ecoregion can be divided into two areas:

- The Central Namib (from the Uniab to the Kuiseb Rivers)
- The Southern Namib (from the Kuiseb River to the town of Luderitz).

The project location is situated in the transitional area between the Southern Desert and Central Desert vegetation types (Mendelsohn, 2002). In the north, the Central Namib merges with the Northern Namib or Kaokoveld Desert ecoregion, and in the south, it merges with the Succulent Karoo ecoregion, which extends up the west coast of South Africa[17]. A climatic transition belt crosses the coastline north of Walvis Bay in Namibia and divides the coastal area into a northern area receiving summer rainfall, considered the Kaokoveld Desert ecoregion and a southern area receiving winter rain (the Namib Desert ecoregion). The narrow strip of land within this transition belt (about 50 km) is the most arid area in southern Africa and receives sporadic, unpredictable rainfall without a clear seasonal pattern (Williamson, 1997).

The entire Namibian coastline, excluding all declared townlands, falls within national parks. From north to south they are the Skeleton Coast-, Dorob-, Namib Naukluft- and Tsau //Khaeb- National Parks (Faul, 2020). Swakopmund is surrounded by the Dorob National Park with the Namib Naukluft National Park 16 km to the east and to the south of the Swakop River as shown in Figure 17 referenced from Faul (2020). The Dorob National Park is more accessible to visitors than other parks in Namibia, allowing for shore angling without park entry permits or fees, resulting in many areas in the Dorob National Park being damaged by off-road driving. This impact is especially noticeable on the coastal plains, which are sensitive to off-road driving as a result of the presence of a biological crust, often associated with large areas covered by lichens that become damaged by vehicles, with a long recovery time.

Between Swakopmund and Walvis Bay is Important Bird Area (IBA) NA012 – the 30-km Beach: Walvis Bay to Swakopmund IBA as shown in Figure 18.

16 https://www.worldwildlife.org/ecoregions/at1315
17 https://www.worldwildlife.org/ecoregions/at1315

At Walvis Bay is the Walvis Bay RAMSAR site while 45 km to the south of Walvis Bay is the Sandwich Harbour RAMSAR site. In addition, the Swakopmund Salt Works and Swakop River Lagoon are also ecologically significant, mainly with respect to birds (Faul, 2020). The Namib Sand Sea World Heritage Site is the only coastal desert with extensive fog influenced dune fields in the world. It is included as World Heritage Site due to exceptional ongoing ecological and geological processes with significant conservation importance for a diverse range of endemic species adapted to the hyper-arid desert conditions where fog is the main water source (https://whc.unesco.org/en/list/1430/).

The project area is located within the municipality of Swakopmund, and therefore there are no impacts on the Dorob National Park to the north of Swakopmund, or the areas of ecological significance located to the south of Swakopmund as shown in Figure 17.

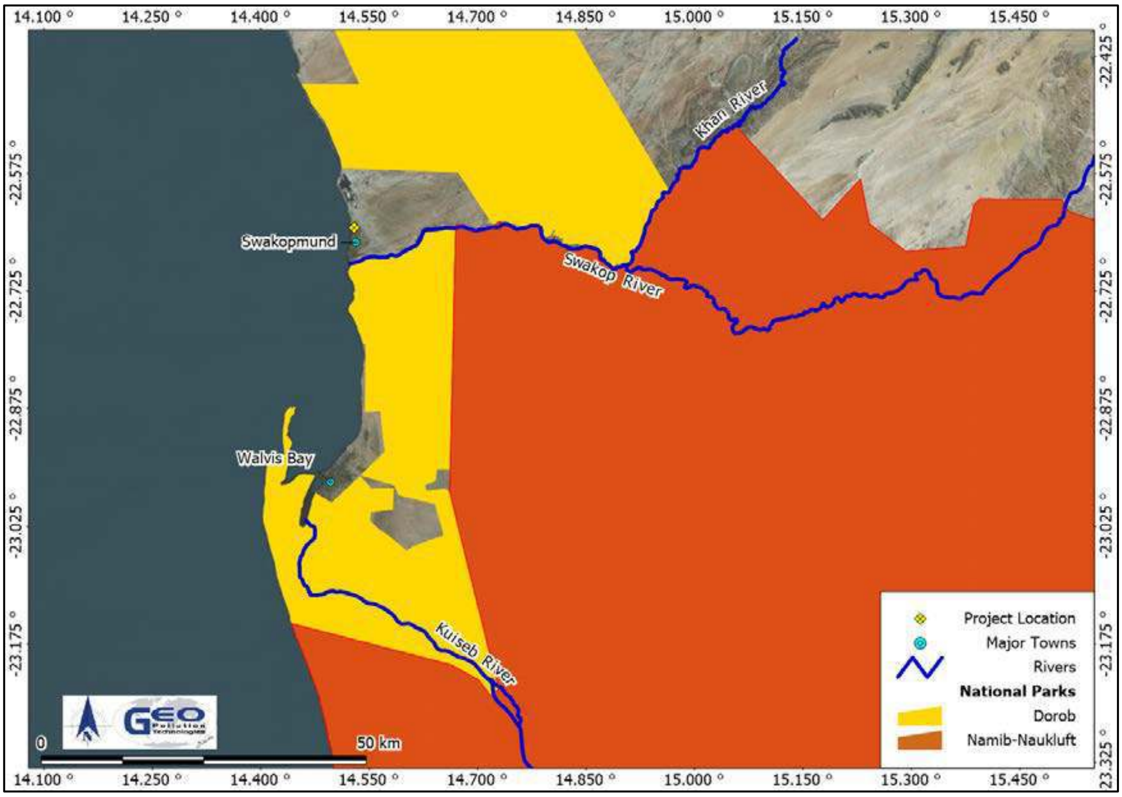


Figure 17 National Parks protected areas and rivers in relation to the project location at Swakopmund (Faul, 2020)

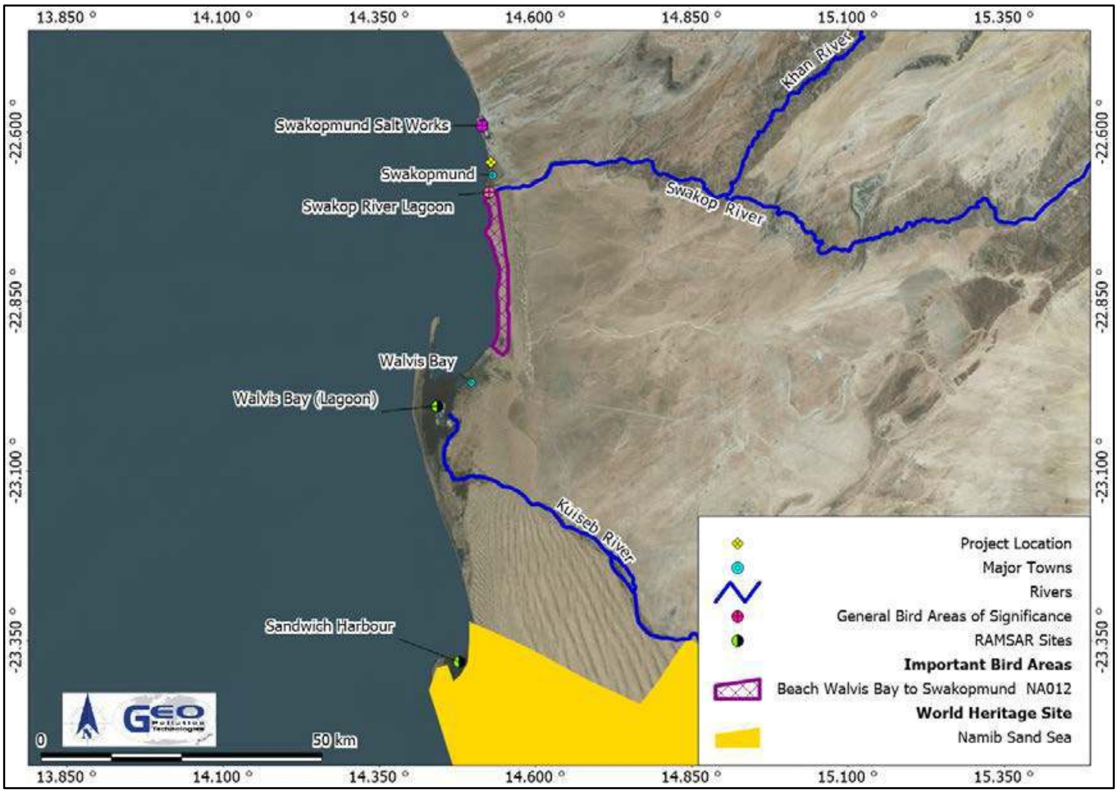


Figure 18 Ecologically significant areas (Faul, 2020)

8.2.2 Flora

Swakopmund is centrally located along the western coastline of Namibia within the Erongo Region (Faul, 2020). It lies on the western edge of the Namib Desert Biome (Giess, 1971), with the cold Atlantic Ocean to the west. The dry Namib Desert and cold Atlantic Ocean generally control water availability and vegetation, and consequently animal biodiversity (Faul, 2020). The project location is situated in the transitional area between the Southern Desert and Central Desert vegetation types (Mendelsohn, 2002). Refer to Figure 19 below.

Found to the north of the Central Namib is a narrow strip of vegetation (up to 200 m wide) that follows the Central Namib coastline north of the ephemeral Swakop River[18] that flows westwards towards Swakopmund as shown in Figure 18 above. A common feature of this vegetation strip are dwarf shrubs filled with sand between their branches, with a variety of dwarf shrubs that grow at rocky sites, including annual grasses. Inland from this strip of vegetation are vast gravel plains that are largely without vegetation except for fields of colourful lichens, some of which are not attached to any substrate and are known as vagrant lichens or Wanderflechten. Towards the extreme east, the gravel plains become more vegetated with annuals, mostly perennial grass species as the predominant life form. These annuals, which lie dormant through extended drought periods as seeds, grow rapidly after a rainfall of anything more than about 20 mm and transform the landscape into a sea of grass. Widely scattered shrubs are also present on rocky outcrops on these plains[19].

18 https://www.worldwildlife.org/ecoregions/at1315
19 https://www.worldwildlife.org/ecoregions/at1315

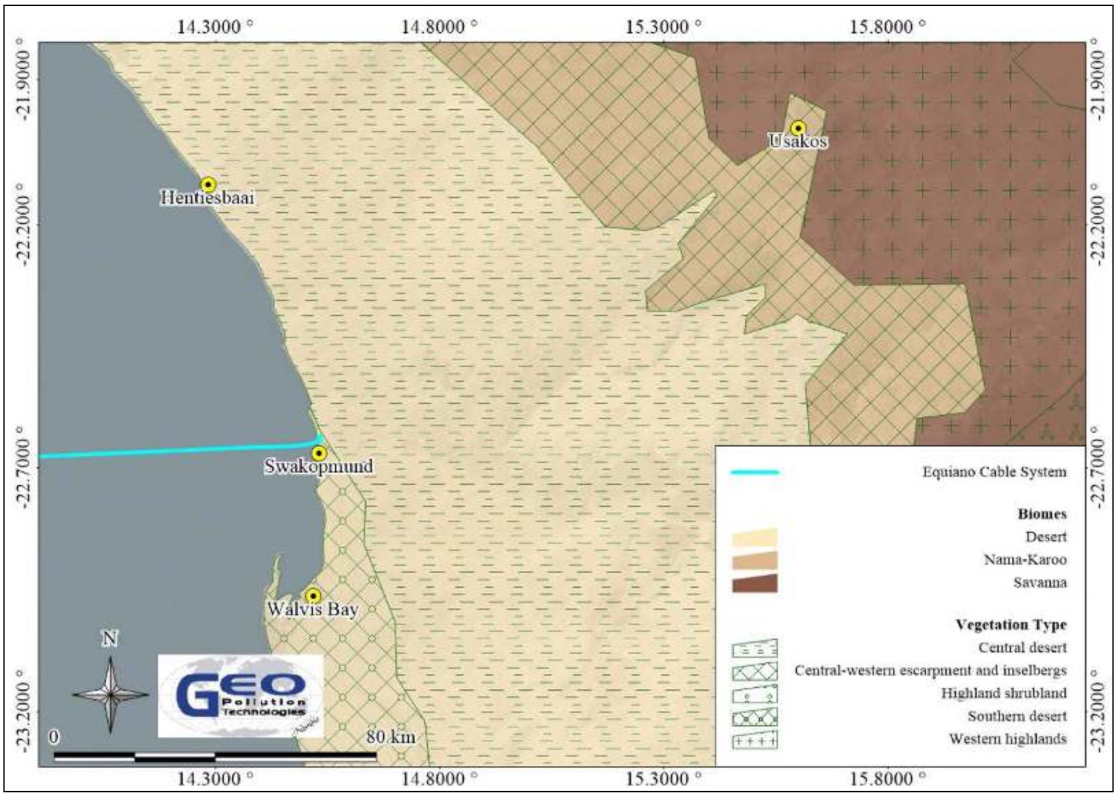


Figure 19 Equiano Cable System landing at Swakopmund showing context of biomes and vegetation structure (referenced from Figure 4-1 in Faul (2020)

The project area is located within the urban environment of the municipality of Swakopmund, with little to no impact on vegetation as described further in Section 10.2.

8.2.3 Fauna

The desert area around Swakopmund can broadly be divided into the Walvis Bay – Swakopmund dune belt, the Gravel Plains of the Central Namib, and the ephemeral Swakop River forming a boundary between the two, as described in Sections 8.2.1 and 8.2.2 above. A narrow beach zone (the coastal plain), associated with a hummock dune belt and small isolated salt flats, is found south and north of Swakopmund (Faul, 2020) The coastline, forming the western boundary of Swakopmund, is mostly a sandy shoreline south of Patrysberg some 7 km away, with a rocky shoreline interspersed with sandy beaches from Patrysberg to north of Swakopmund (Faul, 2020). The dunes of the Namib Sand Sea are relatively uninhabited while the gravel plains have increased diversity on rocky outcrops and in drainage lines with increased vegetation. Rocky outcrops include inselbergs and dolerite ridges where habitat differentiation is more pronounced (Faul, 2020).

The ecology of the area is largely influenced by the climatic conditions characterised by sparse and highly unpredictable rainfall with regular occurrences of fog. Many living organisms have therefore evolved to survive with limited surface water by harvesting fog, or by obtaining water from food, as a main source of water. As a result species richness and abundance are relatively low with a high level of endemism. Many species have also evolved to survive in areas with very specific conditions (micro-habitats), and are thus often range restricted (Faul, 2020).

Reptiles
High species richness and endemism is made up largely of reptiles that have adapted to survive in the harsh environment when most birds and large mammals have not[20]. There are almost 70 reptile species in the ecoregion, of which more than 25 are considered endemic to the ecoregion. Five of these are strictly-endemic to the dry Namib Desert, and at least 20 species are regarded as nearly endemic to the ecoregion (WWF database) [21].

Invertebrates
While vertebrates are relatively well documented throughout Namibia, inventories of invertebrates are often associated with specific project areas, such as where mines have conducted impact assessments. (Faul 2020). Namibia and especially the Namib Desert is famous for its range of tenebrionid beetles (Toktokkie or darkling beetle) of which there are 734 known species in Namibia, 370 being endemic (Irish, 2020). Well-known among them is the fog-basking beetle or head-standing beetle, which harvests fog as water source by "standing on its head" on dune crests to collect fog with its body (Faul, 2020)

Birds
Birds are largely associated with the coastline and river courses (Faul, 2020). The desert does not have a high level of avian biodiversity, with only 180 species recorded to date, due to the extremely arid terrain and a lack of rivers, with even ephemeral rivers absent in the southern part[22]. A study by Kopij (2018) initiated the establishment of an atlas of breeding birds in Swakopmund. Surveys were conducted in the urban area of Swakopmund in the summer months at the beginning of 2016 and over the 2016/2017 summer period. Eighteen different breeding species were identified. Of the eighteen, four species (Cape sparrow, laughing dove, the alien rock dove or feral pigeon and common waxbill) were most abundant, comprising almost 72% of all breeding birds, followed by the southern masked weaver and house sparrow comprising 14.5% of the breeding birds. None of these birds are of any particular conservation concern. The high abundance in most of them are as a result of their reliance on the urban structure in the otherwise very dry arid desert climate. Outside of Swakopmund their abundance decreases significantly (Kopij, 2018). Some of the lesser abundant species, such as the helmeted Guineafowl and Grey Lourie are not present outside of the urban area at all. The Hartlaub's gull and kelp gull are frequent visitors of the beaches where they often scavenge for food.

Mammals
The Namib Desert is home to a large number of small rodent species that occur among the rocky habitats in the western deserts, in the sand dunes and in the vegetation of the gravel plains. The gerbil, Gerbillurus tytonis is restricted to the southern portion of the ecoregion (WWF database). Grant's golden mole (Eremitalpa granti VU) is near-endemic in the Namib Desert, its range extending down into South Africa. This eyeless mole is well-adapted to the desert, able to swim through the loose, dry sands of the Namib dunes. The Namaqua dune molerat (Bathyergus janetta LR) is also near-endemic in the Namib Desert, as are two bat species; the Namib long-eared bat (Laephotis namibensis EN) and the Angola wing-gland bat (Myotis seabrai VU) (Hilton-Taylor 2000). Larger ungulates are scarce in the Namib Desert, with only gemsbok and springbok present (Griffin, 1998). Hartmann's zebra is found in the extreme east of the desert, in the transition belt between the desert and the escarpment. However, they do move further into the desert along vegetated riverbeds (Joubert and Mostert 1975). The predators of the Namib Desert are cheetahs, brown hyena and spotted hyena, Cape foxes and bat-eared foxes. Klipspringers, steenboks,, baboons, and leopards occur along the courses of the Kuiseb and Swakop Rivers (Lovegrove 1993).

20 https://www.worldwildlife.org/ecoregions/at1315
21 https://www.worldwildlife.org/ecoregions/at1315
22 https://www.worldwildlife.org/ecoregions/at1315

As the project area is located with the Swakopmund Municipality within a serviced and developed urban area, the biodiversity in the immediate vicinity of the project area has been significantly impacted on by human activities.

8.2.4 Swakopmund Beach and Coastal Dunes

The Namibian coast is largely undeveloped, with only four significant towns, Swakopmund being one of these, together with Lüderitz, Walvis Bay and Henties Bay providing an important tourism and recreation resources, including coastal diamond mining areas stretching along large sections of the coastline (Theron, 2008). The main harbour and only deepwater port is located at Walvis Bay where seasonal storms cause waves to wash over the peninsular sand spit protecting the Port of Walvis Bay. The Namibian coastline is relatively invulnerable to climate change impacts compared to many other counties, apart from Walvis Bay where the potential exists for breaching of the protective peninsula, (Theron, 2008).

The coastline of Namibia is arid in nature with beach sediments along the coastline that originate from wind-blown sediments and coastal dune systems. The coastline is mostly stable with a longshore current moving sediment within the surf zone with waves that hit the beach at an angle washing the sediment straight back down (in a zig-zag pattern)[23] referred to as longshore drift. Coastal processes in the nearshore and supra tidal environment are driven by a number of complex bio-physical processes (Elko, 2016) and as such, changes in wind and wave regimen, climate state, beach morphology and other factors influence the eco-morphology of dune systems (Bundy, 2020)

The area above the tidal reaches including the dune cordon along the central Namibian Atlantic coastline is affected by mainly two dominant and opposing wind directions, which are a dominant south westerly onshore wind and a sub-dominant north easterly wind, common in the winter. The opposing wind dynamics cause barchan[24] dune forms (particularly where sediment input may be constrained from time to time), longitudinal and sometimes low, hummock dunes (Bundy, 2020). In the Swakopmund region, there is little to no vegetation to stabilise the dune and this coupled with the high wind speeds causes high levels of sand transport.

Sea level rise is a recognized global phenomenon attributed to climate change (Bundy, 2020). According to Heita (2018) increasing sea levels are only considered to be a significant threat to infrastructure and portions of the coastline around Walvis Bay. Swakopmund, on account of its relative elevation, is anticipated to have comparatively lower risk than Walvis Bay, as identified by Theron (2008).

The proposed cable landing site is at Swakopmund, a large city positioned almost centrally along the Namibian coastline. Swakopmund has many extended, crenulate bays (also referred to as half-heart or headland bays which develop in the direction under which it is sheltered in an area called the show zone) that predominate along the central Namibian coast (Elfrink et al 2002). In addition, the town lies approximately at a juncture in the orientation of the Namibian coast from a north-south orientation to that of an SSE-NNW orientation. Bundy (2020) identifies this change in the coastline's orientation as suggesting a differentiation in the nature of inshore, wave driven processes.

23 https://www.google.com/search?q=what+is+longshore+drift+and+how+is+it+related+to+a+longshore+current

24 **Barchans** are propagating crescent-shaped **dunes** that **form** under limited supply of sand, in roughly unidirectional winds (or current flow) and un-vegetated areas, referenced from: https://www.google.com/search?q=barchan+dune+forms&oq=barchan+dune+forms+&aqs=chrome..69i57j0i333.1443j0j15&sourceid=chrome&ie=UTF-8

The establishment of a small coastal breakwater harbour at Swakopmund has interrupted the transport of sediment along the beach having the following impact:

- Restraining the littoral drift along the beach.
- Promoting deposition and landward sediment movement within the embayment.
- Altering points of erosion and deposition within and without the embayment, with areas to the north of the harbour affected by the change in the sediment transport regime which is now mainly a shingle beach.

Bundy (2020) reviewed aerial imagery from before and after the construction of the small coastal breakwater harbour, and observed a widening beach environment at the point where the Equiano Cable System will be landed, in what is now an area of significant disturbance. Bundy (2020) identified that the frontal dune cordon is generally unvegetated apart from occasional communities of salt bush and pencil bush, with the beach and inter tidal fauna communities along the shoreline comprising isopods, amphipods and molluscs. All of these species are transitory and common within the beach and inter tidal areas.

8.3 Climate

The climate of Namibia is determined by its location in relation to the Intertropical Convergence Zone, Subtropical High Pressure Zone and Temperate Zone, with the Subtropical High Pressure Zone being the major contributor to the dry conditions (Atlas of Namibia, 2002; Bryant, 2010). Precipitation over Namibia is mainly controlled by the South Atlantic High (SAH), a high pressure cell (anticyclone) situated west of Namibia in the Subtropical High Pressure Zone (Faul, 2020). The SAH shifts during the year and are at higher latitudes in winter and lower latitudes in summer (Faul, 2020).

A summary of the climate data for Swakopmund is provided in Table 12 below. The climate of the Namibian coastline is classified as hyper-arid with typically low, unpredictable winter rains and strong predominantly southerly or south-westerly winds (Pulfrich, 2020). Further out to sea, a south-easterly component is more prominent (Pulfrich, 2020) Winds reach a peak in the late afternoon and subside between midnight and sunrise (Pulfrich, 2020).

Based on coastal fog, the Namib can be divided into three areas running from west to east: coastal, central, and inland (https://www.worldwildlife.org/ecoregions/at1315). The coastal area has a mean annual rainfall of 2 to 20 mm, and has thick fog which occurs on average between 50-75 days per year, most frequently during the months of February through to May, which is quite dense and appears as a thick bank hugging the shore and may reduce visibility to less than 300m (Olivier, 1992, 1995). Average precipitation per annum along the coastal region between Walvis Bay and the Kunene River is less than 15 mm as shown in Figure 20.

Due to the combination of wind and cool ocean water, temperatures are mild throughout the year. Coastal temperatures average around 16°C, gradually increasing inland (Barnard 1998). In winter, maximum diurnal shifts in temperature can occur caused by the hot easterly ‘Berg’ winds which blow off the desert. During such occasions temperatures can reach up to 30°C. Air temperatures are low as a result of the cool air coming off the Benguela Current, and daily and seasonal temperature changes are minimal, with daily highs and lows differing by as little as 2° to 5 °C (Barnard 1998). Up to about 50 km inland the mean annual rainfall increases from 20 mm to 50 mm. Still further inland, fog is rare, and the mean annual rainfall increases from 50 mm to a maximum of 85 mm in places. Daily and seasonal temperatures increase sharply and become highly variable, with temperatures of below 0° and above 50°C recorded at one location (von Willert et al.1992).

Table 12 Summary of climate date for Swakopmund (Digital Atlas of Namibia, 2002) (referenced from Faul (2020; Figure 4-1)

Classification of climate	Desert
Precipitation	0-50
Variation in annual rainfall (%)	> 100
Average annual evaporation (mm/a)	2,600-2,800
Water deficit (mm/a)	1,701–1,900
Temperature °C	<16

Average Monthly Rainfall (mm)

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
0.2	0.3	0.5	0.8	1.1	0.4	6.3	5.4	13.1	4.2	1.1	0.9

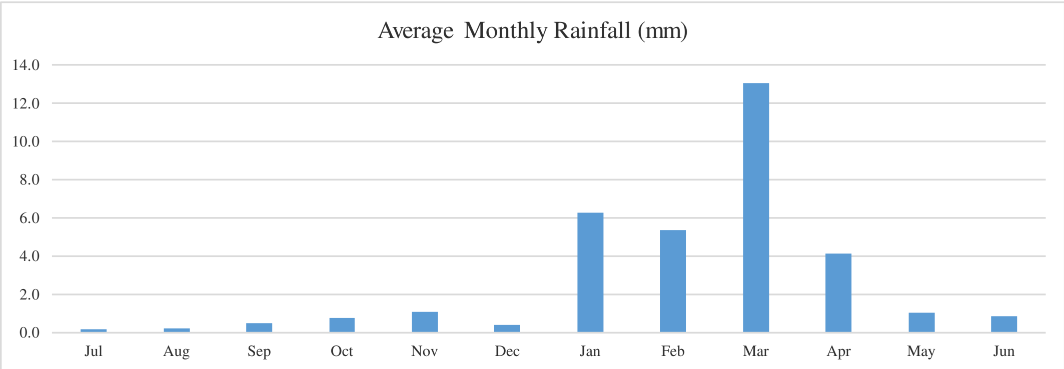


Figure 20 Monthly average rainfall (Digital Atlas of Namibia, 2002)

8.4 Topography and geology

The dune belt forms part of the Namib Sand Sea, a declared United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site. Dunes are mostly different variations of crescent dunes on the coastal side of the Walvis Bay – Swakopmund Dune Belt, and linear dunes on the eastern side before it changes into the gravel plains (Faul, 2020).

The Gravel Plains of the Central Namib largely consist of flat, gentle, undulating plains, intersected by ridgelines and outcrops of harder rock types (dolerite, granite and marble). The gravel plains are covered by coarse gravel and shallow, poorly developed soil, with rocky outcrops and inselbergs, ridge- and drainage- lines supporting greater plant and animal diversity (Faul, 2020).

The Swakop River, originating about 350 km to the east, is one of the major ephemeral rivers of central Namibia that crosses the Namib Desert to reach the Atlantic Ocean in the west. It creates a linear oasis in the arid environment in the lower reaches and forms The Swakop River Estuary at the river mouth where its forms a small ephemeral lagoon (Faul, 2020).

The coastal plains are interspersed by hummock dunes and salt pans. The Swakopmund Salt Works located to the north of Swakopmund acts as a manmade wetland (Faul, 2020).

8.5 Socio-economic overview of the receiving environment

Contextual setting

Swakopmund Constituency is located in the Erongo region of Namibia, which comprises seven electoral constituencies. The council and administrative headquarters for the Erongo Region are located in Swakopmund, which houses the administrative centre of the Municipality of Swakopmund and is located approximately 350 km west of the national capital, Windhoek (Bosman, 2020).

Erongo is one of the fourteen regions of Namibia, comprising the Swakopmund magisterial district up to the Ugab River and includes the Walvis Bay, Omaruru and Karibib magisterial districts with all the main centres within this region connected by paved roads[25]. This region is named after Mount Erongo, a well-known landmark in Namibia.

The regional economy is primarily based on mining such as offshore diamonds, and onshore salt works and uranium, followed by fishing, and ecotourism as mentioned above in the descriptions on these sectors. Other income generating activities include mariculture, guano harvesting, adventure sports and commercial centres such as the mall in Swakopmund.

The COVID-19 pandemic has had a negative effect on the Swakopmund community due to the travel restrictions impacting on tourism generating income, with this sector experiencing an almost complete collapse for the first three quarters of 2020 (Bosman, 2020).

Demographic profile

According to the census data of 2011, it is estimated that the region has a literacy rate of 97%, with services such as water, electricity and sanitation considered to be accessible to the majority of its inhabitants (Bosman, 2020). Refer to Table 13 below providing a summary of the demographic profile of the region compared to the Swakopmund constituency according to the 2001 Census as provided by Bosman (2020).

25 https://en.wikipedia.org/wiki/Erongo_Region

Table 13 Summary of the demographic profile of the region, compared to the Swakopmund constituency, according to the 2001 Census (Bosman, 2020)

<table>
<tr><th>Demographic Variable</th><th colspan="4">Erongo Region</th><th>Swakopmund Constituency</th></tr>
<tr><td>Population</td><td colspan="4">150,809
(Female: 48% Male: 52%)</td><td>44,725
(Female: 48% Male: 52%)</td></tr>
<tr><td>Literacy Rate</td><td colspan="4">97%</td><td>99%</td></tr>
<tr><td>Population Growth Rate</td><td colspan="4">3.4%</td><td>*</td></tr>
<tr><td>Fertility (Average number of children per woman)</td><td colspan="4">1.8</td><td>1.7</td></tr>
<tr><td>Population Distribution</td><td>Urban</td><td>87%</td><td>Rural</td><td>13%</td><td>Constituency is in Urban Area</td></tr>
<tr><td>Employment Rate</td><td colspan="4">70%</td><td>74%</td></tr>
<tr><td>Access to Piped Water Inside Home</td><td colspan="4">56%</td><td>56%</td></tr>
<tr><td>No Toilet Facility</td><td colspan="4">10%</td><td>3%</td></tr>
<tr><td>Energy for Cooking</td><td colspan="4">Municipal electricity 76%</td><td>Municipal electricity 80%</td></tr>
<tr><td colspan="6">* Data not available</td></tr>
</table>

8.6 Cultural Heritage

Archaeological remains in Namibia are protected under the National Heritage Act (2004) and National Heritage Regulations (Government Notice 106 of 2005), and projects of this magnitude are subject to archaeological assessment (Kinahan, 2020). Due to its aridity, western Namibia including the vicinity of Swakopmund and the Equiano project location, presents a marginal environment for human occupation, and in the past, particularly during periods of climatic cooling and extreme dryness the region may have been inhospitable to people. These conditions are reflected in the available archaeological evidence, which spans the last 0.8 million years with a sequence that is characterized by short periods of relatively intensive occupation, and long periods in which there appears to have been little or no human presence (Kinahan, 2011).

Significant changes in human settlement patterns and economic activities occurred during the last 5000 years on the Namib coast and in the immediate desert hinterland. These include the development of several specialised subsistence technologies, a shift towards systematic exploitation of marine resources, and in the last 2000 years the adoption of livestock keeping which lead to the emergence of a predominantly nomadic pastoral economy (Kinahan, 2020). Finally, increasing contact with visiting merchant vessels during the last 250 years lead eventually to colonial rule from 1884 to 1990 when Namibia achieved national independence (Kinahan, 2020).

Kinahan (2020) reports that detailed archaeological surveys have not been carried out in either the marine or terrestrial components of the intended Equiano project. However, extensive surveys of the Namib Desert have been carried out during the last twenty years and these have established with a high degree of certainty, the landscape or terrain associations of archaeological sites dating to within the last one million years. Of relevance to the Swakopmund area, as stated by Kinahan (2020) (Appendix 5) is: "The mid-Pleistocene era is represented in the desert immediately inland of Swakopmund by occasional and dispersed finds of stone tools including handaxes and cleavers. Outcrops of fine grained quartzite and chert are associated with late Pleistocene quarrying activity, while early to mid-Holocene occupation is represented by small scatters of stone tool waste and shellfish remains found among sheltering dolerite boulder outcrops close to the shore. None of the features mentioned here occur within the intended terrestrial component of the Equiano project, and no archaeological remains have been reported."

Historical or colonial heritage sites are almost entirely restricted to the established central business area of Swakopmund, which includes a number of well-preserved examples that are proclaimed national monuments (Kinahan, 2020). The northern parts of Swakopmund including the suburb of Vineta were only developed in the late 1960s, although there have been intermittent developments slightly north of Vineta over the last 50 years involving salt and guano production (Kinahan, 2020). The development of the area to be affected by the installation of the terrestrial Equiano cable took place within the last fifteen years. This area does not contain any known archaeological, palaeontological or heritage sites that have been recorded thus far (Kinahan, 2020).

While no underwater archaeological surveys have been carried out in the offshore zone immediately north of Swakopmund, there is little possibility of underwater heritage there (Kinahan, 2020). Historically, Swakopmund did not have a port or anchorage and people and goods were landed at a jetty constructed in 1905, until ten years later, when Namibia fell under South African rule, the jetty was abandoned in favour of the more convenient port facilities at Walvis Bay (Kinahan, 2020). Kinahan (2020) reports that site of the Equiano cable landfall lies approximately 7.4km north of the historical jetty on a bearing of 11.69°, and that there are a number of minor embayments and tidal zone outcrops between the two points. Longshore drift, driven by the northward flow of the Benguela Current would be expected to carry any flotsam from the historical jetty area out to sea rather than towards the beach in the area of the Equiano cable landfall. A number of vessels have been lost in the area immediately north of Swakopmund (Robertson, et al 2012) but there are no beached shipwrecks recorded at the landfall site and no historical records of shipwrecks remaining offshore along the planned cable route towards the landfall site (Kinahan, 2020).

Potential Underwater heritage

On the basis of documentary records the possibility of underwater heritage of importance within the area to be affected can be dismissed. The Equiano Subsea Cable Network Survey Report (Volume – Segment 24, BMH SWAKOPMUND – BU NAM, Book 1) prepared by Alcatel Submarine Networks includes detailed information on the seabed on the approaches to the Equiano cable landfall site. The seabed data presented in the report are sufficiently detailed to show the configuration of the seabed, including rippled sediment alignments and small solid objects that appear to be rock outcrop. Given the quality of the data which do not reveal any objects of the size and appearance of sunken vessels or parts thereof, or large cargo items, the likelihood of seabed heritage materials on the cable route is negligible (Kinahan, 2020).

Potential heritage along beach and inland route

A foot traverse of the entire route (preferred and alternative) of the on-land cable alignment was made on 30th May 2020 by Kinahan, whose observations were that the beach section from the High-water (BMH) consists of unconsolidated beach sand without any indications of archaeological remains, and that from the BMH the route proceeds along land surfaces that have been extensively modified for purposes of development. He concluded that indications of archaeological or palaeontological remains were not observed.

9 ENVIRONMENTAL ISSUES IDENTIFIED FOR SPECIALIST ASSESSMENT INCLUDING TERMS OF REFERENCE

9.1 Key Environmental Issues for detailed assessment

The screening and information-gathering phase has included obtaining input from the project proponent, the technical team, including the local environmental team, I&APs and guidelines. This has enabled an understanding of the environmental context in order to:

- Identify the key issues of concern for further detailed assessment.
- Focus and tailor the scope of work for specialist studies.

The issues identified have been formulated as seven key questions within which potential impacts are identified and described:

- What impacts will the construction and operation of the Equiano Cable System have on the terrestrial environment (flora and fauna)?
- What impact will the construction and operation of the Equiano Cable System have on the beach and dune cordon at Swakopmund?
- What are the potential social and socio-economic impacts associated with the construction and operation of the proposed Equiano Cable System?
- What impacts will the construction and operation of the Equiano Cable System have on the fishing industry?
- What impacts will the construction of the and operation of the Equiano Cable System have on the marine ecology?
- What impact will the construction of Equiano Cable System have on cultural and heritage resources, including any paleontological resources (if any are identified during the study)?
- What cumulative impacts will the construction of the Equiano Cable System have?

It is important to note that although these aspects have been raised as issues, it is not a given that potential impacts will occur. However, these issues do need to be considered and investigated to inform decision-making and to enable the relevant parties to proactively address any impacts, should they occur. The no-development option will be considered and assessed as part of these issues.

These key issues are elaborated hereunder and the terms of reference for each specialist included.

9.1.1 What impacts will the construction and operation of the Equiano Cable System have on the terrestrial Flora?

The study area has been extensively modified due to its location within the disturbed coastal zone, commercial area and residential areas of the Swakopmund Municipality. The presence of any indigenous vegetation needs to be identified and mitigation measures provided.

9.1.2 What impacts will the construction and operation of the Equiano Cable System have on the terrestrial Fauna?

The study area has been extensively modified by anthropogenic impacts in the form of urban development. Much of the terrestrial environment within the study area falls within the residential settlements with a small section of the project footprint falling within a natural area between the coastline and the commercial areas of Swakopmund. The coastal environment provides a dynamic and sensitive ecosystem that needs to be investigated to understand any potential impacts associated with the terrestrial component of the Equiano Cable System. The impacts need to be identified and mitigation measures provided where applicable.

9.1.3 What impact will the construction and operation of the Equiano Cable System have on the beach and dune cordon at Swakopmund?

Beaches and dunes are formed as a result of a number of drivers in the near shore and supra tidal environment which are driven by bio-physical processes. These processes are often interdependent and when changes in any one of following drivers occurs the morphology of the coastal dune cordon can change drastically:

- Wind and wave regimen.
- Climate state.
- Beach morphology.
- Vegetation cover.

Due to the dynamic nature of beach and dune systems and the numerous factors at play which influence the morphology and function of these dune systems, the construction of the Equiano Cable System may have an impact on the dune cordon at Swakopmund. However, impacts on the dune cordon are only expected to be temporary in nature, limited to the construction phase of the proposed development (less than 10 days to bury the cable through the dune cordon), and highly localised.

9.1.4 What are the potential social impacts associated with the construction and operation of the proposed Equiano Cable System?

Submarine telecommunication cables are important for international telecommunication networks as they transport almost 100% of transoceanic Internet traffic throughout the world (www.iscpc.org). It is widely recognised that access to affordable international bandwidth is key to economic development in every country. Although the national advantages of have submarine telecommunications cables is known, there are some potential social and socio-economic impacts related to the actual landing of the Equiano Cable System.

Further social impact investigations were undertaken by the local environmental team into the direct impacts the proposed landing of the Equiano Cable System will have on local residents, businesses within the area and the social environment.

9.1.5 What impacts will the construction and operation of the Equiano Cable System have on the fishing industry?

Demersal trawling in Namibia and has developed into the country's most important and mature fishing industry which is highly capital intensive and is further characterised by the high rate of employment per ton of fish landed. The fishing industry is a cornerstone of the Namibian economy, earning the second most forex after mining and provides approximately 16,800 direct jobs.

The offshore alignment of the proposed Equiano Cable System passes through the trawling grounds of the demersal trawling industry. Unlike countries like South Africa who have a legislated buffer around telecommunications cables (0.5 Nm each side of the cable) where no trawling or anchoring is permitted Namibia does not have this legislated buffer and impacts on the fishing industry are considered minimal. An investigation into the possible impact on the demersal trawling industry has been included in the fisheries assessment.

9.1.6 What impacts will the construction and operation of the Equiano Cable System have on the marine ecology?

The proposed marine cable is expected to have some direct impact on the marine ecology of the sea bed in the study area during construction of the cable system through cable burial activities, and on the marine waters through the presence of cable laying ships during the construction phase. These impacts are however, limited mainly to the seabed (benthos) and will be limited to the actual cable alignment (less than 5 m wide corridor). The long-term impacts of the marine telecommunications cable on the benthic environment (both fauna and flora) are however, expected to be negligible.

9.1.7 What effects will the construction of Equiano Cable System have on cultural and heritage resources, including any paleontological resources (if any are identified during the study)?

In terms of the National Heritage Act, (2004) it is necessary to appoint a heritage practitioner to determine if any cultural heritage resources occur along the proposed alignment of the Equiano Cable System or if there are any in the vicinity which may need to be avoided by the cable alignment.

9.1.8 What cumulative impacts will the construction of the Equiano Cable System have?

A cumulative impact is an incremental impact upon the environment that results from the impact of a proposed action when added to past, existing and reasonably foreseeable future actions. Cumulative effects can be both positive and negative.

The construction of the Equiano Cable System will naturally add to any cumulative impacts already likely to occur from a wide range of development interventions, i.e. increased employment, increased investment, etc. The aim of this section is to focus on the key cumulative impacts raised as concerns by stakeholders and identified by the specialists, as well as those ones associated with the project that may trigger different development pathways.

In this regard, one key cumulative impact has been identified to date which will require further investigation, namely: the combined impact of current and future marine telecommunication cable systems, on the deep-sea trawling industry.

9.2 Terms of Reference for Specialist Assessments

Potential impacts and issues of concern require further investigation. The significance of these potential impacts needs to be investigated and assessed in detail by way of specialist studies and further input by other project team members, as required.

An integrated approach has been adopted to consider direct, secondary and cumulative impacts. The findings integrated by the EAP to provide a comprehensive understanding of the issues and associated potential impacts. The technical and public participation processes interact to ensure that both processes build a comprehensive investigation of the issues identified.

Seven specialist studies were commissioned as detailed in Table 14 below.

The Terms of Reference for these specialist assessments detailed below. Copies of each report are provided in Appendix 5 as referenced. The environmental baseline referenced from these reports where applicable, is included in Section 8 above.

Table 14 Specialist studies and specialists

Specialist Study	Appendix Reference	Specialist	Organisation
Flora Impact Assessment	Appendix 5	Ms Herta Kolberg	Herta Kolberg Botanical Consulting
Fauna Impact Assessment	Appendix 5	Dr. André Faul	Geo Pollution Technologies (Pty) Ltd
Coastal Assessment	Appendix 5	Mr. Simon Bundy	SDP Ecological & Environmental Services
Social Impact Assessment	Appendix 5	Dr. André Faul; Ms Quzette Bosman & Mr. Stefan Short	Geo Pollution Technologies (Pty) Ltd
Fishing Industry Assessment	Appendix 5	Ms. Sarah. Wilkinson & Mr. David Japp	Capricorn Marine Environmental (Pty) Ltd
Marine Ecology Assessment	Appendix 5	Dr Andrea Pulfrich	Pices Environmental Services (Pty) Ltd
Archaeological Impact Assessment	Appendix 5	Mr John Kinahan	John Kinahan, Archaeologist

The generic terms of reference for all the specialist studies need to contain:

- Details of the person who prepared the report, and the expertise of that person to carry out the specialist study or specialised process (in the form of a curriculum vitae attached as an appendix to the report).
- A declaration that the person is independent.
- An introduction that presents a brief background to the study and an appreciation of the requirements stated in the specific terms of reference for the study.
- The date and season of the site investigation, and the relevance of the season to the outcome of the assessment.
- Details of the approach to the study where activities performed and methods used are presented.
- The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.
- An identification of any areas to be avoided, including buffers.
- A map superimposing the activity, including associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided and buffers.
- A description of any assumptions made and any uncertainties or gaps in knowledge.
- A description of the affected environment and the study area to provide a context under which the assessment took place.
- Description of proposed actions, and alternatives of development and operation of the project that could affect the prevailing environment, and the risks that these actions and alternatives present.

- A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment as well as the environment on the proposed development.
- A reasoned opinion as to whether the proposed activity or portions thereof should be licensed, and if so; any avoidance, management actions, mitigation measures and monitoring recommendations.
- A description of any consultation process that was undertaken during the course of carrying out the specialist study.
- A summary and copies of any comments that were received during any consultation process.
- A clear analysis as to how each recommended mitigation action would reduce negative impacts or enhance positive ones.

9.2.1 Flora Specialist Study

The appointed specialist must provide an assessment of the potential impact that the Equiano Cable System and related infrastructure will have on the flora of the area.. With this in mind, the specialist study should identify and discuss the following key aspects.

1. What are the potential impacts on vegetation arising from the proposed Equiano Cable System and associated construction activities?

Specifically, the Vegetation Assessment must address the following primary elements:

- Description of the vegetation present, the relevant and important characteristics and components thereof, including ecological functioning, which may be affected by the proposed Equiano Cable System or which may affect the proposed development during site establishment, construction, operation and maintenance and/or decommissioning.
- The assessment must consider the terrestrial environment within the development footprint as well as the terrestrial environment directly adjacent to the proposed cable servitude and construction footprints.
- Identification of species of conservation importance potentially affected by the proposed project.
- The impact of the development must be assessed in terms of compliance with relevant guidelines and management priorities.
- Identify and GPS significant sites that should be conserved, indicate on a suitable map, and motivate why they should be conserved.
- Identify the likely risks and impacts (negative and/or positive, including cumulative impacts if relevant) and their significance, which the proposed activity/infrastructure may have on vegetation assemblages and vice versa during site establishment, construction, operation and maintenance and/or decommissioning. Recommend mitigation measures for enhancing positive impacts and avoiding or mitigating negative impacts and risks (to be implemented during the design, construction, operation and/or decommissioning phases), for inclusion in an Environmental Management Programme.
- The identification of permit requirements as related to the removal and/or destruction of vegetation and specific plant species (all protected tree species within the proposed cable servitude must be counted and their position recorded to facilitate permit application processes).
- Address specific issues and concerns raised by stakeholders during the public review process (an Issues and Responses Report will be provided to specialists).
- Discuss any other sensitivities and important issues from your specialist perspective that are not identified in these terms of reference.

9.2.2 Fauna Specialist Study

The appointed specialist must provide an assessment of the potential impacts on terrestrial fauna and ecology arising from the proposed Equiano Cable System and associated construction activities?

- ❑ Animal species identification, including an indication of dominant species, rare and endangered species, and exotic and invader species.
- ❑ Animal species and their habitats.
- ❑ Assessment of the habitat condition for the animals.
- ❑ Desktop study to determine the probability of occurrence of any fauna of concern within these identified habitats.
- ❑ Determine the state of health of the ecosystem by taking into consideration all aspects concerning the natural resources.
- ❑ Recommend mitigation measures to ameliorate the negative impacts of the proposed development on the natural environment to be included in the Environmental Management Programme.
- ❑ The impact of the development must be assessed in terms of compliance with approved guidelines and management priorities.
- ❑ Address specific issues and concerns raised by stakeholders during the public review process (an Issues and Responses Report will be provided to specialists).
- ❑ Discuss any other sensitivities and important issues from your specialist perspective that are not identified in these terms of reference.

9.2.3 Beach and Coastal Dune Dynamics Specialist Study

The appointed specialist must provide an assessment of the potential impact that the Equiano Cable System and associated infrastructure will have on beach and coastal dune dynamics within the project area.

The specialist study should identify and discuss the following key aspects:

1. What are the potential impacts of the proposed Equiano Cable System on the primary dune, beach and beach dynamics, in particular, areas of sensitive vegetation, such as the primary dunes, beach access points and the beach/dune interface?
2. What measures can be applied to rehabilitate, mitigate and manage these impacts in order to optimise environmental integrity at the proposed cable landing points?
3. How should the dunes in question be rehabilitated and what measures are required to ensure dune stability and functionality (i.e. outline a specific action plan)?

The objectives of the dune and coastal dynamics specialist study are to:

- ❑ Provide a description of the primary dunes and dune areas present at Swakopmund and the relevant and important characteristics and components thereof, including dune dynamics.
- ❑ Identify and describe the components, characteristics and natural processes of the coastal environment that may be affected by the proposed development (during pre-construction, construction, operation, maintenance and/or decommissioning), from the perspective of coastal dynamics and dune stability.

- Identify and describe the components of the development that may be affected by the environment (during pre-construction, construction, operation, maintenance and/or decommissioning), from the perspective of coastal dynamics and dune stability.
- The assessment must consider the Equiano Cable System development footprint from the intertidal zone up to the BMH located approximately 130m from the surf zone (FUGRO, 2019).
- Identify the likely risks and impacts (negative and/or positive, including cumulative impacts if relevant) and their significance, which the proposed activity/infrastructure may have on relevant environmental components and processes, and vice versa during site establishment, construction, operation and maintenance and/or decommissioning. Make recommendations on alternatives where additional alternatives could be implemented to avoid negative impacts.
- Recommend mitigation measures for enhancing positive impacts and avoiding or mitigating negative impacts and risks (to be implemented during the design, construction, operation and/or decommissioning phases), for inclusion in an Environmental Management Plan (EMP).
- Identify key impacts that should be monitored as part of ongoing management of the site, and simple methods of monitoring these impacts.
- Identify and delineate by GPS co-ordinates, significant areas that should be conserved or rehabilitated, indicate on a suitable map, and motivate why they should be conserved or rehabilitated.
- The impact of the development must be assessed in terms of compliance with approved guidelines and management priorities.
- Discuss any other sensitivities and important issues from a specialist perspective that are not identified in these terms of reference.
- Address specific issues and concerns raised by stakeholders during the public review phase of the EIA process (an Issues and Responses Report will be provided to specialists).

9.2.4 Social Impact Assessment

The appointed specialist must provide an assessment of the potential impact that the Equiano Cable System and associated infrastructure will have on the social environment:

- Describe the current social environment within the study area.
- Identify and discuss potential impacts (positive and negative, local and regional, including cumulative impacts) of the proposed project on the social environment during construction, operation and decommissioning.
- Identify gaps in knowledge, data or information which may hamper the impact identification and evaluation process.
- Quantify and describe, for each feasible alternative, identified potential social impacts (cumulative, direct and indirect).
- Evaluate the significance of the identified potential social impacts.
- Assess the impact in terms of compliance with approved guidelines and management priorities.
- Conduct a comparative assessment of the identified alternatives.
- Make recommendations regarding mitigation and management measures for unavoidable social impacts.
- Contribute to the preparation of a site specific environmental management plan.
- Produce a specialist impact assessment report.

9.2.5 Fisheries Specialist Study

The appointed specialist must provide an assessment of the potential impact that the Equiano Cable System and related infrastructure will have on the trawling industry based on the alignment selected. With this in mind, the specialist study should identify and discuss the following topics:

- Determine the actual number of trawls (all types but more importantly bottom) per annum over the proposed Equiano Cable alignment and depict how and from what source of information this was calculated as well as the accuracy of the data.
- Typically, at what depths are the bottom trawls along the proposed Equiano Cable alignment?
- Provide details of un-trawlable seabed areas along the proposed cable alignment.
- Provide a detailed explanation of the key methods of how trawls are recorded and clearly depict the accuracy of these recordings.
- Assess the current trawling logs within the area and investigate whether the existing cable alignments and their exclusion zones are avoided by trawling vessels specifically the WACS Cable Systems.
- Provide a brief comment on the impact of the proposed Equiano Cable System alignment and its potential significance to the trawling industry/grounds and also propose an alternate solution with less impact if any. This comment on significance should cover aspects such as the relative percentage of the trawling grounds impacted and/or if the proposed alignment is likely to have any impact on trawling in terms of increased operational costs.
- Address specific issues and concerns raised by relevant stakeholders during the public process (an Issues and Responses Report will be provided to all identified specialists).
- Discuss any other sensitivities and important issues from a fisheries industry perspective that are not identified in these terms of reference.

In addition, the following maps should be generated and be included in the specialist report:

- Provide a map of trawl data over the last five years showing trawls across the proposed Equiano alignment. The map legend should include trawl numbers for each year assessed and specific areas of catches.
- Provide a similar map of trawl data for trawls over the existing WACS cable for the period five years prior to its installation and since its installation.
- Establish the extent of trawling activities in between the cables with separation of surface and bottom trawls.

9.2.6 Marine Ecology

The appointed specialist is to undertake a desktop assessment of the potential impact that the Equiano Cable System and related infrastructure will have on the Marine Benthic Environment based on the alignment selected.

In this context, the specialist study should identify and discuss the following topics:

- An introduction with a brief project overview, study approach, methodology, and assumptions and limitations.
- A description of the marine environment of the project area, focusing on the benthic invertebrate communities based on available literature and previous experience.
- A description of the potential impacts of the project on the benthic invertebrate fauna, followed by an assessment of the significance of these impacts using the assessment criteria provided (it must be noted that marine telecommunications cables once installed have a legislated 500 m buffer either side of the cable where no fishing/trawling or anchoring of vessels may take place).
- Provide a detailed motivation why site investigations were deemed unnecessary.
- In assessment of impacts take into account the spatial scale, intensity, duration, etc. of the impacts and include recommendations for mitigation of impacts.
- Address specific issues and concerns raised by stakeholders during the public review phase and an Issues and Responses Report will be provided to specialists.
- Discuss any other sensitivities and important issues from a marine benthic perspective that are not identified in these terms of reference.

9.2.7 Heritage Specialist Study

The appointed should identify and discuss the following key aspects.

1. What are the potential impacts on heritage resources arising from the proposed landing of the Equiano Cable System, and associated construction and operational activities?

The primary task of the archaeological impact assessment is to identify sensitive archaeological sites that could be affected by the Equiano project. The study is intended to satisfy the requirements of the Environmental Management Act (2007), and those of the National Heritage Act (2004) and National Heritage Regulations (Government Notice 106 of 2005), although the process of external review and clearance may require further, or different mitigation measures to be adopted.

Specifically, the Heritage Impact Assessment must address the following primary elements:

- The identification and assessment of potential impacts on cultural heritage resources, including historical sites arising from the construction and operation of the proposed Equiano Cable System (both onshore and offshore).
- The early identification of any red flag and fatal flaw issues or impacts.
- Information must be provided on the following: (i) Results of an overview survey of the project area, and the identification of cultural heritage resources that may be affected by the proposed project or which may affect the proposed project during construction and operation. (ii) Recommended mitigation measures for enhancing positive impacts and avoiding or minimizing negative impacts and risks (to be implemented during design, construction and operation).

- Identify permit requirements as related to the removal and/or destruction of heritage resources. The completed permit applications must be submitted to ACER for further attention and action.
- Address specific issues and concerns raised by stakeholders during the public review phase of the assessment process (an Issues and Responses Report will be provided to specialists).
- Formulation of a protocol to be followed by Paratus for the identification, protection or recovery of cultural heritage resources during construction and operation, including the completion of all necessary permit applications, which may be required.
- The identification and assessment of any palaeontological aspects or findings arising from the construction and operation of the proposed Equiano Cable System.

10 SPECIALIST ASSESSMENT FINDINGS AND IMPACT ASSESSMENT

Potentially significant impacts and the associated mitigation measures associated with each of the key environmental issues investigated by the various specialists are discussed below.

The assignment of significance ratings for the impacts identified by the specialists is conducted according to the assessment conventions detailed in Section 10.1 included below. The anticipated impacts and the associated significance are rated before mitigation (unmanaged) and following mitigation (managed) for the construction phase of the Equiano Cable System. The operational phase involves activities associated with the construction phase, anticipated only in the event of cable repair. The decommissioning of the Equiano Cable System is not included in this project scope as the expected life of the cable is 25 years. Should decommissioning be required, the identification of impacts and appropriate mitigation measures will be addressed when required.

10.1 Impact assessment conventions

The following methodology has been applied to predict and assess the potential impacts associated with the proposed development:

- **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

- **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.

- **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

- **Nature** – the evaluation of the nature of the impact. Most negative impacts will remain negative, however, after mitigation, significance should reduce:
  - **Positive**.
  - **Negative**.

- **Spatial extent** – the size of the area that will be affected by the impact:
  - **Site specific**.
  - **Local** (limited to the immediate areas around the site; <2 km from site).
  - **Regional** (would include a major portion of an area; within 30 km of site).
  - **National** or **International**.

- **Duration** – the timeframe during which the impact will be experienced:
  - **Short-term** (0-3 years or confined to the period of construction).
  - **Medium-term** (3-10 years).
  - **Long-term** (the impact will only cease after the operational life of the activity).
  - **Permanent** (beyond the anticipated lifetime of the project).

- **Intensity** – this provides an order of magnitude of whether or not the intensity (magnitude/size/frequency) of the impact would be negligible, low, medium or high):
  - **Negligible** (inconsequential or no impact).
  - **Low** (small alteration of systems, patterns or processes).
  - **Medium** (noticeable alteration of systems, patterns or processes).
  - **High** (severe alteration of systems, patterns or processes).

- **Frequency** – this provides a description of any repetitive, continuous or time-linked characteristics of the impact:
  - **Once off** (occurring any time during construction).
  - **Intermittent** (occurring from time to time, without specific periodicity).
  - **Periodic** (occurring at more or less regular intervals).
  - **Continuous** (without interruption).

- **Probability** – the likelihood of the impact occurring:
  - **Improbable** (very low likelihood that the impact will occur).
  - **Probable** (distinct possibility that the impact will occur).
  - **Highly probable** (most likely that the impact will occur).
  - **Definite** (the impact will occur).

- **Irreplaceability** – of resource loss caused by impacts:
  - **High** irreplaceability of resources (the project will destroy unique resources that cannot be replaced).
  - **Moderate** irreplaceability of resources (the project will destroy resources, which can be replaced with effort).
  - **Low** irreplaceability of resources (the project will destroy resources, which are easily replaceable).

- **Reversibility** – the degree to which the impact can be reversed/the ability of the impacted environment to return/be returned to its pre-impacted state (in the same or different location):
  - Impacts are **non-reversible** (impact is permanent).
  - **Low** reversibility.
  - **Moderate** reversibility of impacts.
  - **High** reversibility of impacts (impact is highly reversible at end of project life).

- **Significance** – the significance of the impact on components of the affected environment (and, where relevant, with respect to potential legal infringement) is described:
  Please note that this excludes positive impacts on the environment. In these cases, the level of significance should be denoted as Low**, Moderate** or High**.
  - **Low** (the impact will not have a significant influence on the environment and, thus, will not be required to be significantly accommodated in the project design).
  - **Medium** (the impact will have an adverse effect or influence on the environment, which will require modification of the project design, the implementation of mitigation measures or both).
  - **High** (the impact will have a serious effect on the environment to the extent that, regardless of mitigation measures, it could block the project from proceeding).

- **Confidence** – the degree of confidence in predictions based on available information and specialist knowledge:
  - **Low**.
  - **Medium**.
  - **High**.

10.2 Flora Specialist Study

The impacts identified by the flora specialist (Kolberg, 2020) are described below. Refer to the Report attached at Appendix 5.

10.2.1 Findings

The project area is located within the municipal area of Swakopmund and is developed mainly as a residential area with some business, institutional and recreational facilities. The flora specialist (Kolberg; 2020) reported that there is hardly any natural vegetation to be found in this area, and that vacant erven showed no vegetation, with the beach environment at the BMH location being open, undeveloped sand. The recreational park is planted with exotic species. The route for the cable front haul requires trenching through the recreational park and along roads, most of which are paved, unpaved with sand, cement interlocking brocks, loose pebbles or bitumen, with the occasional presence of non-indigenous plants. The site for the CLS at the Hage Heights Co-location is a large mostly undeveloped area with a few plants of *Arthraerua leubnitziae* of which only one will be directly affected by this development.

The flora specialist (Kolberg; 2020) reported that the receiving environment within the municipality of Swakopmund is previously impacted and that no threatened, protected or CITES listed species were found in the survey. The only species that will be affected by this development is *Arthraerua leubnitziae*, which is endemic to Namibia and restricted to the Namib desert. Only one plant of this species grows at the site of the CLS. Kolberg (2020) confirmed that no permits are required for the removal of vegetation since the only plant that needs to be removed does not have any legal protection status. The owner or lessee of the CLS site (Paratus) can remove this plant or instruct somebody in writing to do so.

This project will not have any significant impacts on the flora of the receiving environment nor on indigenous flora of surrounding areas. The receiving environment falls within the boundaries of the city of Swakopmund so that municipal bylaws apply. No bylaws for Swakopmund that relate to vegetation and would have any impact on this project could be found by the flora specialist (Kolberg, 2020).

The mitigation measures should ensure that the impact on flora is almost negligible. From a flora perspective there is no compelling reason for this project not to go ahead.

10.2.2 Mitigation measures

The following mitigation measures are included in the EMP (Appendix 5):

- ❑ The construction footprint must be clearly demarcated to avoid any damage to other plants within the surrounding areas.
- ❑ Restrict construction activities and storage of materials to the demarcated construction footprint

10.2.3 Flora Impact assessment

Table 15 Impact assessment on flora associated with the construction of the Equiano Cable System

Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Loss of indigenous vegetation and associated habitat	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	High	High	Low	High
	Managed	Negative	Site-specific	Short-term	Low	Once-off	Low	High	High	Low	High
Contamination of soils through infiltration of construction related pollutants	Unmitigated	Negative	Site-specific	Short-term	Low	Once-off	Moderate	Low	Probable	Low	High
	Mitigated	Negative	Site-specific	Short-term	Negligible	Once-off	Low	Low	Improbable	Very Low	High

10.3 Fauna Specialist Study

The impacts identified by the fauna specialist (Faul, 2020) are described below. Refer to the Report attached at Appendix 5.

10.3.1 Findings

The ecosystem is largely degraded within the urban environment with almost all of the natural habitat destroyed for development, and where land is not yet developed, it is often cleared and heavily fragmented. No large mammals occur in Swakopmund and the most abundant vertebrates are birds (Faul, 2020). As with most urban settlements, feral and domestic cats are responsible for the annihilation of birds, small mammals, lizards and insects found within town.

Impacts identified by the Fauna specialist:

- Habitat destruction and disturbance:
  The landing of the cable on the beach will result in temporary disturbance to the beach environment where coastal birds forage. Given the locality of the landing site to the marina and numerous anthropogenic impacts due to urban development these impacts are however not considered to be significant. Disturbance to the beach environment will also be short lived with construction during landing of the cable limited to 2-3 days to land the cable and 1-2 months to build the BMH. It should also be noted that sandy beaches are less sensitive than rocky shorelines. During the landing of the cable vehicles will be required to access the beach. Beach driving impacts negatively on invertebrates which live in the sand particularly between the high water and low water mark on the beach. Impacts on the invertebrates through the use of vehicles on the beach is however not considered significant give the short construction period (2-3 days) and the fact that intertidal area is a highly dynamic environment with constantly moving sands. During the specialist assessment it should be noted that no nest sites, dens or burrows were observed within the coastal habitat at the proposed cable landing point.

- Bird collisions and injury:
  The specialist identified a possible risk to birds flying at night (e.g., flamingos) which are often disorientated by bright, unshielded lighting and may collide with manmade structures and powerlines / overhead cables. Although identified by the specialist the proposed Equiano Cable System will have no overhead cables and no external lighting which means that this impact is unlikely to occur.

- Poaching and illegal wildlife trade:
  This has been identified as an indirect impact associated with locals trying to sell illegal wildlife products to project workers. This impact is unlikely to occur as the workers employed to install the terrestrial components of the Equiano Cable System will more than likely be Namibian citizens and the ASN workers involved with the offshore cable installation reside on the ship and will not come to shore.

- Waste:
  Waste will be produced during construction and operation, which may include left-over food, empty containers and bags, construction material including ropes, wires, etc., and chemical wastes such as empty paint containers. These, if not properly discarded, may trap, entangle or injure animals. Chemicals and hazardous waste may negatively impact animal health or lead to their death.

The faunal ecology study attached at Appendix 5, could not find any reason why the Equiano Cable System installation project cannot continue as presented by the client.

10.3.2 Mitigation measures

The installation of the Equiano Cable System's land-based infrastructure will take place within a heavily disturbed urban environment. As such, its direct impacts on the environment, and specifically animal biodiversity are negligible. Some indirect impacts may result from the workforce who will be involved with the cable installation and activities that they may be involved with outside of the development, but are unlikely (Faul, 2020). Examples include off-road driving for recreational activities in spare time and poaching or illegal wildlife trafficking. Thus, although the environmental classification of impacts in the specialist report are high, the likelihood of them occurring are considered to be negligible. Educational programmes for employees are important, and in-house environmental awareness training of all workers is recommended.

The following mitigation measures are included in the EMP (Appendix 5):

- Habitat destruction and disturbance:
  - Prior to any construction activities, the entire route to be surveyed for any nest sites or burrows that will be impacted by construction activities. If any are present the local office of the Ministry of Environment, Forestry and Tourism (MEFT) should be consulted.
  - Where vehicles access the beach, tyres should be deflated sufficiently to minimize pressure impacts on soil dwelling invertebrates where possible.
  - Any extraordinary sightings of animal burrows or nests must be recorded with proof of notification to MEFT.

- Bird collisions and injury:
  - If work is conducted at night during the construction phase, all lighting should be shielded and directed downwards as far as practicable.
  - Report on any dead or injured birds observed, the likely cause thereof and corrective measures taken.

- Poaching and illegal wildlife trade:
  - Environmental awareness training should be provided to all staff in the form of toolbox talks provided by the appointed contractors on site.
  - Report on any illegal activities.

- Waste:
  - All employees should be briefed on the importance of proper waste handling and disposal and the implications of carelessly discarding waste into the environment.
  - All waste must be securely stored in temporary, closed containers before being discarded at an approved waste disposal facility or recycler. This is especially important during windy conditions.
  - All construction waste must be removed at the end of the construction period and continually during operations when for example maintenance is performed on any of the infrastructure.
  - Disciplinary steps for any employee not adhering to proper waste handling and disposal requirements should be enforced by the appointed contractor.
  - Any waste that are not contained or is blown away by wind must immediately be collected and securely stored until disposal.

10.3.3 Fauna Impact assessment

Table 16 Impact assessment on fauna associated with the construction and operation of the Equiano Cable System

Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Habitat destruction and disturbance	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	Medium	High	Low	High
	Managed	Negative	Site-specific	Short-term	Negligible	Once-off	Low	High	Low	Very Low	High
Poaching and illegal wildlife trade (indirect impact)	Unmanaged	Negative	Site-specific	Short-term	High	Once-off	High	Medium	High	Low	High
	Managed	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Low	Very Low	High
Waste	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	High	High	Low	High
	Managed	Negative	Site-specific	Short-term	Negligible	Once-off	Low	High	Low	Very Low	High

10.4 Beach and Coastal Dune Dynamics Specialist Study

The impacts identified by the coastal specialist (Bundy, 2020) are described below. Refer to the Report attached at Appendix 5.

10.4.1 Findings

The Equiano cable system route along the inshore, intertidal and supra tidal environment lies within a portion of the Swakopmund coastline that has been subject to significant transformation caused by the small coastal breakwater harbour, impacting on biotic and abiotic factors.

The coastal specialist has identified the following impacts:

- Impacts on prevailing coastal morphology
  The proposed cable alignment landing just south of the small coastal breakwater is to be located in a highly disturbed coastal section with dynamic sand movement associated with the long shore drift. The proposed depth that the cable will be buried at is unlikely to result in the exposure of the cable, unless severe scour conditions arise removing most of the beach sand. The burial of the cable will not influence beach erosion or deposition. the positioning of the cable avoids the rip current caused by the breakwater harbour, identified by the coastal specialist

- Habitat disturbance
  The coastal environment is described as having transformed habitats, such as the harbour wall providing an artificial rock barrier in contrast to the adjacent sandy beach, which has been transformed into a zone of sand transport caused by the rip current. The cable laying operation will be of little significance in this disturbed habitat. Faunal species are mobile and temporary within the project site, having little or no direct impact on flora or fauna.

The coastal specialist (Bundy, 2020) commented that selected landing point at Swakopmund is appropriate in terms of limited eco-morphological impact associated with the laying of the cable and during operation in the event of cable repair.

10.4.2 Mitigation measures

The coastal specialist (Bundy, 2020) identified that the impacts on the shoreline and immediate sub-tidal environment are likely to be limited and of little ecological consequence. A number of management interventions should be undertaken during the establishment of the cable at this point. The following mitigation measures are included in the EMP (Appendix 5):

- Where vehicles access the beach, tyres should be deflated sufficiently to minimize pressure impacts on soil dwelling invertebrates where possible.
- Once all trenching and backfilling has been completed, following the laying of the cable, it is proposed that the dune be reinstated and sculpted to mimic the pre-construction state as per the detailed survey conducted in the planning phase.
- No refuelling of vehicles and fuel storage areas are permitted on the beach or coastal dune environment.

10.4.3 Beach and Dune Impact assessment

Table 17 Impact assessment on the beach morphology and dune cordon associated with the construction and operation of the Equiano Cable System

Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Impact on the prevailing coastal morphology (construction and operation)	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Definite	Low	High
	Managed	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Definite	Very-Low	High
Impact on habitat (construction and operation)	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Definite	Low	High
	Managed	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Definite	Very-Low	High

10.5 Social Impact Assessment

The impacts identified by the social impact specialist (Bosman, 2020) are described below. Refer to the Report attached at Appendix 6.4.

10.5.1 Findings

The social impact assessment specialist undertook a quantitative survey across a segment of residences randomly selected along the haul route alignment through Swakopmund. Concerns raised by the surveyed community are grouped into two categories, these being concerns related to property or sidewalk damage during the construction phase and concerns related to the possibility that the project may support 5G initiatives. Support towards the initiative was noted to related to local and regional development potential.

Although the project entails construction activities along the sidewalks of residential properties, it is not foreseen that such construction will result in the temporary or permanent obstruction of property accesses, and in addition no resettlement will be required and no displacement will result from the project. The Proponent has commented to using local unskilled labour and skilled labour, where such skills are available, with management likely to be provided by international parties.

The social impact assessment specialist identified the following impacts:

- Biophysical and socio-physical change:
  - Air quality impact caused by dust generated by construction activities.
  - Noise increase
  - Utility damage, such as sewer and water lines and disruption in service.
- Demographic change:
  - In-migration of a temporary nature of foreign labour force.
- Technical innovation:
  - Skills development
  - Access to innovation / technology
- Economic processes:
  - Development of markets through increased demand for telecommunication services with associated job creation
  - Industrialisation resulting from a change in cultural perception due to expansion of band width and speed, related services and infrastructure requirements, with associated cumulative effects.
- Ideals and aspirations:
  - Community beliefs and aspirations of electronic development and advancement.
  - Dissemination of information about planned operations and interventions for the area.
- Political process / institutional change:
  - Increased risk of deviant social behaviour and pressure to control social ills, with increased pressure on governmental essential and security services.

The social impact assessment specialist concluded that the project would contribute to the social well-being of Namibia as a whole, with social impacts deemed to be manageable. No community objections were received, and it is not foreseen that the project will be rejected or hampered by the public.

10.5.2 Mitigation measures

The following mitigation measures are included in the EMP (Appendix 5):

- Personal protective equipment (PPE) for construction staff working in dusty and noisy environments to be provided.
- Employ dust abatement measures as required.
- Comply with Labour Act regarding hazardous substances.
- Keep a Complaints Register recording all actions taken.
- The Contractor must identify and demarcate the extent of the site and associated work areas. Appropriate barriers and easily understood signage must be in place to block public access to unsafe areas.
- If the construction footprint and construction activities block a regularly used public access route/s, then suitable alternative/s public access route/s must be identified and demarcated accordingly.
- Notification to residents (through a community liaison officer (one of the Contractors staff)) of construction commencement.
- The Proponent should communicate all possible additional job opportunities / contracts clearly to employees (attempting to ensure no incorrect assumptions be made regarding possible employment).
- Promote the employment of workers residing in Namibia (with relevant experience).
- Gender sensitive recruiting and communication regarding employment; e mechanism
- If identified, skills training should be provided to individuals who exhibit potential for development.
- If applicable, skills development and improvement programs to be made available as identified during performance assessments.
- Documented, clear description on the cable alignment to be provided to the local municipal authority to ensure any damage to the cable during any other future excavations are prevented.

10.5.3 Social Impact assessment

Table 18 Impact assessment on social impacts associated with the construction of the Equiano Cable System

Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Dust, noise and service disruption (construction phase)	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	High	High	Low	High
	Managed	Negative	Site-specific	Short-term	Negligible	Once-off	Low	High	Low	Very Low	High
In-migration of temporary labour force	Unmitigated	Negative	Site-specific	Short-term	Low	Once-off	Moderate	Low	Probable	Low	High
	Mitigated	Negative	Site-specific	Short-term	Negligible	Once-off	High	Low	Improbable	Very Low	High
Skills development and increased demand for goods & services (construction & operational phases) and improved internet access and smart technology with future aspirations (operational)	Unmitigated	Negative	Local & regional	Short-term (construction) Long-term (operational)	High (-)	Once-off	High	High	Improbable	High (-)	High
	Mitigated	Positive	Local & regional	Short-term (construction) Long-term (operational)	High (+)	Once-off	NA	Low	Definite	High (+)	High
Cyber-crime (indirect cumulative impact)	Unmitigated	Negative	National	Long-term	Low	Continuous	High	Medium	Probable	Medium	High
	Mitigated	Negative	National	Long-term	Negligible	Continuous	Low	High	Definite	Low	High

10.6 Fisheries Specialist Study

The impacts identified by the fisheries specialist (Wilkinson, 2020) are described below. Refer to the Report attached at Appendix 6.

10.6.1 Findings

The project activities that have been identified as posing a potential risk to the fishing industry include the:

- Cable route survey.
- Cable route clearance operations.
- Installation of the marine telecommunications cable.

These all have the potential to affect fishing activity through either a short term/temporary exclusion of all types of fishing vessels during the route survey and clearance operations and/or a long-term/permanent exclusion to demersal trawling and the anchoring of demersal set fishing gear along the cable route.

Fishermen are required by law to take reasonable care to avoid damaging submarine cables. Those sectors at risk of snagging cables include demersal fisheries, in particular, those that fish via trawl and longline. The demersal longline fishery deploys gear that anchors to the seabed. In the unlikely event of gear breaking, grapnel hooks may be used to retrieve lost lines and these could potentially snag and damage an exposed section of cable. With regards to demersal trawling operations, trawl doors pose a reasonably high risk of snagging.

As a means of protection, the cable would be buried to a depth of 1.0 m to 1.5 m in waters shallower than 1,500 m. The cable may, however, be exposed on the seabed in some areas unsuitable for burial such as over rock or highly mobile sand. Despite burial in some places, protection along the entire cable routing would be afforded by the cable route being included on all nautical charts and notifications to the fishing industry of the newly installed cable.

The fisheries industry specialist has identified the following impacts:

- There is no overlap of the project activities with the operational areas of the tuna pole, deepsea crab and rock lobster sectors and therefore no impact expected on these fisheries.
- Pre-construction and construction phase impacts are considered to be short-term impacting on the small pelagic purse-seine (currently not operational), midwater trawl, demersal trawl, demersal longline, large pelagic longline and linefish sectors, which operate across the proposed routing of the cable.
- Operational phase impacts would affect the demersal fisheries (i.e., those that direct fishing effort at the seabed) are not expected due to the fact that the cable is buried and the cable will be included on all marine charts..
- An impact to demersal fisheries where the areas of operation of these sectors overlaps with the proposed cable route continuously disrupting normal fishing operations and displacing fishing activity into adjacent grounds. Disruptions include:
    - The lifting of ground gear (in the case of trawling) off the seabed whilst transiting over the cable could result in a loss of catch.
    - Should fishing gear foul a cable, the gear may be damaged or lost completely and any catches contained in nets would likely be lost.

  - A worse-case scenario is the potential risk to the vessel of capsizing if an attempt were made to lift the cable in order to free fishing gear.
- The potential effects of the proposed Equiano Cable System activities on each of the sectors were evaluated by Wilkinson (2020). The demersal trawl and longline sectors are considered most vulnerable to the installed cable. Trawlers would be expected to operate along the proposed cable route between the depth range of 240 m to 820 m. Demersal longline vessels operate along the proposed cable route at a depth range of 200 m to 400 m.

Whereas the proposed installation poses a noticeable, negative effect on normal fishing operations, adaptive fishing techniques may lower the impact from medium to low overall significance.

Sectors that could be affected during a temporary exclusion to fishing ground during the pre-installation and installation phase of the Project include the midwater trawl, demersal trawl, demersal longline, large pelagic longline and linefish sectors, which operate in the nearshore vicinity of the proposed cable route. Due to the temporary nature of the activity, and the low proportional overlap, the impact on these sectors is considered to be of low significance.

Apart from the proposed inherent project controls, no additional mitigation measures are considered necessary as the effects on the fishing industry associated with the proposed project are considered to be within an acceptable level. Measures of monitoring that the extent of the effect on fisheries is maintained at an acceptable level is not considered necessary.

10.6.2 Fisheries Industry Mitigation measures

The following mitigation measures are included in the EMP (Appendix 5):

- Standard measures would include a process of notification to affected parties prior to the commencement of installation of the cable. Selected fishing industry associations and MFMR should be informed of the pending activity and the safety clearance requirements of the cable-laying vessel.
- Distribute a Notice to Mariners prior to the commencement of the subsea cable installation. The Notice to Mariners should give notice of an indication of the proposed timeframes for subsea installation and an indication of the 0.5 Nm safety zone around the telecommunications cable routing and cable-laying vessel. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.
- The subsea vessel contractors must adhere to the International Organization for Standards under the ISO 9000 and ISO 9001 and the International Cable Protection Committee (ICPC) recommendations.
- The subsea cable routing must be published in nautical charts, which are distributed by the navy hydrographic office.
- Undertaking all maritime operations in line with International Maritime Law and safe practice guidelines.

10.6.3 Fisheries Impact assessment

Table 19 Impact assessment on the offshore fisheries sector associated with the pre-construction26, construction and operation of the Equiano Cable System

Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability (Low, Medium, High)	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Impact of exclusion of fisheries from fishing ground during pre-construction and construction phases	Unmitigated	Negative	Local	Short-term	Low	Intermittent to Periodic	Low	High	Probable	Low	High
	Mitigated	Negative	Local	Short-term	Low	Intermittent to Periodic	Low	High	Probable	Low	High

26 Survey of route

10.7 Marine Ecology

The impacts identified by the marine specialist (Pulfrich, 2020) are described below. Refer to the Report attached at Appendix 5.

10.7.1 Findings

Potential impacts to the marine environment as a result of the installation and operation of the subsea cable where relevant to the project components and identified by Pulfrich (2020) are summarised below, followed by a more detailed discussion of the impacts of these project components on the marine ecology.

- ❑ **Cable route survey (pre-construction phase)**
  The cable route survey could result in:

  - Physiological injury or behavioural disturbance of marine fauna by the sounds emitted by the geophysical survey equipment.
  - Potential injury to marine mammals and turtles through vessel strikes.

- ❑ **Subsea Cable Installation**
  The installation of the subsea cable will result in:

  - Disturbance of sediments and associated fauna during the pre-lay grapnel run.
  - Disturbance of sediments and associate fauna during cable installation.
  - Elimination of biota in the cable's structural footprint.
  - Reduced area of unconsolidated seabed available for colonisation by animals of any size living within the sediment (infaunal communities).
  - Physical presence of the cable providing an alternative solid layer (substratum) for colonising organisms (that take over new surfaces) living in or on sediments in the sea (benthic communities) or resulting in faunal attraction to fish and mobile invertebrates.

- ❑ **Shore crossing of the Subsea Cable**
  Infrastructure crossing the shore will impact on intertidal and shallow subtidal biota during the construction phase in the following ways:

  - Temporary loss of benthic (living in or on sediments in the sea) habitat and associated sessile (stalkless) communities due to preparation of seabed for buried cable laying and associated activities.
  - Possible temporary impacts on adjacent habitat health due to turbidity generated during trenching and installation.
  - Temporary disturbance of marine biota, particularly marine mammals and coastal birds, due to construction activities.
  - Pollution and accidental spills causing possible impacts to marine water quality and sediments through hydrocarbon pollution by marine construction infrastructure and machinery, and inappropriate disposal of used lubricating oils from marine machinery maintenance.
  - Pollution through potential contamination of marine waters and sediments by inappropriate disposal of spoil from trenching activities or backfilling, and human wastes, which could in turn lead to impacts upon marine flora, fauna and habitat.

- **Operation of the Subsea Cable System**
  As no routine maintenance of the subsea cable system is required, impacts associated with the operational phase would constitute temporary disturbance of the seabed if subsea cable sections require replacing in the event of repair, and impacts would be highly localised and infrequent.

- **Decommissioning**
  As the subsea cable will most likely be left in place at decommissioning, the potential impacts during the decommissioning phase are expected to be minimal and no key issues related to the marine environment are identified at this stage. As full decommissioning will require a separate EIA process, potential issues related to this phase will not be dealt with further in this report.

A more detailed discussion of the impacts of the project components (subsea and shoreline cable installation) on the marine ecology is provided below per phase of the project.

PRE-CONSTRUCTION PHASE:

- Geophysical surveying of the cable route

  The survey vessel would be equipped with a high to very high resolution multi-beam echo sounder (MBES), sub-bottom profiler and side scan sonar.

  The noise emissions from the geophysical sources are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction. The noise impact would therefore be highly localised for the majority of marine mammal species and may cause localised behavioural changes in some marine mammals.

  The maximum impact distance for behavioural disturbance caused by the immediate exposure to individual sonar MBES pulses was predicted to be within approximately 2 km from the MBES source for marine mammals of all hearing groups, at cross-track directions. Evidence of significant behavioural changes that may impact on the wider ecosystem is lacking (Perry, 2005).

  Given the evidence available from the scientific literature and the results of sound transmission loss modelling, the effects of high frequency sonars on marine fauna is considered to be of low intensity, localised along the cable route and short-term (for duration of survey i.e. weeks). Any behavioural or physiological impacts on marine fauna would be fully reversible and consequently the impact is considered of very low significance both without and with mitigation.

CONSTRUCTION PHASE:

- Disturbance of the coastal zone: sandy beach biota during trench excavation and subsea cable installation; and nearshore biota in unconsolidated sediments during trench excavation and cable installation.

  Although the activities on the shore and in the shallow subtidal regions would be localised and confined to within a few metres of the construction site and cable shore-crossing route, the benthic biota would be damaged or destroyed through moving of equipment and machinery and the general activities of contractors around the construction site. Impacts on mobile fauna such as fish and marine mammals that would be capable of avoiding the construction area are considered minimal as well as for any shorebirds feeding and/or roosting in the area would also be disturbed and displaced for the duration of construction activities.

On a high-energy coastline the recovery of the physical characteristics of intertidal and shallow subtidal unconsolidated sediments and suspended sediments to their pre-disturbance state following trenching and cable burial will occur within a few tidal cycles under heavy swell conditions, and will typically result in subsequent rapid recovery of the invertebrate epifaunal and infaunal communities to their previous state. Additionally, if following the disturbance, the surface sediment is similar to the original surface material, and if the final long- term beach profile has similar contours to the original profile, the addition or removal of layers of sand does not have enduring adverse effects on the sandy beach benthos (Hurme & Pullen 1988; Nel & Pulfrich 2002; Nel et al. 2003).

Whilst the construction activities associated specifically with the cable installation are unlikely to have a significant effect at the ecosystem level, the cumulative effects of increasing development along this stretch of coast should be considered. The construction of the small craft harbour adjacent to the portion of the beach through which the cable will be installed, has been severely disturbed, with cumulative impacts on the beach macrofaunal communities expected. The impacts on benthic communities as a result of cable installation through the littoral zone would be once-off and highly localised, due to the narrow footprint of approximately a 10 m wide strip through the intertidal and surf zone. Impacts would be expected to be short-term only as communities within the wave-influenced zone are adapted to frequent natural disturbances and recover relatively rapidly. Although the subsea cable routing passes through benthic habitats identified as ‘endangered’ and ‘vulnerable’ (Central Namib Outer Shelf and Central Namib Shelf Edge, respectively) the loss of resources would be low and impacts would be fully reversible.

As the diameter of the subsea cable is only 38 mm, the proportion of vulnerable and endangered habitat affected by the subsea cable installation can be considered negligible in relation to the available habitat area. Once the subsea cable has been buried, the affected seabed areas would, with time, be recolonised by benthic macrofauna.

- Disturbance and avoidance behaviour of surf zone fish communities, shore birds and installation marine mammals through coastal construction noise and offshore cable noise; behavioural changes and masking of biologically significant sounds in marine fauna due to noise from cable installation operations:

During installation of the subsea cable shore-crossing, noise and vibrations from excavation machinery may have an impact on surf zone biota, marine mammals and shore birds in the area.Noise levels during construction are generally at a frequency much lower than that used by marine mammals for communication (Findlay 1996), and these are therefore unlikely to be significantly affected. Additionally, the maximum radius over which the noise may influence is very small compared to the population distribution ranges of surf zone fish species, resident cetacean species and shore birds. Fish and marine mammals, shorebirds and terrestrial biota are highly mobile and should move out of the noise-affected area (Findlay, 1996).

Further offshore, underwater noise generated during subsea cable installation could affect a wide range of fauna; from benthic invertebrates and demersal species residing on the seabed along the subsea cable route, to those invertebrates and vertebrates occurring throughout the water column and in the pelagic habitat near the surface. Due to their hearing frequency ranges, the taxa most vulnerable to noise disturbance are turtles, pelagic seabirds, large migratory pelagic fish, and both migratory and resident cetaceans.

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (McCauley 1994). These acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Man-made sounds can therefore be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC, 2003). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Other forms of anthropogenic noise include multi-beam sonar systems, seismic acquisition, hydrocarbon and mineral exploration and recovery, and noise associated with underwater blasting, pile driving, and construction.

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön, 2012). The sound level generated by the subsea cable laying vessel and subsea apparatus would fall within the hearing range of most fish and marine mammals, and would be audible for considerable ranges (in the order of tens of kms) before attenuating to below threshold levels. However, the noise is not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, even at close range. The underwater noise may, however, induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna, but there is no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry, 2005).

As the noise associated with construction and subsea cable installation is unavoidable, no direct mitigation measures, other than the no-project alternative, are possible. Impacts of construction noise can, however, be kept to a minimum through responsible construction practices.

- Disturbance of offshore habitats:
  The grapnel used during the pre-lay grapnel run, and the subsea cable plough and tracked trenching/burial ROV implemented during subsea cable laying would result in the disturbance and turnover of unconsolidated sediments in an approximately 0.5 m wide strip along the length of the subsea cable route. Any epifauna or infauna associated with the disturbed sediments are likely to be displaced, damaged or destroyed. Similarly, the plough skids would injure or crush benthic invertebrates in their path. Mobilisation and redistribution of sediments in near-bottom currents during cable burial would result in localised increased suspended sediment concentrations near the seabed and in the water column.

  Once the cable has been laid, the affected seabed areas around the cable would with time be recolonised by benthic macrofauna. Re-colonisation is a site-specific process, with the recovery time and resulting community structure being dependent on sediment characteristics, local hydrodynamic conditions (Morton 1977; van der Veer et al. 1985) and depth. In deep water benthic community recovery rates are considerably slower than in shallower areas where there are strong swell or current effects.

  Impacts would be limited to the medium-term only as recolonisation of disturbed sediments from adjacent areas would occur within a year, but full recovery to functional similarity can take longer (medium- to long-term). The change in habitat from unconsolidated sediments to the hard substratum of the cable would be permanent. Although the subsea cable route passes through outer shelf and shelf edge benthic habitats identified as 'vulnerable' (Central Namib Shelf Edge) and 'endangered' (Central Namib Outer Shelf) the loss of resources would be low and impacts would be partially reversible as unconsolidated habitat will be replaced by hard substratum. Furthermore, the proportion of vulnerable and endangered habitat affected by the subsea cable installation can be considered negligible in relation to the available habitat area.

The potential impacts on benthic organisms of cable installation across the continental shelf and abyss is deemed to be of low significance without mitigation. The elimination of marine benthic communities in the structural footprint of the cable is an unavoidable consequence of the installation of subsea cables, and no direct mitigation measures, other than the no-project option, are possible. Impacts will, however, be temporary as recolonisation of disturbed sediments from adjacent areas will occur within a few weeks.

- Reduced physiological functioning of marine organisms due to increased turbidity in surf zone as a result of excavations and mobilising of sediments:

  Higher levels of suspended sediment concentrations due to trenching and burial activities associated with the subsea cable installation is considered to of low intensity and would extend locally around the subsea cable route and down-current of the shore-crossing, with impacts remaining temporarily. Within the wave-base at least, marine biota are typically adapted to periods of high turbidity and as suspended sediment concentrations would remain at non-life threatening levels, the loss of resources would be low and impacts would be fully reversible. The impact is therefore assessed to be of very low significance without mitigation. As high suspended sediment concentrations are an unavoidable consequence of trenching activities, no direct mitigation measures, other than the no-project alternative, are possible. In the intertidal and shallow subtidal zone, impacts can however be kept to a minimum through responsible construction practices.

- Collisions with and Entanglement by Marine Fauna:

  Vessel traffic can affect large cartilaginous fish species, turtles and marine mammals by direct collisions or propeller injuries. The potential effects of vessel presence on turtles and cetaceans include behavioural disturbance, physiological injury or mortality. As the cable would be under constant tension during installation, entanglements are highly unlikely and once on the seabed, the weight of the cable and torsional (twisting) balance will prevent coils and loops (Carter et al. 2009). In addition, as the cable would be buried along much of its length, entanglements are highly unlikely.

  As much of the cable would be installed in the offshore marine environment, the strong operational lighting used to illuminate the survey and cable vessels may disturb and disorientate pelagic seabirds feeding in the area (Pulfrich, 2020). Operational lights may also result in physiological and behavioural effects of fish and cephalopods as these may be drawn to the lights at night where they may be more easily preyed upon by other fish and seabirds. The response of marine organisms to artificial lights can vary depending on a number of factors such as the species, life stage and the intensity of the light. Considering the extensive distributions and low numbers of oceanic seabirds likely to be encountered in the offshore environment, the likelihood of collisions would be low.

  Depending on the onboard equipment and types of ploughs used, prevailing sea conditions as well as the nature of the seabed, subsea cable vessels can lay 100 -150 km of cable per day, with modern ships and ploughs achieving up to 200 km of cable laying per day (www.independent.co.uk>science), which means that the vessel speed is between 2.3 – 4.5 knots. The pre-laying grapnel run is typically conducted at 0.5 knots; and vessels will maintain the same speed when plough-burying cable. Given the slow speed of the vessel during the pre-lay grapnel run and the cable installation, ship strikes with marine mammals and turtles or entanglement of marine fauna in the cable are unlikely, and should the impact occur it would be very infrequent.

In the event of a collision or entanglement, the impact is deemed of low intensity and would be site specific to the vessel location. Injury through collision and/or entanglement would occur over the short term period and considering the slow vessel speed would likely remain at non-life threatening levels. Although this direct impact could result in a medium loss of resources, the impact is assessed to be of low significance without mitigation.

OPERATIONAL PHASE

- Physical presence of marine cable:

The presence of subsea infrastructure (namely cable and repeaters) can therefore alter the community structure in an area, and effectively increase the availability of hard substrate for colonisation by sessile benthic organisms (where the cable remains unburied), thereby locally altering and increasing biodiversity and biomass. This impact is however considered negligible as the cable diameter in deep water is as little as 16 mm in diameter and will not result in significant changes to benthic communities.

Heat dissipation is associated with marine cables as electricity is required to transmit the signal. Although the potential consequences of this thermal radiation on benthic organisms has not yet been investigated in situ, the narrow footprint of the cables and the expected low temperature differences suggest that impacts are likely to be negligible (Heath 2001; Taormina et al. 2018 and references therein).

Electromagnetic fields are associated with marine telecommunication cables, due to the direct current in the inner conductor that set up a stationary magnetic field in the form of concentric rings emanating from the cable. Animals with the capacity to detect and use constant geomagnetic fields are thus likely to only detect the signal within close proximity to the source (within centimetres) (Heath, 2001; Kraus & Carter, 2015 cited in Pulfrich, 2020).

Modern deep-water fibre-optic cables are composed of hair-like glass fibres, a copper power conductor and steel wire strength member, all of which are sheathed in high-density polyethylene. Where extra protection is required, as for areas of rocky seabed or strong wave and current action, additional steel wire armour is added. The cable-grade polyethylene used for the sheath is essentially inert in seawater. Potential leachates have been identified as zinc passing into the sea water, with concentrations being higher in cables that are cut with exposed wire armour ends. The dilution of leachates would be rapid and any negative effects on marine organisms are likely to be highly localised (Pulfrich, 2020).

Based on available information in the literature, the impacts on marine fauna through the generation of heat, sound, EMFs and leachates by the submarine cable would be of negligible intensity and highly localised along the cable itself. As the subsea cable would be in operation for up to 25 years, the impacts would last over the long-term. No direct mitigation measures, other than the no-project alternative, are possible. The potential impacts on marine biota is consequently deemed to be of very low significance without mitigation.

10.7.2 Marine Ecology mitigation measures

The following mitigation measures are provided by the marine specialist (Pulfrich, 2020) and are included in the EMP (Appendix 5):

- Plan the routing of the proposed subsea cable to avoid sensitive benthic habitats in the coastal and nearshore zone as best possible.
- Align the cable routing as closely as possible to the routes of existing or de-commissioned cables (even when these traverses a Marine Protected Area) thereby avoiding the impact of as yet undisturbed ecosystem types.
- Schedule construction associated with the cable shore crossing to avoid bird breeding (March to September) and whale migration periods (June to November).
- Ensure as much as practicable, that construction activities required for subsea cable installation occur concurrently thereby minimizing the disturbance duration in the coastal and nearshore zone.
- If cable installation is scheduled during the whale migration period (beginning of June to end of November), the cable laying vessel must appoint a crew member as a Marine Mammal Observer (MMO) with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the subsea cable route and record incidence of marine mammals, and their responses to vessel activities. The observation post will keep a record of sightings, noting date, time, coordinates, approximate distance of the ship and additional.
- Keep heavy vehicle traffic associated with construction in the coastal zone to a minimum.
- Restrict disturbance of the intertidal and subtidal areas to the smallest area possible. Once the shore crossing is finalised and the associated construction site is determined, the area located outside of the site should be clearly demarcated and regarded as a 'no-go' area.
- Restrict traffic in the intertidal area to minimum required.

The marine specialist (Pulfrich, 2020) concludes that as long as all the environmental guidelines and appropriate management and monitoring recommendations recommended are implemented, there is no reason why the proposed installation of the Equiano fibre optics cable should not proceed.

10.7.3 Marine Ecology Impact assessment

Table 20 Impact assessment on marine environment associated with the construction and operation (repairing of section of cable) of the Equiano Cable System

Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Impacts of multi-beam and sub-bottom profiling sonar on marine fauna	Unmanaged	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Improbable	Very Low	High
	Managed	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Improbable	Very Low	High
Disturbance and destruction of sandy beach biota during trench excavation and subsea cable installation	Unmanaged	Negative	Site-specific	Short-term	Medium	Once-off	Low	High	Definite	Low	High
	Managed	Negative	Site-specific	Short-term	Medium	Once-off	Low	High	Definite	Low	High
Disturbance and destruction of nearshore biota in unconsolidated sediments during trench excavation and cable installation.	Unmanaged	Negative	Site-specific	Short-term	Medium	Once-off	Low	High	Probable	Low	High
	Managed	Negative	Site-specific	Short-term	Medium	Once-off	Low	High	Probable	Low	High
Disturbance and avoidance behaviour of surf-zone fish communities, shore birds and marine mammals through	Unmitigated	Negative	Site-Specific	Short-term	Low	Once-off	Low	High	Possible	Very Low	High
	Mitigated[27] (no direct mitigation	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Possible	Very Low	High

27 No direct mitigation measures possible, other than no-project alternative; monitoring of marine fauna during construction is recommended as mitigation therefore managed and unmanaged ratings are the same.

coastal construction noise and offshore cable installation noise	measures possible)										
Behavioural changes and masking of biologically significant sounds in marine fauna due to noise from cable installation operations.	Unmitigated	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Possible	Very Low	High
	Mitigated[28]	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Possible	Very Low	High
Description and Nature of Impact	Mitigation	Nature (Positive, Negative, Neutral)	Spatial Extent	Duration (Very low, Low, Medium, High)	Intensity (Low, Medium, High)	Frequency (Once off, Intermittent, Periodic, Continuous)	Irreplaceable loss of resources (Low, Medium, High)	Reversibility of impacts (Low, Medium, High)	Probability	Significance (Low, Medium, High)	Confidence (Low, Medium, High)
Disturbance and destruction of subtidal sandy biota during cable laying	Unmitigated	Negative	Site-specific	Medium to Long-term/ Permanent	Medium	Once-off	Low	Low	Definite	Low	High
	Mitigated[29]	Negative	Site-specific	Medium to Long-term/ Permanent	Medium	Once-off	Low	Low	Definite	Low	High
Reduced physiological functioning or marine organisms due to increased turbidity in surf-zone as a result of excavations and mobilising of sediments	Unmitigated	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Possible	Very Low	High
	Mitigated[30]	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Possible	Very Low	High
Physical presence of the subsea cable.	Unmitigated	Negative	Site-specific	Permanent	Medium	Continuous	Low	Medium (Partially)	Definite	Low	High

28 No direct mitigation measures possible.
29 No direct mitigation measures possible, other than no-project alternative.
30 No direct mitigation measures possible, other than no-project alternative.

	Mitigated[31]	Negative	Site-specific	Permanent	Medium	Continuous	Low	Medium (Partially)	Definite	Low	High
Accidental spillage or leakage of fuel, chemicals or lubricants, cement and disposal of litter may cause water or sediment contamination and/or disturbance to intertidal and subtidal biota.	Unmitigated	Negative	Site-specific	Short-to medium term	Medium	Intermittent	Medium	Medium (Partially)	Probable	Medium	High
	Mitigated	Negative	Site-specific	Short-term	Low	Once-off	Low	High	Improbable	Low	High
Collision with and entanglement by marine fauna	Unmitigated	Negative	Site-specific	Short-term	Low	Once-off	Medium	Medium	Improbable	Low	High
	Mitigated[32]	Negative	Site-specific	Short-term	Low	Once-off	Medium	High	Improbable	Low	High

31 No direct mitigation measures possible, other than no-project alternative.
32 No direct mitigation measures possible, other than no-project alternative; monitoring of marine fauna during construction (an operation for cable repair) is recommended.

10.8 Heritage Specialist Study

10.8.1 Findings

The specialist heritage report (Kinahan, 2020) concluded that:

- No potential impacts on cultural heritage resources were observed in either background sources or direct examination of the onshore component, including historical sites arising from the construction and operation of the proposed Equiano Cable System (both onshore and offshore).
- The assessment has not identified any red flag and fatal flaw issues or impacts.
- The overview survey, comprising background sources or direct examination of the onshore component did not identify any heritage resources that may affect construction and operation of the project.

10.8.2 Mitigation measures

The heritage specialist proposed the following mitigation measures, included in the EMP (Appendix 5):

- Permit requirements will be communicated to the consultant (i.e., ACER/Geo) by either the Environment Commissioner (Ministry of Environment), or the National Heritage Council in the event that the report is referred to the Council for decision.
- The protocol to be followed by Paratus for the identification, protection or recovery of cultural heritage resources during construction and operation, including the completion of all necessary permit applications, which may be required is set out in the Appendix 1 of the EMP (Chance Finds Procedure). Chance finds noted or recovered during construction and operation of proposed Equiano Cable System are to be reported to the National Heritage Council as per the National Heritage Act (27 of 2004).
- It is recommended that on the basis of this assessment the Equiano project has no identified or implied heritage impact implications and should be permitted to proceed. As a precautionary measure however, the project EMP should adopt and implement the Chance Finds Procedure (included in Appendix 5).

10.8.3 Impact assessment

The heritage specialist identified no direct, indirect or cumulative impacts and therefore the rating of impacts is not applicable, as detailed in the report prepared by Kinahan (2020).

10.9 Summary of impact assessment significance ratings

Impact assessment process and findings

Provided mitigation measures as recommended in this report are implemented and construction is undertaken in accordance with specifications contained within the EMP, no significant negative environmental impacts are anticipated from the construction and operation of the Equiano Cable System. A summary of the key impacts is provided in Table 21 below, which describes the nature, intensity, duration, extent and significance of the key impacts, with and without mitigation.

The “no-go” alternative would mean that there will be no Equiano Cable System installed, and no increase in capacity in internet band width in a time of the COVID-19 pandemic when this is an essential service necessary to facilitate remote working, education on line, and growth in the Namibian economy, including that of partner (land-locked) countries.

Table 21 Summary of key impacts of the proposed Equiano Cable System on the environment

Description of Impact	Nature of Impact	Intensity	Duration	Extent	Significance without Mitigation	Significance with Mitigation
Impact on terrestrial flora (Construction Phase)	Negative	Low	Short-term	Site-specific	Low	Low (-)
Contamination of soils through construction related pollutants	Negative	Low	Short-term	Site-specific	Low	Very Low (-)
Impact on terrestrial fauna: habitat destruction and disturbance, including waste/pollution and bird collisions, and illegal wildlife trade (indirect impact) (Construction and Operational Phase)	Negative	Low	Short-term (construction)	Site-specific	Low	Very Low (-)
Impact on beach and dune morphology (Construction Phase and Operational Phase)	Negative	Medium	Short-Term (construction) Long-term (operational related to cable repair)	Site-Specific	Low	Very Low (-)
Public nuisance such as dust, noise and service disruption	Negative	Medium	Short-Term (construction) Long-term (operational related to cable repair)	Site-Specific	Low	Very Low (-)
Temporary employment creation (Construction Phase and Operational Phase)	Positive	Medium	Short-Term (construction) Long-term (operational related to cable repair)	Local	Low (-)	Medium (+)
Improved bandwidth & telecommunications capacity in Namibia (Operational Phase)	Positive	High	Long - Term	National	High (-)	High (+)
Impact on the fishing industry (Construction and Operational	Negative (construction)	Low (construction) Medium	Short-term (construction)	Regional Regional	Low (construction)	Low (-) (construction)

Description of Impact	Nature of Impact	Intensity	Duration	Extent	Significance without Mitigation	Significance with Mitigation
Phase, (including cumulative impact)	Negative (operation)	(operational)	Long-Term (operational)		Medium-Low (operational)	Medium-Low (-) (operational)
Impacts of multi-beam and sub-bottom profiling sonar on marine fauna (pre-construction)	Negative (pre-construction)	Low	Short-term	Site-specific	Very Low	Very Low (-)
Disturbance and destruction of sandy beach biota during trench excavation and subsea cable installation (construction and operation in event of cable repair)	Negative	Medium	Short-term	Site-specific	Low	Low (-)
Disturbance and destruction of nearshore biota in unconsolidated sediments during trench excavation and cable installation (construction and operation in event of cable repair)	Negative	Medium	Short-term	Site-specific	Low	Low (-)
Disturbance and avoidance behaviour of surf-zone fish communities, shore birds and marine mammals through coastal construction noise and offshore cable installation noise (construction and operation in event of cable repair)	Negative	Low	Short-term	Site-specific	Very Low	Very Low (-)
Behavioural changes and masking of biologically significant sounds in marine fauna due to noise from cable installation operations (construction and operation in event of cable repair)	Negative	Low	Short-term	Site-specific	Very Low	Very Low (-)

Description of Impact	Nature of Impact	Intensity	Duration	Extent	Significance without Mitigation	Significance with Mitigation
Disturbance and destruction of subtidal sandy biota during cable laying (construction and operation in event of cable repair)	Negative	Medium	Medium to Long-term/ Permanent	Site-specific	Low	Low (-)
Reduced physiological functioning or marine organisms due to increased turbidity in surf-zone as a result of excavations and mobilising of sediments (construction and operation in event of cable repair)	Negative	Low	Short-term	Site-specific	Very Low	Very Low (-)
Physical presence of the subsea cable (Operational Phase)	Negative	Medium	Continuous	Site-specific	Low	Low (-)
Impact on the marine ecology caused by pollution and accidental spills (Construction and Operational Phase)	Negative	Medium	Short-Term	Local	Medium	Low (-)
Cumulative effects on the marine ecology (Operational Phase)	Negative	Low	Long - Term	Local	Low	Low (-)
Cumulative impact of climate change on the beach environment from erosion	Negative	Low	Long - Term	Local	Medium	Low (-)
Impact on marine and terrestrial heritage resources	No direct, indirect or cumulative impacts identified by the specialist (Kinahan, 2020)					

Based on the impact rating process summarised in the table above, it is evident that most of the negative impacts vary from low to very low, except for the impact on the fishing industry rated as medium-low, with no impacts identified by the heritage specialist. Positive impacts are related to employment creation, economic spin offs and the provision of high-speed data and improved band width with increased telecommunications capacity in Namibia.

11 CONCLUDING REMARKS

The EAP is of the opinion that due environmental process has been followed during the preparation of this Draft Detailed Environmental Impact Scoping Assessment process and the initiation of the associated Public Participation Programme.

The analysis of key issues assessed by the various specialists identify that there are no negative impacts that can be classified as fatal flaws. However, further comment from I&APs is required to confirm the findings and impact assessment of the key issues identified upfront, such as social impacts, impacts on the coastal dune cordon, marine ecology, the trawling industry, and a review of maritime cultural heritage resources.

Following the comment period for the Draft Environmental Impact Assessment Report, the issues raised by stakeholders, together with those of technical specialists and the regulatory authorities, will be captured in the Final Environmental Impact Assessment Report (FEIAR). This report will be submitted to MET for consideration.

12 REFERENCES

Websites:

http://www.met.gov.na/services/environmental-impact-assessment-/233/.
Ministry of Environment, Forestry and Tourism's website accessed on 08/11/2020.

https://www.iscpc.org/ International Cable Protection Committee. Date accessed 4/11/2020.

http://www.imo.org/en/Publications/Pages/CurrentPublications.aspx Date accessed 22 July 2016

http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf United Nations Convention on the Law of the Sea. Date accessed 23 August 2016.

http://www.dirco.gov.za/au.nepad/nepad_overview.htm NEPAD (New African Partnership for Africa's Development). Date accessed 15 August 2016 and 4/11/2020.

https://glossary.ametsoc.org/wiki/Meteoric_water
Date accessed 8/11/2020.

https://www.swkmun.com.na/downloads/regulations/ referenced by Flora specialist (Kolberg, 2020). Website not referenced and access date not provided.

https://www.worldwildlife.org/ecoregions/at1315 Date accessed on 24 November 2020

https://whc.unesco.org/en/list/1430/ referenced by Fauna specialist (Faul, 2020). Access date not provided.

https://www.google.com/search?q=what+is+longshore+drift+and+how+is+it+related+to+a+longshore+current&oq=what+is+long+shore+drift Date accessed 24 November 2020

https://www.google.com/search?q=barchan+dune+forms&oq=barchan+dune+forms+&aqs=chrome..69i57j0i333.1443j0j15&sourceid=chrome&ie=UTF-8
Date accessed 24 November 2020

https://www.google.com/search?q=diatomaceous&oq=diatomaceous+&aqs=chrome..69i57j0i433i457j0l6.2376j0j15&sourceid=chrome&ie=UTF-8
Dated accessed 25 November 2020

https://cmr.mandela.ac.za/EBSA-Portal/Namibia/NA-EBSA-Status-Assessment-Management, Accessed by Pulfrich 5 June 2020

https://cmr.mandela.ac.za/EBSA-Portal/South-Africa (cited by Pulfrich, 2020)

www.independent.co.uk>science (cited by Pulfrich, 2020)

Wikipedia, February 2017. https://en.wikipedia.org/wiki/Fishing_industry_by_country (cited by Wilkinson, 2020)

https://en.wikipedia.org/wiki/Erongo_Region Date accessed 28 November 2020.

Publications and Reports:

ACER (Africa) Environmental Consultants. 29 November 2019. Equiano Cable System Namibian Branch: Swakopmund. Permits in Principle Screening Report.

ASN REH. 2019. *ASN ROUTE ENGINEERING GUIDELINES.*

Atlas of Namibia Project. 2002. Directorate of Environmental Affairs, Ministry of Environment and Tourism. http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/main_namibia_atlas.html

BARNARD, P., C.J. Brown, A.M. Jarvis, and A. Robertson. 1998. Extending the Namibian protected areas network to safeguard hotspots of endemism and diversity. Biodiversity and Conservation 7: 531-547.

BIANCHI, G., CARPENTER, K.E., ROUX, J.-P., MOLLOY, F.J., BOYER, D., BOYER, H.J., 1999. FAO species identification guide for fishery purposes. Field guide to the Living Marine Resources of Namibia, 256 pp.

BOSMAN, Q., Faul, A, and Short, S. 2020 November; Construction and Operations of the Equiano Cable Swakopmund, Namibia: Social Impact Assessment.

BRYANT R. 2010. Characterising the Wind Regime of Sand Seas: Data Sources and Scaling Issues. Global Sand Seas: Past Present and Future. Working Group Conference: Royal Geographical Society in London.

BUNDY, S.C. 2020. Coastal Assessment Proposed Equiano Submarine Telecommunications Cable at Swakopmund Beach, Namibia.

CARTER, L., BURNETT, D., DREW, S., MARLE, G., HAGADORN, L., BARTLETT-MCNEIL, D. & N. IRVINE, 2009. Submarine Cables and the Oceans – Connecting the World. UNEP-WCMC Biodiversity Series No. 31. ICPC/UNEP/UNEP-WCMC.

CLARE, .C. (Dr). 30 September 2020. A Publication from the International Cable Protection Committee (ICPC). Submarine Cable Protection and the Environment. A Bi-Annual Update from ICPC's Marine Environmental Advisor, Dr Mike Clare.

CHAPMAN, P. and L.V. SHANNON, 1985. The Benguela Ecosystem. Part II. Chemistry and related processes. Oceanogr. Mar. Biol. Ann. Rev., 23: 183-251.

ELKO, N, Kate Brodie, Hilary Stockdon, Karl Nordstrom, Chris Houser, Kim McKenna, Laura Moore, Julie Rosati, Peter Ruggiero, Roberta Thuman, and Ian Walker (2016) *Dune management challenges on developed coasts* Shore & Beach Vol. 84, No. 1 Winter 2016.

EMEANA, C.J. T.J. Hughes, J.K. Dix, T.M. Gernon, T.J. Henstock, C.E.L. Thompson, J.A. Pilgrim. 2016. The thermal regime around buried submarine high-voltage cables. Geophysical Journal International, Volume 206, Issue 2, 1 August 2016, Pages 1051–1064, https://doi.org/10.1093/gji/ggw195.

DEPARTMENT OF ENVIRONMENTAL AFFAIRS. Ministry of Environment and Tourism. National Climate Change Strategy & Action Plan 2103 – 2020. Republic of Namibia.

DEPARTMENT OF ENVIRONMENTAL AFFAIRS. Ministry of Environment and Tourism. National Policy on Climate Change for Namibia – 2011. Republic of Namibia.

DONOVAN, C., 2009. Twenty thousand leagues under the sea: A life cycle assessment of fibre optic submarine cable systems. http://www.seeds4green.org/sites/default/files/fibre%20optique.pdf

DUNDEE, B.L., 2006. The diet and foraging ecology of chick-rearing gannets on the Namibian islands in relation to environmental features: a study using telemetry. MSc thesis, University of Cape Town, South Africa.

ELFINK, B, G Prestedge, C B M Rocha, J Juhl. 2002. Shoreline evolution due to highly oblique indicent waves at Walvis Bay, Namibia.

FAUL, A. 2020. Landing of the Proposed Equiano Cable System (Submarine Telecommunications Cable) at Swakopmund, Namibia: Faunal Ecology Study.

FINDLAY, K.P., 1996. The impact of diamond mining noise on marine mammal fauna off southern Namibia. In: Environmental Evaluation Unit Report, Impacts of deep sea diamond mining, in the Atlantic 1 mining licence area in Namibia, on the natural systems of the marine environment. EEU Unpublished Report No. 11/96/158.

FUGRO, 2019. Equiano Subsea Cable Network. Volume – Segment 24 BMH SWAKOPMUND – BU NAM. Book 1 Survey Report.

GIESS, W. 1971. A preliminary vegetation map of Namibia *Dinteria, 4: 5-114*.

GRIFFIN, M. 1998. The species diversity, distribution and conservation of Namibian mammals. Biodiversity and Conservation 7: 483-494.

HEATH, J. 2001. Benign use of the seabed by telecommunications cables. Extracts of response to an environmental enquiry in the USA to assist in providing information on the minimal impact of a cable on the seabed environment, in email dated 9 May 2001, from J. Heath with subject: AP11 from Copenhagen Plenary. HURME, A.K. & E.

HOLNESS, S., KIRKMAN, S., SAMAAI, T., WOLF, T., SINK, K., MAJIEDT, P., NSIANGANGO, S., KAINGE, P., KILONGO, K., KATHENA, J., HARRIS, L., LAGABRIELLE, E., KIRCHNER, C., CHALMERS, R. and M. LOMBARD, 2014. Spatial Biodiversity Assessment and Spatial Management, including Marine Protected Areas. Final report for the Benguela Current Commission project BEH 09-01.

HOLTZHAUSEN, J.A., CAMARADA, T.G., 2007. Migratory Behaviour and Assessment of the Bronze Whaler (Carcharhinus brachyurus), Final Report: BCLME Project Number LMR/CF/03/16.

HUTCHINGS, L, van der Lingen CG, Shannon LJ, Crawford RJM, Verheye HMS, Bartholomae CH, van der Plas AK, Louw D, Kreiner A, Ostrowski M, Fidel Q, Barlow RG, Lamont T, Coetzee J, Shilllington, F, Veitch J, Currie JC and Monteiro PMS. The Benguela Current: An ecosystem of four components. 2009. Progress in Oceanography 83; Pg. 15-32.

ICPC. 2019. *International Cable Protection Committee*. Retrieved from https://www.iscpc.org/.

IRISH, J. 2020. Namibia Biodiversity Database Web Site. Page: Family Tenebrionidae in Namibia. Interpretive collation based on the combined published sources for all included taxa, as listed. URL: http://biodiversity.org.na/taxondisplay.php?nr=3201

KINAHAN, J. 2011. From the beginning: the archaeological evidence. In Wallace, M. and Kinahan, J. A history of Namibia: from the beginning to 1990. London: Hurst & Co., pp 15-44.

KINAHAN, J.K. 2020. Heritage Impact Assessment for the proposed marine telecommunications cable system (Equiano Cable System) to be landed at Swakopmund in Namibia.

KOLBERG, H. May 2020. Flora Assessment Report for the terrestrial portion of a proposed marine telecommunications cable system (Equiano Cable System) at Swakopmund, Namibia.

KOPER, R.P & S. PLÖN, 2012. The potential impacts of anthropogenic noise on marine animals and recommendations for research in South Africa. EWT Research & Technical Paper No. 1. Endangered Wildlife Trust, South Africa.

KOPIJ, G. 2018. Provisional atlas of breeding birds of Swakopmund in the coastal Namib Desert. Lanioturdus 51(2): 2-12.

LOVEGROVE, B. 1993. The Living Deserts of Southern Africa. Fernwood Press, Vlaeberg

LUDYNIA, K., 2007. Identification and characterisation of foraging areas of seabirds in upwelling systems: biological and hydrographic implications for foraging at sea. PhD thesis.

MEIßNER, K., Schabelon, H., Bellebaum, J., & Sordyl, H. (2006). Impacts of submarine cables on the marine environment: A literature review. Report by Institute of Applied Ecology (IfAO), 96.

MENDELSOHN, John & Jarvis, Alice & C, Roberts & Robertson, Tony. (2002). Atlas of Namibia: A Portrait of the Land and its People.

MORTON, J.W., 1977. Ecological effects of dredging and dredge disposal: a literature review. Tech. Papers. U.S. Fish Wildl. Serv., 94: 1-33.

NATIONAL PLANNING COMMISSION. NAMIBIA'S 5TH NATIONAL DEVELOPMENT PLAN (NDP5). 2017/18 – 2021/22.

NEL, R. & A. PULFRICH, 2002. An assessment of the impacts of beach mining operations on beach macrofaunal commu NELSON G. and L. HUTCHINGS, 1983. The Benguela upwelling area. Prog. Oceanogr., 12: 333-356.

NEL, P., PULFRICH, A. and A.J. PENNEY, 2003. Impacts of beach mining operations on sandy beach macrofaunal communities on the beaches of Geelwal Karoo, Report by Pisces Environmental Services (Pty) Ltd prepared for Trans Hex Operations (Pty) Ltd, Cape Town.

NRC, 2003. Ocean noise and marine mammals. National Academy Press, Washington, DC.

OLIVIER, J., 1992. Aspects of the climatology of fog in the Namib. *SA geographer* 19(2): 107-125.

OLIVIER, J., 1995. Spatial fog distribution pattern in the Namib using Meteosat images. *J. Arid Environments,* 29: 129-138.

OSPAR Commission. (2012). Guidelines on Best Environmental Practice (BEP) in Cable Laying and Operation.

PELAGIAN, 2019. Equiano Cable System Segment 24: Namibia Swakopmund Site Visit Report compiled by Pelagian (PL-SVR-102 Site Visit v0.1 05 Sep 2019).

PERRY, J., 2005. Environmental Impact Assessment for Offshore Drilling the Falkland Islands to Desire Petroleum Plc. 186pp.

PULFRICH, A. 2020. Proposed installation of the Equiano Cable System, Swakopmund, Namibia. Marine Ecology Assessment.

ROBERTON, A., Jarvis, A., Mendelsohn, J. and Swart, R. 2012. Namibia's coast: ocean riches and desert treasures.

ROGERS, J., 1977. *Sedimentation on the continental margin off the Orange River and the Namib Desert.* Unpubl. Ph.D. Thesis, Geol. Dept., Univ. Cape Town. 212 pp.

PULLEN, 1988. Biological effects of marine sand mining and fill placement for beach replenishment: Lessons for other uses. Mar. Min., 7: 123-136.

SHANNON, L.V. and M.J. O'TOOLE, 1998. BCLME Thematic Report 2: Integrated overview of the oceanography and environmental variability of the Benguela Current region. Unpublished BCLME Report, 58pp

SHILLINGTON, F. A., PETERSON, W. T., HUTCHINGS, L., PROBYN, T. A., WALDRON, H. N. and J. J. AGENBAG, 1990. A cool upwelling filament off Namibia, South West Africa: Preliminary measurements of physical and biological properties. Deep-Sea Res., 37 (11A): 1753-1772.nities between the Sout River and Olifants River mouth. Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd. September 2002, 38pp

SKOV, H., BLOCH, R., STUER-LAURIDSEN, F., UUSHONA, D., 2008. Strategic Environmental Assessment (SEA) for the coastal areas of the Erongo and Kunene Regions, Prepared for Namibian Coast Conservation and Management Project (NACOMA) 172pp.

TAUNTON-CLARK, J., Shannon, L.V. Annual and inter-annual variability in the South-East Atlantic during the 20th century. South African Journal of Marine Science. 1988; Vol:6 Pg. 97–106.

TAOMINA, B., Bald, J., Want, A., Thouzeau, G., Lejart, M., Desroy, N., & Carlier, A. (2018). A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. Renewable and Sustainable Energy Reviews, 96, 380-391.

THERON, A.K. 2008. Analysis of potential coastal zone climate change impacts and possible response options in the southern Africa region. Stellenbosch, CSIR.

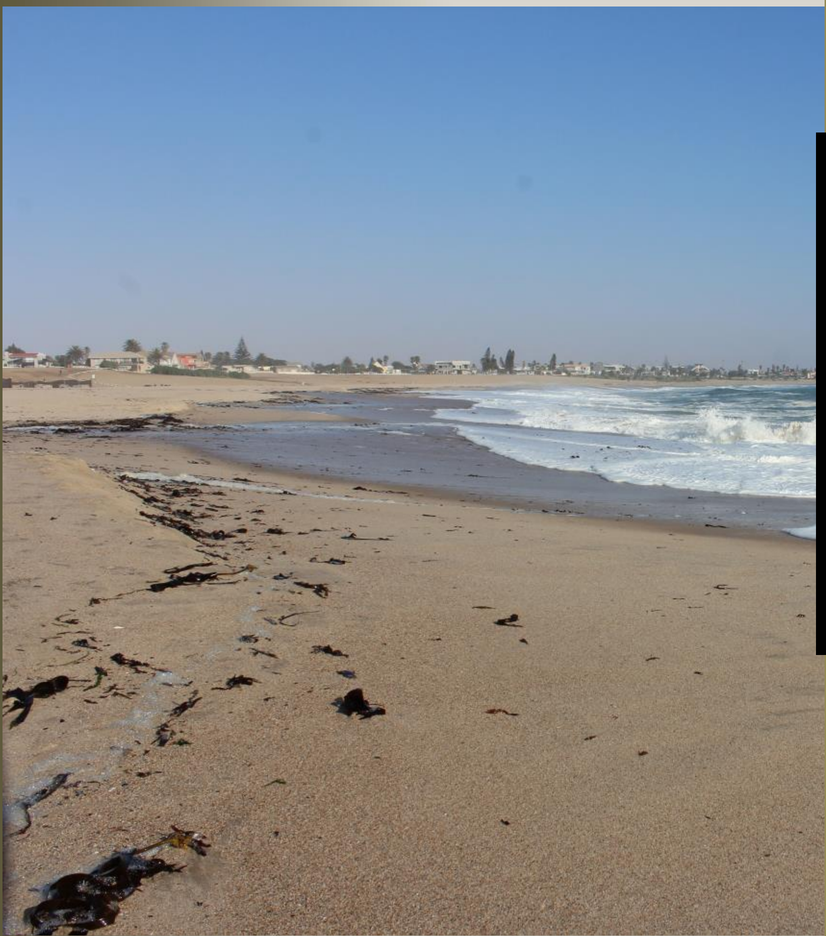
UKHO. (2019). UKHO - ADMIRALTY CHARTS.

VAN DER VEER, H.W., BERGMAN, M.J.N. and J.J. BEUKEMA, 1985. Dredging activities in the Dutch Wadden Sea: effects on macrobenthic fauna. Neth. J. Sea Res., 19: 183–190.

VON WILLERT, D.J., B.M. Eller, M.J.A. Werger, E. Brinckmann, and H.D. Ihlenfeldt. 1992. Life Strategies of Succulents in Deserts. Cambridge University Press.

WILLIAMSON, G. 1997. Preliminary account of the floristic zones of the Sperregebiet (Protected Diamond Area) in southwest Namibia. Dintera 25: 1-68.

WILKINSON, S. 2020. Proposed Marine Telecommunications Cable System (Equiano Cable System) to be landed at Swakopmund, Namibia. Commercial Fisheries Impact Assessment.



COASTAL ASSESSMENT

PROPOSED EQUIANO SUB MARINE TELECOMMUNICATIONS CABLE AT SWAKOPMUND BEACH, NAMIBIA.

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SDP Ecological and Environmental Services

Compilled for : Acer (Africa) Environmental Consultants

August 2020

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Front page image	Swakopmund Beach

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Glossary of Terms and Abbreviations

Associes	Groupings of species, particularly plants commonly found to occur together
Dissipative	A dissipative beach is a wide beach with a low profile associated with high energy surf zones
Dune heel	The leeward extreme of a dune
Dune toe	The seaward extreme of a dune
Eco-morphological	The physical and ecological result of plant and morphological drivers,
Hs	Significant wave height
Psammo-	Of dunes
Slack	A valley or depression with the dune cordon

EXECUTIVE SUMMARY

The proposed landing of a marine telecommunications cable at Swakopmund, is the subject of an application for an Environmental Clearance Certificate from the Namibian Ministry of Environment and Tourism. This report has been compiled to evaluate the bio physical impacts that the laying of such a cable would have on the various components of the inshore coastal environment including the beach and dune cordon, as well as to provide recommendations on environmental management measures to be employed during and following establishment of the cable.

Swakopmund Beach is a wide dissipative beach that lies within a constrained embayment. Such constraint comes from the establishment of a harbour on the northern extent of the bay, which has served to alter coastal processes at this point. The applicant Paratus Telecommunications (Pty) Ltd have selected a point, just south of the harbour breakwater to land the cable and establish a manhole and related infrastructure to service the cable. The findings of this report indicate that this site is the most suitable point of landing on account of the depositional state of the beach at this point, as well as the high level of disturbance associated with the area in and around the harbour breakwater. Management recommendations in respect of the establishment of this route are:

1. The route should be cordoned with possible shuttering being applied within the trench to reduce the need to establish a wider excavation to meet the abovementioned minimum depth.

2. Trenching and excavation to a depth greater than 5m (and as deep as 10m) should apply at points above the high water mark (back beach, frontal dune cordon and dune heel) during the establishment phase to avoid exposure where dune mobility arises.

3. Once all trenching and backfilling has been completed, following the laying of the cable, it is proposed that the beach and back beach be reinstated and sculpted to mimic the pre-construction state.

4. Stabilisation of the dune should be undertaken on a temporary basis utilising geofabric or related materials. Limited planting of materials is proposed.

1. INTRODUCTION

Acer (Africa) Environmental Consultants act as the Environmental Assessment Practitioners on behalf of Paratus Telecommunications (Pty) Ltd who are engaged in the landing of a marine telecommunication cable on the Namibian coast at Swakopmund. Acer (Africa) have commenced with an environmental impact assessment process in order to review and obtain Environmental Clearance certificate in terms of the Environmental Management Act (Act 7 of 2007). Approval from the Namibian Ministry of Environment and Tourism, for the installation of a marine telecommunication cables is required prior to commencement of installation of such infrastructure.

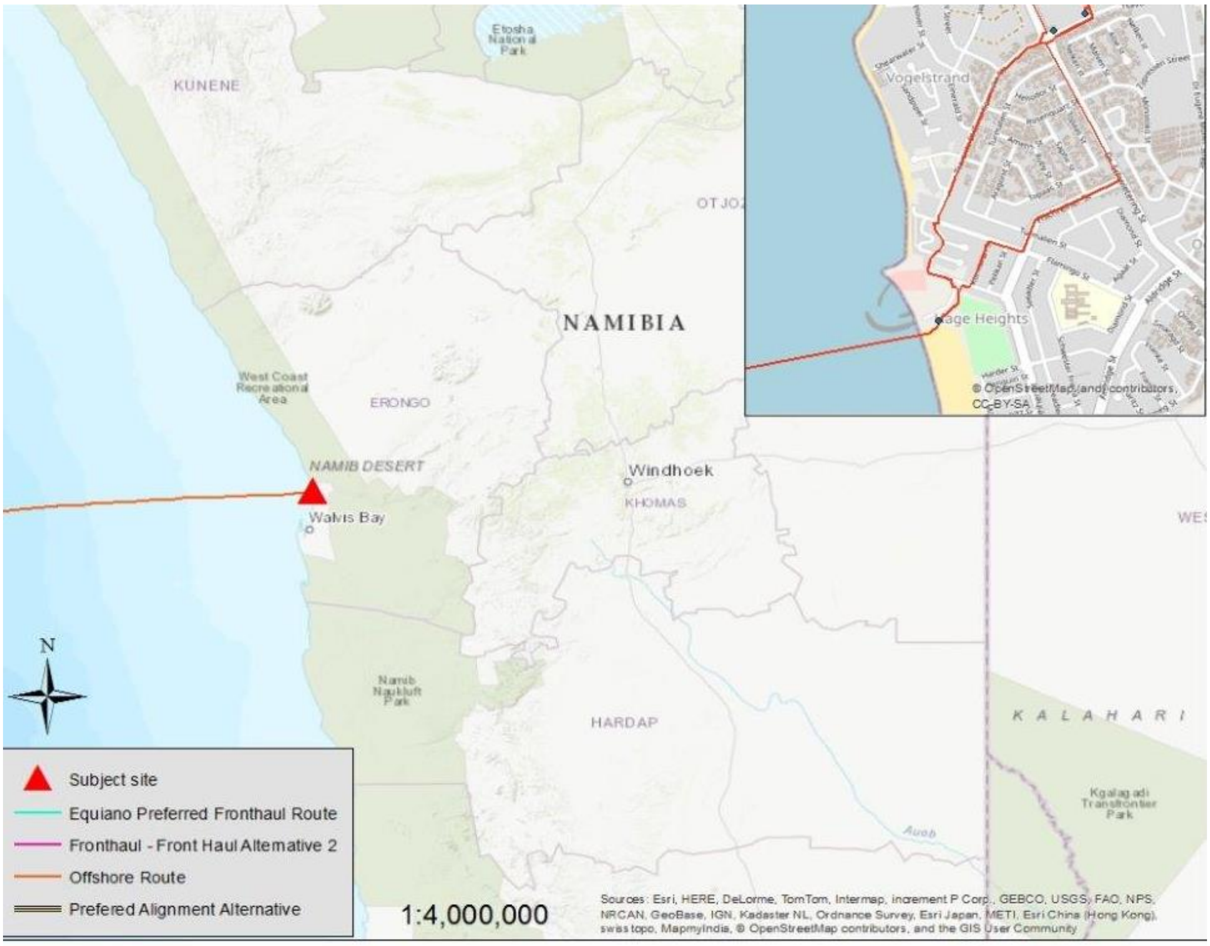

Figure 1. Regional and local map images showing subject site.

The cable is to be landed at Swakopmund Beach which lies within the Swakopmund Municipal area (Figure. 1) and is positioned at 22˚38' S / 14˚31' E. The site can be accessed off Albatross Street. This report serves to provide a bio-physical overview of the inshore marine environment including the dune cordon, beach and intertidal zone within and adjacent to the proposed landing points associated with this cable. The investigation has been undertaken utilising various, selected parameters and identifies factors associated with the area that may be considered drivers that determine the status and ecological function of this environment. In addition, the investigation considers the ecological impacts that may arise within the back beach and dune system from the establishment of the cables, the most appropriate routing for such cables, as well as mitigation and management measures that may be employed during and post the installation phase.

2. PROJECT DESCRIPTION

Telecommunications company, Paratus Telecommunications (Pty) Ltd wish to establish a submarine cable that will provide improved communications within the Swakopmund and other urban centres of Namibia. A major deep water sub marine cable is to be established between Europe and Africa and Paratus Telecommunications wish to provide a link to their customers through a cable landing at Swakopmund.

The project will see a cable being established that traverses a portion of the inter-tidal, beach and dune environment at Swakopmund (Figure 2). The cable will follow an alignment from the beach to a Beach Man Hole (BMH) which will be located within a stabilised point within the dune cordon. The cable from the BMH will traverse through the urban environment of Swakopmund using existing servitudes and road infrastructure to connect with the Cable Landing Station (CLS).

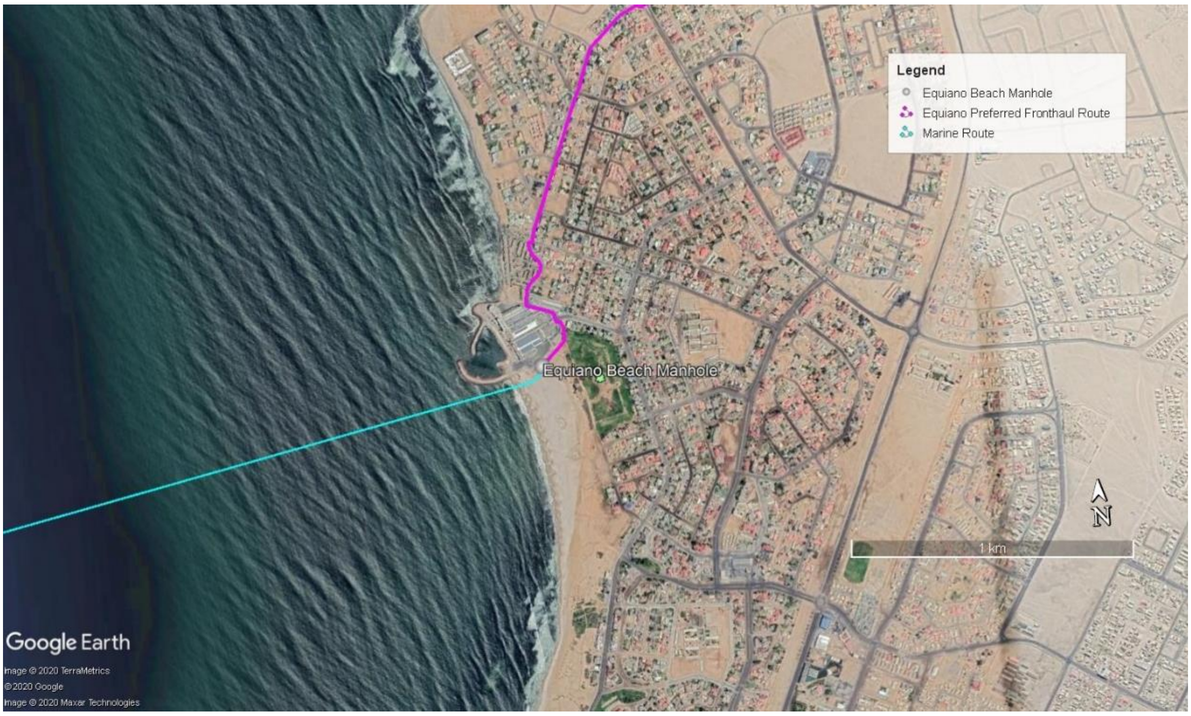

Figure 2. Image indicating proposed landing point for cable at Swakopmund.(Map Google Earth 2019)

Figure 2 indicates the proposed point of landing of the cable, just south of a rock revetment and harbour breakwater. In order to establish the cable, plant machinery and excavators will be utilised to establish a trench which will be established to a depth of approximately 2 m below the prevailing natural ground and beach level. Where trenching within dune systems is required, such depths may be as deep as 9 m. Given the nature of dune and beach sediments, excavations may be relatively wide, in order to accommodate trenching operations to this depth. The beach man hole will form the anchor point for the cable. Excavated material is to be reinstated over the cable and the necessary “rehabilitation” methods are to be employed. The cable will be maintained at a depth of approximately 2m within the intertidal and in shore sub tidal environment, anchored by its own weight.

3. METHOD

In the compilation of this coastal eco-morphological report a desktop review of literature and pertinent information relating to the Namibian coastline as well as the site was undertaken. Specific consideration was given to aerial imagery of the shoreline and dune cordon. Such desktop investigations included;

- Review of recent and historical aerial imagery dating from 1976 to 2019.
- Identification and delineation of the sand sharing system at sub tidal, inter tidal and supra tidal levels using aerial imagery.
- Determination of key drivers within the subject area using aerial imagery

The above was supported by in-field reconnaissance was undertaken on 4 August 2020 whereby:

- Mr W Coetzer of Geopollution Technologies visited the study area in question. Mr Coetzer undertook field reconnaissance on behalf of SDP Ecological & Environmental Services on account of the moratorium on travel, resulting from the COVID-19 pandemic.

- Various images of the coastline were taken as indicating in Figure 3

- General observations were undertaken by Mr Coetzer including sediment samples at depth, the nature of floral and wrack encountered on the beach, as well as images of the off shore wave environment.

- All photographic and other data recorded in the field was transferred to the writer for consideration.

- All of the above information was collated and evaluated in order to determine the eco-morphological drivers inherent within the site and determine the impacts that may arise with the establishment of the cable and associated infrastructure.

Figure 3. Image indicating points of imagery and sampling data supplied by Mr Coetzer.

4. REGIONAL PERSPECTIVE OF THE SUPRA TIDAL ENVIRONMENT

The proposed cable landing site is at Swakopmund, a large city positioned almost centrally along the Namibian coastline. Swakopmund encompasses one of several extended, crenulate bays that predominate along the central Namibian coast (Elfrink et al 2002). In addition, the town lies approximately at a juncture in the orientation of the Namibian coast from a north-south orientation to that of a SSE-NNW orientation. This change in the coastline's orientation suggests a differentiation in the nature of inshore, wave driven processes.

Figure 4 indicates the annual wave and wind roses associated with the Swakopmund coastline. From the wave rose, it is evident that the predominant wave regime arises from a narrow band of incidence positioned between SSW and SW of the shore. The average Hs swell height is consistent at approximately 2m (Elfink et al 2002), with significant dissipation of wave energy arising closer to shore. In addition a small tidal prism of 1m indicates that tidal currents are generally weak.

The coastline of Namibia is primarily xeric in nature and much of the inshore sediments along the coastline are derived from both aeolian deposition from the land and erosion and reworking of nearshore coastal dune system. As a consequence of the wave regime and low level of perturbation evident along the shoreline a low level, littoral or longshore drift is evident, giving rise to a predominantly stable coastline.

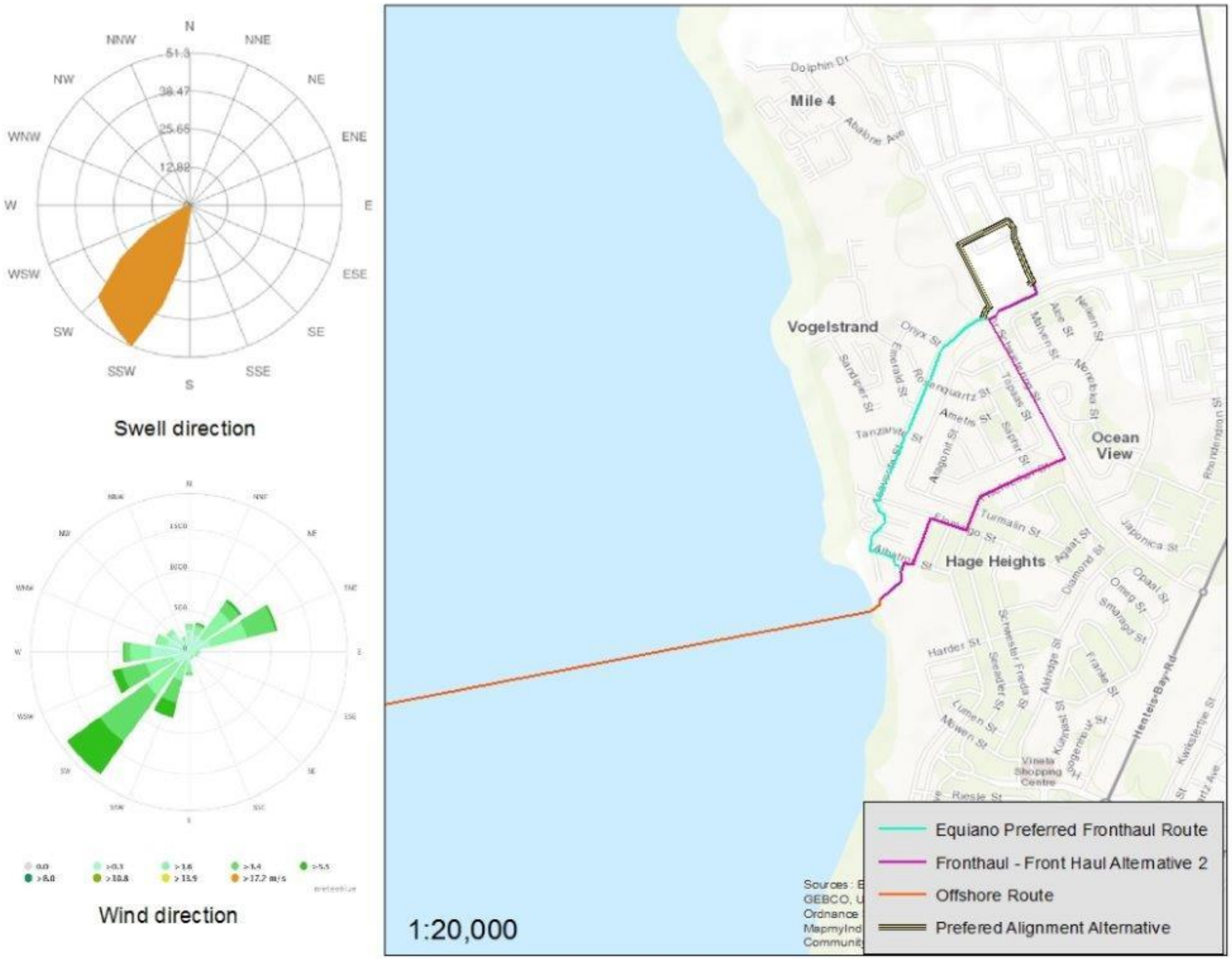

Figure 4 Map indicating subject site with annual wave and wind roses (source : Meteo Blue)

Coastal processes in the nearshore and supra tidal environment are driven by a number of complex bio-physical processes (Elko 2016) and as such, changes in wind and wave regimen, climate state, beach morphology and other factors influence the eco-morphology of dune systems (Hesp 2012).

The supra tidal environment, including the dune cordon along the central Namibian Atlantic coastline is affected by primarily, two dominant and opposing wind directions, namely a dominant south westerly onshore wind and a sub-dominant north easterly wind, common in the winter. As such, these opposing wind regimen give rise to primarily barchan dune forms (particularly where sediment input may be constrained from time to time), longitudinal and sometimes low, hummock dunes. In the Swakopmund region, these dunes are rarely stabilized by vegetation and higher wind speeds, in excess of $6m.s^{-1}$ give rise to significant levels of sand transport. Dune or psammoseral vegetation is further constrained by low rainfall, with expected maxima of 2mm evident in the late summer. (https://www.meteoblue.com).

Sea level rise is a recognized global phenomenon attributed to climate change. Presently the US National Oceanic and Atmospheric Agency (NOAA) estimates an annual increase in sea level along the Namibian coastline of 0.95mm (https://tidesandcurrents.noaa.gov/sltrends). This is considerably less than the global average of approximately 3mm/annum. According to Heita (2018), increasing sea levels are only considered to be a significant threat to infrastructure and portions of the coastline around Walvis Bay. Swakopmund, on account of its relative elevation, is anticipated to have comparatively lower risk than the more southerly city.

From an ecological perspective, habitat complexity and species diversity plays a significant role in determining the state of a dune form (Hesp 2012). However, in the xeric, desert environments of Namibia, it is evident that abiotic factors, in particular wave, wind and other meteorological and sedimentary factors dominate and determine habitat form and state proximal to the coastline. As such activities that alter these factors, such as wave incidence across a given shoreline, are likely to have the greatest influence on associated abiotic and biotic factors.

5. SITE SPECIFIC REVIEW OF CABLE ROUTE

The beaches along the coastline, north of Walvis Bay comprise of a series of shallow crenulate bays backed by barchan and longitudinal dunes. The proposed landing site lies at the far north of a truncated crenulate bay within the Swakopmund beach front (Figure 2). Prior to the establishment of a small coastal breakwater harbour at Swakopmund, (Figure 5 and 6), sediment transport in the form of long shore drift travelled approximately 1.1kilometres, before being directed offshore by a small rocky promontory. Subsequently transport along the beach has been curtailed by the shortening of the embayment by approximately 300m. Such curtailment has served to :

- Restrain the littoral drift along the beach
- Promote deposition and landward sediment movement within the embayment
- Alter points of erosion and deposition within and without the embayment. In particular areas to the north of the harbour are evidently affected by the change in the sediment transport regime, with a shingle beach dominating at this point (Figure 5).

Figure 5. Image of beach to the north of harbour, showing evident shingle beach and rocky intertidal environment.

Figure 6 below presents a comparative image of the state of the subject coastline in 1976 and its more recent state in 2019. Evident from this image is the new harbour (1) which was constructed on and along a shallow rocky promontory, with the expansive beach (2), which has arisen as a result of the interruption of the littoral drift. The landing manhole will clearly lie within this area of significant disturbance.

Figure 6. Comparative aerial imagery of site from 1976 and 2019. Note approximate position of manhole for cable landing point and 1.presence of harbour and 2. expansive or widening beach environment.

The harbour is evidently a major disruptive influence on the Swakopmund coastline at this point. On the southern breakwater, sediment accumulates as the breakwater diffracts incoming waves, while also sets up a reflective wave regimen. A shore perpendicular rip current has also been accentuated, which serves to drive sediment offshore at this point under differing wave conditions.

In addition, habitat form has changed along the breakwaters, which has given rise to differing communities, in particular the presence of a number of Rhodophyta species (algae), which are common as well as *Patella sp* (limpets), in particular *Patella cochlear*. Such species would not generally be prolific in this area under the natural, sand dominated system.

The beach to the south of the breakwater is a semi-dissipative beach form (Figure 7), comprising of a medium to fine sand. A regular series of beach cusps is commonly encountered along the beach (Figure 8) and this is associated with a series of rhythmic inner bars, indicative of a moderately steep foreshore and regular small inshore waves.

Figure 7. View of beach and back beach south of harbour breakwater

Beach cusps are evidence of an inshore transverse bars and rip currents (Wright and Short 1984) where two wave directions converge and a wide sand bar is present, proximal to the beach. In the case of the subject site, the dominant south westerly wave direction intersects with a weaker wave from a differing

Figure 8. Aerial image of cable landing point showing various coastal processes and features associated with site

direction. A rip current is associated with a transverse bar and rip set up, this being evident at the harbour wall (Figure 8). The beach cusps are also driven by low energy, dissipating waves which tend to scour at a central point and flow out at the "horns" of the cusp. The horns are dominant when the backwash flow of a breaking wave is allowed to complete its cycle (Figure 8 and 9). The horns can, under a high tide, serve to establish small rip currents, which also serve to transport sediments.

Figure 9. "Horn" of beach cusp. See Figure 8 for plan image.

The above suggests that the beach and sand sharing environment associated with the landing point can be considered :

- A medium to fine sand, percolative beach environment
- There is generally moderate to high sediment transport levels within the sand sharing system, which determines the inshore wave and current regime at this beach
- A depositional portion of the beach is located at the north of the embayment, next to the harbour wall where the interruption of the littoral drift is leading to a widening of the sand sharing system.
- A rip current is evident along the south face of the harbour wall which effectively drives sediment offshore, where deposition above the high water mark does not arise..

5.1 Ecological aspects

The frontal dune cordon of the subject site is generally unvegetated, however occasional communities of *Salsola* sp (salt bush) are evident, as well as the pencil bush, *Arthraerua leubnitziae* . A number of planted, horticultural specimens are located landward of the sand sharing system, e.g. *Prosopis juliflora*. The disturbed nature and depositional state of the proposed point of landing and the manhole, does not show any natural vegetation within the beach environment that is likely to be affected by the establishment of such infrastructure.

The beach and inter tidal fauna along the shoreline of the subject area are transitory detritus and herbivorous species. More commonly encountered is *Tylos granulatos* an isopod and *Talorchestia sp* (amphipods) all associated with the wrack deposition and kelp along the shoreline. Molluscs encountered along the beach are limited in diversity, these probably being *Bullia digitalis* and *Donax serra*. All of the above mentioned species are both transitory and common within the beach and inter tidal environments.

6. CABLE ROUTE IMPACTS

As indicated above, the selected route along the inshore, intertidal and supra tidal environment lies within a portion of the Swakopmund coastline that has been subject to significant transformation. Such transformation has had a profound effect on both abiotic and biotic factors in and along this portion of the coastline and in particular, in close vicinity to the proposed point of the cable landing. Some general consideration of the impacts that the cable landing may have on the abiotic and biotic factors inherent to the site are discussed below.

6.1 Impacts on prevailing coastal morphology

Giving consideration to Figures 7,8 and 9, as well as the above information, it can be seen that the proposed cable alignment lies within an area of high disturbance and ongoing change according to sediment budgets associated with the littoral drift. Although these budgets may vary over the short to long term and beach inflation and deflation, as well as beach rotation may arise, the depth at which the cable is to be buried within the inshore and beach environment, means that extraordinary levels of sediment would have to be lost to result in future exposure of the cable. Such erosion is likely to arise only under the most severe scour conditions, and in such cases, much of the sediment from the beach would also be lost.

It follows that the cable is unlikely to be exposed within the beach and supratidal environment, once established. In addition, the burial of the cable is unlikely to exacerbate or promote beach inflation or deflation.

It is however recommended that during and following construction a suitable distance between the southern harbour breakwater and the cable be established to allow for ease of establishment of the cable and prevent undue erosion of the beach, exacerbated by the rip current, at this point. Figure 8 above, evidently shows that this factor has been taken into account.

Figure 10. Image showing southern breakwater of harbour and beach, proximal to point of cable landing.

<u>6. 2. Habitat Disturbance</u>

As described above, the nature of the beach landing point, both within the supra tidal, inter tidal and immediate sub tidal environment can generally be described as transformed habitats. The harbour wall serves to provide an artificial rocky revetment that is anomalous with the prevailing beach environment and the beach at this point is subject to a transformed sediment transport state. It follows that habitat disturbance arising from the proposed cable laying activities will be of little significance, will not give rise to further untoward alteration of the beach habitat. Species identified with this area are motile and transitory within the subject site, giving rise to little or no direct impact on flora or fauna..

Given the above, it is apparent that the selected landing point at Swakopmund beach is to be considered appropriate in terms of the limited eco-morphological impact that both the task of laying the cable as well as the operational aspect would effect. Table 2 overleaf, provides a qualitative evaluation and summary of the impacts arising from the construction and utilisation of the identified cable route.

Table 1 Summary and review of ecological impacts arising from utilisation of cable landing route at Swakopmund

Beach Node	Spatial extent	Duration	Probability	Significance	Status	Reversal of impact	Cumulative effects	Confidence	Mitigation measures
Cable Route Construction	Local	Short term	Definite	Low	Low	High	Negligible	High	Sweep landing area prior to excavation to reduce possible impacts on marine fauna present within route. Cordon working area during laying Reinstate sediments and sculpt beach accordingly following laying of cable.:
Cable Route Operation	Local	Long term	Definite	Low	Low	High	Negligible	High	

<u>Explanation of terms</u>

Spatial Extent: Denotes the affected area, - site, local, regional or national

Duration: The period of time over which the impact will be noted. This may be "long term (greater than the duration of project), moderate or medium term (occurs during the lifetime of the project) or "short term" (less than the lifetime of the project and primarily during the implementation stage of the project).

Probability: The likelihood of the impact occurring as a result of the project being undertaken. Such probability may be "high", "moderate" or "low".

Significance: The nature of the impact in respect to the status quo (i.e. alteration of status quo). Such levels of severity may be "high", "moderate" or "low".

Status: This refers to the overall impact determined from the above parameters.

Reversal of impacts : The ease at which impacts, should they arise, may be remediated or addressed (High, moderate or low)

Cumulative effects : The impact of the proposed activity and that of other activities on the receiving environment, resulting in a compounded effect. (High, Moderate or negligible).

Confidence : An indication of the level of surety that the impacts or the parameters identified, will occur.

7. CONCLUSION AND MANAGEMENT INTERVENTIONS

The proposed landing site for the Equiano submarine cable at Swakopmund lies to the immediate south of a concrete rock armour sea wall and will intersect with a depositional point on the beach. The area in question is highly transformed, with coastal processes having been altered on account of the construction of the harbour breakwater. The effect of the harbour wall has an ongoing influence on coastal processes at this point and as such, the selection of this site as the cable landing point is prudent.

It is evident that given the nature of the operations associated with the landing of the cable, as well as the existing transformation of the coastal environment at this point, that impacts on the shoreline and immediate sub tidal environment are likely to be limited and of little ecological consequence,

A number of management interventions should be undertaken during the establishment of the cable at this point, these being

1. Trenching and excavation to a depth approximating 3m should apply at points above the high water mark (back beach, frontal dune cordon and dune heel) during the establishment phase to avoid exposure where dune mobility arises.

2. Once all trenching and backfilling has been completed, following the laying of the cable, it is proposed that the beach and back beach be reinstated and sculpted to mimic the pre-construction state.

3. Stabilisation of the dune should be undertaken on a temporary basis utilising geofabric or related material, where applicable. Limited planting of materials is proposed.

References (cited and uncited)

Elfink B, G Prestedge, C B M Rocha, J Juhl (undated) Shoreline evolution due to highly oblique indicent waves at Walvis Bay, Namibia

Elko N, Kate Brodie, Hilary Stockdon, Karl Nordstrom, Chris Houser, Kim McKenna, Laura Moore, Julie Rosati, Peter Ruggiero, Roberta Thuman, and Ian Walker (2016) *Dune management challenges on developed coasts* Shore & Beach Vol. 84, No. 1 Winter 2016

Liebenberg H D von Oerstzen (2020) " Dust and radon levels on the west coast of Namibia – What did we learn?" Atmospheric Pollution Research 111/14/3/2012

Tsoar H, N Levin, N Porat, L P Maia, HJ Herriman , S A Tatumi, V Claudino Sales (2009) "The effect of climate change on the mobility and stability of coastal sand dunes in Ceara State, NE Brazil" Quaternary Research 2009.

Wright, L.D. and Short, A.D., 1984. *Morphodynamic variability of surf zones and beaches: A synthesis.* Mar. Geol., 56: 93--118.

Field imagery and data supplied by Mr W Coetzer (BSc. Hons.) Environmental Sciences
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LANDING OF THE PROPOSED EQUIANO CABLE SYSTEM (SUBMARINE TELECOMMUNICATIONS CABLE) AT SWAKOPMUND, NAMIBIA

FAUNAL ECOLOGY STUDY

Nov 2020

Project:	**LANDING OF THE PROPOSED EQUIANO CABLE SYSTEM (SUBMARINE TELECOMMUNICATIONS CABLE) AT SWAKOPMUND, NAMIBIA: FAUNAL ECOLOGY STUDY**
Report Version/Date	Final 16 Nov 2020
Prepared for: (Proponent)	Alcatel Submarine Networks
Lead Consultant:	Geo Pollution Technologies (Pty) Ltd PO Box 11073 Windhoek Namibia
Author:	**André Faul** (B.Sc. Zoology, Biochemistry); (B.Sc. (Hons) Zoology); (M.Sc. Conservation Ecology); (Ph.D. Medical Bioscience)
Cite this document as:	Faul A. 2020. Landing of the Proposed Equiano Cable System (Submarine Telecommunications Cable) at Swakopmund, Namibia: Faunal Ecology Study
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Report Approval	**André Faul** Environmental Assessment Practitioner

I Adrian Carter acting as the Proponent's representative, hereby confirm that the project description contained in this report is a true reflection of the information which the Proponent has provided to Geo Pollution Technologies. All material information in the possession of the proponent that reasonably has or may have the potential of influencing any decision or the objectivity of this assessment is fairly represented in this report.

Signed at Cambridge, UK on the 11th day of February 2021

Alcatel Submarine Networks

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LIST OF ABBREVIATIONS

ASN	Alcatel Submarine Networks
BMH	Beach manhole
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLS	Cable landing station
IBA	Important Bird Area
IUCN	International Union for the Conservation of Nature
MEFT	Ministry of Environment, Forestry and Tourism
RAMSAR	The Convention on Wetlands of International Importance especially as Waterfowl Habitat
SABAP	Southern African Bird Atlas Project
SADC	Southern African Development Community
SAH	South Atlantic High
UNESCO	United Nations Educational, Scientific and Cultural Organization

1 INTRODUCTION

Alcatel Submarine Networks (ASN) was appointed to execute the installation of a new subsea telecommunications cable system, the Equiano Cable System, which will connect Africa with Europe. It will be located along the West Coast of Africa, between Portugal and South Africa. Branching units along the cable will in turn connect it to African countries, including Namibia, to increase and improve connectivity in Africa. ACER (Africa) Environmental Consultants was appointed to prepare a detailed environmental impact scoping assessment for the installation and operations of the Namibian branch. Geo Pollution Technologies (Pty) Ltd was in turn requested to prepare a terrestrial faunal ecology study, as part of the impact assessment, for the installation and operations of the land-based infrastructure planned for Swakopmund.

2 BACKGROUND

International telecommunications networks rely significantly on submarine telecommunications cables which are responsible for transporting almost 100% of transoceanic internet traffic throughout the world. The main Equiano Cable System trunk will be located approximately 500 km off the western coast of Africa. From the main trunk, a branching cable will be installed which will land on the Namibian shoreline at Swakopmund. Where the cable reaches the shoreline, it will be buried on the beach (up to 2 m deep) and link with the terrestrial section of the cable at a beach manhole (BMH) to be constructed above the high water mark. The BMH will be approximately 4 m x 2 m and 2 m deep. From the BMH, the terrestrial section of the cable will be installed in conduits leading to a cable landing station (CLS) to be constructed within Hage Heights, Swakopmund.

Installation and construction activities for the terrestrial section of the cable system will involve:

- Excavations and cement works for the construction of the BMH and installation of the cable from the intertidal zone, across the beach, and up to the BMH.
- Construction of a small concrete building, the CLS, in Hage Heights.
- Digging trenches and installation of cable conduits from the BMH to the CLS (where existing ones are not present) along pavements and roads following the cable route.
- Installation of the cable in the conduits between the BMH to the CLS.

The proposed location of the BMH and the cable alignment with alternative are indicated in Figure 2-1. Future, operational activities will be limited to occasional maintenance and repairs of the cable and related infrastructure when required.

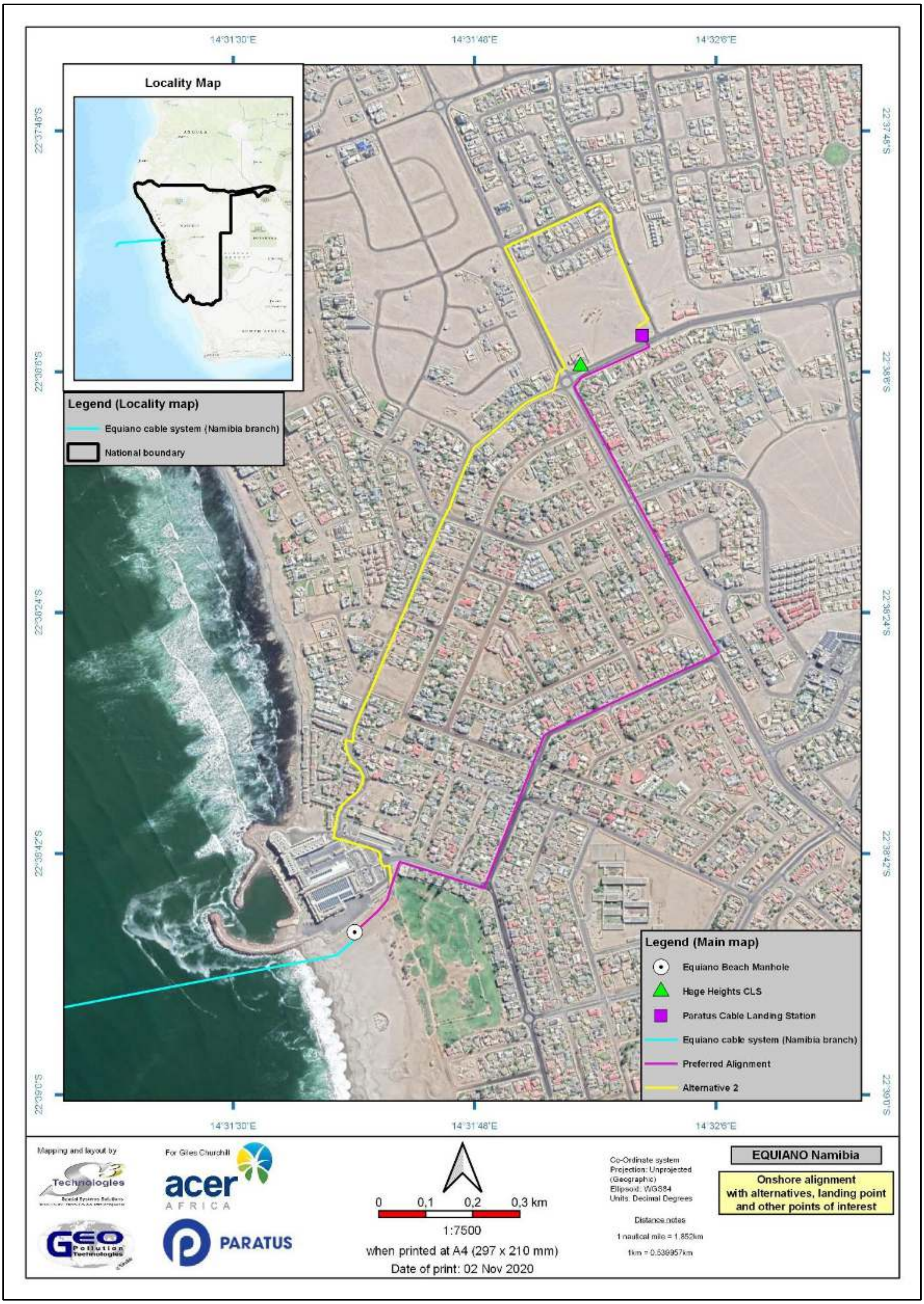

Figure 2-1. Project location and route alternatives

3 LEGISLATION

Namibia is at the forefront of environmental protection and is the first country to actively incorporate environmental protection into its constitution. As such, any activities that may cause environmental harm are governed by prescribed legislation and specifically by the Environmental Management Act. The legislation provided in Table 3-1 and Table 3-2 pertain to environmental protection in Namibia.

Table 3-1. Namibian Law

Law	Key Aspects
The Namibian Constitution	♦ Incorporates a high level of environmental protection. ♦ Incorporates international agreements to which Namibia is signatory (i.e. treaties, conventions, etc.) as part of Namibian law.
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	♦ Defines the environment. ♦ Promotes sustainable management of the environment and use of natural resources. ♦ Provides a process of assessment and control of activities with possible significant effects on the environment.
Environmental Management Act Regulations Government Notice No. 28-30 of 2012	♦ Commencement of the Environmental Management Act. ♦ Lists activities that requires an environmental clearance certificate. ♦ Provides regulations for environmental impact assessment.
Nature Conservation Ordinance Ordinance 4 of 1975	♦ Laws relating to: o game parks and nature reserves o the hunting and protection of wild animals (including game birds), o problem animals o fish o protection of indigenous plants
Controlled Wildlife Products and Trade Act Act No. 9 of 2008, Government Notice No. 292 of 2008	♦ Implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
Animals Protection Act Act No. 71 of 1962, Government Gazette Extraordinary No. 71 of 1962	♦ Concerned with the prevention of cruelty to animals (wild and domestic)

Table 3-2. Relevant multilateral environmental agreements for Namibia

Agreement	Key Aspects
Convention on Biological Diversity, Rio de Janeiro, 1992	♦ Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	♦ Regulates international trade in specimens of wild animals and plants to ensure their survival in the wild.
Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region and Protocol (Abidjan Convention), 1981	♦ Provides an overarching legal framework for all marine-related programmes in West, Central and Southern Africa.
SADC Protocol on Wildlife Conservation and Law Enforcement, 1999	♦ Establish a common framework for conservation and sustainable use of wildlife in the region.

SADC Protocol on Environmental Management for Sustainable Development, 2014	♦ Commitment to integrated and sustainable development.

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT

Swakopmund is centrally located along the western coastline of Namibia within the Erongo Region. It lies on the western edge of the Namib Desert Biome (Giess 1971), with the cold Atlantic Ocean to the west. The dry Namib Desert and cold Atlantic Ocean largely determine water availability and vegetation, and thus also animal biodiversity. The project location is situated in the transitional area between the Southern Desert and Central Desert vegetation types (Mendelsohn 2002), but is within a serviced and developed urban area. As such, the biodiversity in the immediate vicinity of the project area is significantly altered by anthropogenic activities.

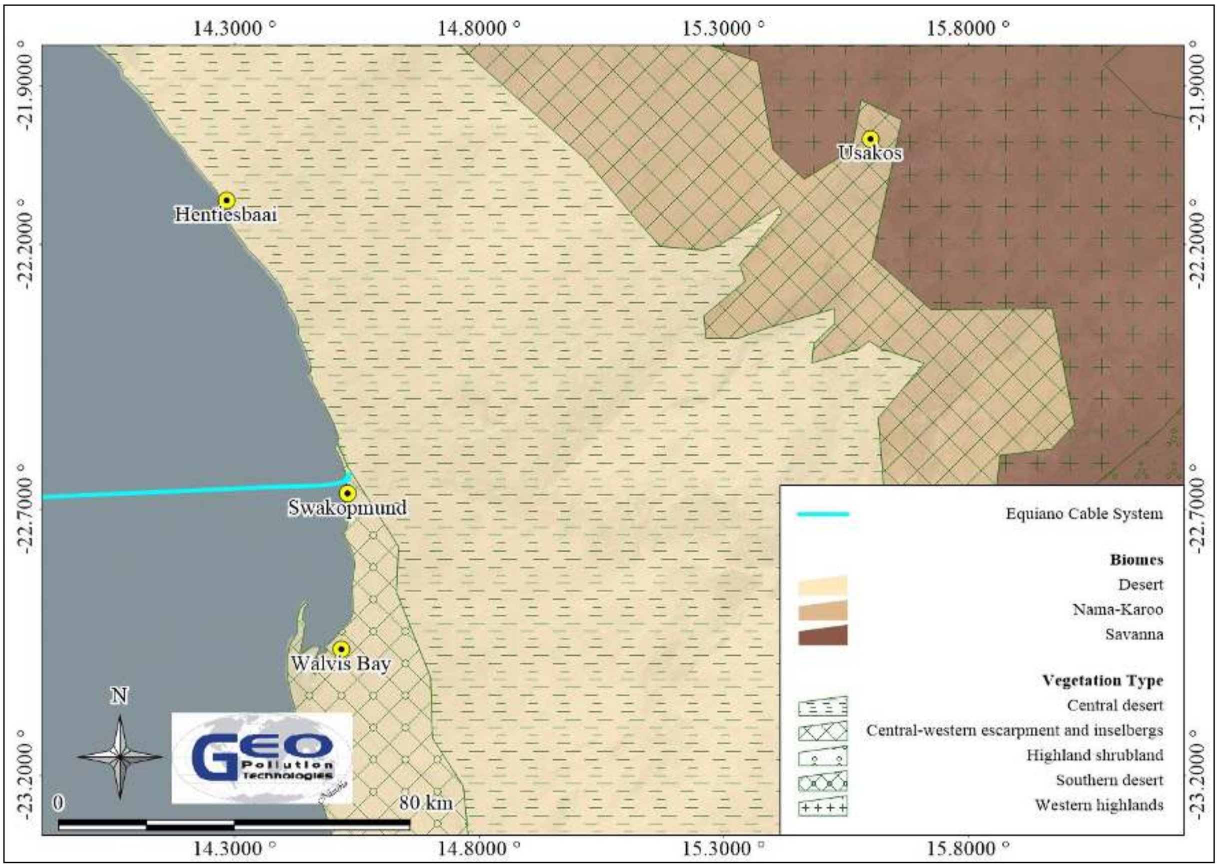

Figure 4-1. Biomes and vegetation structure (Digital Atlas of Namibia 2002)

The Namib Desert characterises the west of Namibia and stretches from north-western South Africa, along the entire Namibian coast, and into the southwest of Angola. The desert area around Swakopmund can broadly be divided into the Walvis Bay – Swakopmund dune belt, the Gravel Plains of the Central Namib, and the ephemeral Swakop River forming a boundary between the two. A narrow beach zone (the coastal plain), associated with a hummock dune belt and small isolated salt flats, is found south and north of Swakopmund. The coastline, forming the western boundary of Swakopmund, is mostly a sandy shoreline south of Patrysberg some 7 km away, with a rocky shoreline interspersed with sandy beaches from Patrysberg to north of Swakopmund.

The ecology of the area is largely influenced by the climatic conditions characterised by low and unpredictable rainfall with regular occurrences of fog (see 4.1). Many living organisms have thus largely evolved to survive with limited surface water by harvesting fog, or by obtaining water from food, as main source of water. As a result species richness and abundance are relatively low with a high level of endemism. Many species have also evolved to survive in areas with very specific conditions (micro-habitats), and are thus often range restricted.

While vertebrates are relatively well documented throughout Namibia, inventories of invertebrates are relatively patchy, and often associated with specific project areas (e.g. mines that conducted impact assessments).

The desert conditions are more favourable to arthropods and reptiles while mammals are limited to relatively few desert adapted species. Birds are also largely associated with the coastline and river courses. The dunes of the Namib Sand Sea are relatively uninhabited while the gravel plains have increased diversity on rocky outcrops and in drainage lines with increased vegetation. Rocky outcrops include inselbergs and dolerite ridges where habitat differentiation is more pronounced.

4.1 CLIMATE

Namibia's climate is dominated by dry conditions for most of the year and particularly so in the west. The location of Namibia, with respect to the Intertropical Convergence Zone, Subtropical High Pressure Zone and Temperate Zone is what determines the climate, with the Subtropical High Pressure Zone being the major contributor to the dry conditions (Atlas of Namibia, 2002; Bryant, 2010) (Figure 4-2).

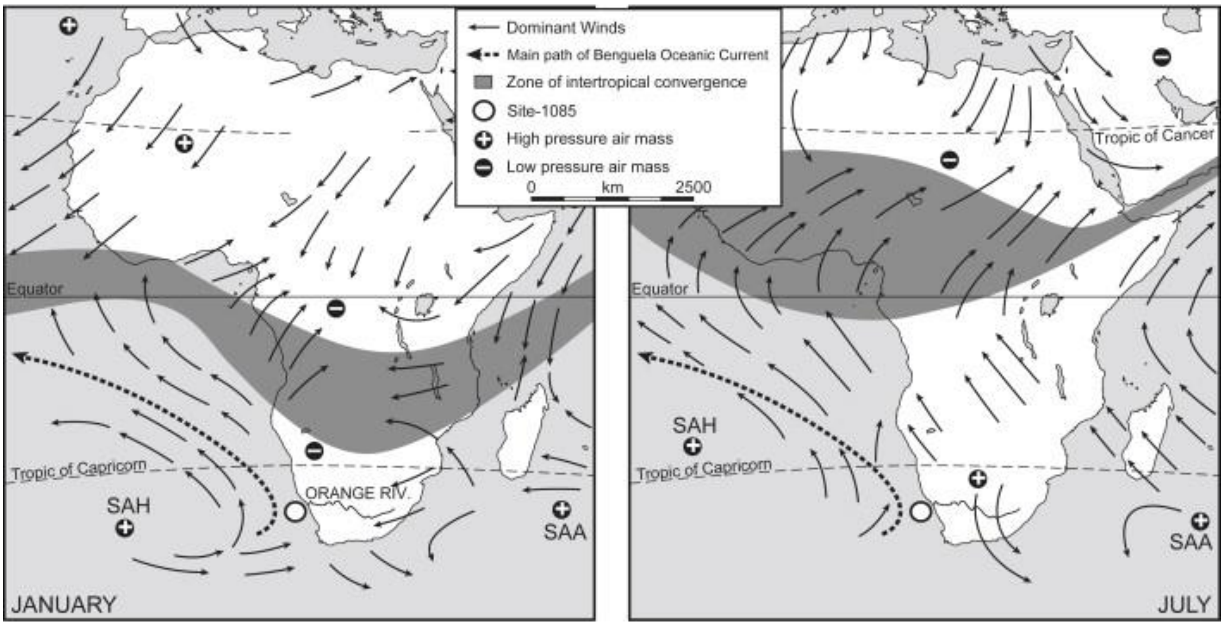

Figure 4-2. Map indicating the Intertropical Convergence Zone, Subtropical High Pressure Zone (SAH+), Benguela Current and Temperate Zone south of Tropic of Capricorn (not indicated) (from: http://www.meteoweb.eu)

Precipitation over Namibia is mainly controlled by the South Atlantic High (SAH), a high pressure cell (anticyclone) situated west of Namibia in the Subtropical High Pressure Zone. The SAH shifts during the year and are at higher latitudes in winter and lower latitudes in summer. In winter, as a result of being situated more north, the high pressure cell pushes any moisture originating from the Intertropical Convergence Zone northwards, preventing rain over Namibia. In summer, because the high pressure cell moves further south and has less of an effect on the Intertropical Convergence Zone, moist air reaches Namibia, resulting in summer rains.

On a more localised scale, the climatic conditions on the central Namibian coast, and inland thereof (coastal plains), are strongly influenced by the cold Benguela current, the SAH and the relatively flat coastal plains that are separated from the central highlands by a steep escarpment. The anticlockwise circulation of the high pressure SAH and the action of the earth's Coriolis force results in strong southerly (longshore) winds blowing northwards up the coastline of Namibia (Bryant, 2010; Corbett, 2018). This longshore wind is responsible for upwelling of the cold, deep waters of the Benguela Current. As a result of the temperature difference between the cold surface water of the Benguela Current and the warm coastal plains, the southerly wind is diverted to a south south-westerly to south-westerly wind along the coast.

The winds are strongest in early to mid-summer (September to January) when the SAH is at its strongest and most persistent, and the temperature difference between the sea and the desert plains are at its greatest. Wind speeds then occasionally exceed 32 km/hr and usually peaks late morning to early afternoon. In winter, the SAH loses strength and the southerly to south-westerly winds are at their weakest. Winter winds do not have enough strength to reach far inland. Autumn to winter conditions do however promote the formation of east wind conditions (berg winds) that can reach speeds of more than 50 km/hr and transport a lot of sand. East winds occur when the inland plateau is cold with a localised high pressure cell, while a low pressure system is present at the coast. The high pressure cell forces air off the escarpment and as the air descents, it warms adiabatically as well as create a low pressure system due to the vertical expansion of the air column. The warm air flows toward the coastal low and as it passes over the Namib plains, it heats up even further. The wind manifests itself as very strong, warm and dry winds during the mornings to early afternoon, but dissipate in the late afternoon.

Throughout the year the prevailing night time regional wind is a weak easterly wind. This results from the mainland cooling to below the temperature of the coastal water. This results in a coastal low versus an onshore high pressure system with first no wind in the early evening, when temperatures between water and land is similar, and then weak easterly winds as the temperature difference increase.

Temperature at Swakopmund is strongly regulated by the cold Benguela current. As a result, there is typically limited variation between diurnal and seasonal temperatures. The average annual temperatures is less than 16 °C with the maximum temperature seldom above 30 °C and minimums rarely below 5 °C. The only real temperature extremes are experienced during east wind conditions in the autumn to early winter months when temperatures can reach the upper thirties or even low forties. This results in these months having an average maximum temperature ranging from 30 °C to 35 °C. As one moves inland from Swakopmund, daytime temperatures increases rather quickly while night time temperatures can get significantly colder in the desert environment.

As explained above, the SAH severely limits the amount of rainfall over Namibia and especially at the coast and over the Namib Desert. As such, the average annual rainfall in Swakopmund is below 50 mm, with more than 100% variation in annual rainfall. Infrequent, heavy rainfall do occur and typically results in rather chaotic conditions as Swakopmund has not been developed to cater for large volumes of storm water. Fog plays a very significant role as source of water for many plants and animals along Namibia’s coast and the Namib Desert. Swakopmund has more than 100 days of fog per year which result from the cold Benguela water cooling the humid air above it to such a temperature that the water vapour condenses to form fog and low level clouds (Mendelsohn et al., 2002).

Table 4-1. Summary of climate data for Swakopmund (Digital Atlas of Namibia 2002)

Classification of climate	Desert
Precipitation	0-50
Variation in annual rainfall (%)	> 100
Average annual evaporation (mm/a)	2,600-2,800
Water deficit (mm/a)	1,701–1,900
Temperature °C	<16

Average Monthly Rainfall (mm)											
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
0.2	**0.3**	**0.5**	**0.8**	**1.1**	**0.4**	**6.3**	**5.4**	**13.1**	**4.2**	**1.1**	**0.9**

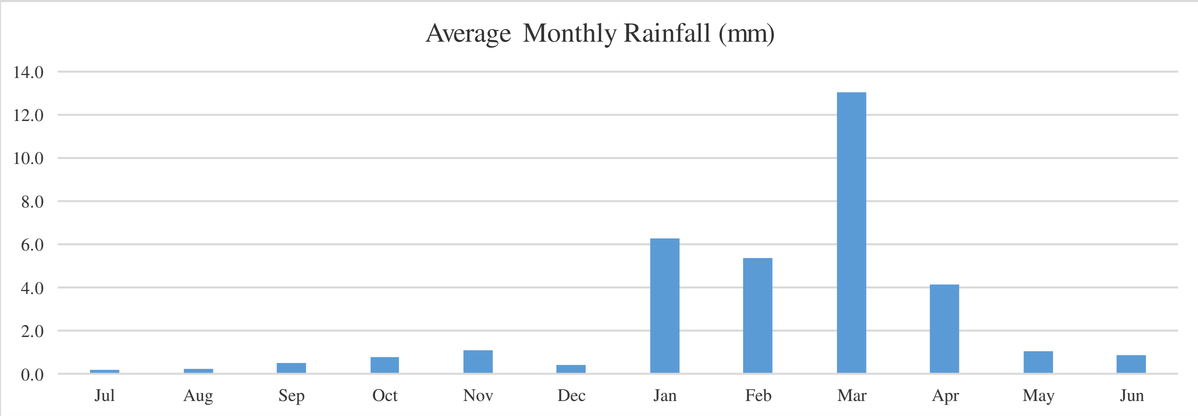

Figure 4-3. Monthly average rainfall (Digital Atlas of Namibia 2002)

4.2 FAUNAL ECOLOGY

Since the project specific location is an urban area, the environment around Swakopmund is described and discussed in this section.

4.2.1 The Walvis Bay – Swakopmund Dune Belt

The dune belt forms part of the Namib Sand Sea, a declared United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site. Dunes are mostly different variations of crescent dunes on the coastal side of the Walvis Bay – Swakopmund Dune Belt, and linear dunes on the eastern side before it transitions into the gravel plains.

The sand dunes are mostly devoid of vegetation while the low lying areas and gravel flats between dunes contain more plants. Low animal species richness and abundance are associated with low plant species richness and abundance. Some of the well-known species of the dune belt are the sidewinding adder (*Bitis peringueyi*), Namib sand gecko (*Pachydactylus rangei*), shovel-snouted lizard (*Meroles anchietae*), numerous tenebrionid beetles (Family Tenebrionidae) and wheel spider (*Carparachne aureoflava*).

Namibia and especially the Namib Desert is famous for its range of tenebrionid beetles (Toktokkie or darkling beetle) of which there are 734 known species in Namibia, 370 being endemic (Irish 2020). Well-known among them is the fog-basking beetle or head-standing beetle, *Onymacris unguicularis*, which harvests fog as water source by "standing on its head" on dune crests to collect fog with its body.

Photo 1. Dune belt with sparse vegetation

Photo 2. Dunes with Swakop River vegetation in foreground

4.2.2 The Gravel Plains of the Central Namib

The Gravel Plains of the Central Namib largely consist of flat and gentle, undulating plains, intersected by ridgelines and outcrops of harder rock types (dolerite, granite and marble). The gravel plains are covered by coarse gravel and shallow, poorly developed soil, and are mostly sparsely populated by plants and animals. The rocky outcrops and inselbergs, ridge- and drainage- lines support greater plant and animal diversity.

Species ranges in the Central Namib are relatively small for many organisms and the species assemblages therefore change relatively quickly with both longitude and latitude (Irish 2015). This is especially true for invertebrates, among which arthropods, like the white coloured darkling beetle, *Cauricara Eburnea* (Photo 6), is the most species rich and abundant taxon. The dry and barren gravel plains only support mammals that are adapted to these harsh conditions. Larger mammals are mostly limited to springbok (*Antidorcas marsupialis*), brown hyena (*Hyaena brunnea*) and black backed jackal (*Canis mesomelas*) while suricates (*Suricata suricatta*), Cape hare (*Lepus capensis*) and a variety of mice, rats and gerbils comprise smaller mammals and rodents. Occasionally, rare sightings are made such as the 2019 visit of a desert adapted elephant (*Loxodonta africana*) to the area while a cheetah (*Acinonyx jubatus)* was found roaming the streets of Swakopmund in 2010. These are rare and extraordinary occurrences and both were relocated to safe locations elsewhere in Namibia.

Birds are the most species rich vertebrate taxa in the area and has the most IUCN II listed species occurring on the gravel plains. A large percentage of reptiles in the area are endemic to Namibia. Table 4-2 presents some data on different animal taxa at a mine within the gravel plains about 5 km northeast of Swakopmund (Irish 2015).

Table 4-2. Summary of animal taxa obtained from a fauna specialist study for a mine on the gravel plains outside Swakop (Irish 2015)

Taxon	No. of Species	Endemic	Range Restricted Endemic	IUCN Status				Legal Status	
				Near Threatened	Vulnerable	Endangered	Critically Endangered	Protected	CITES II
Invertebrates*	160	45	12		2	7	3		
Birds	62	2	0	1	1			53	11
Reptiles	21	13	0						1
Mammals	16	7	1	1					
Total	**259**	**67**	**13**	**2**	**3**	**7**	**3**	**53**	**12**

* Includes only those identified to species level (Irish 2015)

Photo 3. Gravel plains of the central Namib

Photo 4. Pencil bush with animal burrow

Photo 5. Pencil bush on small hummock dune with animal burrow

Photo 6. The Namibian endemic Tenebrionid beetle (toktokkie)

Photo 7. Cape hare in a river wash on the gravel plains

Photo 8. Namaqua chameleon on a gravel road crossing the gravel plains

Photo 9. Windblown waste littering the gravel plains near Swakopmund

Photo 10. NamWater pipeline cutting across the gravel plains

4.2.3 The Swakop River

The Swakop River, originating about 350 km to the east, is one of the major ephemeral rivers of central Namibia that crosses the Namib Desert to reach the Atlantic Ocean in the west. Two major dams in its catchment are the Von Bach and Swakoppoort Dams, both being important in supplying water to the central Namibia and especially Windhoek. As a result of the two dams, as well as impounding of water in smaller tributaries on farms, the Swakop River nowadays rarely reaches the ocean. Water flow in this river is further hampered by significant sand mining activities in its riverbed, leaving deep borrow pits damming the water and reducing downstream flow. The last time the river reached the ocean was 2011. Since then, water has only managed to about 10 km from the river mouth.

The lower reaches of the Swakop River creates a linear oasis in an otherwise very arid environment. The riparian vegetation on its banks (and in the river bed) provides foraging, roosting and nesting sites and refuges for many animals. Some of the larger mammals that occur in, or sometimes visit, the lower reaches of the river include springbok, mountain zebra (*Equus zebra*), klipspringer (*Oreotragus oreotragus*), black-backed jackal (*Canis mesomelas*), baboons (*Papio ursinus*), leopard (Panthera pardus), cape hare (*Lepus capensis*) and numerous other small rodents.

At the river mouth is the Swakop River Estuary, a small ephemeral lagoon, which despite its small size, is an important area for birds. The river bed here has dense stands of reeds and tamarisks and these, together with the lagoon, support a surprisingly large number of birds. Previous bird counts at the estuary itself, has indicated the presence of up to 37 species (October 2012) with a total of up to 1,524 birds during individual counts (January 2001) (Kolberg 2016).

Considering the estuary, river bed, its banks and the beaches and dunes around it, the number of bird species recorded on the South African Bird Atlas Project is 150 (SABAP 2020) while the Roberts Multimedia Birds of SA application indicates up to 240 birds occurring in the area. Among others, the Damara tern (*Sterna balaenarum*), African penguin (*Spheniscus demersus*), lesser flamingo (*Phoenicopterus minor*), Curlew sandpiper (*Calidris ferruginea*) and three species of cormorants, the Cape (*Phalacrocorax capensis*), crowned (*P. coronatus*) and bank (*P. neglectus*) cormorants are listed on the IUCN as being near threatened or threatened with extinction (Table 4-3).

Photo 11. Cormorants roosting on old railway bridge at Swakop river mouth

Photo 12. Water pools in Swakop River with a pied advocet (*Recurvirostra avosetta*)

Photo 13. Bird life in Swakop River (little egret, *Egretta garzetta*)

Photo 14. Swakop River lagoon (Cape teal, *Anas capensis*)

Photo 15. Camels used for tourist rides grazing in Swakop River

Photo 16. Springbok spoor in Swakop River

Table 4-3. Birds of special concern expected to occur in the Swakopmund surroundings

Common Name	Scientific Name	IUCN Status
Red Knot	*Calidris canutus*	Near Threatened
Curlew Sandpiper	*Calidris ferruginea*	Near Threatened
Chestnut-banded Plover	*Charadrius pallidus*	Near Threatened
Bar-tailed Godwit	*Limosa lapponica*	Near Threatened
Cape Gannet	*Morus capensis*	Endangered
Ludwig's Bustard	*Neotis ludwigii*	Endangered
Eurasian Curlew	*Numenius arquata*	Near Threatened
Maccoa Duck	*Oxyura maccoa*	Vulnerable
Cape Cormorant	*Phalacrocorax capensis*	Endangered
Crowned Cormorant	*Phalacrocorax coronatus*	Near Threatened
Bank Cormorant	*Phalacrocorax neglectus*	Endangered
Lesser Flamingo	*Phoenicopterus minor*	Near Threatened
African Penguin	*Spheniscus demersus*	Endangered
Damara Tern	*Sterna balaenarum*	Vulnerable

4.2.4 Coastal Plains

The coastal plains, more or less situated between the coastal road (C32) and the ocean, is mostly interspersed by hummock dunes and salt pans. It is host to an array of birds, reptiles, small mammals and arthropods. Larger mammals like black-backed jackal and brown heyna do visit the area to scavenge for food, often dead seals on the beaches. Ecologically the hummock dunes, mostly covered by dollar bush (*Zygophyllum stapfii*) and pencil bush (*Arthraerua leubnitziae*), are important due to the shelter it provides to various animals. It also trap detritus, offering food to numerous small detrivores. Black hairy thick-tailed scorpions (*Parabutus vilosus*) and Namaqua chameleons (Photo 20) are often seen in around the vegetation on the hummocks while rodents nest in burrows on the hummocks. The Tractrac chat (*Cercomela tractrac*) is often seen nesting under or near the hummocks where it also forages for insects.

Some birds nest on the coastal plains, including the Damara tern. These nests are often non-existent with no nesting material, likely as a camouflage mechanism (Photo 19). Many of the birds utilize the beach to feed on washed out mussels as well as arthropods and insects often attracted by washed out seaweeds. This include gulls and plovers while cormorants and pelicans also use the beaches for resting and basking in the sun. The Namaqua chameleon and the black, hairy thick-tailed scorpion are sometimes found roaming the sandy beaches above the high water mark foraging for food.

Immediately north of Swakopmund is the Swakopmund Salt Works. It acts as a manmade wetland which attracts numerous water birds, including flamingos foraging for food. There are also known Damara tern breeding areas around the salt works (African Conservation Services 2015).

Photo 17. Coastal plain with salt works in background

Photo 18. Birds at salt works

Photo 19. Well camouflaged chick

Photo 20. Namaqua chameleon on coastal plain

Photo 21. Great white pelican (*Pelecanus onocrotalus*) on beach

Photo 21. Greater flamingos (*Phoenicopterus ruber*) foraging in salt pans

Photo 22. Springbok in the coastal zone south of Swakopmund

Photo 23. Black-backed jackal on the beach

4.2.5 Urban Areas

Swakopmund was founded in 1892 as a small German settlement and has over the years grown into a popular tourist town of about 44,000 people resident at the time of the 2011 census. This figure should have grown considerably since then. The core built up area of the town covers roughly 23 km^2 with scattered developments of varying density further inland (e.g. Rössmund Golf Estate, Nonidas smallholdings, Swakopmund Airfield). Within the urban environment the ecosystem is largely degraded with almost all of the natural habitat destroyed for development. Where land is not yet developed, it is often cleared and heavily fragmented. No large mammals occur in Swakopmund and the most abundant vertebrates are birds. As with most urban settlements, feral and domestic cats are responsible for the annihilation of birds, small mammals, lizards and insects found within town.

A study by Kopij (2018) attempted to initiate the establishment of an atlas of breeding birds in Swakopmund. Surveys were conducted in the urban area of Swakopmund in the summer months at the beginning of 2016 and over the 2016/2017 summer period. Eighteen different breeding species were identified. Of the eighteen, four species - the Cape sparrow (*Passer melanurus*), laughing dove (*Spilopelia senegalensis*), the alien rock dove or feral pigeon (*Columba livia*) and common waxbill (*Estrilda astrild*) were most abundant, comprising almost 72% of all breeding birds. Following them were the southern masked weaver (*Ploceus velatus*) and house sparrow (*Passer domesticus*) comprising 14.5% of the breeding birds. None of these birds are of any particular conservation concern. The high abundance in most of them are as a result of their reliance on the urban structure in the otherwise very dry arid desert climate. Outside of Swakopmund their abundance decreases significantly (Kopij 2018). Some of the lesser abundant species like the helmeted Guineafowl (*Numida meleagris*) and grey Lourie (*Corythaixoides concolor*) are not present outside of the urban area at all. The Hartlaub's gull (*Chroicocephalus hartlaubii*) and kelp gull (*Larus dominicanus*) are frequent visitors of the beaches where they often scavenge for food from humans.

Photo 24. Beach zone at cable landing location

Photo 25. Cable landing area

Photo 26. Ornamental vegetation at cable landing area

Photo 27. Cape sparrows foraging at paddock gardens

Photo 28. Tsavorite Street with ornamental vegetation

Photo 29. Hartlaub's gull

Photo 30. Common waxbill

Photo 31. Birds often roost on man-made structures in urban areas (laughing dove)

4.3 PROTECTED AND ECOLOGICALLY SIGNIFICANT AREAS

The entire coastline of Namibia, excluding all declared townlands, falls within national parks. From north to south they are the Skeleton Coast-, Dorob-, Namib Naukluft- and Tsau //Khaeb- National Parks. Swakopmund is surrounded by the Dorob National Park with the Namib Naukluft National Park 16 km to the east and to the south of the Swakop River (Figure 4-4).

The Dorob National Park was previously known as the West Coast Recreational Area, and although now a National Park, it is more accessible to visitors than other parks in Namibia. It for example allows for shore angling without park entry permits or fees. Unfortunately many areas in the Dorob National Park are damaged by vehicle tracks as a result of off-road driving. The coastal plains are specifically sensitive to off-road driving as a result of the presence of a biological crust, often associated with large areas covered by lichens, which when driven over creates tracks that takes decades, if not centuries, to recover.

Between Swakopmund and Walvis Bay is Important Bird Area (IBA) NA012 – the 30-km Beach: Walvis Bay to Swakopmund IBA (Figure 4-5). At Walvis Bay is the Walvis Bay RAMSAR site while 45 km to the south of Walvis Bay is the Sandwich Harbour RAMSAR site. Furthermore the Swakopmund Salt Works and Swakop River Lagoon, discussed earlier, are also ecologically significant, mainly with respect to birds. The Namib Sand Sea World Heritage Site is the only coastal desert with extensive fog influenced dune fields in the world. It is included as World Heritage Site due to exceptional ongoing ecological and geological processes with significant conservation importance for a diverse range of endemic species adapted to the hyper-arid desert conditions where fog is the main water source (https://whc.unesco.org/en/list/1430/).

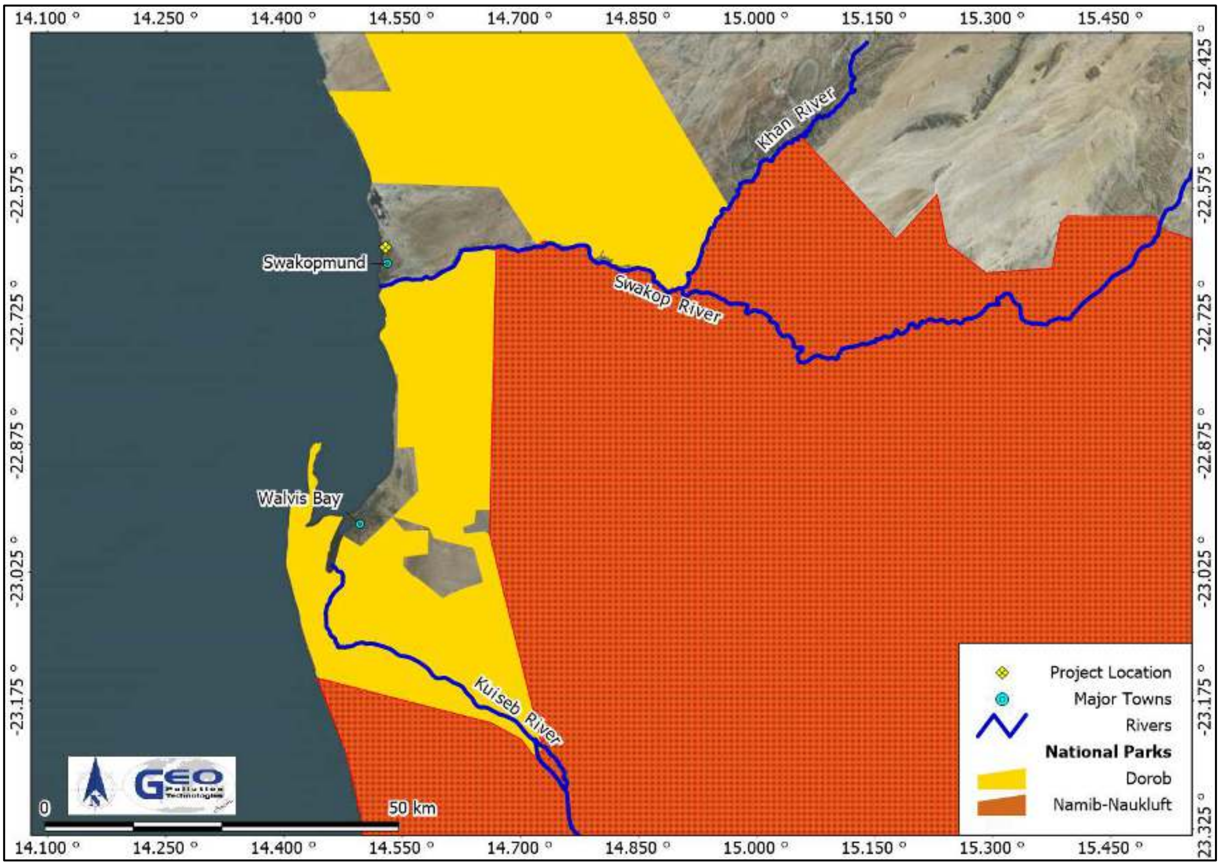

Figure 4-4. Protected areas and rivers in relation to project location

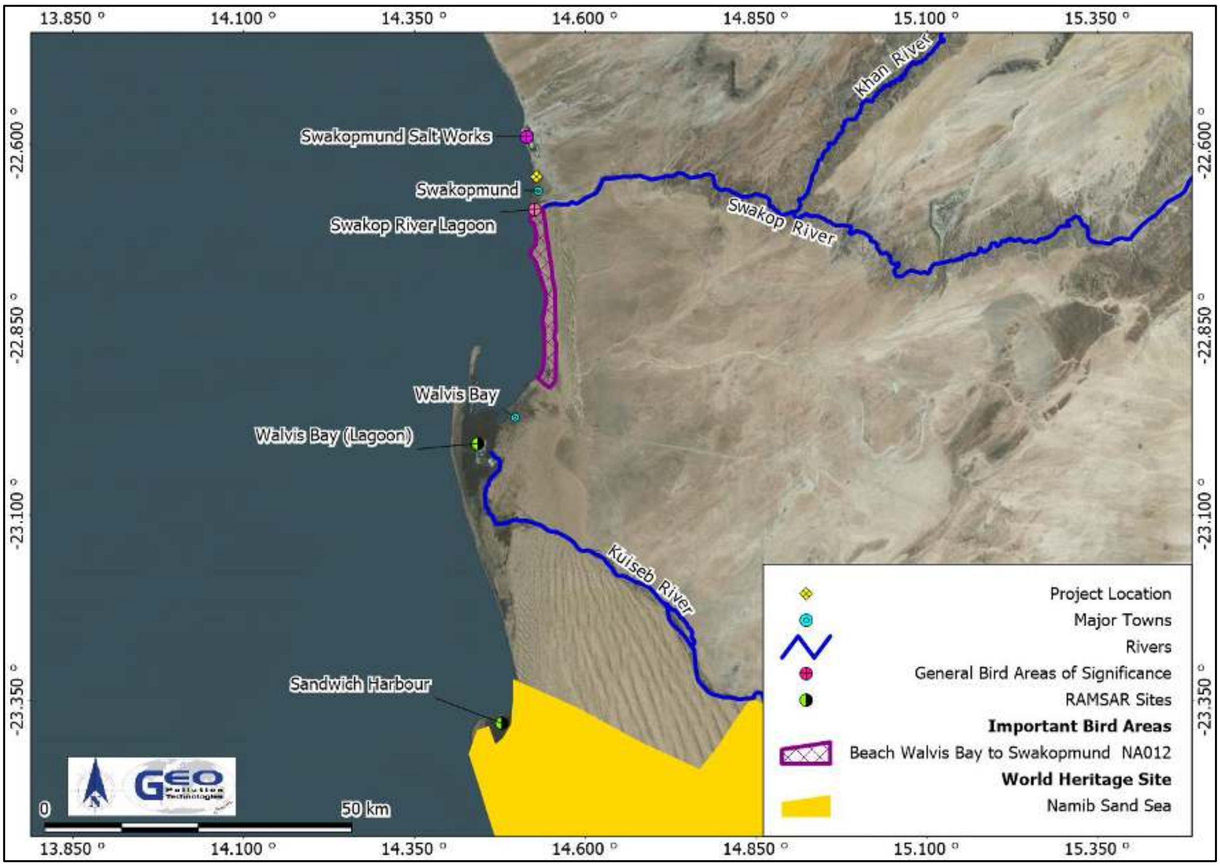

Figure 4-5. Ecologically significant areas

5 ASSESSMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts on the faunal ecology. It provides possible preventative and mitigation measures to prevent or reduce negative impacts and to enhance positive impacts. The Rapid Impact Assessment Method (Pastakia, 1998) will be used during the assessment. The assessment criteria is provided in Table 5-1.

For each impact an environmental classification was determined based on an adapted version of the Rapid Impact Assessment Method (Pastakia, 1998). Impacts are assessed according to the following categories: Importance of condition (A1); Magnitude of Change (A2); Permanence (B1); Reversibility (B2); and Cumulative Nature (B3) (see Table 5-1)

Ranking formulas are then calculated as follow:

Environmental Classification = A1 x A2 x (B1 + B2 + B3)

The environmental classification of impacts is provided in Table 5-2.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

Preventative and mitigation measures are suggested for each impact. These should be considered for the environmental management plan.

Table 5-1. Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3

Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit / disbenefit of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1
Significant negative disbenefit or change	-2
Major disbenefit or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3
Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3
Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2
Strong Cumulative Character	3

Table 5-2. Environmental classification (Pastakia 1998)

Environmental Classification	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Moderately positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Moderately negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely Negative Impact

5.1 HABITAT DESTRUCTION AND DISTURBANCE

Many coastal birds forage along the beaches and rocky shores while some also nest on the coastal plains. Human activity such as urban development and off-road driving have caused significant habitat destruction and caused significant declines in some birds' numbers. The Damara tern is a very good example of such bird. With about 9,000 individuals remaining and some colonies already being locally extinct, development and tourism continue to push this bird to extinction. Efforts are made to protect their breeding grounds, but projects like the past development of Aphrodite Beach residential area and the proposed Desert Rose development south of Swakopmund, are directly on breeding spots of Damara terns, and are not doing the conservation efforts any favour.

Sandy beaches are typically less sensitive than rocky shores. Typically the sandy beaches around Swakopmund are dynamic and recover very quickly after a disturbance. Soil dwelling invertebrates, which occur in shallow sand below the high water mark are vulnerable to beach driving. Where beach driving occur, deep tracks can also trap chicks of small birds, resulting in other beach traffic running over them.

In terms of the Equiano Cable System, all infrastructure will be installed on already disturbed land. Apart from the BMH and CLS, all structures will be below ground and no overhead cables will be installed. During a visit to the project area including terrestrial cable route, no nest sites, dens or burrows were observed although some soil dwelling invertebrates may be present, especially on the sandy beach. No additional habitat destruction is thus expected from the development. Birds foraging for food at the beach landing site, or roosting on structures along the route, may be temporarily disturbed during construction activities. The area has no special significance in terms of food supply and many alternative locations are present.

Where aboveground structures are erected, such as the CLS, habitat may be created for birds to either roost or nest. This may in turn lead to problems with defecation by birds on structures. Bird excrement is corrosive to materials such as metal, is visually unpleasant and requires regular cleaning.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Destruction of nesting, foraging and roosting sites of animals during excavations and installation of telecommunications cables and the construction of the BMH and CLS	4	-1	3	3	3	-36	-4	Improbable
Operations	Creation of habitat for especially birds and issues with excrement build-up	2	-1	3	2	2	-14	-2	Probable

Desired Outcome: No additional habitat loss. Minimum disturbance of animals. No potential habitat creation.

Actions

Prevention:

- The CLS to be designed and constructed in such a way as to discourage the nesting by birds on any of the structures.

Mitigation:

- Prior to any construction activities, the entire route to be surveyed for any nest sites or burrows that will be impacted by construction activities. If any are present the local office of the Ministry of Environment, Forestry and Tourism (MEFT) should be consulted.

- Where vehicles access the beach, tyres should be deflated sufficiently where possible to minimize pressure impacts on soil dwelling invertebrates.

Responsible Body:
- Proponent
- Contractors

Data Sources and Monitoring:
- Any extraordinary sightings of animal burrows or nests must be recorded with proof of notification to MEFT.

5.2 BIRD COLLISIONS AND INJURY

Birds flying at night (e.g. flamingos) are often disorientated by bright, unshielded lighting and may collide with manmade structures and powerlines / overhead cables. No overhead cables will be installed and no external lighting will be required for the operations of the cable system.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Bright lighting disorientating birds resulting in collisions with manmade structures.	4	-1	2	2	3	-28	-3	Improbable
Operations	Bright lighting disorientating birds resulting in collisions with manmade structures.	4	-1	3	2	3	-32	-3	Probable

Desired Outcome: No bird injuries or deaths.

Actions
Prevention:

- If work is conducted at night during the construction phase, all lighting should be shielded and directed downwards as far as is practicable.
- Any external lighting installed on the CLS, save for motion triggered security lighting, should be directed downwards, shielded and only switched on when required.

Mitigation:

- No specific mitigation measures required.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- None

5.3 POACHING AND ILLEGAL WILDLIFE TRADE

This is mostly an indirect impact that may realise as a result of workers present in the area rather than from the installation of the infrastructure. During the construction phase, there may be an influx of workers into the area. While Swakopmund itself does not provide many opportunities for poaching or illegal wildlife trade, the easily accessible surrounding areas do. Some examples of species that may be targeted are springbok, which are very tame and used to humans, for meat; and the Namaqua chameleon and black hairy thick-tailed scorpion as exotic pets. Although probably unlikely, the temptation may also be there to traffic in elephant tusks, rhinoceros horns or pangolin scales which may be sourced from the interior of Namibia. Especially when locals try to sell such products to international crew members and workers.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Illegal trafficking in wildlife or wildlife products and poaching	4	-2	2	2	2	-48	-4	Probable

<u>Desired Outcome:</u> No illegal trafficking and poaching of wildlife.

<u>Actions</u>
Prevention:
- All employees should be briefed on the value of biodiversity and environmental matters.

Mitigation:
- No specific mitigation measures required.

<u>Responsible Body:</u>
- Proponent
- Contractors

<u>Data Sources and Monitoring:</u>
- Report on any illegal activities and the disciplinary actions taken and corrective measures implemented.

5.4 WASTE

During construction and operations some waste will be produced. This may include left-over food, empty containers and bags, construction material including ropes, wires, etc., and chemical wastes such as empty paint containers. These, if not properly discarded, may trap, entangle or injure animals. Chemicals and hazardous waste may negatively impact animal health or lead to their death.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Discarded domestic waste and construction material such as containers, wires, ropes, etc.	3	-1	2	2	3	-21	-3	Probable
Operations	Discarded domestic waste and maintenance material such as empty paint cans.	3	-1	3	2	3	-24	-3	Probable

Desired Outcome: Proper waste storage and disposal methods.

Actions

Prevention:

- All employees should be educated on the importance of proper waste handling and disposal and the implications of carelessly discarding waste into the environment.
- All waste must be securely stored in temporary, closed containers before being discarded at an approved waste disposal facility or recycler. This is especially important during regular strong wind conditions.
- All construction waste must be removed at the end of the construction period and continually during operations when for example maintenance is performed on any of the infrastructure.

Mitigation:

- Any waste that are not contained or is blown away by wind must immediately be collected and securely stored until disposal.
- Any entangled or injured animals, whether from the Proponent's activities or not, must be reported to MEFT.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Report on any encounters with trapped, entangled or injured animals and where it is as a result of the Proponent's activities, corrective measures should be taken and recorded.

6 CONCLUSION

Swakopmund's surrounding areas are ecologically very important and sensitive. As such, most of it is under protection by being included in one of two national parks. The hyper-arid conditions are characterised by desert adapted species with exceptionally high levels of endemism and often significantly range restricted. As such, all developments should be planned with a high level of environmental consideration. Unfortunately, historic developments and activities have not taken special cognisance of the fragile environment and even more worrying is the fact that environmentally detrimental projects are still allowed or considered.

The installation of the Equiano Cable System's land-based infrastructure will take place within an already, heavily disturbed urban setup. As such, its direct impacts on the environment, and specifically animal biodiversity, are negligible. Some indirect impacts may ensue, but is also unlikely. This mainly pertains to the workforce who will be involved with the cable installation and activities that they may be involved with outside of the development. Examples include off-road driving for recreational activities in spare time and poaching or illegal wildlife trafficking that may be pursued when such opportunities are presented to individuals. Thus, although the environmental classification of impacts in this report are high, the likelihood of them occurring are considered to be mostly improbable.

Negative impacts on faunal ecology can be prevented or mitigated. However, strict conditions regarding unintentional or intentional environmental damage should be implemented. Educational programmes for employees are crucial to instil a sense of responsibility for, and respect towards, the natural environment.

In conclusion, the faunal ecology study could not find any reason why the Equiano Cable System installation project cannot continue as presented by the client.

7 REFERENCES

African Conservation Services. 2015. Social and Environmental Impact Assessment for Rössing Uranium's Proposed Desalination Plant near Swakopmund. Baseline Report Bird assessment, Additional study: Monitoring of Damara Terns at Mile 4 Salt Works, summer 2014/2015.

Atlas of Namibia Project. 2002. Directorate of Environmental Affairs, Ministry of Environment and Tourism. http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/main_namibia_atlas.html

Bryant R. 2010. Characterising the Wind Regime of Sand Seas: Data Sources and Scaling Issues. Global Sand Seas: Past Present and Future. Working Group Conference: Royal Geographical Society in London.

Corbett I. 2018. The Influence of the Benguela Low-Level Coastal Jet on the Architecture and Dynamics of Aeolian Transport Corridors in the Sperrgebiet, Namibia. Unpublished Report. https://pdfs.semanticscholar.org/a036/eb86ca35ceee1f19198d2735c93d36f9ac35.pdf?_ga=2.153498104.1710554377.1586180758-213198396.1586180758 Accessed on 7 April 2020

Giess, W. 1971. A preliminary vegetation map of Namibia *Dinteria, 4: 5-114*.

http://sabap2.birdmap.africa/

http://www.meteoweb.eu

https://whc.unesco.org/en/list/1430/

Irish J. 2015. Faunal scoping study for the SwaCa Marble Mining Project, Swakopmund.

Irish J.2020. Namibia Biodiversity Database Web Site. Page: Family Tenebrionidae in Namibia. Interpretive collation based on the combined published sources for all included taxa, as listed. URL: http://biodiversity.org.na/taxondisplay.php?nr=3201

Kolberg H. 2016. Wetland bird counts in Namibia: a summary. Lanioturdus 49(5): 2-191.

Kopij G. 2018. Provisional atlas of breeding birds of Swakopmund in the coastal Namib Desert. Lanioturdus 51(2): 2-12.

Mendelsohn, John & Jarvis, Alice & C, Roberts & Robertson, Tony. (2002). Atlas of Namibia: A Portrait of the Land and its People.

Photos: All photos by Wikus Coetzer & André Faul

FLORA ASSESSMENT REPORT FOR THE TERRESTRIAL PORTION OF A PROPOSED MARINE TELECOMMUNICATIONS CABLE SYSTEM (EQUIANO CABLE SYSTEM) AT SWAKOPMUND, NAMIBIA

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FLORA ASSESSMENT REPORT FOR THE TERRESTRIAL PORTION OF A PROPOSED MARINE TELECOMMUNICATIONS CABLE SYSTEM (EQUIANO CABLE SYSTEM) AT SWAKOPMUND, NAMIBIA

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1. BACKGROUND

Acer (Africa) Environmental Consultants was contracted to do an environmental impact assessment (EIA) on a proposed marine telecommunications cable system (Equiano cable system) that would connect Africa and Europe. A branch of this cable is planned to be landed at Swakopmund, Namibia. The assessment forms part of the application for an environmental clearance certificate (ECC) from the Namibian Ministry of Environment, Forestry and Tourism.

The landed Equiano cable will be buried from the low water mark to the beach manhole (BMH). The BMH will be created by Paratus to the south of the Platz am Meer shopping mall. From here the terrestrial cable will be contained in a trench, to 1 m wide and to 2 m deep along roads/pavement to the Paratus Cable Landing Station (CLS) which will be erected at the corner of Tsavorite and Kiaat streets. Two possible routes are considered for the cable from the BMH to the CLS.

This report covers the vegetation aspects of the terrestrial section of the cable from the BMH to the Paratus CLS in the Swakopmund municipal area.

2. TERMS OF REFERENCE

The terms of reference for this flora assessment were aimed at determining the impact of the Equiano cable project on the vegetation of the receiving environment. The report must contain at least:

- Pictures of the receiving environment.
- Description of the natural vegetation located within the coastal region near Swakopmund including protected species.
- Description of the impact on vegetation anticipated on site.
- A statement on whether any permits are required for the removal of vegetation from authorities.
- Mitigation measures to be implemented on site to minimise impacts on vegetation on site.

3. APPROACH

A desktop study to determine plant species that could possibly occur in the vicinity of the area affected by this development was conducted. It included listing the legal, conservation and distribution status of each species. This entailed collating information from herbarium records (National Herbarium of Namibia), literature (Giess 1968, 1981, 1998) and databases both online and that of the consultant. For legal status, species protected under the Nature Conservation Ordinance 4 of 1975, Forest Act 7 of 2001 and their regulations as well as CITES status was listed. The conservation status according to the IUCN system was derived from the Threatened Plants Programme of the National Botanical Research Institute (NBRI) of Namibia (http://www.nbri.org.na/sections/threatened-plants-programme; Loots, pers. comm. 2012) as well as from literature (Craven & Loots 2002; Craven & Kolberg 2020). The distribution of each species was obtained from the consultant's own database and grouped into species endemic to Namibia (political borders), endemic to the Namib desert (coastal region from southern Angola to the northern coast of the Northern Cape Province of South Africa) and endemic to the Central Namib (from the Kuiseb river in the south to the Ugab river in the north) into which the survey area falls (Giess 1981; Jürgens *et al.* 2012).

The site was visited to conduct a detailed survey of flora present. The survey area for this report consisted of two areas (named Area 1 and Area 2 on the map in **Figure 1**) separated by approximately 10 km. Area 2 is completely within the municipal boundaries of Swakopmund and follows the two alternative routes of the terrestrial cable from the BMH to the CLS (**Figure 1**). Area 1 is located north of Area 2 in the Dorob National Park (**Figure 1**). This area was selected from Google Earth maps as the closest area with more or less undisturbed natural vegetation that would be comparable to Area 2. The area was chosen to the north of the first area because areas to the south are topographically and geologically quite different to the first area.

In Area 2 the survey method consisted of following the exact routes of the proposed cable trenches (Preferred and Alternative) while noting any indigenous flora along this route. Photographs of the general area along the routes were taken. In Area 1, transects of 1 km length from the high-water mark directly due east, were walked and plant species present along them noted. The CLS is about 870 m (straight line) from the high-water mark, thus a transect of 1 km should cover the same vegetation that would have been present in Area 2. Photographs of the general area and individual plant species found, were taken. For Area 1 habitats were identified and the plants occurring in them listed (**Table 2**).

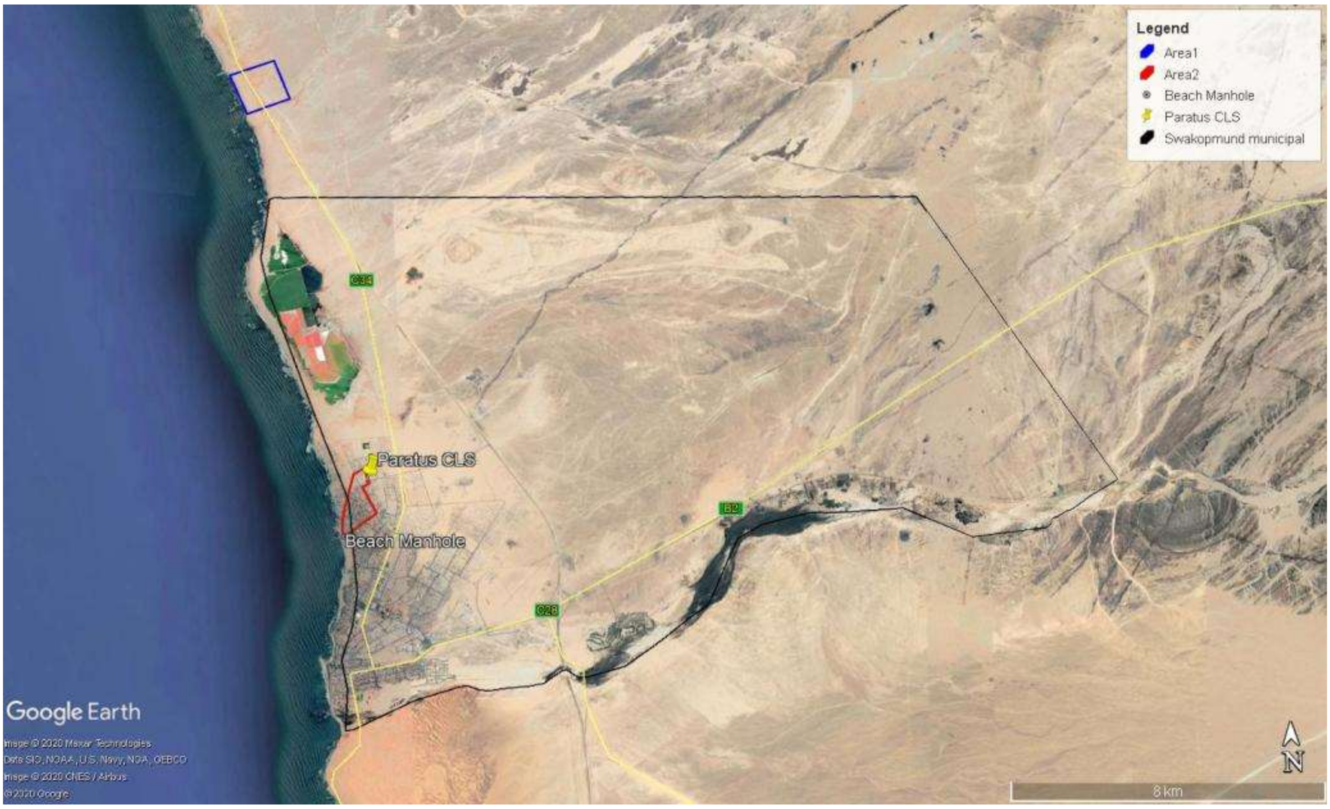

Figure 1: Map showing location of survey areas

The vegetation zone into which the survey area falls was determined using Google Earth and mapping the vegetation type and units according to Mendelsohn *et al.* (2010) onto the base map.

Nomenclature of plant species follows Craven & Kolberg (2020) (https://herbaria.plants.ox.ac.uk/bol/namibia).

4. LEGAL CONTEXT

As the Law Above All Laws, the Constitution of the Republic of Namibia protects vegetation resources through provision of the appropriate legal background. According to Article 100 all natural resources are owned by the State unless they are otherwise lawfully owned. Article 95(l) compels the State to " actively promote and maintain the welfare of the people by adopting, inter alia, policies aimed at the following: ....(l) maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future; ....". Article 91(c) stipulates that one of the functions of the Ombudsman is " ..... the duty to investigate complaints concerning the over-utilization of living natural resources, the irrational exploitation of non-renewable resources, the degradation and destruction of ecosystems and failure to protect the beauty and character of Namibia;...." (Republic of Namibia 1990).

A flora assessment report forms part of the requirements for application for an environmental clearance certificate (ECC) under the Environmental Management Act (Act 7 of 2007) of Namibia (Government of the Republic of Namibia 2007). According to the Government Notice No. 29 (2012), this project has to obtain an ECC (Text Box 1).

Several mechanisms are used to protect indigenous plants in Namibia. Plants protected under the Nature Conservation Ordinance 4 of 1975 (Administration of South West Africa 1975) may not be removed without permission from the Ministry of Environment, Forestry and Tourism (MEFT). All other indigenous plants may only be removed by the owner or lessee of the land or by a person who has the written permission of the owner or lessee of the land.

> Text Box 1:
>
> **ANNEXURE**
> **LIST OF ACTIVITIES THAT MAY NOT BE UNDERTAKEN WITHOUT ENVIRONMENTAL CLEARANCE CERTIFICATE**
>
> **..............**
>
> **INFRASTRUCTURE**
>
> 10.1 The construction of-
> (a) ....
>
> (g) communication networks including towers, telecommunication and marine telecommunication lines and cables;
> (h) ....
>
> Excerpt from Government Notice No. 29, Government Gazette No. 4878, Namibia (2012). Schedule to Environmental Management Act 7 of 2007.

The regulations (Government of the Republic of Namibia 2015) for the Forest Act 12 of 2001(Government of the Republic of Namibia 2001) list 80 protected plant species. Besides protecting listed species, this Act also regulates the protection of especially soil and water resources by stipulating that vegetation may not be removed, cut or destroyed on sand dunes, drifting sand or gullies and that no vegetation may be removed within 100 m from rivers, streams or watercourses without a permit.

The Water Resources Management Act 11 of 2013, although passed by parliament, will only come into force once the Minister gives notice in the Government Gazette (Government of the Republic of Namibia 2013). The Act aims to manage and protect Namibia's water resources and all associated issues. It prohibits the removal of vegetation along watercourses or in water management areas. No regulations have been gazetted and for the time being the Ministry of Agriculture, Water and Land Reform still uses the old Water Act, Act 54 of 1956 (Administration of South West Africa 1956). Under this old Act the Minister has the power to control any activities that influence the normal flow of water, including removal of vegetation along watercourses or in catchment areas (Ruppel & Ruppel-Schlichting 2013).

The receiving environment falls within the boundaries of the city of Swakopmund so that municipal bylaws apply. No bylaws for Swakopmund that relate to vegetation and would have any impact on this project could be found (https://www.swkmun.com.na/downloads/regulations/).

Namibia is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This regulates trade across international borders of species listed in its Appendices. Should any of these species be removed from the area to be developed, they may not be moved across Namibian borders without prior consent (permit) from the Ministry of Environment, Forestry and Tourism.

5. RESULTS AND DISCUSSION

5.1 Desktop study

A list of 186 indigenous plant species that occur near Swakopmund is presented in **ANNEX 1**. Properties of these species are included. These are their legal status (protected species under the Nature Conservation Ordinance or Forest Act, listed on CITES), preliminary IUCN category (threat) and distribution. The distributions were divided into categories from a very narrow range to widespread, where the definitions as shown in **Table 1** were used.

Only one annual species is restricted to the central parts of the Namib Desert, while nine species are restricted to Namibia and the Namib. Twenty-eight species are restricted to the Namib (Namibia and/or Angola and/or South Africa), fourteen species are endemic to Namibia but are spread wider than the Namib while nine occur mainly in Namibia (near-endemic) but are not restricted to the Namib. No threatened species are expected to occur in the survey area. Nine plant species in the Swakopmund area are protected by law.

Table 1: Definitions of distribution range as used in Annex 1

Range Category	Definition
central Namib only	endemic to Namibia and restricted to the area around Swakopmund and Walvis Bay
endemic to Namibia, Namib only	endemic to Namibia and restricted to the Namib desert
Namib	near-endemic to Namibia and restricted to the Namib desert i.e. it occurs mainly in Namibia with a smaller range in the Namib of Angola and/or South Africa
endemic to Namibia	endemic to Namibia but also spread outside the Namib
near-endemic to Namibia	occurs mainly in Namibia with a smaller range outside the country but not restricted to the Namib desert
[empty]	widespread in Namibia and across several countries

The list of possible species derived from the desktop study includes species recorded for the entire quarter-degree square (2214DA) in which the survey area is located. Since this includes the Swakop river and areas south of it as well as areas much further inland than the survey area and with different vegetation, many of the species on this list would not be expected within the first kilometre from the ocean, that is, not in the survey area.

5.2 Natural Vegetation (Area 1)

Area 1 falls outside the Swakopmund municipal area and is located in the Dorob National Park. It is located where the Central and Southern Desert vegetation types meet. Vegetation units within these vegetation types at Area 1 according to Mendelsohn *et al.* (2010) are the gravel plains of the central Namib, southern Namib and the Swakop and Khan river canyons.

The vegetation in Area 1 could be divided into four habitats (**Figure 2**). A narrow strip of beach hummock vegetation (**Figure 3**) is at most 200 m wide from the high-water mark inland. The hummock-forming species are *Arthraerua leubnitziae* and *Tetraena clavata*. The area further inland from the hummock belt consists of a mosaic of shallow saline/gypsum pans (**Figure 4**), low dolerite outcrops (**Figure 5**) and flat to slightly undulating, pale gravel plains (**Figure 6**). The saline pans were devoid of any vegetation. In the dolerite outcrops only *Brownanthus kuntzei* was found as well as unidentified lichen/s (**Figure 11**). The gravel plains are dominated by *Arthraerua leubnitziae* (not hummock-forming here). A few plants of *Senecio engleranus* were found on the gravel plains.

Figure 2: Map showing extent of habitats in Area 1

Figure 3: Beach Hummocks habitat

Figure 4: Saline Pan habitat

Figure 5: Dolerite Outcrops habitat

Figure 6: Gravel Plains habitat

Three randomly chosen 1km transects were walked in Area 1 and only four plant species were found (**Table 2**). On the way from Swakopmund to Area 1 five other species (**Error! Reference source not found.**) were seen, meaning they could occur in Area 1 but were not picked up in the transects. They are far less abundant than the species recorded in the transects. **None of these species are threatened, protected or CITES listed** but all are typical Namib Desert species.

Table 2: Indigenous plant species found in Area 1 (natural vegetation)

Species	Habitat	Comment
Arthraerua leubnitziae (Amaranthaceae) (Figure **1**)	Beach hummocks Gravel plains	Endemic to Namibia, Namib only
Brownanthus kuntzei (Aizoaceae) (Figure **8**)	Dolerite outcrops	Namib of Angola & Namibia
Senecio engleranus (Asteraceae) (Figure **9**)	Gravel plains	Endemic to Namibia, Namib only
Tetraena clavata (Zygophyllaceae) (Figure **10**)	Beach hummocks	Namib of Namibia & South Africa

Table 3: Plant species observed near Area 1

Species	Habitat	Comment
Lycium tetrandrum (Solanaceae)	Beach hummocks	near-endemic to Namibia
Mesembryanthemum guerichianum (Aizoaceae)	Gravel plains Saline pans	annual, appears after rains
Opophytum cryptanthum (Aizoaceae)	Gravel plains Saline pans	annual, appears after rains
Psilocaulon salicornioides (Aizoaceae)	Gravel plains	near-endemic to Namibia
Tetragonia reduplicata (Aizoaceae)	Beach hummocks	near-endemic to Namibia
Tetraena stapfii (Zygophyllaceae)	Beach hummocks Gravel plains	Namib of Angola & Namibia

Figure 7: *Arthraerua leubnitziae*

Figure 8: *Brownanthus kuntzei*

Figure 9: *Senecio engleranus*

Figure 10: *Tetraena clavata*

Figure 11: Unidentified crustose lichen(s) on south-western face of dolerite rocks

5.3 Receiving Environment (Area 2)

Area 2 is located entirely within the municipal area of Swakopmund (**Figure 1**). The area is developed mainly as a residential area with some business, institutional and recreational facilities. There is hardly any natural vegetation to be found in this area.

The routes (Preferred and Alternative, **Figure 12**) along which trenches for the Equiano cabling are to be dug are mostly paved. Road and pavement construction ranges from unpaved sand (**Figure 13**) to cement interlocked bricks (most common, **Figure 14**), loose pebbles (**Figure 15**) or bitumen (**Figure 16**). In a few instances pavements have been planted with non-indigenous plants (**Figure 17**). Empty erven showed no vegetation (**Figure 18**).

Figure 12: Map of Receiving Area showing Preferred and Alternative routes

Figure 13: Unpaved pavement with bitumen road

Figure 14: Interlock paving of road and pavement

Figure 15: Pavement with loose pebbles

Figure 16: Bitumen surfaced road with interlocked pavement

Figure 17: Exotic plants on pavement

Figure 18: Empty erf devoid of vegetation

At the BMH the area is open, undeveloped sand, bordered by interlock-paved parking for the Platz am Meer shopping centre to the north and a recreational park planted with exotic species to the north-east to south-east (**Figure 19**). The site of the Paratus CLS on the corner of Kiaat and Tsavorite streets is on a large, mostly undeveloped area with a few plants of *Arthraerua leubnitziae* of which only one will be directly affected by this development (**Figure 20, 21, 22**). The Hage Heights CLS with some telecommunication masts and large, planted exotic palms (*Phoenix* sp.) are situated to the west and south-west of the Paratus CLS.

From a vegetation perspective there is no difference between the Preferred and Alternative routes.

Figure 19: Beach Manhole area

Figure 20: Area surrounding site of CLS

Figure 21: Paratus CLS construction area demarcated by white rocks

Figure 22: Shrub of *Arthraerua leubnitziae* located within the Paratus CLS footprint area

5.4 Protected, Threatened or Narrowly Endemic Species Impacted

The receiving environment (Area 2) is previously impacted. No threatened, protected or CITES listed species were found in this survey. The only species that will be affected by this development is *Arthraerua leubnitziae*, which is endemic to Namibia and restricted to the Namib desert. Only one plant of this species grows at the site of the CLS.

No permits are required for the removal of vegetation since the only plant that needs to be removed does not have any legal protection status. The owner or lessee of the CLS site (Paratus) is allowed to remove this plant or instruct somebody in writing to do so.

6. Impact Assessment on Vegetation

Impact Description	**Removal and destruction of indigenous vegetation to make way for infrastructure (cable trenches, CLS building).**
Direct impacts	**destruction of indigenous plants** One indigenous plant (*Arthraerua leubnitziae*) needs to be removed for construction of the CLS. The cabling route does not contain any indigenous plants, so that there is no need for the removal of these.
Indirect impacts	**none on indigenous vegetation** Digging of trenches and construction of the CLS will not have any impacts on surrounding indigenous vegetation which is at least 10 km away from the development site.
Cumulative impacts	**Further destruction of indigenous plants** in addition to that already caused by town development and the possible impact of the proposed SIMBA submarine telecommunications cable that may be landed at Swakopmund but of which there is no alignment available at present.
Nature	**negative**
Spatial extent	**site specific** The nature of the work for cabling trenches and CLS construction is such that it will not impact areas more than 10 m outside the footprint area. There is no indigenous vegetation along the cable routes; only one indigenous plant needs to be removed for construction of the CLS. The vegetation in areas immediately surrounding the CLS will not be impacted because there is hardly any vegetation; the few plants of *Arthraerua leubnitziae* that are found here can be retained and activities planned around them.
Duration	**permanent** The indigenous plant removed will be replaced with infrastructure.
Intensity	**negligible** The removal of one plant of *Arthraerua leubnitziae* at the CLS will have an inconsequential effect on the ecosystem. The species is not protected, threatened or rare.
Frequency	**once off** Removal of the one plant at the CLS will occur only once, prior to construction.
Probability	**definite** The plant to be removed at the CLS site is within the limits of the construction site and will therefore be destroyed.
Irreplaceability	**moderate** The plant to be removed could be replaced with another one of its species with some effort: plant not available at nurseries, does not transplant, cultivation method unknown; there may not be any space within the CLS site to plant it.
Reversibility	**moderate** The indigenous vegetation at the CLS site could be rehabilitated to its pre-impact state with some effort.
Significance	**low** Any natural vegetation that may have been at the site has previously been impacted by town development. The impact of this project will be merely the removal of one plant of a species that is neither protected, threatened, rare nor with an extremely narrow distribution range.
Legal Implications	**none for vegetation** The one species affected by this development is not listed as protected by either the Nature Conservation Ordinance 4 of 1975 nor the Forest Act 12 of 2001; it is not listed on CITES; no permits are required for its removal.

Mitigation Measures	Mitigation measures for vegetation only apply at the CLS site, not the cabling routes. During construction of the CLS **the area surrounding the actual construction site** will most probably be used by the contractor for storage of materials and equipment. Very few plants of *Arthraerua leubnitziae* are located in this area. The project or construction manager should ensure that these plants are not impacted through removal, covering with building materials, especially sand, dumping of refuse or liquids (e.g. hydrocarbons, water used to clean equipment, especially water containing cement) on the plants or use of plant parts for any purpose (e.g. fires). Contractors on site must be made aware of this. The single plant of *A. leubnitziae* that is located **in the construction area** can be removed.
Confidence	**high** On-site data was collected; precise construction alignment and methods were available; the consultant has more than 35 years' experience in the Namibian flora.

7. Conclusion

This project will not have any significant impacts on the flora of the receiving environment nor on indigenous flora of surrounding areas. The mitigation measures should ensure that the impact on flora is almost negligible. From a flora perspective there is no compelling reason for this project not to go ahead.

8. Bibliography

Administration of South West Africa. 1956. Water Act 54 of 1956. Extraordinary Official Gazette of South West Africa No. 2015. Windhoek. (https://www.lac.org.na/laws/1956/og2015.pdf and http://www.lac.org.na/laws/annoSTAT/Water%20Act%2054%20of%201956.pdf).

Administration of South West Africa. 1975. Nature Conservation Ordinance 4 of 1975. Government Notice No. 147. Extraordinary Official Gazette of South West Africa No. 3469. Windhoek. (https://www.lac.org.na/laws/1975/og3469.pdf and https://www.lac.org.na/laws/annoSWA/ENVIRONMENT%20(1975)%20-%20Nature%20Conservation%20Ordinance%204%20of%201975%20(annotated).pdf).

Craven, P. & Loots, S. 2002. Namibia. In: Golding, J.S. (ed.), Southern African Plant Red Data Lists. *Southern African Botanical Diversity Network Report* No. 14: 61 – 92.

Craven, P. & Kolberg, H. 2020. Plants of Namibia. Online database. https://herbaria.plants.ox.ac.uk/bol/namibia

Giess, W. 1968. A short report on the vegetation of the Namib coastal area from Swakopmund to Cape Fria. *Dinteria* 1:13 - 29.

Giess, W. 1981. Die in der zentralen Namib von Südwestafrika/Namibia festgestellten Pflanzenarten und ihre Biotope. *Dinteria* 15:13 - 72.

Giess, W. 1998. A preliminary vegetation map of South West Africa. Third Revised Edition. *Dinteria* 4:1 – 112.

Government of the Republic of Namibia. 2001. Government Notice No. 138. Promulgation of the Forest Act, 2001 (Act 12 of 2001). Government Gazette No. 2793. Windhoek. (https://www.lac.org.na/laws/annoSTAT/Forest%20Act%2012%20of%202001.pdf)

Government of the Republic of Namibia. 2007. Government Notice No. 232. Promulgation of Environmental Management Act, 2007 (Act No. 7 of 2007). Government Gazette No. 3966. Windhoek. (https://laws.parliament.na/cms_documents/environmental-management-act-98a722d979.pdf).

Government of the Republic of Namibia. 2012. Government Notice No. 29. List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007. Government Gazette No. 4878. Windhoek. (https://www.lac.org.na/laws/2012/4878.pdf).

Government of the Republic of Namibia (GRN). 2013. Government Notice No. 284. Promulgation of Water Resources Management Act, No. 11 of 2013. Government Gazette No. 3357. Windhoek. (https://www.lac.org.na/laws/2013/5367.pdf)

Government of the Republic of Namibia. 2015. Government Notice No. 170. Forest Regulations: Forest Act, 2001. Government Gazette No. 5801. Windhoek. (http://www.lac.org.na/laws/2015/5801.pdf).

Jürgens, N., Oldeland, J., Hachfeld, B., Erb, E. & Schulz, C. 2012. Ecology and spatial patterns of large-scale vegetation units within the central Namib Desert. *Journal of Arid Environments* 93: 59 - 79.

Loots, S. 2012. List of threatened plants. Threatened Plants Programme, NBRI, Windhoek. Pers. comm.

Mendelsohn, J., Jarvis, A., Roberts, C. & Robertson, A. 2010. Atlas of Namibia. A portrait of the land and its people. 3rd Edition. Sunbird Publishers, Cape Town.

Republic of Namibia. 1990. Constitution of the Republic of Namibia. https://www.lac.org.na/laws/annoSTAT/Namibian%20Constitution.pdf

Ruppel, O.C. & Ruppel-Schlichting, K. (Eds.) 2013. *Environmental Law and Policy in Namibia - towards making Africa the Tree of Life*. Fully revised second edition. https://namibia.hss.de/fileadmin/user_upload/Projects_HSS/Namibia/Dokumente/bis_2016/Environmental_Law_and_Policy_in_Namibia_-_Towards_making_Africa_the_Tree_of_Life_2013.pdf Accessed in May 2020.

ANNEX 1: Indigenous plant species recorded for quarter-degree square 2214DA around Swakopmund

FAMILY	SPECIES	LEGAL	IUCN (pre-2001)	DISTRIBUTION
Acanthaceae	Blepharis grossa (Nees) T.Anderson			near-endemic to Namibia
Acanthaceae	Blepharis obmitrata C.B.Clarke			
Acanthaceae	Justicia cleomoides S.Moore			near-endemic to Namibia
Acanthaceae	Justicia desertorum Engl.			Endemic to Namibia, Namib only
Acanthaceae	Justicia divaricata Licht. ex Roem. & Schult.			
Acanthaceae	Petalidium setosum C.B.Clarke ex Schinz			near-endemic to Namibia
Aizoaceae	Aizoanthemum dinteri (Schinz) Friedrich			Endemic to Namibia
Aizoaceae	Aizoanthemum galenioides (Fenzl ex Sond.) Friedrich			central Namib only
Aizoaceae	Brownanthus kuntzei (Schinz) Ihlenf. & Bittrich			Namib
Aizoaceae	Galenia africana L.			
Aizoaceae	Galenia namaensis Schinz			
Aizoaceae	Galenia papulosa (Eckl. & Zeyh.) Sond.			
Aizoaceae	Galenia procumbens L.f.			
Aizoaceae	Galenia sarcophylla Fenzl ex Harv. & Sond.			
Aizoaceae	Mesembryanthemum guerichianum Pax			
Aizoaceae	Opophytum cryptanthum (Hook.f) Gerbaulet			
Aizoaceae	Psilocaulon salicornioides (Pax) Schwantes			near-endemic to Namibia
Aizoaceae	Tetragonia arbuscula Fenzl			
Aizoaceae	Tetragonia calycina Fenzl			
Aizoaceae	Tetragonia reduplicata Welw. ex Oliv.			near-endemic to Namibia
Aizoaceae	Trianthema hereroensis Schinz		NT	Endemic to Namibia, Namib only
Aizoaceae	Zaleya pentandra (L.) C.Jeffrey			
Amaranthaceae	Arthraerua leubnitziae (Kuntze) Schinz		NT	Endemic to Namibia, Namib only
Amaranthaceae	Atriplex suberecta I.Verd.			
Amaranthaceae	Atriplex vestita (Thunb.) Aellen var. appendiculata Aellen			
Amaranthaceae	Calicorema capitata (Moq.) Hook.f			
Amaranthaceae	Caroxylon aphyllum (L.f.) Tzvelev		DD	
Amaranthaceae	Caroxylon gemmiferum (Botsch.) Mucina			Endemic to Namibia
Amaranthaceae	Caroxylon nollothense (Aellen) Mucina			Namib
Amaranthaceae	Caroxylon parviflorum (Botsch.) Mucina		DD	Endemic to Namibia, Namib only
Amaranthaceae	Caroxylon pillansii (Botsch.) Mucina		DD	Endemic to Namibia
Amaranthaceae	Caroxylon procerum (Botsch.) Mucina			Endemic to Namibia, Namib only
Amaranthaceae	Caroxylon seydelii (Botsch.) Mucina		DD	Endemic to Namibia
Amaranthaceae	Hermbstaedtia spathulifolia (Engl.) Baker			Endemic to Namibia, Namib only
Amaranthaceae	Nelsia quadrangula (Engl.) Schinz			
Amaranthaceae	Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott var. affinis (Moss) O'Callaghan			
Amaranthaceae	Suaeda merxmuelleri Aellen		DD	Namib
Amaranthaceae	Suaeda plumosa Aellen			Endemic to Namibia
Apocynaceae	Gomphocarpus filiformis (E.Mey.) D.Dietr.		LC	Namib
Apocynaceae	Hoodia gordonii (Masson) Sw. ex Decne.	NC		
Apocynaceae	Orthanthera albida Schinz			Namib
Asteraceae	Arctotis venusta T.Norl.			
Asteraceae	Cotula anthemoides L.			

FAMILY	SPECIES	LEGAL	IUCN (pre-2001)	DISTRIBUTION
Asteraceae	Cotula coronopifolia L.			
Asteraceae	Dauresia alliariifolia (O.Hoffm.) B.Nord. & Pelser			Namib
Asteraceae	Doellia cafra (DC.) Anderb.			
Asteraceae	Felicia anthemidodes (Hiern) Mendonça			
Asteraceae	Felicia smaragdina (S.Moore) Merxm.		NT	Endemic to Namibia
Asteraceae	Gazania jurineifolia DC. subsp. scabra (DC.) Roessler			Namib
Asteraceae	Geigeria alata (Hochst. & Steud. ex DC.) Benth. & Hook.f ex Oliv. & Hiern		NT	
Asteraceae	Geigeria ornativa O.Hoffm. subsp. ornativa var. ornativa			
Asteraceae	Helichrysum argyrosphaerum DC.			
Asteraceae	Helichrysum candolleanum H.Buek			
Asteraceae	Helichrysum roseo-niveum Marloth & O.Hoffm.			Namib
Asteraceae	Litogyne gariepina (DC.) Anderb.			
Asteraceae	Myxopappus acutilobus (DC.) Kaellersjo			near-endemic to Namibia
Asteraceae	Myxopappus hereroensis (O.Hoffm.) Kaellersjo		NT	Endemic to Namibia, Namib only
Asteraceae	Nidorella resedifolia DC. subsp. resedifolia			
Asteraceae	Nolletia chrysocomoides Cass.			
Asteraceae	Ondetia linearis Benth.		NT	Endemic to Namibia
Asteraceae	Othonna lasiocarpa (DC.) Sch.Bip.			Namib
Asteraceae	Pechuel-loeschea leubnitziae (Kuntze) O.Hoffm.			
Asteraceae	Pentzia calva S.Moore			
Asteraceae	Senecio engleranus O.Hoffm.			Endemic to Namibia, Namib only
Asteraceae	Tripteris microcarpa Harv. subsp. microcarpa			
Asteraceae	Tripteris microcarpa Harv. subsp. septentrionalis (T.Norl.) B.Nord.			
Boraginaceae	Codon royenii L.		NT	Namib
Boraginaceae	Euploca ovalifolia (Forssk.) Diane & Hilger			
Boraginaceae	Euploca rariflora (Stocks) Diane & Hilger subsp. hereroensis (Schinz) Diane & Hilger			
Boraginaceae	Heliotropium oliveranum Schinz			
Boraginaceae	Heliotropium tubulosum E.Mey. ex DC.			
Boraginaceae	Trichodesma africanum (L.) Lehm.			
Boraginaceae	Trichodesma angustifolium Harv. subsp. angustifolium			
Brassicaceae	Lepidium englerianum (Muschl.) Al-Shehbaz			
Burseraceae	Commiphora wildii Merxm.	F		Namib
Campanulaceae	Lobelia thermalis Thunb.			
Capparaceae	Boscia albitrunca (Schinz) Gilg & Gilg-Ben.	F		
Capparaceae	Boscia foetida Schinz			
Capparaceae	Maerua schinzii Pax	F		
Characeae	Chara vulgaris L. var. vulgaris			
Cleomaceae	Cleome elegantissima Briq.			
Cleomaceae	Cleome foliosa Hook.f var. foliosa			
Cleomaceae	Cleome foliosa Hook.f var. lutea (Sond.) Codd & Kers			
Cleomaceae	Cleome semitetrandra Sond.			
Colchicaceae	Hexacyrtis dickiana Dinter			Namib
Colchicaceae	Ornithoglossum vulgare B.Nord.			
Crassulaceae	Cotyledon orbiculata L.			
Cucurbitaceae	Acanthosicyos horridus Welw. ex Hook.f	F		Namib

FAMILY	SPECIES	LEGAL	IUCN (pre-2001)	DISTRIBUTION
Cucurbitaceae	Citrullus ecirrhosus Cogn.			Namib
Cucurbitaceae	Cucumis africanus L.f.			
Cucurbitaceae	Dactyliandra welwitschii Hook.f			near-endemic to Namibia
Cyperaceae	Afroscirpoides dioeca (Kunth) Garcia-Madrid			near-endemic to Namibia
Cyperaceae	Bulbostylis contexta (Nees) M.Bodard			
Cyperaceae	Cyperus esculentus L.			
Cyperaceae	Cyperus laevigatus L.			
Cyperaceae	Cyperus marginatus Thunb.			
Cyperaceae	Eleocharis schlechteri C.B.Clarke			
Ebenaceae	Euclea pseudebenus E.Mey. ex A.DC.	F		
Euphorbiaceae	Euphorbia glanduligera Pax			
Euphorbiaceae	Euphorbia phylloclada Boiss.			Namib
Frankeniaceae	Frankenia pulverulenta L.			
Geraniaceae	Pelargonium otaviense R.Knuth		NT	Endemic to Namibia
Gisekiaceae	Gisekia africana (Lour.) Kuntze var. africana			
Juncaceae	Juncus rigidus Desf.			
Kewaceae	Kewa caespitosa (Friedrich) Christenh.			Namib
Kewaceae	Kewa salsoloides (Burch.) Christenh.			Namib
Lamiaceae	Acrotome fleckii (Guerke) Launert			Endemic to Namibia
Lamiaceae	Ocimum americanum L.			
Leguminosae	Adenolobus pechuelii (Kuntze) Torre & Hillc. subsp. pechuelii			Endemic to Namibia
Leguminosae	Crotalaria argyraea Welw. ex Baker			
Leguminosae	Crotalaria colorata Schinz subsp. colorata			Endemic to Namibia, Namib only
Leguminosae	Cullen tomentosum (Thunb.) J.W.Grimes			
Leguminosae	Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var. africana			
Leguminosae	Faidherbia albida (Delile) A.Chev.	F		
Leguminosae	Indigofera pechuelii Kuntze			Endemic to Namibia
Leguminosae	Microcharis disjuncta (J.B.Gillett) Schrire			
Leguminosae	Parkinsonia africana Sond.			
Leguminosae	Sesbania pachycarpa DC. subsp. dinterana J.B.Gillett			Endemic to Namibia
Leguminosae	Tephrosia dregeana E.Mey.			
Loasaceae	Kissenia capensis Endl.			
Lophiocarpaceae	Lophiocarpus polystachyus Turcz.			
Loranthaceae	Tapinanthus oleifolius (J.C.Wendl.) Danser			
Malvaceae	Grewia tenax (Forssk.) Fiori			
Malvaceae	Hermannia affinis K.Schum.			
Malvaceae	Hermannia amabilis Marloth ex K.Schum.			Endemic to Namibia
Malvaceae	Hermannia modesta (Ehrenb.) Mast.			
Molluginaceae	Corrigiola litoralis L. subsp. litoralis			
Molluginaceae	Mollugo cerviana (L.) Ser. ex DC.			
Moraceae	Ficus cordata Thunb.	F		
Neuradaceae	Grielum sinuatum Licht. ex Burch.			
Plumbaginaceae	Dyerophytum africanum (Lam.) Kuntze			
Poaceae	Anthephora pubescens Nees			
Poaceae	Cenchrus foermeranus (Leeke) Morrone			
Poaceae	Cladoraphis spinosa (L.f.) S.M.Phillips			Namib

FAMILY	SPECIES	LEGAL	IUCN (pre-2001)	DISTRIBUTION
Poaceae	Entoplocamia aristulata (Hack. & Rendle) Stapf			Endemic to Namibia
Poaceae	Eragrostis annulata Rendle ex Scott-Elliot			
Poaceae	Eragrostis dinteri Stapf			
Poaceae	Eragrostis echinochloidea Stapf			
Poaceae	Eragrostis nindensis Ficalho & Hiern			
Poaceae	Eragrostis superba Peyr.			
Poaceae	Fingerhuthia africana Lehm.			
Poaceae	Odyssea paucinervis (Nees) Stapf			
Poaceae	Panicum repens L.			
Poaceae	Paspalum vaginatum Sw.			
Poaceae	Phragmites australis (Cav.) Steud.			
Poaceae	Pogonarthria fleckii (Hack.) Hack.			
Poaceae	Sporobolus consimilis Fresen.			
Poaceae	Sporobolus nebulosus Hack.			Namib
Poaceae	Sporobolus virginicus (L.) Kunth			
Poaceae	Sporobolus welwitschii Rendle			
Poaceae	Stipagrostis ciliata (Desf.) De Winter var. capensis (Trin. & Rupr.) De Winter			
Poaceae	Stipagrostis hermannii (Mez) De Winter			Namib
Poaceae	Stipagrostis hochstetteriana (L.C.Beck ex Hack.) De Winter var. secalina (Henrard) De Winter			
Poaceae	Stipagrostis namaquensis (Nees) De Winter			
Poaceae	Stipagrostis schaeferi (Mez) De Winter			Namib
Poaceae	Stipagrostis subacaulis (Nees) De Winter			Namib
Poaceae	Stipagrostis uniplumis (Licht.) De Winter var. uniplumis			
Poaceae	Tragus berteronianus Schult.			
Poaceae	Tricholaena monachne (Trin.) Stapf & C.E.Hubb.			
Poaceae	Triraphis pumilio R.Br.			Namib
Poaceae	Triraphis ramosissima Hack.			
Polygonaceae	Polygonum plebeium R.Br.			
Polygonaceae	Rumex lanceolatus Thunb.			
Potamogetonaceae	Stuckenia pectinata (L.) Börner			
Potamogetonaceae	Zannichellia palustris L. subsp. palustris			
Ruppiaceae	Ruppia maritima L.			
Rutaceae	Thamnosma africana Engl.			
Salvadoraceae	Salvadora persica L.			
Scrophulariaceae	Camptoloma rotundifolium Benth.			Namib
Scrophulariaceae	Hebenstretia parviflora E.Mey.			
Scrophulariaceae	Jamesbrittenia canescens (Benth.) Hilliard var. canescens			near-endemic to Namibia
Scrophulariaceae	Jamesbrittenia maxii (Hiern) Hilliard			Namib
Scrophulariaceae	Manulea conferta Pilg.			
Scrophulariaceae	Selago alopecuroides Rolfe			
Scrophulariaceae	Selago dinteri Rolfe			
Solanaceae	Lycium decumbens Welw. ex Hiern		DD	Namib
Solanaceae	Lycium oxycarpum Dunal			
Solanaceae	Lycium tetrandrum Thunb.			near-endemic to Namibia
Tamaricaceae	Tamarix usneoides E.Mey. ex Bunge	F		
Vahliaceae	Vahlia capensis (L.f.) Thunb.			

FAMILY	SPECIES	LEGAL	IUCN (pre-2001)	DISTRIBUTION
Verbenaceae	Chascanum garipense E.Mey.			
Zygophyllaceae	Tetraena clavata (Schltr. & Diels) Beier & Thulin			Namib
Zygophyllaceae	Tetraena simplex (L.) Beier & Thulin			
Zygophyllaceae	Tetraena stapfii (Schinz) Beier & Thulin			Namib
Zygophyllaceae	Tribulus excrucians Wawra			
Zygophyllaceae	Tribulus zeyheri Sond.			

11 June 2020

ACER (Africa) Environmental Consultants
PO Box 503
Mtunzini 3867
South Africa

For attention: Mr G. Churchill, Senior Environmental Assessment Practitioner

HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED MARINE TELECOMMUNICATIONS CABLE SYSTEM (EQUIANO CABLE SYSTEM) TO BE LANDED AT SWAKOPMUND IN NAMIBIA

John Kinahan, Archaeologist
P.O. Box 22407
Windhoek
Namibia

DECLARATION

I hereby declare that I do:

(a) have knowledge of and experience in conducting assessments, including knowledge of Namibian legislation, regulations and guidelines that have relevance to the proposed activity;

(b) perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

(c) comply with the Act, these regulations, guidelines and other applicable laws.

I also declare that there is, to my knowledge, no information in my possession that reasonably has or may have the potential of influencing –

(i) any decision to be taken with respect to the application in terms of the Act and the regulations; or

(ii) the objectivity of this report, plan or document prepared in terms of the Act and these regulations.

John Kinahan, Archaeologist

TABLE OF CONTENTS

LIST OF ACRONYMS

BMH	Beach Man Hole
CLS	Cable Landing Station
EAP	Environmental Assessment Practitioner
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
OIS	Oxygen Isotope Stage
My	Million years

1. INTRODUCTION

1.1 BACKGROUND

Alcatel Submarine Networks Ltd. Is involved in the construction of the Equiano subsea cable system from Portugal to South Africa. The project will include among its several landing sites a branch to Swakopmund on the coast of Namibia. The undersea cable Segment S24 (BMH SWAKOPMUND and BU NAM) will connect to a cable landing station at a point known as Hage Heights in the northern suburb of Vineta, in Swakopmund.

ACER (Africa) Environmental Consultants has been engaged to carry out a full environmental impact assessment (EIA) of the proposed project in terms of the Environmental Management Act (2007). Archaeological remains in Namibia are protected under the National Heritage Act (2004) and National Heritage Regulations (Government Notice 106 of 2005), and projects of this magnitude are subject to archaeological assessment. ACER (Africa) has accordingly appointed the undersigned, J. Kinahan, archaeologist, to carry out this assessment.

1.2 TERMS OF REFERENCE

The primary task of the archaeological impact assessment was to identify sensitive archaeological sites that could be affected by the Equiano project. The archaeological assessment forms the basis of recommended management actions to avoid or reduce negative impacts, as part of the environmental impact assessment. The study is intended to satisfy the requirements of the Environmental Management Act (2007), and those of the National Heritage Act (2004) and National Heritage Regulations (Government Notice 106 of 2005), although the process of external review and clearance may require further, or different mitigation measures to be adopted.

Specifically, the Heritage Impact Assessment must address the following primary elements:

1. The identification and assessment of potential impacts on cultural heritage resources, including historical sites arising from the construction and operation of the proposed Equiano Cable System (both onshore and offshore).
2. The early identification of any red flag and fatal flaw issues or impacts.
3. Information must be provided on the following: (i) Results of an overview survey of the project area, and the identification of cultural heritage resources that may be affected by the proposed project or which may affect the proposed project during construction and operation. (ii) Recommended mitigation measures for enhancing positive impacts and avoiding or minimizing negative impacts and risks (to be implemented during design, construction and operation).
4. Identify permit requirements as related to the removal and/or destruction of heritage resources. The completed permit applications must be submitted to ACER for further attention and action.
5. θ Address specific issues and concerns raised by stakeholders during the public review phase of the assessment process (an Issues and Responses Report will be provided to specialists).

6. Formulation of a protocol to be followed by Paratus for the identification, protection or recovery of cultural heritage resources during construction and operation, including the completion of all necessary permit applications, which may be required.
7. The identification and assessment of any palaeontological aspects or findings arising from the construction and operation of proposed Equiano Cable System.

1.3 ASSUMPTIONS & LIMITATIONS

The archaeological assessment relies on the indicative value of surface finds, augmented by inference from the results of surveys and excavations carried out in the course of previous work in the same general area as the Equiano project. Based on these data, it is possible to predict the likely occurrence of further archaeological sites with some accuracy, and to present a general statement (see Receiving Environment, below) of the local archaeological site distribution. However, since the assessment is limited to surface observations and existing survey data, it is necessary to caution the proponent that hidden, or buried archaeological or palaeontological remains might be exposed as the project proceeds

2. LEGAL REQUIREMENTS

The principal instrument of legal protection for archaeological/heritage resources in Namibia is the National Heritage Act (27 of 2004). Part V Section 46 of the Act prohibits removal, damage, alteration or excavation of heritage sites or remains. Section 48 *ff* sets out the procedure for application and granting of permits such as might be required in the event of damage to a protected site occurring as an inevitable result of development. Section 51 (3) sets out the requirements for impact assessment. Part VI Section 55 Paragraphs 3 and 4 require that any person who discovers an archaeological site should notify the National Heritage Council. Heritage sites or remains are defined in Part 1, Definitions 1, as "any remains of human habitation or occupation that are 50 or more years old found on or beneath the surface on land or in the sea".

It is important to be aware that no specific regulations or operating guidelines have been formulated for the implementation of the National Heritage Act in respect of archaeological impact assessment. However, archaeological impact assessment of large projects has become accepted practice in Namibia, especially where project proponents need also to consider international guidelines. In the present case the appropriate international guidelines are those of the World Bank OP/ BP 4.11 in respect of "Physical Cultural Resources" (R2006-0049, revised April 2013). Of these guidelines, those relating to project screening, baseline survey and mitigation are the most relevant.

Archaeological impact assessment in Namibia may also take place under the rubric of the Environmental Management Act (7 of 2007) which specifically includes anthropogenic elements in its definition of environment. The List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007 (Govt Notice 29 of 2012), and the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Govt Notice 30 of 2012) both apply to the management of impacts on archaeological sites and remains whether these are considered in detail by the environmental assessment or not.

3. PROJECT DESCRIPTION

The part of the Equiano project under consideration here includes works performed in laying the undersea cable from where it enters Namibia's Exclusive Economic Zone (EEZ), through Namibian Territorial Waters, and onto land until it reaches the Paratus Cable Landing Station (CLS) in Swakopmund (see Figure 1). On the approaches to the coastline at Swakopmund, the cable will be buried beneath the sandy seabed. This will involve the use of a specially designed plough, submerged onto the seabed by the cable laying ship. Cable is then fed from the ship to the plough which effectively buries the cable to a depth of approximately 1 - 1.5 metres, to protect the cable from the hazards posed by ships' anchors, fishing trawls/lines and the like.

In advance of cable-laying, route clearance operations will be conducted to ensure that the burial operation will not be hindered by out of service cables or discarded fishing gear as well as other debris such as wires and hawsers which may have been deposited on the seabed along the route. The operation is performed only where plough burial is proposed to clear away debris on the seafloor which could obstruct and damage the plough or the new cable, and is carried out by dragging grapnels behind a vessel along the proposed cable route to clear the route of debris. Different types of grapnels can be used depending on the seabed conditions.

The Swakopmund shore-end landing will be performed directly from the main cable installation vessel. In the near shore zone (in waters less than 9 m in depth) external protective measures such as articulated split pipes will be installed around the Equiano cable to guard against damage. Once the cable has made landfall and been buried on the beach section of the cable alignment, the cable will be anchored at the existing BMH manhole. From the BMH, the land cable will be laid to the Paratus CLS to be built on the corner of Kiaat and Tsavorite Streets. The cable will be installed by trenching with the trench having a width of up to 1 m and a depth of up to 2 m in places. Two possible cable alignments were considered ground inspection during the archaeological survey.

4. THE RECEIVING ENVIRONMENT

Background: Due to its aridity, western Namibia including the vicinity of Swakopmund and the Equiano project location, presents a marginal environment for human occupation, and in the past, particularly during periods of climatic cooling and hyper-aridity, the region may have been quite inimical to settlement. These conditions are reflected in the available archaeological evidence, which spans the last 0.8 million years with a sequence that is characterized by short periods of relatively intensive occupation, and long periods in which there appears to have been little or no human presence (see Kinahan 2011).

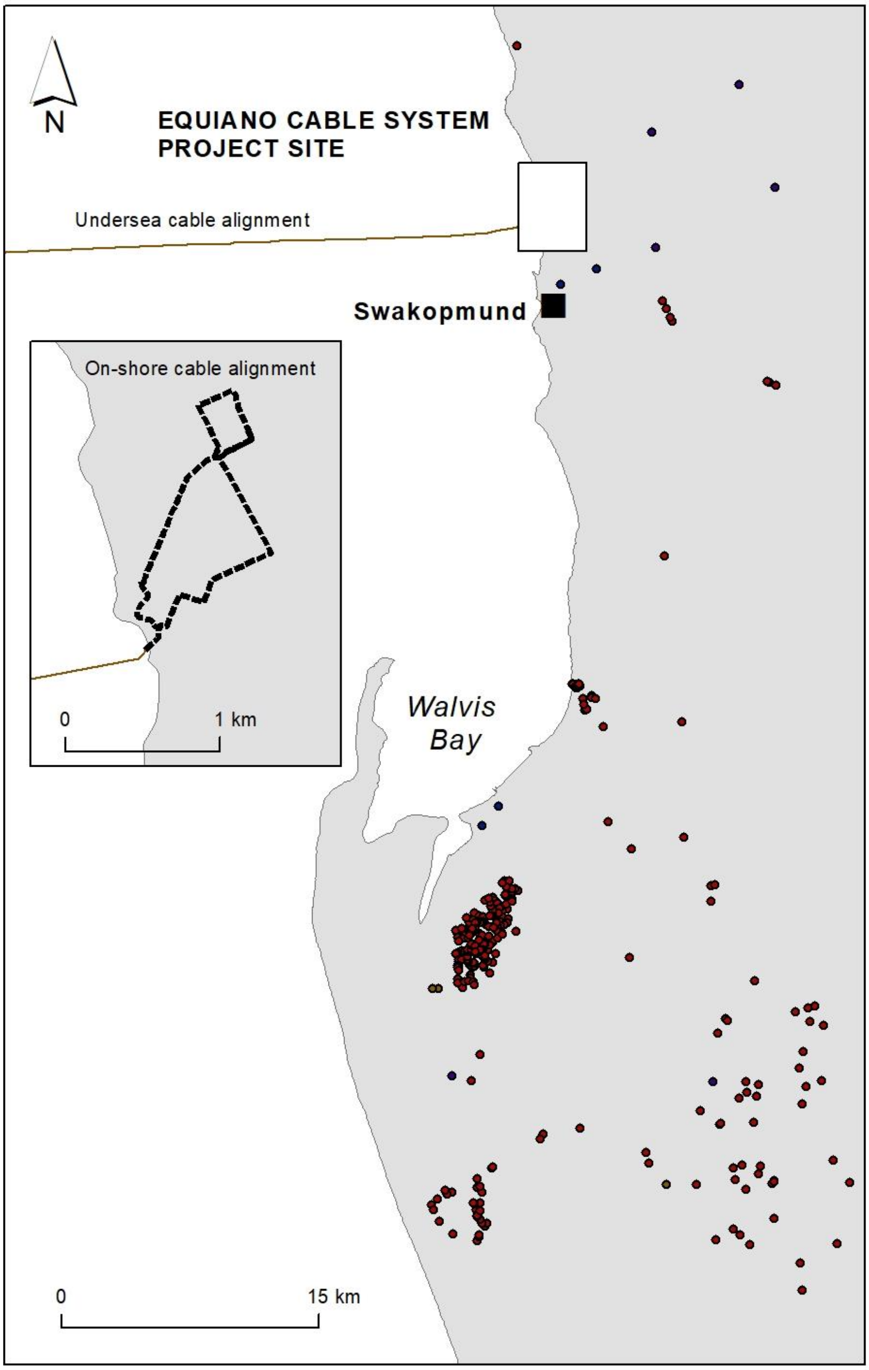

Figure 1: The Equiano project site in relation to known archaeological and heritage sites.

The regional sequence may be simplified as follows:

- Early to mid-Pleistocene (ca. 2my to 0.128my; OIS 6, 7, 19 &c): represented by surface scatters of stone tools and artefact debris, usually transported from original context by fluvial action, and seldom occurring in sealed stratigraphic context.
- Mid- to upper Pleistocene (ca. 0.128my to 0.040my; OIS 3, 4 & 5a-e): represented by dense surface scatters and rare occupation evidence in sealed stratigraphic context, with occasional associated evidence of food remains.
- Late Pleistocene to late Holocene (ca. 0.040my to recent; OIS 1 & 2): represented by increasingly dense and highly diverse evidence of settlement, subsistence practices and ritual art, as well as grave sites and other remains.
- Historical (the last ca. 250 years): represented by remains of crude buildings, livestock enclosures, wagon routes and watering points. Of particular importance in the project area is evidence of early colonial settlement on the northern side of the Swakop River mouth

For the most part, early to mid-Pleistocene sites are associated with pans, outwash gravels, drainage lines and river gravels, although on the Namib coast some mid-Pleistocene sites are associated with relict beach levels (Corvinus 1983; Deacon & Lancaster 1988). These sites are difficult to detect and are usually overlooked in the course of mining or construction work. An example of mid-Pleistocene stone artefacts is illustrated in Figure 2. Mid- to upper Pleistocene sites occur in similar contexts to the earlier material, but hill foot-slopes and outcrops of rock suitable for artefact production (e.g. chert, fine-grained quartzites) are also focal points. Late Pleistocene to late Holocene sites occur in almost every terrain setting, with the exception of very steep slopes and mountain tops (Deacon 1972; Kinahan 2011). These sites often exhibit locally integrated distribution patterns which allow some reconstruction of land-use and subsistence. Major Holocene sites include stratified occupation deposits, containing an array of organic and inorganic residues. Although there are no known sites in the near vicinity of the project area, there are apparent links between the coast and a number of important rock shelter sites in the Namib Desert and on the escarpment. Early historical sites tend to be concentrated along routes suitable for wagon transport, and a more recent, broader landscape distribution associated with colonial settlement.

Finally, although little detailed work has been done so far, coastal and near-coastal sites have yielded important palaeoenvironmental evidence relating to Pleistocene and Holocene sea-level changes and associated changes in the composition of intertidal marine fauna. Thus far, the most detailed work has been carried out on the mid-Holocene Optimum marine transgression with study sites located at Bogenfels and at Anixab (Hottentot Bay) (see Compton 2006, 2007; Kinahan & Kinahan 2009, 2016). These studies have shown that there is considerable potential for further palaeoenvironmental research. It should be noted that the relict beach sites are not strictly speaking protected in terms of the National Heritage Act, despite their research value. Rapid aridification in the late Holocene resulted in significant changes in human settlement patterns in the Namib. Large parts of the desert were unoccupied for several thousand years and in some key environments such as desert inselberge small groups of people continued to live in what amounted to refugium situations.

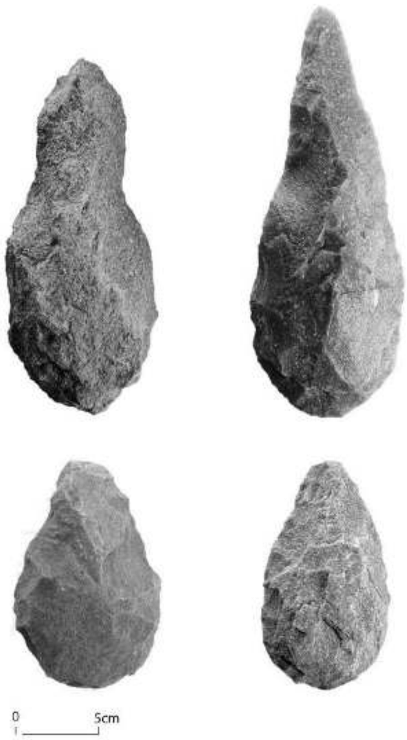

Figure 2: Examples of typical mid-Pleistocene Acheulean handaxes from the Namib Desert.

Significant changes in human settlement patterns and economic activities occurred during the last 5000 years on the Namib coast and in the immediate desert hinterland. These include the development of several specialized subsistence technologies, a shift towards systematic exploitation of marine resources, and in the last 2000 years the adoption of livestock keeping which lead to the emergence of a predominantly nomadic pastoral economy. Finally, increasing contact with visiting merchant vessels during the last 250 years lead eventually to the imposition of colonial rule, lasting from 1884 to 1990 when Namibia achieved national independence.

Available information: No detailed archaeological surveys have been carried out in either the marine or terrestrial components of the intended Equiano project. However, extensive surveys of the Namib Desert have been carried out during the last twenty years and these have established with a high degree of certainty the landscape or terrain associations of archaeological sites dating to within the last one million years. The mid-Pleistocene era is represented in the desert immediately inland of Swakopmund by occasional and dispersed finds of stone tools including handaxes and cleavers. Outcrops of fine grained quartzite and chert are associated with late Pleistocene quarrying activity, while early to mid-Holocene occupation is represented by small scatters of stone tool waste and shellfish remains found among sheltering dolerite boulder outcrops close to the shore. None of the features mentioned here occur within the intended terrestrial component of the Equiano project, and no archaeological remains have been reported.

Historical or colonial heritage sites are almost entirely restricted to the established central business area of Swakopmund which includes a number of well preserved examples that are proclaimed national monuments. The northern parts of Swakopmund including the suburb of Vineta were only developed in the late 1960s, although there have been intermittent developments slightly north of Vineta over the last 50 years involving salt and guano production. The development of the area to be affected by the installation of the terrestrial Equiano cable took place within the last fifteen years. This area does not contain any known archaeological, palaeontological or heritage sites that have been recorded thus far.

While no underwater archaeological surveys have been carried out in the offshore zone immediately north of Swakopmund, there is little possibility of underwater heritage there. Historically, Swakopmund did not have a port or anchorage and people and goods were landed at a jetty constructed in 1905. Ten years later, when Namibia fell under South African rule, the jetty was abandoned in favour of the more convenient port facilities at Walvis Bay. The site of the Equiano cable landfall lies approximately 7.4km north of the historical jetty on a bearing of 11.69°. There are a number of minor embayments and tidal zone outcrops between the two points. Longshore drift, driven by the northward flow of the Benguela Current would be expected to carry any flotsam from the historical jetty area out to sea rather than towards the beach in the area of the Equiano cable landfall. A number of vessels have been lost in the area immediately north of Swakopmund (Robertson *et al* 2012) but there are no beached shipwrecks recorded at the landfall site and no historical records of shipwrecks remaining offshore along the planned cable route towards the landfall site.

<u>Observations:</u> On the basis of documentary records the possibility of underwater heritage of importance within the area to be affected can be dismissed. The Equiano Subsea Cable Network Survey Report (Volume – Segment 24, BMH SWAKOPMUND – BU NAM, Book 1) prepared by Alcatel Submarine Networks includes detailed information on the seabed on the approaches to the Equiano cable landfall site. The seabed data presented in the report are sufficiently detailed to show the configuration of the seabed, including rippled sediment alignments and small solid objects that appear to be rock outcrop. Given the quality of the data which do not reveal any objects of the size and appearance of sunken vessels or parts thereof, or large cargo items, the likelihood of seabed heritage materials on the cable route is negligible.

A foot traverse of the entire route (preferred and alternative) of the on-land cable alignment was made on 30th May 2020. The beach section from the high water mark to the Beach Man Hole BMH consists of unconsolidated beach sand without any indications of archaeological remains. It is possible that these sediments were artificially introduced as part of the landscaping works for the establishment of the recreational harbour at this site. From the BMH, the route proceeds along Kormoran St (dirt), Flamingo St (inter-lock bricks), Fischreiher St (dirt), Dr Schweitering St (tar with dirt verges), Bottle Tree St (tar), Kiaat St (tar), re-joining Dr Schweitering St to negotiate a traffic circle (inter-lock bricks), and returning to the BMH via Tsavorite St (tar with inter-lock brick verges). As far as could be ascertained, the whole of the route (preferred and alternative) covers what is either reclaimed (i.e. artificial) land, or land surface that has been extensively modified for purposes of development. No indications of archaeological or palaeontological remains were observed.

5. IMPACT ASSESSMENT

Following the conventions adopted by the EAP (ACER) for the purposes of integrated assessment, the following heritage discipline specific assessment is offered.

- Direct impacts: None, during construction or operation
- Indirect impacts: None, during construction or operation
- Cumulative impacts: None, during construction or operation
- Nature: No specifically heritage related impacts, therefore not applicable
- Spatial extent: Not applicable
- Duration: Not applicable
- Frequency: Not applicable
- Irreplaceability: Not applicable
- Reversibility: Not applicable
- Significance: Not applicable
- Confidence: High, due to quality of background sources and direct examination of the on-shore alignment

6. CONCLUSIONS & RECOMMENDATIONS

In answer to the six Heritage Impact Assessment primary elements listed in the Terms of Reference, the following conclusions may be drawn.

- No potential impacts on cultural heritage resources were observed in either background sources or direct examination of the on-shore component, including historical sites arising from the construction and operation of the proposed Equiano Cable System (both onshore and offshore).
- The assessment has not identified any red flag and fatal flaw issues or impacts.
- The overview survey, comprising background sources or direct examination of the on-shore component did not identify any heritage resources that may affect construction and operation of the project. Mitigation measures are set out under Recommendations, below.
- Permit requirements will be communicated to the consultant (i.e. Acer, Africa) by either the Environment Commissioner (Ministry of Environment), or the National Heritage Council in the event that the report is referred to the Council for decision.
- The protocol to be followed by Paratus for the identification, protection or recovery of cultural heritage resources during construction and operation, including the completion of all necessary

permit applications, which may be required is set out in the Appendix 1 Chance Finds Procedure. Chance finds noted or recovered during construction and operation of proposed Equiano Cable System are to be reported to the National Heritage Council as per the National Heritage Act (27 of 2004).

It is recommended that on the basis of this assessment the Equiano project has no identified or implied heritage impact implications and should be permitted to proceed. As a precautionary measure however, the project EMP should adopt and implement the Chance Finds Procedure set out in Appendix 1.

7. BIBLIOGRAPHY

Compton, J. 2006. The mid-Holocene sea-level highstand at Bogenfels Pan on the southwest coast of Namibia. *Quaternary Research* 66: 303-310.

Compton, J. 2007. Holocene evolution of the Anichab Pan on the south-west coast of Namibia. *Sedimentology* 54: 55-70.

Corvinus, G. 1983. *The Raised Beaches of the West Coast of South West Africa/Namibia: an interpretation of their Archaeological and Palaeontological Data.* Forschungen zur Allgemeinen und Vergleichenden Archäologie, 5, München: C.H. Beck.

Deacon, H. 1972. A Review of the post-Pleistocene in South Africa. *South African Archaeological Society Goodwin Series* 1: 26-45.

Deacon, J. and Lancaster, N. 1988. *Late Quaternary palaeoenvironments of southern Africa.* Oxford : Oxford University Press.

Kinahan, J. 2011. From the beginning: the archaeological evidence. In Wallace, M. and Kinahan, J. *A history of Namibia: from the beginning to 1990.* London: Hurst & Co., pp 15-44.

Kinahan, J. and Kinahan. J.H.A. 2016. Post-Pleistocene archaeology and geomorphological processes on the Namib Desert coast of southwestern Africa. *Journal of Island and Coastal Archaeology* 12 (1): 65-77.

Kinahan, J.H.A. and Kinahan, J. 2009. 'A thousand fine vessels are ploughing the main...' Archaeological traces of the nineteenth century 'Guano Rage' on the south-western coast of Africa. *Australasian Historical Archaeology* 27: 43–54.

Robertson, A., Jarvis, A., Mendelsohn, J. and Swart, R. 2012. *Namibia's coast: ocean riches and desert treasures.*

Windhoek: Directorate of Environmental Affairs, Ministry of Environment.

Appendix 1: Chance Finds procedure

Areas of proposed development activity are subject to heritage survey and assessment at the planning stage. These surveys are based on surface indications alone, and it is therefore possible that sites or items of heritage significance will be found in the course of development work. The procedure set out here covers the reporting and management of such finds.

Scope: The "chance finds" procedure covers the actions to be taken from the discovery of a heritage site or item, to its investigation and assessment by a trained archaeologist or other appropriately qualified person.

Compliance: The "chance finds" procedure is intended to ensure compliance with relevant provisions of the National Heritage Act (27 of 2004), especially Section 55 (4): *" a person who discovers any archaeological …. object ……must as soon as practicable report the discovery to the Council".* The procedure of reporting set out below must be observed so that heritage remains reported to the NHC are correctly identified in the field.

Responsibility:

Operator	To exercise due caution if archaeological remains are found
Foreman	To secure site and advise management timeously
Superintendent	To determine safe working boundary and request inspection
Archaeologist	To inspect, identify, advise management, and recover remains

Procedure:

<u>Action by person identifying archaeological or heritage material</u>

a) If operating machinery or equipment stop work

b) Identify the site with flag tape

c) Determine GPS position if possible

d) Report findings to foreman

<u>Action by foreman</u>

a) Report findings, site location and actions taken to superintendent

b) Cease any works in immediate vicinity

<u>Action by superintendent</u>

a) Visit site and determine whether work can proceed without damage to findings

b) Determine and mark exclusion boundary

c) Site location and details to be added to project GIS for field confirmation by archaeologist

<u>Action by archaeologist</u>

a) Inspect site and confirm addition to project GIS

b) Advise NHC and request written permission to remove findings from work area

c) Recovery, packaging and labelling of findings for transfer to National Museum

<u>In the event of discovering human remains</u>

a) Actions as above

b) Field inspection by archaeologist to confirm that remains are human

c) Advise and liaise with NHC and Police

d) Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed.

CONSTRUCTION AND OPERATIONS OF THE EQUIANO CABLE SWAKOPMUND, NAMIBIA

SOCIAL IMPACT ASSESSMENT

Assessed by:

Assessed for:

Alcatel Submarine Networks

November 2020

Project:	**CONSTRUCTION AND OPERATIONS OF THE EQUIANO CABLE SWAKOPMUND, NAMIBIA: SOCIAL IMPACT ASSESSMENT**	
Report: Version/Date:	Final November 2020	
Prepared for: (Proponent)	**Alcatel Submarine Networks**	
Lead Consultant	Geo Pollution Technologies (Pty) Ltd PO Box 11073 Windhoek Namibia	TEL.: (+264-61) 257411 FAX.: (+264) 88626368
Main Project Team:	**Quzette Bosman** (BA. Geography/Sociology); (BA (Hons) Environmental Management) **André Faul** (BSc Zoology/Biochemistry; BSc (Hons) Zoology; MSc (For) Conservation Ecology; PhD Medical Bioscience) **Stefan Short** Health and Safety Supervisor / GIS Technician	
Cite this document as:	Bosman Q, Faul A, Short S; 2020 November; Construction and Operations of the Equiano Cable Swakopmund, Namibia: Social Impact Assessment	
Copyright	Copyright on this document is reserved. No part of this document may be utilised without the written permission of Geo Pollution Technologies (Pty) Ltd.	
Report Approval	[signature] **Andre Faul** Environmental Assessment Practitioner	

I Adrian Carter acting as the Proponent's representative, hereby confirm that the project description contained in this report is a true reflection of the information which the Proponent has provided to Geo Pollution Technologies. All material information in the possession of the proponent that reasonably has or may have the potential of influencing any decision or the objectivity of this assessment is fairly represented in this report.

Signed at Cambridge, UK on the 11th day of February 2021

[signature]

Alcatel Submarine Networks

EXECUTIVE SUMMARY

Alcatel Submarine Networks (ASN) was appointed to execute the installation of a new subsea telecommunications cable extending from Europe along the west coast of Africa. A branch of this cable will extend to Namibia. ACER (Africa) Environmental Consultants (ACER) was appointed by ASN to conduct an environmental assessment for the installation and operations of the Namibian branch of the cable while Paratus Telecommunications (Pty) Ltd (Paratus) is the designated landing partner of the Equiano Cable System in Namibia.

As part of the environmental assessment, ACER appointed Geo Pollution Technologies (Pty) Ltd (GPT), a Namibian based company, to conduct a Social Impact Assessment (SIA) for the project. In addition, GPT also conducted the public participation process of the project. This SIA will form part of the environmental assessment, which is ultimately prepared on behalf of Paratus Telecommunications, to apply for an environmental clearance certificate (ECC) for the project.

Possible social impacts stemming from the construction and implementation of the project was assessed on a local and national scale. Construction phase linked impacts can be readily mitigated, while operational impacts have a much wider social sphere of influence. Localised community impacts have been assessed and documented, indicating an overall positive rating for the operational phase. The general perception of the community, which may be affected by the construction phase, remains positive with some concerns. Construction phase activities will constitute the majority of local impacts and relate not only to possible changes in the socio-physical environment, but also to social structures or processes of the community. Such impacts will be of short duration and may be managed and even prevented in many instances.

Operational phase activities sees the cable realising its purpose in strengthening the current telecommunication network in Namibia. Mainly linked to the telecommunication network, is the internet, providing with it a range of social and economic opportunities. However, also linked to the internet and telecommunications, are security and social challenges, which may translate into criminal activities in a wide range of forms. Therefore, additional development in terms of national cyber security and related social services, will be required. Such initiatives are not required by / or, the responsibility of the Proponent, but rather national governing bodies.

The project will contribute to the social well-being of Namibia as a whole. Social impacts are deemed manageable. No community objections were received and it is not foreseen that the project will be rejected or hampered by the public.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ASN	Alcatel Submarine Networks
ECC	Environmental Clearance Certificate
EMA	Environmental Management Act, 2007 (Act No. 7 of 2007)
EMP	Environmental Management Plan
EMS	Environmental Management System
GDP	Gross Domestic Product
GIS	Geographic Information System
GPT	Geo Pollution Technologies (Pty) Ltd
IAP	Interested and Affected Party
Km	Kilometre
m	meter
PPE	Personal Protective Equipment
SADC	Southern African Development Countries
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
WHO	World Health Organization
WACS	West Africa Cable System
BMH	Beach Man Hole

GLOSSARY OF TERMS

Alternatives - A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Assessment - The process of collecting, organising, analysing, interpreting and communicating information relevant to decision making.

Biodiversity - The variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part.

Census - A canvass of a given area, resulting in an enumeration of the entire population and often the compilation of other demographic, social, and economic information pertaining to that population at a specific time

Competent Authority - means a body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

Cumulative Impacts - in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Demography - The scientific study of human populations, including their sizes, compositions, distributions, densities, growth, and other characteristics, as well as the causes and consequences of changes in these factors.

Ethnicity - The cultural practices, language, cuisine, and traditions — not biological or physical differences — used to distinguish groups of people

Environment - As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values".

Environmental Assessment (EA) – Namibian terminology for a process of assessing the effects on the environment through either a Scoping Assessment or a combination of a Scoping- and Detailed Assessment.

Environmental Management Plan (EMP) - A working document on environmental and socio-economic mitigation measures, which must be implemented by several responsible parties during all the phases of the proposed project.

Environmental Management System (EMS) - An Environment Management System, or EMS, is a comprehensive approach to managing environmental issues, integrating environment-oriented thinking into every aspect of business management. An EMS ensures environmental considerations are a priority, along with other concerns such as costs, product quality, investments, PR productivity and strategic planning. An EMS generally makes a positive impact on a company's bottom line. It increases efficiency and focuses on customer needs and marketplace conditions, improving both the company's financial and environmental performance. By using an EMS to convert environmental problems into commercial opportunities, companies usually become more competitive.

Evaluation – means the process of ascertaining the relative importance or significance of information, the light of people's values, preference and judgements in order to make a decision.

Gender - refers to the economic, social, political, and cultural attributes, constraints and opportunities associated with being a woman or a man. The social definitions of what it means to be a woman or a man vary among cultures and change over time. Gender is a sociocultural expression of particular characteristics and roles that are associated with certain groups of people with reference to their sex and sexuality.

Hazard - Anything that has the potential to cause damage to life, property and/or the environment. The hazard of a particular material or installation is constant; that is, it would present the same hazard wherever it was present.

The Human Development Index (HDI) - is a statistic composite index of life expectancy, education (Literacy Rate, Gross Enrollment Ratio at different levels and Net Attendance Ratio), and per capita income indicators, which are used to rank countries into four tiers of human development

Human Immunodeficiency Virus (HIV) - Retrovirus that infects cells of the immune system, destroying or impairing their function. As the infection progresses, the immune system becomes weaker, and the person becomes more susceptible to infections. HIV is transmitted through unprotected sexual intercourse, transfusion of contaminated blood, sharing of contaminated needles, and between a mother and her infant during pregnancy, childbirth and breastfeeding.

In-migration - The process of entering one administrative subdivision of a country (such as a province or state) from another subdivision to take up residence

Interested and Affected Party (I&AP) - any person, group of persons or organisation interested in, or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity.

Migration - The movement of people across a specified boundary for the purpose of establishing a new or semi-permanent residence. Divided into international migration (migration between countries) and internal migration (migration within a country).

Mitigate - The implementation of practical measures to reduce adverse impacts.

Proponent (Applicant) - Any person who has submitted or intends to submit an application for an authorisation, as legislated by the Environmental Management Act no. 7 of 2007, to undertake an activity or activities identified as a listed activity or listed activities; or in any other notice published by the Minister or Ministry of Environment & Tourism.

Population Density - Population per unit of land area; for example, people per square mile or people per square kilometre of arable land.

Population Increase The total population increase resulting from the interaction of births, deaths, and migration in a population in a given period of time.

Public - Citizens who have diverse cultural, educational, political and socio-economic characteristics. The public is not a homogeneous and unified group of people with a set of agreed common interests and aims. There is no single public. There are a number of publics, some of whom may emerge at any time during the process depending on their particular concerns and the issues involved.

Scoping Process - process of identifying: issues that will be relevant for consideration of the application; the potential environmental impacts of the proposed activity; and alternatives to the proposed activity that are feasible and reasonable.

Significant Effect/Impact - means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment

Stakeholder Engagement - The process of engagement between stakeholders (the proponent, authorities and IAPs) during the planning, assessment, implementation and/or management of proposals or activities. The level of stakeholder engagement varies depending on the nature of the proposal or activity as well as the level of commitment by stakeholders to the process. Stakeholder engagement can therefore be described by a spectrum or continuum of increasing levels of engagement in the decision-making process. The term is considered to be more appropriate than the term "public participation".

Stakeholders - A sub-group of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term therefore includes the proponent, authorities (both the lead authority and other authorities) and all interested and affected parties (IAPs). The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

Sustainable Development - "Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations" – the definition of the World Commission on Environment and Development (1987). "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" – the definition given in a publication called "Caring for the Earth: A Strategy for Sustainable Living" by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme and the World Wide Fund for Nature (1991).

1 INTRODUCTION

The Equiano Cable System is a new subsea cable that will serve as an additional digital link between western Africa and Europe. The Equiano Cable System, which will extend from Portugal to South Africa along the west coast of Africa, will have several branching units. These branching units extend to additional African countries, including Namibia. Paratus Telecommunications (Pty) Ltd (Paratus) is the designated landing partner of the Equiano Cable System in Namibia. The Namibian partner is licensed to operate international telecommunications infrastructure in the country and will obtain local permits to land the Equiano Cable System at Swakopmund.

Alcatel Submarine Networks (ASN) was appointed to execute the installation of the cable. ACER (Africa) Environmental Consultants was appointed by ASN to conduct an environmental assessment for the installation and operations of the Namibian branch of the cable. The environmental assessment is required as per the Namibian Environmental Management Act No. 7 of 2007 (EMA). ACER in turn requested Geo Pollution Technologies (Pty) Ltd, a Namibian environmental consulting firm, to conduct a Social Impact Assessment (SIA) for the land-based component of the project. The SIA will form part of the environmental assessment, which is ultimately prepared on behalf of Paratus Telecommunications, to apply for an environmental clearance certificate (ECC) for the project.

This SIA will serve to inform and contribute to socially responsible investment initiatives and contribute to ASN's commitment to the United Nations Millennium Development Goals for the communities within which they operate and affect. The SIA reaches far beyond statutory public participation procedures which focuses on informing the public to allow them a matter of say about planned activities. It is a research and analytical process which intends to influence decision making and the management of social issues related to the project development. As per the International Association of Impact Assessors (IAIA), Social Impact Assessors may ascribe to a set of ethics which is internationally accepted in the Social Impact Assessors fraternity. Geo Pollution Technologies (Pty) Ltd have committed to this set of ethics as may be viewed in Appendix A.

2 PROJECT DESCRIPTION

Submarine fibre optic cables are important for international telecommunications networks, transporting almost 100% of transoceanic internet traffic throughout the world. This is significant, because it is widely recognized that access to affordable international bandwidth, is key to economic development in every country. Improvement in Africa's information technology infrastructure via telecommunications cables is expected to remove one of the current key inhibitors to development in Africa and support economic growth and opportunities on the continent. With the landing of the Equiano Cable System, Namibia will benefit from enhanced capacity and reliability of services such as telecommuting, high definition (HD) television broadcasting, internet services, video conferencing, advanced multimedia and mobile video applications.

Information regarding the exact planned activities required for the development was obtained from the project instructing agent, ACER (Africa) Environmental Consultants. The Equiano Cable System will be constructed and operated in a similar fashion to that of the existing West Africa Cable System (WACS) which was installed in 2010. Although the SIA is focussed on the land-based section of the Equiano Cable System, a brief description of the entire project is provided for purposes of completeness.

The main Equiano Cable System trunk will be located approximately 500 km from the shoreline in international waters. Branch cables will run from the main trunk to the shoreline, through territorial waters, to the beach landing site in each country. The final route of the marine portion of the cable will be identified based on a combination of engineering, environmental and economic factors; however, the general alignment of the Equiano Cable System will follow the WACS submarine cable alignment in the Exclusive Economic Zone. The cable will reach the shore just south of the Platz Am Meer shopping mall and commercial centre in Swakopmund' s Vineta North suburb. Land alignment options are focussed from the Hage Heights suburb into Extension 15 where the cable landing station is located (corner of Kiaat and Tsavorite (Figure 2-1).

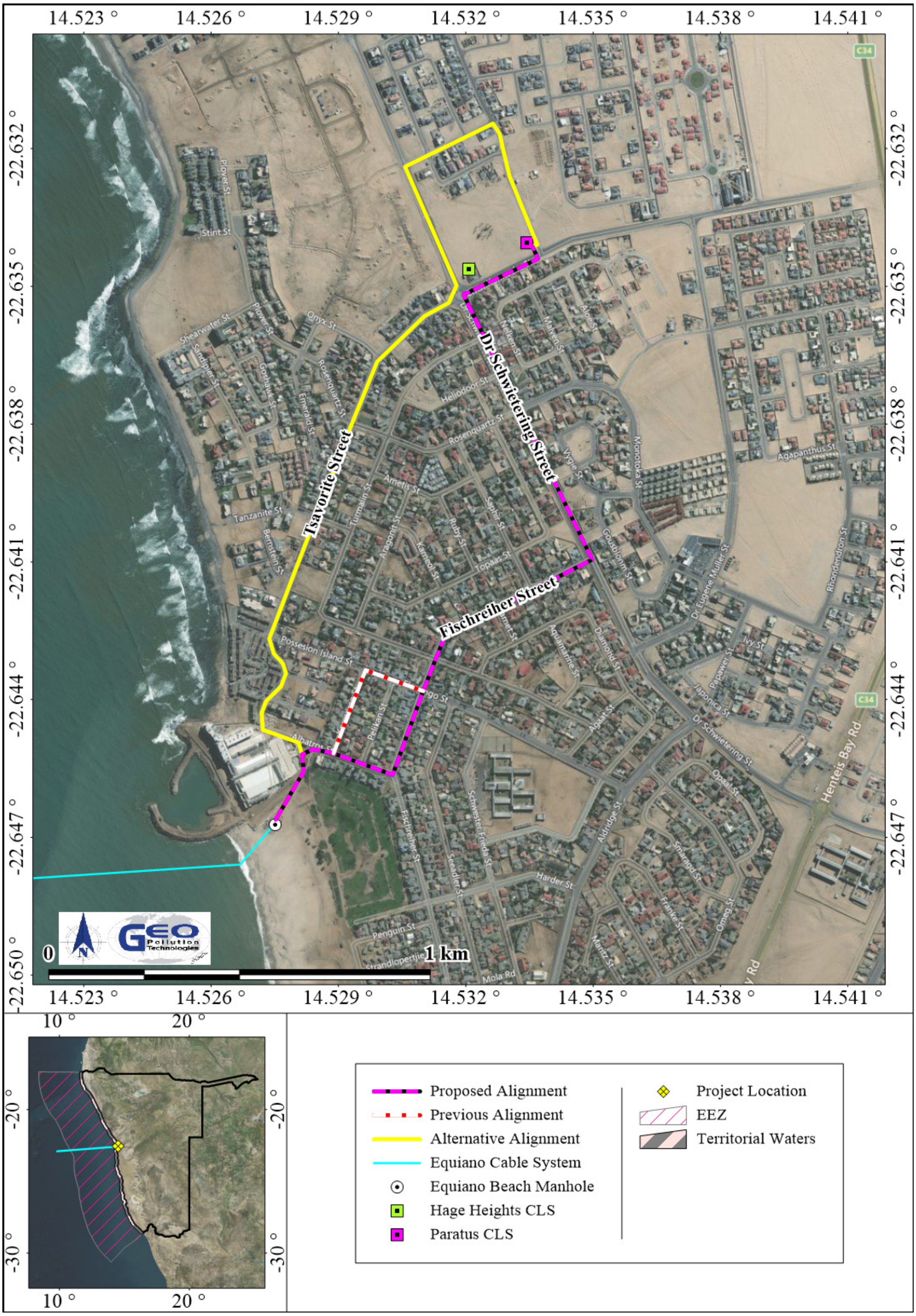

Figure 2-1. Project location

The onshore portion of the proposed Equiano branching unit to Swakopmund will include the installation and operation of the following project components:

- Laying of the cable in the offshore environment, including cable burial (1 – 1.5 m meter below the seabed) to a water depth of 1,500 m. The proposed Equiano Cable System: Namibia Branch, will run perpendicular to the coast from the main cable to the landing point at Swakopmund and approaches Namibian coastal waters from the west (i.e. from international waters).
- Within the shallow water environment, the cable will be buried in sediment wherever possible and the route will be adjusted to avoid obvious visible rock. The aim is to bury the cable to a depth of 1 m where possible.
- Excavations within the intertidal zone to bury the cable before being installed into the beach man hole (BMH) which will be constructed directly inland of the beach at the preferred landing point.
- On the beach, the cable will be buried to a depth of 2 m, substrate permitting.
- Construction of a BMH at the preferred landing point. The BMH will be constructed underground and will have the following dimensions: length (approximately 4.0 m); breadth (approximately 2.0 m) and depth (approximately 2.0 m).
- At the BMH, the marine section of the Equiano cable will be connected to the terrestrial section of the cable. The terrestrial cable will be buried along the sidewalk of an existing traffic route (road). The laying of the cable will entail the digging of a narrow trench (of about 45 cm in width) on the sidewalk of the road. The Equiano Cable System will be laid therein. For instances where there is pavement/interlocks etc., the paving will be lifted and replaced once the cable is laid. At tarred or cement entrances, the tar/cement will be lifted and the area re-tarred or re-cemented (sealing the surface which was disrupted). All operations will be conducted as per all Municipal requirements and consideration to existing utilities within the sidewalk.
- The terrestrial cable is proposed to be connected to a new cable landing station (CLS), planned to be constructed by Paratus, near the existing WACS Colocation (Hage Heights) in Swakopmund (Figure 3). The CLS, comprising of a small building, will serve as the Equiano Cable System's telecommunications distribution point

The above listed activities will be conducted in a phased approach. These include pre-installation, installation, operation and decommissioning. Each of these phases are detailed below.

2.1 PRE-INSTALLATION

A detailed survey of the sea bottom and geology will be undertaken to inform the cable route along the proposed cable alignment. Also, a survey will be conducted at the landing site to determine the final shore alignment of the cable to the BMH at Swakopmund. During this phase, all permitting and legislative requirements related to the installation and operation of the Equiano Cable System will be initiated. It include the application for an ECC and authorities approvals. Labour requirements during pre-installation relate mostly to the service sector and highly skilled labour. Professional services are employed nationally and internationally to consider the project feasibility, conduct planning and mostly generate information to inform the project execution. During this phase, in-house labour resources will be allocated to the project for the international and local partners. Additional services in the local, professional sector will be employed where available.

2.2 INSTALLATION

The Equiano cable will be installed using a purpose-built cable ship. The burial technique used depends on the seabed conditions and site-specific biophysical conditions. A highly skilled international team will conduct the work, supplemented with local service providers where possible.

From the surf zone, the Equiano cable will be buried along a route up to the beach (by manual labour or excavating machinery). From the beach, it will be buried and anchored to a BMH located behind the beach. A narrow trench to the BMH will be dug to bury the cable. Where necessary, the cable will be placed in a conduit or articulated pipes to protect it from external damage that may be caused by abrasion or other physical contact. Labour requirements for the laying of the cable will require a skilled and semi-skilled workforce, most of which will be contracted locally.

2.3 OPERATION

Once installed and operational, the cable will not require routine maintenance. If the cable is damaged or needs repair, the damaged portion of the cable can be retrieved and repaired or replaced. The local landing partner will operate the land based telecommunications infrastructure and provide all labour requirements.

2.4 DECOMMISSIONING

At the end of the cable lifetime (approximately 25 years) it is likely that the cable will remain in place, or in some places it may be removed. The terrestrial components, such as the BMH and cable station may be reused for a new submarine cable or an alternate purpose.

3 ALTERNATIVES

During the deployment of the project, various alternatives were considered in terms of their environmental, technical and social suitability. At the time of the compilation of this report, most of the alternatives could be ruled out with the only remaining deliberations centred on the route of the terrestrial section of the cable, between the BMH and the CLS. A brief description of the most pertinent alternatives are presented below.

3.1 BEACH LANDING SITE ALTERNATIVES

Two beach landing site alternatives (BMH locations) in Swakopmund were considered for the landing of the Equiano Cable System Namibia Branch, viz. the Paddock Gardens and Baobab Avenue beach landing alternative (Figure 3-1). Of the two beach landing points, the preferred option is Paddock Gardens. The Baobab Avenue beach landing alternative is not viable given the risk of changing beach profiles and possible damage to the Equiano Cable System during the operations phase. The site has a rock shoreline and mobile beach profile.

Figure 3-1. Baobab Avenue alternative beach landing site (BMH)

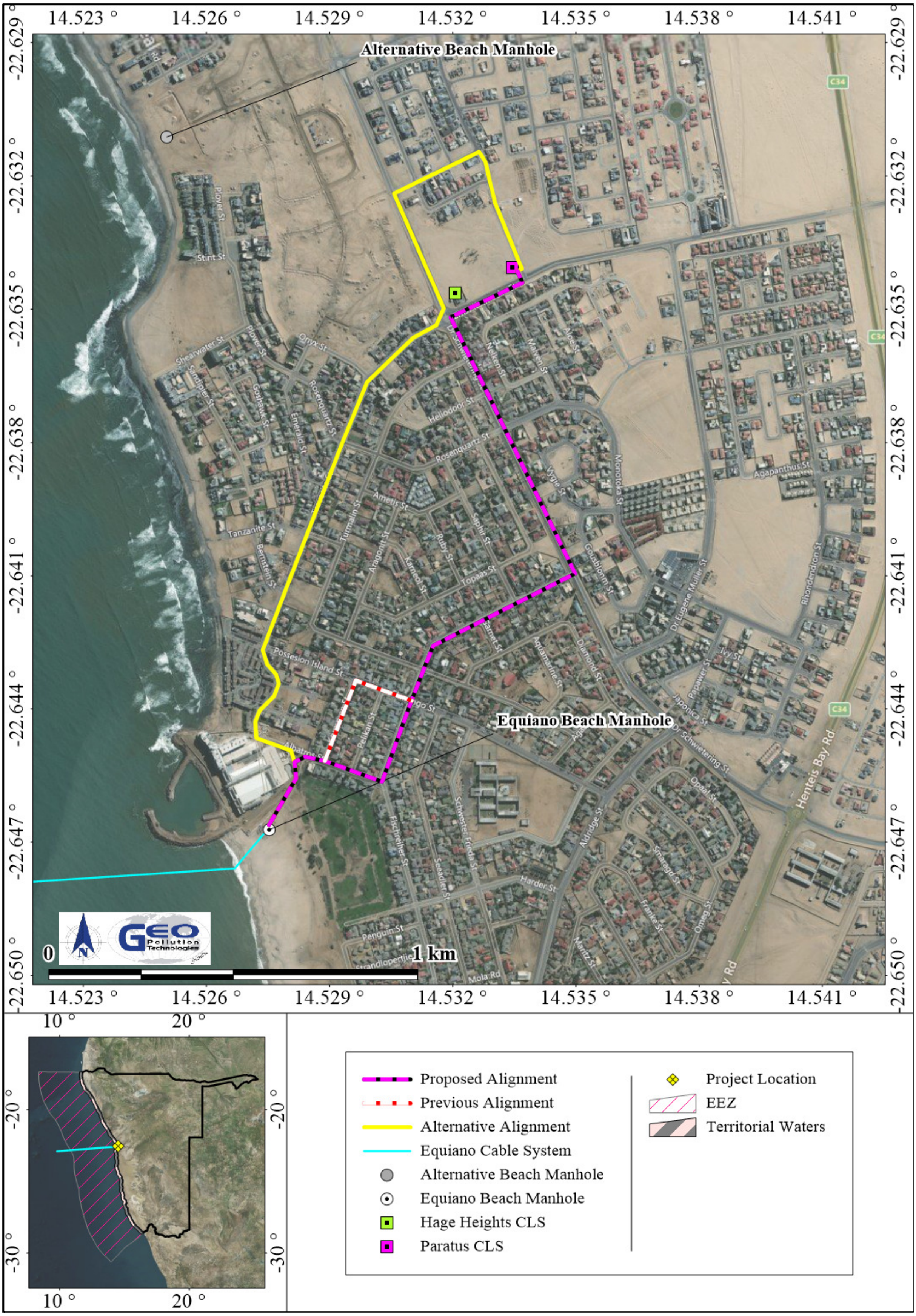

Figure 3-2. Location of alternatives on-shore alignments and beach landing sites

3.2 CABLE LANDING STATION SITE AND ON-SHORE ALIGNMENTS

From the proposed BMH at the Paddock Gardens beach landing site, two alternatives for the terrestrial cable alignment to the proposed CLS site were considered. The different routes are depicted in Figure 3-2. No biophysical constraint/factors which could constitute a fatal flaw were identified during screening, which could preclude the installation of the Equiano Cable System. Neither could any social constraints be identified that would render any route not feasible. The preferred alignment is mainly along Tsavorite Street and has the advantage of being a more direct route to the CLS. This minimises impacts on surrounding residents during construction (shorter construction period) and reduces risks during operation (reduced maintenance requirements). A small deviation from the former alignments is indicated as the previous alignment. The deviation motivation should be indicated in the environmental assessment. The final alignment alternatives will be communicated in the environmental assessment. For the purposes of the SIA, the entire area as a whole was considered. Therefore a qualitative and quantitative survey was conducted for both major alignment alternatives.

4 METHODOLOGY

The research approach to this assessment comprised quantitative and qualitative components. Various interviews were held with members of community. Due to Covid-19 safety precautions and considerations, meetings were not held in person, but rather electronically. This presented some challenges as electronic surveys are notorious to be unwelcome, especially in social structures where time is of high value. Interviews in person instil a greater feeling of trustworthiness and compliance. Interviews were mainly held with a sample set of the property owners along the various alternative routes. During interviews and discussion, all participants were made aware of their rights and permission requested to conduct a brief interview. The purpose and goals of the project and this SIA were communicated and it was made clear to community members that participation was purely voluntary and that they could refuse any question or deny any information or even participation at any time. Care was taken to be gender sensitive during interviews. All participants were further made aware of their right to take any grievance about the proposed project and the SIA to the relevant team leaders and/or company representative and additional information regarding this was provided to them mostly electronically.

4.1 QUANTITATIVE COMPONENT

A document review of information provided regarding the proposed project and a desktop review of the Swakopmund community were conducted from which a questionnaire was compiled. The desktop and document review further provided a clear view of the proposed project. The questionnaire was designed to generate information about the property details and related occupants. It considered general data such as the gender of the survey person, age group, dwelling type, access to piped water, electricity, etc. It also aimed at obtaining the economically active status of the participant. This section of the survey also considered the presence of any disabled or special needs persons, historical or culturally sensitive resources, and related features. Data generated by the sample set of interviews which were conducted throughout the identified affected areas (including various alternatives) and on various levels, was used during the community profiling and socio-economic analysis (as baseline statistics). During the interviews held, no contact or personal information was required, rendering each interview anonymous. Care was taken to ensure confidentially as interviews were conducted on a one on one basis.

4.2 QUALITATIVE COMPONENT

As part of the interviews held, the questionnaire had a qualitative component wherein interviewees were provided an opportunity to give their opinions about the project and highlight concerns, or ask questions regarding the project, SIA or process. The subjective nature of opinions provide for a qualitative components. This data was used during impact assessment and further used considering possible mitigation measures for the project. This component further highlighted some concerns which could be investigated during the environmental assessment.

Therefore such concerns were already provided to the project team, prior to the finalisation of this SIA.

The above interviews and discussions proved insightful in providing a comprehensive impression of perceived similar activities being conducted in the area. It also highlighted sensitive community areas. Both qualitative and quantitative interviews (in combination with the public participation process), enabled an inclusive participatory processes and deliberative spaces to help community members:

- Understand how they will be impacted;
- Determine the acceptability of likely impacts and proposed benefits (as discussed during qualitative interviews);
- Make informed decisions about the project (to be conducted during the review of the SIA and environmental assessment);
- Facilitate community visioning about desired futures (as mentioned in the various qualitative assessment components);
- Contribute to mitigation and monitoring plans (as community suggestions to management of construction impacts have been incorporated); and
- Prepare for change (as communities are engaged with and informed about the proposed project in the community, which may contribute to social change processes).

The work conducted above was facilitated by site visits and telephonic discussions. The community profile was developed to include:

- A thorough stakeholder analysis (desk-top review and community site visit);
- An assessment of the differing needs, interests, values and aspirations of the various subgroups of the affected communities; and
- A discussion of internet use related trends happening in those communities.

Once all of the data could be captured and analysed, key social norms and human rights issues related to the project, in relation to the greater and unique community setting could be identified. Once the issues have been identified, social changes and impacts could be predicted and rated according to significance. The project is not foreseen to contribute to social change within the community, however, the cumulative nature of all impacts associated with the project was considered as part of community impacts. Possible mitigation or enhancement measures were identified and listed in the report. Based on these findings, suggested management measures have been recommended as to be incorporated into the Proponent's environmental management system (EMS) in an effort to monitor the social change processes and community health.

4.3 STAKEHOLDER IDENTIFICATION

Communities are integrated and complex structures that are linked and interdependent on various levels. Generally understood to be a group of people who share something in common such as norms, values and often a sense of place, which are located in a given geographical area. Modern views, place heavier emphasis on communal challenge experiences, than geographical location. In Swakopmund the community is largely knit together through common living condition similarities and social structure. The combined factors, set within the unique cultural context and geographic location, promotes a sense of community and unity. The localised community, has been considered, for the purposes of this assessment, as one of the groups to be affected by activities which may impact social change processes. The other group being the national users of telecommunications. The unique social fabric is largely built on independent units within the community, augmented with limited interdependence between community components. Consequently, should there be a factor which can have an impact on any portion of the community, it may affect the entire community, however, not to the same extend as that of a more interdependent community. In other words, the community is less reliant on their neighbours and community structures than other communities.

5 APPLICABLE LEGAL FRAMEWORK AND STANDARDS

Although Namibia has no specific guidelines or policies to guide factors and activities which may bring about social change processes, there is a matrix of provisions which may be applied as developed by integrating various laws which may be pertinent to human environmental conditions and rights. The most pertinent legislations sets considered during this assessment are listed below.

5.1 NAMIBIAN CONSTITUTION

The Constitution of the Republic of Namibia, 1990.

Article 100 of the Constitution vests all natural resources in the State, unless otherwise legally owned. Thus, unless legal ownership to natural resources in a specific locality is proven, such natural resources are owned by the State. The provision thus implies that natural resources can be legally owned as private property.

Article 95 (l) stipulates that the state shall actively promote and maintain the welfare of the people by adopting policies which include the: “management of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis for the benefits of all Namibians…”. With this particular Article, Namibia is obliged to protect its environment and to promote a sustainable use of its natural resources. Further to these environmental key provisions, Article 144 must be pointed out as the constitutional link to international environmental law applicable in Namibia and which provides that: “Unless otherwise provided by this Constitution or Act of Parliament, the general rules of public international law and international agreements binding upon Namibia under this Constitution shall form part of the law of Namibia.”

This article recommends that a relatively high level of environmental protection is called for in respect of groundwater utilization, management, pollution control and waste management. “Environmental” being defined to include the social sphere “human environment” as defined by the Environmental Management Act, No. 7 of 2007 as listed below.

5.2 ENVIRONMENTAL MANAGEMENT ACT OF NAMIBIA (2007)

The Act provides a broad definition to the term “environment” - land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values.

5.3 PUBLIC AND ENVIRONMENTAL HEALTH ACT

Act No. 1 of 2015, Government Notice No. 86 of 2015 Provides a framework for a structured more uniform public and environmental health system, and for incidental matters. The Act has not yet been enforced and will largely serve to replace the Public Health Act No. 36 of 1919 which provides for the protection of health of all people.

The objects of this Act are to -

- promote public health and wellbeing;
- prevent injuries, diseases and disabilities;
- protect individuals and communities from public health risks, and
- encourage community participation in order to create a healthy environment; and provides for early detection of diseases and public health risks.

5.4 LABOUR ACT OF 2007

Provides for Labour Law and the protection and safety of employees. The project will mostly require labour during the planning and construction phases, with no significant labour requirements identified for operational phase.

5.5 GUIDELINES FOR INTEGRATING HIV AND GENDER RELATED ISSUES INTO ENVIRONMENTAL IMPACT ASSESSMENTS FOR CAPITAL PROJECTS IN NAMIBIA

Although the project is not considered to be a capital project, the Guidelines for Integrating HIV and Gender Related Issues into Environmental Impact Assessments for Capital Projects, was considered for the project in terms of best practise. The guidelines provide management practises, as guided by various acts and policies, which should be considered in the EMP. The guidelines in particular incorporate the National Gender Policy (2010-2020) of March 2010 which aims to achieve gender equality and empowerment of women in the socio-economic, cultural and political development of Namibia. This is especially pertinent for the construction industry which does not employ as many women as men.

5.6 UNITED NATIONS: UNIVERSAL DECLARATION OF HUMAN RIGHTS

Telecommunication networks provide a platform for the use of the internet. Access to internet services has been declared a human right by the United Nations, in the sense that such access should be unmonitored and uncensored. The declaration is based on the fact that the internet has become 'a key means' by which individuals can exercise their right to freedom of opinion and expression, as stated in Article 19 of the Universal Declaration of Human Rights and the International Covenant on Civil and Political Rights (https://www.un.org/en/universal-declaration-human-rights/index.html). In a resolution adopted by the UN Human Rights Council (2016), the following objective is noted about internet access:

"Stressing the importance of applying a comprehensive human rights-based approach when providing and expanding access to the internet and for the internet to be open, accessible and nurtured by multi-stakeholder participation"

The resolution further:

"Recognizes the global and open nature of the internet as a driving force in accelerating progress towards development in its various forms, including in achieving the Sustainable Development Goals"

The project will contribute to sustainable access to the internet (telecommunications) while also contributing to improved internet access in Namibia.

6 DESCRIPTION OF SOCIAL BASELINE & COMMUNITY PROFILE

Prior to establishing possible social change processes and related impacts, a description of the baseline community is required against which change may be measured. Although some social aspects are frequently considered to be subjective in nature, definite community trends can be identified and various demographic aspects listed.

6.1 REGIONAL DESCRIPTION AND DEMOGRAPHIC PROFILE

Swakopmund is located in the Swakopmund Constituency, one of the seven electoral constituencies that make up the Erongo Region of Namibia. The council and administrative headquarters for the Erongo Region are located in Swakopmund, which also houses the administrative centre of the Municipality of Swakopmund. The town is located approximately 350 km west of the national capital, Windhoek.

The Erongo Region is one of the best developed regions in Namibia. It accommodates large mining industries, the majority of the fishing industry and popular tourism destinations. The distribution of people is however varied, as expected, with the urban centres having a much higher density than the rural parts of the region, especially taking into consideration the vast, mostly inhospitable, Namib Desert that forms a large part of the Erongo Region. It is bordered by the Kunene-, Otjozondjupa, Khomas- and Hardap Regions of Namibia, with the name giving prominence to Mount Erongo.

According to the census data of 2011, it is estimated that the region has a literacy rate of 97%, while services such as water, electricity and sanitation have been deemed to be accessible to the majority of its inhabitants.

Natural resource development is facilitated by well-established infrastructure throughout the region. The fishing and uranium mining industries contribute largely to the region's Gross Domestic Product (GDP). However, other resources such as salt- and aggregate mining also contribute, albeit to a lesser degree. The mining and fishing industries are centred on Walvis Bay and the recently upgraded Port of Walvis Bay. Walvis Bay has a strong industrial sector which is related to the harbour. Port activities and development of the natural resources in the region (including, uranium, salt and fish); have contributed significantly to the economy. Similarly the tourism and hospitality sector employs a large portion of the economically active workforce. The region has been classified as a "mid-range" region according to the Human Development Scale of the International Human Development Index (https://globaldatalab.org). In recent years the benefits-to-community of resource development in the region, has been hampered by corruption and nepotism. In the mining sector more foreign labourers are employed, while the allegedly fraudulent distribution of fishing quotas has resulted in many job losses. Such reduction in the economic profile of the area has had a definite effect on social change processes. In addition, it increased the inequality margin of the region as a whole. Although Swakopmund has been affected, the impacts on the community has not been as severe as the impacts on the Walvis Bay urban community in the Erongo Region. In contrast, the Covid-19 pandemic had a much greater impact on the Swakopmund community, which is much more reliant on the tourism sector. This sector has seen an almost complete collapse for the first three quarters of 2020.

Table 6-1. Summary of the demographic profile of the region, compared to the Swakopmund constituency, according to the 2001 Census

Demographic Variable	**Erongo Region**				**Swakopmund Constituency**
Population	150,809 (Female: 48% Male: 52%)				44,725 (Female: 48% Male: 52%)
Literacy Rate	97%				99%
Population Growth Rate	3.4%				*
Fertility (Average number of children per woman)	1.8				1.7
Population Distribution	**Urban**	87%	**Rural**	13%	Constituency is in Urban Area
Employment Rate	70%				74%
Access to Piped Water Inside Home	56%				56%
No Toilet Facility	10%				3%
Energy for Cooking	Municipal electricity 76%				Municipal electricity 80%
* Data not available					

6.2 LOCAL AMENITIES

All administrative and municipal functions for the Swakopmund Constituency are performed from Swakopmund. It is a centre with many cultural and historical resources, many of which exemplify German colonial architecture, especially in the city core. The city is divided into various suburbs and the project location (inclusive of all alternative routes,) can potentially affect nine residential areas including Vineta, Hage Heights Ocean View and their extensions (Figure 6-1).

Utilities and services to these areas are provided mainly by the Swakopmund Municipality. Such services include electricity and water provision. There is a government school south of the project area, but no state-owned health facilities. A private subacute and rehabilitation hospital is located east of the CLS with some private health-related outlets in the commercial Ocean View Shopping Centre and Platz Am Meer Mall (Figure 6-2).

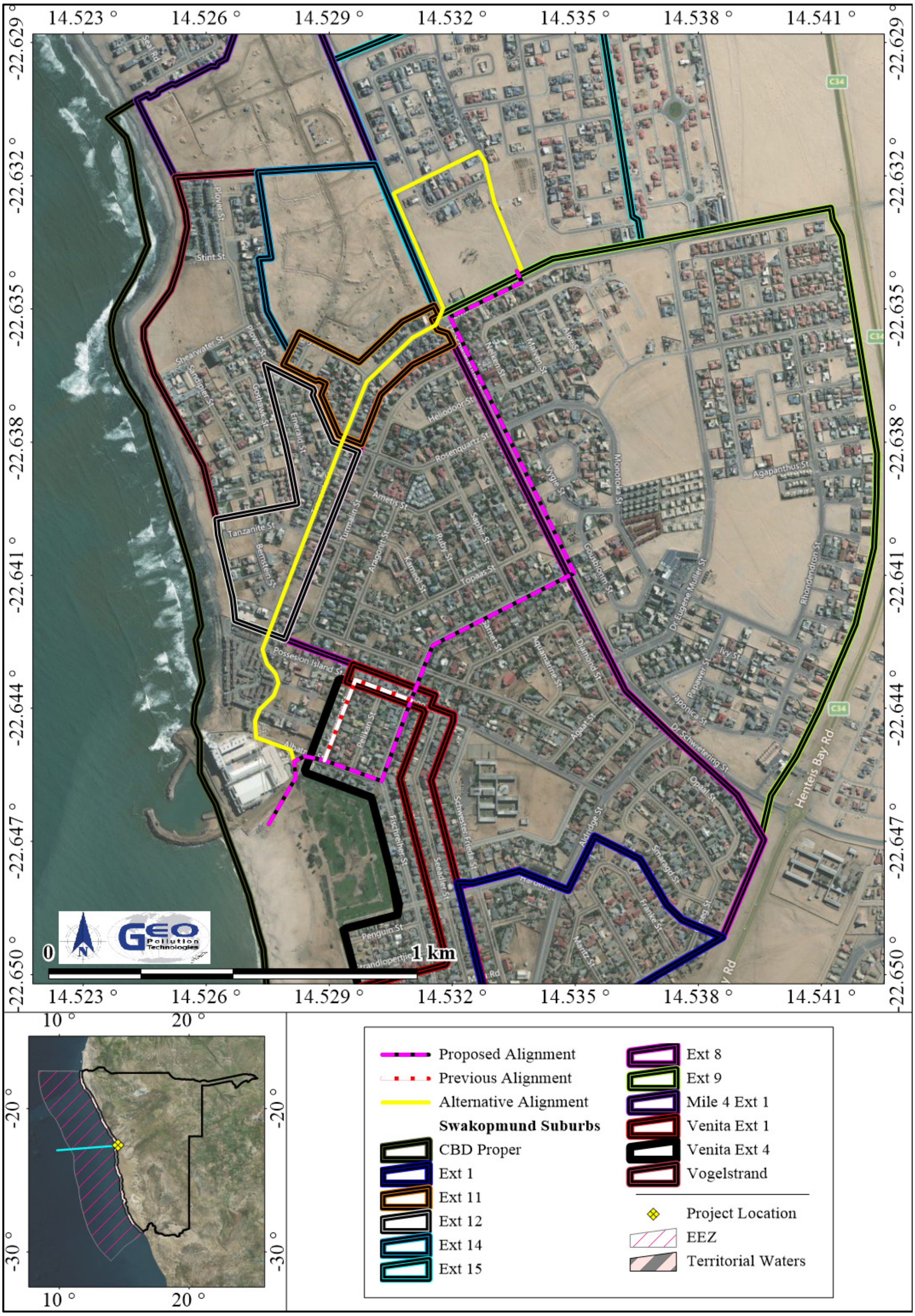

Figure 6-1. Swakopmund suburbs in the project area

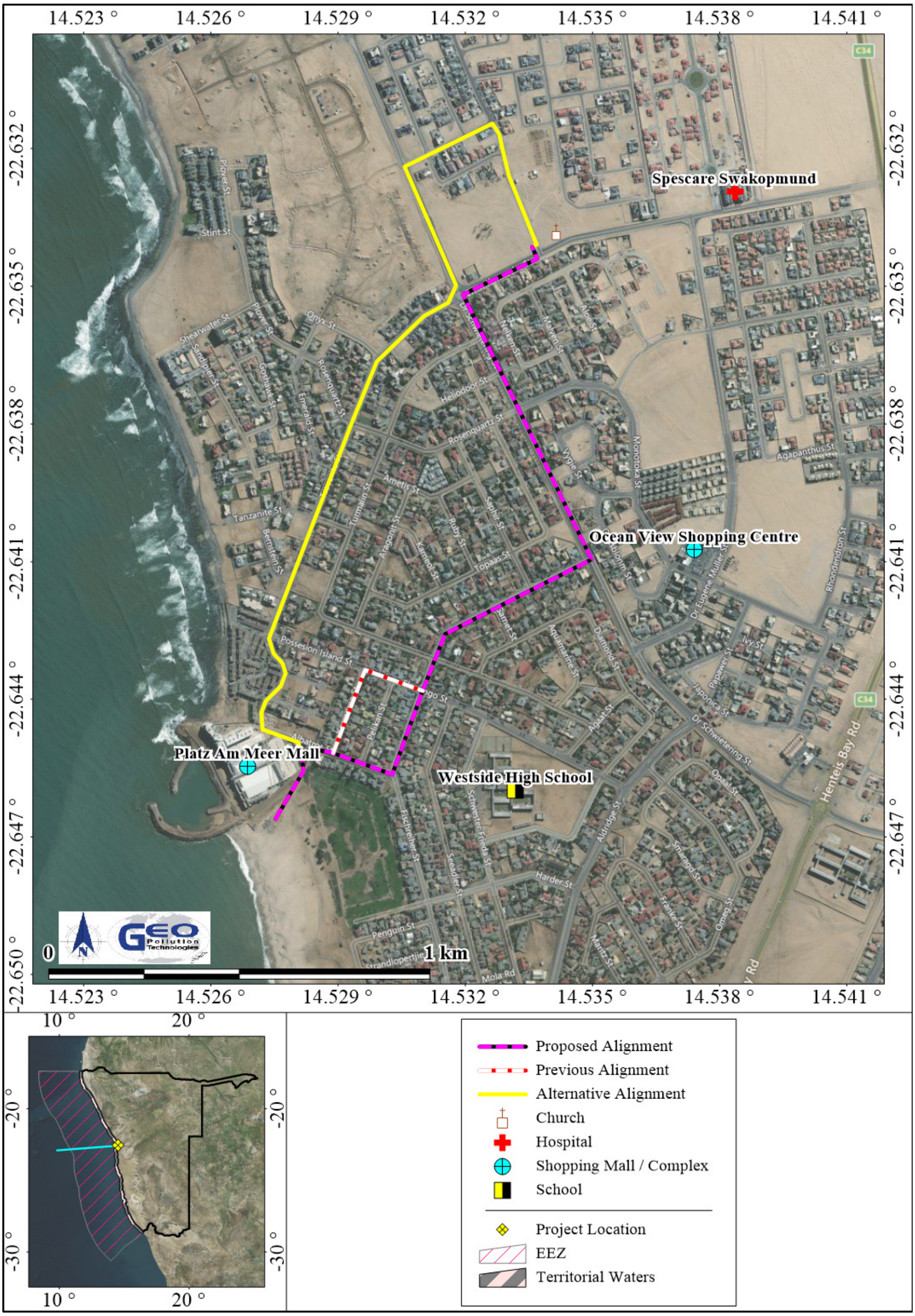

Figure 6-2. **Community services within the area**

6.3 SURVEY RESULTS: DESCRIPTION OF LOCAL COMMUNITY AND SURVEY AREA

6.3.1 Community Demography

The quantitative survey which was conducted across a segment of the residences, proved insightful in determining community profile and concerns. Information was gathered about education, living conditions as well as general aspirations towards the future related to the project, set in the framework for current activities and developments. The group interviewed were randomly selected, the only criteria being that they should be representative of an alignment option. In other words, the property surveyed should be located along one of the routes considered for the alignment. As per the figures below it can be seen that women made up 59% of the surveyed group and that there were no individuals in the age group younger than 30 years of age. More than 30% of the surveyed participants are retired while 94% of the surveyed participants had a tertiary level education. The majority of the group are part of the established community in Swakopmund.

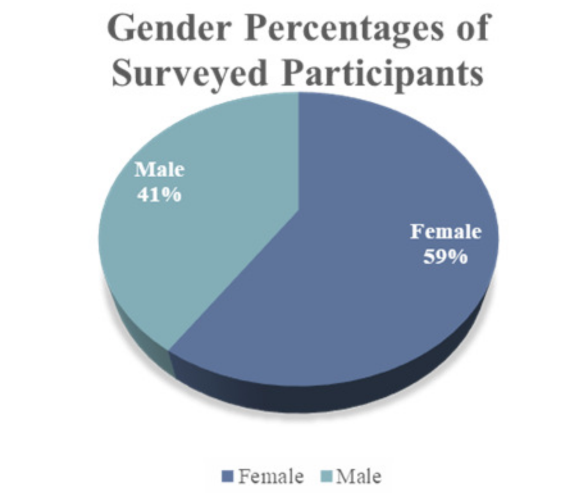

Figure 6-3. Gender percentages of surveyed participants

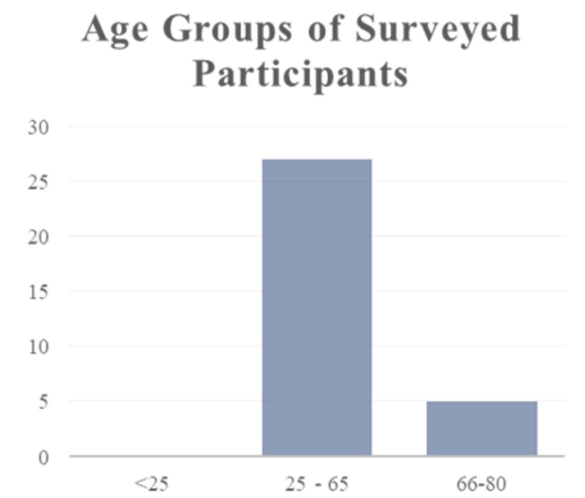

Figure 6-4. Age groups of surveyed participates

Specific enquiry was made with regards to disabled persons which may live as dependants with the surveyed participants. It was found that 15% of the surveyed participants have disabled or special needs persons living with them. None however, required any special entrance to the properties. In general, households with normal dependants made up around 42% of the surveyed participants.

6.3.2 Infrastructure and Housing

Some of areas which may be affected are very old, with properties having been developed more than 50 years ago. None of the participants however confirmed any historically significant or protected buildings. Other areas are very new with much younger dwellings. A few properties have not been developed as yet. In general, the study area is largely used for permanent residence (as opposed to holiday accommodation), a significant portion of which include retired residents. Very view participants of the survey indicated that the property is used (either partly or solely) in the hospitality and tourism industry (Figure 6-5). No dwellings were constructed of any material other than brick or stone, with all having sturdy roofs.

The majority of the properties' entrances and sidewalks are paved with no recorded solid surface covering (e.g. tar). The percentage of paved sidewalks (among interviewed sample set) are presented in Figure 6-6. Uncovered sidewalks are often associated with the rear boundary of properties, as most homeowners rather focus on beautifying (i.e. paving) the front of the property, the front also acting as entrance to the home. For some properties the cable will follow such uncovered sidewalks at the rear of the property, as can mainly be found in

Dr Schwiettering Street. A small percentage of the surveyed group did not complete this section of the questionnaire and therefore allows a small margin of variability in the presentation of the findings.

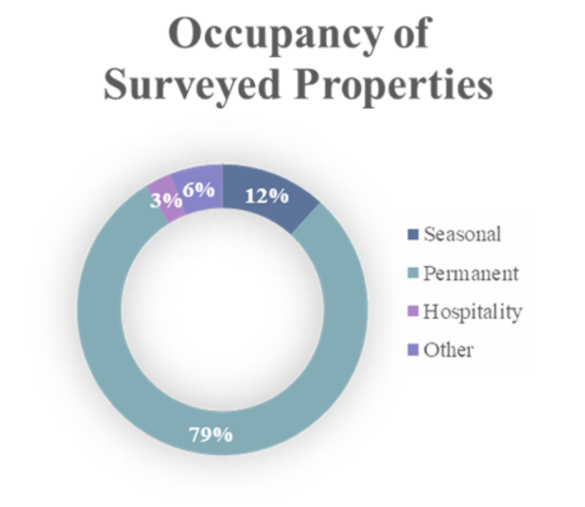	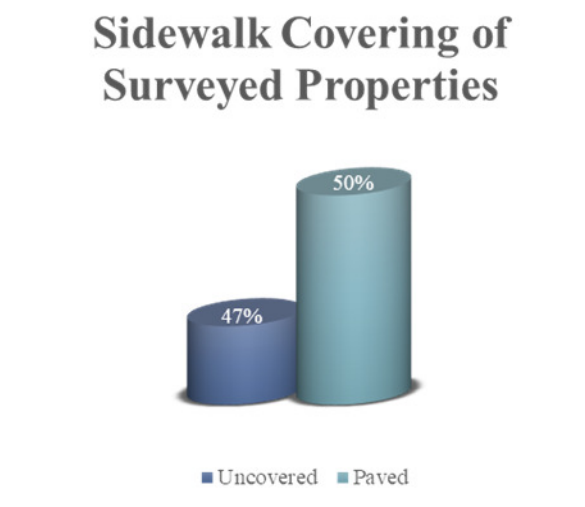
Figure 6-5. Occupancy of surveyed properties	**Figure 6-6. Sidewalk covering of surveyed properties**

Additional information related to the services and utilities of the properties was gathered. All dwellings have access to piped water and municipal electricity supply. All properties are linked to the municipal sewerage systems while only some still have land-line telephone connections. The majority of these utilities are installed underground on sidewalks. It was noted that in recent months, the general area has seen the laying of, what is perceived as, fibre optic cables, conducted by companies such as MTC and Paratus. These operations did disturb the neighbourhood and although perceived as generally "necessary", operations have caused damage to some property owners paving and/or underground utilities. It is indicated that the area has full 4G LTE coverage (https://digitalnamibia.nsa.org.na/).

6.3.3 Community concerns and aspirations

For purposes of this assessment, the surveyed group may be considered as a representative segment of the larger community residing in the area. The qualitative assessment, which also allows for persons to provide comments or concerns regarding the project, any comments received during the *public participation notification* process were included in the assessment of community concerns and aspirations.

Initially the study found that almost all participants received the project concept well, with limited concerns. However, during the survey of a certain geographic area, perceptions changed considerably and the proposed project was met with scepticism and mistrust in this particular area. After additional discussions were held with members from that geographical area, it became evident that that particular community's trust was broken by another similar project. Controversy over a telecommunications tower which was erected in the area, has literally negatively charged the aspirations of the community. In general however, it was found that the majority of the community had a favourable outlook regarding the project (Figure 6-7). A large portion of the group indicated that they are not necessarily negative about the project, but do have some concerns (mostly and usually related to the construction phase or 5G technology) (Figure 6-8).

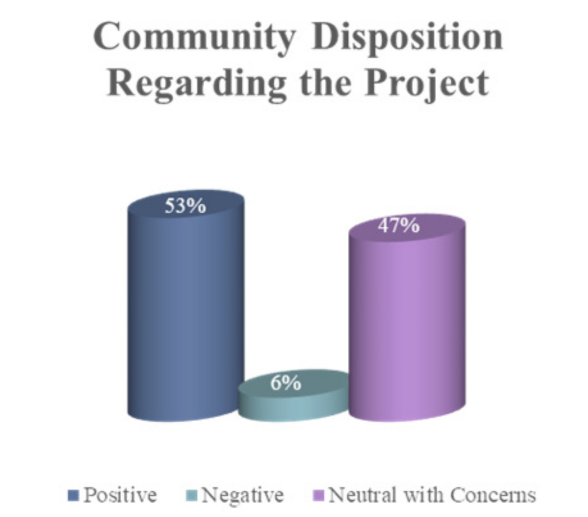

Figure 6-7. Feelings towards the project

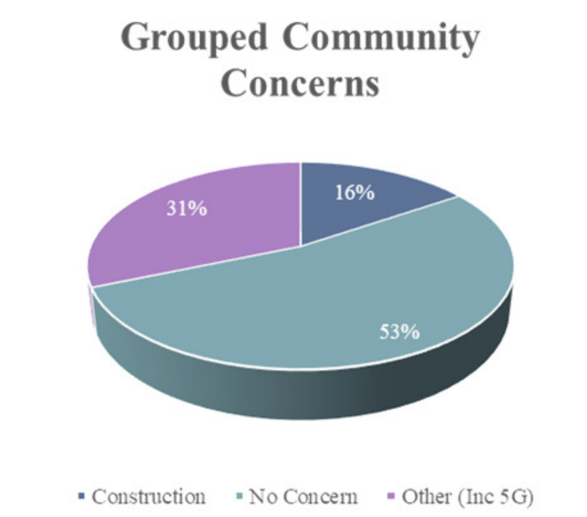

Figure 6-8. Grouped community concerns

Concerns raised by the surveyed community are grouped into two categories, these being concerns related to property or sidewalk damage during the construction phase and concerns related to the possibility that the project may support 5G initiatives. Support towards the initiative was noted to be connected to the notion that the project will lead to the development of the town and country on some level. Some of the comments gathered are presented in Table 6-2.

Table 6-2. Some comments documented during the qualitative survey

General Comments	Concerns	Supporting Remarks
♦ There has been four such cables put down around my house, in the last three years. ♦ None can go without internet lately, so no real comment. ♦ There is a court case in Windhoek related to the lifting of the sidewalk and the argument that Paratus did not have right to do so. Have you sorted the sidewalk issue with Swakopmund Municipality?	♦ I anticipate that underground utilities will be damaged, as has happened in the past. ♦ Previous construction has left our sidewalk disheveled with broken tiles. ♦ If is tis connected to 5G, it is not good or welcomed. ♦ Will construction affect the foundation of my property? And if it is connected to 5G it is not good.	♦ This project should happen as soon as possible. We are in full support thereof and very positive about it. Just get it done. ♦ I support the development of the town and Namibia. ♦ Technology is advancement therefore the project is good for us. ♦ We appreciate the work you do.

7 LOCAL CONTENT

Although the project entails construction activities along the sidewalks of residential properties, it is not foreseen that such construction will result in the temporary or permanent obstruction of property accesses. Therefore, no resettlement will be required. No displacement will result from the project, but rather an improvement of telecommunications services for Namibia as a whole. It is not foreseen that any part of the social fabric of the residential area will disintegrate. There is an unfortunate history in Namibia relating to the construction industry and foreign investment or involvement. During capital or related projects, foreign companies are known to bring in their entire construction crew, including skilled and semi-skilled labour. Local communities rarely benefit significantly in terms of employment and skills development. The temporary in-migration of such a labour force results in definite social change processes which ultimately affect the community. There further is a shift to not only focus on labour resources during the construction phase, but, for a project such as this, also skills development and training related to the maintenance and operation of the cable, especially relating the BMH and coastal portion of the project.

> **Local Content** In its simplest formulation, local content refers to the requirement, expectation or commitment of a company to ensure that value is retained within a host country, region or community through its workforce and/or procurement opportunities. More than this, however, local content is a philosophy about shared value that considers the strategies a business can enact to increase local content to maximise benefits to the local community and company alike.

The Proponent has exhibited definite initiatives to ensure that value and revenue remains within Namibia and within the Erongo Region. Local Namibian labour (translating as a project partner) will be extended upon once construction is initiated, thus increasing the contribution to the local economy. Local business should be supported in Erongo and Namibia where goods and skills are available. Although some international contractors will be employed, such persons have been brought into the country due to their skills and experience in the marine telecommunications infrastructure sector. International expertise brought in by the Proponent in relation to proposed operations remain very limited and only on a managerial level. The Proponent has commented to using local skilled and unskilled labour. All skilled labour will be contracted to Namibians where such skills are available with training and management that may be provided by international parties.

8 IMPACT IDENTIFICATION

Social Impacts are mainly driven by social change within communities and target groups. social change in turn may be set in action through a variety of project related activities, some resulting in gradual change while others may constitute immediate change. These changes, resulting from possible variations in the bio-physical or socio-cultural spheres, may be deemed to be cyclical or one directional. For the purpose of this assessment, the possible changes in the bio-physical environment have been assessed separately from social change processes.

In structural functionalism, social change is regarded as an adaptive response to some tension within the social system. When some part of an integrated social system changes, a tension between this and other parts of the system is created, which will be resolved by the adaptive change of the other parts. Some social changes may further result from the innovations that are adopted in a society. These can include technological inventions, new scientific knowledge, new beliefs, or a new fashion in the sphere of leisure. Diffusion is not automatic, but selective. An innovation is adopted only by people who are motivated to do so. To be accepted, the innovation must be compatible with important aspects of the culture. An example related to this community would be the use of the internet for various social and economic applications. The social change processes which have been identified for this assessment have been included in Table 8-1.

> Change in a certain direction creates the conditions for change in another (perhaps even the opposite) direction. More specifically, it is often assumed that growth has its limits and that in approaching these limits, the change curve will inevitably be bent. Ecological conditions such as the availability of natural resources, for instance, can limit population, economic, and organizational growth.

Table 8-1. List of social change processes and possible associated social impacts

Social Change Process	Aspect of Change	Possible Social Impact	Affected Group
Bio-physical & Socio-physical Change	**Air Quality -** Increase in dust at property entrances during construction.	♦ Increase in health risk exposure ♦ Nuisance factor	♦ Local community ♦ Employees
	Noise -. Increase in noise close to property during construction.	♦ Increase in health risk exposure ♦ Nuisance factor	♦ Local community ♦ Employees
	Utility Damage – Water- and sewer line damage / disruption in service.	♦ Reduction in quality of living	♦ Local community
Demographic Change	**In-Migration –** temporary in-migration of foreign labour force.	♦ Increased pressure on existing community services and function ♦ Social ills and deviant behaviour	♦ Local community ♦ Employees
Technological Innovation	**Skills Development – S**kills developed with skilled labour employed for off- and on-shore project implementation.	♦ Contribution to community development goals ♦ Increased amount of experienced and skilled workforce	♦ Local community ♦ Employees
	Access to Innovation / Technology- Increased access to innovation and technology as telecommunications is strengthened in the region and Namibia.	♦ Community of growth and development	♦ Local community ♦ Employees
Economic Processes	**Development of Markets –** Increased demand for telecommunications services with increase in number of jobs created.	♦ Platform for social and economic diversification and growth	♦ Local and national community ♦ Employees
	Industrialisation – Change in cultural perception of the area due to expansion of internet capabilities (speed/bandwidth) and related services and infrastructure requirements. Strongly cumulative in nature.	♦ Contribution to community development goals	♦ National development
Ideals & Aspirations	**Community Beliefs & Aspirations -** Aspirations of electronic development and advancement. Dissemination of information about planned operations and interventions for the area.	♦ Community aspirations ♦ Community mistrust	♦ Local community
Political Process / Institutional Change	**Governmental Services –** Increased risk of deviant social behaviour and pressure to control social ills.	♦ Increased pressure on governmental essential and security services	♦ Local and national community

For the purposes of this assessment, the Rapid Impact Assessment Method was adopted. However, some of the wording was adapted for clearer un-ambiguous comprehension. The Environmental Classification (ES) of impacts is provided in Table 8-2 while the assessment criteria is provided in Table 8-3 and Table 8-4. The class value refers to the ranking every impact is provided with, as per these tables. Ranking formulas for the Environmental Classification are calculated as follow:

$A = A1 \times A2$

$B = B1 + B2 + B3$

Environmental Classification (ES) = A x B

Table 8-2. Environmental classification of impacts according to the rapid impact assessment method of Pastakia 1998

Environmental Classification (ES)	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Medium positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Medium negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely Negative Impact

Table 8-3. Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3
Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit / disadvantage of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1
Significant negative disadvantage or change	-2
Major disadvantage or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3

Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3
Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2
Strong Cumulative Character	3

Table 8-4. Criteria for impact evaluation (Directorate of Environmental Affairs, 2008)

Risk Event	**Description of the risk that may lead to an impact.**
Probability	Refers to the probability that a specific impact will happen following a risk event. **Improbable** (low likelihood) **Probable** (distinct possibility) Highly probable (most likely) **Definite** (impact will occur regardless of prevention measures)
Confidence Level	The degree of confidence in the predictions, based on the availability of information and specialist knowledge. **Low** (based on the availability of specialist knowledge and other information) **Medium** (based on the availability of specialist knowledge and other information) **High** (based on the availability of specialist knowledge and other information)
Significance of impact (no mitigation)	**None** (A concern or potential impact that, upon evaluation, is found to have no significant impact at all.) **Low** (Any magnitude, impacts will be localised and temporary. Accordingly the impact is not expected to require amendment to the project design.) **Medium** (Impacts of moderate magnitude locally to regionally in the short term. Accordingly the impact is expected to require modification of the project design or alternative mitigation.) **High** (Impacts of high magnitude locally and in the long term and/or regionally and beyond. Accordingly the impact could have a 'no go' implication for the project unless mitigation or re-design is practically achievable.)
Mitigation	Description of possible mitigation measures
Significance of impact (with mitigation)	**None** (A concern or potential impact that, upon evaluation, is found to have no significant impact at all.) **Low** (Any magnitude, impacts will be localised and temporary. Accordingly the impact is not expected to require amendment to the project design.)

Risk Event	Description of the risk that may lead to an impact.
	Medium (Impacts of moderate magnitude locally to regionally in the short term. Accordingly the impact is expected to require modification of the project design or alternative mitigation.) **High** (Impacts of high magnitude locally and in the long term and/or regionally and beyond. Accordingly the impact could have a 'no go' implication for the project unless mitigation or re-design is practically achievable.)

8.1 BIO-PHYSICAL & SOCIO-PHYSICAL CHANGE

8.1.1 Bio- Physical Change: Air Quality

Particulate matter is a known health concern related to air quality. Specific parameters were developed by the World Health Organisation (WHO) relating to the allowable limits of particulate matter in ambient air. Construction activities will require the digging of a trench into the soil next to residences. The scale of the proposed operations are so limited that it is not foreseen that dust will have a significant health impact on any resident. Dust may, at most, be a nuisance factor for residents, considering cumulative aspects and the windy climate of the area. Any possible impact which might emanate from the project will be on a local scale. Human labour will be used during the construction phase and limited vehicle use will be required for the transportation of materials and equipment. It is not foreseen that the greenhouse gas emissions (GHG) from such activities will have a significant impact on the community health.

Table 8-5. Bio-Physical Change – Decrease of Air Quality (Dust and GHGs)

Nature of Impact	Increased health risk exposure of community and employees (respiratory problems related to particulate matter), and nuisance factor.						
Secondary / Indirect Impact	Possible additional health related conditions						
Importance of Condition(A1)	**Magnitude of Change/Effect (A2)**	**Permanence (B1)**	**Reversibility (B2)**	**Cumulative (B3)**	**A**	**B**	**ES**
1	-1	2	2	1	-1	5	-5
Degree of Confidence in Predictions	High	**Probability**	Definite				
Significance (Primary Impact) (without mitigation)	Low negative impact (ES -1)						
Mitigation / Enhancement	Personal protective equipment (PPE) such as dust masks, to be provided to employees working in dusty environments on land Employ dust abatement measures if required Comply with Labour Act regarding hazardous substances						
Significance (Primary Impact) (with mitigation)	Low negative impact (ES -1)						
Social Monitoring	Records to be kept of any complaints received including all actions taken to rectify it						
Residual Impact	No residual impacts of significance / No operational phase impact						

8.1.2 Socio-Physical Change: Noise

Construction noise, which may constitute high volume and repetitive noises, are known to impact human health. Similarly, as with particulate matter in air quality, noise standards have been developed by the WHO to protect communities against the health impacts of noise. The project will have a short construction period (2-4 days for the length of the on-shore component) which will ensure very short periods of noise to be experienced by residents). Mechanical excavations may be required in some areas which will increase the intensity of the construction noise generated. The impact is not considered to be of significance due to the temporary nature and short duration.

Table 8-6. Socio-Physical Change – Noise

<table>
<tr><td colspan="2">Nature of Impact</td><td colspan="6">Increase in health risk exposure due to repetitive, high or intense noise volumes</td></tr>
<tr><td colspan="2">Secondary / Indirect Impact</td><td colspan="6">Nuisance and business disruption (service sector)</td></tr>
<tr><td>Importance of Condition(A1)</td><td>Magnitude of Change/Effect (A2)</td><td>Permanence (B1)</td><td>Reversibility (B2)</td><td>Cumulative (B3)</td><td>A</td><td>B</td><td>ES</td></tr>
<tr><td>1</td><td>-1</td><td>2</td><td>2</td><td>1</td><td>-1</td><td>5</td><td>-5</td></tr>
<tr><td colspan="2">Degree of Confidence in Predictions</td><td>High</td><td colspan="2">Probability</td><td colspan="3">Definite</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (without mitigation)</td><td colspan="6">Low negative impact (ES -1)</td></tr>
<tr><td colspan="2">Mitigation / Enhancement</td><td colspan="6">PPE, such as hearing protection, to be provided to employees operating in noisy environments
Notification to residents (through a community liaison officer) of construction commencement
Allow for a community grievance mechanism</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (with mitigation)</td><td colspan="6">Low negative impact (ES -1)</td></tr>
<tr><td colspan="2">Social Monitoring</td><td colspan="6">Health records to be considered for noise related impact (not only related to hearing)
Record of any complaints received and actions taken</td></tr>
<tr><td colspan="2">Residual Impact</td><td colspan="6">No residual impacts of significance / No operational phase impact</td></tr>
</table>

8.1.3 Socio-Physical Change: Utility Damage

Construction activities will see trenching activities along the sidewalks of the chosen cable alignment. The sidewalks in these residential neighbourhoods also hold the bulk service and utility supply infrastructure for the individual properties. Such utilities include water pipelines, sewer lines, electricity and telephone lines. Some areas have also seen the installation of internet cables (fibre) by local operators (not related to this project). The installation of aforementioned fibre, which entailed a similar process as proposed for this project, had seen the damage of existing utilities. Damage to such utilities results in a disruption of services. Depending on the severity of the damage, as well as what was damaged, such disruptions could have significant effects on local residents. The magnitude of the individual impact may be very high. Such an incident could further lead to the disruption of the entire neighbourhood (puncturing of pipelines, etc.). It is typical in the construction industry that such damage can be fairly quickly resolved (within a couple of hours to a day). However, if not dealt with correctly, impacts may linger and result in deteriorated individual and community living conditions.

Table 8-7. Environmental / Bio-Physical Change – Utility Damage

<table>
<tr><td colspan="2">Nature of Impact</td><td colspan="6">Damage to existing underground utilities</td></tr>
<tr><td colspan="2">Secondary / Indirect Impact</td><td colspan="6">Nuisance and business disruption (service sector)</td></tr>
<tr><td>Importance of Condition(A1)</td><td>Magnitude of Change/Effect (A2)</td><td>Permanence (B1)</td><td>Reversibility (B2)</td><td>Cumulative (B3)</td><td>A</td><td>B</td><td>ES</td></tr>
<tr><td>2</td><td>-2</td><td>2</td><td>2</td><td>1</td><td>-4</td><td>5</td><td>-20</td></tr>
<tr><td colspan="2">Degree of Confidence in Predictions</td><td colspan="2">Medium</td><td>Probability</td><td colspan="3">Improbable</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (without mitigation)</td><td colspan="6">Medium negative impact (ES -3)</td></tr>
<tr><td colspan="2">Mitigation / Enhancement</td><td colspan="6">Obtain municipal plans or inputs with regards to the location of existing utilities. Signed-off documentation to be provided by authorities.
Notification to residents (through a community liaison officer) of construction commencement.
Allow for a community grievance mechanism</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (with mitigation)</td><td colspan="6">Low negative impact (ES -2)</td></tr>
<tr><td colspan="2">Social Monitoring</td><td colspan="6">Record of any incidents related to utility damage and actions taken
Record of any complaints received and actions taken</td></tr>
<tr><td colspan="2">Residual Impact</td><td colspan="6">None should issue be resolved</td></tr>
</table>

8.1.4 Demographic Change: In-migration

Proposed operations are not expected to create a change in the demographic profile through in-migration to the local community. Although operational and construction activities may result in risks to community health, it is not foreseen that such risks will be significant. Demographic change frequently lead to changes in community health. Should the Proponent employ a foreign company during the construction phase, there is a probability that a large portion of the construction crew will operate in or from Swakopmund or Walvis Bay. Thus, seasonal in-migration is expected during the construction phase and partly during the operational phase (which may require a skilled workforce for periodic maintenance and operational challenges).

Social aspects have proven to be most affected during the construction phase of capital projects. An increase in foreign people in the area (foreign labourers and local, potential job seekers) may potentially increase the risk of criminal and socially/culturally deviant behaviour. However, the proponent is not the only employer in the area and therefore potential impacts on the demographic profile are largely cumulative. The project will probably result in seasonal / temporary international labour migration. Accommodation within Walvis Bay or Swakopmund will be required for the construction crew (if not local). Seasonal migration is especially known to have significant effects on local communities which include an increase in risky social behaviour such as substance abuse and commercial sex (LeBeau, 2008). The same is true for the unskilled, local labour force which may suddenly have more economic means (and may potentially be propositioned by local sex workers). It is therefore expected that there will be a rise in socially risky and deviant behaviour within the local community. Seasonal migration as well as a highly mobile workforce are very likely to increases the key HIV/AIDS drivers in Walvis Bay / Swakopmund. Thus, there may be an escalation in exposure to communicable infection and similar health related diseases.

Table 8-8. Demographic Change – In Migration (Temporary Labour Force)

<table>
<tr><td colspan="2">Nature of Impact</td><td colspan="6">Population composition and increased number of people</td></tr>
<tr><td colspan="2">Secondary / Indirect Impact</td><td colspan="6">Numerous. Considered to be the contributing factor to various impacts</td></tr>
<tr><td>Importance of Condition(A1)</td><td>Magnitude of Change/Effect (A2)</td><td>Permanence (B1)</td><td>Reversibility (B2)</td><td>Cumulative (B3)</td><td>A</td><td>B</td><td>ES</td></tr>
<tr><td>2</td><td>-2</td><td>2</td><td>2</td><td>3</td><td>-4</td><td>7</td><td>-28</td></tr>
<tr><td colspan="2">Degree of Confidence in Predictions</td><td colspan="2">High</td><td colspan="1">Probability</td><td colspan="3">Probable</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (without mitigation)</td><td colspan="6">Medium negative impact (ES -3)</td></tr>
<tr><td colspan="2">Mitigation / Enhancement</td><td colspan="6">The Proponent should communicate all possible additional job opportunities / contracts clearly to employees (attempting to ensure no incorrect assumptions be made regarding possible employment)
Employ workers residing in Namibia (with relevant experience)
All provisions of the Labour Act to be adhered to.
Gender sensitive recruiting and communication regarding employment.</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (with mitigation)</td><td colspan="6">Moderately negative impact (ES -3)</td></tr>
<tr><td colspan="2">Social Monitoring</td><td colspan="6">Employment records.
All employee and community communication regarding employment kept on file.</td></tr>
<tr><td colspan="2">Residual Impact</td><td colspan="6">Various as per secondary impact</td></tr>
</table>

8.1.5 Technological Innovation: Skills Development & Access to Technological Services

Specialised skills linked to new or rare technologies may be required. Skills required for the operations and maintenance of the Equiano cable may be transferred to contracted or permanent employees through training. Training of current employees (of the local partner) rather than appointing of foreign employees should be encouraged. Similarly, the sourcing of a local skilled and unskilled labour force should be priority. During the qualitative assessment, some of the surveyed participants mentioned that specialised skills are available in the local community.

The regional workforce's exposure to innovative technologies and skills development will contribute positively to skills levels and employability. Technological advancement through installation of state of the art telecommunications infrastructure will positively contribute to national reliability of telecommunications services.

Telecommunications are considered to be an essential tool in the global economy, and also in terms of reporting on human rights violations by expanding platforms on which persons can exercise their right of freedom of expression. The project will directly and indirectly contribute to improved access to telecommunications and is considered a project of national importance.

Table 8-9. Technological Innovation - Skills Developed and Improved Internet Access

Nature of Impact		Contribution to community development goals and increased ease of access to the telecommunications					
Secondary / Indirect Impact		Contribution to development of Namibia on various levels					
Importance of Condition(A1)	**Magnitude of Change/Effect (A2)**	**Permanence (B1)**	**Reversibility (B2)**	**Cumulative (B3)**	**A**	**B**	**ES**
3	2	2	2	3	6	7	42
Degree of Confidence in Predictions		High	**Probability**	Probable			
Significance (Primary Impact) (without mitigation)		Significantly positive impact (ES 4)					
Mitigation / Enhancement		Skills training to be provided to individuals who exhibit potential for development. All training to be managerial or institutionally certified. Skills development and improvement programs to be made available as identified during performance assessments Training preference provided to Namibians					
Significance (Primary Impact) (with mitigation)		Significantly positive impact (ES 4)					
Social Monitoring		Documenting of skills development initiatives All records of performance assessments & training as well as success rates of initiatives kept. Initiatives to be tailored and adjusted where required annually					
Residual Impact		Increased skills pool, sustaining access to world services					

8.1.6 Economic Processes: Development of Markets

Increased demand for internet services and technologies is linked to sustainable internet access. The demand in internet services is a key driver for job creation and entrepreneurship. The internet provides a plethora of opportunities, which not only increases the possibility of economic opportunities, but also have the potential to diversify local and national markets. Sustained and/or improved access to the internet is further recognised to have definite links in achieving sustainable goals developed by the United Nations (and as personified by individual member states). It is a long term impact (operational phase) which is irreversible in the (social) sense that, what has been experienced on or through telecommunications and the internet, cannot be unseen. Experience brought on through such means will remain even in the event of telecommunications within a country, being restricted.

Table 8-10. Economic Processes -Increased Demand for Goods and Services

Nature of Impact		New informal markets & increased community services					
Secondary / Indirect Impact		Increased economic activity					
Importance of Condition(A1)	**Magnitude of Change/Effect (A2)**	**Permanence (B1)**	**Reversibility (B2)**	**Cumulative (B3)**	**A**	**B**	**ES**
3	2	3	3	3	9	6	54
Degree of Confidence in Predictions		High	**Probability**	Probable			

Significance (Primary Impact) (without mitigation)	Significantly positive impact (ES 4)
Mitigation / Enhancement	Maintenance on the cable to be conducted on a regular basis and interruptions minimised. Documented, clear description on the cable alignment to be provided to the local municipal authority to ensure any damage to the cable during any other future excavations are prevented. Securing the BMH and CLS from vandalism and climatic conditions which may cause weathering of material (corrosion).
Significance (Primary Impact)e (with mitigation)	Significantly positive impact (ES 4)
Social Monitoring	No social monitoring has been identified.
Residual Impact	Numerous residual impacts relate to the social impacts related to economic advancements enabled through telecommunications.

8.1.7 Economic Processes: Industrialisation (Smart Technology)

Current telecommunications access (as per current telecommunications infrastructure in Namibia) served the Namibian population in the past. Access to telecommunications m and specifically the internet, is enabled by what is termed smart technology. Namibia has seen a growth in both the demand for telecommunications services as well as a rise in demand for devices to access such services. Increasing reliance and innovation on such smart technology is in many instances linked to the internet. Thereby the project will aid in facilitating the sustainable use (including the increased demand) and related access of the internet through smart devices. This will contribute to the global fourth industrial revolution.

Table 8-11. Economic Processes - Industrialisation (Smart Technology)

Nature of Impact	**Contribution to local, national and international deployment**						
Secondary / Indirect Impact	Community living conditions improvement						
Importance of Condition(A1)	**Magnitude of Change/Effect (A2)**	**Permanence (B1)**	**Reversibility (B2)**	**Cumulative (B3)**	**A**	**B**	**ES**
3	1	2	2	1	3	5	15
Degree of Confidence in Predictions	High	**Probability**	High				
Significance (Primary Impact) (without mitigation)	Positive impact (ES 2)						
Mitigation / Enhancement	Infrastructure to be maintained by implementing agencies.						
Significance (Primary Impact) (with mitigation)	Positive impact (ES 2)						
Social Monitoring	Maintenance of infrastructure to be documented						
Residual Impact	Contribution to national infrastructure development						

8.1.8 Ideals & Aspirations: Community Beliefs & Aspirations

Information about the project may bring about a change in cultural perceptions of the perceived expansion of telecommunications capabilities (e.g. internet speed/bandwidth) and related services and infrastructure requirements. Although the project objectives are to sustain current telecommunications capabilities (accommodating the increase in demand) the perception of having “faster” internet is strongly cumulative in nature and experienced by the majority of the community. This could have been compounded by the preceding fibre installations as conducted in the major urban centres in Namibia. The mere mention of the cable has brought hope and new aspirations for future social and economic opportunity. It should be noted that the positive aspirations linked to the project exclude any mention or relation to 5G. Any connection to 5G (made by the individual assumptions) is met with severe scepticism. In general construction concerns have also been noted. However, the proposed development was overall well received. Vague information or no information at all about proposed plans and operations for the future, may result in community and employee mistrust and even social-civil action. Continued communication with the community and employees are vital.

Table 8-12. Ideals & Aspirations – Plans and Aspirations for the Future

<table>
<tr><td colspan="2">Nature of Impact</td><td colspan="6">Contribution to community health and positive aspirations</td></tr>
<tr><td colspan="2">Secondary / Indirect Impact</td><td colspan="6">Continued positive feelings towards the project and related advancements.</td></tr>
<tr><td>Importance of Condition(A1)</td><td>Magnitude of Change/Effect (A2)</td><td>Permanence (B1)</td><td>Reversibility (B2)</td><td>Cumulative (B3)</td><td>A</td><td>B</td><td>ES</td></tr>
<tr><td>1</td><td>1</td><td>2</td><td>2</td><td>1</td><td>1</td><td>5</td><td>5</td></tr>
<tr><td colspan="2">Degree of Confidence in Predictions</td><td colspan="2">Medium</td><td>Probability</td><td colspan="3">Definite</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (without mitigation)</td><td colspan="6">Positive impact (ES 1)</td></tr>
<tr><td colspan="2">Mitigation / Enhancement</td><td colspan="6">Clear communication regarding all aspects of operations and proposed expansions to be maintained with community members</td></tr>
<tr><td colspan="2">Significance (Primary Impact) (with mitigation)</td><td colspan="6">Positive impact (ES 1)</td></tr>
<tr><td colspan="2">Social Monitoring</td><td colspan="6">All communication with community leaders and forums to be kept (such communication frequency and level to be designed to be community sensitive)</td></tr>
<tr><td colspan="2">Residual Impact</td><td colspan="6">Contribution towards building a peaceful society</td></tr>
</table>

8.1.9 Political Process / Institutional Change: Welfare & Social Services

With the ubiquity of the internet coupled with the “uncontrolled” environment, crime related to internet use has increased with the proliferation of internet access. Internet crime, known as cybercrime, is mostly linked to economic losses or socially deviant behaviour. However, especially socially deviant behaviour may contribute to the implementation of violent crime. Economic cybercrimes relate mostly to the banking and investing sectors with links to individuals or organisations and their credentials. Data breaches and their consequences have also had profound effects on consumers with personal information and credit details being stolen. Similarly abuse of intellectual property rights may lead to loss of income of rights holders.

The spread of social network usage throughout all age groups, have made cyber bullying and cyber stalking increasingly common, especially among teenagers. Social medial platforms and internet pages may further act as platforms to fuel racism and radicalisation for political or social beliefs. This often results in criminal and or socially deviant behaviour. An example would be the looting and vandalism or properties in the name of activism.

Such platforms may also be utilised by what is known as 'hacktivists'. Hacktivists use their cyber abilities to assist civil or environmental rights movements or actions. In Namibia, a similar event was recently experienced when many government websites were hacked in protest to an environmental decision supported by the Namibian Government. It is further speculated that the internet is used for international interference in elections through social media and other cyber capabilities.

All cybercrime increases pressure on security and social structure of a community, also in Namibia. Such structure includes mostly security and heath (mental health and counselling). The project will however not result in any such crime, as it will support internet access, which is already established in Namibia, and not internet crime. However, access in itself provides, for opportunities to engage in deviant or criminal activities. According to various independent reports for Namibia, the country is still in its infancy of cyber security awareness and management. Therefore, additional pressure is also on governmental services to improve policies and strategies in guarding against such crimes.

Table 8-13. Political Process / Institutional Change: Increased pressure on social and security provided services

Nature of Impact		Increased number of people in need of social services such as cyber security and counselling					
Secondary / Indirect Impact		Decreased community well-being					
Importance of Condition(A1)	**Magnitude of Change/Effect (A2)**	**Permanence (B1)**	**Reversibility (B2)**	**Cumulative (B3)**	**A**	**B**	**ES**
2	-1	2	3	1	-2	6	-12
Degree of Confidence in Predictions		Medium	**Probability**	Moderate			
Significance (Primary Impact) (without mitigation)		Low negative impact					
Mitigation / Enhancement		No mitigation measures have been identified for the opponent					
Significance (Primary Impact)e (with mitigation)		Low negative impact					
Social Monitoring		No social monitoring was identified for the proponent					
Residual Impact		Various residual impacts may remain related to all spheres of life					

The most significant impacts discussed above is summarised below indicating mostly negative impacts for the short construction phase and positive impacts for the operational phase.

Table 8-14. Summary of assessed social impacts

Impact Category	Impact Type	Construction	Operations
	Positive Rating Scale: Maximum Value	5	5
	Negative Rating Scale: Maximum Value	-5	-5
PC	Decrease of Air Quality (Dust and GHGs)	-1	
SC	Noise	-1	
EO	Utility Damage	-3	
SC	In-migration (Temporary Labour Force)	-3	
SE	Skills Development & Access to Technological Services	1	4
SE	Increased demand for goods and services	1	4
SE	Industrialisation (Smart Technology)	2	2
SC	Plans and Aspirations for the Future	1	1
SE	Welfare & Social Services	-2	-2

PC = Physical/Chemical SC = Sociological/Cultural EO = Economical/Operational SE = Sociological/Economic

9 IMPLEMENTATION OF MITIGATION MEASURES & SOCIAL MONITORING

The above listed mitigation measures is a summary of integrated and complex initiatives which are being proposed. The mitigation and enhancement measures which have been cited are part of a much greater network of responsible social development within which these measures are lodged. It is therefore proposed that the proponent compile a social strategy which will not only have components to address employee requirements, but will also consider the local community (especially during the construction phase). Such a strategy may be implemented as part of an EMS.

The following is suggested to be incorporated:

- Employing of community liaison officer (CLM) to facilitate community communication, field community grievances, initiation and maintaining monitoring feedback sessions etc.
- The community liaison officer may further be functional in developing impacts and benefits agreements if so required.
- A community grievance mechanism should be made available as part of the ongoing community engagement (communication) and grievance strategy.
- Provide the contact details of a social worker to address social deviant behaviour and possible incidents of social issues. It is further suggested that a mechanism be made available to employees seeking assistance in dealing with social ills and deviant behaviour.
- The proponent should keep documentation of all discussions held with the local government regarding community services, existing utilities and planned initiatives.

10 CONCLUSION

The SIA is based on one component of a much larger project. The successful implementation of the larger project has a definite link to the project component being accessed at hand (Namibian branch of the Equiano cable). The nature of the greater project and the local component, are inter-linked and aims to serve the global community. Therefore, although construction phase linked impacts can be readily assessed and mitigation measures provided for, operational impacts have a much wider social sphere of influence, the magnitude of which is beyond the scope of this SIA.

Localised community impacts have been assessed and documented, indicating an overall positive rating for the operational phase. The general perception of the community, which may be affected by the construction phase, remains positive with some concerns. Construction phase activities will constitute the majority of local impacts and relate not only to possible changes in the physical environment, but also to social structures or processes of the community. Such impacts will be of short duration and may be managed and even prevented in many instances.

Operational phase activities sees the cable realising its purpose in strengthening the current telecommunication network in Namibia. Mainly linked to the telecommunication network, is the internet, providing with it a range of social and economic opportunities. However, also linked to the internet are security and social challenges, which may translate into criminal activities in a wide range of forms. Therefore, additional development in terms of national cyber security and related social services, will be required. Such initiatives are not required by / or, the responsibility of the Proponent, but rather national governing bodies.

The project will contribute to the social well-being of Namibia as a whole. Social impacts are deemed manageable. No community objections were received and it is not foreseen that the project will be rejected or hampered by the public.

11 REFERENCES

Digital Atlas of Namibia Unpublished Report. Ministry of Environment & Tourism

Directorate of Environmental Affairs, 2008. Procedures and Guidelines for Environmental Impact Assessment (EIA) and Environmental Management Plans (EMP), Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek.

https://globaldatalab.org/shdi/shdi/NAM/?levels=1%2B4&interpolation=0&extrapolation=0&nearest_real=0 [accessed 29 October 2020]

LeBeau, D 2008 Corridors of Mobility: Mobility and HIV vulnerability factors in four sites along transport corridors in Namibia. IMO & IPPR https://www.academia.edu/169878/CORRIDORS_OF_MOBILITY_Mobility_and_HIV_ vulnerability_factors_in_four_sites_along_transport_corridors_in_Namibia_2008. [accessed 29 October 2020]

Meteoblue. (2018, July). Meteoblue/Archive/Climate. Retrieved from https://www.meteoblue.com/en/weather/forecast/modelclimate/-24.8436N16.9806E https://en.climate-data.org/location/169737/ accessed 12 July 2018

Miller, R.2008. The Geology of Namibia, Volume 2. Neoproterozoic to Lower Palaeozoic, Ministry of Mines and Energy Geological Survey.

Namibia Statistics Agency. Namibia household Income and Expenditure Survey 2009/2010.

Namibia Statistics Agency. Namibia 2011 Population and Housing Census Main Report.

Nickel Development Institute. http://www.nickelinstitute.org/~/Media/Files/TechnicalLiterature/ StainlessSteelsinABC_GuidelinesforCorrosionPrevention_11024_.pdf Accessed 08/05/2013

Pastakia, C.M.R.; 1998; The Rapid Impact Assessment Matrix (RIAM) – A new tool for Environmental Impact Assessment.

UN Human Rights Council, The promotion, protection and enjoyment of human rights on the Internet : resolution / adopted by the Human Rights Council, 18 July 2016, A/HRC/RES/32/13, available at: https://www.refworld.org/docid/57e916464.html [accessed 6 November 2020]

PROPOSED MARINE TELECOMMUNICATIONS CABLE SYSTEM (EQUIANO CABLE SYSTEM) TO BE LANDED AT SWAKOPMUND, NAMIBIA

COMMERCIAL FISHERIES IMPACT ASSESSMENT

November 2020

Prepared for the Environmental Assessment Practitioner:

ACER (Africa) Environmental Consultants

On behalf of :

Paratus Telecommunications (Pty) Ltd

INDEX

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Sarah Wilkinson has worked on marine resource assessments, specializing in spatial and temporal analysis (GIS), as well as the economic impacts of fisheries exploitation in the southern African region. Nikita Steele has worked as an environmental assessment practitioner conducting environmental impact assessments and has experience in marine research.

This specialist report was compiled for ACER (Africa) Environmental Consultants for their use in compiling an Environmental Impact Assessment (EIA) Report for the alignment of the Equiano Cable System off the West Coast of Namibia. We do hereby declare that we are financially and otherwise independent of the Applicant and of ACER (Africa) Environmental Consultants.

Sarah Wilkinson

EXECUTIVE SUMMARY

Alcatel Submarine Networks (ASN) has been appointed as the supplier and installer of the Equiano Cable System, Google's new subsea telecommunications cable that will connect Africa and Europe. Once complete, the Equiano Cable System would run along the West Coast of Africa between Portugal and South Africa with branching units along the way that could be used to extend connectivity to additional West African countries, including Namibia.

This report was compiled as part of the Environmental Impact Assessment Report for the Namibian branch of the cable. The report provides a specialist assessment of the impact of the proposed project activities on the commercial fisheries sectors that are active in the Namibian Exclusive Economic Zone (EEZ). This assessment has been prepared for the Environmental Assessment Practitioner ACER (Africa) Environmental Consultants on behalf of Paratus Telecommunications (Pty) Ltd 2007/0100 (the designated Landing Partner of the Equiano Cable System in Namibia).

The proposed cable alignment would traverse the Namibian EEZ from deep to shallow waters, making landfall at Swakopmund. The cable would be laid by a purpose-built cable-laying ship. Consistent with industry practice, the cable would rest unarmoured on the seabed in water depths greater than 1 500 m. Towards the approach to the coastline, the cable would be buried beneath the sandy seabed of the shallower marine waters to a depth of approximately 1 m, where possible. This burial is intended to provide protection to the cable from the hazards posed by ships' anchors and fishing gear. In nearshore areas, heavier armouring would provide additional protection to the subsea cable.

Once installed, the cable routing would be published in official notices to mariners and nautical charts, which are distributed by the navy hydrographic office. Although there is no Namibian legislation that prohibits trawling or anchoring across the cable, skippers would take reasonable care zone and this could present an impact of long-term duration on fishing sectors that trawl or anchor fishing gear on the seabed. The Namibian fisheries that would fall into these categories include the hake- and monk-directed trawl sectors and demersal hake-directed longline sector. Although not currently operational, the deep-water trawl fishery for orange roughy could be affected were it to reopen in the future[1]. Based on the high levels of demersal trawl and demersal longline fishing effort recorded in the area, the intensity of the impact would result in a noticeable alteration to current fishing activity; however, due to the overall limited extent of the impact and with the adoption of adaptive fishing techniques the overall significance could be considered to be low.

Prior to installation, a detailed survey would be undertaken (using multibeam echosounder, side-scan sonar and sub-bottom profiling to determine the optimal routing of the subsea cable. Immediately prior to installation a clearance operation would be conducted to remove any obstacles from the path of the final subsea cable route where burial is required. During the pre-installation surveys and installation of the cable, any and all fishing vessels would be required to maintain a safe operational distance of at least 500 m from the project vessels. Restriction of access to fishing ground could therefore be experienced by all types of fishing vessels in the short-term duration during this phase of the project. Within the Namibian commercial fisheries this would include the small pelagic purse-seine (currently not operational), midwater trawl, demersal trawl, demersal longline, large pelagic longline and linefish sectors – all of which were found to operate across the proposed routing of the cable. The impact on fisheries during the pre-installation and installation activities was assessed to be of overall very low significance.

Standard measures would include a process of notification to affected parties prior to the commencement of installation of the cable. Selected fishing industry associations and MFMR should be informed of the pending activity and the safety clearance requirements of the cable-laying vessel.

The following actions are recommended:

[1] MFMR have indicated that there is no current plan to reopen the fishery, although biomass surveys are regularly undertaken within management areas to ascertain the stock status.

- Distribute a Notice to Mariners prior to the commencement of the subsea cable installation. The Notice to Mariners should give notice of an indication of the proposed timeframes for subsea installation and an indication of the 0.5 Nm safety zone around the cable-laying vessel. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible
- The subsea vessel contractors must adhere to the International Organization for Standards under the ISO 9000 and ISO 9001 and the International Cable Protection Committee (ICPC) recommendations.
- The subsea cable routing must be published in nautical charts by the navy hydrographic office.
- Undertaking all maritime operations in line with International Maritime Law and safe practice guidelines.

Summary table : Proportional overlap of each fishery with the proposed cable route (inclusive of 0.5 Nm to either side of the cable).

Sector	Overlap with proposed cable route	% of fishing ground affected by exclusion corridor	Potential long-term impact of cable exclusion	Current Activity Status of Fishery
Small pelagic purse-seine	Yes	0.4	N/A	Not Active: Fishery was closed for a three-year period commencing 01 January 2018
Midwater trawl	Yes	0.2	N/A	Active
Demersal trawl	Yes (between 240m and 820m isobaths)	0.2	Yes	Active
Demersal longline	Yes (between 200m and 400m)	0.2	Yes	Active
Large pelagic long-line	Yes	1.0	N/A	Active
Tuna pole	No	0	N/A	Active
Line-fish	Yes	0.4	N/A	Active
Deep-sea crab	No	0	Yes	Active
Deep-water trawl	Yes (between 300m and 1800m)	unknown	Yes	Not Active: Fishery has been closed since 2007
Rock lobster	No	0	Yes	Active

ACRONYMS, ABBREVIATIONS AND UNITS

ACER	ACER (Africa) Environmental Consultants
ASN	Alcatel Submarine Networks
CapMarine	Capricorn Marine Environmental (Pty) Ltd
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CPUE	Catch Per Unit Effort
EAP	Environmental Assessment Practitioner
ECC	Environmental Clearance Certificate
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GRT	Gross Registered Tonnage
HP	Horse Power
ICCAT	International Convention for the Conservation of Atlantic Tunas
ICSEAF	International Commission for South East Atlantic Fisheries
IUU	Illegal, Unreported and Unregulated fishing
kg	Kilogram
m	Metres
MFMR	Ministry of Fisheries and Marine Resources
NAMPORT	Namibian Ports Authority
NatMIRC	National Marine Information and Research Centre
NEMA	Namibian Environmental Management Act
QMAs	Quota Management Areas
RFMO	Regional Fisheries Management Organisation
t	Tonnes
TAC	Total Allowable Catch
TAE	Total Allowable Effort
UNCLOS	United Nations Convention of the Law of the Sea
VMS	Vessel Monitoring System

1. INTRODUCTION

Alcatel Submarine Networks (ASN) has been appointed as the supplier and installer of the Equiano Cable System, Google's new subsea telecommunications cable that will connect Africa and Europe. Once complete, the Equiano Cable System would run along the West Coast of Africa between Portugal and South Africa with branching units along the way that could be used to extend connectivity to additional West African countries, including Namibia (Figure 1.1).

Paratus Telecommunications Pty Ltd 2007/0100 is the designated Landing Partner of the Equiano Cable System in Namibia, and will undertake the proposed installation of the Equiano Cable System to be landed at Swakopmund, Namibia (Figure 1.2). The proposed project triggers a number of listed activities in terms of the Namibian Environmental Impact Assessment (EIA) Regulations, 2012. As such, an Environmental Clearance Certificate (ECC) is required before such activities can commence.

ACER (Africa) Environmental Consultants (ACER) has been appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the EIA for the proposed installation and Capricorn Marine Environmental (Pty) Ltd has been contracted by ACER to undertake a Fisheries Impact Assessment Specialist Study required for the EIA process.

This report provides an assessment of the commercial fishing grounds along the selected route alignment of the cable and the potential impact that the Equiano Cable System and related infrastructure would have on the Namibian fishing industry. The assessment has been prepared in line with the requirements of the Namibian Environmental Management Act (Act 7 of 2007) and specifically, the Environmental Impact Assessment Regulations (Government Notice 30 of 2011).

Figure 1-1: Proposed routing of the Equiano Cable System

Figure 1-2: Proposed alignment of the Equiano Cable System within Namibian waters via branch to Swakopmund.

2. TERMS OF REFERENCE

The appointed specialist must provide an assessment of the potential impact that the Equiano Cable System and related infrastructure will have on the trawling/commercial fishing industry based on the alignment selected. In this context, the specialist study should identify and discuss the following topics:

- Determine the actual number of bottom trawls and commercial fishing activity per annum over the proposed Equiano Cable alignment and depict how and from what source of information this was calculated as well as the accuracy of the data.
- Typically, at what depths are the bottom trawls along the proposed Equiano Cable alignment undertaken?
- Provide a detailed explanation of the key methods on how trawls/commercial fishing activities are recorded and clearly depict the accuracy of these recordings.
- Assess the current trawling/commercial fishing logs and investigate whether the existing cable alignments and their exclusion zones are avoided by trawling/commercial fishing vessels.
- Provide a brief comment on the impact of the proposed Equiano Cable System alignment and its potential significance to the trawling/commercial fishing industry. This comment on significance should cover aspects such as the relative percentage of the trawl/commercial fishing grounds impacted and/or if the proposed alignment is likely to have any impact on trawling/commercial fishing in terms of increased operational costs.
- Address specific issues and concerns raised by stakeholders during the public review phase of the assessment process (an Issues and Responses Report will be provided to specialists).
- Discuss any other sensitivities and important issues from a fisheries perspective that are not identified in these terms of reference.

In addition, the following maps should be generated and included in the specialist report:

- A map of trawl/commercial fishing data over the last five years showing trawls/commercial fishing across the proposed Equiano Cable alignment and existing cables and their exclusion zones. The map legend should include trawl/commercial fishing activity numbers for each year assessed.

In addition, all specialist studies must contain:

- Details of the person who prepared the report, and the expertise of that person to carry out the specialist study or specialised process (in the form of a curriculum vitae attached as an appendix to the report).
- A declaration that the person is independent and has objectively assessed potential impacts.
- An introduction that presents a brief background to the study and an appreciation of the requirements stated in the specific terms of reference for the study.
- The influence of seasonality on the trawl/commercial fishing data interrogated and presented in the report.

Details of the approach to the study where activities performed, and methods used are presented.

- The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.
- An identification of any areas to be avoided, including buffers.
- A map superimposing the activity, including associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided and buffers.

- A description of any assumptions made and any uncertainties or gaps in knowledge.
- A description of the affected environment and the study area to provide a context under which the assessment took place.
- Description of proposed actions, and alternatives of development and operation of the project that could affect the prevailing environment, and the risks that these actions and alternatives present.
- A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment as well as the environment on the proposed development.
- A reasoned opinion as to whether the proposed activity or portions thereof should be licensed, and if so; any avoidance, management actions, mitigation measures and monitoring recommendations. These must be provided in a form that enables the seamless capture of measures into an [Environmental] Management Plan.
- A description of any consultation process that was undertaken during the course of carrying out the specialist study.
- A summary and copies of any comments that were received during any consultation process.
- A clear analysis as to how each recommended mitigation action would reduce negative impacts or enhance positive ones.

3. PROJECT DESCRIPTION

The section of the Equiano Cable System which forms part of the Detailed Scoping and Environmental Assessment includes the section of cable from where it enters Namibia's Exclusive Economic Zone (EEZ)[2] through Namibian Territorial Waters and onto land until it reaches the Paratus Cable Landing Station (CLS) in Swakopmund.

The Marine Components of the Equiano Cable System are described further below, whereas the description of the nearshore (intertidal zone to beach) and terrestrial components (Beach Man Hole to Cable Landing Station) are excluded from the current report.

3.1 Marine Fibre Optic Cable

The proposed cable route will run down the West Coast of Africa (generally parallel to the coastline) and approach Namibian coastal waters from the north. Offshore, the cable is laid by a purpose-built cable-laying ship. Consistent with industry practice, the unarmoured cable will rest on the seabed in water depths greater than 1,500 m, where the risk of inadvertent damage from human activities is negligible.

As the cable route changes direction and towards the approach to the coastline of Swakopmund, the cable will be buried beneath the sandy seabed of the shallower marine waters (the proposed route alignment for the Equiano Cable System is shown in Figure 1.2. This is typically achieved with the use of a specially designed plough, which is submerged onto the seabed by the cable laying ship. The cable is then fed from the ship to the plough which effectively buries the cable to a depth of approximately 1 m, where burial is possible. This burial is intended to provide protection to the cable from the hazards posed by ships' anchors, fishing trawls/lines and the like. In good sea conditions, up to 20 km of cable can be installed and buried per day.

[2] The-sea outside the territorial sea of Namibia (first 12 nautical miles from the low water line (the line of the lowest astronomical tide)) but within a distance of two hundred nautical miles from the low water line or any other base line from which the territorial sea was measured constitutes the exclusive economic zone of Namibia (Government Notice 7 of 1990 promulgated in terms of Act 3 of 1990).

The diameters of the marine fibre optic cables range from 17 mm diameter (cables installed at a water depth of between 7,000 – 1,500 m) to 37.5 mm diameter).

Within the shallow water environment (water depth of up to 1,000 m), the cable will be buried in sediment wherever possible and the route will be adjusted to avoid obvious visible rock. The aim is to bury the cable to a depth of 1 m where possible. If rock is encountered at a depth shallower than 1 m, no effort will be made to trench through or excavate any rock but rather lay the cable upon the rock substrate. In such situations, the cable will be securely held in place by its own weight and the weight of the rest of the cable more deeply buried in sand. As such, there will be no need to anchor or to pin or clamp the cable to rocky substrates.

3.2 Cable Route Survey and Route Clearance Operations

Prior to the installation of the Equiano Cable System, the following offshore marine investigations will be performed by ASN.

3.2.1 Cable Route Survey

The proposed cable routes will be surveyed to identify whether the substrate and topography of the ocean floor are suitable for the installation of the Equiano Cable System. The survey will include the following activities:

- A geophysical survey of the deep water, shallow water, and inshore sections of each proposed cable route alternative. This will include the establishment of bathymetric corridor widths of 500 m (inshore and up to a depth of 500 m). In deeper water, this corridor will extend up to three times the water depth centred on the proposed cable route.
- Conducting a side scan sonar and survey of a 500 m corridor width (inshore and up to a depth of 500 m) centred along the proposed cable route.
- The cable route will be surveyed using Multi-Beam Echo Sounder (MBES) Swath Bathymetry systems. The MBES equipment is integrated with the surface navigation equipment (GPS).
- Bathymetric data will be processed using an onboard workstation with specialised software to verify the coverage and accuracy of the collected bathymetry data and to provide colour contour charts. These charts will be used to review the proposed route and, where necessary, plan offset lines.
- In the shallow water sections, an integrated Side Scan Sonar and a Sub-Bottom Profiler will be used. These will be housed in a device which will be towed behind a boat to get to an optimum position close to the seabed. The position of this towed device will be tracked acoustically using an Ultra-Short Base Line (USBL) tracking system.
- A burial assessment survey will be undertaken from the shore line up to a depth of 1,000 m to test the suitability of the substrate for cable burial. The survey will include Cone Penetrometer Tests (CPTs) with an average of one CPT taken at 4 km intervals in planned burial areas.
- The landing sites for all cable segments will be positioned utilising a GPS and topographic surveying practices. (The in-shore survey vessels will use a GPS navigation system).
- At the landing site, the survey of the shore approach will be supported where appropriate by a diver/swim team equipped with both video camera and bar probes. Any obstructions, potential hazards or engineering constraints to the submarine cable will be located and fully documented.

- The offshore alignment of the proposed Equiano Cable System passes through the trawling grounds of the demersal trawling industry and may impact on fisheries through the restriction of fishing activities within a proclaimed buffer (no fishing or anchoring within 0.5 Nm either side of the telecommunications cable).

3.2.2 Cable Route Clearance Operations

Prior to the installation of the Equiano Cable System, route clearance operations will be conducted along those sections of the route where burial is to be performed to ensure that, as far as practically possible, the burial operation will not be hindered by out of service cables or discarded fishing gear. This route clearance operation is typically called the Pre-Lay Grapnel Run (PLGR). The objective of the PLGR operation is the clearance of any seabed debris, for example, wires or hawsers, fishing equipment etc, which may have been deposited along the route as well as the recovery of Out of Service (OOS) cables as per the ICPC recommendations. The operation is performed only where plough burial is proposed to clear away debris on the seafloor which could obstruct and damage the plough or the new cable.

PLGR is undertaken by dragging grapnels behind a vessel along the proposed cable route to clear the route of debris. Different types of grapnels can be used depending on the seabed conditions (Gillford in rockier areas and Rennies and Flat Fish in softer sandy sediments).

The PLGR operations are normally carried out by a vessel specifically fitted with winches and grapnels, and capable of sustaining good slow speed positional control. The vessel will be equipped with navigation and positioning systems to the same specification as the main lay vessel.

Any debris recovered during these operations will be discharged onshore on completion of the operations and disposed in accordance with local regulations.

3.3 Installation of the Marine Telecommunications Cable

The Equiano Cable System will be installed using a purpose-built cable vessel fully equipped with all the necessary equipment, tools and facilities to safely handle and install, join, test, and power the submerged plant, including simultaneous lay and plough burial. The vessel will have sufficient power and dynamic positioning capability to carry out the installation in the expected weather and current conditions. During cable laying, an automatic log of all critical operational parameters will be kept including navigational data, speed, tension, slack, cable counter and plough data.

Surface Laying Operations

Surface laying implies that the cable will be laid on the surface of the seabed. The objective is to install the cable as close as possible to the planned route with the correct amount of cable slack to enable the cable to conform to the contours of the seabed without loops or suspensions.

Plough Burial Operations

The cable will be buried to a target depth as defined in the burial plan, and as determined by the cable route and burial assessment surveys. Burial depth will be controlled by adjusting the height of the plough's front skids. The depth of burial achieved will be continuously recorded by the plough and logged with the vessel's data. In areas where plough burial is planned, the cable will be buried to a target depth of between 1 m.

Crossing Existing Submarine Cables and Pipelines

For cable route planning, ASN uses the Global Marine Cable Database augmented by ASN's own internal databases and Admiralty Charts to identify all known existing and proposed telecommunication and power cable systems and pipelines that will be crossed by the Equiano Cable System. Where existing cables are crossed, the industry norm is to ensure that the crossing is undertaken using a similar type cable, i.e. an armoured cable crosses an armoured cable, or an unarmoured cable crosses an un-armoured cable. Where seabed conditions allow, post lay cable burial using a Remote Operated Vehicle (ROV) can be performed to afford additional protection to the cables at the crossing point.

If the Equiano Cable System requires a pipeline crossing, ASN recommends the application of Uraduct (or similar product) to the cable at the point of contact with the pipeline. Uraduct is a protection system designed and developed to protect subsea fiber optic cables, power cables, umbilicals, flexible flowlines, rigid flowlines, hoses and bundled products from abrasion and impact. Generally, the length of URaDUCT required for a pipeline crossing is dependent on water depth and subject to the final refinement by the cable owners, cable installers and pipeline owners. Mattressing[3] can also be used when crossing pipelines; however, this is not considered necessary for standard pipeline crossings but may be installed in special circumstances at the request of the pipeline operator. (There will be no pipeline crossing in Namibian waters, but there are pipeline crossings in other parts of the system).

Note that a description of the shore-end and terrestrial components of the project are not included in the current report.

4. APPROACH AND METHODOLOGY

4.1 Description of Potential Impacts on Fisheries

Exclusion Zone

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a vessel that is engaged in the laying of a cable is defined as a "vessel restricted in its ability to manoeuvre" which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Vessels engaged in fishing shall, so far as possible, keep out of the way of the operation.

4.2 Impact Assessment Methodology

The assessment was focused on the marine portions of the project and the effects caused by temporary exclusion of fishing in the area during the cable laying operations. The shore-based activities of the project were not considered to be applicable for assessing impacts to commercial fishing and were not included in this analysis.

The spatial distribution of catch was mapped at an appropriate resolution for each fishing sector (based on the fishing method and resulting area covered by fishing gear). The catches recorded in the affected area were extracted for the period 2005 to 2019 (where available) (see Table 4-1). The proposed routing of the cable was mapped and a spatial buffer of 0.5 nautical miles to either side of the cable route was applied to indicate 1) the temporary exclusion of fishing vessels during cable-laying operations and 2) the potential

[3] Generally, mattresses are made of high strength concrete segments linked together with a network of high strength polypropylene ropes to form a continuous flexible concrete barrier which is used to separate structures ensuring the protection of infrastructure.

area of exclusion to trawling and anchoring surrounding the installed cable (applicable to demersal fishing operations only). This area was mapped and the spatial overlap expressed as a percentage of fishing ground available to each sector. This measurement was used as an indication of the relative extent of the impact on each fishery where an overlap of less than 10% was considered to be local in extent and an overlap of greater than 10% was considered to be regional in extent. The average annual catch taken within the impacted area was used to calculate the amount of catch (also expressed as a percentage of overall total landings) that would potentially be lost.

The findings were described according to the following set of conventions provided by the EAP (ACER) for purposes of an integrated assessment of potential impacts, and the determination of impact significance:

- **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

- **Indirect impacts** of an activity are indirect or induced changes that may occur because of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place because of the activity.

- **Cumulative impacts** are those that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over time and can include both direct and indirect impacts.

- **Nature** – the evaluation of the nature is impact specific. Most negative impacts will remain negative, however, after mitigation, significance should reduce:
    - Positive
    - Negative

- **Spatial extent** – the size of the area that will be affected by the impact:
    - Site specific
    - Local (limited to the immediate areas around the site; < 2 km from site)
    - Regional (would include a major portion of an area; within 30 km of site)
    - National or International

- **Duration** – the timeframe during which the impact will be experienced:
    - Short-term (0-3 years or confined to the period of construction)
    - Medium-term (3-10 years)
    - Long-term (the impact will only cease after the operational life of the activity)
    - Permanent (beyond the anticipated lifetime of the project).

- **Intensity** – this provides an order of magnitude of whether the intensity (magnitude/size/frequency) of the impact would be negligible, low, medium or high):
    - Negligible (inconsequential or no impact)
    - Low (small alteration of natural systems, patterns or processes)
    - Medium (noticeable alteration of natural systems, patterns or processes)
    - High (severe alteration of natural systems, patterns or processes).

- **Frequency** – this provides a description of any repetitive, continuous or time-linked characteristics of the impact:
    - Once Off (occurring any time during construction)
    - Intermittent (occurring from time to time, without specific periodicity)
    - Periodic (occurring at more or less regular intervals)
    - Continuous (without interruption).
- **Probability** – the likelihood of the impact occurring:
    - Improbable (very low likelihood that the impact will occur)
    - Probable (distinct possibility that the impact will occur)
    - Highly probable (most likely that the impact will occur)
    - Definite (the impact will occur).
- **Irreplaceability** – of resource loss caused by impacts:
    - High irreplaceability of resources (the project will destroy unique resources that cannot be replaced)
    - Moderate irreplaceability of resources (the project will destroy resources, which can be replaced with effort)
    - Low irreplaceability of resources (the project will destroy resources, which are easily replaceable)
- **Reversibility** – this describes the ability of the impacted environment to return/be returned to its pre-impacted state (in the same or different location):
    - Impacts are non-reversible (impact is permanent)
    - Low reversibility
    - Moderate reversibility
    - High reversibility of impacts (impact is highly reversible at end of project life).
- **Significance** – the significance of the impact on components of the affected environment (and, where relevant, with respect to potential legal infringement) is described as:
    - Low (the impact will not have a significant influence on the environment and, thus, will not be required to be significantly accommodated in the project design)
    - Medium (the impact will have an adverse effect or influence on the environment, which will require modification of the project design, the implementation of mitigation measures or both)
    - High (the impact will have a serious effect on the environment to the extent that, regardless of mitigation measures, it could block the project from proceeding).
- **Confidence** – the degree of confidence in predictions based on available information and specialist knowledge:
    - Low
    - Medium
    - High

4.3 Data Sources

Namibian commercial fisheries catch and effort data were sourced from the Ministry of Fisheries and Marine Resources (MFMR) for the period 2005 to 2019, where available. Data on fishing rights holdings and industrial bodies was sourced from the 2019 edition of the Fishing Industry Handbook[4]. Information on species distribution was taken from the Benguela Current Large Marine Ecosystem (BCLME) Annual State of the Stocks Report 2011[5].

Table 4-1: Date range of data used for each fishery sector assessed.

Section Ref.	Sector	Date Range		Comment
		Catch	Effort	
5.5.1	Small pelagic purse-seine	2005 – 2017	2005 – 2017	Fishery was closed for a three-year period commencing 01 January 2018
5.5.2	Midwater trawl	2005 – 2018	2005 – 2018	
5.5.3	Demersal trawl	2005 – 2018	2005 – 2018	
5.5.4	Demersal longline	2005 – 2018	2005 – 2018	
5.5.5	Large pelagic long-line	2004 – 2019	2004 – 2019	
5.5.6	Tuna pole	2004 – 2019	2004 – 2019	
5.5.7	Line-fish	2000 – 2019	2000 – 2019	
5.5.8	Deep-sea crab	2013 – 2018	2013 – 2018	
5.5.9	Deep-water trawl	1994 – 2007	N/A	Fishery has been closed since 2007
5.5.10	Rock lobster	2005 – 2016	2005 – 2016	

4.4 Assumptions, Limitations and Information Gaps

The study is based on a number of assumptions and is subject to certain limitations listed below. The outcome of the impact assessment is, however, not expected to be affected by these assumptions and limitations:

- The official governmental record of Namibian commercial fisheries data was used to show fishing catch and effort relative to the licence area. These data are derived from logbooks that are completed by skippers whilst at sea and then transcribed into electronic format by the Ministry of Fisheries and Marine Resources (MFMR). It is assumed that there would be a proportion of erroneous data due to inaccurate reporting and recording, but that this is likely to be minimal in comparison to the total volume of the dataset. Where obvious errors in the reporting of fishing positions were identified these were excluded from the analysis.
- The fishing positions are reported by the skippers as the start latitude and longitude of each fishing event and the accuracy of the reported positions is assumed to be to the nearest nautical minute (approximately 1 nautical mile).
- The dataset used to map the spatial distribution for each fishery covers at least a ten-year period and includes the most recent available data. The time span for each sector is listed in Table 4-1.
- Based on the description provided for the current project, the cable would be protected from damage by trawling (and other fishing operations) through burial to a depth of 1 m. This action is implemented

[4] Fishing Industry Handbook South Africa, Namibia and Moçambique (2019) 47th edition George Warman Publications, Cape Town, South Africa

[5] Benguela Current Large Marine Ecosystem State of Stocks Review 2011 (2nd Edition; Ed C. Kirchner). Benguela Current Commission.

to reduce the risk of damage to the cable rather than a mitigation of the impact of loss of ground to fishermen. The cable routing would be charted and trawl skippers would need to take reasonable care not to trawl over the cable, once installed. Therefore, the current assessment is based on the assumption that demersal fishing activity would be excluded along the entire length of the proposed cable route to a distance of 0.5 nm on either side of the cable.

5. DESCRIPTION OF RECEIVING ENVIRONMENT

5.1 Background

Namibia has one of the most productive fishing grounds in the world, based on the Benguela Current System (FAO, August 2015). Namibia is Africa's fourth largest capture fisheries nation behind Morocco, South Africa and Mauritania, and 36th worldwide.[6] Namibia's 200 nautical mile Exclusive Economic Zone (EEZ) supports some 20 different commercially exploited marine species. The three main Namibian commercial species (hake, sardine and horse mackerel) comprise the primary species of historical importance in Namibia. Other species of more recent importance include orange roughy, the deepwater crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna. The majority of sectors are considered by MFMR to be sustainably utilised.

Prior to Namibian independence in 1990, fisheries in Namibian water were managed under a Regional Fisheries Management Organisation (RFMO) known as the International Commission for South East Atlantic Fisheries (ICSEAF). During this time fish resources were heavily exploited by foreign fishing fleets operating under ICSEAF as well as Illegal, Unreported and Unregulated fishing (IUU). The ICSEAF RFMO was disbanded in 1989, critically however, during the period of tenure of this organisation, several international measures were introduced under the United Nations Convention of the Law of the Sea (UNCLOS). This included the United Nations Fish Stocks Agreement for Highly Migratory Species, and the declaration of the 200 nm EEZ. Since independence, the Namibian government has taken over the management of its fisheries and drastically cut Total Allowable Catch (TAC) levels for key commercial species, which has allowed most fish stocks to recover to maximum sustainable levels (MFMR, August 2004). Namibia has gained international repute for its well-managed fishery and has become an exporter of quality fish products to countries including South Africa, Democratic Republic of the Congo, Mozambique, Spain, Italy and Portugal (MFMR, 2013).

The fishing industry is a cornerstone of the Namibian economy, generating approximately N$10 billion in export revenue (2016) - the second most important forex earner after mining, while it sustains some 16 800 direct jobs (Ministry of Fisheries and Marine Resources, 17 February 2017) - 70% of which are in the hake sector.

Each of these fisheries sectors are covered in the following overview of the current status of Namibian fisheries. Note also, because of the poor data records of these fisheries associated with irregular management, it is only since Namibian independence that attempts have been made to reconstruct the historical catches of these fisheries.

5.2 Overview of the Status of Namibian Fisheries since 1990s

The Namibian fishing industry is the country's second largest export earner of foreign currency and the third largest economic sector in terms of contribution to the Gross Domestic Product (GDP). In terms of the value of production, Namibia ranks among the top ten fishing countries globally (Food and Agricultural

[6] Wikipedia, February 2017. https://en.wikipedia.org/wiki/Fishing_industry_by_country

Organization (FAO): http//www.fao.com.na). Supported by the high productivity of the Benguela upwelling ecosystem, abundant fish stocks have historically typified Namibian waters[7]. Fish resources in upwelling systems are typically high in biomass and relatively low in diversity (relative to non-upwelling environments). Commercial fish stocks, as found in the Benguela system typically support intensive commercial fisheries. Although varying in importance at different times in history, Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, linefish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay and surrounds. The main commercial fisheries, targeted species and gear types are shown in Table 5-1 and recent TACs are presented in Table 5-2 below. The allocation of TACs and management of each fishing sector is the responsibility of MFMR.

Table 5-1: List of fisheries that operate within Namibian waters, targeted species and gear types used.

Fishery	Gear Type	Targeted Species
Mariculture	Long-lines, rafts	Pacific oysters, European oysters, Black mussel, Seaweed (Gracilaria sp.)
Small pelagic	Purse-seine	Sardine (*Sardinops sagax*), Horse mackerel (*Trachurus capensis*)
Mid-water trawl	Mid-water trawl	Horse mackerel (*Trachurus capensis)*
Demersal trawl	Demersal trawl	Cape hakes (*Merluccius paradoxus, M. capensis*), Monkfish (*Lophius vomerinus)*
Demersal long-line	Demersal long-line	Cape hakes (*Merluccius paradoxus, M. capensis*)
Large pelagic long-line	Pelagic long-line	Albacore tuna (*Thunnus alalunga*), Yellowfin tuna (*T. albacares*), Bigeye tuna (*T. obesus*), Swordfish (*Xiphias gladius*), shark spp.
Tuna pole	Pole and line	Albacore tuna
Line-fish	Hand line	Silver kob (*Argyrosomus inodorus*), Dusky kob (*A. coronus*)
Deep-sea crab	Demersal long-line trap	Red crab (*Chaceon maritae*)
Deep-water trawl	Demersal trawl	Orange roughy (*Hoplostethus atlanticus),* Alfonsino (*Beryx splendens*)
Rock Lobster	Demersal trap	Rock lobster (*Jasus lalandii*)

Table 5-2: Total Allowable Catches (tons) from 2009/10 to 2020/21 (supplied by Ministry of Fisheries and Marine Resources, Namibia).

Year	Sardine / Pilchard	Hake	Horse Mackerel	Crab	Rock Lobster	Monk
2009/10	17 000	149 000	230 000	2700	350	8 500
2010/11	25 000	140 000	247 000	2700	275	9 000
2011/12	25 000	180 000	310 000	2850	350	13 000
2012/13	31 000	170 000	310 000	3100	350	14 000
2013/14	25 000	140 000	350 000	3100	350	10 000

[7] Noting that in the ICSEAF period these resources were over-exploited. The northern Benguela (Namibian waters) however remains a highly productive upwelling system resulting in proportionately (to many other countries) abundant commercial fish resources

2014/15	25 000	210 000	350 000	3150	300	12 000
2015/16	15 000	140 000	335 000	3446	250	10 000
2016/17	14 000	154 000	340 000	3400	240	9800
2017/18	0	154 000	340 000	3400	230	9600
2018/19	0	154 000	349 000	3900	200	9600
2020/21*	0	154 000	349 000	3900	180	9600

Note: Deepwater trawl TAC is currently not applied for Alfonsino and Orange roughy. There is no TAC (output control) for albacore tuna – this is an effort (input) controlled sector with no restriction on catch.

" *Provisional" noting that fishing rights not yet allocated and current rights and allowable catches subject to extension of 2018/19 allocations

Namibia has only two major fishing ports from which all the main commercial fishing operations are based namely, Walvis Bay and Lüderitz. In central Namibia, the major port is Walvis Bay and it is from this port that the majority of fishing vessels operate. Most of the fishing conducted from this port is, for economic and logistical reasons, directed at fishing grounds in the central and northern part of Namibia and to a lesser extent the southerly fishing grounds towards the South African border. A significant amount of fishing activity also takes place from Lüderitz, from where hake trawlers and longliners operate, as well as a small rock lobster fishery based in southern Namibian waters.

There are currently 116 Namibian-registered commercial fishing vessels. The dominant fleet comprises demersal trawlers that include both large freezer vessels (up to 70 m in length), as well as a smaller fleet of monk trawlers. These vessels fish year round, with the exception of a one month closed season in October, and range the length of the Namibian EEZ. There is a 200 m fishing depth restriction (i.e. no bottom trawling permitted shallower than 200 m). Prior to Namibian independence in 1990, a much larger fleet of trawlers existed, however Namibia now exercises strict effort control and vessel size limits. The only other fleets of significance are the mid-water trawlers that target horse mackerel and the large pelagic tuna long-line vessels. The mid-water fleet was historically uncontrolled and comprised of many large industrial vessels mostly of eastern origin (Ukranian and Russian). Currently these large midwater trawl vessels (mostly >100 m in length) operate in the northern waters of Namibia and are restricted to fewer than 20 vessels.

The large pelagic (tunas and shark) long-line vessels operate broadly in Namibian waters, but unlike the mid-water vessels, concentrate in the south near the South African border targeting the migrations of albacore and yellowfin tuna. The numbers of these vessels varies and is dependent on the seasonal availability of tuna and tuna-like species. The tuna pole (baitboat) vessels are a small fleet[8] and also increase in numbers depending on the number of licenses issued to South African boats. The tuna long-liners are also variable with the number of licenses issued to both Namibian flags and others (mostly Asian) fluctuating annually. The extent and number of these vessels is difficult to ascertain (as they are unpublished), although the actual numbers are limited and are less than the numbers of licensed Namibian boats.

There are few known foreign fishing vessels licensed to fish in Namibian waters, although the majority of the current mid-water fleet have permits to fish under foreign flag registration, but as a rule all licensed fishers must reflag under Namibia. There is a possibility that licenses may have been issued to foreign tuna boats, although these would be few in number and they would be closely monitored by the Namibian compliance units and their Vessel Monitoring System (VMS).

[8] The baitboat fleet consists of up to 20 Namibian vessels. This is a small number of vessels compared to South Africa. However, because of the variable and migratory nature of tuna, the number of vessels participating in the fishery varies depending on the seasonal and inter-annual availability of tuna. Namibia also licenses South African vessels to optimise the exploitation of these resources when they are available.

5.3 Fisheries Management and Research

The commercial exploitation of fish stocks is managed by MFMR, which is advised by the Ministry's National Marine Information and Research Centre (NatMIRC) in Swakopmund. TACs are set annually by the Minister on recommendation by an advisory council. Commercial fisheries are represented at industry level by the Confederation of Namibian Fishing Industries, and at fish species sector-specific level by the Midwater Trawling Association of Namibia, the Namibian Hake Association, Namibian Monk and Sole Association, Namibian Tuna and Hake Longlining Association and the Pelagic Fishing Association of Namibia.

MFMR conducts regular research (biomass) surveys for demersal, mid-water and small pelagic species. These surveys are normally fixed at specific times of the year and cover the entire continental shelf from the Angolan to the South African maritime borders. For example the demersal trawl surveys take place in January and/or February over the period of one month. MFMR surveys normally follow fixed transects from inshore to offshore. Surveys have a systematic transect design, with a semi-random distribution of stations along transects designed to statistically optimise the number of stations according to the area of every 100 m depth zone out to 500 m. Transects normally run perpendicular to the coastline are 20-80 nm long and are spaced between 20 and 25 nm apart. Most of the sampling stations (trawls) take place during daylight hours.

Swept-area biomass surveys for hake are conducted annually to obtain an index of abundance, determine the geographical distribution and collect biological information of the stock. From 1990 to 1999, these surveys were conducted with the Norwegian R/V *Dr Fridtjof Nansen* (Sætersdal *et al* 1999). Since 2000, Namibian commercial trawlers (using the same trawl gears as that of the *Dr Fridtjof Nansen*) were used for the surveys. Since 2002, the commercial trawler *F/V Blue Sea 1*[9] has been used to conduct these surveys. These surveys are normally carried out over the period of one month during January and February and cover the entire continental shelf from the Angolan to the South African maritime border. The method of abundance estimation from these surveys is based on depth stratification and trawls range in depth from 100 m to 600 m. During trawling the vessel tows the net for a period of 30 minutes at a speed of approximately 3 knots.

Scientific acoustic surveys are carried out between February and March each year to estimate the biomass of small pelagic species (using the survey vessel F/V *Welwitchia*). These surveys cover the Namibian shelf from the coastline to the 500 m depth contour (and up to the 2000 m contour northwards of 18°30´S). The vessel surveys along pre-determined transects that run perpendicular to depth contours (East-West / West-East direction).

5.4 Stock Distribution, Spawning and Recruitment

The distribution patterns for the Namibian commercial stocks are summarised as follows:

- **The sardine stock** ranges along the entire Namibian coast, but in recent years predominantly from 25°S northwards to southern Angola, inshore of the 200 m bathymetric contour. The southern border of this range is demarcated by the Lüderitz upwelling front, a region of cold, upwelled water located off the port of Lüderitz. Historically, spawning occurred continuously from September to April with two seasonal peaks evident – the first from October to December in an inshore area between Walvis Bay and Palgrave Point and the second from February to March near the 200 m isobath between Palgrave Point and Cape Frio (King, 1977). The fishery collapsed in the 1960's and currently the status remains overexploited with a low biomass estimate and a significantly contracted distribution pattern compared to historical levels. The fishery is currently closed after a three-year moratorium was implemented on 01 January 2018 due to a significant population reduction. Scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019).

[9] Namibia now also has new research vessel, the *FV Mirabalis* undertaking routine fishery surveys

- **Cape horse mackerel** occurs predominantly north of 25°S with juveniles present in the inshore regions up to the 200 m isobath and adult horse mackerel populations extending into waters up to 500 m deep. Biomass estimates in this region are mostly low in summer and higher in winter and early spring. Abundance of horse mackerel is, therefore, higher at these times and increases availability of the species to the fisheries exploiting them. Spawning is heaviest in the north between October and March (O'Toole 1977).

- **Albacore tuna, yellowfin tuna, bigeye tuna, shark and swordfish** are large pelagic species with an extensive offshore distribution ranging along the entire Namibian coastline. The abundance of these species has a strong seasonal signal resulting in increased availability to the fisheries targeting them at different periods. For albacore tuna, availability increases from the last trimester (summer) and peaks in the first trimester (late summer to early autumn). Baitboats using pole and line target albacore tuna primarily in southern Namibia in the first trimester (January to March). For the pelagic longline sector targeting yellowfin tuna, bigeye tuna and swordfish, the availability of these target species is highest in the second and third trimesters. It is important to note that weather conditions play an important role in operations within the tuna fisheries (pole and line and long-line). With the onset of summer there is cold water upwelling as a result of increasing south-easterly winds. The availability of longfin tuna is associated with this increased biological activity and bait fish (sardine and anchovy) abundance. The longline tuna fishing season peaks two to three months later than the fishery for albacore tuna.
- **Hake** is the most commercially important Namibian fishery. Within the Namibian EEZ the hake stock extends along the entire shelf and slope approximately between the 100 m and 1000 m isobaths. Hake spawn and recruit throughout the year with peaks in spawning thought to occur in early summer (Botha 1980, Olivar *et al.* 1988) along the shelf break off central Namibia.
- **Monkfish** is found along the entire extent of the Namibian coast, with the fishery concentrated between 17°15'S and 29°30'S at depths of 200 m to 500 m. Spawning is irregular and variable and is thought to occur throughout the year (Macpherson 1985) with two separate areas of recruitment recorded between the 100 m and 300 m isobaths off Walvis Bay and Lüderitz (Leslie and Grant 1990).
- **Deep-sea red crab stocks** are distributed predominantly from 23°35'S northwards into Angola within a depth range of approximately 300 m to 1000 m. Spawning takes place throughout the year (Le Roux 1997) on the shallower waters of the continental slope with adult females generally occurring at shallower depths to that of males.
- **Orange roughy** has a discontinuous pattern of distribution along the continental slope with concentrations of fish within four known spawning grounds (within designated Quota Management Areas) within the Namibian EEZ. The species has a short, intense spawning period of about a month from July to August (Boyer and Hampton 2001) during which period individuals aggregate. As a result of overexploitation of the stock(s), the fishery has been closed since 2007; however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery.
- **Rock lobster** is found from 25°S to 28°30'S at depths shallower than 100 m. The depth distribution of adults varies seasonally in response to changes in the concentration of dissolved oxygen in the water. Adults moult during spring (males) and late autumn/early winter (females), with egg hatching peaking in October/November. Fishing activity is greatest over January and February with the number of active vessels declining towards the end of the fishing season in May.

The principle commercial fish species in Namibia undergo a critical migration pattern which is central to the sustainability of the small pelagic and hake fisheries. In Namibian waters, hake spawning commences north of the powerful Lüderitz upwelling centre (27°S) and continues up to the Angola–Benguela Front (16–19°S). Sardines and horse mackerel also spawn in the region between Lüderitz and the Angola–Benguela front. Circulation patterns at depth reveal complex eddying and considerable southward and onshore transport beneath the general surface drift to the north-west (Sundby *et al.* 2001). As eggs drift, hatching takes place followed by larval development. Settlement of larvae occurs in the inshore areas. Sardine spawning peaks

30–80 km offshore during September–October off the central Namibian shelf, with larvae occurring slightly further offshore and recruits appearing close inshore, so there appears to be a simple inshore–offshore movement over the Namibian shelf. Spawning also occurs in mid-summer in the vicinity of the Angola–Benguela Front (Crawford *et al.* 1987). During late summer (December – March) warm water from the Angolan Current pushes southwards into central Namibian waters, allowing pelagic spawning products to be brought into the nursery grounds off central Namibia. There is a high likelihood of substantial offshore transport associated with this convergent frontal region (Shannon 1985).

5.5 Description of Commercial Fishing Sectors and Fisheries Research Surveys

5.5.1 Small Pelagic Purse-Seine

The pelagic purse-seine fishery is based on the Namibian stock of Benguela sardine (*Sardinops sagax*) (also regionally referred to as pilchard), and small quantities of juvenile horse mackerel. The purse-seine fishery in Namibia commenced in 1947 following World War II and an increased demand for canned fish. The fishery was the largest by volume of fish landings in the Benguela ecosystem and grew rapidly until 1968, at which time the stock collapsed. Over the period 1960 to 1977, landings of pilchard averaged 580 000 tons per year and fell to a mere 46 000 tons in 1978 (see Figure 5-1). Following peak catches of 1.4 million tons recorded in 1968 (Cochrane et al., 2009; refer to Figure 5-2), there was a sharp decrease attributed to stock collapse due primarily to overfishing and environmental perturbations (Boyer et al. 2001). Since independence, Namibia has issued a small TAC of pilchard to sustain the small pelagic sector and to allow land-based factory turnover and in addition, they allow part of this catch to target juvenile horse mackerel (Kirchner et al., 2014). In recent years the resource base has been unable to sustain even these minimal TACs and the fishery has been closed and reopened on an ad hoc basis depending on resource availability. A three-year moratorium was implemented on 01 January 2018 due to a significant population reduction, and extensive scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019). This fishery is currently closed and may be reopened at the earliest during January 2021. Recent landings (2005 to 2017) are shown in Figure 5-2 and monthly trends in landings and catch composition are shown in Figure 5-3 (source MFMR, 2019).

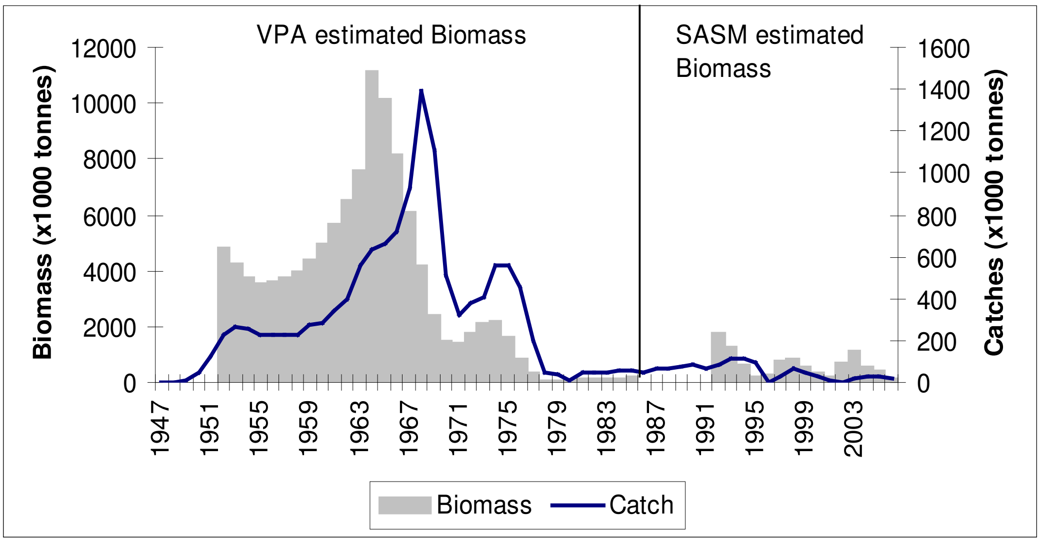

Figure 5-1: Biomass estimates from 1952-1985 of Namibian sardine (Virtual Population Analysis) from 1991-2006 as well as catches taken throughout this period (after Cochrane et al. 2009).

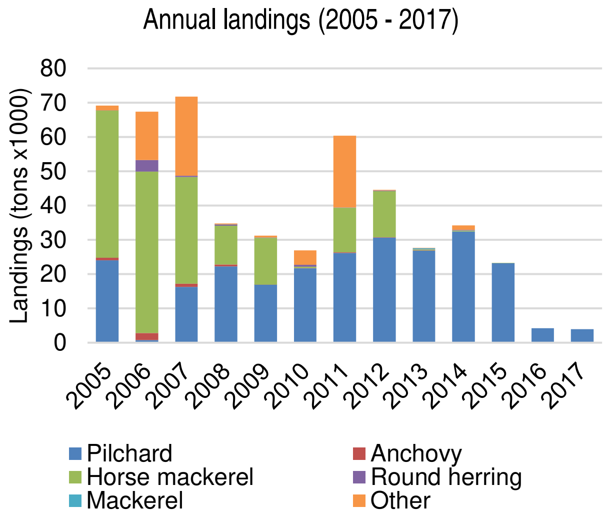

Figure 5-2: Annual landings (tons) of small pelagic species by the purse-seine sector from 2005 to 2017 (Source: MFMR).

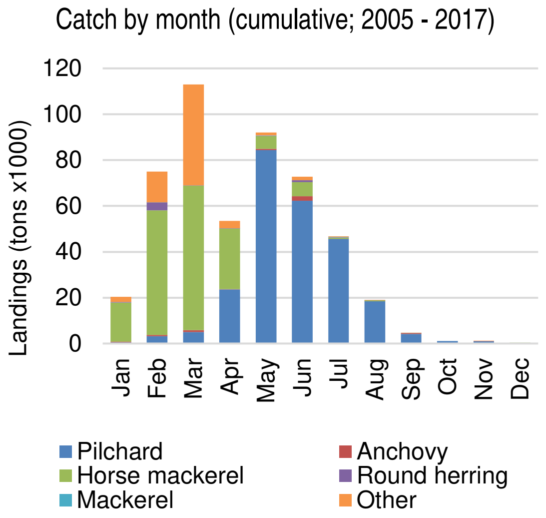

Figure 5-3: Monthly cumulative landings of small pelagic species by the purse-seine sector from 2005 to 2017 (Source: MFMR).

The industry operates from the harbour at Walvis Bay, except for the period 1964-1974 when Lüderitz was used as well. The small pelagic fleet consists of 36 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 21 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 to 90 m (see Figure 5-4 and Figure 5-5). Netting walls surround aggregated fish, preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped on board into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered on board and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

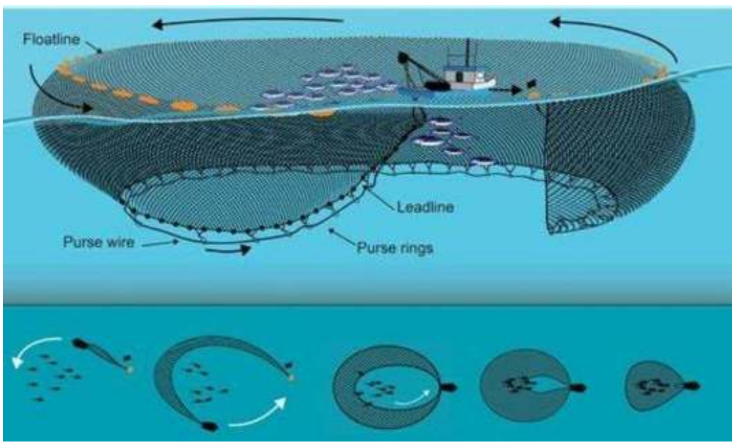

Figure 5-4: Schematic of typical purse-seine gear deployed in the small pelagic fishery (http://www.afma.gov.au/ portfolio-item/purse-seine).

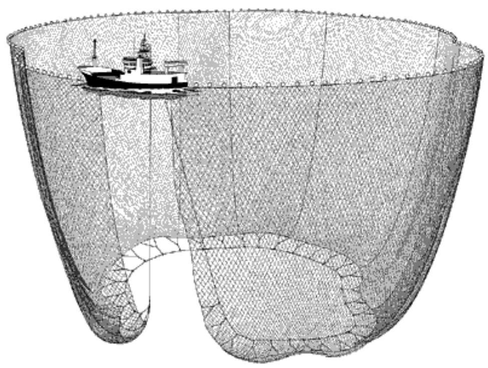

Figure 5-5: Typical configuration of purse-seine gear used to target small pelagic species (http://www.fao.org).

The extent of the stock distribution has effectively contracted since stock collapse, prior to which the historical distribution was throughout the Benguela system. Recent biomass surveys have shown small aggregations of the stock mostly located inshore of the 200 m isobath. The distribution of commercial fishing activity within the Namibian EEZ and in relation to the proposed routing of the Equiano Cable is shown in Figure 5-6. The fishery operates northwards of 25°S to the Angolan border primarily inshore of 200 m, but there is evidence of fishing activity across the proposed cable routing from a maximum depth of about 300 m extending into shallow waters adjacent to the coastline. In the vicinity of the proposed cable routing, fishing activity has been recorded from the 300 m depth contour up to the 30 m depth contour off the coast of Swakopmund.

The proposed cable routing (inclusive of 1 nm corridor) covers 205 km^2 of the total ground of approximately 50,218 km^2 (0.4%) used by the sector. An average of four fishing events per year yielding a total of 219 tons of catch were reported within this area over the period 2005 to 2017. This is equivalent to 0.6% of the average annual catch landed nationally by the sector over this time period. The fishery has been closed since 2018, however.

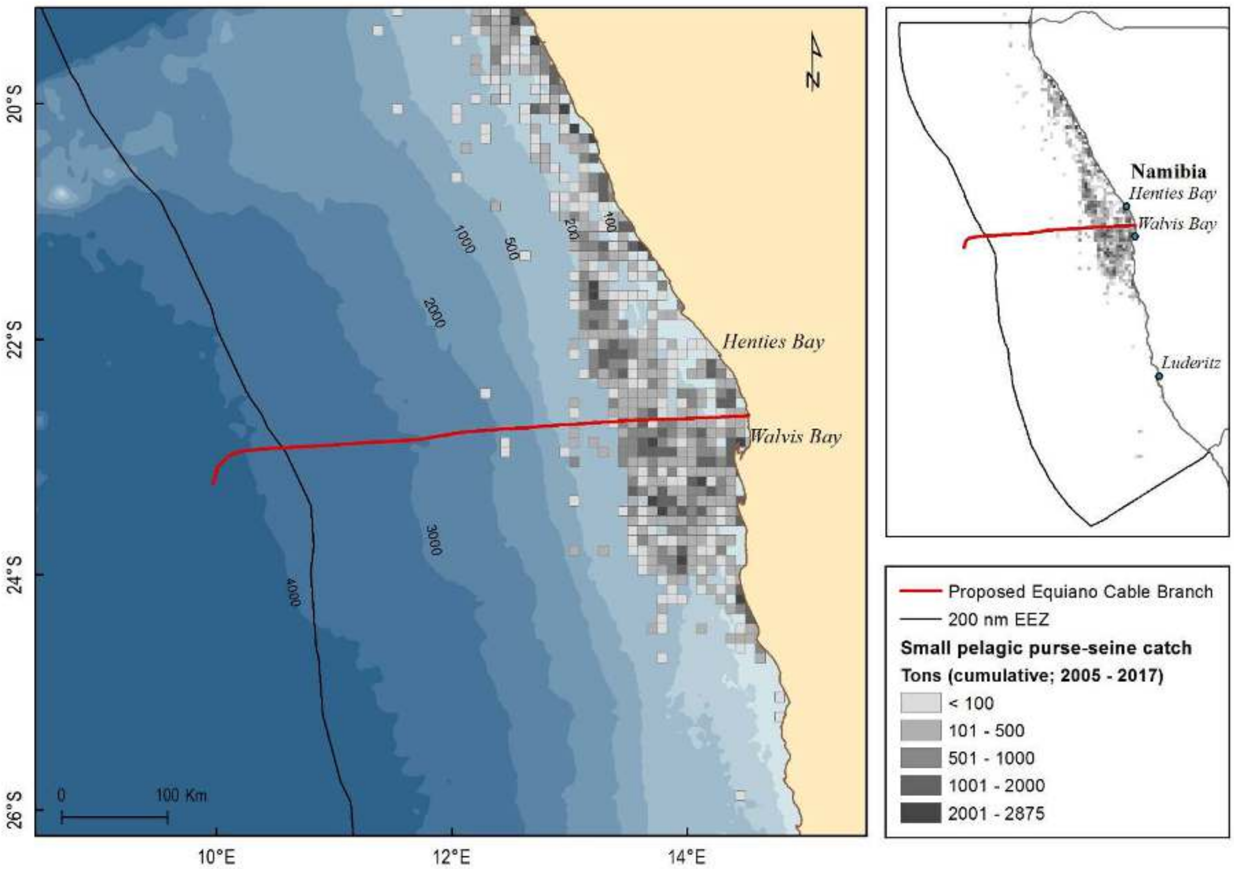

Figure 5-6: Spatial distribution of small pelagic purse-seine catch (2005 – 2017) in the vicinity of the proposed routing of the Equiano Cable in the Namibian EEZ.

5.5.2 Midwater Trawl

The fishery for Cape horse mackerel (*Trachurus capensis*) is the largest contributor by volume and second highest contributor by value to the Namibian fishing industry. The stock is caught by the mid-water trawl fishery (targeting adult horse mackerel) and pelagic purse-seine fishery (smaller quantities of juvenile horse mackerel). The midwater fishery operates using trawls within the water column to catch schools of adult horse mackerel. The catch is either converted to fishmeal or sold as frozen, whole product with landings for the year 2006 valued at N$800 million (MFMR unpublished data in Kirchner *et al.*, 2010). The processing of horse mackerel is an emerging employment creator, as value addition through on-shore fish processing is a key strategy for revenue and job creation under Government's National Development Plan, NDP 5, together with development of mariculture (National Planning Commission, 2016).

The history of the sector in Namibian waters shows initial low catches reported in the early 1960s and a fluctuating but overall increase to a maximum of 600 000 tons in the early 1980s. Since the 1990s landings were on average 300 000 tons per year and the current TAC for horse mackerel is 349 000 tons (2018/19). Figure 5-7 shows the TACs set from 1997 to 2018 for the pelagic and mid-water fisheries targeting the Namibian stock of horse mackerel.

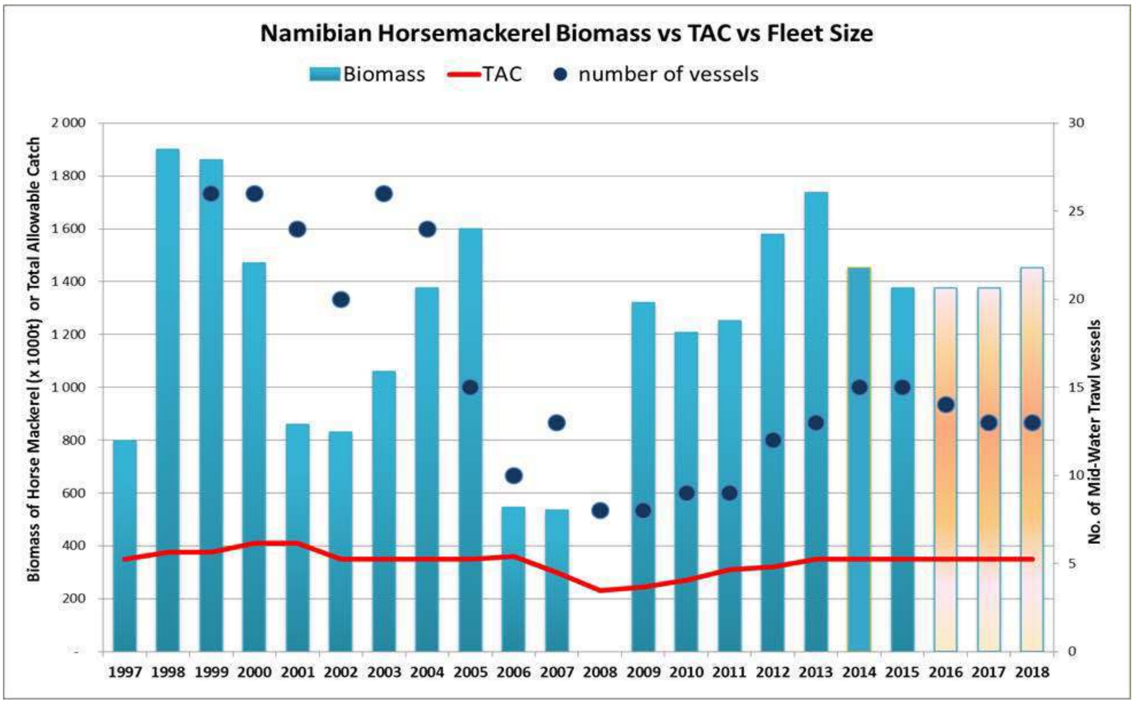

Figure 5-7: Estimated biomass of horse mackerel, TACs set for the mid-water fishery and number of licenced vessels (1997 to 2018).

Prior to independence, the fleet was dominated by various eastern block countries. After independence, the fishery underwent structural changes and it is currently mainly composed of the Russian fleet registered in Namibia but still operated by a foreign crew[10]. The fleet size has decreased since independence from 57 to 22 at present. Of these, only one is Namibian-flagged, although a further eight are based permanently in Namibia. Vessels range in length between 60 m and 120 m. In 2013, 67 rights-holders were registered within the mid-water trawl fishery, with the duration of rights ranging from seven to 15 years. Fishing rights are in the process of being reallocated and have as of yet not been finalised.

The target catch species is meso-pelagic (i.e. found at depths between 200 m and 1000 m above the sea floor (Crawford *et al*. 1987)) and shoals migrate vertically upwards through the water column between dusk and dawn. Mid-water trawlers exploit this behaviour (diurnal vertical migration) by adjusting the depth at which the net is towed (this typically varies from 400 m to just below the water surface). The net itself does

[10] These are large industrial vessels, primarily of Russian origin, that are flagged as Namibian and must carry a proportion of Namibian crew. The right to fish horse mackerel is only permitted to Namibian nationals who charter these vessels to catch their fish allocations.

not come into contact with the seafloor (unlike demersal trawl gear) and towing speed is greater than that of demersal trawlers (between 4.8 and 6.8 knots). Trawl warps are heavy, ranging from 32 mm to 38 mm in diameter. Net openings range from 40 m to 80 m in height and up to 120 m in width. Weights in front of, and along the ground-rope assist in maintaining the vertical opening of the trawl. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net is usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. On modern, large mid-water trawls, approximately three quarters of the length of the trawl is made with mesh sizes above 400 mm. A schematic diagram showing the configuration of midwater trawling gear is shown in Figure 5-8.

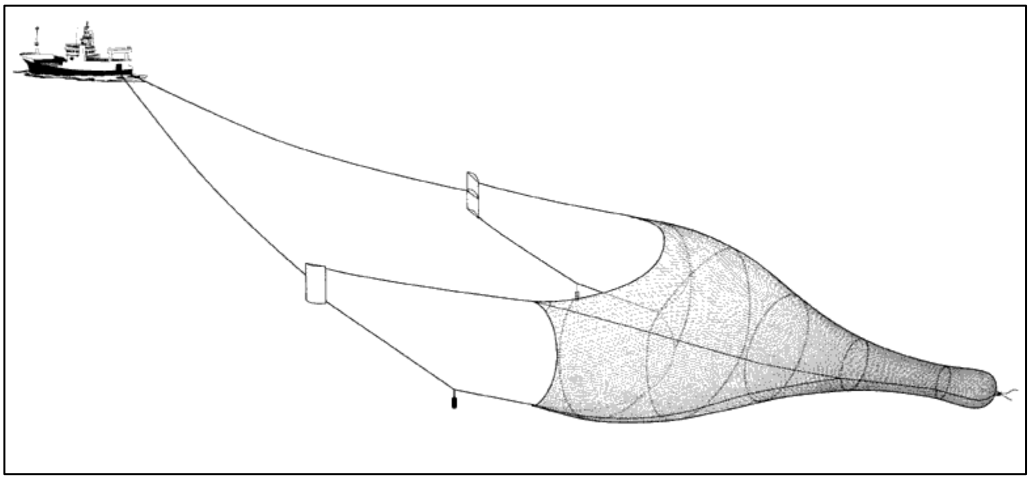

Figure 5-8: Typical gear configuration used during mid-water trawling operations.

The fishery operates year-round with relatively constant catch and effort values by month. The mid-water trawl fleet operates exclusively out of the port of Walvis Bay and fishing grounds extend north of 25ºS to the border of Angola. Juvenile Cape horse mackerel move into deeper water when mature and are fished mostly between the 200 m and 500 m isobaths towards the shelf break. The distribution of horse mackerel-directed fishing grounds in relation to the proposed routing of the Equiano Cable is shown in Figure 5-9.

The proposed cable routing crosses through midwater trawl fishing grounds at a seafloor depth range of 200 m to 500 m. The proposed exclusion zone[11] covers 143 km^2 or 0.2% of the total area of fishing ground (~64,228 km^2) used by the sector. Catch within this affected area amounted to 606.4 tons or 0.2% of the average annual catch landed nationally by the sector over the period 2005 to 2017.

[11] An exclusion corridor of 0.5 Nm to either side of the proposed cable routing where it coincides with fishing ground.

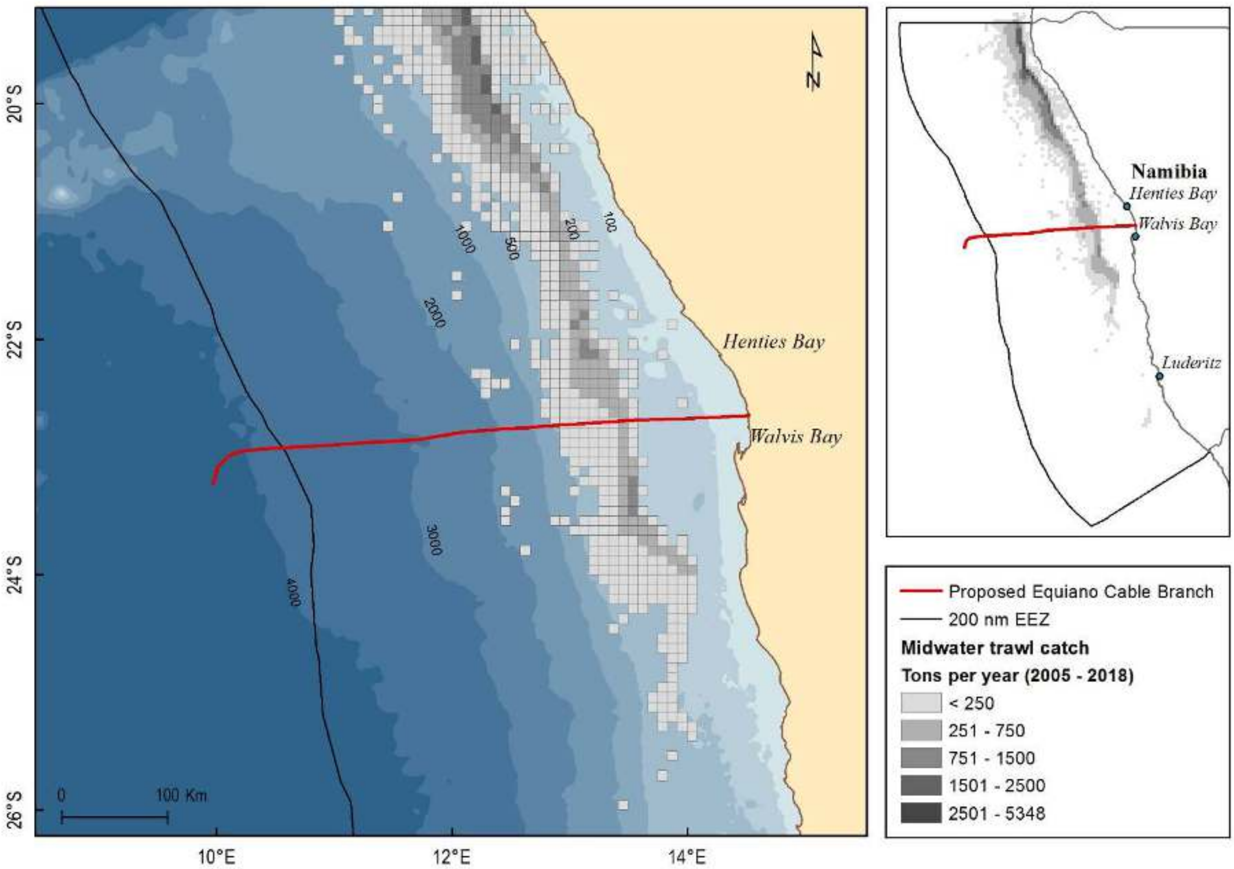

Figure 5-9: Spatial Distribution of Midwater Trawl Catch (2005 – 2018) within the Namibian EEZ and in relation to the proposed routing of the Namibian branch of the Equiano Cable.

5.5.3 Demersal Trawl

The most economically important species in Namibia are shallow-water hake (*Merluccius capensis*) and deepwater hake (*Merluccius paradoxus*). Shallow-water hake is the predominant species, but, because they look very similar, it is difficult to record data separately and the two species are managed as one stock. A proportion of the smaller vessels in demersal trawl fleet target monkfish (*Lophius* spp.), sole and kingklip.

Catches of hake in Namibian waters reached almost 1 million tons in the mid-1970s at the peak of their exploitation (some believe this was a gross underestimated) and was fished by many nations including eastern-block countries, South Africa and Spain (which remains significantly involved in Namibian fisheries). The fishery is currently managed through a TAC, which varies from year to year with a current annual hake TAC of 154 000 tons (2018/19). TACs for hake and monkfish over the period 1991 to 2018 are shown in Figure 5-10. The fishery is active year-round except for a closed period during October each year (see Figure 5-11).

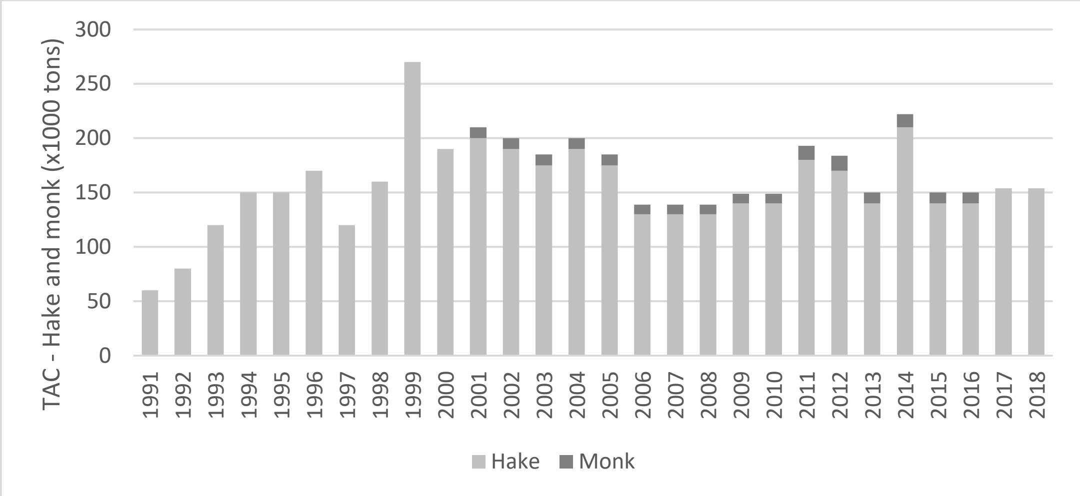

Figure 5-10: Total Allowable Catch set for Hake and Monkfish from 1991 to 2018.

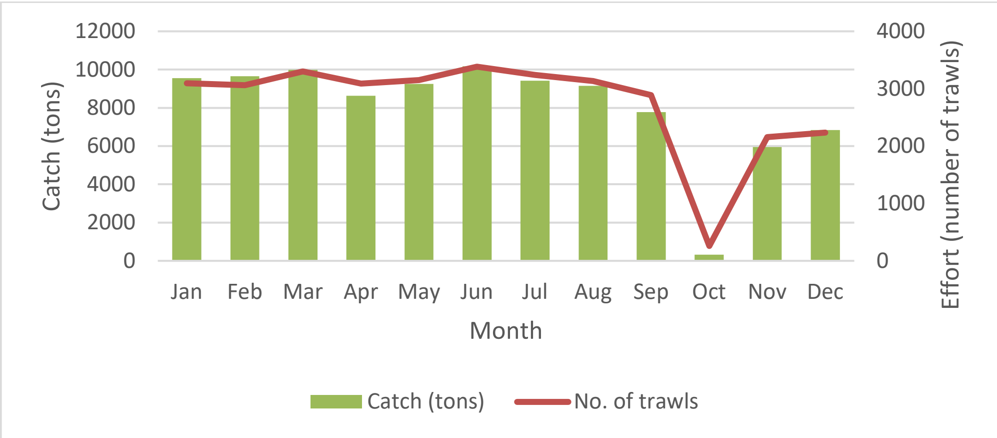

Figure 5-11: Average landings by month reported for wetfish trawlers from 2005 to 2017.

A fleet of 71 demersal trawlers are currently licensed to operate within the fishery. The deep-sea fleet is divided into wetfish and freezer vessels (70:30 ratio is prescribed) which differ in terms of the capacity for the processing of fish offshore (freezers process at sea and wetfish vessel land fish at factories ashore for processing) and in terms of vessel size and capacity (shaft power of 750 – 3 000 kW). Wetfish vessels have an average length of 45 m, are generally smaller than freezer vessels which may be up to 90 m in length. Whilst freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port (catch is retained on ice). The majority of trawlers operate from the port of Walvis Bay, with fewer vessel operating from Lüderitz.

Trawl gear is towed astern of the vessel and configurations are similar for both freezer and wetfish vessels (refer to Figure 5-12). Typical demersal trawl gear configuration consists of:

- Steel warps up to 32 mm diameter - in pairs up to 3 km long when towed;
- A pair of trawl doors/otter boards (500 kg to 3 tons each);
- Net footropes which may have heavy steel bobbins attached (up to 24" diameter) as well as large rubber rollers ("rock-hoppers"); and
- Net mesh (diamond or square shape) is normally wide at the net opening whereas the bottom end of the net (or cod-end) has a 130 mm stretched mesh.

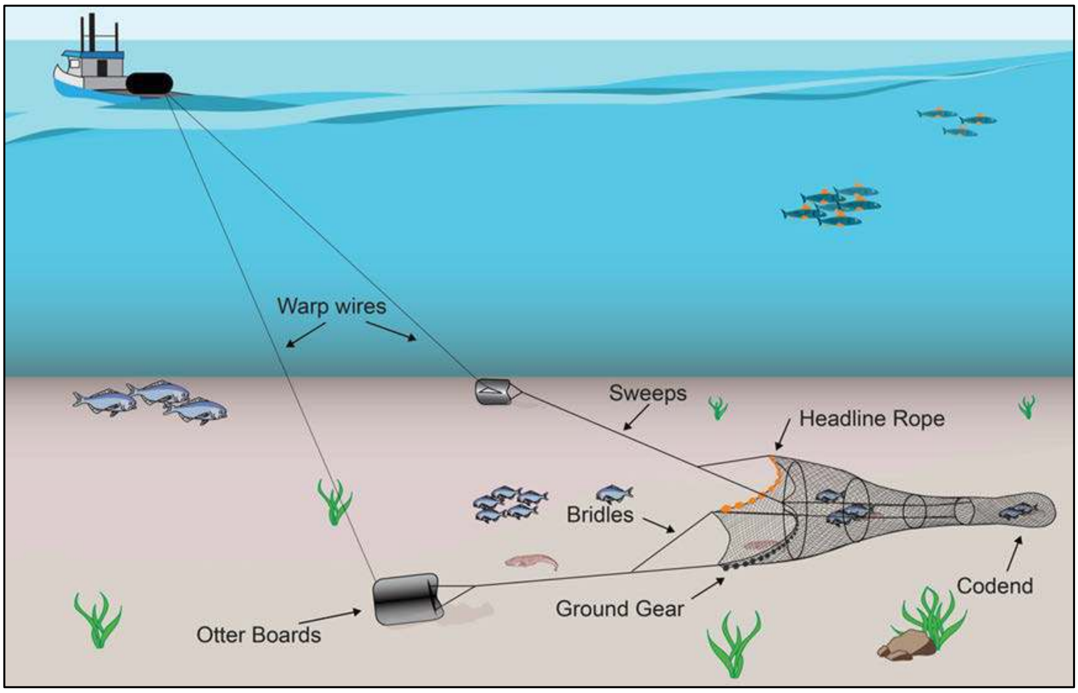

Figure 5-12: Schematic diagram of trawl gear typically used by deep-sea demersal trawlers targeting hake (Source: http://www.afma.gov.au/portfolio-item/trawling

Otter trawling is the main trawling method used in the Namibian hake and monk-directed fisheries. This method of trawling makes use of trawl doors (also known as otter boards) that are dragged along the seafloor ahead of the net, maintaining the horizontal net opening. Bottom contact is made by the footrope and by long cables and bridles between the doors and the footrope. Behind the trawl doors are bridles connecting the doors to the wings of the net (to the ends of the footrope and headrope). A headline, bearing floats and the weighted footrope (that may include rope, steel wire, chains, rubber discs, spacers, bobbins or weights) maintain the vertical net opening. The "belly", "wings" and the "cod-end" (the part of the net that retains the catch) may contact the seabed.

Generally, trawlers tow their gear at 3.5 knots for two to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height and the swept area on the seabed between the doors may be up to 150 m. The opening of the net is maintained by the vertical spread of the trawl doors, which are in contact with the seafloor. There is a wide range of ground gear configurations used with different companies, vessels and skippers using different combinations that have varied over time, in different grounds and with different fishing strategies relating to market demands. The intention in demersal hake trawling is to have the ground gear in close contact with the seafloor surface and to skim over it rather than to dig into the ground although trawl doors often penetrate up to 150 mm into the seafloor on soft grounds. Footrope protection such as the use of wire in the footrope, bound ropes along the footrope, the addition of rubber disks or rollers (large rollers are considered rock hoper gear or rubber or steel bobbins at regular intervals along the footrope is required, particularly for fishing in hard or irregular ground.

Fishing grounds extend along the entire coastline following the distribution of hake and monkfish along the continental shelf at a depth range of 200 m[12] to approximately 850 m. The total extent of fishing grounds used by the demersal trawl fleet is approximately 78,895 km^2. Figure 5-13 shows these fishing grounds in

[12] Namibia has a designated area closed to most "offshore" fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Demersal trawling is prohibited in waters shallower than 200 m.

relation to the proposed routing of the Equiano Cable branch within the Namibian EEZ. The proposed cable routing crosses through demersal trawl fishing grounds at a seafloor depth range of 240 m to 820 m. The proposed cable routing (inclusive of 1 nm exclusion corridor) covers approximately 143 km² or 0.2% of the total fishing ground used by the sector. Based on fishing records for the period 2005 to 2018, an average of 285 trawls per year were reported within a distance of 1 Nm of the potential exclusion zone. The associated catch and effort recordings for these trawls amounted to 790 hours and 618 tons per year. Catch within this affected area amounted to 618 tons or 0.7% of the average annual catch landed nationally by the sector over the period 2005 to 2018.

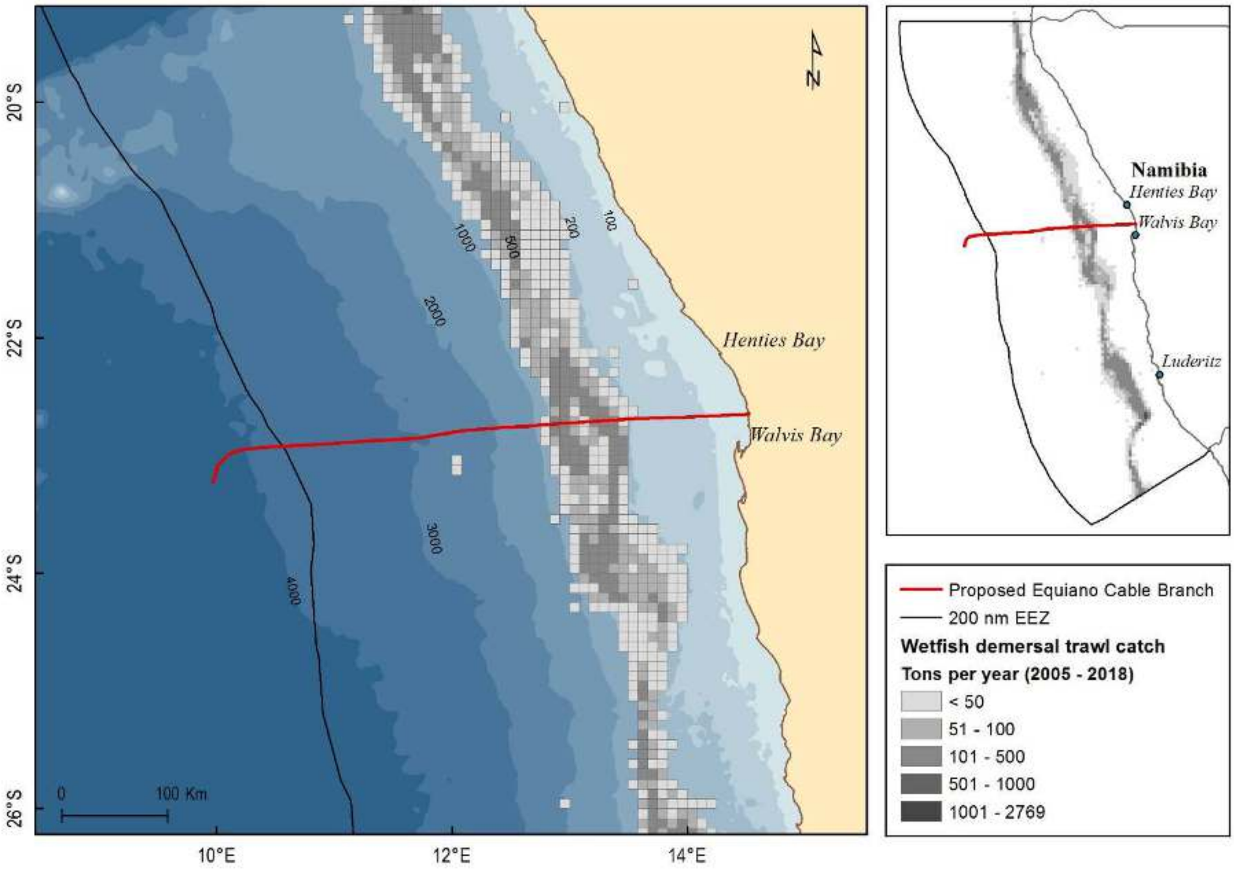

Figure 5-13: Spatial distribution of the catch of hake (2005 – 2018) by demersal trawl vessels in the relation to the proposed routing of the Equiano Cable branch within the Namibian EEZ.

5.5.4 Demersal Longline

Similar to the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. The catch packed unfrozen, on ice, and is landed as either prime quality (PQ) or headed and gutted. A total hake TAC of 154 000 tons was set for 2018/19 but less than 10 000 tons of this is caught by longline vessels. Figure 5-14 shows annual landings recorded by the sector from 2005 to 2018. Vessels operate year-round but operations are particularly low in October (see Figure 5-15).

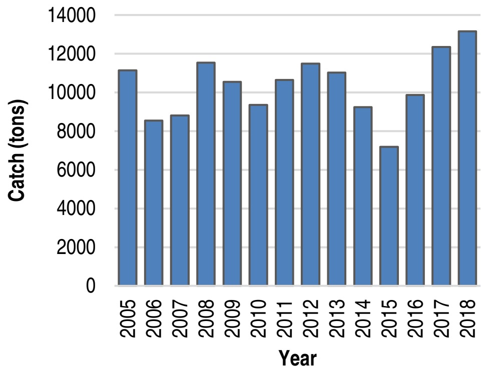

Figure 5-14: Landings recorded for the Namibian demersal long-line sector from 2005 to 2018.

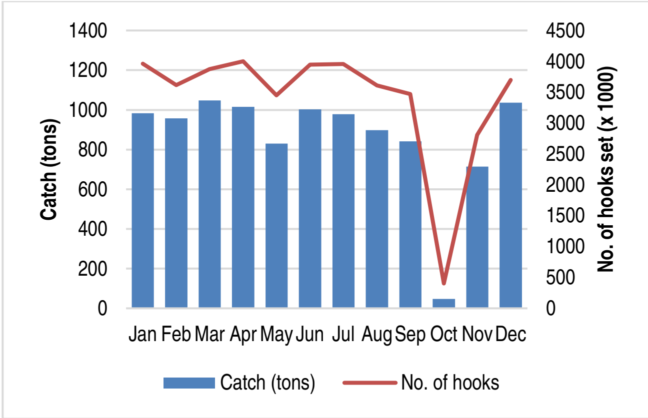

Figure 5-15: Average monthly catch (tons) recorded by the Namibian demersal longline sector between 2005 and 2018.

A demersal long-line vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (see Figure 5-17). Steel anchors, of 40 to 60 kg are placed at the ends of each line to anchor it. These anchor positions are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically 20 – 30 nautical miles in length. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of 5 – 9 knots. Once deployed the line is left to soak for up to eight hours before retrieval commences. A line hauler is used to retrieve gear (at a speed of approximately 1 knot) and can take six to ten hours to complete. Long-line vessels are similar in size and power to wet-fish trawlers and may vary in length from 18 m to 50 m and remain at sea for four to seven days at a time.

Namibia has a designated area closed to most "offshore" fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Long-line vessels fish in similar areas targeted by the hake-directed trawling fleet, in a broad area extending from the 200 m to 650 m contour along the full length of the Namibian coastline. Some 18 vessels operate within the sector. Those based in Lüderitz mostly work South of 26°S towards the South Africa border while those based in Walvis Bay operate between 23°S and 26°S and North of 23°S. Figure 5-17 shows the distribution of catch reported in relation to the proposed routing of the Equiano Cable within the Namibian EEZ. The proposed cable routing crosses through demersal longline fishing grounds at a seafloor depth range of 200 m to 400 m.

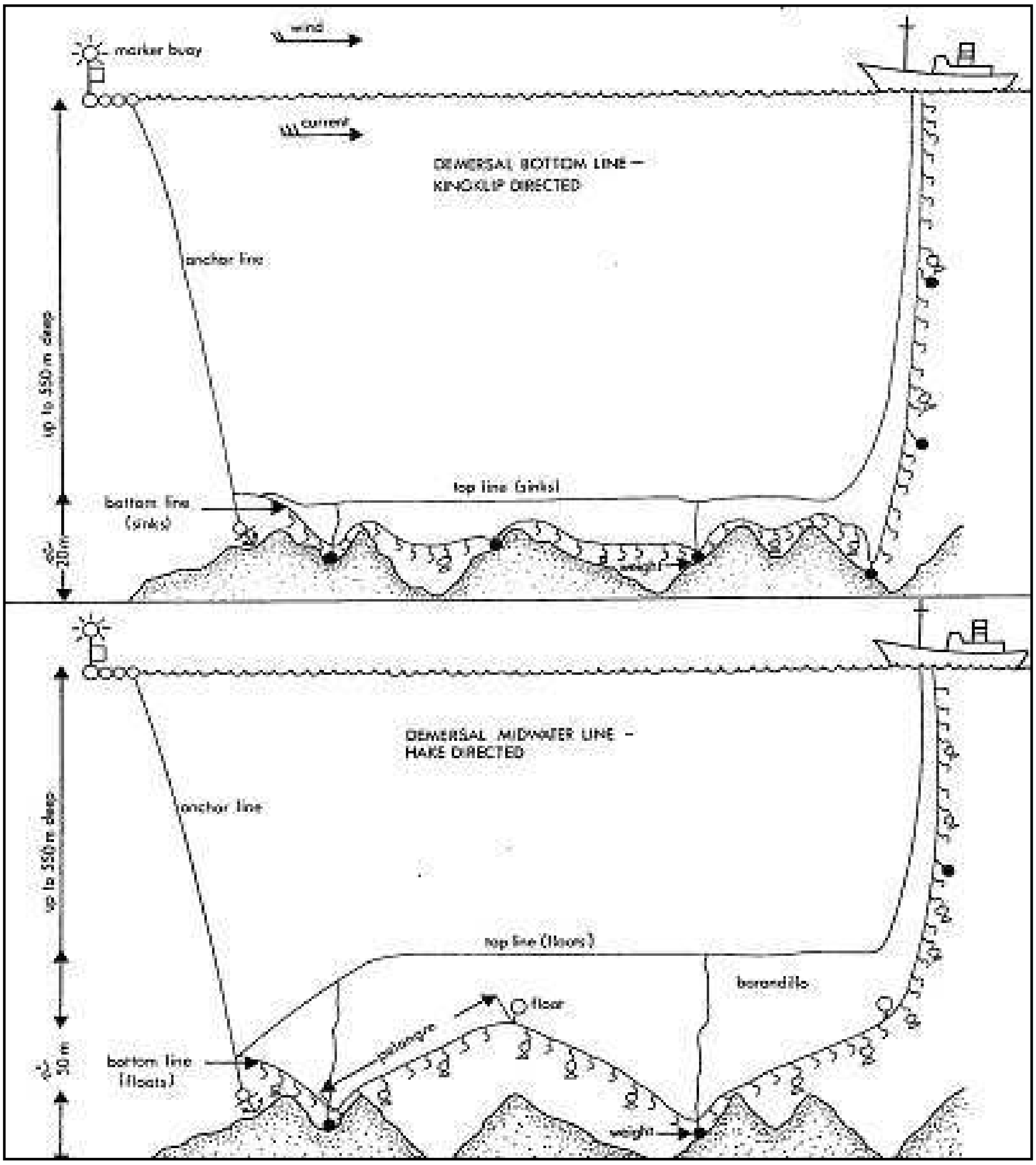

Figure 5-16: Typical configuration of demersal (bottom-set) gear used within the demersal long-line fishery (Source: Japp, 1989).

The proposed exclusion area[13] covers 111 km^2 or 0.2% of the total fishing ground used by the sector (approximately 57,208 km^2 in extent). Approximately 31 lines (541,000 hooks) per year were set within 1 Nm of the exclusion zone (1.5% of total effort expenditure). Catch within the area amounted to an average of 150.4 tons per year or 1.5% of the average annual catch landed nationally by the sector over the period 2005 to 2018.

[13] Inclusive of 0.5 Nm exclusion corridor to either side of the proposed cable routing across the seafloor depth range 200 m to 400 m

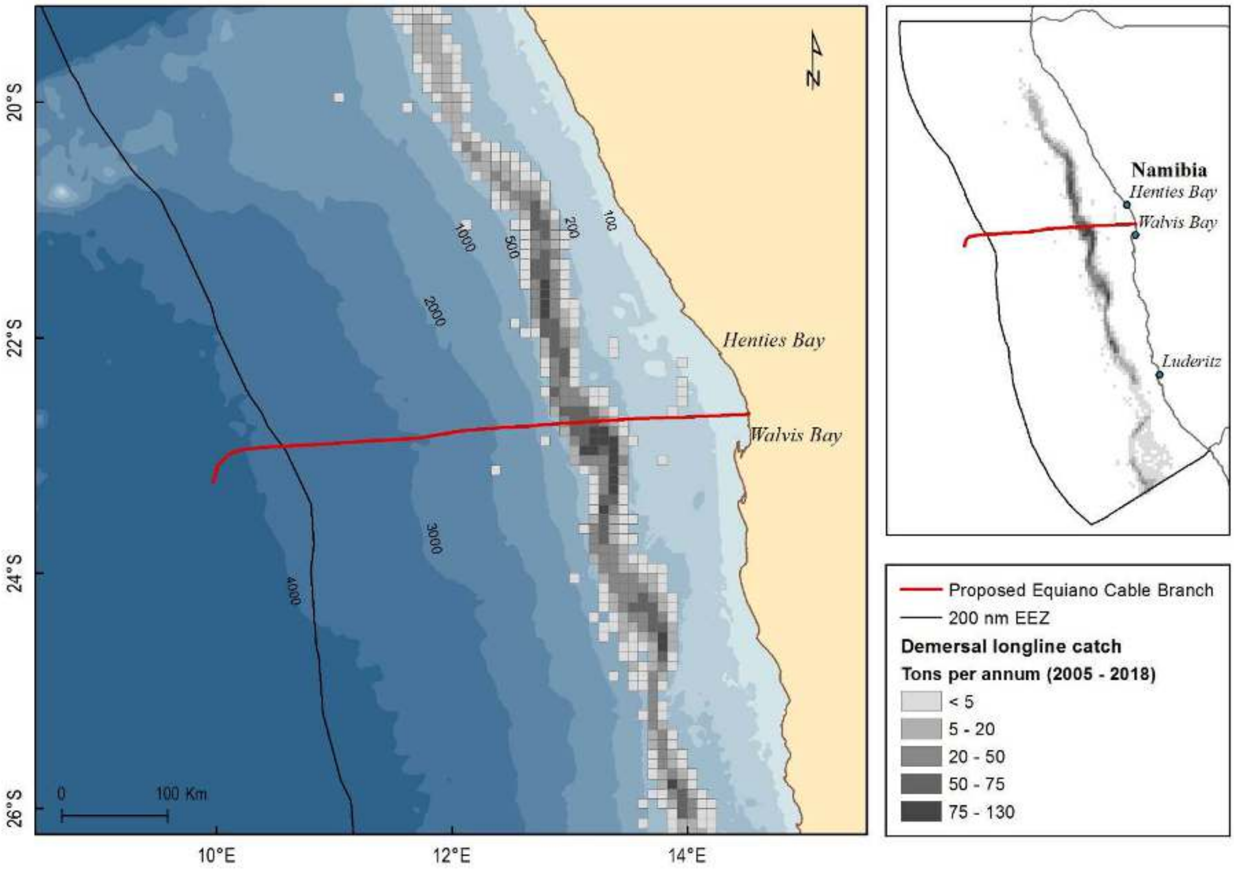

Figure 5-17: Spatial distribution of catch (2005 – 2018) reported by the demersal long-line fishery targeting Cape hakes (M. capensis; M. paradoxus) in relation to the proposed routing of the Equiano Cable within the Namibian EEZ.

5.5.5 Large Pelagic Longline

This sector makes use of surface long-lines to target migratory pelagic species including yellowfin tuna (*T. albacares*), bigeye tuna (*T. obesus*), swordfish (*Xiphias gladius*) and various pelagic shark species. Commercial landings of these species by the fishery is variable and Namibian-reported catch from 1992 to 2016 is shown in Figure 5-18 (ICCAT, 2018). There is provision for up to 26 fishing rights and 40 vessels (http://www.mfmr.gov.na/).

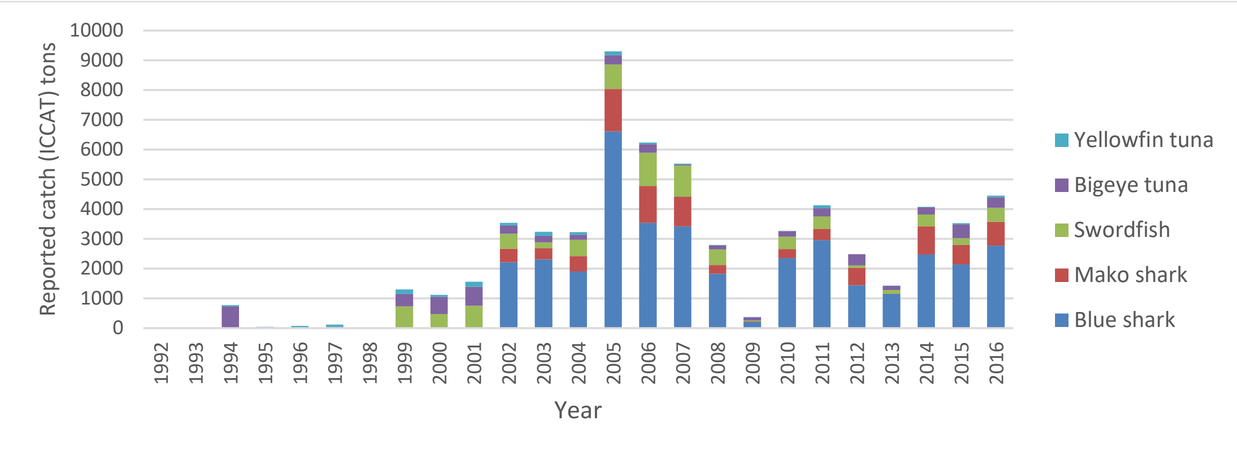

Figure 5-18: Total nominal longline catch (tons) of blue shark, shortfin mako shark, Atlantic swordfish, bigeye tuna and yellowfin tuna reported by Namibia between 1992 and 2016. Source: ICCAT statistical bulletin, 2018.

Yellowfin tuna are distributed between 10°S and 40°S in the south Atlantic, and spawn in the central Atlantic off Brazil in the austral summer (Penney *et al.* 1992). According to Crawford *et al.* (1987) juvenile and immature yellowfin tuna occur throughout the year in the Benguela system. After reaching sexual maturity they migrate (in summer) from feeding grounds off the West Coast of southern Africa to the spawning grounds in the central Atlantic. Bigeye tuna occurs in the Atlantic between 45°N and 45°S. Spawning takes place in the Gulf of Guinea and in the eastern central Atlantic north of 5°N and it is thought that bigeye tuna migrate to the Benguela system to feed. Swordfish spawn in warm tropical and subtropical waters and migrate to colder temperate waters during summer and autumn months. Tuna are targeted at thermocline fronts, predominantly along and offshore of the shelf break. Pelagic long-line vessels set a drifting mainline, up to 50-100 km in length, and are marked at intervals along its length with radio buoys (Dahn) and floats to facilitate later retrieval (see Figure 5-19). Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Between radio buoys the mainline is kept near the surface or at a certain depth by means of ridged hard-plastic buoys, (connected via a "buoy-lines" of approximately 20 m to 30 m). The buoys are spaced approximately 500 m apart along the length of the mainline. Hooks are attached to the mainline on branch lines, (droppers), which are clipped to the mainline at intervals of 20 m to 30 m between the ridged buoys. The main line can consist of twisted tarred rope (6 mm to 8 mm diameter), nylon monofilament (5 mm to 7.5 mm diameter) or braided monofilament (~6 mm in diameter). A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. Refer to Figure 5-19 for a schematic diagram of pelagic long-line gear and Figure 5-20 for photographs of an example of vessel, marker buoys and lines.

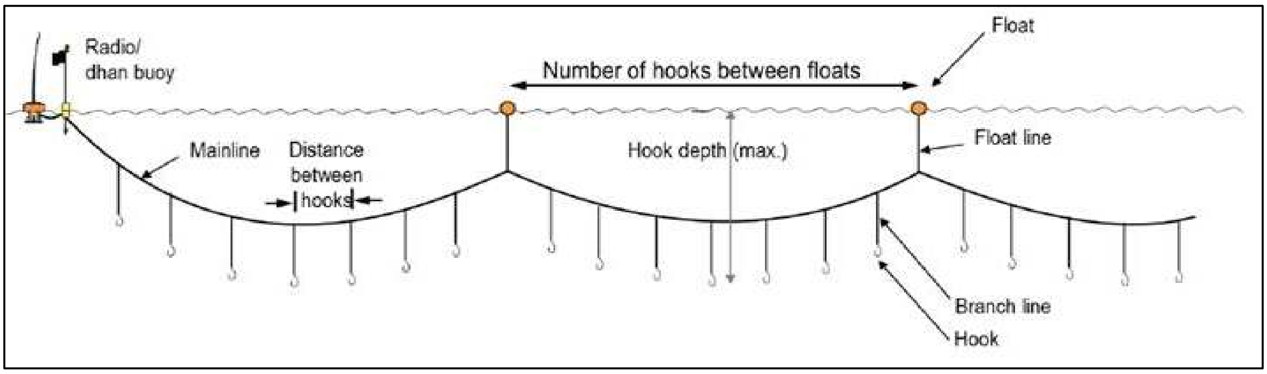

Figure 5-19: Schematic diagram of gear typically used by the pelagic long-line fishery (Source: IOTC ROSS Observer Training Manual, 2015).

Figure 5-20: Photographs showing marker buoys (left), radio buoys (centre) and monofilament branch lines (right) (Source: CapMarine, 2015).

Long-line vessels targeting pelagic tuna species and swordfish operate extensively around the entire coast along the shelf-break and into deeper waters. The spatial distribution of fishing effort is widespread and may be expected predominantly along the shelf break (approximately along the 500 m isobath) and into deeper waters (2 000 m). Effort occurs year-round with a slight peak over the period March to May (see Figure 5-21). Figure 5-22 shows the spatial distribution of commercial catches within the Namibian EEZ and in relation to the proposed routing of the Equiano Cable. The proposed cable routing crosses through fishing grounds utilised by the sector.

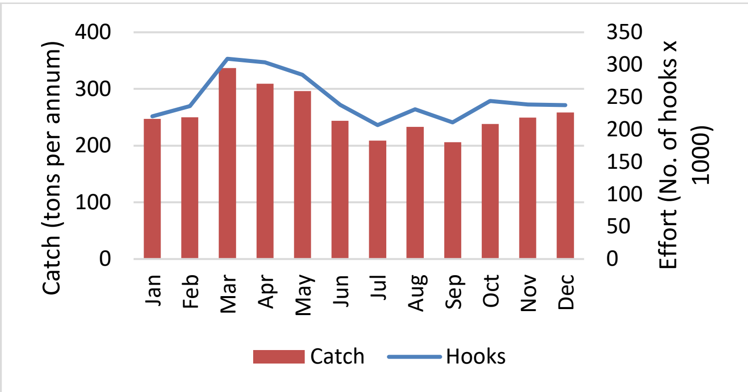

Figure 5-21: Monthly average catch and effort recorded within the large pelagic longline sector within Namibian waters (2003 – 2019).

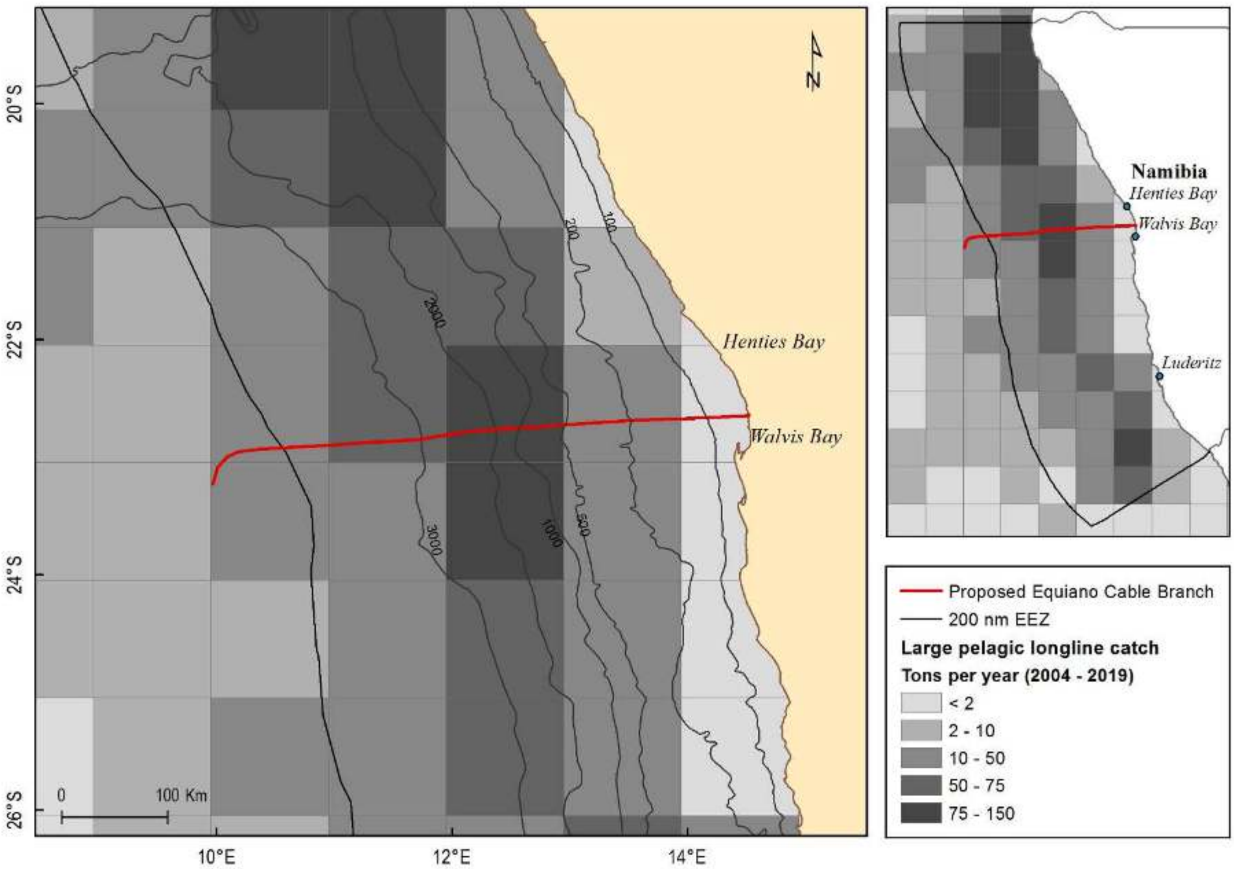

Figure 5-22: Spatial distribution of catch recorded by the pelagic long-line fishery in relation to the proposed routing of the Equiano Cable within the Namibian EEZ. Catch is displayed on a 60 x 60 minute grid (average catch per year over the period 2003 to 2019).

The proposed cable routing (inclusive of 1 nm exclusion corridor) covers 908 km^2 of the fishing area used by the sector. Because the gear used by this fishery drifts along with surface currents, lines cover a large area during the time that they are deployed. The spatial mapping of the catch and effort used in this assessment is based on the position recorded at the start of line setting and does not take into account the large area covered by the mobile gear before it is retrieved. For the purposes of this assessment, the fishing events within 5 Nm of the exclusion zone were used to provide an indication of the proportion of catch and effort in the vicinity of the proposed cable routing. Catch within this affected area amounted to an average of 32 tons per year or 1% of the average annual catch landed nationally by the sector over the period 2004 to 2019. An annual average of 28,000 hooks were set in the area which is equivalent to 0.9% of the overall national effort expended by the sector.

5.5.6 Tuna Pole

Poling for tuna is predominantly based on the southern Atlantic albacore (longfin tuna) stock (*T. alalunga*) and a very small amount of skipjack tuna (*Katsumonus pelamis*), yellowfin tuna and bigeye tuna. Namibia's quota for tuna and swordfish is allocated by the International Commission for Conservation of Atlantic Tunas (ICCAT), of which Namibia is a member. Catches of albacore tuna for Namibia and South Africa apply to what is referred to as the Atlantic "southern stock" (ICCAT Statistical Bulletin 2012).

Albacore are a temperate species of tuna, favouring subtropical ocean waters of 16° to 20°C (Penney et al 1998). Albacore found in the waters off the coast of southern Africa are proposed to originate from the south Atlantic stock (Penrith 1963, Yeh et al 1996, Penney et al 1998), with some degree of mixing of individuals between the Atlantic and Indian Oceans (Morita 1978, ICCAT Report 2011). Southern albacore migrate annually through their Atlantic distribution range between 10°S and 40°S. Nepgen (1971) noted that juvenile and sub-adult albacore are present in the Benguela region throughout the year. They migrate locally along the west coast feeding at upwelling and topographically induced fronts (Penney et al 1992). The pole-and-line (also referred to as baitboat) and long-line fisheries target albacore that occur in four main areas of the Benguela region: the Vema Seamount off Namibia, Tripp Seamount south of Lüderitz, South Bank south of Hondeklip Bay and the Cape Canyon (Penney et al 1992). Adults of the population occur mostly off Brazil, Argentina and Namibia (Penney et al 1992).

Because of the irregular data availability and dependence on reporting of both South African and Namibian catches to the Regional Fishery Management Organisation (RFMO) (ICCAT) interpretation of catching performance is split between the South African and Namibian data. Overall baitboat catch rate trends exhibit large fluctuations, with a somewhat declining overall trend (ICCAT, 2012). Catch records start from 1960 and climbed steeply in the 1970's and peaked in the late 1990s. Thereafter, catches tapered off to between 6000 tons and 8000 tons per year but have steadily declined since 2009, to below 6000 tons in 2015. In 2016, the estimated Namibian and South African catches were below that of the previous five year (ICCAT, 2018) and in 2018, Namibian catches declined to approximately 1000 tons (MFMR, pers. comm). Figure 5-23 shows the total catches of albacore and yellowfin tuna by the South African and Namibian tuna pole ("baitboat") sectors, combined, as well as the relative proportion of the Namibian component of the catch which approximates 20% of the total reported for the two target species.

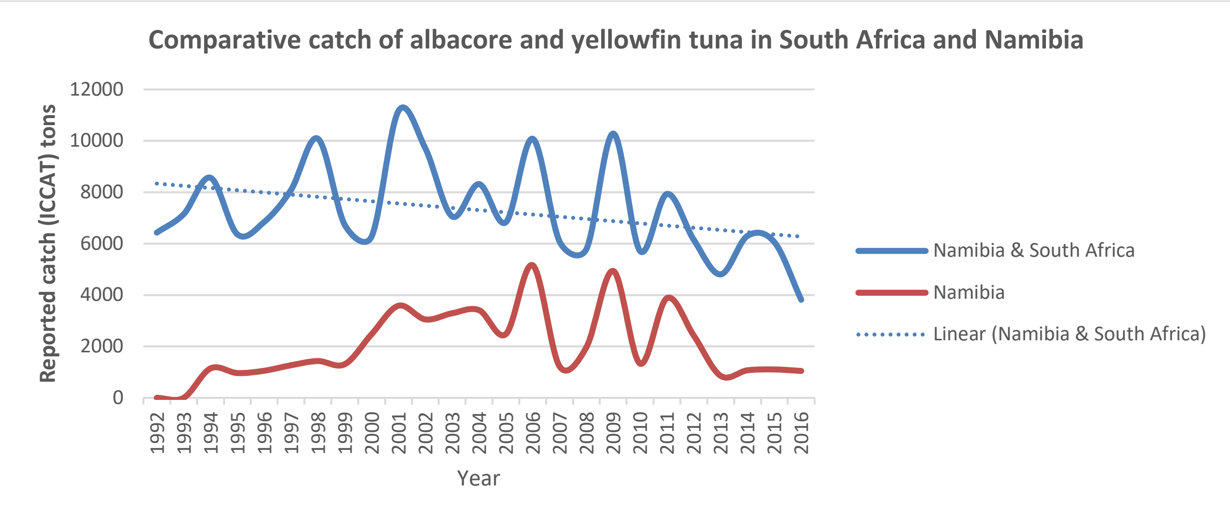

Figure 5-23: Total nominal baitboat and longline catch (tons) of longfin (albacore) and yellowfin tuna reported by South Africa and Namibia between 1992 and 2016. Source: ICCAT statistical bulletin, 2018.

Vessels operating within the fishery are typically small (< 25 m in length). Catch is stored on ice, chilled sea water or frozen and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on the distance of the fishing grounds from port. Vessels drift whilst attracting and catching pelagic tuna species. Whilst at sea, the majority of time is spent searching for fish with actual fishing events taking place over a relatively short period of time. Sonars and echo sounders are used to locate schools of tuna. At the start of fishing, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface, thereby attracting tuna to the surface. Live bait is flung out to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the 2 to 3 m poles are fitted with a short length of fishing line leading to a hook. Hooked fish are pulled from the water and many tons can be landed in a short period of time. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 5-24). The nature of the fishery and communication between vessels often results in a large number of these vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and as they do not anchor or have any fixed gear in the water, these vessels remain manoeuvrable.

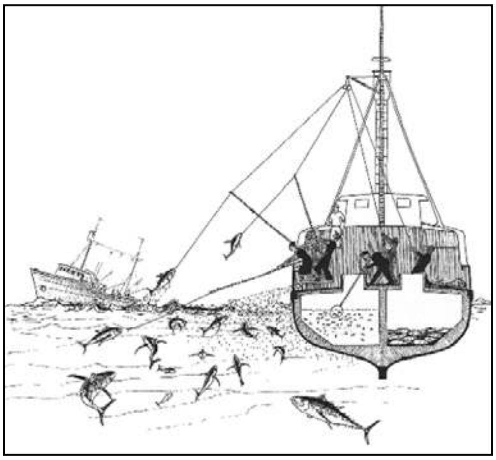

Figure 5-24: Schematic diagram of pole and line operation (www.fao.org/fishery).

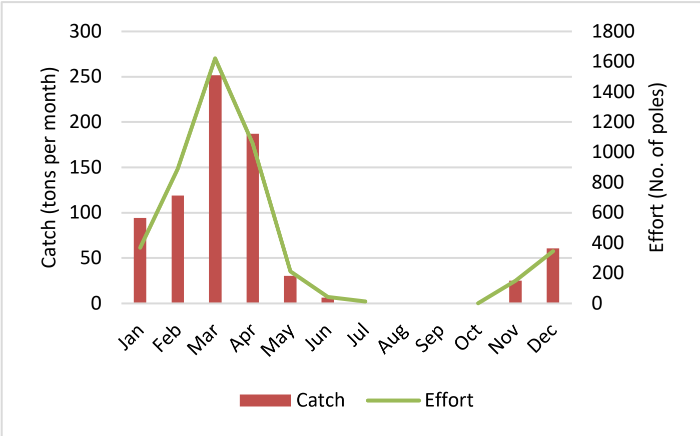

Figure 5-25: Average monthly catch and effort recorded by the tuna pole and line fleet in Namibian waters (2003 – 2019). Source: MFMR, 2020.

Approximately 36 South African pole and line vessels operate under arrangements with Namibian right holders each year, however, the number of active vessels and landed catch have recently shown a decline. As already discussed, the fishery is seasonal with vessel activity mostly between December and May and peak catches in March and April (see Figure 5-25). Effort fluctuates according to the availability of fish in the area, but once a shoal of tuna is located a number of vessels will move into the area and target a single shoal which may remain in the area for days at a time. As such the fishery is dependent on window periods of favourable conditions relating to catch availability.

Aggregations of albacore tuna occur in specific areas, in particular Tripp Seamount which is situated just north of the South Africa/ Namibia maritime border. Catches in this area are variable from year to year, although boats will frequent the area knowing that albacore aggregate around the seamount after migrating through South African waters. The movement of albacore between South Africa and Namibia is not clear although it is believed that the fish move northwards following bathymetric features and generally stay beyond the 200 m depth contour. Figure 5-26 shows the spatial distribution of fishing effort in relation to the proposed routing of the Equiano Cable within the Namibian EEZ. The proposed cable routing does not coincide with areas routinely fished by the tuna pole fleet, with the closest activity likely to be 300 km from the proposed routing.

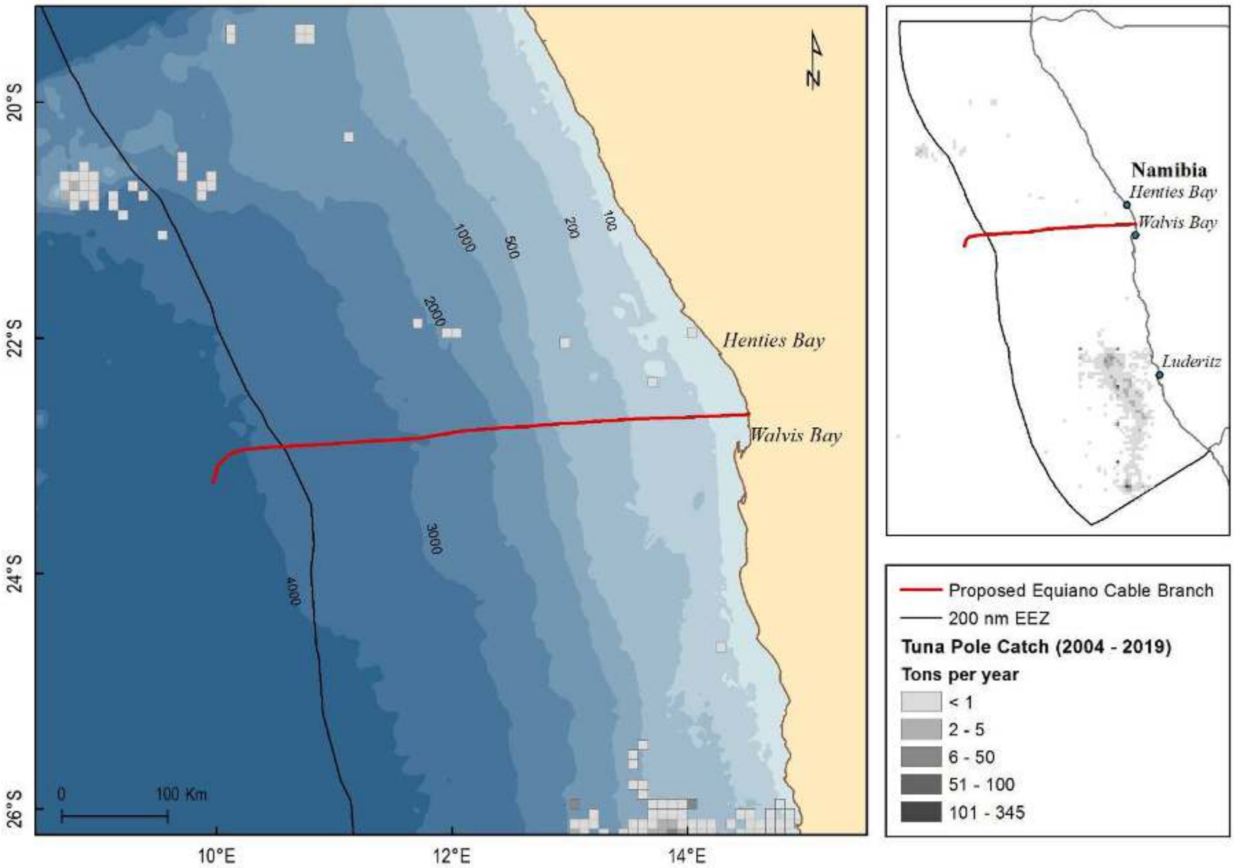

Figure 5-26: Spatial distribution of fishing effort expended by the tuna pole and line fleet (2003 – 2019) along the Namibian coastline and in relation to the proposed routing of the Equiano Cable branch within the Namibian EEZ.

5.5.7 Line-fish

The traditional line fishery primarily targets snoek (*Thyrsites atun*) with bycatch of yellowtail, silver kob (*Argyrosomus inodorus*), dusky kob (*A. coronus*), and shark, which are sold on the local market. Snoek availability to the fishery is seasonal. Catches peak in late summer where after the fish migrate south into South African waters. The other species caught, such as kob and shark occurs year round, but is in relatively small amounts. Operationally the fishery is limited in extent to Walvis Bay, Swakopmund and Henties Bay and also due to the small size of the boats does not operate much further than 12 nm offshore (i.e. 22 km). There is also a small component of the fishery operating out of Lüderitz in the South. The two commercial components of the linefish sector comprise a fleet of up to 26 small deck boats. Commercial operators sell linefish on the local market as well as exporting regionally to South Africa and Zimbabwe.

Average monthly landings are shown in Figure 5-27 with catches dropping in the mid-winter period with catches increase from spring into summer. This trend is associated with both the availability of snoek and also with weather and sea conditions which make it difficult for the fishery to operate during this time due to the small size of the boats used. The distribution of linefish catch in relation to the proposed routing of the Equiano Cable is shown in Figure 5-28. The sector operates inshore of the 200 m depth contour with incidental reports of fishing in deeper waters[14]. The proposed cable routing coincides with fishing areas utilized by the sector. The proposed cable routing (inclusive of 1 nm exclusion corridor) covers 245 km^2

[14] Possibly incorrectly-reported fishing positions or errors in the transcription of records from logbooks to database.

(0.4%) of the fishing area ground used by the sector (~67,421 km²). Catch within the affected area amounted to 10.8 tons per year or 1% of the average annual catch landed nationally by the sector over the period 2000 to 2019. In terms of effort, 188 lines or 1.3% of the total national effort expenditure was directed within the affected area.

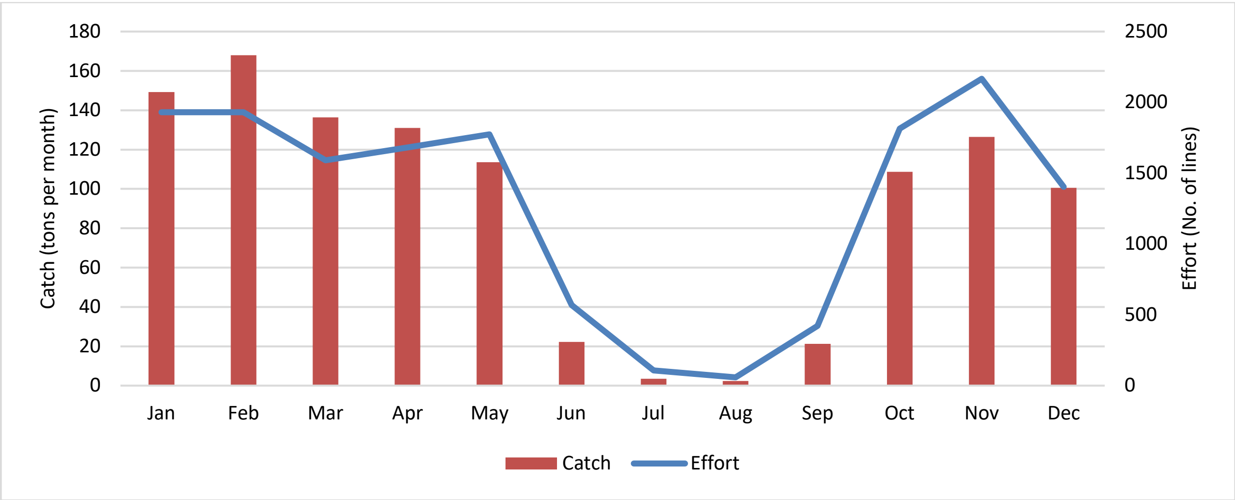

Figure 5-27: Average monthly catch and effort recorded by linefish vessels in Namibian waters (2000 – 2019). Source: MFMR, 2020.

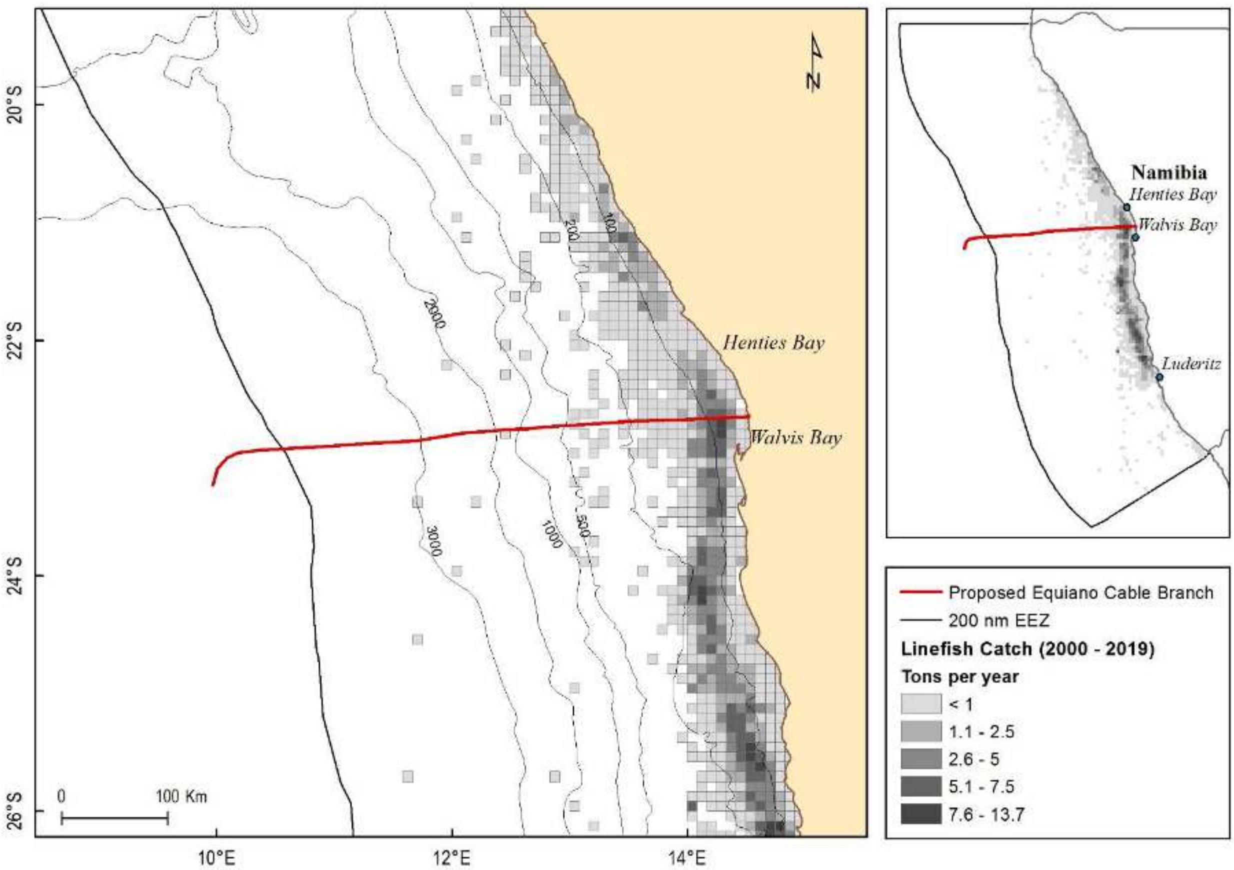

Figure 5-28: Spatial distribution of catch taken between 2000 and 2019 by ski-boats operating within the line-fish sector along the Namibian coastline and in relation to the proposed routing of the Equiano Cable branch within Namibian waters.

5.5.8 Deepsea Crab

The Namibian deep-sea crab fishery is based on two species of crab namely spider crab (*Lithodes ferox*) and red crab (*Chaceon maritae*). The fishery commenced in 1973 with a peak in catches of 10 000 tons in 1983. Catches remained high during the 1980s between 5000 tons and 7000 tons. Following heavy exploitation by foreign fleets during this period, catch rates dropped significantly and have averaged at approximately 2000 tons in 1997 and have been steadily increasing since then. The TAC for 2018/19 has been set at 3900 tons (see Figure 5-29).

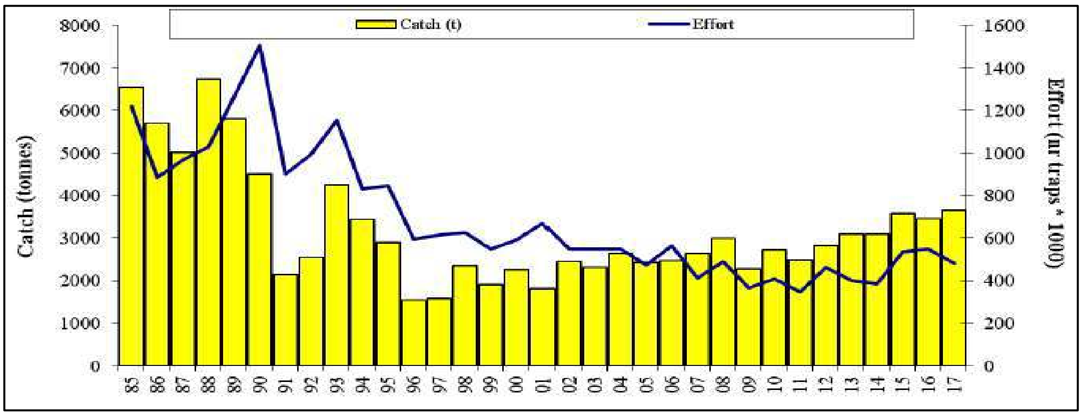

Figure 5-29: TACs set for red crab (C. maritae) from 1985 to 2017[15].

The distribution of red crab extends from ~5°S to just South of Walvis Bay and the commercial fishery operates in grounds extending northwards of 23°S and into Angolan waters (Figure 5-31). There is a minimum operational depth of 400 m set for the fishery, which sets traps at depths of up to 1200 m. The fishery is small, with only two vessels currently operating from the port of Walvis Bay. Vessels are active year-round but with relatively low fishing effort from November to February.

Method of capture involves the setting of a demersal long-line with a string of approximately 400 Japanese-style traps (otherwise known as “pots”) attached to each line (Figure 5-30). Traps are made of plastic and dimensions are approximately 1.5 m width at the base and 0.7 m in height. They are spaced 15 m apart and typically baited with horse mackerel or skipjack. The line is typically 6000 m in length and weighted at each end by a steel anchor. A surface buoy and radar reflector mark each end of the line via a connecting dropper line that allows retrieval of the gear. Up to 1200 traps may be set each day (or two to three lines) and are left to soak for between 24 and 120 hours before being retrieved.

[15] Benguela Current Commission (2018) : Report of the Regional Demersal Working Group meeting 10-14 Dec. 2018.

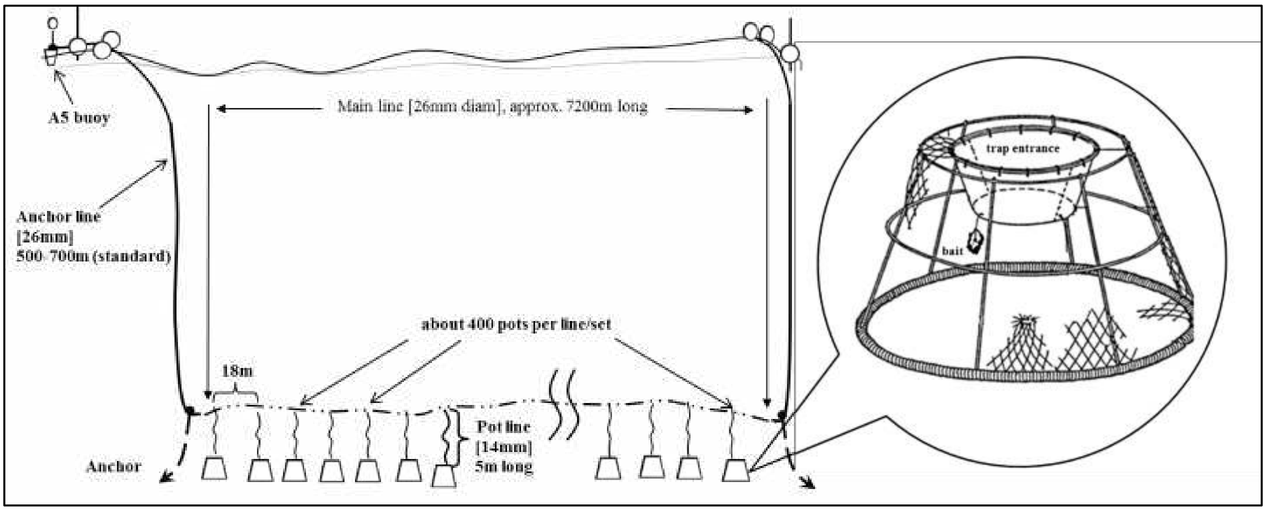

Figure 5-30: Schematic diagram of the gear configuration used by the deep-sea crab fishery (SEAFO, 2018).

Fishing grounds in relation to the proposed Equiano Cable routing are shown in Figure 5-31. The cable is situated a minimum of 25 km from the southern extent of the reported crab fishing grounds and therefore the fishery is not expected to be operational across the proposed cable routing.

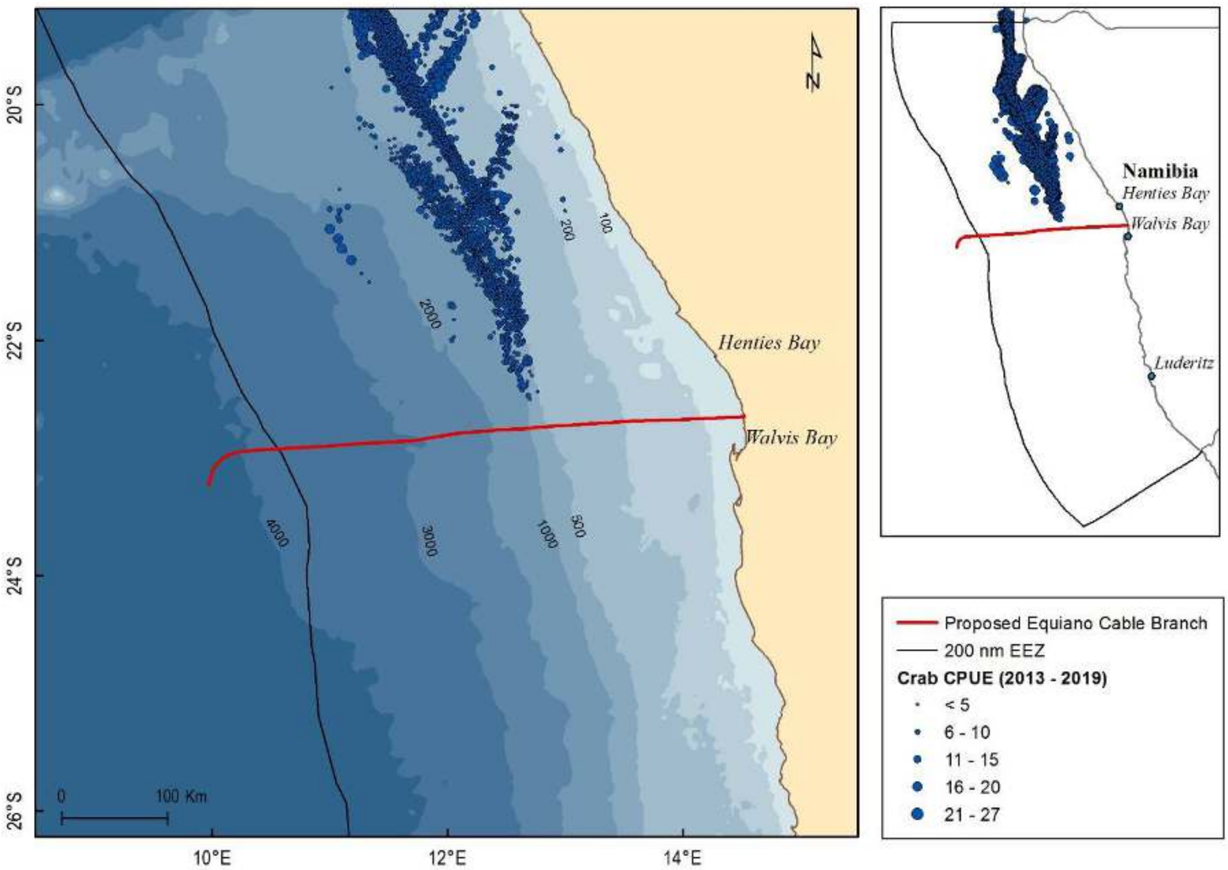

Figure 5-31: Spatial Distribution of catch taken by the Deep-Sea Crab Fishery (2013 – 2018) in relation to the proposed routing of the Equiano Cable within the Namibian EEZ.

5.5.9 Deep-Water Trawl

The deep-water trawl fishery is a small but lucrative fishing sector directed at the outer Namibian shelf from 400 m to 1500 m water depth targeting orange roughy (*Hoplostethus atlanticus*) and alfonsino (*Beryx splendens*). Both species are extremely long-lived and aggregate densely, leading to high catch rates. General aggregations of the stock occur between June and August. Fishable aggregations are usually found on hard grounds on features such as seamounts, drop-off features or canyons (Branch, 2001). Off Namibia orange roughy has a restricted spawning period of less than a month in late July, when spawning takes place in dense aggregations close to the bottom in small areas typically between 10 and 100 km^2 in extent (Boyer and Hampton 2001b). The fishery uses a similar gear configuration to that used by the demersal hake-directed trawl fishery. Alfonsino is taken primarily as a bycatch in the orange roughy fishery, although after the collapse of the orange roughy stock, the deep-water trawl boats continued to fish for alfonsino (which is a species more widely distributed than orange roughy and also are not as closely associated with bottom substrate). However, with the demise of the orange roughy, the economic incentives to fish in deep-water was lost and as a result alfonsino catches also effectively stopped.

The fishery is split into four Quota Management Areas (QMA's) referred to as "Hotspot", "Rix", "Frankies" and "Johnies" and TACs are set for each specific QMA. Fishing grounds were discovered in 1995/1996 and total catches reached 15500 tons in 1997. At this point catch limits were set (see Figure 5-32) and effort was limited to five vessels. Following a steep decline in biomass levels, the TAC was decreased from 12 000 tons in 1998 to 1875 tons in 2000. By 2007 the number of vessels had dropped to one and total catches declined to 270 tons. The fishery has ceased commercial operations due to stock collapse however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery. Research surveys are undertaken in July each year by MFMR to assess the status of the resource.

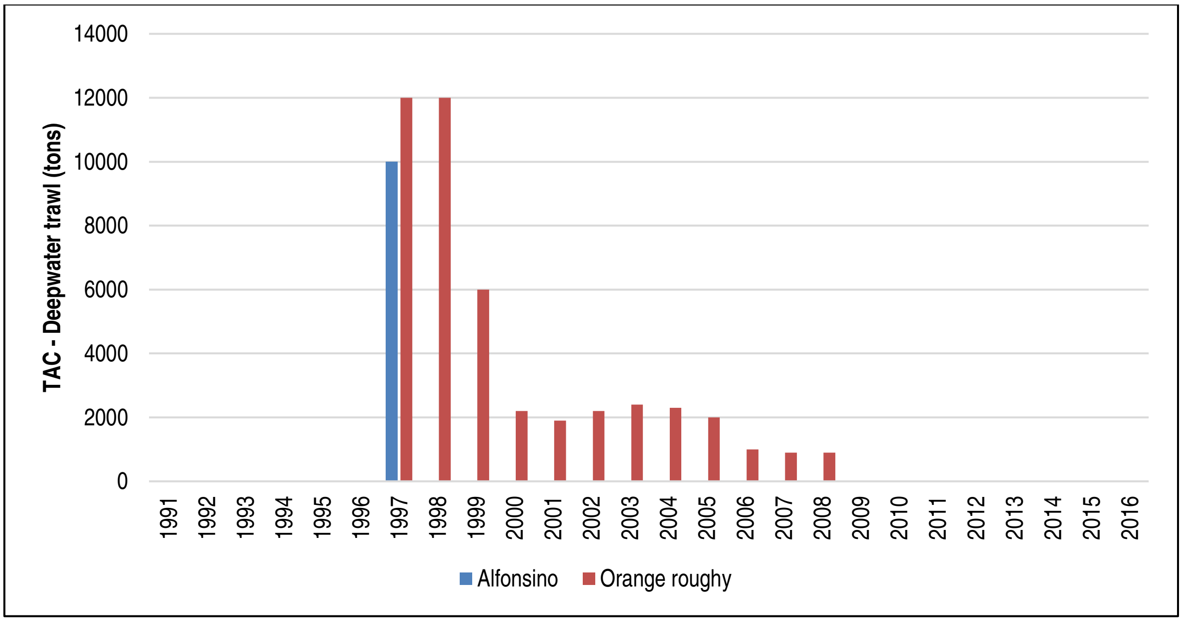

Figure 5-32: TACs issued for Orange Roughy (H. atlanticus) and Alfonsino (B. splendens), Targeted by the Namibian Deep-Water Trawl Fishery.

The proposed routing of the Equiano Cable branch within the Namibian EEZ does cross through the QMA referred to as "Rix" (see Figure 5-33). The historic catches taken with the management area prior to 2008 are unavailable, however, Table 5-3 shows the stock biomass estimates within Rix and all four management areas.

Table 5-3: Biomass estimates of orange roughy from acoustic and swept-area surveys conducted within the Rix QMA and all three QMAs (adapted from MFMR, 2019[16])

QMA	Biomass estimate (tons)							
	2004	2005	2006	2007	No data	2016	2017	2018
QMA: Rix Acoustic estimate	*	*	3 345	1 786	ANS	2 618	5 019	2 217
QMAs: All Total Biomass	9 874	9 710	7 395	11 370	ANS	26 221	17 713	26 928

ANS Area not surveyed *Behaviour of orange roughy did not permit acoustic assessment

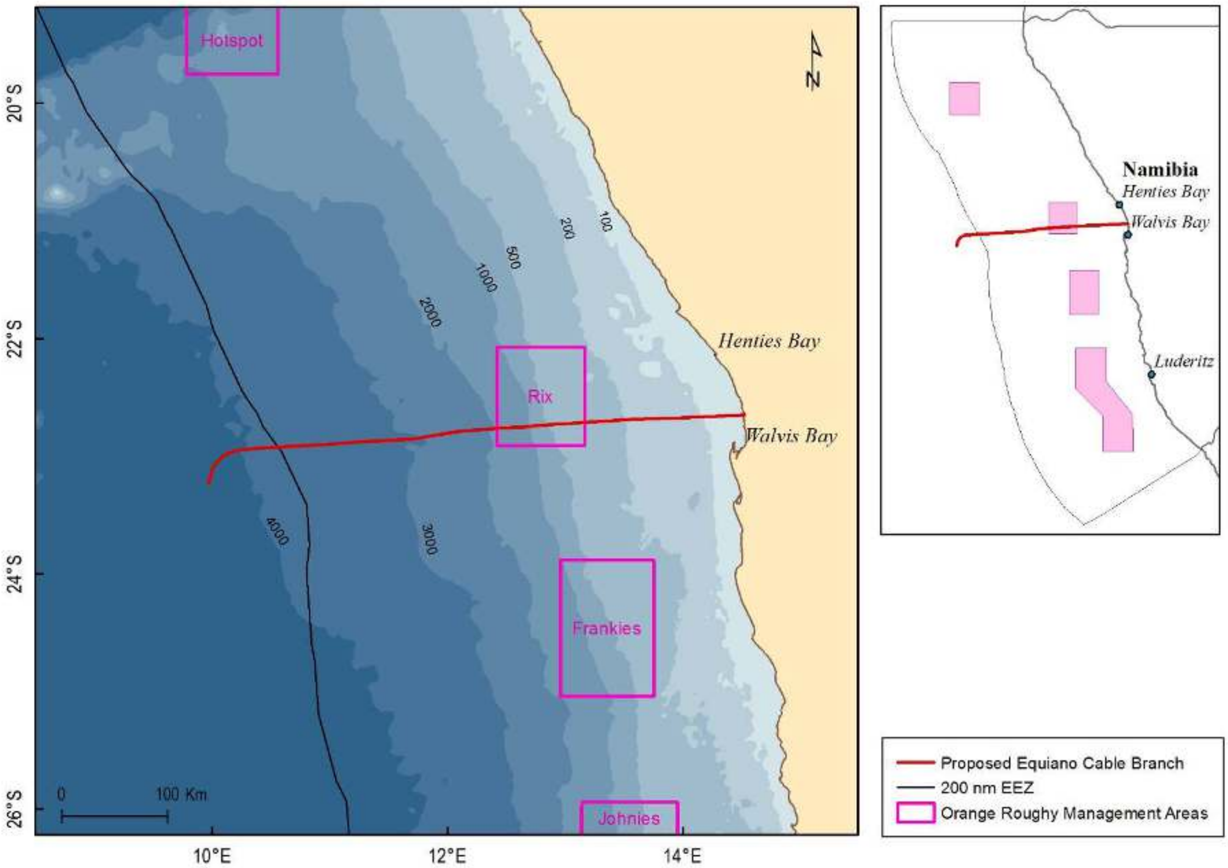

Figure 5-33: Management Areas Used by the Deep-Water Trawl Fishery (1994–2007) in relation the proposed Equiano Cable routing within the Namibian EEZ.

Impact on research trawls: MFMR conducts annual acoustic and swept-area surveys on all indicated orange roughy grounds which includes the "Rix" QMA. These scientific surveys are aimed at determining the biomass of the stock which enables advice on possible re-opening of the fishery. Should the surveys be required to avoid surveying in the vicinity of the proposed cable routing, this may compromise the assessment of stock biomass within the QMA. During these surveys, trawl gear is towed at a speed of

[16] MFMR (2019): Survey of the Orange Roughy Stock: Cruise Report No 1/2018 (Survey No. 201801: 10 – 27 July 2018). Orange Roughy Research, Demersal Subdivision. National Marine Information and Research Centre (NatMIRC), Swakopmund.

approximatley 3.5 knots along the depth contour. The default is to trawl in a northern direction, but if the stratum border is crossed during the towing by doing this, the towing course is selected to the south. The duration of each trawl is targeted for maximum 30 minutes on the seabed. Recent orange roughy biomass surveys have been undertaken using the MV *Pemba Bay* which is a commercial vessel operated by a Spanish company through the National Fishing Corporation (FISHCOR). The vessel is a 48 m factory stern trawler, with 907 GRT and 1496 HP. The trawl net is based on the standard New Zealand 'Arrow' rough bottom trawl, with cut-away lower wings. Sweep and bridle lengths of 100 m and 50 m, respectively. A 'rock-hopper' footrope was used with 21"rock-hoppers. The net had a 5-6 m headline height when towed at an average speed of about 3.5 knots. Wingspread is estimated at 15 m.

5.5.10 Rock Lobster

The small but valuable fishery of rock lobster (*Jasus lalandii*) is based exclusively in the port of Lüderitz. Catch is landed whole and is managed using a TAC. Historically, the fishery sustained relatively constant catches of up to 9000 tons per year until a decline in the late 1960s. Figure 5-34 shows the commercial rock lobster catches from 1986 to 2017, with the TAC for 2018/19 set at 200 tonnes. The TACs have not been filled in the last 13 years and this is thought to be caused by rough sea conditions that inhibit the feeding behaviour of rock lobster and subsequently lower their catchability. The industry lands between 50% and 80% of the total TAC each season. The catch season is a six-month period with a closed period extending from 1 May to 31 October and highest activity levels are experienced over January and February. The number of active vessels correlates to the allocated quota each season with 16 active during 2014/15.

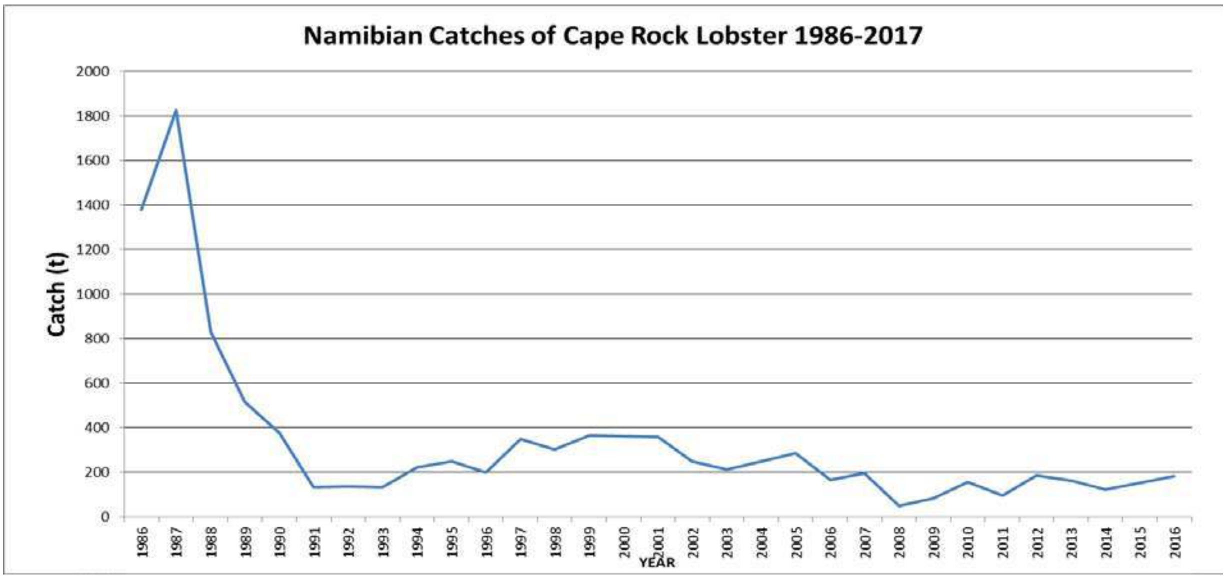

Figure 5-34: Management Catches of rock lobster in Namibia from 1986 to 2017 (Source: FAO catch statistics).

The sector operates in water depths of between 10 m and 80 m. Baited traps consisting of rectangular metal frames covered by netting, are deployed from small dinghy's and delivered to larger catcher reefers to take to shore for processing. The rock lobster fishing fleet consists of vessels that range in length from 7 m to 21 m. Traps are usually set in the late morning and allowed to soak overnight before being retrieved by winch early the following morning.

Within Namibian waters, the lobster stock is commercially exploited between the Orange River border in the south to Easter Cliffs/Sylvia Hill north of Mercury Island (approximately 25°S). The fishery is spatially managed through the demarcation of catch grounds by management area. The Equiano Cable route makes landfall in Swakopmund, situated approximately 293 km from the closest management area at Easter Cliff (see Figure 5-35). There is no overlap between the proposed cable route and commercial rock lobster fishing grounds.

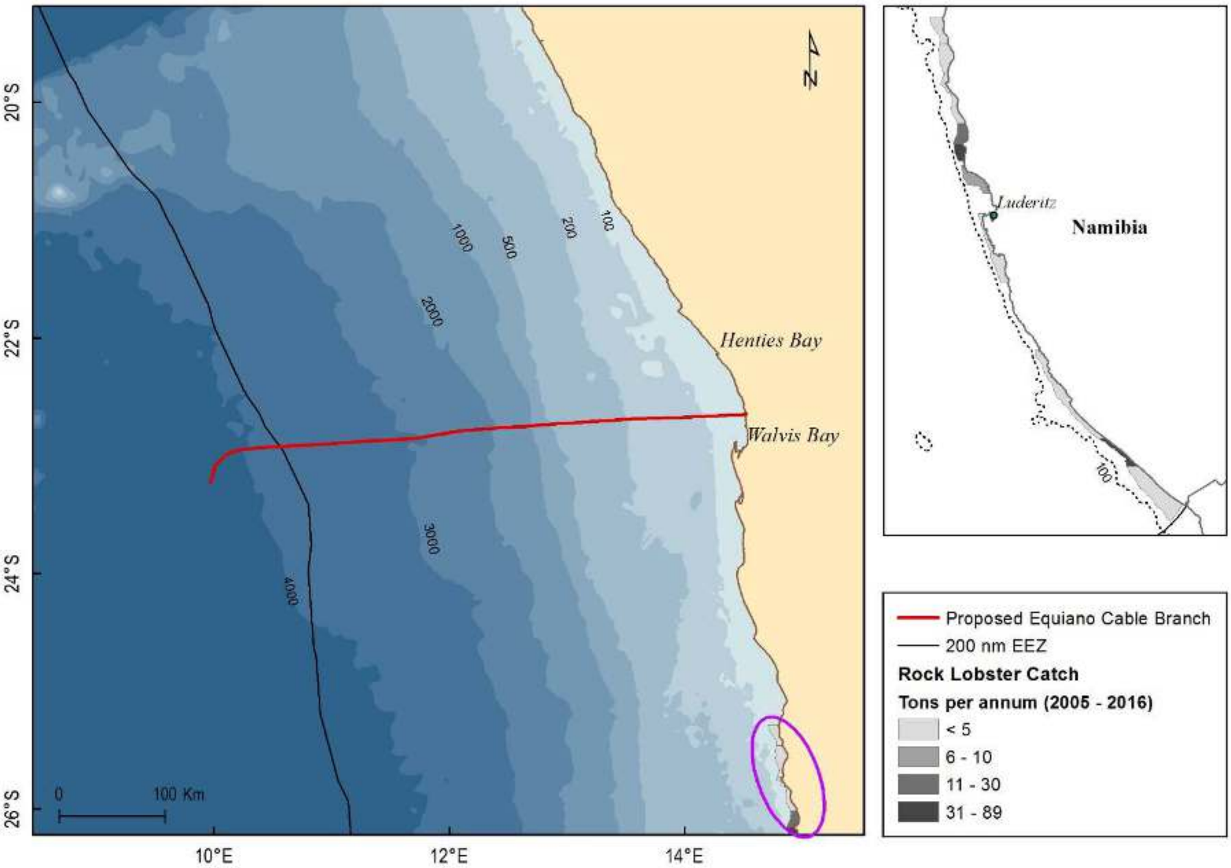

Figure 5-35: Spatial Distribution of Rock Lobster Catch (2005 – 2016) in relation to the proposed Equiano Cable routing within the Namibian EEZ.

6. IMPACT DESCRIPTION AND ASSESSMENT

6.1 Description of the Source of Impact

The project activities that have been identified as posing a potential risk to the fishing industry include 1) the cable route survey, 2) the cable route clearance operations and 3) the installation of the marine telecommunications cable and maintenance thereof. These all have the potential to affect fishing activity through the short term/temporary exclusion of all types of fishing vessels during the route survey and clearance operations. Fishing vessels would be required to maintain a safe operational distance from the Project vessels during the pre-grapnel run and installation of the cable. Once installed, the cable route would be charted by the South African Navy Hydrographic Office.

Historically, commercial fishing has accounted for more than 40 percent of all submarine cable faults worldwide (CSRIC, 2014). Commercial fishing-related damage is most often caused by bottom-tending fishing gear such as trawl nets and dredges, but it is also cause by longlines anchored to the seabed and pot and trap fisheries using grapnels for gear retrieval. For the current project, the cable will be buried to a depth of 1 m, where feasible, in waters shallower than 1,500 m, thus protection will be provided against snagging by trawl gear (in particular trawl doors which dig into the top sediment layer of the seabed). Where burial is not possible, either due to seabed obstructions, hard ground or at depths greater than 1,500 m, the cable will laid directly on the seabed. If a piece of fishing gear or anchor hooks or snags a cable, there would be a likelihood of damage to the cable. Cable damage by bending, crushing and stretching can occur long before the cable breaks. Cables are at risk of damage, therefore, where anchors, grapnels or other equipment are used to drag for lost or unmarked gear. In nearshore areas, cable will be protected against potential damage by heavy armouring.

6.2 Description of the Potential Impact

All fishing vessels would be required to maintain a safe operational distance from the Project vessels during the MBES survey, pre-grapnel run and installation of the cable. Thus the sensitive receptors during the Pre-Installation and Installation Phases of the Project would potentially be any fishing sector that operates in the vicinity of the proposed cable routing.

Once installed, fishermen are required by law to take reasonable care to avoid damaging submarine cables. This means in practice not fishing near known cable locations, which are indicated on navigational charts. This would be relevant only for those fishing sectors that direct fishing effort at the seabed i.e. trawling or anchoring of gear at the seabed. The requirement that fishermen avoid contact likely to break cables is established in the United Nations Convention on the Law of the Sea (UNCLOS). A trawler would be required to "fly" its gear so as to avoid contact with the cable – this refers to shortening the trawl warps and hauling the gear up off the ground until clear of the obstruction. These days precision placement of the gear is possible even at depth due to the sensors attached to the gear. Therefore, the impact to fisheries would equate to exclusion from fishing ground and an associated loss in catch over the time that gear is lifted off the seabed.

In the event that trawling gear snags a submarine cable, lifting the cable can be much more dangerous than pulling free from other seabed obstructions. When the winch is engaged the tension in the trawl warp increases as more cable is lifted from the seabed. The tension in the warps could build up rapidly to a point which would capsize the vessel. Most capsizes of this type are due to human error, and a well-designed vessel should have adequate resistance against capsizing. The combined winch and engine power of a modern trawler are capable of exerting considerable tension in the warp which in turn acts as a downward force on the towing block. This is frequently positioned above the vessel centre of gravity. If the load is also applied to one side then the vessel has the means of creating enough force to capsize itself (Drew and Hopper, 1996).

In areas where the cable is not buried the cable would be exposed and vulnerable to snagging by demersal longline and trawling gear. If this were to occur, besides the potential for damage to the cable, snagging could result in the loss of fishing gear.

6.3 Project Controls and Industry Objectives

Most of the larger companies operating in the submarine cable industry typically work to standards and quality management systems set by the International Organization for Standards under the ISO 9000 and ISO 9001 schemes. In addition, the International Cable Protection Committee (ICPC) publishes recommendations on key issues such as cable routing, cable protection and cable recovery that are available to anyone on request. Although their observance is not mandatory, these recommendations are designed to facilitate quality improvement and are often cited by third parties as examples of best practice in the industry (ICPC, 2009). For the current project, the cable will be buried to a depth of 1 m, where feasible, in waters shallower than 1,500 m, thus protection will be provided against snagging by trawl gear (in particular trawl doors which dig into the top sediment layer of the seabed). Where burial is not possible, either due to seabed obstructions, hard ground or at depths greater than 1,500 m, the cable will laid directly on the seabed.

6.4 Impact Assessment

The spatial distribution of fishing effort of each sector in relation to the proposed cable route is provided in Section 5. Note that there is no overlap of the project activities with the operational areas of the tuna pole, deepsea crab and rock lobster sectors and therefore no impact expected on these fisheries.

Sectors that could be affected during by the short-term exclusion to fishing ground during the pre-installation and installation phases of the project include the small pelagic purse-seine (currently not operational), midwater trawl, demersal trawl, demersal longline, large pelagic longline and linefish sectors, which operate across the proposed routing of the cable. The presence of project vessels would present a direct but temporary impact which would be local in extent. The spatial extent of the impact on all sectors is considered to be local as the affected area covers a very low proportion of fishing ground utilised by each of these sectors. The significance of the impact on these fisheries is expected to be low, due to the short-term and intermittent to periodic nature of the impact. Although specific mitigation is not considered necessary during this phase of the project, advance notification to industry prior to and during installation activities could result in the redirection of fishing effort away from the affected area resulting a reduction of the likelihood of the impact occurring (refer to Table 6-1).

Table 6-1: Impact of Exclusion of Fisheries from Fishing Ground during Pre-Installation and Installation phases of the project.

1	Midwater Trawl, Demersal Trawl, Demersal Longline, Large Pelagic Longline, Linefish	
Project Phase:	**Pre-Installation and Installation**	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
	Pre-Mitigation Impact	**Residual Impact**
Spatial Extent	**Local**	**Local**
	Midwater Trawl: Limited to 143 km^2 (0.2% of fishing ground) Demersal Trawl: Limited to 143 km^2 (0.2% of fishing ground) Demersal Longline: Limited to 111 km^2 (0.2% of fishing ground) Large Pelagic Longline: Catch within affected area amounts to 1% of overall catch Linefish: Limited to 245 km^2 (0.4% of fishing ground)	
Duration	**Short-term**	**Short-term**
	The impact will cease after installation activities have been completed	
Intensity	**Low**	**Low**
	Small alteration of fishing operations	
Frequency	**Intermittent to Periodic**	**Intermittent to Periodic**
	Occurring from time-to-time / Occurring at more or less regular intervals	
Probability	**Probable**	**Improbable**
Irreplaceability	**Low**	**Low**
Reversibility	**High**	**High**
	The impacted environment is able to return to its pre-impacted state at the end of the project life	
Significance	**Low**	**Low**
	The impact will not have a significant influence on the environment and, thus, will not be required to be significantly accommodated in the project design	

Confidence	High	High

The demersal fisheries (i.e. those that direct fishing effort at the seabed) that could be affected by exclusion to fishing during the Operational Phase of the Project include the hake- and monk-directed trawl sector and demersal hake-directed longline sector. Although currently not operational, the deep-water trawl fishery for orange roughy could be affected were it to reopen. The area of exclusion would result in localised, but continuous disruption of fishing activity for these sectors which operate regularly across the proposed cable routing at a depth range of 240 m to 820 m (demersal trawl) and 200 m to 400 m (demersal longline). The deepwater trawl fishery, were it to reopen, could operate within a designated fishing management area referred to as "Rix" which covers a depth range of 300 m to 1800 m along the proposed cable route. The intensity of the impact on these sectors is considered to be medium, resulting in a noticeable alteration to normal fishing activity. An exclusion zone in this area would have an adverse effect on fishing operations; however, if trawlers are able to lift the trawl gear off the seabed whilst traversing the exclusion zone, the overall disruption to normal fishing operations could be reduced. Such adaptive measures may result in a lowering of the overall significance of the impact from medium to low.

6.5 Mitigation Measures

Standard measures would include a process of notification to affected parties prior to the commencement of installation of the cable. Selected fishing industry associations and MFMR should be informed of the pending activity and the safety clearance requirements of the cable-laying vessel.

The following actions are recommended:

- Distribute a Notice to Mariners prior to the commencement of the subsea cable installation. The Notice to Mariners should give notice of the proposed timeframes for subsea installation and an indication of the 0.5 Nm safety zone around the cable-laying vessel. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible
- The subsea vessel contractors must adhere to the International Organization for Standards under the ISO 9000 and ISO 9001 and the International Cable Protection Committee (ICPC) recommendations.
- The subsea cable routing must be published in nautical charts, which are distributed by the navy hydrographic office.
- Undertaking all maritime operations in line with International Maritime Law and safe practice guidelines.

No additional mitigation measures are considered necessary. Refer to Table 6-1 for the Impact Ratings on fisheries during the installations phase of the project (i.e. route survey and cable-laying).

Although burial of the cable in shallow water areas has been factored into the project design, this measure is taken as a precaution to reduce the risk of damage to the cable and does not allow for the resumption of trawling or anchoring within these areas.

7. CONCLUSIONS

The project activities that have been identified as posing a potential risk to the fishing industry include 1) the cable route survey, 2) the cable route clearance operations and 3) the installation of the marine telecommunications cable. These all have the potential to affect fishing activity through either a short term/temporary exclusion of all types of fishing vessels during the route survey and clearance operations and/or a long-term/permanent exclusion to demersal trawling and the anchoring of demersal set fishing gear along the cable route where it passes through fishing grounds.

As a means of protection against human activities, including fishing, the cable would be buried to a depth of 1.0 m in waters shallower than 1,500 m; however, the cable may be exposed on the seabed in some areas unsuitable for burial, eg rock or highly mobile sand. The cable routing would be published in official notices to mariners and nautical charts, which are distributed by the navy hydrographic office.

Fishermen are required by law to take reasonable care to avoid damaging submarine cables. Those sectors at risk of snagging cables include demersal fisheries, in particular, those that fish via trawl and longline. The demersal longline fishery deploys gear that anchors to the seabed. In the unlikely event of gear breaking, grapnel hooks may be used to retrieve lost lines and these could potentially snag and damage an exposed section of cable. With regards to demersal trawling operations, trawl doors pose a reasonably high risk of snagging.

With regards to the Namibian fishing industry this would present an impact to demersal fisheries where the areas of operation of these sectors coincides with the proposed cable route. In practical terms, normal fishing operations would be disrupted and fishing activity would be displaced into adjacent grounds, or through the lifting ground gear (in the case of trawling) off the seabed whilst transiting over the cable. This could result in a loss of catch. In the event that gear were to foul a cable, the gear may be damaged or lost completely. Any catches contained in nets would likely be lost. At worst, there would be a risk to the vessel of capsizing if an attempt were made to lift the cable in order to free fishing gear.

The potential effects of the proposed Project activities on each of the sectors were evaluated. The demersal trawl and longline sectors would be expected to operate along the proposed cable route between the depth range of 240 m to 820 m. Similarly, demersal longline vessels operate along the proposed cable route at a depth range of 200 m to 400 m. The proposed cable routing covers approximately 0.2% of the total fishing area utilised by each of these sectors. Whereas the proposed installation poses a noticeable, negative effect on normal fishing operations, adaptive fishing techniques may lower the impact from medium to low overall significance.

Sectors that could be affected during a temporary exclusion to fishing ground during the pre-installation and installation phase of the Project include the midwater trawl, demersal trawl, demersal longline, large pelagic longline and linefish sectors, which operate in the nearshore vicinity of the proposed cable route. Due to the temporary nature of the activity, and the low proportional overlap, the impact on these sectors is considered to be of low significance.

Apart from the proposed inherent project controls, no additional mitigation measures are considered necessary as the effects on the fishing industry associated with the proposed Project are considered to be within an acceptable level. Measures of monitoring that the extent of the effect on fisheries is maintained at an acceptable level is not considered necessary.

8. REFERENCES

Benguela Current Large Marine Ecosystem State of Stocks Review 2011 (2nd Edition; Ed C. Kirchner). Benguela Current Commission.

Benguela Current Commission, 2014. Strategic Action Programme 2015 – 2019. https://www.benguelacc.org/.../684-bcc-strategic-action-programme-2015-2019-eng

Benguela Current Commission, 2014. BCLME State of the Marine Environment Report.

BCC, 2018. Benguela Current Commission. Report of the Regional Demersal Working Group, 10-14 December 2018. (Unpub. Report)

Botha L (1980) The biology of the Cape hakes *Merluccius capensis* Cast. and *M. paradoxus* Franca in the Cape of Good Hope area Ph.D. thesis, University of Stellenbosch (182 pp.)

Boyer D C and Hampton I (2001) An overview of the living marine resources of Namibia in A decade of Namibian Fisheries Science S. Afr. J. mar. Sci (23) Eds Payne A I L, Pillar S C and Crawford R J M.

Boyer DC, Boyer HJ, Fossen I, Kreiner A. (2001) Changes in abundance of the northern Benguela sardine stock during the decades 1990–2000 with comments on the relative importance of fishing and the environment. Afr. J. of Mar. Sci., 23: 67–84.

Branch, T.A. 2001. A review of orange roughy Hoplostethus atlanticus fisheries, estimation methods, biology and stock structure. S. Afr. J. mar. Sci. 23: 181 – 203

Cochrane, K.L. and S. Wilkinson. 2015. Assessment of the potential impacts on the small pelagic fishery of the proposed 2D seismic survey by Rhino Oil and Gas Exploration South Africa (Pty) Ltd in the inshore area between Saldanha Bay and Cape Agulhas. Prepared for SLR Environmental Consultants (Pty) Ltd; unpublished.

Cochrane, K.L., J. Augustyn, T. Fairweather, D. Japp, K. Kilongo, J. Iitebu, N. Moroff, J.P. Roux, L.J. Shannon, B. van Zyl and F. Vaz Velho. (2009). Ecosystem Approaches for Fisheries (EAF) Management in the BCLME (Project LMR/EAF/03/01) : Sardine (Pilchard) (TROM Review) Benguela Current Large Marine Ecosystem – governance and management for an ecosystem approach to fisheries in the region. Coastal Management 37: 235-254. .

Crawford R J M, Shannon L V and Pollock D E (1987) The Benguela ecosystem (4) The major fish and invertebrate resources In Oceanography and Marine Biology: An Annual Review 25 Barnes M (Ed) Aberdeen; University Press (353-505).

Fisheries and Aquaculture industry in Namibia. The Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean (ATFALCO): Series Report No. 2 on the Fisheries and Aquaculture review in the 22 ATLAFCO member countries. October 2012.

Holness, S., Wolf, T., Lombard M. and C. Kirchner. 2012. Spatial Biodiversity Assessment and Spatial Management, including Marine Protected Areas: Spatial summary of pressures on marine systems. Benguela Current Commission.

ICPC, 2009. International Cable Protection Committee http://www.iscpc.org/

King D P F (1977) Influence of temperature, dissolved oxygen and salinity on incubation and early larval development of the South West African pilchard *Sardinops ocellata* Invenstl Rep. Sea Fish. Brch S. Afr. 114 (35 pp.)

Kirchner, C, Kainge, P and J. Kathena. 2014. Evaluation of the Status of the Namibian Hake Resource (Merluccius spp.) Using Statistical Catch-at-Age Analysis. Environment for Development Discussion Paper Series October 2012 EfD DP 12-12

Kirchner, C., Bauleth-d'Almeida, G. and M. Wilhelm. 2010. Assessment and management of Cape horse mackerel *Trachurus trachurus capensis* off Namibia based on a fleet-disaggregated age-structured production model. African Journal of Marine Science, 32(3).

Fishing Industry Handbook South Africa, Namibia and Moçambique (2016) 44th edition George Warman Publications

Le Roux L (1997) Stock assessment and population dynamics of the deep-sea red crab *Chaceon maritae* (Brachyura, Geryonidae) off the Namibian Coast M.Sc. thesis, Univerisity of Iceland (88 pp.)

Leslie R W and Grant W S (1990) Lack of congruence between genetic and morphometric stock structure of the southern African anglerfish *Lophius vomerinus* S. Afr. J. mar. Sci. 9 (379-398)

Macpherson E (1985) Daily ration and feeding periodicity of some fishes off the coast of Namibia Mar. Ecol. Prog. Ser. 26(3): 253-260

Olivar M P, Rubies P and Salat J (1988) Early life history and spawning of *Merluccius capensis* Castelnau in the northern Benguela Current S. Afr. J. mar. Sci. 6 (245-254)

O'Toole M J (1977) Investigation into some important fish larvae in the South-East Atlantic Ph.D. thesis University of Cape Town (299 pp.)

Russell, D. 2017. Namibia : Seismic impact on fish; the state of tuna. In: Fishing Industry News, August 2017 edition.

Russell, D. 2013. Key Issues and Possible Impacts of Seismic Activities on Tunas: For the Large Pelagic and Hake Longlining Association in Namibia. Presented at Benguela Current Commission 5th Annual Science Forum. 24 September 2013.

Schneider, GIC. 2013. Seismic Acquisitions and the Impact on the Large Pelagic Albacore Tuna Pole and Line Industry in Namibia. Geological survey of Namibia

Staby and J-O. Krakstad. Report on BCLME project LMR/CF/03/08:Review of the state of knowledge, research (past and present) of the distribution, biology, ecology, and abundance of non-exploited mesopelagic fish (Order Anguilliformes, Argentiniformes, Stomiiformes, Myctophiformes, Aulopiformes) and the bearded goby (*Sufflogobius bibarbatus*) in the Benguela Ecosystem.

Sætersdal G, Bianchi G, Strømme T, Venema SC (1999) The Dr Fridtjof Nansen programme 1975–1993. Investigation of fishery resources in developing countries. History of the programme and review of results. FAO fisheries technical paper 391, Rome

Strømme .T, Lipinski M.R. and P. Kainge (2015) Life cycle of hake and likely management implications. Rev Fish Biol Fisheries.

Tarr P., Krugmann H., Rosso V., Tarr J., et al. 2007. Analysis of threats and challenges to marine biodiversity and marine habitats in Namibia and Angola. Final report for Benguela Current Large Marine Ecosystem Programme project BEHP/BTA/04/01. 132pp + annexes.

Tarr, P. and Figueira, M., September 1999. Namibia's Environmental Assessment Framework: - the evolution of policy and practise. Research Discussion Paper No. 34, September 1999. Directorate of Environmental Affairs, Ministry of Environment and Tourism. http://www.the-eis.com/data/literature/RDP%2034.pdf

The Communications Security, Reliability and Interoperability Council IV (CSRIC): Working Group 8 (December 2014). Submarine cable routing and landing: Final Report 1 – Spatial Separation. Pp 72

UNEP-WCMC, 2009. United Nations Environment Programme and World Conservation Monitoring Centre datasets. http://www.unep-wcmc.org/oneocean/ datasets.aspx

Wilhelm, M and A. Kanandjembo 2007. Biomass and biological data from the Namibian annual horse mackerel abundance surveys, updated for 2007. MFMR

Wilson, J., 2006. Predicting seafloor cable faults from fishing gear – US Navy Experience. Presentation at ICPC Plenary Meeting, May 2006; Vancouver, Canada.

Appendix 1: Relevant Legislature

The International Convention for the Protection of Submarine Cables (1884) is the foundation of modern international law for submarine cables as contained in the Geneva Conventions on the High Seas 1958 (Articles 26–30) and Continental Shelf 1958 (Article 4) and in the United Nations Convention on the Law of the Sea (1982) (UNCLOS).

Coastal states exercise sovereign rights and jurisdiction in the EEZ and on the continental shelf for the purpose of exploring and exploiting their natural resources, but other states enjoy the freedom to lay and maintain submarine cables in the EEZ and on the continental shelf. In the territorial sea, coastal states may establish conditions for cables or pipelines entering these zones (UNCLOS, Article 79(4)). At the same time, the laying and maintenance of submarine cables are considered reasonable uses of the sea and coastal states benefit from them. Outside of the territorial sea, the core legal principles applying to international cables can be summarized as follows (UNCLOS, Articles 21, 58, 71, 79, 87, 112-115 and 297(1)(a)):

- the freedoms to lay, maintain and repair cables outside of territorial seas, including cable route surveys incident to cable laying (the term laying refers to new cables while the term maintaining relates to both new and existing cables and includes repair) (Nordquist *et al.*, 1993, p. 915);
- the requirement that parties apply domestic laws to prosecute persons who endanger or damage cables wilfully or through culpable negligence;
- the requirement that vessels, unless saving lives or ships, avoid actions likely to damage cables;
- the requirement that vessels must sacrifice their anchors or fishing gear to avoid injury to cables;
- the requirement that cable owners must indemnify vessel owners for lawful sacrifices of their anchors or fishing gear;
- the requirement that the owner of a cable or pipeline, who in laying or repairing that cable or pipeline causes injury to a prior laid cable or pipeline, indemnify the owner of the first laid cable or pipeline for the repair costs; and
- the requirement that coastal states along with pipeline and cable owners shall not take actions which prejudice the repair and maintenance of existing cables.

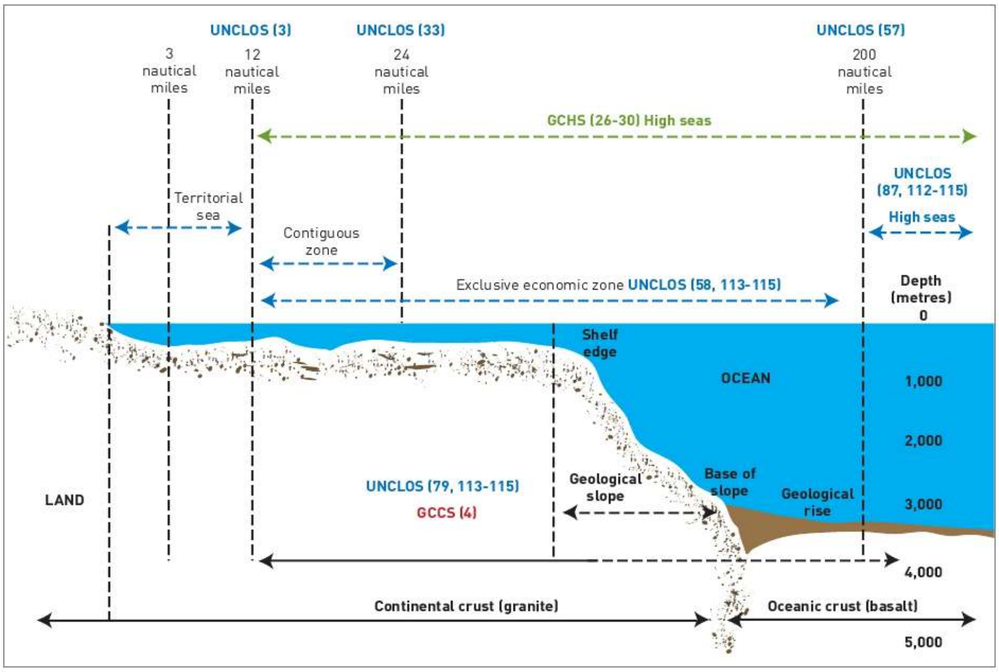

*Figure 1. Legal boundaries of the ocean from territorial sea to exclusive economic zone and onto the high seas (*Source: D. Burnett in UNEP-WCMC, 2009)

Under UNCLOS and the earlier 1884 International Convention for the Protection of Submarine Cables, if a mariner damages a cable and the damage could be avoided by taking reasonable care as a prudent seaman, then the person causing the damage is liable. If a mariner damages a cable with fishing gear or an anchor, when he could have seen that cable on a chart and avoided it, he may be liable for the damage. In addition to civil liability for damages, the mariner may face criminal sanctions for culpable negligence or wilful injury to a cable.

International law also requires that a vessel that has gear or an anchor caught on a cable is required to sacrifice the gear or anchor to avoid injury to the cable. Provided the mariner was not negligent in contacting the cable in the first place, the mariner is entitled to indemnity for the cost of the sacrificed gear or anchor by the owners of the cable. To claim indemnity for the sacrifice, the mariner should file within 24 hours of arrival in port a declaration setting forth the circumstances of the sacrifice with the cable owner, if known, or the local government maritime authorities like the coast guard. In the case of a valid sacrifice, the cable owner may be required to pay the indemnity for the sacrificed gear or anchor.

PROPOSED INSTALLATION
OF THE EQUIANO CABLE SYSTEM,
SWAKOPMUND, NAMIBIA

Marine Ecology Assessment

Prepared for:

ACER (Africa) Environmental Consultants

June 2020

PISCES ENVIRONMENTAL SERVICES (PTY) LTD

PROPOSED INSTALLATION OF THE EQUIANO CABLE SYSTEM, SWAKOPMUND, NAMIBIA

MARINE ECOLOGY ASSESSMENT

Prepared for

ACER (Africa) Environmental Consultants

Prepared by

Andrea Pulfrich
Pisces Environmental Services (Pty) Ltd

June 2020

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ABBREVIATIONS and UNITS

CBD	Convention of Biological Diversity
CCA	CCA Environmental
CITES	Convention on International Trade in Endangered Species
cm	centimetres
cm/sec	centimetres per second
CMS	Centre for Marine Studies
CMS	Convention on Migratory Species
CSIR	Council for Scientific and Industrial Research
dB	decibell
DEA	Department of Environmental Affairs
E	East
EBSA	Ecologically or Biologically Significant marine Areas
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMPr	Environmental Management Programme
ENE	east-northeast
gC/m^2	grams Carbon per square metre
ha	hectares
Hz	Herz
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
km	kilometre
km^2	square kilometre
MPA	Marine Protected Area
m	metres
m^2	square metres
mg/m^3	milligrams per cubic metre
ml	millilitre
mm	millimetre
m/sec	metres per second
m^3/sec	cubic metres per second
NE	northeast
NNE	north-northeast
ROV	Remotely Operated Vehicle
S	south
S&EIR	Scoping and Environmental Impact Report
SSW	south-southwest
SW	southwest
WSW	west-southwest
µPa	micro Pascal
°C	degrees Centigrade
percent	percent

~	approximately
<	less than
>	greater than

GLOSSARY

Benthic	Referring to organisms living in, or on, the sediments of aquatic habitats (lakes, rivers, ponds, etc.).
Benthos	The sum total of organisms living in, or on, the sediments of aquatic habitats.
Benthic organisms	Organisms living in, or on, sediments of aquatic habitats.
Biodiversity	The variety of life forms, including the plants, animals and micro-organisms, the genes they contain and the ecosystems and ecological processes of which they are a part.
Biomass	The living weight of a plant or animal population, usually expressed on a unit area basis.
Biota	The sum total of the living organisms of any designated area.
Community structure	All the types of taxa present in a community and their relative abundance.
Community	An assemblage of organisms characterized by a distinctive combination of species occupying a common environment and interacting with one another.
Ecosystem	A community of plants, animals and organisms interacting with each other and with the non-living (physical and chemical) components of their environment
Environmental impact	A positive or negative environmental change (biophysical, social and/or economic) caused by human action.
Epifauna	Organisms, which live at or on the sediment surface being either attached (sessile) or capable of movement.
Habitat	The place where a population (*eg,* animal, plant, micro-organism) lives and its surroundings, both living and non-living.
Infauna	Animals of any size living within the sediment. They move freely through interstitial spaces between sedimentary particles or they build burrows or tubes.
Macrofauna	Animals >1 mm.
Macrophyte	A member of the macroscopic plant life of an area, especially of a body of water; large aquatic plant.
Meiofauna	Animals <1 mm.
Marine environment	Marine environment includes estuaries, coastal marine and nearshore zones, and open-ocean-deep-sea regions.
Pollution	The introduction of unwanted components into waters, air or soil, usually as result of human activity; *eg,* hot water in rivers, sewage in the sea, oil on land.
Population	The total number of individuals of the species or taxon.

Recruitment	The replenishment or addition of individuals of an animal or plant population through reproduction, dispersion and migration.
Sediment	Unconsolidated mineral and organic particulate material that settles to the bottom of aquatic environment.
Species	A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group.
Subtidal	The zone below the low-tide level, *ie,* it is never exposed at low tide.
Surf zone	Also referred to as the 'breaker zone' where water depths are less than half the wavelength of the incoming waves with the result that the orbital pattern of the waves collapses and breakers are formed.
Suspended material	Total mass of material suspended in a given volume of water, measured in mg/ℓ.
Suspended matter	Suspended material.
Suspended sediment	Unconsolidated mineral and organic particulate material that is suspended in a given volume of water, measured in mg/ℓ.
Taxon (Taxa)	Any group of organisms considered to be sufficiently distinct from other such groups to be treated as a separate unit (*eg,* species, genera, families).
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
Turbidity	Measure of the light-scattering properties of a volume of water, usually measured in nephelometric turbidity units.
Vulnerable	A taxon is vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

EXPERTISE AND DECLARATION OF INDEPENDENCE

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

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

This specialist report was compiled on behalf of ACER (Africa) Environmental Consultants for their use in preparing a Scoping and Environmental Impact Report (S&EIR) for the proposed installation of the Equiano Cable System in Namibia. I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicant and ACER.

Andrea Pulfrich

Dr Andrea Pulfrich

1. GENERAL INTRODUCTION

The Project involves the installation and operation of a fibre optical submarine cable to provide international capacity and reliability. The Equiano Cable System would be installed by Paratus Telecommunications (Pty) Ltd 2007/0100, to link Namibia with key international telecommunications hubs in West Africa (Nigeria) and Europe (Portugal). Paratus Telecommunications (Pty) Ltd 2007/0100 is the designated Landing Partner of the Equiano Cable System in Namibia, and is licensed to operate international telecommunications infrastructure in the country. Paratus Telecommunications will obtain the required local permits to land the Equiano Cable System at Swakopmund.

Alcatel Submarine Networks (ASN) has been appointed as the supplier and installer of the Equiano Cable System. The system will be installed in phases, with the first phase entailing the installation of cable landings at Melkbosstrand (South Africa), Swakopmund (Namibia), Lagos (Nigeria) and Lisbon (Portugal).

The main cable ('trunk') will run approximately 11,500 km along the West Coast of Africa from Melkbosstrand in South Africa to Lisbon in Portugal with various Branching Units, including the one to Swakopmund, off the main trunk *en route*. When entering Namibia's territorial waters the Cable System will follow a general west-east alignment from the branching node at 23°13.843'S, 09°58.246'E to the landing location at 22°38.830'S; 14°31.615'E, adjacent and to the south of the small craft harbour in Swakopmund.

The system includes a 14 mm to 35 mm diameter subsea cable that will enter the Namibian Exclusive Economic Zone (EEZ) (approximately 470 km from the seashore) and continue for ~490 km through the EEZ and Territorial Waters, to a landing site at Swakopmund (Figure 1). As part of the EIA process, an assessment was undertaken of the impact of the proposed Project on the Namibian fishing industry (Japp & Wilkinson 2020).

The installation of the subsea cable system is provisionally scheduled to commence in the last quarter of 2020 and to be completed by the begining of 2021.

1.1. Scope of Work

This specialist report was compiled as a desktop study on behalf of ACER Environmental Consultants, for inclusion in the S&EIR and for developing an EMPr for the proposed installation of the subsea cable system off Swakopmund on the Namibian coast.

The terms of reference for this study are:

- Undertake a desktop assessment of the potential impact that the Equiano Cable System and related infrastructure will have on the Marine Benthic Environment based on the alignment selected. In this context, the specialist study should identify and discuss the following topics:
    a) An introduction with a brief project overview, study approach, methodology, and assumptions and limitations.
    b) A description of the marine environment of the project area, focusing on the benthic invertebrate communities based on available literature and previous experience.
    c) A description of the potential impacts of the project on the benthic invertebrate fauna, followed by an assessment of the significance of these impacts using the assessment criteria provided (it must be noted that marine telecommunications cables once installed have a legislated 500 m buffer either side of the cable where no fishing/trawling or anchoring of vessels may take place).
- Provide a detailed motivation why site investigations were deemed unnecessary.

- In assessment of impacts take into account the spatial scale, intensity, duration, etc. of the impacts and include recommendations for mitigation of impacts.
- Address specific issues and concerns raised by stakeholders during the public review phase of the EIA process (an Issues and Responses Report will be provided to specialists).
- Discuss any other sensitivities and important issues from a Marine Benthic perspective that are not identified in these terms of reference.

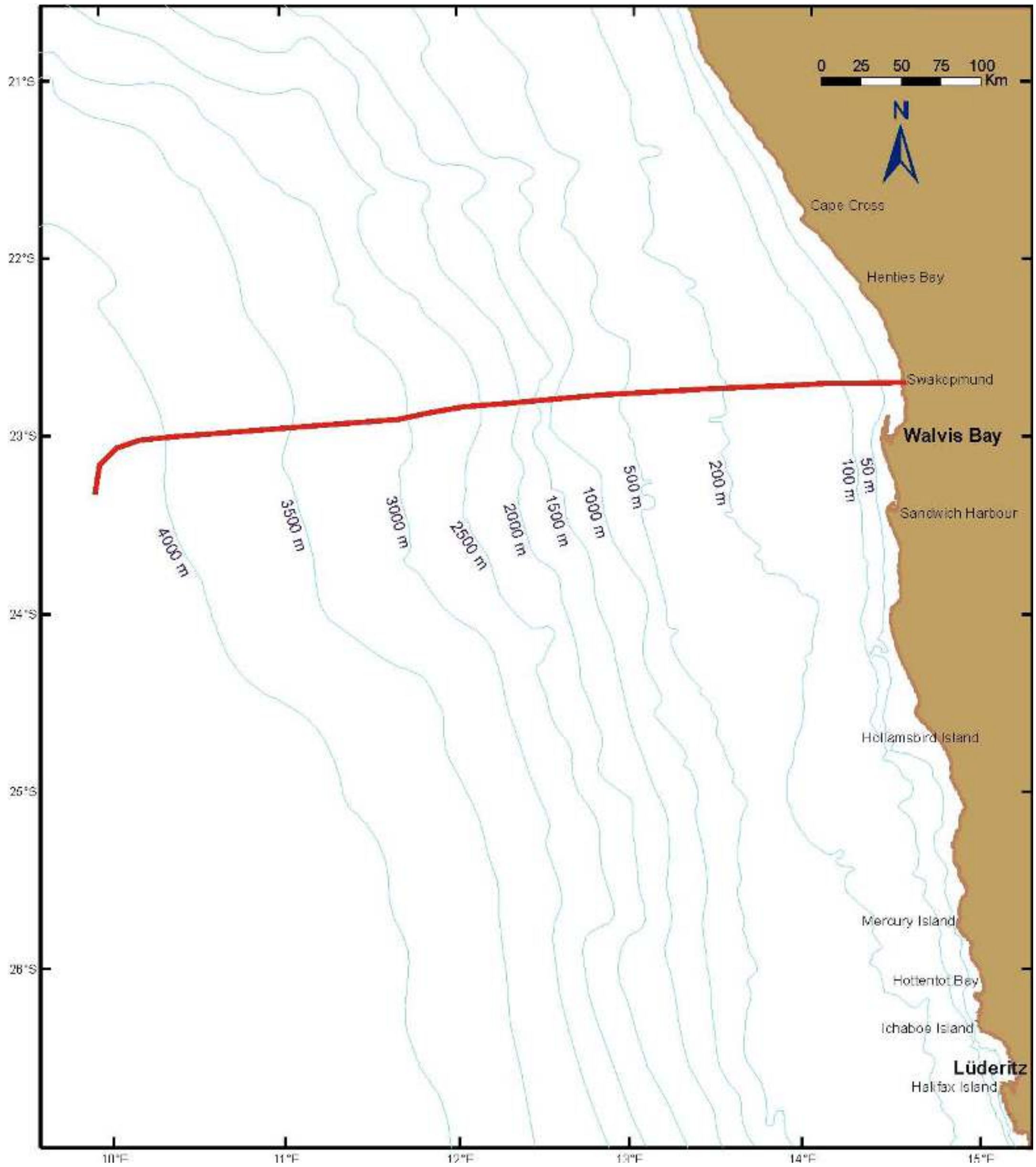


Figure 1: Map indicating proposed route of the Equiano Cable System in relation to bathymetric features off Namibia.

1.2. Approach to the Study

As determined by the terms of reference, this study has adopted a 'desktop' approach. Consequently, the description of the natural baseline environment in the Marine Study Area is based on a review and collation of existing information and data from the scientific literature, and various internal reports. The information for the identification of potential impacts on benthic communities was drawn from various scientific publications, and information sourced from the Internet. The sources consulted are listed in the Reference chapter.

All identified marine impacts are summarised, categorised and ranked in appropriate impact assessment tables, to be incorporated into the EIA Report.

2. DESCRIPTION OF THE PROPOSED PROJECT

2.1. Project Location

The project involves the installation and operation of a 17-37.5-mm diameter subsea fibre optic cable system, the main trunk of which will run ~11,500 km from Portugal to South Africa. Branches will split from the main trunk to landing sites located *en route*, including Ghana, Nigeria, St Helena and Namibia. Namibia will be a branch of the main trunk of the cable, whose end station is located at Melkbosstrand in South Africa (see Figure 1).

The main trunk of the marine cable will be located ~200 to 500 km from the shoreline in international waters, with branch cables running to the shoreline through territorial waters to the landing site in each country. The proposed cable routes will be geophysically surveyed to identify whether the substrate and topography of the ocean floor are suitable for cable installation. Survey approaches will comprise side scan sonar (inshore and up to a depth of 500 m), Multi-Beam Echo Sounder Swath Bathymetry and sub-bottom profiling. In deeper waters, surveying will be undertaken with hull-mounted equipment, whereas in shallower waters equipment will be housed in a 'fish' towed behind the survey vessel. A burial assessment survey involving Cone Penetrometer Tests will be undertaken from the shore line up to a depth of 1,000 m to test the suitability of the substrate for cable burial. At the landing site the survey of the shore approach will be supported where appropriate by a diver/swim team equipped with both video camera and bar probes to determine the final cable alignment at the shore crossing.

The landing site at Swakopmund is characterized by a stretch of sandy beach adjacent to and south of the small craft harbour (Figure 2). At the shore crossing, the buried subsea fibre optics cable will enter a beach manhole installed as part of the project by Paratus. From the beach manhole, the land cable will be installed to the Paratus cable landing station on the corner of Kaats and Tsavorite Street. The cable will be installed into a trench 1 m wide and up to 2 m deep in places. Two possible cable alignments from the beac manhole to the cable landing station are being considered.

Figure 2: GoogleEarth image showing the routing of the proposed Equiano Cable System in shallow waters and the shore crossing at the beach south of the small craft harbour in Swakopmund.

2.2. Installation Phase

The installation of the cable would involve two main phases, namely:

- Following a Cable Route Desktop Study, a **cable route survey** is undertaken of the offshore and nearshore seabed to provide the necessary information for detailed engineering, construction, installation and subsequent maintenance of the cable. The main objective of the survey is to define a routing that will maximise cable survivability and avoid seabed features that may pose a hazard to cable integrity or that constitute habitat of conservation interest. In water of depths less than 1,000 m, multibeam swath bathymetry, sub-bottom profiling and side scan sonar surveys are undertaken along a 500-m wide corridor along the cable route. This allows adjustment of the cable position off the centre line if required by seabed hazards. In water of depths greater than 1,000 m, only multibeam bathymetry will be acquired. All the systems are hull-mounted and no towed equipment will be used. Sound levels from the acoustic equipment would range from 190 to 240 dB re 1 µPa at 1 m.
  - swath bathymetry systems (multibeam echo sounders (MBES)) produce a digital terrain model of the seafloor (source levels of 190-220 dB re 1 µPa at 1 m);
  - sub-bottom profiler seismic systems (e.g. boomer, sparker, chirp and sleeve gun), which generate profiles beneath the seafloor to give a cross section view of the sediment layers (source levels of 200-230 dB re 1 µPa at 1 m); and
  - side-scan sonar systems, which produce acoustic intensity images of the seafloor and are used to map the different sediment textures from associated lithology of the seafloor (source levels of 190-242 dB re 1 µPa at 1 m).

  Seabed sampling and *in situ* testing of seabed physical properties, are also usually undertaken to determine the type and thickness of sediment suitable for cable burial thereby assisting in defining the most appropriate mode of burial (e.g. ploughing, jetting,, horizontal directional drilling and trenching)
- A **pre-lay grapnel run**, which is conducted immediately in advance of cable installation to remove any obstacles from the path of the final subsea cable route in water depths up to 1,500 m. The operation involves the towing of one or an array of grapnels by the main cable laying vessel, or another designated vessel, along the route where burial is required or where seabed debris needs to be cleared. The grapnel is towed at a rate that ensures it maintains contact with the seabed and can penetrate up to 40 cm into unconsolidated sediments. As a matter of routine maintenance or in the event of increased tension, the grapnel array is recovered onboard the vessel and inspected. Usually a single tow is made along the route, although in areas where other marine activity or seabed debris are high, additional runs may be required. Depending on the seabed conditions, different types of grapnels can be used (Gillford in rockier areas and Rennies and Flat Fish in softer sandy sediments). Route clearance will be performed at specific locations where decommissioned cables are known to cross the Equiano cable route where burial is planned.
- **Subsea cable installation**, which is undertaken by a specialised cable laying vessel that places the cable on the seabed along the predetermined route. At depths exceeding 1,500 m the cable can be placed directly on the seabed without the need for burial because at these depths it is highly unlikely that the cable could be damaged by contact with bottom tending deep sea fishing gears such as trawls and dredges. At depths shallower than 1,500 m, a trench 1.0 – 1.5 m deep is excavated in the unconsolidated sediments by a specialised subsea cable plough to receive the cable. The foot print of the plough is limited to the area in which the four plough skids and the plough share, which is approximately 0.75 m wide, are in contact with the

seabed. Within this width, a spoil heap of unconsolidated material exists to one side of the plough line; but the height of this is normally less than 0.25 m and will be eroded with time due to bottom currents. The plough itself is 5 m wide, with a submerged weight of 13 tonnes. The plough is designed to backfill the cable burial trench during operation. Heavier armouring around the cable is also used to provide additional protection, particularly in areas of uneaven or rocky seabed. A Remotely Operated Vehicle ROV equipped with jetting tools may be deployed to undertake Post Lay Burial to a depth of 1 m – this is reserved for restricted areas where ploughing is ineffective or impractical.

In the littoral zone (<15 m) to the landing point on the beach, the cable will be installed through 'direct shore end operation'. This involves floating the shore end cable directly from the main cable installation vessel to the beach landing point using buoys and assisted by small boats and divers. The sections of the cable crossing the low water mark and the beach will be buried in the seabed using diver-operated hand-held jets. The expected maximum width of the seabed fluidised by the jet burial is approximately 200 mm with burial to a target depth of 1.0 m. In rocky areas where burial cannot be achieved, or where additional cable protection is required, conduiting or an articulated split-pipe may be used to maximise cable security and protection. Articulated pipe is typically applied to beyond the surf zone, but may extend further offshore at landings where cable burial may prove difficult.

- The **shore-crossing** of the cable segment from the low water mark to the beach man hole will involve trenching of the beach sediments to a target depth of 2 m below the beach level, or until bedrock is reached. No effort will be made to excavate or trench through rock if this is encountered at a depth shallower than 2 m. The cable will be laid upon the bedrock and will be held in place by its own weight, thereby avoiding the need to anchor or clamp the cable to the bedrock. The beach excavation will typically be carried out using tracked backhoe diggers and hand tools.

Table 1: Summary of Cable Installation Activities revalent to the marine environment.

Conditions/Environment	Installation Method
Water depth >1,500 m	No burial, cable surface laid without armouring.
Water depth < 1,500 m	Ploughing from the subsea cable lay vessel to a target water depth of 15 m with Post Lay Burial to a depth of 1 m reserved for areas where ploughing is ineffective or impractical.
Littoral zone	Trench excavation using diver-operated hand-held jets. . The subsea cable is generally protected by clamping additional pipe sections around it (articulated pipe or uraduct protection). In areas of hard seabed and high wave energy, the split pipes may be pinned to the seabed to prevent movement. Where possible, Existing anchor sites will be used.
Beach landing	Trenching above the High Water Mark (HWM) to achieve burial to 2 m depth

2.3. Operations

Once installed and operational the subsea cable will not require routine maintenance, although cable repair may be required as a result of physical damage (either anthropogenic or natural) or failure. To effect repairs on deep sea cables, the damaged subsea cable is cut at the seabed and each end separately brought to the surface, whereupon a new section is spliced in. Dedicated repair ships are on standby to respond to any emergency repairs.

2.4. Decommissioning

The subsea cable is expected to be operational for at least 25 years. Options for decommissioning of the system at the end of the Project's lifetime include retirement in place, or removal and salvage. Decommissioning would involve demolition, recovery and removal of terrestrial components (if they are not re-used for new cables or another purpose). The cable will be decommissioned in line with regulations in force at the end of the Project lifetime.

The subsea cable is likely to be left in place, as per current global industry practice. This is done in accordance with a Decommissioning Plan, details of which will be provided in the EIA Report.

3. DESCRIPTION OF THE BASELINE MARINE ENVIRONMENT

This environmental description encompasses the coastal zone and shallow nearshore waters (< 40 m depth) extending from Walvis Bay north to Henties Bay (see Figure 1). Where information from offshore environments exists, these are included. Some of the data presented are, however, more regional in nature, e.g. the wave climate, nearshore currents, etc. The purpose of this environmental description is to provide the marine baseline environmental context within which the installation of the Equiano Cable System will take place. The summaries presented below are based on information gleaned from Morant (2006), and Penney *et al.* (2007).

3.1. Geophysical Characteristics

3.1.1 Bathymetry

The continental shelf off Namibia is variable in width. Off the Orange River the shelf is wide (230 km) and characterised by well-defined shelf breaks, a shallow outer shelf and the aerofoil-shaped submarine Recent River Delta on the inner shelf. It narrows to the north reaching its narrowest point (90 km) off Chameis Bay, before widening again to 130 km off Lüderitz and Walvis Bay (Rogers 1977). Off Terrace Bay the shelf gives rise to the Walvis Ridge, an underwater plateau extending south-westwards far into the south Atlantic, before narrowing again towards Cape Frio. Off Walvis Bay and Swakopmund there is a double shelf break, with the inner and outer breaks beginning at depths of around 140 m and 400 m, respectively (Shannon & O'Toole 1998).

The salient topographic features of the shelf include the relatively steep descent to about 100 m, the gentle decline to about 180 m, and the undulating depths to about 200 m. The most prominent topographic feature in the study area is the Walvis Ridge, which extends from the African coast at around 18°S more than 3 000 km south-westwards to Tristan da Cunha, the Gough Islands and the Mid-Atlantic Ridge. This plateau effectively splits the abyssal plain of the Southeast Atlantic into the Angola Basin to the north and the Cape Basin to the south. The variable topography of the shelf is of significance for near shore circulation and for fisheries (Shannon & O'Toole 1998).

3.1.2 Coastal and Inner-shelf Geology and Seabed Geomorphology

Figure 3 illustrates the distribution of seabed surface sediment types off the central Namibian coast. The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Birch *et al.* 1976; Rogers 1977; Rogers & Bremner 1991). As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. Off central Namibia, the muddy sand in the near shore area off Henties Bay gives way to a tongue of organic-rich sandy mud, which extends from south of Sandwich Harbour to ~ 20°40'S northwards to Pelgrave Point (Figure 3). These biogenic muds are the main determinants of the formation of low-oxygen waters and sulphur eruptions off central Namibia (see Sections 3.2.9 & 3.2.10). Further offshore these give way to muddy sands, sands and gravels before changing again into mud-dominated seabed beyond the 500-m contour. The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

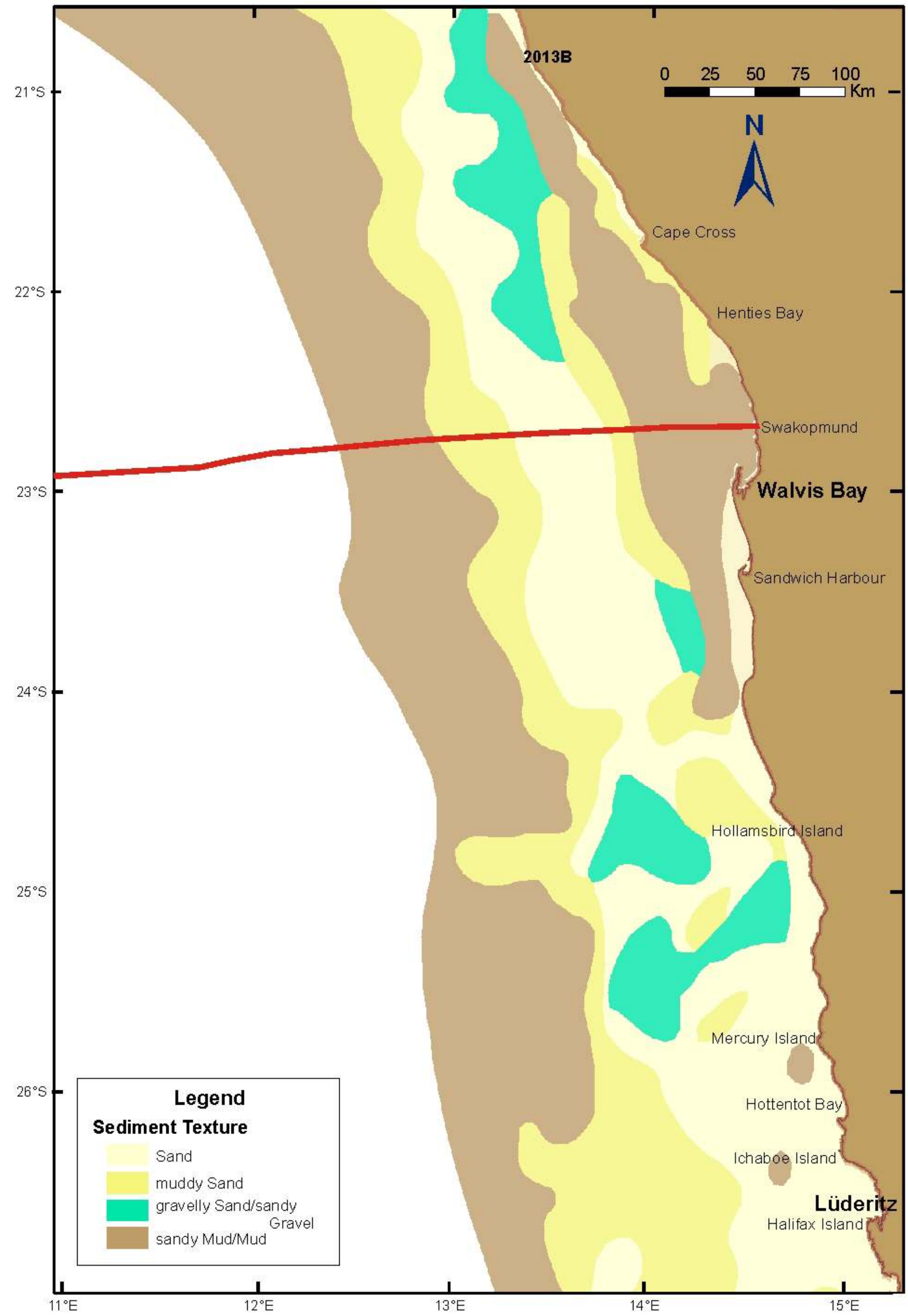


Figure 3: The routing of the proposed Equiano Cable System (red line) in relation to the offshore seabed sediments in the region.

3.2. Biophysical Characteristics

3.2.1 Climate

The climate of the Namibian coastline is classified as hyper-arid with typically low, unpredictable winter rains and strong predominantly southerly or south-westerly winds. Further out to sea, a south-easterly component is more prominent. Winds reach a peak in the late afternoon and subside between midnight and sunrise.

The Namibian coastline is characterised by the frequent occurrence of fog, which occurs on average between 50-75 days per year, being most frequent during the months of February through May. The fog lies close to the coast extending about 20 nautical miles (~35 km) seawards (Olivier 1992, 1995). This fog, which is usually quite dense, appears as a thick bank hugging the shore and may reduce visibility to <300 m.

Average precipitation per annum along the coastal region between Walvis Bay and the Kunene River is <15 mm. Due to the combination of wind and cool ocean water, temperatures are mild throughout the year. Coastal temperatures average around 16°C, gradually increasing inland (Barnard 1998). In winter, maximum diurnal shifts in temperature can occur caused by the hot easterly 'Berg' winds which blow off the desert. During such occasions temperatures up to 30°C are not uncommon.

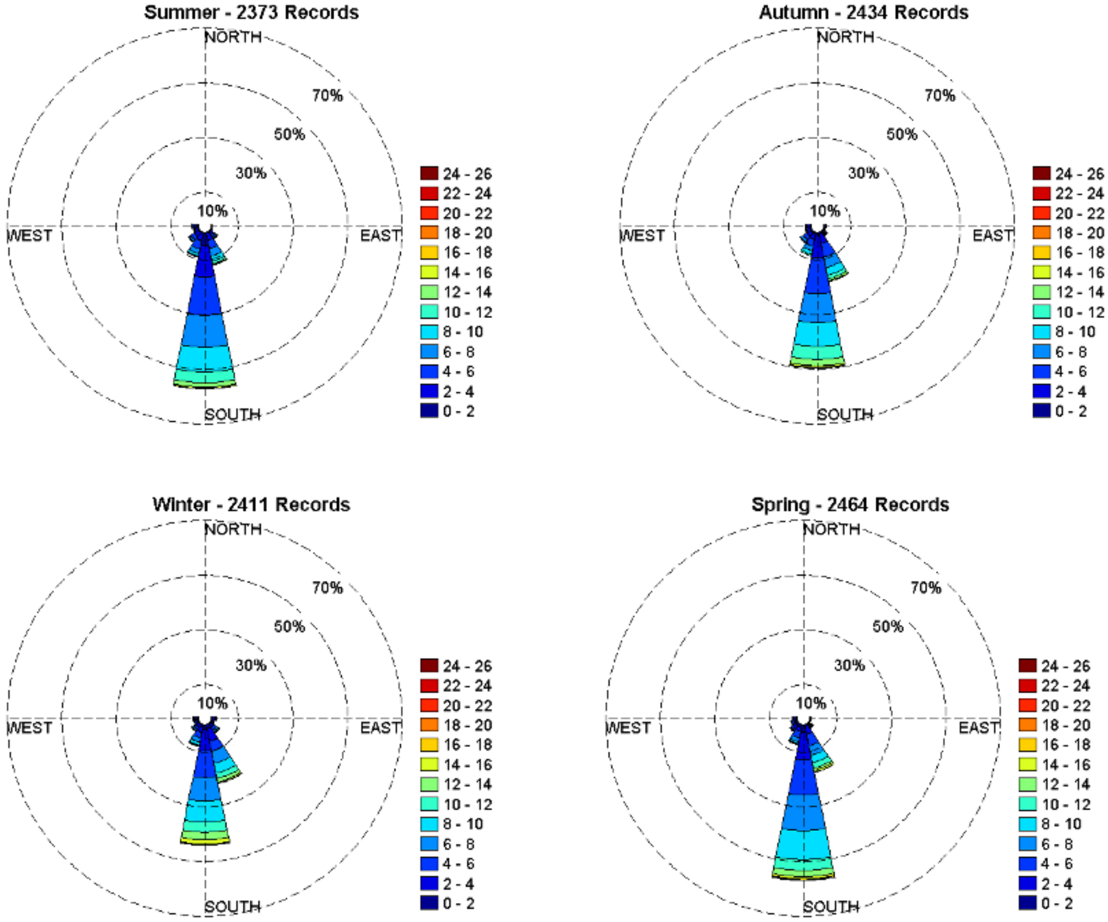
3.2.2 Wind Patterns

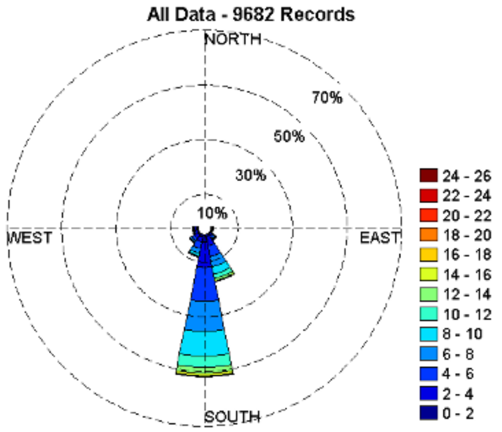
The atmospheric features and processes active on the West Coast of southern Africa have been described by Nelson & Hutchings (1983), Kamstra (1985), Shannon (1985), Shannon & Nelson (1996) and Shannon & O'Toole (1998). The description below is summarised from these authors.

Winds at the sea surface are seasonally modulated and significantly influence the oceanography of the Benguela region. The winds in the system are vigorous with gale force winds occurring in all seasons, but being most frequent in spring. The prevailing winds are controlled by the south Atlantic subtropical anticyclone, the seasonal atmospheric pressure field over the subcontinent, and the eastward moving mid-latitude cyclones south of the southern African subcontinent. The south Atlantic anticyclone is a perennial feature that forms part of the discontinuous belt of high-pressure systems, which encircle the subtropical southern hemisphere. It undergoes seasonal variations in that it is strongest in the austral summer when it also attains its southernmost extension lying southwest and south of the subcontinent. In contrast, the mid-latitude cyclones passing south of the subcontinent result in a short-term cyclicity of wind events. Gale force and strong wind events extend typically over 2-3 days for both south-southeast and north-northwest winds. Five-day strong wind events are rare.

Seasonal wind roses for the Walvis Bay area are illustrated in Figure 4.

The arid coastal plain of the southern African West Coast acts as a thermal barrier to cross-flow thereby topographically steering the winds along the coast. This induces the characteristically moderate to strong southerly winds in the region, with wind speeds often exceeding 10 m/s. These winds bring cool, moist air into the coastal region. The winds produce coastal upwelling and play an important role in the loss of sediment from beaches. These strong equatorwards winds are interrupted by the passing of coastal lows with which are associated periods of calm or north or northwest wind conditions. These northerlies occur throughout the year, but are more frequent in spring and summer.





Period	1960-01-07 to 2010-07-23
Station	VOS data
Position	22.0 - 23.9°S and 13.0 - 14.7°E
Sensor Height	0 m
Records	9682

Figure 4: Seasonal wind roses for the offshore Walvis Bay area (Source: Voluntary Observing Ship (VOS) data from the Southern Africa Data Centre for Oceanography (SADCO)).

During autumn and winter, the south Atlantic anticyclone weakens and migrates north-westwards causing catabatic, or easterly 'berg' winds. These powerful offshore winds can exceed 50 km/h, producing sandstorms that considerably reduce visibility at sea and on land. Although they occur intermittently for about a week at a time, they have a strong effect on the coastal temperatures, which often exceed 30°C during 'berg' wind periods (Shannon & O'Toole 1998). The winds also play a significant role in sediment input into the coastal marine environment with transport of the sediments up to 150 km offshore (Figure 5).

Figure 5: Satellite image showing aerosol plumes of sand and dust being blown out to sea during a northeast 'berg' wind event along the central Namibian coast (Image source: www.intute.ac.uk).

3.2.3 Large-Scale Circulation and Coastal Currents

The Namibian coastline is strongly influenced by the Benguela Current. Current velocities in continental shelf areas generally range between 10–30 cm/s (Boyd & Oberholster 1994). The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al.* 1990; Nelson & Hutchings 1983). Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate northwest (alongshore) direction. Near bottom shelf flow is mainly poleward (Nelson 1989) with low velocities of typically 5 cm/s. The poleward flow becomes more consistent in the southern Benguela.

In the nearshore zone, strong wave activity from the south and southwest (generated by winds and waves in the South Atlantic and Southern Ocean) drives a predominantly northward long-shore current (Shillington *et al.* 1990). Surface currents appear to be topographically steered, following the major topographic features (Nelson & Hutchings 1983). Current velocities vary accordingly (~10-35 cm/s), with increased speeds in areas of steep topography and reduced velocities in areas of regular topography. Surface-current measurements at Swakopmund between 1971 and 1972 (CSIR 2005) indicated that currents are quite variable, with flows primarily <30 cm/s and an average velocity of 14 cm/s. Current speeds in reverse flows observed between Walvis Bay and Henties Bay range between 2 - 17 cm/s. Near bottom shelf flow is mainly poleward (Nelson 1989) with low velocities of typically 5 cm/s.

Typically wave-driven flows dominate in the surf zone (characteristically 150 m to 250 m wide), with the influence of waves on currents extending out to the base of the wave effect (~40 m; Rogers 1979). The influence of wave-driven flows extends beyond the surf zone in the form of rip currents. Longshore currents are driven by the momentum flux of shoaling waves approaching the shoreline at an angle, while cross-shelf currents are driven by the shoaling waves. The magnitude of these currents is determined primarily by wave height, wave period, angle of incidence of the wave at the coast and bathymetry. Surf zone currents have the ability to transport unconsolidated sediments along the coast in the northward littoral drift.

Nearshore velocities have not been reported for the Walvis Bay – Swakopmund area and are difficult to estimate because of acceleration features such as surf zone rips and sandbanks. However, computational model estimates using nearshore profiles and wave conditions representative of this coastal region suggest time-averaged northerly longshore flows with a cross-shore mean of between 0.2 to 0.5 m/s. Instantaneous measurements of cross-shore averaged longshore velocities are often much larger. Surf zone-averaged longshore velocities in other exposed coastal regions commonly peak at between 1.0 m/s to 1.5 m/s, with extremes exceeding 2 m/s for high wave conditions (CSIR 2002). The southerly longshore flows are considered to remain below 0.5 m/s.

3.2.4 Waves and Tides

The Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20-point exposure scale (McLachlan 1980). The coastline is influenced by major swells generated in the roaring forties, as well as significant sea waves generated locally by the persistent southerly winds.

The central Namibian coastline is influenced by major swells generated in the Roaring Forties, as well as significant sea waves generated locally by the persistent southerly winds. Apart from Walvis Bay and Swakopmund, wave shelter in the form of west to north-facing embayments, and coast lying in the lee of headlands are extremely limited.

The wave regime along the southern African West Coast shows no strong seasonal variation except for slight increases in swell from WSW-W direction in winter (Figure 6). The median significant wave height is 2.4 m with a dominant peak energy period of ~12 seconds. Longer period swells (11 to 15 seconds), generated by mid-latitude cyclones occur about 25-30 times a year. These originate from the S-SW sectors, with the largest waves recorded along the southern African West Coast attaining 4-7 m. Wind-induced waves, on the other hand, have shorter wave periods (~8 seconds), are generally steeper than swell waves, and tend to come from a more southeasterly direction (CSIR 1996). Waves are concentrated in a fairly narrow directional band with 73% of the deep-sea waves originate from the SSE (165°) to SW (225°) sector. Generally, wave heights decrease with water depth and distance longshore. On occasion, the prevailing southwesterly winds can reach gale force velocities in excess of 70 km/hr, producing swells up to a maximum height of 10 m.

In common with the rest of the southern African coast, tides in the study area are regular and semi-diurnal. The maximum tidal variation is approximately 2 m, with a typical tidal variation of ~1 m. Variations of the absolute water level as a result of meteorological conditions such as wind and waves can however occur adjacent to the shoreline and differences of up to 0.5 m in level from the tidal predictions are not uncommon. Tidal currents are minimal with measurements of 0.1 m/s reported at Walvis Bay. Table 2 lists mean tidal levels for Walvis Bay.

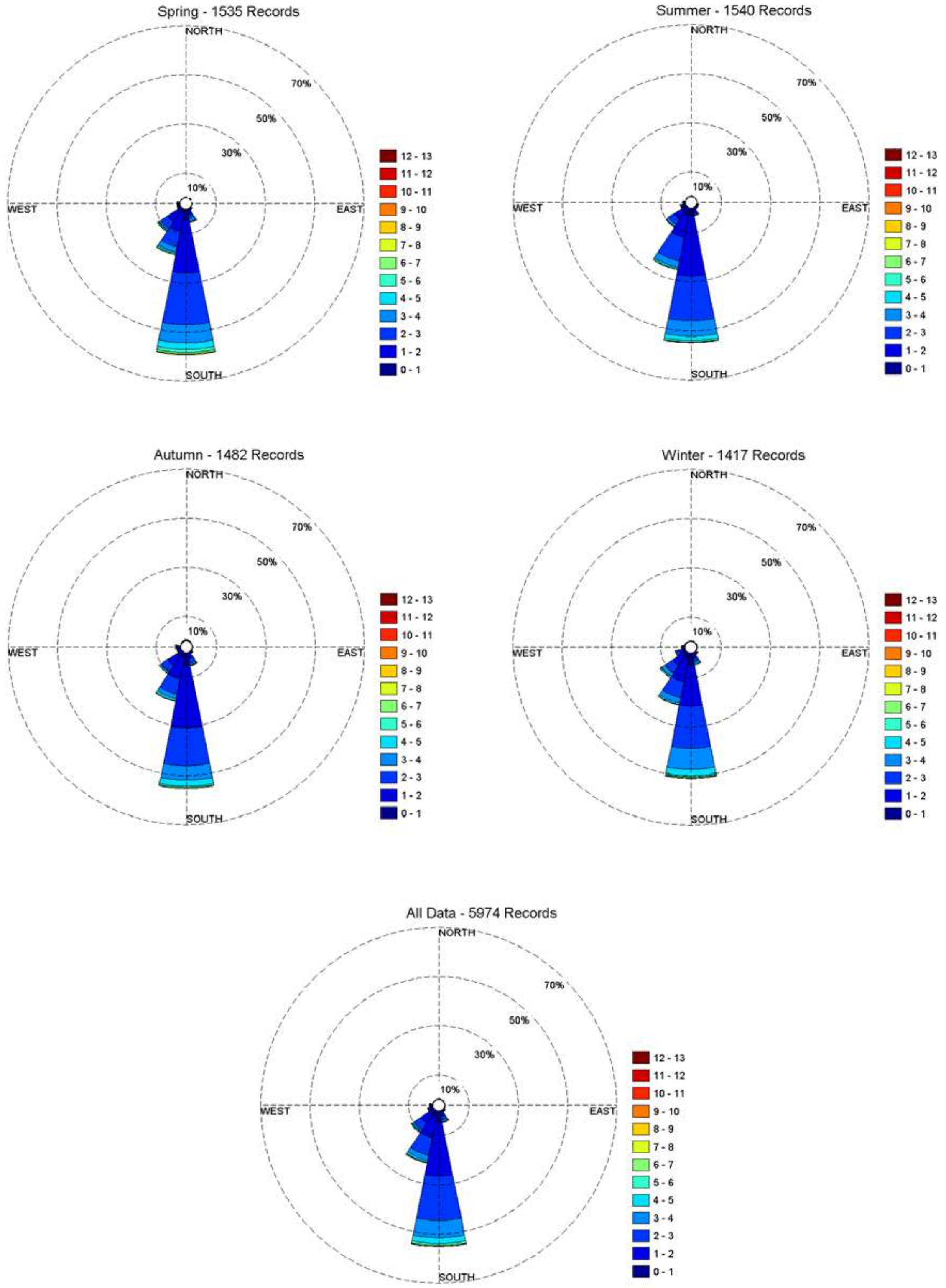


Figure 6: Seasonal swell data for the offshore Walvis Bay Area (22°-24°S; 13°-15°E). (Source: Voluntary Observing Ship (VOS) data from the Southern Africa Data Centre for Oceanography (SADCO)).

Table 2: Tide statistics for Walvis Bay from the SA Tide Tables (SAN 2020). All levels are referenced to Chart Datum.

Description		Level in m
Highest Astronomical Tide	HAT	+1.97
Mean High Water of Spring Tide	MHWS	+1.69
Mean High Water of Neap Tide	MHWN	+1.29
Mean Level	ML	+0.98
Mean Sea Level	MSL	+0.97
Mean Low Water of Neap Tide	MLWN	+0.67
Mean Low Water of Spring Tide	MLWS	+0.27
Lowest Astronomical Tide	LAT	0.00

3.2.5 Upwelling

The major feature of the Benguela Current Coastal is upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. Consequently, it is a semi-permanent feature at Lüderitz and upwelling can occur there throughout the year and areas to the north due to perennial southerly winds (Figure 7; Shannon 1985). The Lüderitz upwelling cell is the most intense upwelling cell in the system (Figure 7), with the seaward extent reaching nearly 300 km, and the upwelling water is derived from 300-400 m depth (Longhurst 2006). A detailed analysis of water mass characteristics revealed a discontinuity in the central and intermediate water layers along the shelf north and south of Lüderitz (Duncombe Rae 2005). The Lüderitz / Orange River region thus forms a major environmental barrier between the northern and southern Benguela sub-systems (Ekau & Verheye 2005). Off northern and central Namibia, several secondary upwelling cells occur. Upwelling in these cells is perennial, with a late winter maximum (Shannon 1985).

3.2.6 Water Masses and Temperature

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the study area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf (Nelson & Hutchings 1983). Salinities range between 34.5‰ and 35.5‰ (Shannon 1985). For the Swakopmund area an ambient salinity of 34.2‰ has been reported (CSIR 2009). Data recorded over a ten year period at Swakopmund (1988 – 1998) show that seawater temperatures vary between 10°C and 23°C, averaging 14.9°C. They show a strong seasonality with lowest temperatures occurring during winter when upwelling is at a maximum (Figure 8).

During the non-upwelling season in summer, daily seawater temperature fluctuations of several degrees are common along the central Namibian nearshore coast. It appears that the thermal regime of the surf zone is controlled by the locally-forced Ekman offshore transport, which leads the associated temperature fluctuations by one day (Bartholomae & Hagen 2007). This time-lag suggests the existence of a persistent recirculation cell in nearshore waters in this region.

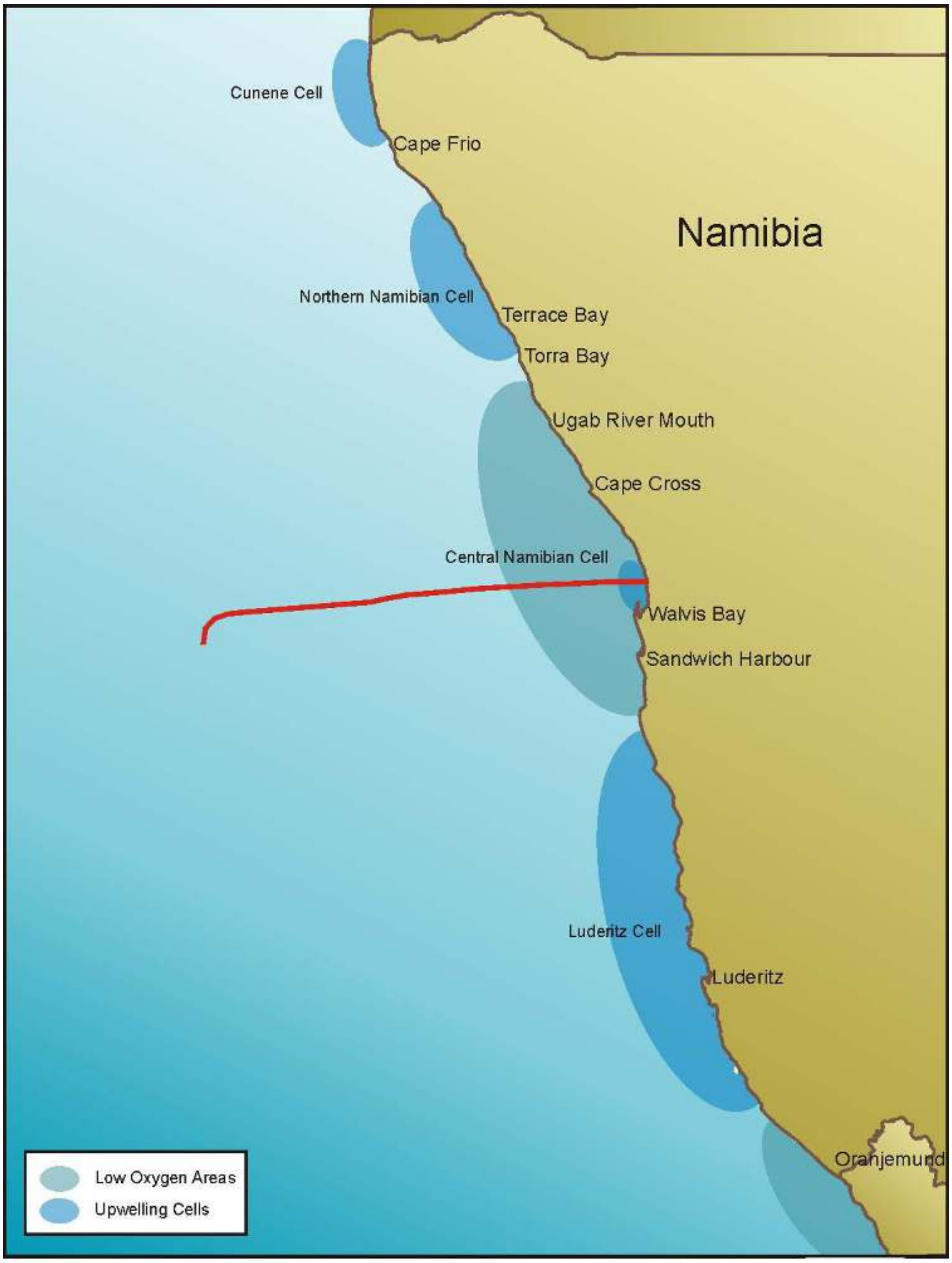


Figure 7: The Equiano Cable System route (red line) in relation to the upwelling centres and low oxygen areas on the west coast of Namibia (Adapted from Shannon 1985).

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially on the bottom. SACW itself has depressed oxygen concentrations (~80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur (Visser 1969; Bailey *et al.* 1985; Chapman & Shannon 1985).

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

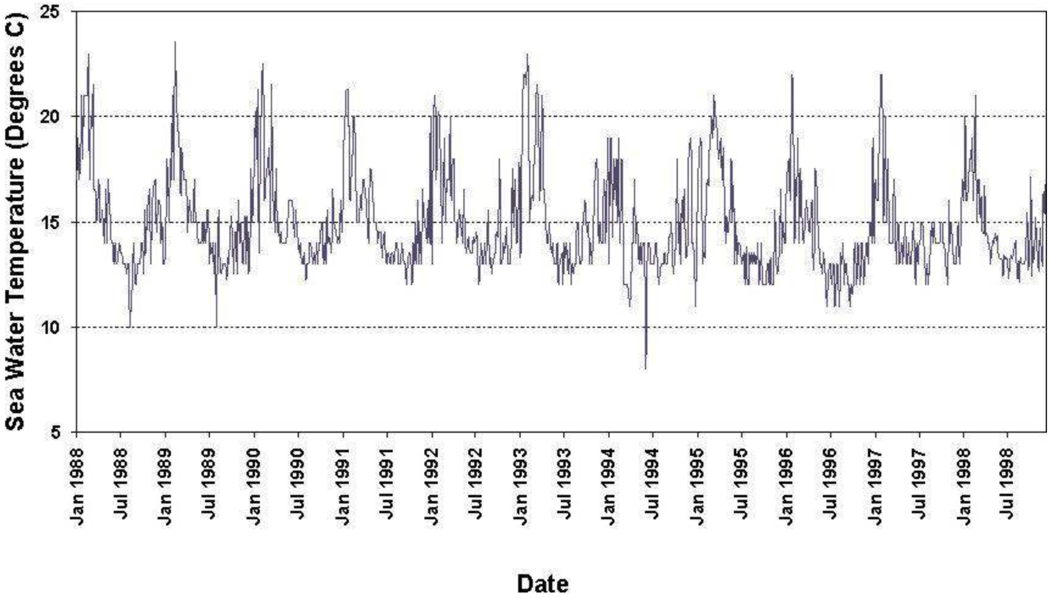


Figure 8: Seawater temperatures at Swakopmund recorded between 1988 and 1998.

3.2.7 Turbidity

Turbidity is a measure of the degree to which the water looses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) is typically divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. PIM loading in nearshore waters is strongly related to natural inputs from rivers or from 'berg' wind events, or through resuspension of material on the seabed.

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/ℓ to several tens of mg/ℓ (Bricelj & Malouf 1984; Berg & Newell 1986; Fegley *et al.* 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/ℓ, showing significant long-shore variation (Zoutendyk 1992, 1995). Considerably higher concentrations of PIM have, however, been reported from southern African west coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions.

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

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly southwesterly swell and wind-induced waves. Longshore sediment transport, however, varies considerably in the shore-perpendicular dimension. Sediment transport in the surf zone is much higher than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith & Mocke 2002).

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments, and resuspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake *et al.* 1985; Ward 1985).

The powerful easterly 'berg' winds occurring along the Namibian coastline in autumn and winter also play a significant role in sediment input into the coastal marine environment (Figure 5), potentially contributing the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Zoutendyk 1992; Shannon & O'Toole 1998; Lane & Carter 1999). For example, for a single 'berg'-wind event it was estimated that 50 million tons of dust were blown into the sea by extensive sandstorms along much of the coast from Cape Frio, Namibia in the north to Kleinzee, South Africa in the south (Shannon & Anderson 1982) with transport of the sediments up to 150 km offshore.

3.2.8 Organic Inputs

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

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon *et al.* 2003). Thirty six percent of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African west coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters overlying these muds and the generation of hydrogen sulphide and sulphur eruptions along the coast.

An associated phenomenon ubiquitous to the Benguela system are red tides (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions, with sometimes spectacular effects. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water. Periodic low oxygen events associated with massive algal blooms in the nearshore can have catastrophic effects on the biota (see below).

3.2.9 Low Oxygen Events

The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches, there are corresponding preferential areas for the formation of oxygen-poor water, the main one being off central Namibia (Chapman & Shannon 1985) (see Figure 7). The distribution of oxygen-poor water is subject to short (daily) and medium term (seasonal) variability in the volumes of oxygen depleted water that develops (De Decker 1970; Bailey & Chapman 1991). Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased intermoult period in the rock-lobster population (Beyers *et al.* 1994). The oxygen-depleted subsurface waters characteristic of the southern and central Namibian shelf are an important factor determining the distribution of rock lobster in the area. During the summer months of upwelling, lobsters show a seasonal inshore migration (Pollock & Shannon 1987), and during periods of low oxygen become concentrated in shallower, better-oxygenated nearshore waters.

On a larger scale, periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities. Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of other marine biota and fish (Newman & Pollock 1974; Matthews & Pitcher 1996; Pitcher 1998; Cockroft *et al.* 2000). Very recently, in March 2008, a series of red tide or algal blooms dominated by the (non-toxic) dinoflagellate Ceratium furca occurred along the central Namibian coast (MFMR 2008). These bloom formations ended in disaster for many coastal marine species and resulted in what was possibly the largest rock lobster walkout in recent memory (Figure 9). Other fish mortalities included those of rock suckers, rock fish, sole, eels, shy sharks, and other animals such as octopuses and red bait, which were trapped in the low oxygen area below the surf zone (Louw 2008). The main cause for these mortalities and walkouts is oxygen starvation that results from the decomposition of huge amounts of organic matter. The blooms developed during a time where high temperatures combined with a lack of wind. These anoxic conditions were further exacerbated by the release of hydrogen sulphide - which is highly toxic to most marine organisms. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'bergwind periods', when similar warm windless conditions occur for extended periods.

Figure 9: 'Walk-outs' and mass mortalities of rock lobsters at the central Namibian coast (Image source: Louw 2008).

3.2.10 Sulphur Eruptions

Closely associated with seafloor hypoxia, particularly off central Namibia between Cape Cross and Conception Bay, is the generation of toxic hydrogen sulphide and methane within the organically-rich, anoxic muds following decay of expansive algal blooms. Under conditions of severe oxygen depletion, hydrogen sulphide (H_2S) gas is formed by anaerobic bacteria in anoxic seabed muds (Brüchert *et al.* 2003). This is periodically released from the muds as 'sulphur eruptions', causing upwelling of anoxic water and formation of surface slicks of sulphur discoloured water (Emeis *et al.* 2004), and even the temporary formation of floating mud islands (Waldron 1901). Such eruptions are accompanied by a characteristic pungent smell along the coast and the sea takes on a lime green colour (Figure 10). These eruptions strip dissolved oxygen from the surrounding water column. Such complex chemical and biological processes are often associated with the occurrence of harmful algal blooms, causing large-scale mortalities to fish and crustaceans (see above).

Sulphur eruptions have been known to occur off the Namibian coast for centuries (Waldron 1901), and the biota in the area are likely to be naturally adapted to such pulsed events, and to subsequent hypoxia. However, satellite remote sensing has recently shown that eruptions occur more frequently, are more extensive and of longer duration than previously suspected, and that resultant hypoxic conditions last longer than thought (Weeks *et al.* 2004).

The role of micro-organisms in the detoxification of sulphidic water was investigated by a collaborative group of German and Namibian scientists (http://www.mpi-bremen.de/ Projekte_9.html; http://idw-online.de/pages/de/news 292832). During a research cruise in January 2004, a sulphidic water mass covering 7,000 km^2 of coastal seafloor was encountered off the coast off Namibia. The surface waters, however, were well oxygenated. In the presence of oxygen, sulphide is oxidized and transformed into non-toxic forms of sulphur. An intermediate layer in the water column was discovered, which contained neither hydrogen sulphide nor oxygen. It was ascertained that sulphide diffusing upwards from the anoxic bottom water is consumed by autotrophic denitrifying bacteria below the oxic zone. The intermediate water layer is the habitat of detoxifying microorganisms, which by using nitrate transform sulphide into finely dispersed particles of sulphur that are non-toxic. Thus, the microorganisms create a buffer zone between the toxic deep water and the oxygenated surface waters. These results, however, also suggest that animals living on or near the seafloor in coastal waters may be affected by sulphur eruptions more often than previously thought, and that satellite imagery may underestimate the occurrence of sulphidic events as the hydrogen sulphide is consumed by bacteria before it reaches the sea surface.

Figure 10: Satellite image showing discoloured water offshore the central Namibian coast resulting from a nearshore sulphur eruption (satellite image source: www.intute.ac.uk).

3.3 Biological Environment

Biogeographically the central Namibian coastline falls into the warm-temperate Namib Province, which extends northwards from Lüderitz into southern Angola (Emanuel *et al.* 1992). The coastal, wind-induced upwelling characterising the Namibian coastline, is the principle physical process which shapes the marine ecology of the central Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions (Barnard 1998). During periods of less intense winds off the northern Nambian coast (*Benguela Niños*), upwelling weakens and the warmer, more saline waters of the Angola Current intrude southwards along the coast introducing organisms normally associated with the subtropical conditions typical off Angola (Barnard 1998). As these events are typically temporary, the species of tropical west African origin associated with them will not be discussed here.

The coastline of central Namibia is dominated by sandy beaches, with rocky habitats being represented only by occasional small rocky outcrops. Consequently, marine ecosystems along the coast comprise a limited range of habitats that include:

- sandy intertidal and subtidal substrates,
- intertidal rocky shores and subtidal reefs, and
- the water body.

The benthic communities within these habitats are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. They consist of many hundreds of species, often displaying considerable temporal and spatial variability. The biological communities 'typical' of each of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the proposed project.

3.3.1 Sandy Substrate Habitats and Biota

The benthic biota of soft bottom substrates constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into megafauna (animals >10 mm), macrofauna (>1 mm) and meiofauna (<1 mm).

Intertidal Sandy Beaches

Sandy beaches are one of the most dynamic coastal environments. The composition of their faunal communities is largely dependent on the interaction of wave energy, beach slope and sand particle size, which is called beach morphodynamics. Three morphodynamic beach types are described: dissipative, reflective and intermediate beaches (McLachlan *et al.* 1993, Defeo & McLachlan 2005). Generally, dissipative beaches are relatively wide and flat with fine sands and high wave energy. Waves start to break far from the shore in a series of spilling breakers that 'dissipate' their energy along a broad surf zone. This generates slow swashes with long periods, resulting in less turbulent conditions on the gently sloping beach face. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches have low wave energy, and are coarse grained (>500 µm sand) with narrow and steep intertidal beach faces. The relative absence of a surf zone causes the waves to break directly on the shore causing a high turnover of sand. The result is depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan *et al.* 1993; Jaramillo *et al.* 1995). This variability is mainly attributable to the amount and quality of food available. Beaches with a high input of e.g. kelp wrack have a rich and diverse drift-line fauna, which is sparse or absent on beaches lacking a drift-line (Branch & Griffiths 1988; Field & Griffiths 1991).

In the area between Walvis Bay and the Kunene River, beaches make up 44 % of the coastline (Bally *et al.* 1984). A number of studies have been conducted on sandy beaches in central Namibia, including Sandwich Harbour (Stuart 1975; Kensley & Penrith 1977), the Paaltjies (McLachlan 1985) and Langstrand (McLachlan 1985, 1986; Donn & Cockcroft 1989), beaches near Walvis Bay and Cape Cross (Donn & Cockcroft 1989), around the Areva Desalination plant near Wlotzkasbaken (Pulfrich 2007), between Mile 9 and Wlotzkasbaken (Pulfrich 2015) and south of Langstrand (Laird *et al.* 2018) and the recent surveys undertaken between Patrysberg and Henties Bay as part of the Benguela Current Commission's Project "Improving Ocean Governance in the Benguela Current Large Marine Ecosystem" (Kreiner *et al.* 2019).

A further study by Tarr *et al.* (1985) investigated the ecology of three beaches further north on the Skeleton Coast. The results of these studies are summarised below.

Most beaches on the central Namibian coastline are open ocean beaches receiving continuous wave action. They are classified as exposed to very exposed on the 20-point exposure rating scale (McLachlan 1980), and intermediate to reflective and composed of well-sorted medium to coarse sands. The beaches tend to be characterised by well-developed berms, and are well-drained and oxygenated.

Numerous methods of classifying beach zonation have been proposed, based either on physical or biological criteria. The general scheme proposed by Branch & Griffiths (1988) is used below, supplemented by data from central Namibian beach studies (Stuart 1975; Kensley & Penrith 1977; McLachlan 1985, 1986; Donn 1986; Donn & Cockcroft 1989; Pulfrich 2007, 2015; Laird *et al.* 2018; Kreiner *et al.* 2019) (Figure 11).

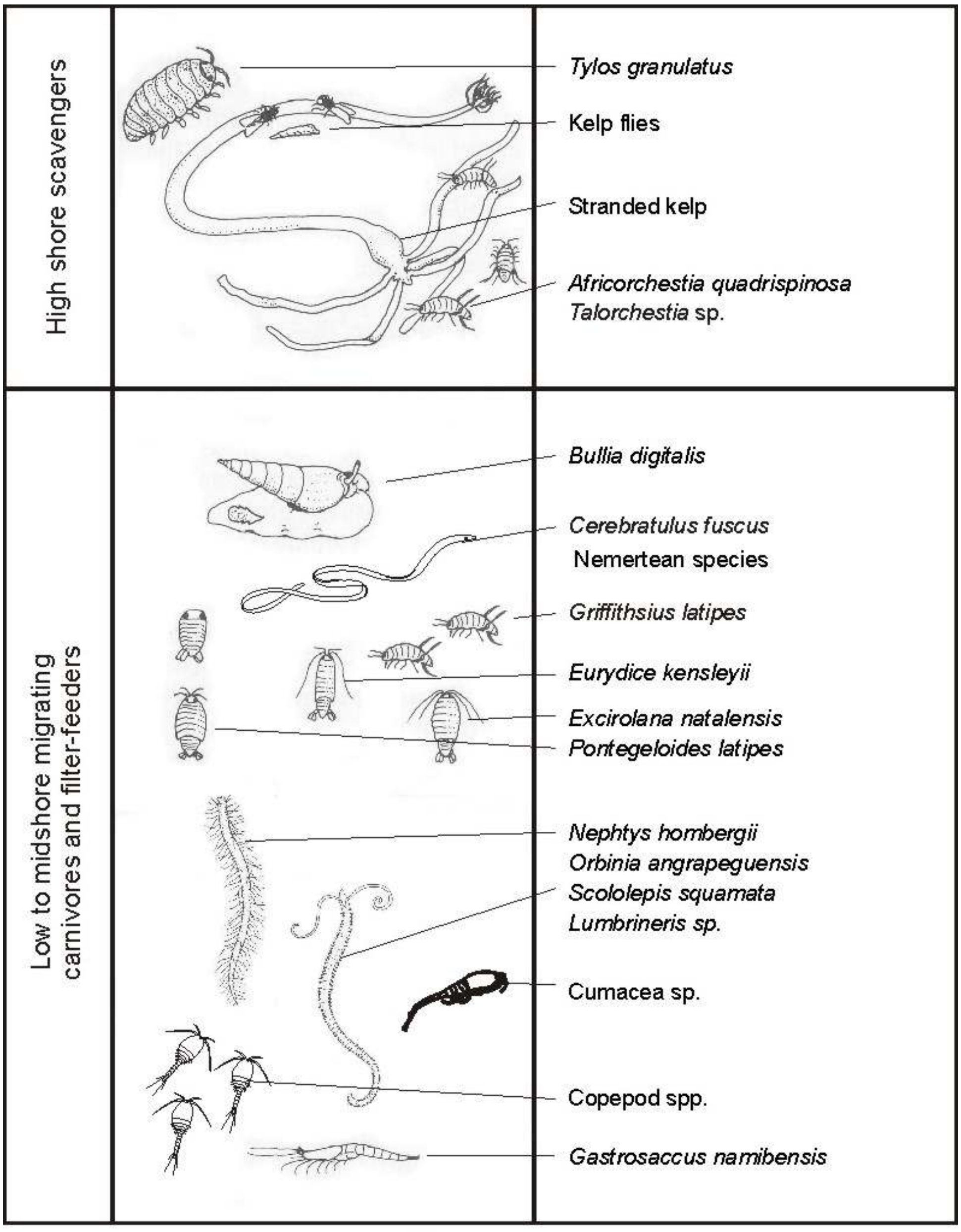


Figure 11: Schematic representation of the West Coast intertidal beach zonation (adapted from Branch & Branch 1981). Species commonly occurring on the central Namibian beaches are listed.

The **supralittoral zone** is situated above the high water spring (HWS) tide level, and receives water input only from large waves at spring high tides or through sea spray. The supralittoral is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, often associated with and feeding on algal wrack deposited near or on the driftline. Terrestrial species include a diverse array of beetles and arachnids and some oligochaetes, while semi-terrestrial fauna include the oniscid isopod *Tylos granulatus*, the talitrid amphipods *Africorchestia quadrispinosa* and *Talorchestia* sp., and the gamarrid amphipod *Bathyporeia griffithsi*. Community composition depends on the nature and extent of wrack, in addition to the physical factors structuring beach communities, as described above.

The **intertidal zone**, also termed the mid-littoral zone, has a vertical range of about 2 m. This mid-shore region is characterised by the cirolanid isopods *Eurydice* (*longicornis*=) *kensleyi*, *Excirolana latipes* and *Excirolana natalensis*, the deposit-feeding polychaetes *Scolelepis squamata* and *Lumbrineis* sp. and the amphipod *Griffithsius latipes*. In some areas, juvenile and adult sand mussels *Donax serra* (Bivalvia, Mollusca) may also be present in considerable numbers. Donn & Cockcroft (1989) reported that at Cape Cross this bivalve contributed 75% to the total macrofaunal biomass.

The **inner turbulent zone** extends from the low water spring tide level to about 2 m depth, and is characterised by highly motile specie. The bentho-planktic mysid *Gastrosaccus namibensis*, and Nemertean worms are typical of this zone, although they generally extend partially into the midlittoral above.

The **transition zone** spans approximately 2-3 m depth and marks the area to which the break point might move during storms. Extreme turbulence is experienced in this zone, and as a consequence this zone typically harbours the lowest diversity on sandy beaches. Typical fauna of this zone include the polychaetes *Nephtys hombergi* and *Glycera convoluta*, nemertean worms, various amphipod species including *Urothoe grimaldi*, and the isopods *Cirolana hirtipes* and E*urydice (longicornis=) kensleyi*.

Below 3 m depth extends the **outer turbulent zone**, where turbulence is significantly decreased and which is marked by a sudden increase in species diversity and biomass. The abundance of polychaete and nemertean worms increases significantly from that in the transition zone. The three spot swimming crab *Ovalipes punctatus*, as well as the gastropods *Bullia laevissima* and *Natica forata* may be present.

The surf zone in the study area is rich in phytoplankton (primarily dinoflagellates and diatoms) and zooplankton. Particulate organic matter is commonly deposited on the beaches as foam and scum. The organic matter, both in suspension and deposited on the sand, is thought to represent the main food input into these beaches, thereby accounting for the dominance of filter-feeders in the macrofaunal biomass (McLachlan 1985).

Most of the macrofaunal species recorded from beaches in central Namibia are ubiquitous throughout the biogeographic province, and no rare or endangered species are known. The invertebrate communities are similar to those recorded from beaches in southern Namibia (McLachlan & De Ruyck 1993; Nel *et al.* 1997; Meyer *et al.* 1998; Clark & Nel 2002; Clark *et al.* 2004; Pulfrich 2004a; Clark *et al.* 2005, 2006; Pulfrich & Atkinson 2007; Pulfrich *et al.* 2014, 2015; Pulfrich & Hutchings 2019). The mean abundance and biomass reported by Laird *et al.* (2018) for the Langstrand beach was 756 individuals/m^2 and 9.3 g/m^2 (dry weight), respectively. For Mile 9, north of Swakopmund Pulfrich (2015) reported much lower mean abundance and biomass values of 67 individuals/m^2 and 0.2 g/m^2 (dry weight), respectively, indicating the spatial variability of these parameters. The central Namibian beaches are all characterised by a relatively depauparate invertebrate fauna, both with regard to species diversity and biomass, which is typical of high-energy west coast beaches.

Subtidal Sandy Habitats

In the subtidal region, the structure and composition of benthic soft bottom communities is primarily a function of water depth and sediment grain size, but other factors such as current velocity, organic content, and food abundance also play a role (Snelgrove & Butman 1994; Flach & Thomsen 1998; Ellingsen 2002).

With the exception of numerous studies on the benthic fauna of Walvis Bay lagoon (Kensley 1978; CSIR 1989, 1992; COWI 2003; Tjipute & Skuuluka 2006; Laird *et al.* 2018), there is a noticeable scarcity of published information on the subtidal soft sediment biota along the rest of the central Namibian coast. The only reference sourced was that of Donn & Cockcroft (1989) who investigated macrofauna to 5 m depth at Langstrand (see description for outer-turbulent zone above). In general, almost no scientific work on subtidal benthic communities has been done in the vicinity of the study area, or within the general region (J. Basson, MFMR, pers. comm.) and no further information could be obtained.

Beyond the outer turbulent zone to 80 m depth, species diversity, abundance and biomass generally increases with communities being characterised equally by polychaetes, crustaceans and molluscs. The midshelf mudbelt is a particularly rich benthic habitat where biomass can attain 60 g/m^2 dry weight (Christie 1974; see also Steffani 2007b). The comparatively high benthic biomass in this mudbelt region represents an important food source to carnivores such as the mantis shrimp, cephalopods and demersal fish species (Lane & Carter 1999). In deeper water beyond this rich zone biomass declines to 4.9 g/m^2 at 200 m depth and then is consistently low (<3 g/m^2) on the outer shelf (Christie 1974).

Typical species occurring at depths of up to 60 m included the snail *Nassarius* spp., the polychaetes *Orbinia angrapequensis*, *Nepthys sphaerocirrata*, several members of the spionid genera *Prionospio*, and the amphipods *Urothoe grimaldi* and *Ampelisca brevicornis*. The bivalves *Tellina gilchristi* and *Dosinia lupinus orbignyi* are also common in certain areas. All these species are typical of the southern African West Coast (Christie 1974; 1976; McLachlan 1986; Parkins & Field 1998; Pulfrich & Penney 1999; Goosen *et al.* 2000; Steffani & Pulfrich 2004a; 2007; Steffani, unpublished data) (Figure 12).

Whilst many empirical studies related community structure to sediment composition (e.g. Christie 1974; Warwick *et al.* 1991; Yates *et al.* 1993; Desprez 2000; van Dalfsen *et al.* 2000), other studies have illustrated the high natural variability of soft-bottom communities, both in space and time, on scales of hundreds of metres to metres (e.g. Kenny *et al.* 1998; Kendall & Widdicombe 1999; van Dalfsen *et al.* 2000; Zajac *et al.* 2000; Parry *et al.* 2003), with evidence of mass mortalities and substantial recruitments (Steffani & Pulfrich 2004a). It is likely that the distribution of marine communities in the mixed deposits of the coastal zone is controlled by complex interactions between physical and biological factors at the sediment–water interface, rather than by the granulometric properties of the sediments alone (Snelgrove & Butman 1994; Seiderer & Newell 1999). For example, off central Namibia it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al.* 2006). Although there is a poor understanding of the responses of local continental shelf macrofauna to low oxygen conditions, it is safe to assume that in areas of frequent oxygen deficiency the communities will be characterised by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered complete oxygen depletion. Local hydrodynamic conditions, and patchy settlement of larvae, will also contribute to small-scale variability of benthic community structure.

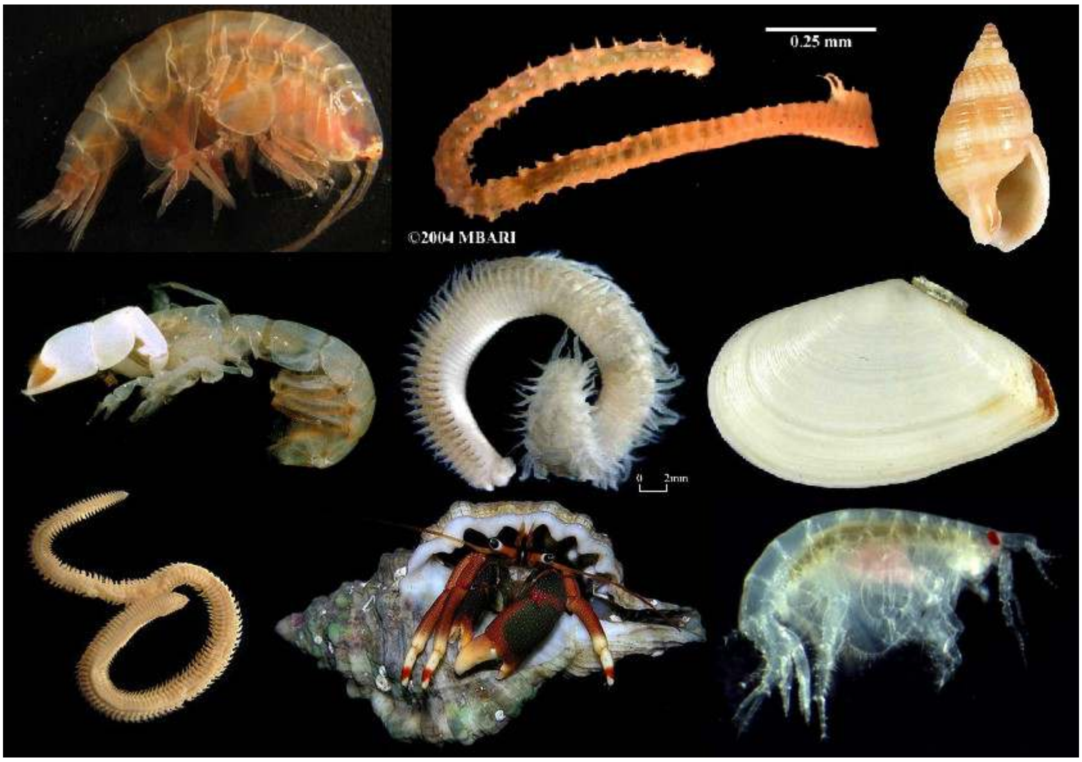


Figure 12: Benthic macrofaunal genera commonly found in nearshore sediments include: (top: left to right) *Ampelisca*, *Prionospio*, *Nassarius*; (middle: left to right) *Callianassa*, *Orbinia*, *Tellina*; (bottom: left to right) *Nephtys*, hermit crab, *Bathyporeia*.

It is evident that an array of environmental factors and their complex interplay is ultimately responsible for the structure of benthic communities. Yet the relative importance of each of these factors is difficult to determine as these factors interact and combine to define a distinct habitat in which the animals occur. However, it is clear that water depth and sediment composition are two of the major components of the physical environment determining the macrofauna community structure off southern Namibia (Steffani & Pulfrich 2004a, 2004b, 2007; Steffani 2007a, 2007b, 2009a, 2009b, 2009c, 2010a, 2010b, 2010c, 2012a, 2012b, 2014). However, in the deepwater shelf areas off central Namibia, it is likely that occurrence of oxygen minimum zones (OMZs) and the periodic intrusion of low oxygen water masses will play a major role in determining variability in community structure (Monteiro & van der Plas 2006).

Specialised benthic assemblages (protozoans and metazoans) can thrive in OMZs (Levin 2003), and many organisms have adapted to low oxygen conditions by developing highly efficient ways to extract oxygen from depleted water. Within OMZs, benthic foraminiferans, meiofauna and macrofauna typically exhibit high dominance and relatively low species richness. In the OMZ core, where oxygen concentration is lowest, macrofauna and megafauna (>10 cm) often have depressed densities and low diversity, despite being able to form dense aggregations at OMZ edges (Levin 2003, Levin *et al.* 2009). Taxa most tolerant of severe oxygen depletion (~0.2 ml/ℓ) include calcareous foraminiferans, nematodes, and polychaetes, with agglutinated protozoans, harpacticoid copepods, and calcified invertebrates typically being less tolerant. Small-bodied animals, with greater surface area for O_2 adsorption, are thought to be more prevalent than large-bodied taxa under conditions of permanent hypoxia as they are better able to cover their metabolic demands and often able to metabolise anaerobically (Levin 2003). Meiofauna may thus increase in dominance in relation to macro- and megafauna. This was not the case, however, within the lower OMZs of the Oman (Levin *et al.* 2000) and Pakistan margins (Levin *et al.* 2009), where the abundant food supply in the lower or edge OMZs is thought to be responsible for promoting larger macrofaunal body size.

There is a poor understanding of the responses of local continental shelf macrofauna to low oxygen conditions, as very little is known about the benthic fauna specific to the Namibian OMZ. It is safe to assume that in areas of frequent oxygen deficiency the communities will be characterised by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered complete oxygen depletion. Local hydrodynamic conditions, and patchy settlement of larvae, will also contribute to small-scale variability of benthic community structure.

Data collected from between 150 m and 300 m depth offshore of the area between Meob Bay and Conception Bay showed that overall species richness of benthic macrofauna assemblages was relatively low and strongly dominated by polychaetes, particularly the spionid polychaete *Paraprionospio pinnata*. This species is dominant in oxygen-constrained environments worldwide. Crustaceans were poorly represented, both in terms of abundance and biomass (Steffani 2011). The phyla distribution is generally in common with other OMZs around the world.

Demersal Invertebrate and Fish Species

Also associated with soft-bottom substrates are demersal communities that comprise bottom-dwelling invertebrate and vertebrate species, most of which are dependent on the invertebrate benthic macrofauna as a food source.

As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the southern African West Coast (Roel 1987). Changes in fish communities occur with increasing depth (Roel 1987; Smale *et al.* 1993; Macpherson and Gordoa 1992; Bianchi *et al.* 2001; Atkinson 2009), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). Common commercial demersal species found mostly on the continental shelf but also extending beyond 500 m water depth include both the shallow-water hake, *Merluccuis capensis* and the deep-water hake (*Merluccius paradoxus*), monkfish (*Lophius vomerinus*), and kingklip (*Genypterus capensis*). There are also many other demersal "bycatch" species that include jacopever (*Helicolenus dactylopterus*), angelfish/pomfret (*Brama brama*), kingklip (*Genypterus capensis*) and gurnard (*Chelidonichtyes* sp), as well as several cephalopod species (such as squid and cuttlefishes) and many elasmobranch (sharks and rays) species (Compagno *et al.* 1991). Roel (1987) showed seasonal variations in the distribution ranges shelf communities, with species such as the pelagic goby *Sufflogobius bibarbatus*, and West Coast sole *Austroglossus microlepis* occurring in shallow water during summer only. The deep-sea community was found to be homogenous both spatially and temporally. In a more recent study, however, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (Sea Surface Temperatures and upwelling anomalies) (Howard *et al.* 2007).

A further invertebrate demersal species of commercial importantance in Namibia is the deepsea red crab *Chaceon maritae*, which occurs at depths of 300-1,000 m along the entire west coast of Africa from West Sahara to central Namibia. In Namibia, densities are highest between the Kunene and latitude 18°S. Larger animals tend to occur more frequently between latitudes 20° - 23°S, where densities are lower. The species is slow-growing taking up to 25-30 years to reach maximum size. Females occur at depths of 350-500 m, whereas males become more dominant in deeper water (Le Roux 1998). Spawning occurs throughout the year.

3.3.2 Rocky Habitats and Biota

Intertidal Rocky Shores

The central and northern coasts of Namibia are bounded to the east by the Namib Desert and are characterised primarily by gravel plains and shifting dunes. In common with most semi-exposed to exposed coastlines on the southern African west coast, the rocky shores that occur in the region are strongly influenced by sediments, and include considerable amounts of sand intermixed with the benthic biota. This intertidal mixture of rock and sand is referred to as a mixed shore, and constitutes 40 % of the coastline between the Kunene River and Walvis Bay (Bally *et al.* 1984). In the study area, mixed shores are limited to small low-shore outcrops that are exposed only at low water spring, which alternate with stretches of low-shore platform reefs and extensive pebble and sandy beaches.

Typically, the intertidal area of rocky shores can be divided into different zones according to height on the shore. Each zone is distinguishable by its different biological communities, which is largely a result of the different exposure times to air. The level of wave action is particularly important on the low shore. Generally, biomass is greater on exposed shores, which are dominated by filter-feeders. Sheltered shores support lower biomass, and algae form a large portion of this biomass (McQuaid & Branch 1984; McQuaid *et al.* 1985).

Mixed shores incorporate elements of the trophic structures of both rocky and sandy shores. As fluctuations in the degree of sand coverage are common (often adopting a seasonal affect), the fauna and flora of mixed shores are generally impoverished when compared to more homogenous shores. The macrobenthos is characterized by sand-tolerant species whose lower limits on the shore are determined by their abilities to withstand physical smothering by sand (Daly & Mathieson 1977; Dethier 1984; van Tamelen 1996). The rocky shores along the coastline around Swakopmund are heavily influenced by mobile sediments. Patchy dominance in the mid- and low-shore by ephemeral green algae (*Ulva* spp., *Cladophora* spp.) also suggest that these shores are periodically smothered by sands, as these algae proliferate as soon as sediments are eroded away.

The published data on rocky intertidal biota around Swakopmund is restricted to only a single published study documenting the area between Walvis Bay and Swakopmund (Nashima 2013). The information sourced from these publications, is complemented by unpublished data on rocky biota in the Wlotzkasbaken area supplied by MFMR (B. Currie, MFMR, unpublished data), an unpublished student report on invertebrate macrofauna occurring at three shores between Walvis Bay and Swakopmund (Ssemakula 2010), surveys undertaken in the area between Mile 9 and Wlotzkasbaken (Pulfrich 2015) and south of Langstrand (Laird *et al.* 2018), and the recent surveys undertaken between Langstrand and Mile 9 as part of the Benguela Current Commission's Project "Improving Ocean Governance in the Benguela Current Large Marine Ecosystem" (Kreiner *et al.* 2019).

Typical species in the high shore include the tiny snail *Afrolittorina knysnaensis*, the false limpet *Siphonaria capensis*, the limpet *Scutellastra granularis*, and often dense stands of the barnacle *Chthamalus dentatus*. Further down the shore the indigenous mytilid mussels, *Choromytilus meridionalis* and *Perna perna* occur. The invasive alien mussels *Semimytilus algosus* and *Mytilus* *galloprovincialis* are also present, the former forming dense mats at times as much as 20 cm off the rock. The resulting habitat matrix provides a complex environment for other invertebrate species such as amphipods and brittlestars. Foliose algae are represented primarily by the red algae *Caulacanthus ustulatus*, *Ceramium* spp., *Centroceras clavulatum*, *Plocamium* spp. and *Mazzaella capensis* and the ephemeral green algae *Ulva* spp. and *Cladaphora* spp (Figure 13). In sand influenced areas the sand-tolerant algae *Nothogenia erinacea* and *Gelidium capense*, and the anemone *Bunodactis reynaudi* also occur.

Figure 13: Typical intertidal rocky communities in the vicinity of Swakopmund showing intertidal zonation (left) and inundation by mobile sediments (right).

Although not directly harbouring any rare faunal or floral species, rocky intertidal shores are food-rich habitats for seabirds and wetland birds, attracting higher numbers of birds than the surrounding sandy beaches. Rocky intertidal fauna most sensitive to disturbance are the large limpet species. They tend to be the first ones eliminated by disturbance and the last to recover because of possible narrow tolerance limits to changes in environmental conditions. They act as keystone species on rocky shore, controlling the abundance of foliose algae and hence many other species (Branch 1981).

Nearshore Subtidal Reefs

Reports on the benthic biota of nearshore reefs in Namibia are restricted primarily to research undertaken in the vicinity of Lüderitz (Beyers 1979; Tomalin 1995; Pulfrich 1998; Pulfrich & Penney 1998, 1999b, 2001). No scientific surveys have been undertaken of rocky subtidal habitats in the study area (J. Basson, MFMR, pers. com.), and information on the faunal and floral communities is limited to qualitative reports from nearshore diver surveys undertaken as part of the EIAs for the Mile 6 and Rössing Desalination Plants (Pulfrich & Steffani 2008; B-4 Engineering & Diving 2014). These accounts report that the offshore reefs are typically low-relief platforms covered by a veneer of sand and unconsolidated sediments of varying thickness. The benthic communities inhabiting these reefs are dominated by sand-tolerant and deposit feeding species, although kelp occurs sparsely offshore (Pulfrich & Steffani 2008). Benthic organisms included tube worms, which construct compact sandy reefs up to 0.6 m in height, inhabited by various rocky bottom species including polychaetes, amphipods, isopods, rock boring bivalves and sea anemones. Other species recorded included the indigenous mussel *Perna perna*, and the predatory gastropod *Stramonita haemastoma* occured, with the emergent rocks densely covered by encrusting coralline algae, red foliose algae (*Rhodymenia obtusa*, *Rhodymenia natalensis*, *Ceramium capense* and *Polyopes constrictus*), and green algae (e.g. *Cladophora flagelliformis*). Additional species including polychaetes (*Nereis* spp., *Naineris laevigata* and *Pherusa swakopiana*), isopods (*Amakusanthura africana*), amphipods (*Maera hinderella*), boring bivalves (*Petricola bicolor* and *Gregariella petagnae*), sea anemones (*Actinia* sp.), barnacles, brittle stars and encrusting bryozoans were also reported (Pulfrich and Steffani 2008).

Deep-water coral communities

There has been increasing interest in deep-water corals in recent years because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths exceeding 150 m. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al.* 1997; MacIssac *et al.* 2001). Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement (Hovland *et al.* 2002). Substantial shelf areas in the productive Benguela region should thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities. Such communities would also be expected with topographic features such as the Walvis Ridge (and its associated seamounts) to the north and west of the cable route.

3.3.3 Pelagic Communities

The pelagic communities are typically divided into plankton and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles. Seabirds are dealt with in a separate specialist study and will thus not be discussed further here.

Plankton

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

Off the Namibian coastline, phytoplankton are the principle primary producers with mean annual productivity being comparatively high at 2 g C/m^2/day. The phytoplankton is dominated by diatoms, which are adapted to the turbulent sea conditions. Diatom blooms occur after upwelling events, whereas dinoflagellates are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations (Barnard 1998). A study on phytoplankton in the surf zone off two beaches in the Walvis Bay and Cape Cross area showed relatively low primary production values of only 10-20 mg C/m^2/day compared to those from oceanic waters. This was attributed to the high turbidity in this environment (McLachlan 1986). In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present. Charateristic species belong to the genus *Gymnodinium*, *Peridinium*, *Navicula*, and *Thalassiosira* (McLachlan 1986).

Namibian zooplankton reaches maximum abundance in a belt parallel to the coastline and offshore of the maximum phytoplankton abundance. Samples collected over a full seasonal cycle (February to December) along a 10 to 90-nautical-miles transect offshore Walvis Bay showed that the mesozooplankton (<2 mm body width) community included egg, larval, juvenile and adult stages of copepods, cladocerans, euphausiids, decapods, chaetognaths, hydromedusae and salps, as well as protozoans and meroplankton larvae (Hansen *et al.* 2005). Copepods are the most dominant group making up 70–85% of the zooplankton. The four dominant calanoid copepod species, in order of abundance, are *M. lucens*, *C. carinatus*, *R. nasutus* and *Centropages* spp. During the period of intense upwelling, the two herbivorous species, *C. carinatus* and *R. nasutus*, increase in abundance inshore, leading to a shift in dominance from *C. carinatus* to *M. lucens* with increasing distance offshore. Seasonal patterns in copepod abundance, with low numbers during autumn (March–June) and increasing considerably during winter/early summer (July–December), appear to be linked to the period of strongest coastal upwelling in the northern Benguela (May–December), allowing a time lag of about 3–8 weeks, which is required for copepods to respond and build up large populations (Hansen *et al.* 2005). This suggest close coupling between hydrography, phytoplankton and zooplankton. Timonin *et al.* (1992) described three phases of the upwelling cycle (quiescent, active and relaxed upwelling) in the northern Benguela, each one characterised by specific patterns of zooplankton abundance, taxonomic composition and inshore-offshore distribution. It seems that zooplankton biomass closely follows the changes in upwelling intensity and phytoplankton standing crop. Consistently higher biomass of zooplankton occurs offshore to the west and northwest of Walvis Bay (Barnard 1998).

Ichthyoplankton constitutes the eggs and larvae of fish. As the preferred spawning grounds of numerous commercially exploited fish species are located off central and northern Namibia (Figure 14), their eggs and larvae form an important contribution to the ichthyoplankton in the region. Phytoplankton, zooplankton and ichthyoplankton abundances in the project area will be seasonally high, with diversity increasing in the vicinity of the confluence between the Angola and Benguela currents and west of the oceanic front and shelf-break.

Pelagic Invertebrates

Pelagic invertebrates that may be encountered in the offshore portions of project area are the colossal squid *Mesonychoteuthis hamiltoni* and the giant squid *Architeuthis* sp. Both are deep dwelling species, with the colossal squid's distribution confined to the entire circum-antarctic Southern Ocean (Figure 15, top) while the giant squid is usually found near continental and island slopes all around the world's oceans (Figure 15, bottom). Both species could thus potentially occur in the pelagic habitats of the project area, although the likelihood of encounter is extremely low. Growing to in excess of 10 m in length, they are the principal prey of the sperm whale, and are also taken by beaked whaled, pilot whales, elephant seals and sleeper sharks. Nothing is known of their vertical distribution, but data from trawled specimens and sperm whale diving behaviour suggest they may span a depth range of 300 – 1,000 m. They lack gas-filled swim bladders and maintain neutral buoyancy through an ammonium chloride solution occurring throughout their bodies.

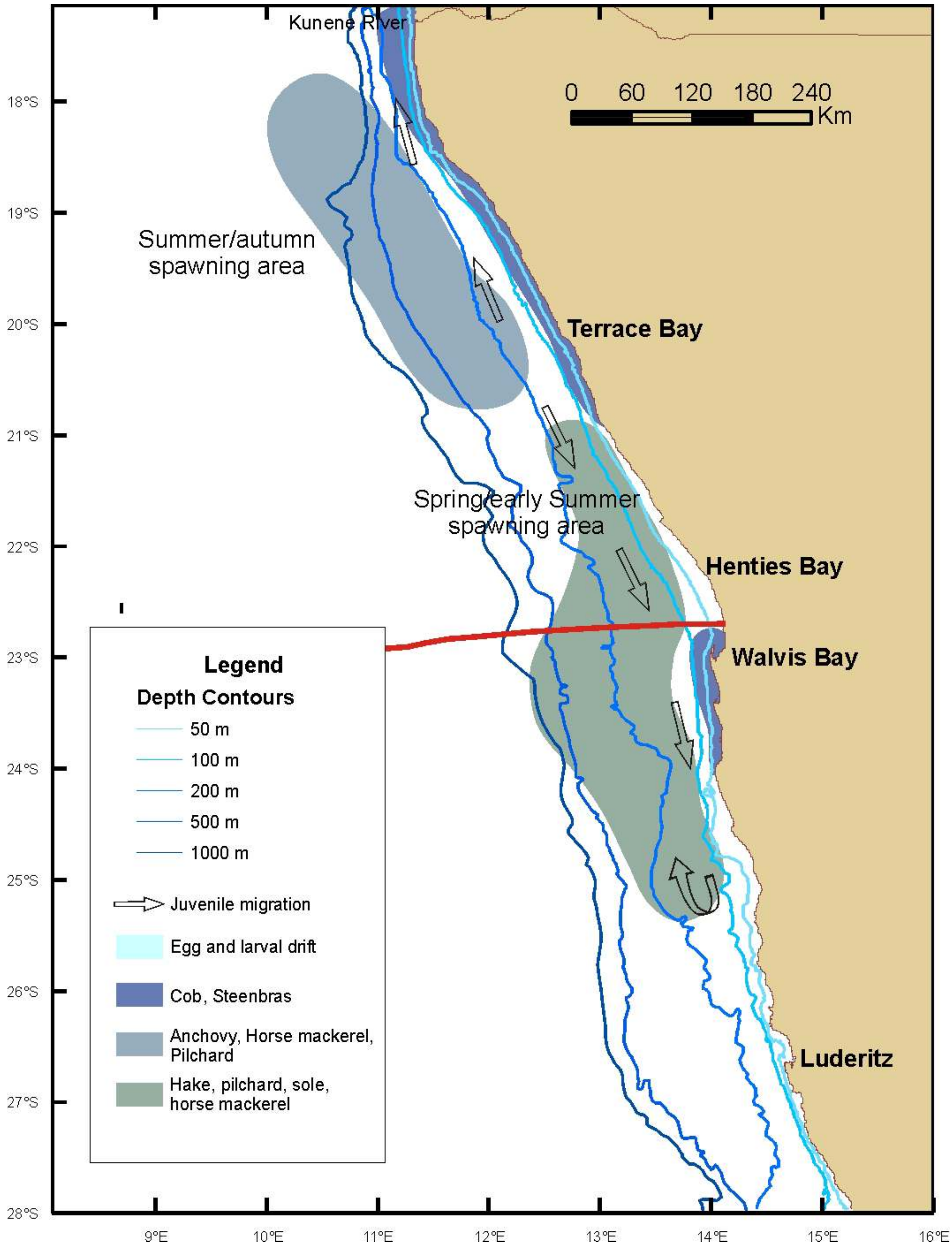


Figure 14: The Equiano Cable routing (red line) in relation to major spawning areas in the central Benguela region (adapted from Cruikshank 1990).

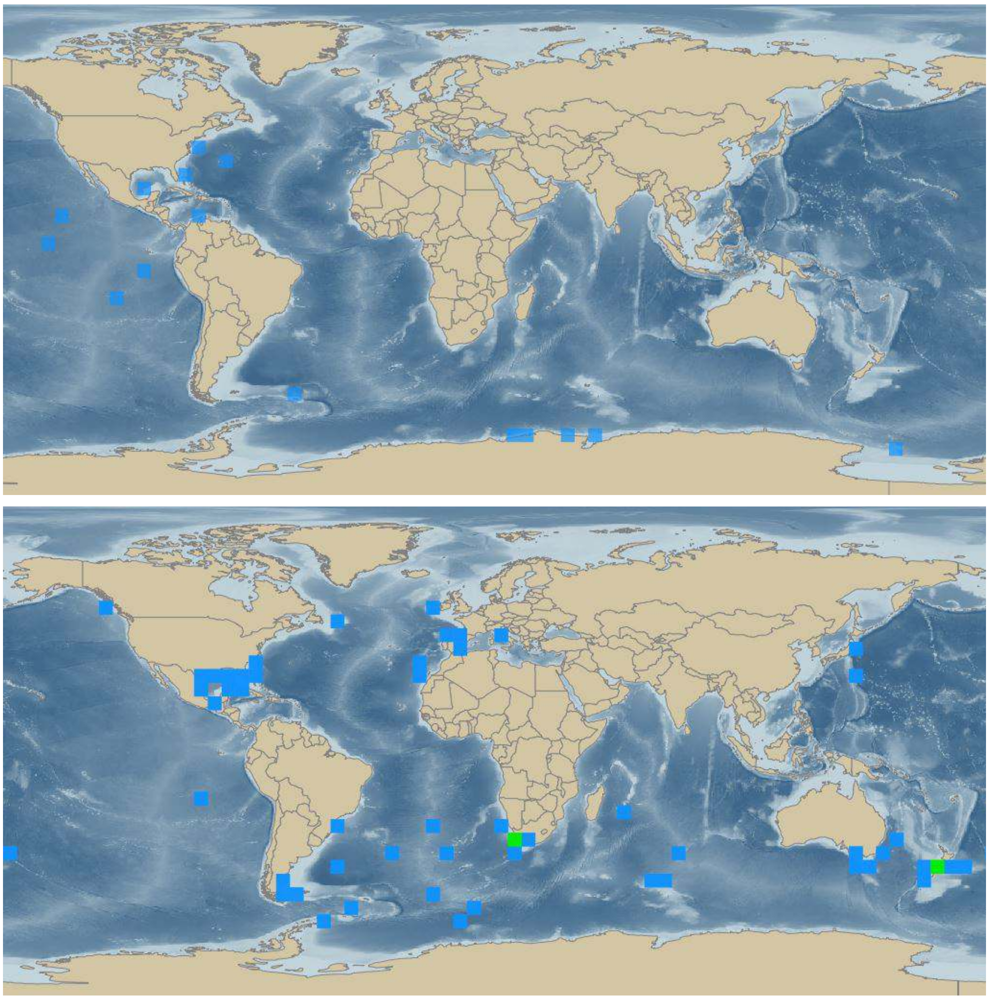


Figure 15: Distribution of the colossal squid (top) and the giant squid (bottom). Blue squares <5 records, green squares 5-10 records (Source: http://iobis.org).

Pelagic Fish

The surf zone and outer turbulent zone habitats of sandy beaches are considered to be important nursery habitats for marine fishes (Modde 1980; Lasiak 1981; Clark *et al.* 1994). However, the composition and abundance of the individual assemblages seems to be heavily dependent on wave exposure (Blaber & Blaber 1980; Potter *et al.* 1990; Clark 1997a, b). Surf zone fish communities off the coast of central Namibia have been studied at Langstrand (McLachlan 1986; Romer 1988), between Mile 9 and Wlotzkasbaken (Pulfrich 2015) and south of Langstrand to the Walvis Bay Naval Base (Laird *et al.* 2018). Species from the surf zone off Langstrand beach and further south included galjoen (*Dichistius capensis*), West Coast steenbras (*Lithognathus aureti*), flathead mullet (*Mugil cephalus*), southern mullet (*Chelon richardsonii*) and Cape silverside (*Atherina breviceps*) (McLachlan 1986; Romer 1988; Laird *et al.* 2018). The size composition of the catches confirmed that most of these species utilize the surf zone in the area as a nursery. North of Mile 9 the surf zone fish catches were more diverse with silver kob (*Argyrosomus inodorus*), Blacktail (*Diplodus capensis*), elf (*Pomatomus saltatrix*), bluntnose guitarfish (*Rhinobatos blochii*) and maned blennie (*Scartella emarginata*) also being reported (Pulfrich 2015). Off Cape Cross only two species were recorded, these being sandsharks (*Rhinobatos annulatus*) and West Coast steenbras. Many of these species are important in the catches of recreational and/commercial net fisheries and linefisheries in Namibia (Kirchner *et al.* 2000; Holtzhausen et al 2001, Stage & Kirchner 2005).

A number of the nearshore teleost and chondrichthyan species are considered 'Near Threatened' or 'Vulnerable' (Table 3).

Table 3: Some of the more important linefish species likely to occur off Central Namibia. The Global IUCN Conservation Status are also provided.

Common Name	Species	IUCN Conservation Status
Teleosts		
Silver kob	*Argyrosomus inodorus*	Vulnerable
Elf	*Pomatomus saltatrix*	Vulnerable
West Coast steenbras	*Lithognathus aureti*	Near threatened
West coast dusky kob	*Argyrosomus coronus*	Data deficient
Chondrichthyans		
Bronze whaler	*Carcharhinus brachyurus*	Near threatened
Six gill shark	*Hexanchus griseus*	Near threatened
Spotted gullyshark	*Triakis megalopterus*	Near threatened
Smooth houndshark	*Mustelus mustelus*	Vulnerable
Broadnose seven-gill cow shark	*Heptranchias perlo*	Near threatened

The biological, behavioural and life-history characteristics of the three most important linefish species in Namibian coastal waters are summarised below.

Silver kob *Argyrosomus inodorus* are distributed from northern Namibia to the warm temperate / subtropical transition zone on South Africa's east coast (Griffiths & Heemstra 1995). Four stocks have been identified, one in Namibia, with its core distribution from Cape Frio in the north to Meob Bay in the south (Kirchner 2001). Spawning occurs throughout the year but mostly in the warmer months from October to March when water temperatures are above 15°C and large adult fish occur in the nearshore, particularly in the identified spawning areas of Sandwich Harbour and Meob Bay. Adults are migratory whereas juveniles are resident in the surf zone.

West coast dusky kob *Argyrosomus coronus* are distributed from northern Namibia to northern Angola (Griffiths & Heemstra 1995), but do occur as far south as St Helena Bay in South Africa (Lamberth *et al.* 2008). Early juveniles frequent muddy sediments in 50-100 m depth, moving inshore once they reach 300 mm total length. These juveniles and adolescents are resident in the nearshore, and are especially abundant in the turbid plume off the Cunene River Mouth and in selected surf zones of northern and central Namibia (Potts *et al.* 2010). The adults are migratory according to the movement of the Angola-Benguela frontal zone, moving northwards as far as Gabon in winter and returning to southern Angola in spring where spawning occurs in the offshore (Potts *et al.* 2010).

West coast steenbras *Lithognathus aureti* are endemic to the west coast of southern Africa, but rarely found outside Namibia's territorial waters (Holtzhausen 2000). Tagging studies have indicated that *L. aureti* comprise two separate closed populations; one in the vicinity of Meob Bay and one from central Namibia northwards (Holtzhauzen *et al.* 2001). Spawning localities are as yet unknown but tagging evidence suggests that males migrate considerable distances in search of gravid females (Holtzhausen 2000).

The spawning habitat of West coast steenbras is thought to also be limited. The bulk of the population exists in the nearshore at <10 m depth, with juveniles occurring in the intertidal surf zone (McLachlan 1986). By inference, spawning occurs in the surf zone and eggs and larvae from both populations drift northwards (Holtzhausen 2000). Whereas juveniles occur in the surf zone throughout its range, spawning habitat may be extremely limited and has yet to be clearly identified.

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*) (Figure 16, left), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) (Figure 16, right) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford *et al.* 1987), and generally occur within the 200 m contour, although they may often be found very close inshore, just beyond the surf zone. They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried up the coast in northward flowing waters. Historically, two seasonal spawning peaks for pilchard occurred; the first from October to December in an inshore area between Walvis Bay and Palgrave Point and the second from February to March near the 200 m isobath between Palgrave Point and Cape Frio. However, since the collapse of the pilchard stock, spawning in the south has decreased (Crawford *et al.* 1987). Recruitment success relies on the interaction of oceanographic events, and is thus subject to spatial and temporal variability. Consequently, the abundance of adults and juveniles of these small pelagic fish is highly variable both within and between species. The Namibian pelagic stock is currently considered to be in a critical condition due to a combination of over-fishing and unfavourable environmental conditions as a result of Benguela Niños.


Figure 16: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

Since the collapse of the pelagic fisheries, jellyfish biomass has increased and the structure of the Benguelan fish community has shifted, making the bearded goby (*Sufflogobius bibarbatus*) the new predominant prey species. Gobies have a high tolerance for low oxygen and high H_2S levels, which enables them to feed on benthic fauna within hypoxic waters during the day, and then move to oxygen-richer pelagic waters at night, when predation pressure is lower, to feed on live jellyfish (Utne-Palm *et al.* 2010; van der Bank *et al.* 2011).

Two species that migrate along the southern African West Coast following the shoals of anchovy and pilchards are snoek *Thyrsites atun* and chub mackerel *Scomber japonicas*. Their appearance along the Namibian coast are highly seasonal. Snoek are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. The abundance and seasonal migrations of chub mackerel are thought to be related to the availability of their shoaling prey species (Payne & Crawford 1989).

The fish most likely to be encountered in the offshore waters of the project area are the large migratory pelagic species, including various tunas, billfish and sharks, many of which are considered threatened by the International Union for the Conservation of Nature (IUCN), primarily due to overfishing (Table 4). Tuna and swordfish are targeted by high seas fishing fleets and illegal overfishing has severely damaged the stocks of many of these species. Similarly, pelagic sharks, are either caught as bycatch in the pelagic tuna longline fisheries, or are specifically targeted for their fins, where the fins are removed and the remainder of the body discarded.

Table 4: Some of the more important large migratory pelagic fish likely to occur in the offshore regions of the West Coast. The Global IUCN Conservation Status are also provided.

Common Name	Species	IUCN Conservation Status
Tunas		
Southern Bluefin Tuna	*Thunnus maccoyii*	Critically Endangered
Bigeye Tuna	*Thunnus obesus*	Vulnerable
Longfin Tuna/Albacore	*Thunnus alalunga*	Near Threatened
Yellowfin Tuna	*Thunnus albacares*	Near Threatened
Frigate Tuna	*Auxis thazard*	Least concern
Eastern Little Tuna	*Euthynnus affinis*	Least concern
Skipjack Tuna	*Katsuwonus pelamis*	Least concern
Billfish		
Blue Marlin	*Makaira nigricans*	Vulnerable
Striped Marlin	*Kajikia audax*	Near Threatened
Sailfish	*Istiophorus platypterus*	Least concern
Swordfish	*Xiphias gladius*	Least concern
White Marlin	*Kajikia albida*	Vulnerable
Black Marlin	*Istiompax indica*	Data deficient
Pelagic Sharks		
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Vulnerable
Dusky Shark	*Carcharhinus obscurus*	Vulnerable
Great White Shark	*Carcharodon carcharias*	Vulnerable
Shortfin Mako	*Isurus oxyrinchus*	Endangered
Longfin Mako	*Isurus paucus*	Vulnerable
Whale Shark	*Rhincodon typus*	Endangered
Blue Shark	*Prionace glauca*	Near Threatened

Species occurring off Namibia include the albacore/longfin tuna *Thunnus alalunga* (Figure 17, right), yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis* tunas, as well as the Atlantic blue marlin *Makaira nigricans* (Figure 17, left), the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne I Crawford 1989). Large pelagic species migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela. The distributions of these species is dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Penney *et al.* 1992).

A number of species of pelagic sharks are also known to occur off the southern African West Coast, including blue *Prionace glauca*, short-fin mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Occurring throughout the world in warm temperate waters, these species are usually found further offshore. Of these the blue shark is listed as 'Near threatened', and the short-fin mako, whitetip, and great white as 'Vulnerable' on the International Union for Conservation of Nature (IUCN).

Figure 17: Large migratory pelagic fish such as blue marlin (left) and longfin tuna (right) occur in offshore waters (photos: www.samathatours.com; www.osfimages.com).

Turtles

Five of the eight species of turtle worldwide occur off Namibia (Bianchi *et al.* 1999). Turtles that are occasionally sighted off central Namibia, include the Leatherback Turtle (*Dermochelys coriacea*) (Figure 18, left), the largest living marine reptile. Limited information is available on marine turtles in Namibian waters, although leatherback turtles, which are known to frequent the cold southern ocean, are the most commonly-sighted turtle species in the region. Observations of Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*) (Figure 18, right), Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) turtles in the area are rare.

Leatherbacks turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish). While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al.* 2004). Their large size allows them to maintain a constant core body temperature and consequently they can penetrate colder temperate waters.

The South Atlantic population of leatherback turtles is the largest in the world, with as many as 40,000 females thought to nest in an area centred on Gabon, yet the trajectory of this population is currently unknown (Witt *et al.* 2011). Namibia is gaining recognition as a feeding area for leatherback turtles that are either migrating through the area or undertaking feeding excursions into Namibian waters. The turtles are thought to be attracted by the large amount of gelatinous plankton in the Benguela ecosystem (Lynam *et al.* 2006). Based on tag returns from animals found dead in Namibia, these turtles are thought to come mainly from Gabonese and Brazilian nesting grounds (R. Braby, pers. comm., Namibia Coast Conservation and Management Project – NACOMA, 25 August 2010).

Figure 18: Leatherback (left) and loggerhead turtles (right) occur along the coast of Central Namibia (Photos: Ketos Ecology 2009; www.aquaworld-crete.com).

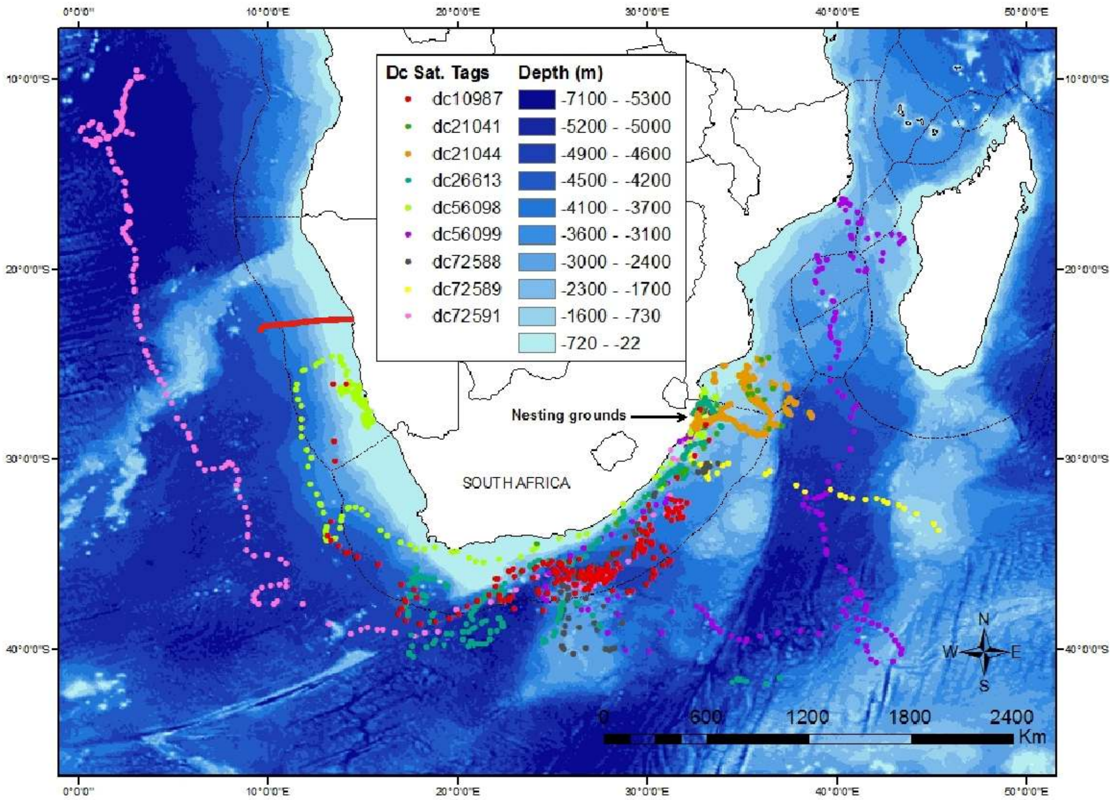


Figure 19: The Equiano Cable routing (red line) in relation to the post-nesting distribution of nine satellite tagged leatherback females (1996 – 2006; Oceans and Coast, unpublished data).

Although they tend to avoid nearshore areas, they may be encountered in the area around Walvis Bay between October and April when prevailing north wind conditions result in elevated seawater temperatures (Figure 19). Several anthropogenic factors threaten sea turtle populations including entanglement in fishing gear, incidental catches in fisheries, vessel strikes, ingestion of marine debris, pollution, decline of habitat along the Western Atlantic coast and loss of nesting habitat (Carr 1987; National Research Council (NRC) 1990; Lutz & Alfaro-Shulman 1991; Lutcavage *et al.* 1997; Witzell 1999; Witherington & Martin 2000; Dwyer *et al.* 2003; James *et al.* 2005).

Leatherback Turtles are listed as 'Vulnerable' worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species).

Loggerhead and Olive Ridley turtles are globally listed as 'Vulnerable' whereas Hawksbill are globally listed as 'Critically Endangered', and Green turtles as 'Endangered'. The most recent conservation status, which assessed the species on a scale of Regional Management Units (RMU), is provided in Table 5. From this it is evident that leatherback and loggerhead turtles, the two species most likely to be encountered in the licence area, are rated as 'Critically Endangered' and 'Near Threatened', respectively in the Southwest Indian RMU[2]. Although not a signatory of CMS, Namibia has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. Namibia is thus committed to conserve these species at an international level.

Table 5: Global and Regional Conservation Status of the turtles occurring off the southern African coastline showing variation depending on the listing used.

Listing	Leatherback	Loggerhead	Green	Hawksbill	Olive Ridley
IUCN Red List:					
Species (date)	V (2013)	V (2017)	E (2004)	CR (2008)	V (2008)
Population (RMU)	CR (2013)	NT (2017)	*	*	*
Sub-Regional/National (RSA)					
NEMBA TOPS (2007)	CR	CR	E	CR	E
Hughes & Nel (2014)	E	V	NT	NT	DD

NT – Near Threatened V – Vulnerable E – Endangered CR – Critically Endangered

DD – Data Deficient * Not yet assessed

NEMBA TOPS: South African National Environmental Management: Biodiversity Act – List of Threatened Or Protected Species (TOPS)

2 Regional Management Units (RMUs) organise marine turtles that might be on independent evolutionary trajectories within regional entities into units of protection above the level of nesting populations, but below the level of species.

Seabirds

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. In total, 11 species of seabirds are known to breed along the southern Namibian coast (Table 6). Most seabirds breeding in Namibia are restricted to areas where they are safe from land predators, although some species are able to breed on the mainland coast in inaccessible places. In general most breed on the islands off the southern Namibian coast, or on the man-made guano platforms in Walvis Bay, Swakopmund and Cape Cross. The southern Namibian islands and guano platforms therefore provide a vital breeding habitat to most species of seabirds that breed in Namibia. However, the number of successfully breeding birds at the particular breeding sites varies with food abundance (J. Kemper, MFMR Lüderitz, pers. comm.). With the exception of Kelp Gull and White-breasted Cormorants all the breeding species are listed Red Data species in Namibia.

Most of the seabird species breeding in Namibia feed relatively close inshore (10-30 km). Cape Gannets (Figure 20, left), however, are known to forage up to 140 km offshore (Dundee 2006; Ludynia 2007), and African Penguins (Figure 20, right) have also been recorded as far as 60 km offshore.

Other Red-listed species found foraging, or roosting along the coastline of southern Namibia are listed in Table 6. Among the species present there are nine species of albatrosses, petrels or giant-petrels recorded in the waters off Namibia's southern coast (Boyer & Boyer 2015). However, population numbers are poorly known and they do not breed in Namibian waters. Forty-nine species of pelagic seabirds have been recorded in the region, of which 14 are resident. Highest pelagic seabird densities occur offshore of the shelf-break in winter. Pelagic seabirds potentially encountered in the offshore portions of the project area are provided in Table 7.

Table 6: Namibian breeding seabird species with their Namibian and global IUCN Red-listing classification (from Kemper *et al.* 2007; Simmons *et al.* 2015).

Species	Namibian	Global IUCN
African Penguin *Spheniscus demersus*	Endangered	Endangered
Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered
Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered
Cape Gannet *Morus capensis*	Critically Endangered	Endangered
Crowned Cormorant *Phalacrocorax coronatus*	Near Threatened	Near Threatened
African Black Oystercatcher *Haematopus moquini*	Near Threatened	Near Threatened
White-breasted cormorant *Phalacrocorax carbo*	Least Concern	Least Concern
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern
Hartlaub's Gull *Larus hartlaubii*	Vulnerable	Least Concern
Swift Tern *Sterna bergii bergii*	Vulnerable	Least Concern
Damara Tern *Sterna balaenarum*	Near Threatened	Vulnerable

*In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

Figure 20: Cape Gannets *Morus capensis* (left) (Photo: NACOMA) and African Penguins *Spheniscus demersus* (right) (Photo: Klaus Jost) breed primarily on the offshore Islands.

Table 7: Other Namibian Red-listed bird species with their Namibian and global IUCN Red-listing classification (from Kemper *et al.* 2007; Simmons *et al.* 2015).

Species	Namibian	Global IUCN
Tristan Albatross *Diomedea dabbenena*	Critically Endangered	Critically Endangered
Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*	Endangered	Endangered[1]
Black-browed Albatross *Thalassarche melanophrys*	Endangered	Least Concern
Wandering Albatross *Diomedea exulans*	Vulnerable	Vulnerable
Spectacled Petrel *Procellaria conspicillata*	Vulnerable	Vulnerable
White-capped Albatross *Thalassarche sneadi*	Near Threatened	Near Threatened
Caspian Tern *Sterna caspia*	Vulnerable	Least Concern
Greater Flamingo *Phoenicopterus ruber*	Vulnerable	Near Threatened
Lesser Flamingo *Phoenicopterus minor*	Vulnerable	Near Threatened
White-chinned Petrel *Procellaria aequinoctialis*	Vulnerable	Vulnerable
Chestnut-banded Plover *Charadrius pallidus*	Near Threatened	Least Concern
Sooty Shearwater *Puffinus griseus*	Near Threatened	Near Threatened
Northern Giant-Petrel *Macronectes halli*	Near Threatened	Least Concern
Shy Albatross *Thalassarche cauta*	Near Threatened	Near Threatened

*In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

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

The 30 km long shoreline between Walvis Bay and Swakopmund has the highest linear count of birds in southern Africa at ~450 birds/km with totals exceeding 13,000 shorebirds of 31 species, most of which are Palearctic migrants (Simmons *et al.* 1999; Molloy & Reinikainen 2003; http://www.ramsar.org/profile/profiles_namibia.htm). Individual 10 km sections, peak even higher at 770 birds/km. Birds reported from the 30 km stretch of coast between Walvis Bay and Swakopmund include African Black Oystercatcher, Kelp Gull, Cape cormorant, Turnstone (*Arenaria interpres*), Curlew Sandpiper (*Calidris ferruginea*), Grey plover (*Pluvialis squatarola*), Swift Tern, Damara tern and Common Tern (*Sterna hirundo*) (Simmons *et al.* 1999).

The coastline between Walvis Bay and Cape Cross also boasts three man-made guano platforms: "Bird Rock" north of Walvis Bay is 200 m offshore, whereas those north of Swakopmund and at Cape Cross have been erected in salt pans. About 99% of the birds occurring on the platforms are Cape Cormorants, although White-breasted Cormorants, Crowned Cormorants and Great White Pelicans also breed on the platforms (http://www.namibweb. com/guano.htm; http://web.uct.ac.za/ depts/stats/adu/walvisbay guano platform.htm). The Swakopmund platform has supported up to 700,000 Cape Cormorants in the past, and an average of 45,000 birds has been supported in recent years. Breeding species on the platform include Damara Tern and Chestnut-banded Plover.

Marine Mammals

Marine mammals occurring off the Namibian coastline include cetaceans (whales and dolphins) and seals. The cetacean fauna of the Namibia comprises 33 species of whales and dolphins known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (Table 8), and their seasonality (Table 9). Apart from the resident species such as the endemic Heaviside's dolphin, bottlenose and dusky dolphins, Namibia's waters also host species that migrate between Antarctic feeding grounds and warmer low latitude breeding ground waters, as well as species with a circum-global distribution. The project area lies close to the northern boundary of the cool Benguela ecosystem. Both cetacean species associated with the Benguela ecosystem (e.g. dusky dolphins) and those associated with the warmer sub-tropical habitat off Angola are likely to be encountered in the area.

The distribution of cetaceans in Namibian waters can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Species from both environments may be found on the shelf edge area (200-1,000 m) making this the most species-rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters as species associated with the pelagic environment tend to be wide ranging across 1,000s of km. The most common species within the broader licence area (in terms of likely encounter rate not total population sizes) are likely to be the humpback whale and pilot whale.

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

Table 8 lists the cetaceans likely to be found within the project area based on data sourced from: Findlay *et al.* (1992), Best (2007), Weir (2011), Dr J-P Roux, (MFMR pers comm) and unpublished records held by the Namibian Dolphin Project, which includes sightings from fisheries observers and Marine Mammal Observers (MMOs) (de Rock *et al.* 2019). The South Africa red list of cetacean fauna was updated in 2016 and global reviews are underway. As the Namibian list has not been updated recently the South African red list ratings are used as the most up to date. A review of the distribution and seasonality of the key cetacean species likely to be found within the broader project area is provided below, based on information provided by the Sea Search - Namibian Dolphin Project (NDP), which has been conducting research in Namibian waters since 2008.

Table 8: List of cetacean species known (from historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur in Namibian waters. Likely occurrence in probable habitat (Shelf or Offshore) is indicated by 'yes', 'no' (unlikely), 'edge' (shelf edge 200-500 m depth) or '?' (unknown). IUCN Conservation Status is based on the SA Red List Assessment (2014) (Child *et al.* 2016).

Common Name	Species	Shelf	Offshore	Seasonality	IUCN Conservation Status
Delphinids					
Dusky dolphin	*Lagenorhynchus obscurus*	Yes (0- 800 m)	No	Year round	Data Deficient
Heaviside's dolphin	*Cephalorhynchus heavisidii*	Yes (0-200 m)	No	Year round	Least Concern
Common bottlenose dolphin	*Tursiops truncatus*	Yes	Yes	Year round	Least Concern
Common (short beaked) dolphin	*Delphinus delphis*	Yes	Yes	Year round	Least Concern
Southern right whale dolphin	*Lissodelphis peronii*	Yes	Yes	Year round	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	Edge	Yes	Year round	Least Concern
Striped dolphin	*Stenella coeruleoalba*	No	Yes	Year round	Least Concern
Long-finned pilot whale	*Globicephala melas*	Edge	Yes	Year round	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	No	Yes	Year round	Least Concern
Rough-toothed dolphin	*Steno bredanensis*	No	Yes	Year round	Least Concern
Killer whale	*Orcinus orca*	Yes	Yes	Year round	Data Deficient
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Least Concern
Pygmy killer whale	*Feresa attenuata*	Occasional	Yes	Year round	Least Concern
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	?	Least Concern
Sperm whales					
Pygmy sperm whale	*Kogia breviceps*	Edge	Yes	Year round	Data Deficient
Dwarf sperm whale	*Kogia sima*	Edge	?	?	Data Deficient
Sperm whale *	*Physeter macrocephalus*	Edge	Yes	Year round	Vulnerable

Common Name	Species	Shelf	Offshore	Seasonality	IUCN Conservation Status
Beaked whales					
Cuvier's	*Ziphius cavirostris*	No	Yes	Year round	Data Deficient
Arnoux's	*Beradius arnouxii*	No	Yes	Year round	Data Deficient
Southern bottlenose	*Hyperoodon planifrons*	No	Yes	Year round	Least Concern
Layard's	*Mesoplodon layardii*	No	Yes	Year round	Data Deficient
True's	*M. mirus*	No	Yes	Year round	Data Deficient
Gray's	*M. grayi*	No	Yes	Year round	Data Deficient
Blainville's	*M. densirostris*	No	Yes	Year round	Data Deficient
Baleen whales					
Antarctic Minke	*Balaenoptera bonaerensis*	Yes	Yes	Higher in Winter	Least Concern
Dwarf minke*	*B. acutorostrata*	Yes	Yes	Year round	Least Concern
Fin whale	*B. physalus*	Yes	Yes	MJJ & ON, rarely in summer	Endangered
Blue whale	*B. musculus*	No	Yes	Higher in MJJ	Critically Endangered
Sei whale	*B. borealis*	Edge	Yes	MJ & ASO	Endangered
Bryde's (offshore)	*B. brydei*	Yes	Yes	Higher in Summer (JFM)	Not assessed
Bryde's (inshore)	*B brydei (subspp)*	Yes	Yes	Year round	Vulnerable
Pygmy right	*Caperea marginata*	Yes	?	Year round	Data Deficient
Humpback	*Megaptera novaeangliae*	Yes	Yes	Year round, higher in JJASON	Vulnerable
Southern right	*Eubalaena australis*	Yes	No	Year round, higher in JASON	Least Concern

Table 9: Seasonality of baleen whales in the broader project area based on data from multiple sources, predominantly commercial catches (Best 2007 and other sources) and data from stranding events (NDP unpubl data). Values of high (H), Medium (M) and Low (L) are relative within each row (species) and not comparable between species. For abundance / likely encounter rate within the broader project area, see Table 7.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bryde's Inshore	L	L	L	L	L	L	L	L	L	L	L	L
Bryde's Offshore	**H**	**H**	**H**	L	L	L	L	L	L	L	L	L
Sei	L	L	L	L	**H**	**H**	L	**H**	**H**	**H**	L	L
Fin	M	M	M	**H**	**H**	**H**	M	**H**	**H**	**H**	M	M
Blue	L	L	L	L	L	**H**	**H**	**H**	L	M	L	L
Minke	M	M	M	**H**	**H**	**H**	M	**H**	**H**	**H**	M	M
Humpback	M	M	L	L	L	**H**	**H**	M	M	L	M	**H**
Southern Right	**H**	M	L	**L**	L	**H**	**H**	**H**	**M**	**M**	**H**	**H**
Pygmy right	**H**	**H**	**H**	M	L	L	L	L	L	L	M	M

Mysticete (Baleen) whales

The majority of mysticetes whales fall into the family Balaenidae. Those occurring in the study area include the blue, fin, sei, Antarctic minke, dwarf minke, humpback and Bryde's whale (see Table 8 for scientific names). The majority of these species occur in pelagic waters with only the occasional visit to shelf waters. All of these species show some degree of migration through the latitudes of the project area when *en route* between higher latitude (Antarctic or Sub Antarctic) feeding grounds and lower latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality in Namibian waters can be either unimodal, usually in winter months, or bimodal (e.g. May-July and October-November) reflecting a northward and southward migration through the area. Northward and southward migrations may take place at different distances from the coast due to whales following geographic or oceanographic features, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.There is very little information on **sei whales** in Namibian waters and most information on the species from the southern African sub-region originates from whaling data from 1958-1963. Sei whales spend time at high altitudes (40-50°S) during summer months and migrate north through South African waters (where they were historically hunted in relatively high numbers) to unknown breeding grounds further north (Best 2007). As whaling catches were confirmed off both Congo and Angola, it is likely that they migrate through Namibian waters. Due to their migration pattern, densities in the project area are likely to show a bimodal peak with numbers predicted to be highest in May and June, and again in August, September, and October. All whales were historically caught in waters deeper than 200 m with most catches from deeper than 1,000 m (Best & Lockyer 2002). There is no current information on the abundance or distribution of this species in the region, but a recent sighting of a mother and calf in March 2012 (NDP unpublished data) and a stranding in Walvis Bay in July 2013 (NDP unpublished data) confirms their contemporary and probably year round occurrence on the Namibian continental shelf and beyond.

Two genetically and morphologically distinct populations of **Bryde's whales** live off the west coast of southern Africa (Best 2001; Penry 2010). The "offshore population" lives beyond the shelf (>200 m depth) off west Africa and migrates between wintering grounds off equatorial west Africa (Gabon) and summering grounds off western South Africa. Its seasonality on the west coast is thus opposite to the majority of the balaenopterids with abundance likely to be highest in the project area in January - March. Several strandings of adult offshore Bryde's whales have occurred in central Namibia. The "inshore population" of Bryde's whales is unique amongst baleen whales in the region by being non-migratory. The range of the population is the continental shelf and Agulhas Bank of South Africa ranging from Durban in the east to at least St Helena Bay off the west coast with possible movements further north into the winter months (Best 2007). A live stranding of a calf of this population in Walvis Bay confirms the current occurrence of this population in Namibian waters. An additional live sighting in the Namibian Islands MPA and a third stranding of a Bryde's whale adult in April 2013 have not been assigned to a population, but support regular, year-round occurrence of both populations of the species in the central Benguela ecosystem. Encounters in the project area are likely to occur.

Fin whales were historically caught off the west coast of South Africa and Namibia. A bimodal peak in the catch data from South African shore based stations suggests animals were migrating further north to breed (during May-June) before returning to Antarctic feeding grounds (during August-October). However, the location of the breeding ground (if any) and how far north it is remains a mystery (Best 2007). Some juvenile animals may feed year round in deeper waters off the shelf (Best 2007). Four strandings have occurred between Walvis Bay and the Kunene River, Namibia in the last decade during January, April (2) and October. Groups of 5-8 animals have been seen on multiple occasions on the coast either side of Lüderitz in April, May of 2014 and January 2015 (NDP unpubl. data) confirming their contemporary occurrence in Namibian waters and potential use of the upwelling areas for feeding. To date, most sightings or strandings have occurred in late summer (April-May), supporting evidence from whaling data that this is a peak time of occurrence in southern Namibia. Encounters in the licence area may occur.

Antarctic **blue whales** were historically caught in high numbers during commercial whaling activities, with a single peak in catch rates during July in Walvis Bay, Namibia and Namibe, Angola suggesting that in the eastern South Atlantic these latitudes are close to the northern migration limit for the species (Best 2007). Evidence of blue whale presence off Namibia is rapidly increasing. Recent acoustic detections of blue whales in the Antarctic peak between December and January (Tomisch *et al.* 2016) and in northern Namibia between May and July (Thomisch 2017) supporting observed timing from whaling records. Several recent (2014-2015) sightings of blue whales have occurred during seismic surveys off the southern part of Namibia in water >1,000 m deep confirming their current existence in the area and occurrence in Autumn months. Encounters in the project area may occur.

Two forms of **minke whale** occur in the southern Hemisphere, the Antarctic minke whale and the dwarf minke whale; both species occur in the Benguela (Best 2007; NDP unpubl. data). Antarctic minke whales range from the pack ice of Antarctica to tropical waters and are usually seen more than ~50 km offshore. Although adults of the species do migrate from the Southern Ocean (summer) to tropical/temperate waters (winter) where they are thought to breed, some animals, especially juveniles, are known to stay in tropical/temperate waters year round. Regular sightings of semi-resident Antarctic minke whales in Lüderitz Bay, especially in summer months (December - March) and a stranding of a single animal in Walvis Bay (in February 2014) confirm the contemporary occurrence of the species in Namibia (NDP unpubl. data). Recent data available off the Walvis Ridge shows acoustic presence in June - August and November - December (Thomisch *et al.* 2016), supporting observations from whaling records. The dwarf minke whale has a more temperate distribution than the Antarctic minke and they do not range further south than 60-65°S. Dwarf minke whales have a similar migration pattern to Antarctic minkes with at least some animals migrating to the Southern Ocean in summer months. Around southern Africa, dwarf minke whales occur closer to shore than Antarctic minkes and have been seen <2 km from shore on several occasions around South Africa. Both species are generally solitary and densities are likely to be low in the project area.

The **pygmy right whale** is the smallest of the baleen whales reaching only 6 m total length as an adult (Best 2007). The species is typically associated with cool temperate waters between 30°S and 55°S and records in Namibia are the northern most for the species with no confirmed records north of Walvis Bay, so it is unlikely to occur in the licence area (Leeney *et al.* 2013).

The most abundant baleen whales in the Benguela are southern right whales and humpback whales (Figure 23). In the last decade, both species have been increasingly observed to remain on the west coast of South Africa well after the 'traditional' South African whale season (June - November) into spring and summer (October - February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bays (Barendse *et al.* 2011; Mate *et al.* 2011). Increasing numbers of summer records of both species, suggest that animals may also be feeding in upwelling areas off Namibia, especially the southern half of the country near the Lüderitz upwelling cell (NDP unpubl. data) and will therefore occur in or pass through the project area.

The southern African population of **southern right whales** historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baie dos Tigres) and is considered to be a single population within this range (Roux *et al.* 2015). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6 100 individuals including all age and sex classes, and still growing at ~6.5% per annum (Brandaõ *et al.* 2018). When the population numbers crashed, the range contracted down to just the south coast of South Africa, but as the population recovers, it is repopulating its historic grounds including Namibia (Roux *et al.* 2001, 2015; de Rock *et al.* 2019) and Mozambique (Banks *et al.* 2011). Southern right whales are seen regularly in Namibian coastal waters (<3 km from shore), especially in the southern half of the Namibian coastline (Roux *et al.* 2001, 2011) Right whales have been recorded in Namibian waters in all months of the year (J-P Roux pers comm) but with numbers peaking in winter (June - August). A secondary peak in summer (November - January) also occurs, probably associated with animals feeding off the west coast of South Africa performing exploratory trips into southern Namibia (NDP unpubl. data). Notably, all available records have been very close to shore with only a few out to 100 m depth.

Figure 21: The Southern Right whale *Eubalaena australis* (left) and the humpback whale *Megaptera novaeangliae* (right) migrate along the coastal and shelf waters of southern Africa, including Namibia (Photos: www.NamibianDolphinProject.com).

The majority of **humpback whales** passing through the Benguela are migrating to breeding grounds off tropical west Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009; Barendse *et al.* 2010). A recent synthesis of available humpback whale data from Namibia (Elwen *et al.* 2014) shows that in coastal waters, the northward migration stream is larger than the southward peak supporting earlier observations from whale catches (Best & Allison 2010). This supports previous suggestions that animals migrating north strike the coast at varying places mostly north of St Helena Bay (South Africa) resulting in increasing whale density on shelf waters as one moves north towards Angola, but no clear migration 'corridor'. On the southward migration, there is evidence from satellite tagged animals and the smaller secondary peak in numbers in Walvis Bay, that many humpback whales follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs), possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2013; Rosenbaum *et al.* 2014). Although migrating through the Benguela, there is no existing evidence of a clear 'corridor' and humpback whales appear to be spread out widely across the shelf and into deeper pelagic waters, especially during the southward migration (Barendse *et al.* 2010; Best & Allison 2010; Elwen *et al.* 2014). Regular sightings of humpback whales in spring and summer months in Namibia, especially in the Lüderitz area, suggest that summer feeding is occurring in Namibian waters as well (or at least that animals foraging off West South Africa range up into southern Namibia). The most recent abundance estimates available put the number of animals in the west African breeding population to be in excess of 9,000 individuals in 2005 (IWC 2012) and it is likely to have increased since this time at about 5% per annum (IWC 2012). Humpback whales are thus likely to be the most frequently encountered baleen whale in the project area, ranging from the coast out beyond the shelf, with year round presence but numbers peaking in June – July (northern migration) and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem.

Odontocete (toothed) whales

The Odontoceti are a varied group of animals including the dolphins, porpoises, beaked whales and sperm whales. Species occurring within the broader project area display a diversity of features, for example their ranging patterns vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6 m long (Heaviside's dolphin) to 17 m (bull sperm whale).

All information about **sperm whales** in the southern African subregion stems from data collected during commercial whaling activities, *i.e.* pre 1985 (Best 2007). Sperm whales are the largest of the toothed whales and have a complex, structured social system with adult males behaving differently to younger males and female groups. They live in deep ocean waters, usually greater than 1,000 m depth, although they occasionally come into waters 500-200 m deep on the shelf (Best 2007). They are relatively abundant globally (Whitehead 2002), although no estimates are available for the southern African subregion. Seasonality of catches off west South Africa suggests that medium and large sized males are more abundant in winter months, while female groups are more abundant in autumn (March-April), although animals occur year round (Best 2007). Sperm whales were one of the most frequently seen cetacean species from offshore seismic survey vessels operating between Angola and the Gulf of Guinea. All sightings were made in water deeper than 780 m, and numbers peaked during April – June (Weir 2011). Sperm whales feed at great depths during dives in excess of 30 minutes making them difficult to detect visually. Sperm whales in the project area are likely to be encountered in deeper waters (>500 m), predominantly in the winter months (April - October).

There are almost no data available on the abundance, distribution, or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters (greater than 200 m) off the Namibian continental shelf (see Table 8). **Beaked whales** are all considered to be true deep-water species, usually recorded in waters in excess of 1 000 m (Best 2007). All the beaked whales that may be encountered in the project area are pelagic species that tend to occur in small groups usually less than five, although larger aggregations of some species are known (MacLeod and D'Amico 2006; Best 2007). The long, deep dives of beaked whales make them difficult to detect visually.

The genus *Kogia* currently contains two recognised species, the **dwarf (*K. sima*) and pygmy (*K. breviceps*) sperm whales**. Both species are deep water specialists living primarily off the shelf. Due to their small body size, cryptic behaviour and small school sizes, these whales are difficult to observe at sea, and morphological similarities make field identification to species level problematic. The majority of what is known about Kogiid whales in the southern African subregion results from studies of stranded specimens (e.g. Ross 1979; Findlay *et al.* 1992; Plön 2004). There are >30 records of *K. breviceps* collected along the Namibian coastline with a peak in strandings in June and August. A single account of *K. sima* collected in Walvis Bay in 2010, demonstrates that this species also occurs in Namibian waters (Elwen *et al.* 2014) and as a warm-water specialist is likely to occur within the project area.

Killer whales have a circum-global distribution being found in all oceans from the equator to the ice edge (Best 2007). Killer whales occur year round in low densities off western South Africa (Best *et al.* 2010), Namibia (Elwen & Leeney 2011) and in the Eastern Tropical Atlantic (Weir *et al.* 2010). Killer whales are found in all depths from the coast to deep open ocean environments and may thus be encountered in the project area at low levels.

False killer whales are recognized as a single species globally, although clear differences in morphological and genetic characteristics between different study sites show that there is substantial difference between populations and a revision of the species taxonomy may be needed (Best 2007). The species has a tropical to temperate distribution and most sightings off southern Africa have occurred in water deeper than 1,000 m but with a few close to shore as well (Findlay *et al.* 1992; NDP Unpubl. data). False killer whales usually occur in groups ranging in size from 1-100 animals (mean 20.2) (Best 2007), and are thus likely to be fairly easily seen in most weather conditions. However, the strong bonds and matrilineal social structure of this species makes it vulnerable to mass stranding (8 instances of 4 or more animals stranding together have occurred in the western Cape, South Africa, all between St Helena Bay and Cape Agulhas (Kirkman *et al.* 2010). There is no information on population numbers of conservation status and no evidence of seasonality in the region (Best 2007).

Long- and short-finned pilot whales (*Globicephala melas and G.macrorhynchus*) display a preference for temperate waters and are usually associated with the continental shelf or deep water adjacent to it (Mate *et al.* 2005; Findlay *et al.* 1992; Weir 2011). They are regularly seen associated with the shelf edge by MMOs, fisheries observers and researchers operating in Namibian waters (NDP unpubl. data; De Rock *et al.* 2019). The distinction between long-finned and short finned (*G. macrorhynchus*) pilot whales is difficult to make at sea. Short finned pilot whales are regarded as a more tropical species (Best 2007), and most sightings within the Benguela Ecosystem are thought to be long-finned pilot whales, however, due to the low latitude and offshore nature of the project, it is likely that either could be encountered.

Dusky dolphins (*Lagenorhynchus obscurus*) (Figure 24, left) are likely to be the most frequently encountered small cetacean in water less than 500 m deep, although their distribution this far north in their range is not well known. The species is very boat friendly and will often approach boats to bowride. This species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al.* 1992). Although no information is available on the size of the population, they are regularly encountered in near shore waters off South Africa and Lüderitz, although near-shore encounters are rare along the central Namibian coast (Walvis Bay area), with most records coming from beyond 5 nautical miles from the coast (Elwen *et al.* 2010;

NDP unpubl. data). In a recent survey of the Namibian Islands Marine Protected Area (between latitudes of 24°29' S and 27°57' S and depths of 30-200 m) dusky dolphin were the most commonly detected cetacean species with group sizes ranging from 1 to 70 individuals (NDP unpubl. data), although group sizes up to 800 have been reported in southern African waters (Findlay *et al.* 1992).

Heaviside's dolphins (Figure 24, right) are relatively abundant in both the southern and northern Benguela ecosystem with several hundred animals living and breeding in the areas around Walvis Bay and Lüderitz. Heaviside's dolphins are resident year-round. This species occupies waters from the coast to at least 200 m depth (Elwen *et al.* 2006; Best 2007), and may show a diurnal onshore-offshore movement pattern feeding offshore at night, although this varies throughout the range. This species occupies waters from the coast to at least 200 m depth (Elwen *et al.* 2006; Best 2007).

Figure 22: The dusky dolphin *Lagenorhynchus obscurus* (left) and endemic Heaviside's dolphin *Cephalorhynchus heavisidii* (right) (Photos: www.NamibianDolphinProject.com)).

The **common dolphin** (*Delphinus delphis*) is known to occur offshore in Namibian waters (Findlay *et al.* 1992). A stranding in Lüderitz (May 2012, NDP unpublished data) and MMO reports have confirmed their occurrence in the region. Although group sizes can be large, averaging 267 (± *SD* 287) for the southern African region (Findlay *et al.* 1992), average sizes of 37 (± *SD* 31) have been reported for the Namibian region (NDP unpublished data). They are more frequently seen in the warmer waters offshore and to the north of the country, and all sightings to date have been in water deeper than 500 m. There is no evidence of seasonality.

Common bottlenose dolphins (*Tursiops truncatus*) are widely distributed in tropical and temperate waters throughout the world, but frequently occur in small (10s to low 100s) isolated coastal populations. Within Nambian waters two populations of bottlenose dolphins occur. A small population inhabits the very near shore coastal waters (mostly <15 m deep) of the central Namibian coastline from approximately Lüderitz in the south to at least Cape Cross in the north, and is considered a conservation concern. The population is thought to number less than 100 individuals (Elwen *et al.* 2011). An offshore 'form' of common bottlenose dolphin occurs around the coast of southern Africa including Namibia and Angola (Best 2007) with sightings restricted to the continental shelf edge and deeper. Offshore bottlenose dolphins frequently form mixed species groups, often with pilot whales or Risso's dolphins.

The cold waters of the Benguela provide a northwards extension of the normally subantarctic habitat of **southern right whale dolphins** (*Lissodelphis peronii*) (Best 2007). Most records in the region originate in a relatively restricted region between 26°S and 30°S roughly between Lüderitz and Tripp Seamount in water 100-2,000m deep (Rose & Payne 1991; Best 2007; NDP Unpublished data). There was a live stranding of two individuals in Lüderitz Bay in December 2013. They are often seen in mixed species groups with other dolphins such as dusky dolphins. It is possible that the Namibian sightings represent a regionally unique and resident population (Findlay *et al.* 1992).

Several other species of toothed whales that might occur in the deeper waters of the project area at low levels include the pygmy killer whale, Risso's, and Striped dolphins, and Cuvier's and Layard's beaked whales. Nothing is known about the population size or density of these species in the project area but it is likely that encounters would be rare (Findlay *et al.* 1992; Best 2007).

In summary, there is very little current data on the presence, density or conservation status of any cetaceans within the project area. All information provided above is based on at least some level of projection of information from studies elsewhere in the region, at some time in the past (often decades ago) or extrapolated from knowledge of habitat choice of the species. The large whale species for which there are current data available are the humpback and southern right whale, although with almost all data being limited to the continental shelf. Both these species are known to use feeding grounds around Cape Columbine in South Africa, with numbers there highest between September and February. Whaling data indicates that several other large whale species are also most abundant on the West Coast during this period: fin whales peak in May-July and October-November; sei whale numbers peak in May-June and again in August-October and offshore Bryde's whale numbers are likely to be highest in January-March. Whale numbers on the shelf and in offshore waters are thus likely to be highest between October and February.

Of the migratory cetaceans, the blue whale is considered 'Critically Endangered', and sei and fin whales are listed as 'Endangered' in the IUCN Red Data book. All whales and dolphins are given protection under the Namibian Law. The regulations under the Namibian Marine Resources Act, 2000 (No. 27 of 2000) states that no whales or dolphins may be harassed, killed or fished.

Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 25) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (see Figure 29). Vagrant records from four other species of seal more usually associated with the subantarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas),* subantarctic fur seal (*Arctocephalus tropicalis),* crabeater *(Lobodon carcinophagus)* and leopard seals (*Hydrurga leptonyx)* (David 1989).

Currently, half the Namibian seal population occurs in southern Namibia, south of Lüderitz. It consists of about 300,000 seals, producing roughly 100,000 pups per year. Atlas Bay, Wolf Bay and Long Islands (near Lüderitz) together represent the largest breeding concentration (about 68,000 pups) of seals in Namibia. Population estimates fluctuate widely between years in terms of pup production, particularly since the mid-1990s (MFMR unpubl. Data; Kirkman *et al.* 2007). These southern Namibian colonies have important conservation value since they are largely undisturbed at present, as public access to the southern Namibian coast is restricted.

A further large breeding site is at Cape Cross north of Walvis Bay where about 51,000 pups are born annually (MFMR unpubl. Data). The colony supports an estimated 157 000 adults (Hampton 2003), with unpublished data from Marine and Coastal Management (MCM, South Africa) suggesting a number of 187,000 (Mecenero *et al.* 2006). A further colony of ~9,600 individuals exists on Hollamsbird Island south of Sandwich Harbour. There are also seal colonies at Cape Frio and Möwe Bay. The colony at Pelican Point in Walvis Bay is primarily a haul-out site. The mainland seal colonies present a focal point of carnivore and scavenger activity in the area, as jackals and hyena are drawn to this important food source.

Figure 23: Colony of Cape fur seals *Arctocephalus pusillus pusillus* (Photo: Dirk Heinrich).

The Cape fur seal population in the Benguela is regularly monitored by the South African and Namibian governments (e.g. Kirkman *et al.* 2012). Surveys of the full species range done every three years providing data on seal pup production (which can be translated to adult population size), thereby allowing for the generation of high quality data on the population dynamics of this species. The population is considered to be healthy and stable in size although there has been a northward shift in the distribution of the breeding population (Kirkman *et al.* 2012).

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles (~220 km) offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

There is a controlled annual quota, determined by government policy, for the harvesting of Cape fur seals on the Namibian coastline. The Total Allowable Catch (TAC) currently stands at 60,000 pups and 5,000 bulls, distributed among four licence holders. The seals are exploited mainly for their pelts (pups), blubber and genitalia (bulls). The pups are clubbed and the adults shot. These harvesting practices have raised concern among environmental and animal welfare organisations (Molloy & Reinikainen 2003).

3.4 Other Uses of the Area

3.4.1 Mariculture Activities

Mariculture (marine aquaculture) has gained considerable interest in Namibia over the last few years and is being conducted at an increasing scale in Walvis Bay. A Strategic Environmental Assessment developed for the Erongo Region, indicated that suitable locations for sea-based and land-based aquaculture were limited and would primarily be associated with Walvis Bay and Swakopmund (Skov *et al.* 2008). Two plots between Walvis Bay and Swakopmund have been specifically zoned for land-based aquaculture developments that propose to produce shrimp, finfish and abalone. A further area to the north of Swakopmund (north of the Mile 4 Saltworks) was identified as a potential development area for land-based aquaculture.

In Walvis Bay, several companies are engaged in cultivation of Pacific oyster (*Crassostrea gigas*) and European flat oyster (*Ostrea edulis*) in the lee of Pelican Point, using suspended baskets on long lines in deeper areas and platforms in shallower depths. An Aqua Park for oyster farming has been proposed for the shallow areas in the lee of Pelican Point (Skov *et al.* 2008). The ~1,200 ha area, which is under the jurisdiction of Namport, is located within the boundaries of the Walvis Bay Nature Reserve and has been zoned for aquaculture. The Aqua Park is a large development and may accommodate 10-20 oyster farms.

Oyster cultivation is also conducted in the feed-water ponds of the Walvis Bay and Swakopmund salt works (Figure 24). Oyster spat is imported from Chile and South Africa, and are grown out in trays and mesh bags suspended from ropes or wooden structures within the ponds (Maurihungirire & Griffin 1998; http://www.keetmanshoop.com/oysters.htm; http://www.ncp.co.za/WalvisHomeProducts Oysters.asp). In 2007, the industry exported oysters worth about N$35 million. In March 2008, however, the oyster industry suffered huge losses with an estimated 80 - 90% of the stock being destroyed by a severe red tide event coupled with unusually high water temperatures (up to 25°C) and the release of hydrogen sulphide into the sea. It has been suggested that long-term climatic trends in the Benguela ecosystem may lead to higher frequency of such low oxygen events (Monteiro *et al.* 2008). Mariculture in the region may thus become an increasingly risky prospect.

Figure 24: Oyster cultivation in the salt works at Swakopmund (Photo: http://www.ncp.co.za/WalvisHomeProductsOysters.asp).

3.4.2 Ecotourism

The old West Coast Recreation Area, now part of the newly proclaimed Dorob National Park, is renowned for its excellent angling, and is visited annually by thousands of fishermen. Popular beach angling spots along the coast have been identified and named to indicate their distance from Swakopmund (e.g. Mile 14, Mile 72 and Mile 108, at which campsites are located). Next to fishing from the shore, several skiboat operators from Swakopmund and Walvis Bay also offer guided angling tours. Specifically shark angling tours targeting bronze whalers, have become increasingly popular over the last decade and have become an established part of the local coastal tourist industry (Holtzhausen & Camarada 2007).

Swakopmund itself is described as the coastal playground of Namibia, and is increasingly attracting international tourism. Although its environment is its greatest economic asset (Skov *et al.* 2008), the area has now also become world-famous for adventure seekers who visit the area for quad-biking, sand boarding, tandem skydiving, camel and horse trails, paragliding, hot air ballooning etc.

In recent years Walvis Bay has also begun successfully marketing its natural marine and desert attractions - the Bay itself and the Lagoon, the Kuiseb Delta and the Namib Desert, and the Dunebelt north of it. Specifically marine ecotourism has become increasingly important, with ten whale-watching operators currently offering general nature trips that include sightings of dolphins and whales, as well as other marine life (e.g. fur seals, turtles and sunfish) out of both Walvis Bay and Swakopmund.

Various operators in Walvis Bay also offer 4x4 excursions to the Sandwich Harbour area, which include the Walvis Bay Lagoon, the Saltpans, the Kuiseb River Delta, and - if weather and tides allow for it - the Sandwich Harbour Lagoon (Figure 24, left).

Figure 25: Ecotourism in the study area includes 4x4 excursions to Sandwich Harbour (left) and kayak tours to Pelican Point (right) (Photos: www.sandwich-harbour.com).

Other recreational activities in the study area are leisure boating, kayaking, windsurfing and various beach activities (Figure 25, right). In addition, the Walvis Bay and Swakop lagoons provide ample opportunity for excellent bird watching.

3.4.3 Industrial Uses

Desalination Plants

A Reverse Osmosis (RO) desalination plant 30 km north of Wlotzkasbaken provides water for the Areva Resources Southern Africa mine, a Uranium mine 65 km north-east of Swakopmund. The annual net production of treated water from this desalination plant is 20 million m^3/annum with an associated sea water abstraction rate of ~48 million m^3/annum and a brine discharge volume of ~31 million m^3/annum.

A further RO desalination plant was planned by NamWater at Mile 6 just north of Swakopmund, also to provide water for the fast growing Uranium Mining Industry. The plant would have an output capacity of 25 million m^3/annum. The outcome, timelines and commercial aspects to the NamWater project however remain uncertain. These uncertainties were a significant motivator for the proposed Rössing Uranium desalination plant, which was to have a much smaller capacity of ~3 million m^3/year. Neither of these desalination plant projects have, however, come to fruition.

Saltworks

Namibia is the largest salt producer in sub-saharan Africa. Salt is the most important non-metallic minerals mined in Namibia, with the bulk of the salt output coming from the seawater evaporation pans at Walvis Bay and Swakopmund. The Swakopmund-based Salt Company (Pty) Ltd produces around 120,000 tons of edible salt annually (http://www.saltco.com/index.html). The saltworks are situated about 7 km (4 miles) north of Swakopmund. Production of the concentrated brine at the saltpan began in 1933, but by 1952 the salt source was exhausted. Seawater has since been pumped into open evaporation and concentration ponds from which crystallized salt is removed with mechanical scrapers. The pans are shallow and of varying salinity. Apart from a few halophytes, the saltworks are devoid of vegetation.

The aquatic portion of the Swakopmund saltworks, which encompasses 400 ha, has been registered as a private nature reserve. The shallow expanses of water created to permit evaporation in the salt-producing process are ideal feeding grounds for thousands of wetland birds. Other visitors are the Black-necked grebe and a large colony of Cape cormorants. A large wooden commercial guano platform covering 31,000 m^2 has been built in one of the northern pans. The value of these commercial saltpans as habitat for waders and others birds is obvious from biannual wetland counts (up to 93,000 birds of ~35 species at any one time) and the breeding of terns, cormorants and plovers in and around the saltworks (BirdLife International 2008 BirdLife's online World Bird Database: the site for bird conservation. Version 2.1. Cambridge, UK: BirdLife International. Available: http://www.birdlife.org).

The Walvis Bay Salt Refiners in Walvis Bay produce primarily chemical grade salt. The Walvis Bay salt field operation, is one of the largest wind and solar evaporation facilities in Africa, processing 24 million tons of sea water each year to produce more than 400,000 tons of high-quality salt. Although the construction of the saltworks destroyed large areas of naturally flooded salt pan, it does provide large areas of permanently flooded shallow water with a range of salinities not naturally occurring in this environment (Figure 26, right). Nutrients found in the ponds sustain a variety of wetland birds such as flamingos and other waders. Up to 120,000 birds at a time have been viewed at the salt field and more than 60 different species have been identified.

Guano

Guano is rich in Nitrogen (14-16%), Phosphorus (9%) and Potassium (3%), and consequently is valuable as an agricultural fertilizer. The man-made guano platforms at Walvis Bay (Figure 26, left), Swakopmund and Cape Cross are unique in the world, and guano has been scraped annually from them since the 1930s. The wooden platform between Swakopmund and Walvis Bay is located ~200 m offshore and has an area of 1.7 ha. A further two platforms of 4 ha each have been erected at the salt pans north of Swakopmund (see above) and at Cape Cross. The platforms are unique in the world, and currently produce about 2,500 tons of guano per season. Due to the absence of sand on the platforms, the guano is of a very high quality, fetching about N$ 700 per ton. It is reaped every 12-18 month after the end of the main summer breeding season (http://www.traveltonamibia.com/guano.htm).

Figure 26: The Bird Island guano platform (left; photo: T. Mufeti) and the Cape Cross platforms (right; photo: P. Tarr).

Diamond Mining and Hydrocarbon Exploration

Other users of the offshore areas include the commercial fishing industry (see Specialist Report on Fisheries), oil and gas licence holders and marine mining (diamonds and marine phosphates) concession holders (Figure 27).

The Namibian Minerals (Mining and Prospecting) Act (Act 33 of 1992) allows for various types of prospecting and mining licences, issued by the Ministry of Mines and Energy, covering both small-scale and formal activities.

The current offshore marine mining concessions, established by the Ministry of Mines and Energy under the new mineral legislation, extend virtually the full length of country's coastline from the Orange River to the Kunene. The concessions are irregularly divided into Exclusive Prospecting Licences (EPLs) and Mining Licence Areas (MLAs), in response to applications for specific areas (Figure 27). EPLs are particularly dynamic, as they are valid for three years only, and so the licence holders change regularly, often without having actively undertaken any prospecting or sampling operations in the concession before their leases expire.

The marine diamond mining industry is dominated by a few major companies, notably Namdeb Holdings (Pty) Ltd (which operates most of the coastal mining areas), De Beers Marine Namibia (Pty)

Ltd (which operates in the Atlantic 1 ML area offshore of Oranjemund), Samicor and Diamond Fields Namibia (Pty) Ltd. Current activities are all focused on the area south of Lüderitz.

In the early 2010s, the growing interest in the exploration of Namibian offshore phosphate resources, saw the application to dredge phosphate-rich sediments in ML-170 and ML-159 south of Walvis Bay. Environmental resistance against the proposed mining resulted in a two-year moratorium on marine phosphate mining in Namibia being placed in September 2013. Continued resistence has resulted in the moratorium never being officially lifted.

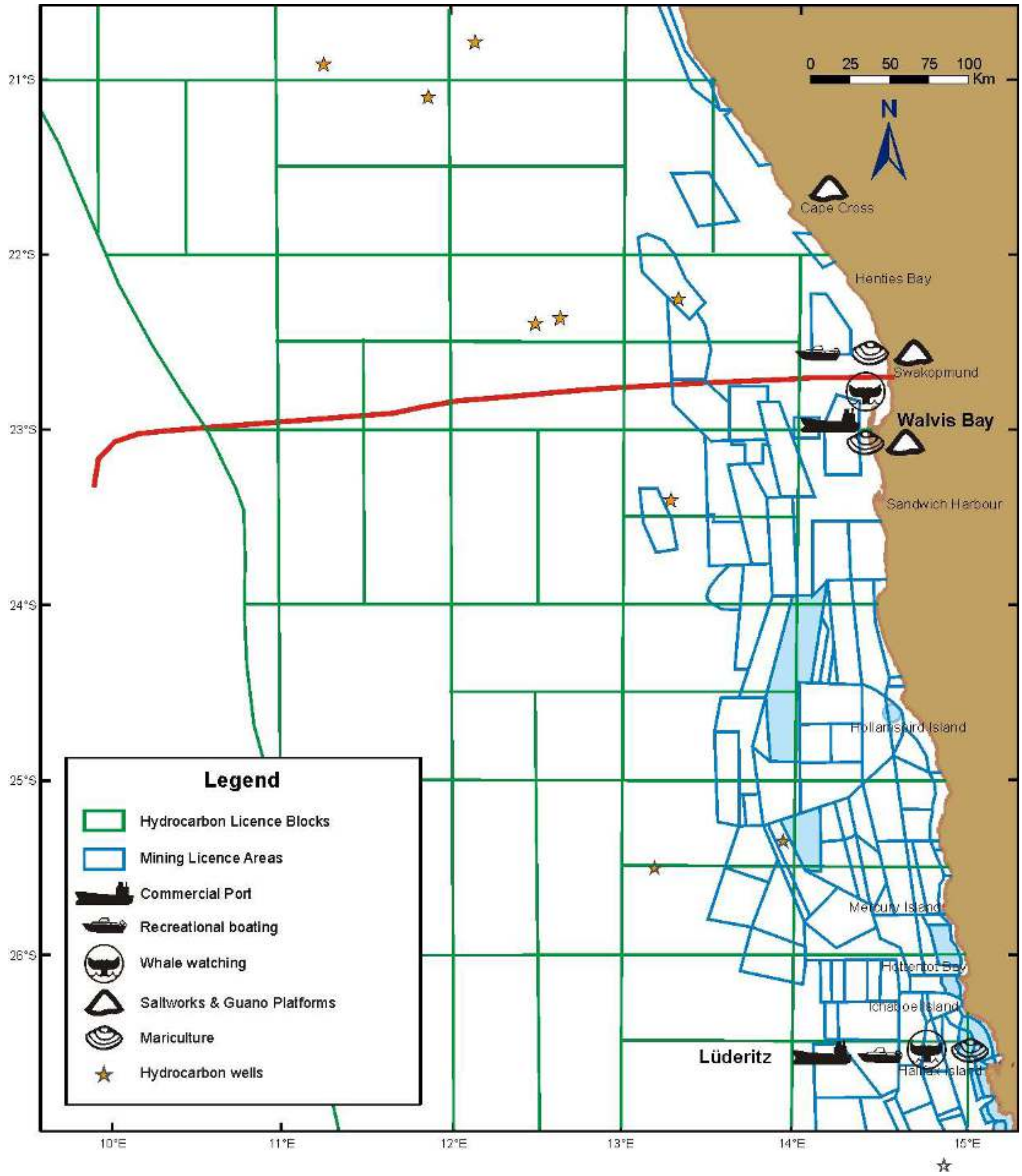


Figure 27: The Equiano Cable route (red line) in relation to the mining licence consessions (blue) and hydrocarbon licence blocks (green) off central Namibia. Active mining licences are shaded.

As with marine mining, the Namibian Petroleum (Exploration and Production) Act, 1991 (No. 2 of 1991) provides for the reconnaissance, exploration, production and disposal of petroleum within offshore licence blocks issued by the Ministry of Mines and Energy (Figure 27). An exploration licence is valid for a maximum period of 4 years, whereas a production licence is valid for a maximum period of 25 years and may be renewed only once for a further period of 10 years. Numerous 3D seismic aquisition campaigns have been undertaken off central Namibia in the past 5 years, with applications for the drilling of exploration wells having been submitted.

3.4.4 Conservation Areas and Marine Protected Areas

The coastline of Namibia is part of a continuum of protected areas that stretches from Southern Angola into Namaqualand in South Africa, namely the Skeleton Coast National Park, the Dorob National Park, the Namib-Naukluft National Park and the Sperrgebiet National Park.

The **Dorob National Park** was proclaimed in 2010 and extends along 1,600 kms of coastline from the Ugab River along the coast, through the former 'West Coast Recreation Area', the dune belt and to the northwestern boundary of the Namib-Naukluft Part (Figure 28). Among the areas excluded from the park are the municipal areas of Swakopmund, Walvis Bay and Hentiesbaai, the peri-urban area of Wlotzkasbaken, the Cape Cross Seal Reserve, and several farms in the Swakop River. While tourism, sports and recreational activities are allowed in non-sensitive areas, the remainder of the park has been divided into numerous priority conservation areas, which include Damara tern breeding sites, gravel plains, important birds areas, the Kuiseb Delta, Sandwich Harbour, Swakop River, Tsumas Delta, Walvis Bay Lagoon, birding areas and lichen fields. The marine component of the park includes the Walvis Bay Lagoon Ramsar sites. The management plan for the Dorob National Park includes the regulation of access for bike and quad-bikes, off-road driving, sandboarding, horse riding, bicycling, etc. as well as access by motorized boats and kayaks and canoes to the marine component of the park (www.nacoma.org.na).

The **Cape Cross Seal Reserve**, which is located within the Dorob National Park, is situated approximately 130 km north of Swakopmund. With a surrounding area of 60 km^2, the Cape Cross Seal Reserve was proclaimed in 1968 to protect the largest of the 23 breeding colonies of Cape fur seals along the southern African West Coast. Emergent offshore reefs, which serve as seabird nesting areas, are also protected.

The **Skeleton Coast National Park** extends 500 km from the Ugab River in the south to the Kunene River in the north, covering a total land-area of approximately 16,400 km^2. The coastline is characterised by many shipwrecks, dense coastal fogs and cold onshore winds. The general public has access only to the southern section between the Ugab and Hoanib rivers, staying at Terrace Bay and Torra Bay. Although open all year to linefish boats, Torra Bay and Terrace Bay are partly closed or restricted to rock- and surf-anglers. There is a seal colony at Cape Frio. The northern section of the Skeleton Coast Park is a tourism concession area and restricted to fly-in safaris only. The park is managed as a wilderness area by the Ministry of Environment and Tourism (MET) due to its ecological sensitivity.

Walvis Bay lagoon is the largest single area of shallow sheltered water along the Namibian coastline. The tidal inlet consists of adjacent intertidal areas, Pelican Point, mudflats exposed at low tide, and sandbars serving as roosting and feeding sites for resident and migratory birds. The wetland consists of natural areas of the lagoon and the Walvis Bay saltworks (Barnard 1998). The site supports up to 250,000 individuals of wetland birds, some species such as flamingos occurring in impressive numbers. Eleven endangered bird species are regularly observed (http://www.ramsar.org/profile/profiles_namibia.htm).

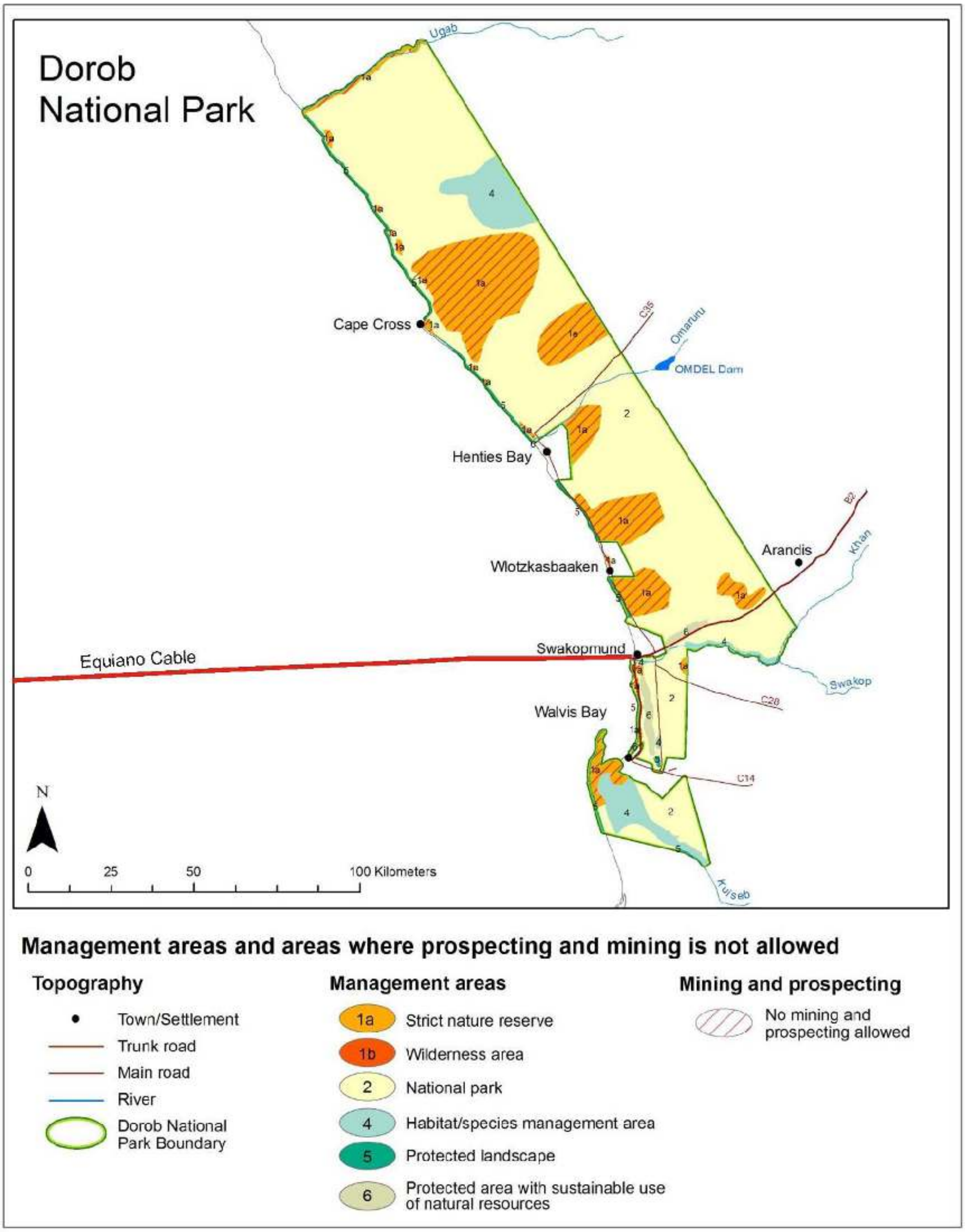


Figure 28: The Equiano Cable route (red line) in relation to the Dorob National Park and nearby strict nature reserves (Orange).

Sandwich Harbour, located 55 km south of Walvis Bay, is one of Namibia's four proclaimed RAMSAR sites and one of southern Africa's richest coastal wetlands. The area consists of two distinct parts: a northern, saltmarsh and adjoining intertidal sand flat area, which supports typical emergent vegetation, and a southern area of mudflats and raised shingle bars under tidal influence. The area supports an extremely rich avifauna including eight endangered species among the large numbers of waders, terns, pelicans and flamingos. Bird numbers are reported to reach 175,000, with Palearctic waders reaching densities of 7,000 birds per km^2. Several archaeological sites dating back 1,000 years also exist within the area (Barnard 1998).

The **Namibian Islands' Marine Protected Area** (NIMPA) was officially launched on 2 July 2009 under the Namibian Marine Resources Act (No. 29 of 1992 and No. 27 of 2000). The MPA, which lies well to the south of the project area, spans an area of 9,555 km^2, and includes a rock-lobster sanctuary constituting 478 km^2 between Chameis Bay and Prince of Wales Bay. The offshore islands, whose combined surface area amounts to only 2.35 km^2 have been given priority conservation and highest protection status (Currie *et al.* 2009). The area has been further zoned into four degrees of incremental protection. These are detailed in Currie *et al.* (2008).

In the spatial marine biodiversity assessment undertaken for Namibia (Holness *et al.* 2014), a number of offshore and coastal area were identified as being of high priority for place-based conservation measures. To this end, Ecologically or Biologically Significant Areas (EBSA) spanning the coastline between Angola and South Africa were proposed and inscribed under the Convention of Biological Diversity (CBD). The principal objective of the EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. Brief descriptions of these EBSAs, drawn largely from the EBSA-Portal (https://cmr.mandela.ac.za/EBSA-Portal/South-Africa), are provided below.

Of the eight identified EBSAs off Namibia, two fall solely within Namibian national jurisdiction (Namib Flyway and Namibian Islands), while one is shared with Angola (Namibe) and two are shared with South Africa (Orange Shelf Edge and Orange Cone). The Benguela Upwelling System transboundary EBSA extends along the entire southern African West Coast from Cape Point to the Kunene River and includes a portion of the high seas beyond the Angolan EEZ (Figure 29).

The **Benguela Upwelling System** is a transboundary EBSA is globally unique as the only cold-water upwelling system to be bounded in the north and south by warm-water current systems, and is characterized by very high primary production (>1,000 mg C.m^{-2}.day^{-1}). It includes important spawning and nursery areas for fish as well as foraging areas for threatened vertebrates, such as sea- and shorebirds, turtles, sharks, and marine mammals. Another key characteristic feature is the diatomaceous mud-belt in the Northern Benguela, which supports regionally unique low-oxygen benthic communities that depend on sulphide oxidising bacteria.

The Equiano Cable Route crosses the **Namib Flyway EBSA**, which extends from 18 km north of Cape Cross to 30 km south of Conception Bay, spanning about 380 km of coastline bordering the Dorob National Park, Cape Cross Seal Reserve and the Namib-Naukluft Park. The weak upwelling cell off Walvis Bay and the sheltered bays (Walvis Bay and Sandwich Harbour) and shallow waters featured in this EBSA (Cape Cross lagoons, Swakop River Mouth Lagoon, Walvis Bay Lagoon and Mile 4 salt works) lead to warmer waters and higher productivity. Two of Namibia's five Ramsar sites (Walvis Bay and Sandwich Harbour) are included, both of which are of international importance for resident bird species as well as resident and transient marine mammals, and constitute key refueling and roosting habitats for many species of migrating waterbirds. The EBSA includes six terrestrial IBAs

(Table 10), and two proposed marine IBAs (Figure 30). The coastline includes mixed rocky and sandy shoreline, which together with the adjacent marine inshore environment supports resident, Palearctic, Oceanic and intra-African migrant bird species. The area also encompasses key spawning and nursery areas of various fish species, including sardine and anchovy - important forage fish for a range of marine predators. The area is highly relevant in terms of its importance for life-history stages of species, threatened, endangered or declining species and/or habitats, and biological productivity.

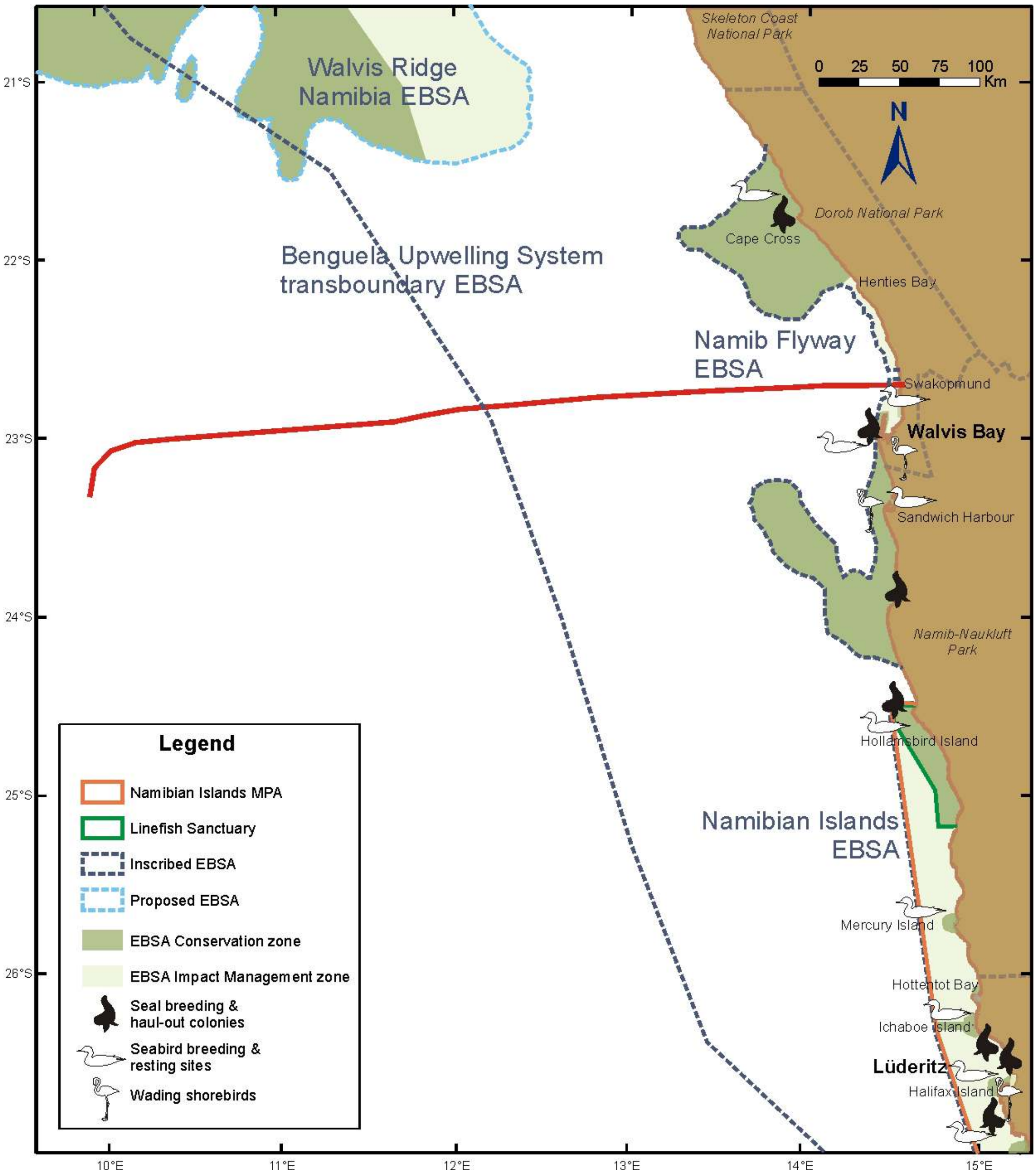


Figure 29: The Equiano Cable route (red line) in relation to the Namibian Islands Marine Protected Area, Ecologically and Biologically Significant Areas (EBSAs) and the marine spatial planning zones within these.

Table 10: List of Important Bird Areas (IBAs) and their criteria listings.

Site Name	IBA Criteria
Cape Cross lagoon	A1, A4i, A4iii
Namib-Naukluft Park	A1, A2, A3, A4i
Mile 4 saltworks	A1, A4i, A4iii
30-Kilometre Beach: WalvisSwakopmund	A1, A4i
Walvis Bay	A1, A4i, A4iii
Sandwich Harbour	A1, A4i, A4iii

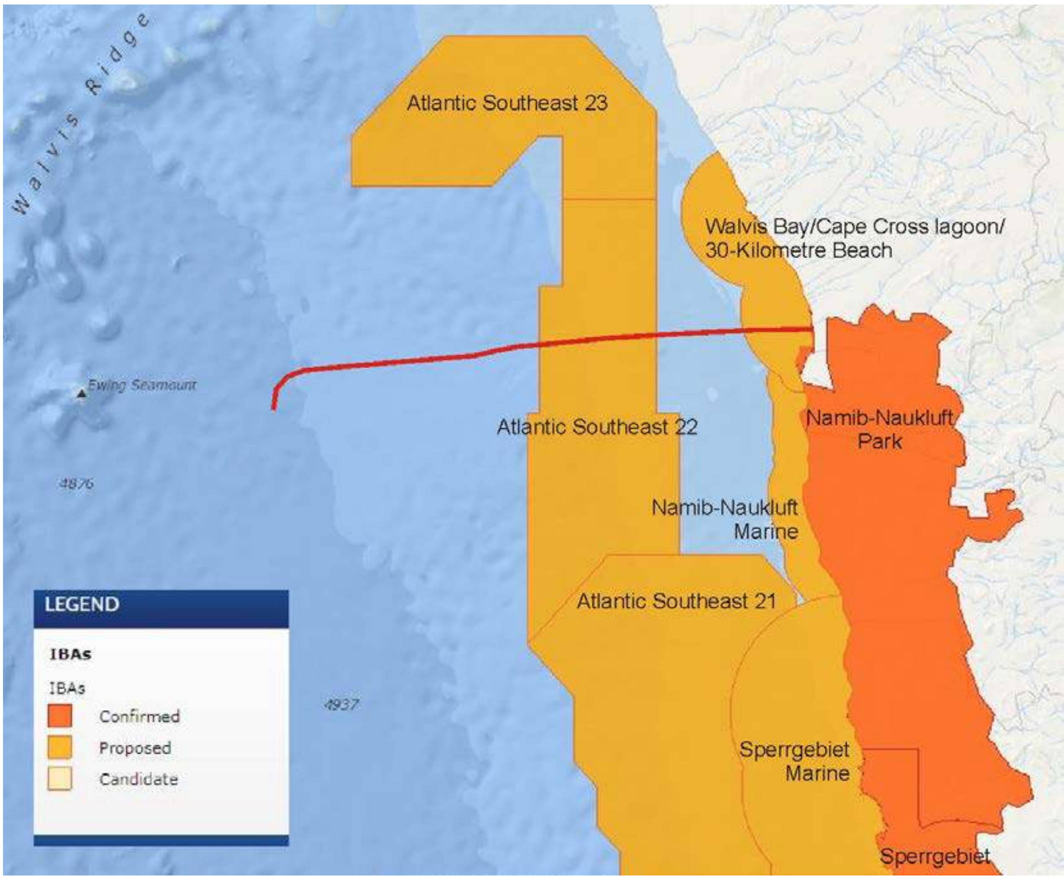


Figure 30: The Equiano Cable route (red line) in relation to confirmed and proposed coastal and marine IBAs in central Namibia (Source: https://maps.birdlife.org/marineIBAs).

The Namib Flyway area also hosts several 'Near threatened' and 'Vulnerable' fish species, and is considered an important foraging area for leatherback turtles from both the nesting grounds in Brazil and KwaZulu-Natal in South Africa. The Namib Flyway also includes three 'Endangered' habitat types (Central Namib Outer Shelf, Kuiseb Lagoon Coast and Kuiseb Mixed Shore), with the area being particularly important for Central Namib Outer Shelf and Kuiseb Lagoon Coast (Figure 31).

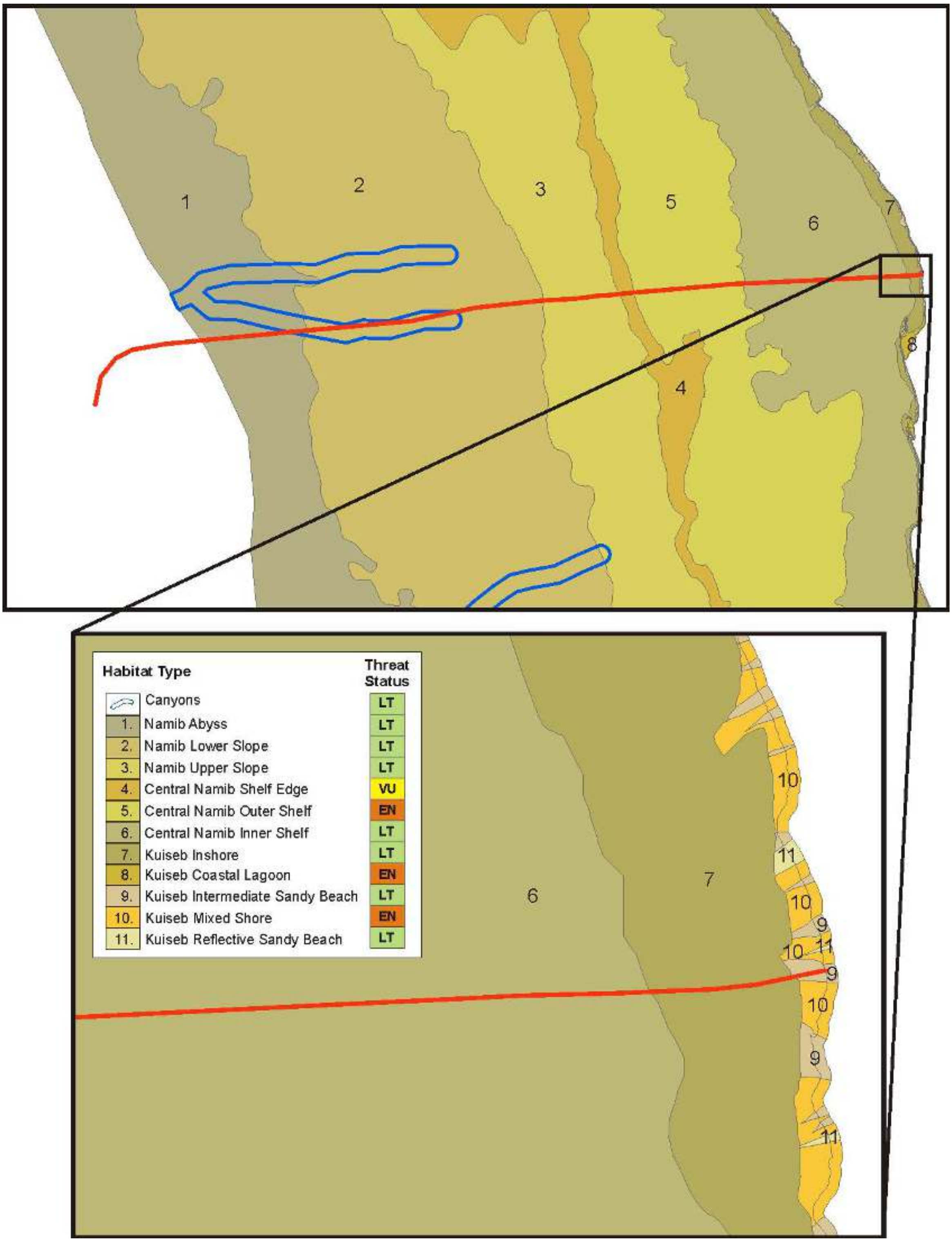


Figure 31: The Equiano Cable route (red line) in relation to the distribution of Namibian benthic and coastal habitats. The positions of potential submarine canyons are also shown (blue lines) (adapted from Holness *et al.* 2014). LT=Least Threatened; VU=Vulnerable; EN=Endangered.

Although no specific management actions have as yet been formulated for the EBSAs, two biodiversity zones have recently been defined within each EBSA as part of the marine spatial planning process. The management objective in the zones marked for 'Conservation' is "*strict place-based biodiversity protection aimed at securing key biodiversity features in a natural or semi-natural state, or as near to this state as possible*". The management objective in the zones marked for 'Impact Management' is "*management of impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state*" (https://cmr.mandela.ac.za/EBSA-Portal/Namibia/NA-EBSA-Status-Assessment-Management, accessed 5 June 2020) (Figure 29).

Table 11: Ecosystem threat status for marine and coastal habitat types off Central namibia (adapted from Holness *et al.* 2014). Those habitats affected by the Equiano Cable System are shaded. The number refers to the numbers used in the legend of Figure 31.

No.	Habitat Type	Threat Status	Available Area (ha)
1	Namib Abyss	Least Threatened	80,093.8
2	Namib Lower Slope	Least Threatened	138,013.0
3	Namib Upper Slope	Least Threatened	59,066.3
4	Central Namib Shelf Edge	Vulnerable	32,745.5
5	Central Namib Outer Shelf	Endangered	40,939.6
6	Central Namib Inner Shelf	Least Threatened	38,243.7
7	Kuiseb Inshore	Least Threatened	2,911.1
8	Kuiseb Coastal Lagoon	Endangered	162.1
9	Kuiseb Intermediate Sandy Beach	Least Threatened	400.4
10	Kuiseb Mixed Shore	Endangered	63.6
11	Kuiseb Reflective Sandy Beach	Least Threatened	69.5

4. ASSESSMENT OF IMPACTS ON MARINE FAUNA

4.1. Impact Assessment Methodology

An EIA methodology should minimise subjectivity as far as possible and accurately assess the project impacts. In order to achieve this ACER has followed the methodology defined below.

4.1.1 Impact Identification and Characterisation

An 'impact' is any change to a resource or receptor caused by the presence of a project component or by a project-related activity. Impacts can be negative, positive or neutral.

Nature of the Impact *– describes whether the impact would have a negative, positive or zero effect on the affected environment*	
Positive	The impact benefits the environment
Negative	The impact results in a cost to the environment
Neutral	The impact has no effect

Type of impacts assessed:

Type of impacts assessed	
Direct (Primary)	Impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
Indirect	Indirect or induced changes that may occur because of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place because of the activity.
Cumulative	Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over time and can include both direct and indirect impacts.

Impacts are described in terms of their characteristics, including the impact type and the impact spatial and temporal features (namely extent, duration, scale and frequency). The following convention was used to determine significance ratings in the assessment:

Rating	Definition of Rating
Intensity *– establishes whether the magnitude of the impact is destructive or benign in relation to the sensitivity of the receiving environment*	
Negligible	Inconsequential change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected.
Low	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable.
Medium	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way.
High	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease.
Duration *– the time frame over which the impact will be experienced*	
Short-term	<3 years.
Medium-term	3 – 10 years.
Long-term	>10 years, but where the impact will eventually cease either because of natural processes or by human intervention.
Permanent	Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient.
Extent *– defines the physical extent or spatial scale of the impact*	
Site specific	Impacts are limited to the site area only.
Local	Impacts extend only as far as the activity; limited to the site and its immediate surroundings; <2 km.
Regional	Impacts are confined to the region or are experienced within 30 km of the site.
National	Impacts are limited to the coastline of South Africa.
International	Impacts extend beyond the borders of South Africa.
Loss of resources *- the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable*	
Low	Where the activity results in a loss of a particular resource which is easily replaceable.
Medium	Where the loss of a resource occurs, but it can be replaced with effort.
High	Where the activity results in an irreplaceable loss of a resource.
Reversibility *– defines the potential for recovery to pre-impact conditions*	
Irreversible	Impacts are permanent.
Low	Where the impact can be reversed to only a limited degree.
Medium	Where the impact can be partially reversed.
High	Where the impact can be completely reversed.

***Probability** – the likelihood of the impact occurring*	
Improbable	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
Probable	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
Highly Probable	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
Definite	Where the impact would occur regardless of any prevention measures, i.e. > 80%chance of occurring.

Using the core criteria above (namely extent, duration, intensity and loss of resources), the consequence of the impact is determined:

***Consequence** – attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*	
Low	Impacts could be EITHER: of low intensity, duration, extent and impact on irreplaceable resources; OR of low intensity with up to two of the other criteria rated as medium; OR of medium intensity with all three other criteria rated as low.
Medium	Impacts are of medium intensity with at least two of the other criteria rated as medium.
High	Impacts could be EITHER: of high Intensity and impact on irreplaceable resources, with any combination of extent and duration; OR of high intensity, with all of the other criteria rated medium or high.

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	**POSSIBLE**	**PROBABLE**	**DEFINITE**
CONSEQUENCE	**LOW**	VERY LOW	VERY LOW	LOW	LOW
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH

Further criteria assessed are:

Frequency - Description of any repetitive, continuous or time-linked characteristics of the impact	
Once-off	occuring any time during construction.
Intermittent	occuring from time to time, without specific periodicity.
Periodic	occuring at more or less regular intervals.
Continuous	occuring without interruption.
Degree of confidence in predictions *– in terms of basing the assessment on available information and specialist knowledge*	
Low	Less than 35 % sure of impact prediction.
Medium	Between 35 % and 70 % sure of impact prediction.
High	Greater than 70 % sure of impact prediction.

A key objective of an EIA is to identify and define environmentally and technically acceptable and cost effective measures to manage and mitigate potential impacts. Mitigation measures are developed to avoid, reduce, remedy or compensate for potential negative impacts, and to enhance potential environmental benefits.

The priority is to first apply mitigation measures to the source of the impact (i.e. to avoid or reduce the magnitude of the impact from the associated project activity), and then to address the resultant effect to the resource/receptor *via* abatement or compensatory measures or offsets (i.e. to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

Degree to which impact can be mitigated *- the degree to which an impact can be reduced / enhanced*	
None	No change in impact after mitigation.
Very Low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
Low	Where the significance rating drops by one level, after mitigation.
Medium	Where the significance rating drops by two to three levels, after mitigation.
High	Where the significance rating drops by more than three levels, after mitigation.

4.2. Identification of Impacts

Potential impacts to the marine environment as a result of the installation and operation of the subsea cable are briefly summarised below, and discussed in more detail in Sections 4.3 and 4.4.

4.2.1 Cable Route Survey

The cable route survey could result in:

- Physiological injury or behavioural disturbance of marine fauna by the sounds emitted by the geophysical survey equipment; and
- Potential injury to marine mammals and turtles through vessel strikes.

4.2.2 Subsea Cable Installation

The installation of the subsea cable would result in:

- Disturbance of sediments and associated fauna during the pre-lay grapnel run;
- Disturbance of sediments and associate fauna during cable installation;
- Elimination of biota in the cable's structural footprint;
- Reduced area of unconsolidated seabed available for colonisation by infaunal communities; and
- Physical presence of the cable providing an alternative substratum for colonising benthic communities, or resulting in faunal attraction to fish and mobile invertebrates.

4.2.3 Shore crossing of the Subsea Cable

Infrastructure crossing the shore will impact on intertidal and shallow subtidal biota during the construction phase in the following ways:

- Temporary loss of benthic habitat and associated sessile communities due to preparation of seabed for buried cable laying and associated activities;
- Possible temporary impacts on adjacent habitat health due to turbidity generated during trenching and installation;
- Temporary disturbance of marine biota, particularly marine mammals and coastal birds, due to construction activities;
- Possible impacts to marine water quality and sediments through hydrocarbon pollution by marine construction infrastructure and machinery, and inappropriate disposal of used lubricating oils from marine machinery maintenance; and
- Potential contamination of marine waters and sediments by inappropriate disposal of spoil from trenching activities or backfilling, and human wastes, which could in turn lead to impacts upon marine flora, fauna and habitat.

4.2.4 Operation of the Subsea Cable System

As no routine maintenance of the subsea cable system is required, impacts associated with the operational phase would consitute temporary disturbance of the seabed if subsea cable sections require replacing. Impacts would be highly localised and sporadic.

4.2.5 Decommissioning

As the subsea cable will most likely be left in place at decommissioning, the potential impacts during the decommissioning phase are expected to be minimal and no key issues related to the marine environment are identified at this stage. As full decommissioning will require a separate EIA process, potential issues related to this phase will not be dealt with further in this report.

4.3. Geophysical Surveying of the Cable Route

Noise propagation represents energy travelling either as a wave or a pressure pulse through a gas or a liquid. Due to the physical differences between air and water (density and the speed at which sound travels), the decibel units used to describe noise underwater are different from those describing noise in air. Furthermore, hearing sensitivities vary between species and taxonomic groups. Underwater noise generated by drilling activities is therefore treated separately from noise generated in the air.

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC 2003). Natural ambient noise will vary considerably with weather and sea state, ranging from about 80 to 120 dB re 1 µPa (Croft & Li 2017). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 µPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans, and under the right conditions, these sounds can propagate 100s of kilometres thereby affecting very large geographic areas (Coley 1994, 1995; NRC 2003; Pidcock *et al.* 2003). Other forms of anthropogenic noise include 1) multi-beam sonar systems, 2) seismic acquisition, 3) hydrocarbon and mineral exploration and recovery, and 4) noise associated with underwater blasting, pile driving, and construction (Figure 32).

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012), as such sound sources interfere directly or indirectly with the animals' biological activities. Reactions of marine mammals to anthropogenic sounds have been reviewed by McCauley (1994), Richardson *et al.* (1995), Gordon & Moscrop (1996) and Perry (1998) (amongst others), who concluded that anthropogenic sounds could affect marine animals in the surrounding area in the following ways:

- Physiological injury and/or disorientation;
- Behavioural disturbance and subsequent displacement from key habitats;
- Masking of important environmental sounds and communication;
- Indirect effects due to effects on prey.

It is the received level of the sound, however, that has the potential to traumatise or cause physiological injury to marine animals. As sound attenuates with distance, the received level depends on the animal's proximity to the sound source and the attenuation characteristics of the sound.

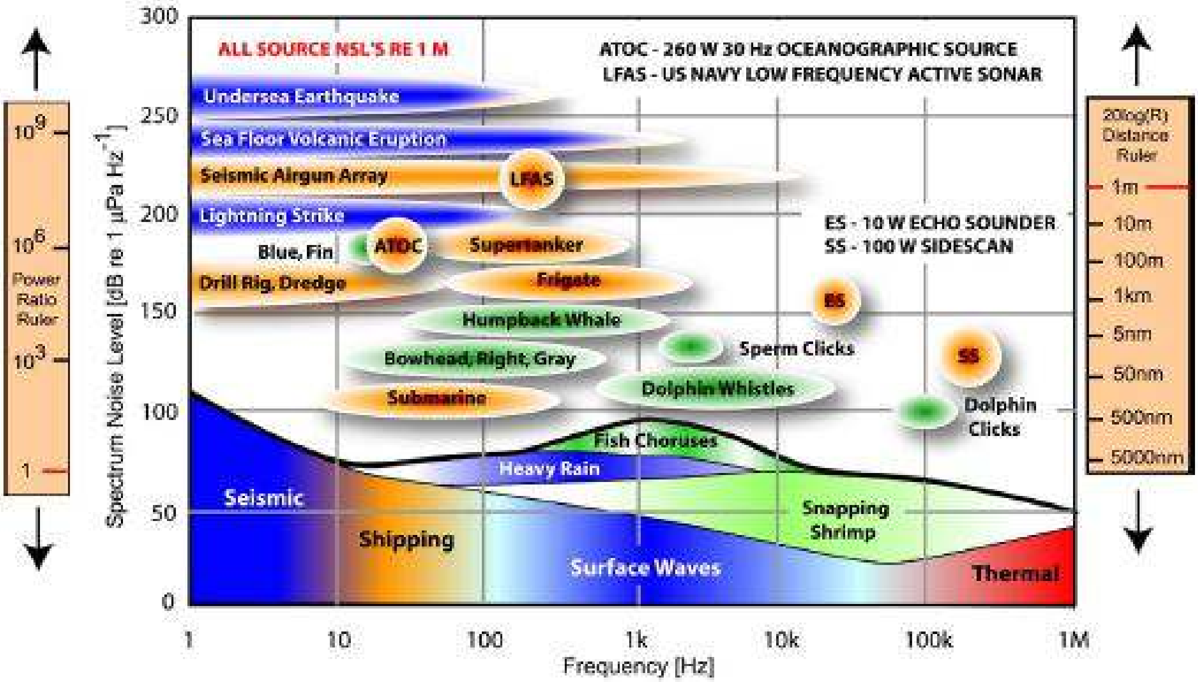


Figure 32: Comparison of noise sources in the ocean (Goold & Coates 2001).

The survey vessel would be equipped with a high to very high resolution multi-beam echo sounder (MBES), sub-bottom profiler and side scan sonar. This equipment emits a fan of acoustic beams from a transducer at frequencies ranging from 12 – 850 kHz[3] and typically produce maximum sound levels in the order of 190 to 240 dB re 1 μPa at 1 m. The operating frequencies falls into the high frequency kHz range, and are thus beyond the low frequency hearing ranges of fish species and sea turtles (from below 100 Hz to up to a few kHz) (Table 12). The high frequency active sonar sources, however, have energy profiles that clearly overlap with cetaceans' hearing sensitivity frequency range, particularly for cetaceans of High Frequency and Very High Frequency hearing groups, and would be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels. The noise emissions from the geophysical sources are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction. The noise impact would therefore be highly localised for the majority of marine mammal species. As surveys using the MBES, sub-bottom profiling and side sacan sonar sources have much lower noise emissions compared with seismic airgun sources, no specific considerations have been put in place in developing assessment criteria for these. Despite being audible by most marine mammals, the emission of underwater noise from geophysical surveying is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals (Burkhardt *et al.* 2008; Lurton 2010; Lurton 2015). Whereas behavioural effects (e.g. avoidance of the source) have been reported, there has been no evidence of physical damage (i.e. Permanent Threshold Shifts (PTS) and

3 Low frequency MBES (12-50 kHz) are designed for deep water (4,000 – 6,000 m) and intermediate depths and continental slopes. Medium- (70-150 kHz) and high-frequency (>200 kHz) MBES are designed for shallow to intermediate depths and ultrashallow depths (few metres to tens of metres), respectively (Lurton 2015).

Table 12: Known hearing frequency ranges of various marine taxa (adapted from Koper & Plön 2012; Southall *et al.* 2019).

Taxa	Order	Hearing frequency (kHz)
Shellfish	Crustaceans	0.1 – 3
Fish	Teleosts	
Hearing specialists		0.03 - >3
Hearing generalists		0.03 – 1
Sharks and skates	Elasmobranchs	0.1 – 1.5
African penguins	Sphenisciformes	0.6 - 15
Sea turtles	Chelonia	0.1 – 1
Seals and sea lions	Pinnipeds	0.75 – 75
Low Frequency Cetaceans	Mysticetes	0.007 – 22
High-frequency Cetaceans	Odontocetes	0.15 – 160
Very High-Frequency Cetaceans	Odontocetes	0.2 - 180

Temportary Threshold Shifts (TTS)) (Childerhouse *et al.* 2016). Recent sound transmission loss modelling studies undertaken for MBES surveys to depths of 3,600 m off the edge of the Agulhas Bank (Li & Lewis 2020) have predicted that marine mammals of all hearing groups except very-high-frequency cetaceans would experience PTS effect within 10 m from the MBES source, whereas for very-high-frequency cetaceans the maximum zones of PTS effect occurs within ~70 m from the MBES source along the cross-track direction. The zones of TTS due to a single pulse exposure for marine mammals of all hearing groups except very-high-frequency cetaceans are predicted to be within approximately 25 m from the MBES source, extending to within 140 m from the MBES source along the cross-track direction for very-high frequency cetaceans. Therefore, only directly below or within the sonar beam would received sound levels be in the 240 dB range where exposure would result in trauma or physiological injury. Furthermore, as the anticipated radius of influence of a multi-beam sonar is significantly less than that for a seismic airgun array, the statistical probability of crossing a cetacean or pinniped with the narrow multi-beam fan several times, or even once, is very small. As most pelagic species likely to be encountered along the cable route are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur.

Due to the extremely strong source directivity characteristics, the sound energy emissions from individual MBES pulses at cross-track directions are expected to dominate cumulative sound energy exposure at receiving locations. Very high-frequency cetaceans were predicted to have the highest zones of impact for cumulative PTS and TTS, being in the order of 400 m and 1,200 m, respectively. However, as these are limited to cross-track directions, the actual impact footprints are significantly smaller than with omnidirectional noise emissions. For cetaceans of other hearing groups and for seals, no PTS impact was predicted. For Low Frequency and High Frequency cetaceans, the cumulative sound exposure impact was predicted to be highly localised around the MBES source location, with the highest impact zone being <100 m from the source.

The underwater noise from the survey systems may, however, induce localised behavioural changes in some marine mammal. The maximum impact distance for behavioural disturbance caused by the immediate exposure to individual sonar MBES pulses was predicted to be within ~2 km from the

MBES source for marine mammals of all hearing groups, at cross-track directions. Evidence of significant behavioural changes that may impact on the wider ecosystem is lacking (Perry 2005).

Given the evidence available from the scientific literature and the results of sound transmission loss modelling, the effects of high frequency sonars on marine fauna is considered to be of low intensity, localised along the cable route and short-term (for duration of survey i.e. weeks). Any behavioural or physiological impacts on marine fauna would be fully reversible and consequently the impact is considered of **VERY LOW** significance both without and with mitigation.

Mitigation Measures

Despite the low significance of impacts for geophysical surveys, the Joint Nature Conservation Committee (JNCC) provides a list of guidelines to be followed by anyone planning marine sonar operations that could cause acoustic or physical disturbance to marine mammals (JNCC 2017). These have been revised to be more applicable to the southern African situation.

- Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 μPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the area.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- Avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November), and ensure that migration paths are not blocked by sonar operations. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place at night or between June and November.
- A MMO and PAM operator should be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

Impacts of multi-beam and sub-bottom profiling sonar on marine fauna		
Characteristic	**Impact**	**Residual Impact**
Intensity	Low	Low
Duration	Short-term; for duration of survey	Short-term
Extent	Local: limited to within the path of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Improbable	Improbable
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4. Installation of the Subsea Cable

Construction phase impacts associated with the installation of the subsea cable are discussed below.

4.4.1 Disturbance of the Coastal Zone

Installation of the subsea cable through the surf zone and across the beach would require the subsea cable to be buried to sufficient depth to ensure it is not exposed during seasonal variation of the beach levels. Excavated material would be disposed of onto the beach and into the surf zone down-current of the construction site. Subtidal trenching would result in the mobilisation and redistribution of sediments in tidal currents and the littoral drift. This would result in localised increased suspended sediment concentrations in the water column. Where burial cannot be achieved and additional cable protection is required, an articulated split-pipe may be used to maximise cable security. The trenching and cable burial process would result in disturbance of high shore, intertidal and shallow subtidal sandy beach habitats and their associated macrobenthic communities through displacement, injury or crushing.

Although the activities on the shore and in the shallow subtidal regions would be localised and confined to within a few 10s of metres of the construction site and cable shore-crossing route, the benthic biota would be damaged or destroyed through moving of equipment and machinery and the general activities of contractors around the construction site. Mobile organisms such as fish and marine mammals, on the other hand, would be capable of avoiding the construction area. Any shorebirds feeding and/or roosting in the area would also be disturbed and displaced for the duration of construction activities.

The invertebrate macrofauna inhabiting these beaches are all important components of the detritus / beach-cast seaweed-based food chains, being mostly scavengers, particulate organic matter and filter-feeders (McLachlan & Brown 2006). As such, they assimilate food sources available from the detritus accumulations typical of this coast and, in turn, become prey for surf zone fishes and migratory shorebirds that feed on the beach slope and in the swash zone. By providing energy input to higher trophic levels, they are all important in nearshore nutrient cycling, and significant reduction or loss of these macrofaunal assemblages may therefore have cascade effects through the coastal ecosystem (Dugan *et al.* 2003).

On a high-energy coastline the recovery of the physical characteristics of intertidal and shallow subtidal unconsolidated sediments to their pre-disturbance state following trenching and cable burial will occur within a few tidal cycles under heavy swell conditions, and will typically result in subsequent rapid recovery of the invertebrate epifaunal and infaunal communities to their previous state. Previous studies on the impact of cofferdam and larger-scale seawall mining on macrofaunal beach communities identified that the physical state of beaches on the southern African west coast is entirely driven by natural conditions, and is not affected (except during the actual disturbance) in the medium- to long-term (Pulfrich *et al.* 2004; Pulfrich *et al.* 2015; Pulfrich & Hutchings 2019). Removal of beach sands results in a significant, yet localised and short-term decrease in macrofaunal abundance and biomass. Intertidal beach macrofauna appear to be relatively tolerant to disturbance, and re-colonization of disturbed areas is rapid (van der Merwe & van der Merwe 1991; Brown & Odendaal 1994; Newell *et al.* 1998; Peterson *et al.* 2000; Schoeman *et al.* 2000; Seiderer & Newell 2000; Nel *et al.* 2003). Impacted areas are initially colonized by small, abundant and opportunistic pioneer species with fast breeding responses to tolerable conditions (e.g. crustaceans and polychaetes). If, following the disturbance, the surface sediment is similar to the original surface material, and if the final long- term beach profile has similar contours to the original profile, the addition or removal of layers of sand does not have enduring adverse effects on the sandy beach benthos (Hurme & Pullen 1988; Nel & Pulfrich 2002; Nel *et al.* 2003).

Provided the construction activities are all conducted concurrently, the duration of the construction disturbance should be limited to a few weeks. Disturbed subtidal communities within the wave base (<40 m water depth) might recover even faster (Newell *et al.* 1998). However, while recovery of the intertidal and subtidal communities is rapid, physical alteration of the shoreline in ways that cannot be remediated by swell action, such as deposition of large piles of pebbles and boulders, can be more or less permanent. Whilst the construction activities associated specifically with the cable installation are unlikely to have a significant effect at the ecosystem level, the cumulative effects of increasing development along this stretch of coast must be kept in mind. With construction of the small craft harbour the portion of the beach through which the cable will be installed, will already have been severely disturbed. It is also popular as a recreational beach. Cumulative impacts on the beach macrofaunal communities can therefore be expected.

The impacts on benthic communities as a result of cable installation through the littoral zone would be of medium intensity. Impacts would, however, be once-off and highly localised, being restricted to an ~10 m wide strip through the intertidal and surf zone. Impacts would be expected to endure over the short-term only as communities within the wave-influenced zone are adapted to frequent natural disturbances and recover relatively rapidly. Although the subsea cable routing passes through benthic habitats identified as 'endangered' and 'vulnerable' (Central Namib Outer Shelf and Central Namib Shelf Edge, respectively) the loss of resources would be low and impacts would be fully reversible. Disturbance of intertidal and shallow subtidal benthic organisms will definitely occur, but the potential impacts of the cable's shoreline crossing on benthic organisms is deemed to be of **LOW** significance without mitigation.

Mitigation Measures

The following mitigation measures are recommended:

- Plan routing of proposed subsea cable to as far as practicably possible avoid sensitive benthic habitats in the coastal and nearshore zone;
- Ensure that construction activities required for subsea cable installation occur concurrently thereby minimizing the disturbance duration in the coastal and nearshore zone;
- Schedule construction associated with the cable shore crossing to avoid bird breeding (March to September) and whale migration (June to November) periods;
- Restrict disturbance of the intertidal and subtidal areas to the smallest area possible. Once the shore crossing is finalised and the associated construction site is determined, the area located outside of the site should be clearly demarcated and regarded as a 'no-go' area;
- Restrict traffic in the intertidal area to minimum required;
- Restrict traffic to clearly demarcated access routes and construction areas only. These areas should be defined in consultation with the Environmental Control Officer (ECO);
- Have good house-keeping practices in place during construction, specifically waste management;
- No accumulations of excavated sediments or rock stockpiles should be left above the high water mark. Any substantial sediment accumulations below the high water mark should be levelled to follow the natural profile; and
- A vehicle access permit must be obtained from DEA (Branch Oceans and Coasts) prior driving in the coastal zone.

Disturbance and destruction of sandy beach biota during trench excavation and** subsea **cable installation		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Short-term; recovery is expected within 2-5 years	Short-term
Extent	Local: limited to within a few metres of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Definite	Definite
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.2 Disturbance of nearshore Benthic Habitats

Trenching of the subsea cable in the littoral zone beyond 10-15 m depth would result in the mobilisation and redistribution of sediments in tidal currents and the littoral drift. This would result in localised increased suspended sediment concentrations in the water column. Where burial cannot be achieved and additional cable protection is required, an articulated split-pipe may be used to maximise cable security. Within the wave-base (0 – 50 m), the subsea cable and/or articulated split-pipes may be held in place with saddle clamps at specific locations. This would require drilling into the bedrock to secure the clamps. The subsea cable burial and/or securing process would result in disturbance of subtidal unconsolidated sediments and their associated macrobenthic communities through displacement, injury or crushing.

Although the activities in the subtidal regions would be localised and confined to within a few metres of the subsea cable route, the benthic biota would be disturbed, damaged or destroyed through displacement of sediments during trenching and subsea cable burial. Mobile organisms such as fish and marine mammals, on the other hand, would be capable of avoiding the construction area. Any seabirds feeding in the area may also be disturbed and displaced for the duration of construction activities.

Once the subsea cable has been buried, the affected seabed areas would, with time, be recolonised by benthic macrofauna. The ecological recovery of the disturbed sea floor is generally defined as the establishment of a successional community of species, which progresses towards a community that is similar in species composition, population density and biomass to that previously present (Ellis 1996; Ellis & Garnett 1996; Ellis 2000). In general, communities of short-lived species and/or species with a high reproduction rate (opportunists) may recover more rapidly than communities of slow growing, long-lived species. Opportunists are usually small, mobile, highly reproductive and fast growing species and are the early colonisers. Sediments in the nearshore wave-base regime, which are subjected to frequent disturbances, are typically inhabited by these opportunistic species (Newell *et al.* 1998). Recolonisation will start rapidly after cessation of trenching, and species diversity and abundance may recover within short periods (weeks) whereas biomass often remains reduced for several years (Kenny & Rees 1994, 1996). Disturbed subtidal communities within the wave base (<40 m water depth) and in areas of substantial longshore sediment drift might recover even faster (Newell *et al.* 1998; Porter-Smith *et al.* 2004; Sherwood *et al.* 2016). Although recovery is site specific and dependent on different modes of cable burial and varied sediment environments, Kraus and Carter (2018) reported that on the inner and middle shelf, recovery of benthic communities following cable burial by plough typically occurs within 1-2 years (see also Grannis 2005; Sherwood *et al.* 2016). From their study they concluded that the physical presence of the cable and the disturbance caused by its burial had little effect on the benthic communities along the cable route.

The impacts of trenching and increased suspended sediments on benthic communities within and beyond the surf zone as a result of the subsea cable installation would be of medium intensity. Impacts would be once-off and highly localised, being restricted to within a few metres of the cable trench and subsea cable route, possibly extending to immediately adjacent areas. Impacts would be expected to endure over the short-term only as communities within the wave-influenced zone are adapted to frequent natural disturbances and recover relatively rapidly. Although the cable route passes through benthic habitats identified as 'endangered' and 'vulnerable' (Central Namib Outer Shelf and Central Namib Shelf Edge, respectively), the loss of resources would be low and impacts would be fully reversible. As the diameter of the subsea cable is only 38 mm at most, the proportion of vulnerable and endangered habitat affected by the subsea cable installation can be considered negligible in relation to the available habitat area (see Table 11). The potential impacts of cable installation on benthic organisms in the nearshore environments is consequently deemed to be of **LOW** significance without mitigation.

Mitigation Measures

The following mitigation measure is recommended:

- Plan routing of proposed subsea cable to as far as practicably possible avoid sensitive benthic habitats in the nearshore zone.

Disturbance and destruction of nearshore biota in unconsolidated sediments during trench excavation and cable installation		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Short-term; recovery is expected within 2-5 years	Short-term
Extent	Local: limited to within a few metres of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Probable	Probable
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.3 Disturbance of Offshore Habitats

The grapnel used during the pre-lay grapnel run, and the subsea cable plough and/or tracked jet-trenching/burial ROV implemented during subsea cable laying would result in the disturbance and turnover of unconsolidated sediments along a swath of seabed. The extent of disturbed seabed depends on the cable laying method used (i.e. ploughing or jetting), which in turn depends on the nature of the sea-floor. Each method results in different spatial and temporal scales of damage (Kraus and Carter 2018; Taormina *et al.* 2018). Ploughs are usually 2–8 m wide, mounted on skids, wheels or caterpillar tracks, and are towed by a cable laying ship. The plough blade disturbes a swath of seabed ≤1 m wide but potentially extending to a depth of 3 m. The excavated sediment is allowed to fall back into the furrow once the cable has been laid (Kraus & Carter 2018; Taormina *et al.* 2018). Any epifauna or infauna associated with the disturbed sediments are likely to be displaced, damaged or destroyed. Similarly, the plough skids would injure or crush benthic invertebrates in their path. Mobilisation and redistribution of sediments in near-bottom currents during cable burial would result in localised increased suspended sediment concentrations near the seabed and in the water column (see Section 4.4.5).

In contrast, during jetting the seabed is liquified to allow the cable to settle in the trench, with burial occuring through the redeposition of sediments out of the slurry. Although the jetted trench is also typically ≤1 m wide, sediment disturbance is extensive and redeposition can spread to 100s of metres from the trench, with plumes of the suspended mud fractions potentially extending to 2 km from the cable route, thereby creating a larger impact footprint (Kraus & Carter 2018).

As the cable is typically only 20 mm[4] – 200 mm[5] in diameter the disturbance associated with laying it on top of the sediment or consolidated substrate is limited to the footprint of the cable itself and any protective encasing material. Impacts associated with placing the cable directly onto the seabed include crushing, damaging or displacement of oarganisms (Dunham *et al.* 2015; Taormina *et al.* 2018). Unless cables traverse habitats supporting vulnerable slow-growing species (e.g. glass sponges, deep-water corals) (see for example Dunham *et al.* 2015), the loss of substratum would, however, be temporary the cable itself would provide an alternative substratum for colonising benthic communities or provide shelter for mobile invertebrates (see Section 4.4.6). Where the subsea cable is exposed, colonisation of the cable would commence within a few weeks. Studies from elsewhere have determined that benthic macro- and mega-fauna within 0–100 m of trenched and surface-laid cables showed negligible changes in abundance and distribution following cable installation (Kogan *et al.* 2006; Kuhnz *et al.* 2015).

Once the cable has been laid, the affected seabed areas around the cable would with time be recolonised by benthic macrofauna, with the encrusting epifauna resembling that inabiting natural reefs in the area. The rate of recovery/re-colonisation depends largely on the type of community that inhabits the affected benthic habitats, the extent to which the community is naturally adapted to high levels of disturbances, the sediment character (grain size) and physical factors such as depth and exposure (waves, currents) (Newell *et al.* 1998; Herrmann *et al.* 1999). More stable deep-water habitats are typified by large, often burrowing, slow growing and long-lived species (Newell *et al.* 1998). As long-lived species need longer to re-establish the normal age and size structure of the population, biomass often remains reduced for several years (Kenny & Rees 1994, 1996; see also Duna *et al.* 2016; Biccard *et al.* 2016, 2017, 2018, 2019).

It must be kept in mind, however, that re-colonisation is a site specific process, with the recovery time and resulting community structure being dependent not only upon sediment characteristics, but also local hydrodynamic conditions (Morton 1977; van der Veer *et al.* 1985) and depth. In deep water benthic community recovery rates are appreciably slower than in shallower areas subject to strong swell or current effects. Recovery of benthic macrofaunal communities following diamond mining in 80-150 m depth off the southern African West Coast has been demonstrated to occur within eight years (Duna *et al.* 2016), but at depths excess of 1,000 m, re-colonization of disturbed seabeds to conditions similar to undisturbed areas is thought to take decades (Foell *et al.* 1990, 1992a, 1992b, Thiel & Schriever 1994; Schriever *et al.* 1997; Schratzberger & Warwick 1999). In contrast, recovery of shallow water (<30 m depth) sandy seabed communities can occur within 1 year following disturbance (Saloman *et al.* 1982; Hall & Harding 1997). Provided the sediment characteristics of the areas disturbed along the cable route are not dramatically altered, full recovery of such communities on the continental shelf following disturbance by the grapnel and cable plough would be expected within 5-10 years (Lopez-Jamar *et al.* 1995; Ellis & Garnett 1996; Kaiser *et al.* 1996). Studies on recovery of the seabed and associated benthic communities in

[4] un-armoured cable at depths >900 m.

[5] armoured cable in the littoral zone, articulated split-pipes.

deeper water also reported impacts persisting for as long as 15 years (Grannis 2005; Kuhnz *et al.* 2015), with recovery depending upon depositional rates of suspended load and bed load. The impacts assocated with cable burial are, however, a once-off disturbance, with affected communities able to recover naturally following the cable installation. NOAA (2005) noted that a single impact such as a cable burial, is preferred to continuous, multiple or recurring impacts such as those associated with, for example, a demersal trawl.

The potential direct impacts on benthic organisms of crushing and sediment disturbance would be of medium intensity and once off (unless cable repair is necessary). Although the cable will extend along some 11,500 km of seabed, benthic impacts will be highly localised along the length of the subsea cable route. Impacts would be limited to the medium-term only as recolonisation of disturbed sediments from adjacent areas would occur within a year, but full recovery to functional similarlity can take longer (medium- to long-term). The change in habitat from unconsolidated sediments to the hard sustratum of the cable itself would, however, be permenent. Although the subsea cable route passes through outer shelf and shelf edge benthic habitats identified as 'vulnerable' (Central Namib Shelf Edge) and 'endangered' (Central Namib Outer Shelf) the loss of resources would be low and impacts would be partially reversible as unconsolidated habitat will be replaced by hard substratum. Furthermore, the proportion of vulnerable and endangered habitat affected by the subsea cable installation can be considered negligible in relation to the available habitat area (see Table 11). Consequently, the potential impacts on benthic organisms of cable installation across the continental shelf and abyss is deemed to be of **LOW** significance without mitigation. The elimination of marine benthic communities in the structural footprint of the cable is an unavoidable consequence of the installation of subsea cables, and no direct mitigation measures, other than the no-project option, are possible. Impacts will, however, be temporary as recolonisation of disturbed sediments from adjacent areas will occur within a few weeks.

Mitigation Measures

The following mitigation measures are recommended:

- Plan routing of proposed subsea cable to as far as practicably possible avoid sensitive deepwater benthic habitats; and
- Align routing of cable as closely as possible to the routes of existing or de-commissioned cables (even when these traverse a Marine Protected Area) thereby avoiding the impact of as yet undisturbed ecoststem types.

Disturbance and destruction of offshore benthic biota during cable laying		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Medium- to Long-term: recovery of deep-water benthos can be expected within 10 years	Medium-term
Extent	Site specific: limited to the subsea cable route	Site specific
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Definite	Possible
Reversibility	Partially reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.4 Increase in Noise

During installation of the subsea cable shore-crossing, noise and vibrations from excavation machinery may have an impact on surf zone biota, marine mammals and shore birds in the area. Noise levels during construction are generally at a frequency much lower than that used by marine mammals for communication (Findlay 1996), and these are therefore unlikely to be significantly affected. Additionally, the maximum radius over which the noise may influence is very small compared to the population distribution ranges of surf zone fish species, resident cetacean species and shore birds. Both fish and marine mammals are highly mobile and should move out of the noise-affected area (Findlay 1996). Similarly, shorebirds and terrestrial biota are typically highly mobile and would be able to move out of the noise-affected area. However, birds that nest and breed on beaches (e.g. African Black Oystercatcher, Damara terns) would be particularly susceptible to disturbance and noise from pedestrian traffic and construction activities on the beach.

Further offshore, underwater noise generated during subsea cable installation could affect a wide range of fauna; from benthic invertebrates and demersal species residing on the seabed along the subsea cable route, to those invertebrates and vertebrates occurring throughout the water column and in the pelagic habitat near the surface. Due to their hearing frequency ranges, the taxa most vulnerable to noise disturbance are turtles, pelagic seabirds, large migratory pelagic fish, and both migratory and resident cetaceans.

The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012). The sound level generated by the subsea cable laying vessel and subsea apparatus would fall within the hearing range of most fish and marine mammals, and would be audible for considerable ranges (in the order of tens of kms) before attenuating to below threshold levels. However, the noise is not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, even at close range. The underwater noise may, however, induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna. As much of the cable route crosses the main offshore shipping lanes that pass around southern Africa, the vessel noise component of the ambient noise environment is expected to be significant along the cable route. Given the significant local shipping traffic and relatively strong metocean conditions specific to the area, ambient noise levels are expected to be 90 - 130 dB re 1 µPa for the frequency range 10 Hz – 10 kHz (SLR Consulting Australia 2019). The noise generated by the cable laying vessel would be no different from that of other vessel traffic throughout the oceans, and from the point of vessel operations no specific mitigation (e.g. avoidance of marine mammal migration periods) is therefore deemed necessary when the vessel is in high seas waters.

Disturbance and injury to marine biota due to construction noise or noise generated by the vessel and cable plough is thus deemed of low magnitude within the immediate vicinity of the construction site/subsea cable route, with impacts persisting over the short-term only. In both cases impacts are fully reversible once construction and subsea cable installation operations are complete. Without mitigation, the direct impacts of construction and vessel noise are therefore assessed to be of **VERY LOW** significance, respectively. As the noise associated with construction and subsea cable installation is unavoidable, no direct mitigation measures, other than the no-project alternative, are possible. Impacts of construction noise can, however, be kept to a minimum through responsible construction practices.

Mitigation Measures

The following mitigation measures are recommended:

- Relevant vessel staff trained in seabird, turtle and marine mammal identification and observation techniques should be assigned for observation, distance estimation and reporting, to perform marine mammal observations and notifications.

Disturbance and avoidance behaviour of surf zone fish communities, shore birds and marine mammals through coastal construction noise and offshore cable installation noise		
Characteristic	**Impact**	**Residual Impact**
Intensity	Low	Low
Duration	Temorary (Short): for duration of shore-crossing installation and construction	Temporary
Extent	Local: limited to the construction site and around the cable vessel	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Possible	Possible
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

Behavioural changes and masking of biologically significant sounds in Marine Fauna due to noise from cable installation operations		
Characteristic	**Impact**	**Residual Impact**
Intensity	Low	Low
Duration	Temorary (Short): for duration of shore-crossing installation and construction	Short-term
Extent	Local: limited to the construction site and around the cable vessel	Local
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Possible	Possible
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.5 Increased Turbidity

The disturbance and turnover of sediments during the pre-lay grapnel run and during trenching will result in increased suspended sediments in the water column and physical smothering of biota by the re-depositing sediments. The effect of sediment plumes generated by cable burial on the resident biota depends upon several variables including (i) the mode of burial (jetting will produce more suspended sediment than ploughing), (ii) sediment type (mud produces longer-lived plumes compared to sand and gravel), (iii) rate of plume dispersal by waves and currents and (iv) the response of the biota to increased turbidity (e.g. Gooding *et al.* 2012; Meißner *et al.* 2006). Generally,plumes tend to be short-lived when mainly sandy deposits of the inner shelf are ploughed as the coarse sediment grain-size will encourage rapid deposition close to the trench (Swanson *et al.* 2006; Gooding *et al.* 2012; Taormina *et al.* 2018). In contrast, cable burial in mid-to outer shelf and upper slope mud deposits will generate sediment plumes that have the potential to last for days due to the fine grain-size, with active shelf currents, especially along the shelf edge, affecting plume stability and dilution and potentially distributing suspended sediments up to 2 km from the trench (Gooding *et al.* 2012).

The effects of elevated levels of particulate inorganic matter and depositions of sediment have been well studied, and are known to have marked, but relatively predictable effects in determining the composition and ecology of intertidal and subtidal benthic communities (e.g. Zoutendyk & Duvenage 1989; Engledow & Bolton 1994; Iglesias *et al.* 1996; Slattery & Bockus 1997). Increased suspended sediments in the surf zone and nearshore can potentially affect light penetration and thus phytoplankton productivity and algal growth, whereas further offshore it can load the water with inorganic suspended particles, which may affect the feeding and absorption efficiency of filter-feeders. The increase accurrence of turbidity plumes near the surface can also affect the feeding success of visual predators (Simmons 2005; Braby 2009; Peterson *et al.* 2001), For example, the foraging areas of African Penguins and Cape Gannets overlaps with the section of the cable crossing north of Robben Island (Grémillet *et al.* 2008; Campbell 2016) and suspended sediment plumes generated during cable installation could affect foraging success. However, due to the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and highly localised. Any biological effects on nectonic and planktonic communities would be negligible (Aldredge *et al.* 1986). Turbid water is a natural occurrence along the Southern African coast, resulting from aeolian and riverine inputs, resuspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones.

The impact of the sediment plume, however, is expected to be localised and temporary (only for the duration of pre-lay, construction and trenching activities below the low water mark). As the biota of sandy and rocky intertidal and subtidal habitats in the wave-dominated nearshore areas of southern Africa are well adapted to high suspended sediment concentrations, periodic sand deposition and resuspension, impacts are expected to occur at a sublethal level only. Considering the extended ranges ove which visual predators such as seabirds feed, localised suspended sediment plumes are not expected to effect their feeding efficiency in any way.

Rapid deposition of material from the water column and direct deposition of excavated sands on adjacent areas of seabed may result in the physical smothering of resident biota by the depositing sediments. Some mobile benthic animals inhabiting soft-sediments are capable of migrating vertically through more than 30 cm of deposited sediment (Maurer *et al.* 1979; Newell *et al.* 1998; Ellis 2000; Schratzberger *et al.* 2000a, 2000b). Sand inundation of shallow-water reef habitats was found to directly affect species diversity, whereby community structure and species richness appears to be controlled by the frequency, nature and scale of disturbance of the system by sedimentation (Seapy & Littler 1982; Littler *et al.* 1983; Schiel & Foster 1986, McQuaid & Dower 1990, Santos 1993, Airoldi & Cinelli 1997 amongst others). For example, frequent sand inundation may lead to the removal of grazers, thereby resulting in the proliferation of algae (Hawkins & Hartnoll 1983; Littler *et al.* 1983; Marshall & McQuaid 1989; Pulfrich *et al.* 2003a, 2003b; Pulfrich & Branch 2014).

Elevated suspended sediment concentrations due to trenching and burial activities associated with the subsea cable installation is deemed of low intensity and would extend locally around the subsea cable route and down-current of the shore-crossing, with impacts persisting only temporarily. Within the wave-base at least, marine biota are typically adapted to periods of elevated turbidity and as suspended sediment concentrations would remain at sub-lethal levels, the loss of resources would be low and impacts would be fully reversible. The impact is therefore assessed to be of **VERY LOW** significance without mitigation. As elevated suspended sediment concentrations are an unavoidable consequence of trenching activities, no direct mitigation measures, other than the no-project alternative, are possible. In the intertidal and shallow subtidal zone, impacts can however be kept to a minimum through responsible construction practices.

Reduced physiological functioning of marine organisms due to increased turbidity in surf zone as a result of excavations and mobilising of sediments		
Characteristic	**Impact**	**Residual Impact**
Intensity	Low	Low
Duration	Temporary; suspended sediment plumes will rapidly dissipate	Temporary
Extent	Local: limited to within a few metres of the subsea cable route, but with indirect effects on adjacent areas	Local
Frequency	Intermittent during trenching	Intermittent
Loss of resource	Low	Low
Probability	Possible	Possible
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.6 Physical Presence of Subsea Cable

Although the cable is typically only 25 mm – 375 mm in diameter, its presence and that of any protective steel sleeves or concrete mattresseseffectively reduces the area of seabed available for colonisation by macrobenthic infauna in seabed sediments. The subsea cable itself and any protective covering, however, would serve as an alternative substratum for colonising benthic communities or provide shelter for mobile invertebrates and demersal fish (Figure 33). Assuming that the hydrographical conditions around the subsea cable and repeaters would not be significantly different to those on the seabed, a similar community to that typically found on hard substrata in the area can be expected to develop over time. As offshore portions of the subsea cable will be located on unconsolidated sediments, biota developing on the structures would be different from the original soft sediment macrobenthic communities and the artificial reef effect is expected to be stronger than where cables are laid on top of or among natural rocky reefs (Taormina *et al.* 2018). The presence of subsea infrastructure (namely cable and repeaters) can therefore alter the community structure in an area, and effectively increase the availability of hard substrate for colonisation by sessile benthic organisms, thereby locally altering and increasing biodiversity and biomass (Grannis 2005; Kogan *et al.* 2006; Bicknell *et al.* 2019), potentially also attracting mobile macro- and megafauna who utilize the biofouling community as a food source. Where cable protections are of a different structure than the surrounding natural reef (e.g. concrete mattresses vs. boulders), different species assemblages and reef effects may result (Sheehan *et al.* 2018).

The composition of the fouling community on artificial structures depends on the age (length of time immersed in water) and the composition of the substratum, and usually differs somewhat from the communities of nearby natural rocky reefs (Connell & Glasby 1999; Connell 2001). In the intertidal and shallow subtidal habitats, colonisation of hard substratum goes through successional stages (Connell & Slayter 1977). Early successional communities are characterized by opportunistic algae (eg, *Ulva* sp., *Enteromorpha* sp.). These are eventually displaced by slower growing, long-lived species such as mussels, sponges and/or coralline algae, and mobile organisms, such as urchins and lobsters, which feed on the fouling community. With time, a consistent increase in biomass, cover and number of species can usually be observed (Bombace *et al.* 1994; Relini *et al.* 1994; Connell & Glasby 1999). Depending on the supply of larvae and the success of recruitment, the colonization process can take up to several years. For example, a community colonising concrete blocks in the Mediterranean was found to still be changing after five years with large algae and sponges in particular increasing in abundance (Relini *et al.* 1994). Other artificial reef communities, on the other hand, were reported to reach similar numbers of species (but not densities and biomass) to those at nearby natural reefs within eight months (Hueckel *et al.* 1989).

Figure 33: Subsea cables can provide alternative substratum for colonising benthic biota (left) and shelter for mobile invertebrates (right) (Source: www.digit.in/telecom/reliance-jio-launches-longest-100gbps-subsea-cable-system-aae-1-35827; www.farinia.com).

Studies investigating the abundance, diversity and size class structure of macrobenthos associated with oil platforms (Ellis *et al.* 1996) and marine renewable energy devices (Macleod *et al.* 2016; Want *et al.* 2017; Dannheim *et al.* 2019) concluded that differences in community structure of associated fauna were attributable to the physical presence of the subsea infrastructure, and the unique physical environment around each piece of infrastructure. Differences in epifaunal communities near the structures compared to far away were attributed to differences in food availability and predation. Mobile fish and invertebrates would be attracted by the shelter and food (biofouling organisms) provided by the underwater structures (Bull & Kendall 1994; Fechhelm *et al.* 2001; Copping & Hemery 2020 and references therein). Designated cable protection zones with suitable habitats may in fact help to maintain and improve biodiversity and species abundance, and therefore act as *de facto* marine reserves or sanctuaries (Shears & Usmar 2006), although this concept has yet to be proven.

The impacts on marine biodiversity through the physical presence of the subsea cable would be of medium intensity and highly localised along the cable itself. As the subsea cable would likely be left in place on the seabed beyond decommissioning of the project, its impacts would thus be permanent. No direct mitigation measures, other than the no-project alternative, are possible. The potential impacts on marine biota is consequently deemed to be of **LOW** significance without mitigation.

Physical presence of the subsea cable		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Medium
Duration	Permanent: cable will be left in place	Permanent
Extent	Site-specific: limited to the cable and repeaters	Site-specific
Frequency	Once-off	Once-off
Loss of resource	Low	Low
Probability	Definite	Definite
Reversibility	Partially reversible	Partially reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Very Low	

4.4.7 Other potential Impacts of Subsea Cable

Heat Dissipation

A subsequent effect of burying subsea cables in the sediment is the localized increase in temperature at the cable-sediment interface. While high and medium voltage seabed power transmission cables can emit heat, the voltage associated with telecommunication cables (for powering the repeaters) is very low, and any associated heat emissions are understood to be negligible. Although the potential consequences of this thermal radiation on benthic organisms has not yet been investigated *in situ*, the narrow footprint of the cables and the expected low temperature differences suggest that impacts are likely to be negligible (Heath 2001; Taormina *et al.* 2018 and references therein).

Sound Emmissions

Under normal operations, fibre optics cables do not emit any audible sound. During the laying of the cable it does vibrate as a result of regular vortex shedding as its descends through the water column. At ~10 Hz, this is a low frequency phenomenon and well below the hearing frequencies of marine fauna (see Table 12). Once the cable comes to rest on the seabed the sound ceases (Heath 2001).

In areas of high wave or current action on the continental shelf, cables can be exposed and undermined. Where undermining is significant, the suspended cable can vibrate or strum under the water motions (Carter *et al.* 2009). This sound would likewise be of low frequency and would not be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals. The sound is expected to attenuate rapidly to below ambient levels.

Electric and Electromagnetic fields

Fibreoptics cables carry a constant direct current of 1 - 1.6 Amps to power the underwater repeaters. This current is fed along the inner conductor and depending on the length of the cable span it may require several thousands of volts to maintain it. Typically half of the required voltage is applied at positive polarity to one end of the system and half the voltage at negative polarity to the other end, thereby establishing a zero voltage point midway along the cable span and reducing the level of voltage stress on the cable and repeaters. There is no external electric field associated with the power on the inner conductor as the polyethylene insulation ensures that the electric field remains only within the cable insulation (Heath 2001).

The direct current in the inner conductor does, however, set up a stationary magnetic field in the form of concentric rings emanating from the cable. The magnetizing force produced by this field diminishes with increasing radius from the cable such that at a distance of 1 m from the cable, the electromagnetic field (EMF) would be in the order of 0.32 micro Tesla. This is two orders of magnitude lower than the typical magnetic flux densities of the earth, which range from 30 microTesla at the equator to 60 microTesla at the magnetic poles. Animals with the capacity to detect and use constant geomagnetic fields are thus likely to only detect the signal within close proximity to the source (within centimetres) (Heath 2001; but see also Kraus & Carter 2015).

The marine environment is by no means devoid of electric and magnetic fields. An electrical current is generated (induced) in any conductor moving through a magnetic field (as per Faraday's Law). The geomagnetic field may thus also produce weak electric fields when, for example, an ocean current moves at right angles to it. Furthermore, all marine animals are electrical conductors as they continually generate internal voltage gradients and electrical currents as part of normal functions, sensory and motor mechanisms, reproductive processes, and membrane integrity. Organisms use internal electric potentials and signals for a wide variety of biological functions (e.g orientation or prey detection), and in some cases can perceive very small electric and magnetic fields. Perturbations from external electric and magnetic fields on such physiological systems need not necessarily have detrimental biological effects, as the magnitude of the effect will depend on the field intensities and exposure times to them, their frequency content, modulation, etc. Comprehensive descriptions on electromagnetism and its potential effects on marine organisms are provided in the reviews by Johnsson & Ramstad (2004) and Buchanan *et al.* (2006).

A wide variety of taxa are sensitive to electromagnetic fields and some examples are provided summarised from Johnsson & Ramstad (2004) and Buchanan *et al.* (2006) . Western Atlantic spiny lobsters (*Panulirus argus*), which undertake mass migrations, were found to orientate to the polarity of the Earth's field or to an induced magnetic field. Most species of salmon travel great distances from their natal streams to oceanic feeding grounds, and some (Pacific, Atlantic, Chinook, Sockeye) have been reported to orientate magnetically. While the electroreceptive sensitivity of sharks, skates, and rays is well established, and some studies have shown that these fishes can detect the Earth's geomagnetic field, empirical evidence that elasmobranchs use geotaxis to navigate is still lacking. There is strong evidence that turtle hatchings (at least loggerhead and leatherback sea turtles) and loggerhead juveniles use geomagnetic orientation to navigate long distances although there is little evidence that adults do the same. It has been theorized that cetaceans use geomagnetic information for orientation, with live strandings being attributed to areas where geomagnetic contour lines run perpendicular to shore, generally occurring 1-2 days after major geomagnetic storms.

Elasmobranchs and chimaerids are the taxa most likely to detect the electrical fields produced by fibre-optics cables because their electroreceptive organs are sensitive to stimuli in the very low frequency range from 0.125 Hz to 8.0 Hz. This may explain fibre-optic cable failures as a result of shark attacks in water depths of 1,060 – 1,900 m. Although the reasons for the attacks are uncertain, sharks may be encouraged by the electromagnetic fields, particularly from suspended cables that strum in the currents (Carter *et al.* 2009).

The injection of a low frequency electrical signal from the land station is known as 'toning' and is undertaken to aid in cable location in the event of a fault or when a safe distance needs to be kept from a cable during other marine work. The resultant proportion of current in the seawater, enables electrodes trailed from a ship to detect the cable by locating the maximum level of the tone. The level of the signal injected is usually 160 mA at 25 Hz. The attenuation of the cables at low frequency is such that a tone injected at the terminal should be detectable across most of the continental shelf by the electrodes whose threshold level of detection on electrodes is normally around 20mA. Toning has been used for many years on submarine cables throughout the world, and no adverse affects on marine life has been reported.

Leaching of Contaminants

Modern deep-water fibre-optic cables are composed of hair-like glass fibres, a copper power conductor and steel wire strength member, all of which are sheathed in high-density polyethylene. Where extra protection is required, as for areas of rocky seabed or strong wave and current action, additional steel wire armour is added. No anti-fouling agents are used. The cable-grade polyethylene used for the sheath is essentially inert in seawater. Oxidation, hydrolysis and mineralization processes for polyethylene are extremely slow, with the total conversion to carbon dioxide and water estimated to take centuries. The effects of ultraviolet light, the main cause of degradation in most plastics, are minimized through the use of light-stabilized materials, burial of the cable into the seabed and the natural reduction in light penetration through the photic zone. Where the cable is located on the energetic continental shelf and mechanical abbrasion of the cable's plastic sheathing by fine-grained particles is possible, the cable is either armoured or buried (Carter *et al.* 2009).

A study investigating potential leachates of copper, iron and zinc from the conductors and galvanized steel armour, identified that only zinc passed into the seawater, yielding concentrations of less than 6 mg/l for intact cables and less than 11 mg/l for cut cables with exposed wire armour ends[6]. The amount of leaching declined after ~10 days. Although this is above the recommended BCLME water quality guideline value of 5 µg/l (CSIR 2006), dilution of leachates by the surrounding water would be rapid and any negative effects on marine organisms are likely to be highly localised. Although zinc is an essential food element and occurs as Zn^{II} in dissolved form, it is listed amongst the 129 priority pollutants by the US Environmnetal Protection Agency as it can have lethal and sub-lethal effects at concentrations as low as 170 µg/l, particularly on the egg and larval stages of marine invertebrates.

Based on available information in the literature, the impacts on marine fauna through the generation of heat, sound, EMFs and leachates by the submarine cable would be of negligible intensity and highly localised along the cable itself. As the subsea cable would be in operation for up to 25 years, the impacts would persist over the long-term. No direct mitigation measures, other than the no-project alternative, are possible. The potential impacts on marine biota is consequently deemed to be of **VERY LOW** significance without mitigation.

6 Tests were carried out in a small, finite volume of seawater (Collins 2007)

Mitigation Measures

No mitigation other than the no-go option is deemed feasible or necessary.

Heat, Sound, Electromagnetic fields and leaching of contaminats from thesubsea cable		
Characteristic	**Impact**	**Residual Impact**
Intensity	Negligible	Negligible
Duration	Long-term: for the life time of the cable	Long-term
Extent	Site-specific: limited to the cable and repeaters	Site-specific
Frequency	Intermittent (Leaching) to Continuous (heat, EMF)	Intermittent to Continuous
Loss of resource	Low	Low
Probability	Improbable	Improbable
Reversibility	Fully reversible	Fully reversible
Significance of Impact	**VERY LOW**	**VERY LOW**
Confidence	High	
Mitigation Potential	None	

4.5. Decommissioning Phase

No decommissioning procedures have been developed at this stage. In the case of decommissioning the cable will most likely be left in place. The potential impacts during the decommissioning phase are thus expected to be minimal in comparison to those occurring during the installation phase.

4.6. Unplanned Events

4.6.1 Pollution and Accidental Spills

Trenching during installation of the shore-crossing of the subsea cable will involve excavation and construction activities. There would thus be potential for or accidental spillage or leakage of fuel, chemicals or lubricants, litter, inappropriate disposal of human wastes and general degradation of ecosystem health on the shoreline. Any release of liquid hydrocarbons has the potential for direct, indirect and cumulative effects on the marine environment through contamination of the water and/or sediments. These effects include physical oiling and toxicity impacts to marine fauna and flora, localised mortality of plankton, pelagic eggs and fish larvae, and habitat loss or contamination (CSIR 1998; Perry 2005). Many of the compounds in petroleum products have been known to smother organisms, lower fertility and cause disease in aquatic organisms. Hydrocarbons are incorporated into sediments through attachment to fine-grained particles, sinking and deposition in low turbulence areas. Due to differential uptake and elimination rates, filter-feeders, particularly mussels, can bioaccumulate organic (hydrocarbons) contaminants (Birkeland *et al.* 1976).

During construction, litter can enter the marine environment. Inputs can be either direct by discarding garbage into the sea, or indirectly from the land when litter is blown into the water by wind. Marine litter is a cosmopolitan problem, with significant implications for the environment and human activity all over the world. Marine litter travels over long distances with ocean currents and winds. It originates from many sources and has a wide spectrum of environmental, economic, safety, health and cultural impacts. It is not only unsightly, but can cause serious harm to marine organisms, such as turtles, birds, fish and marine mammals. Considering the very slow rate of decomposition of most marine litter, a continuous input of large quantities will result in a gradual increase in litter in coastal and marine environment. Suitable waste management practices should thus be in place to ensure that littering is avoided.

Potential hydrocarbon spills and pollution in the intertidal and shallow subtidal zone during installation of the subsea cable are deemed of medium intensity within the immediate vicinity of the construction site, with impacts persisting over the short- to medium-term. Impacts of pollution and accidental spills would be direct, indirect and cumulative. As the some of the coastal habitats in the immediate vicinity of the shore-crossing have been identified as 'endangered' (Kuiseb Mixed Shore) the loss of resources could potentially be medium, with impacts being only partially reversible in the worst-case scenario. Pollution and accidental spills on the shoreline during the construction phase is probable and the impact is therefore assessed to be of **MEDIUM** significance.

Mitigation Measures

The recommended mitigation measures for the construction phase of the proposed Equiano cable installation are:

- Keep heavy vehicle traffic associated with construction in the coastal zone to a minimum.
- Restrict vehicles to clearly demarcated access routes and construction areas only. These should be selected under guidance of the local municipality.
- Conduct a comprehensive environmental awareness programme amongst contracted construction personnel, emphasising compliance with relevant provincial and national legislation and the EMPr, pollution control and minimising construction impacts to the intertidal habitat and associated communities.
- For equipment maintained in the field, oils and lubricants must be contained and correctly disposed of off-site.
- Maintain vehicles and equipment to ensure that no oils, diesel, fuel or hydraulic fluids are spilled.
- There is to be no vehicle maintenance or refuelling on beach.
- Vehicles should have a spill kit (peatsorb/ drip trays) onboard in the event of a spill to ensure that all accidental diesel and hydrocarbon spills are cleaned up accordingly.
- No mixing of concrete in the intertidal zone.
- Regularly clean up concrete spilled during construction.
- No dumping of construction materials, excess concrete or mortar in the intertidal and subtidal zones or on the sea bed.
- Ensure regular collection and removal of refuse and litter from intertidal areas.
- Good housekeeping must form an integral part of any construction operations on the beach from start-up.

- All construction activities in the coastal zone must be managed according to a strictly enforced EMPr.
- After completion of construction activities remove all artificial constructions or created shore modifications from above and within the intertidal zone. No accumulations of excavated intertidal sediments should be left above the high water mark, and any substantial sediment accumulations below the high water mark should be levelled.

If these mitigation measures are implemented, all residual impacts are expected to be of low significance.

Accidental spillage or leakage of fuel, chemicals or lubricants, cement and disposal of litter may cause water or sediment contamination and/or disturbance to intertidal and subtidal biota		
Characteristic	**Impact**	**Residual Impact**
Intensity	Medium	Low
Duration	Short- to Medium-term	Short-term
Extent	Site-specific: limited to the cable and repeaters	Site-specific
Frequency	Intermittent	Once-off
Loss of resource	Medium	Low
Probability	Probable	Possible
Reversibility	Partially reversible	Fully reversible
Significance of Impact	**MEDIUM**	**LOW**
Confidence	High	
Mitigation Potential	High	

4.6.2 Collisions with and entanglement by Marine Fauna

Vessel traffic can affect large cartilaginous fish species, turtles and marine mammals by direct collisions or propeller injuries. The potential effects of vessel presence on turtles and cetaceans include behavioural disturbance, physiological injury or mortality.

Collisions between cetaceans and vessels are not limited to survey or cable laying vessels. In areas of heavy ship traffic, whales and dolphins can experience propeller or collision injuries, with most of these injuries caused by fast moving vessels. Injuries and deaths resulting from direct ship collisions represent a significant threat to several whale populations (Laist *et al.* 2001; Jensen & Silber 2003). All types and sizes of vessels hit whales, but most lethal and serious injuries are caused by larger vessels and most vessel strikes occur on the continental shelf and when vessels were doing in excess of 10 knots (Laist *et al.* 2001).

During acquisition of swath bathymetry, the survey vessel typically travels at a speed of around 6 knots. Depending on the onboard equipment and types of ploughs used, prevailing sea conditions as well as the nature of the seabed, subsea cable vessels can lay 100-150 km of cable per day, with modern ships and ploughs achieving up to 200 km of cable laying per day (www.independent.co.uk>science). This equates to a vessel speed of between 2.3 – 4.5 knots. Once the cable has reached the seabed, the ship can increase its speed to 6-8 knots, slowing only to pass repeaters and amplifiers through the machinery that controls cable tension and pay-out speed

(Carter *et al.* 2009). The pre-laying grapnel run is typically conducted at 0.5 knots; and vessels will maintain the same speed when plough-burying cable. Given the slow speed of the vessels during surveying, the pre-lay grapnel run and the cable installation, ship strikes with marine mammals and turtles are unlikely, and should the impact occur it would be very infrequent.

Ship strikes have been reported to result in medium-term effects such as evasive behaviour by animals experiencing stress, or longer-term effects such as decreased fitness or habitual avoidance of areas where disturbance is common and in the worst case death (see for example Constantine 2001; Hastie *et al.* 2003; Lusseau 2004, 2005; Bejder *et al.* 2006; Lusseau *et al.* 2009). Ship strikes have been documented from many regions and for numerous species of whales (Panigada *et al.* 2006; Douglas *et al.* 2008; Elvin & Taggart 2008) and dolphins (Bloom & Jager 1994; Elwen & Leeney 2010), with large baleen whales being particularly susceptible to collision.

Entanglement of whales with old telegraph cables occurred during the telegraph era (1850s to 1950s) at sites where cables had been repaired on the edge of the continental shelf or on the adjacent continental slope in water depths down to 1,135 m. With improved design, laying and maintenance techniques,sincedevelopment of the coaxial submarine cables in the 1950s and into the fibre-optic era in the early 1980s, no further entanglements with marine mammals have been recorded (Wood & Carter 2008). As the cable would be under constant tension during installation, entanglements are highly unlikely and once on the seabed, the weight of the cable and torsional balance will prevent coils and loops (Carter *et al.* 2009). Furthermore, as the cable would be buried along much of its length on the continental shelf, entanglements are highly unlikely.

As much of the cable would be installed in the offshore marine environment, the strong operational lighting used to illuminate the survey and cable vessels may disturb and disorientate pelagic seabirds feeding in the area. Operational lights may also result in physiological and behavioural effects of fish and cephalopods as these may be drawn to the lights at night where they may be more easily preyed upon by other fish and seabirds. The response of marine organisms to artificial lights can vary depending on a number of factors such as the species, life stage and the intensity of the light. Considering the extensive distributions and low numbers of pelagic seabirds likely to be encountered in the offshore environment, the olikelihood of collisions would be low.

In the event of a collision or entaglement, the impact is deemed of low intensity and would be site specific to the vessel/cable location. Injury through collision and/or entanglement would persist over the short term and considering the slow vessel speed would likely remain at sub-lethal levels. Although this direct impact could result in a medium loss of resources, the impact is assessed to be of **LOW** significance without mitigation.

Mitigation Measures

The recommended mitigation measures for the installation phase of the proposed Equiano subsea cable are:

- Give consideration for the subsea cable-laying vessels to accommodate dedicated independent Marine Mammal Observers (MMOs) with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the subsea cable route and record incidence of marine mammals, and their responses to vessel activities. Data collected should include position, distance from the vessel, swimming speed and direction, and obvious changes in behaviour (eg, startle responses or changes in surfacing/diving frequencies, breathing patterns). Both the identification and the behaviour of the animals must be recorded accurately.

- Alternatively, relevant vessel staff trained in seabird, turtle and marine mammal identification and observation techniques should be assigned for observation, distance estimation and reporting, to perform marine mammal observations and notifications.

Collions with and Entanglement by Marine Fauna		
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Site-specific: limited to around the vessel	Site-specific
Frequency	Once-off	Once-off
Loss of resource	Medium	Low
Probability	Improbable	Improbable
Reversibility	Partially reversible	Fully reversible
Significance of Impact	**LOW**	**LOW**
Confidence	High	
Mitigation Potential	Medium	

5. ENVIRONMENTAL STATEMENT AND CONCLUSIONS

5.1. Environmental Statement

Installation of the cable will potentially result in localised disturbance of the upper beach and intertidal and shallow subtidal sandy habitats, as well as unconsolidated seabed beyond the surf zone and across the shelf. Most potentially negative impacts were rated as being of low significance, with only pollution and accidental spills during construction rated as medium significance. As recovery of marine communities over the short- to medium-term can be expected, residual impacts were all considered minor.

5.2. Management Recommendations

From the marine ecology assessment in Chapter 4, certain recommendations can be put forward as how best to manage potential impacts to the marine environment of the proposed installation of the subsea cable. These include:

- Plan routing of proposed cable to as far as practicably possible avoid sensitive benthic habitats in the coastal and nearshore zone.
- Keep heavy vehicle traffic associated with construction and cable installation in the coastal zone to a minimum.
- Restrict vehicles to clearly demarcated access routes and construction areas only. These should be selected under guidance of the local municipality.
- Conduct a comprehensive environmental awareness programme amongst contracted construction personnel, emphasising compliance with relevant provincial and national legislation and the EMPr, pollution control and minimising construction impacts to the intertidal habitat and associated communities.
- For equipment maintained in the field, oils and lubricants must be contained and correctly disposed of off-site.
- Maintain vehicles and equipment to ensure that no oils, diesel, fuel or hydraulic fluids are spilled.
- There is to be no vehicle maintenance or refuelling on the beach.
- Vehicles should have a spill kit (peatsorb/ drip trays) onboard in the event of a spill to ensure that all accidental diesel and hydrocarbon spills are cleaned up accordingly.
- No mixing of concrete in the intertidal zone.
- Regularly clean up concrete spilled during construction.
- No dumping of construction materials, excess concrete or mortar in the intertidal and subtidal zones or on the sea bed.
- Ensure regular collection and removal of refuse and litter from intertidal areas.
- Good housekeeping must form an integral part of any construction operations on the beach from start-up.

- All construction activities in the coastal zone must be managed according to a strictly enforced EMPr.
- After completion of construction activities remove all artificial constructions or created shore modifications from above and within the intertidal zone. No accumulations of excavated intertidal sediments should be left above the high water mark, and any substantial sediment accumulations below the high water mark should be levelled.
- Give consideration for the subsea cable-laying vessels to accommodate dedicated independent MMOs with experience in seabird, turtle and marine mammal identification and observation techniques, to carry out daylight observations of the subsea cable route and record incidence of marine mammals, and their responses to vessel activities. Data collected should include position, distance from the vessel, swimming speed and direction, and obvious changes in behaviour (eg, startle responses or changes in surfacing/diving frequencies, breathing patterns). Both the identification and the behaviour of the animals must be recorded accurately.
- Alternatively, relevant vessel staff trained in seabird, turtle and marine mammal identification and observation techniques should be assigned for observation, distance estimation and reporting, to perform marine mammal observations and notifications.

5.3. Conclusions

If all environmental guidelines and appropriate management and monitoring recommendations advanced in this report are implemented, there is no reason why the proposed installation of the Equiano fibre optics cable should not proceed.

6. LITERATURE CITED

AIROLDI, L. & F. CINELLI, 1997. Effects of sedimentation on subtidal macroalgal assemblages: an experimental study from a Mediterranean rocky shore. *Journal of Experimental Marine Biology & Ecology* **215**: 269-288.

ALDREDGE, A.L., M. ELIAS & C.C. GOTSCHALK, 1986. Effects of drilling muds and mud additives on the primary production of natural assemblages of marine phytoplankton. *Mar. Environ. Res.* **19**: 157-176.

ATKINSON, L.J., 2009. Effects of demersal trawling on marine infaunal, epifaunal and fish assemblages: studies in the southern Benguela and Oslofjord. PhD Thesis. University of Cape Town, pp 141.

B-4 ENGINEERING & DIVING, 2014. Transect Line Survey Report, 22 September 2014. Conducted as part of the baseline for the Environmental Impact Assessment for Rössing Uranium's proposed Desalination Plant near Swakopmund.

BAILEY, G.W., BEYERS, C.J. DE B. and S.R. LIPSCHITZ, 1985. Seasonal variation of oxygen deficiency in waters off southern South West Africa in 1975 and 1976 and its relation to catchability and distribution of the Cape rock-lobster *Jasus lalandii*. *S. Afr. J. Mar. Sci.*, **3**: 197-214.

BAILEY G.W. and P. CHAPMAN, 1991. Chemical and physical oceanography. In: Short-term variability during an Anchor Station Study in the southern Benguela Upwelling system. *Prog. Oceanogr.*, **28**: 9-37.

BALLY, R., McQUAID, C.D. & A.C. BROWN, 1984. Shores of mixed sand and rock: an unexplored marine ecosystem. South African Journal of Science 80, 500-503.

BANKS, A. BEST, P.B., GULLAN, A., GUISSAMULO, A., COCKCROFT, V. and K. FINDLAY, 2011. Recent sightings of southern right whales in Mozambique. Document SC/S11/RW17 submitted to IWC Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

BARENDSE, J., BEST, P.B., THOMTON, M., POMILLA, C. CARVALHO, I. and H.C. ROSENBAUM, 2010. Migration redefined ? Seasonality, movements and group composition of humpback whales *Megaptera novaeangliae* off the west coast of South Africa. *Afr. J. mar. Sci.*, **32(1)**: 1-22.

BARENDSE, J., BEST, P.B., THORNTON, M., ELWEN, S.H., ROSENBAUM, H.C., CARVALHO, I., POMILLA, C., COLLINS, T.J.Q. and M.A. MEŸER, 2011. Transit station or destination? Attendance patterns, regional movement, and population estimate of humpback whales *Megaptera novaeangliae* off West South Africa based on photographic and genotypic matching. *African Journal of Marine Science*, **33(3)**: 353-373.

BARNARD, P., 1998. *Biological diversity in Namibia - a country study*. Namibian National Biodiversity Task Force, Windhoek.

BEJDER, L., SAMUELS, A., WHITEHEAD, H. & N. GALES, 2006. Interpreting short-term behavioral responses to disturbance within a longitudinal perspective. *Animal Behavior* 72: 1149-1158.

BARTHOLOMAE, C.H. & A.K.,VAN DER PLAS 2007. Towards the development of environmental indices for the Namibian shelf, with particular reference to fisheries management. African Journal of Marine Science 29, 25-35.

BERG, J.A. and R.I.E. NEWELL, 1986. Temporal and spatial variations in the composition of seston available to the suspension-feeder *Crassostrea virginica*. *Estuar. Coast. Shelf. Sci.*, **23**: 375–386.

BEST, P.B., 2001. Distribution and population separation of Bryde's whale *Balaenoptera edeni* off southern Africa. *Mar. Ecol. Prog. Ser.*, 220: 277 – 289.

BEST, P.B., 2007. Whales and Dolphins of the Southern African Subregion. Cambridge University Press, Cape Town, South Africa.

BEST, P.B. and C. ALLISON, 2010. Catch History, seasonal and temporal trends in the migration of humpback whales along the west coast of southern Africa. IWC sc/62/SH5.

BEST, P.B. and C.H. LOCKYER, 2002. Reproduction, growth and migrations of sei whales *Balaenoptera borealis* off the west coast of South Africa in the 1960s. *South African Journal of Marine Science*, **24**: 111-133.

BEST P.B., MEŸER, M.A. & C. LOCKYER, 2010. Killer whales in South African waters – a review of their biology. *African Journal of Marine Science*. **32**: 171–186.

BETT, B.J. & A.L. RICE, 1992. The influence of hexactinellid sponge (Pheronema carpenteri) spicules on the patchy distribution of macrobenthos in the porcupine seabight (bathyal ne atlantic). *Ophelia* 36: 217–226.

BEYERS C.J. De B., 1979. Stock assessment and some morphometric and biological characteristics of the rock-lobster Jasus lalandii on Marshall Rocks, its main commercial fishing area off South West Africa, 1971-1974. Investigational Report of the Sea Fisheries Branch, South Africa 117, 1-26.

BEYERS, C.J. DE B., WILKE, C.G. & P.C GOOSEN, 1994. The effects of oxygen deficiency on growth, intermoult period, mortality and ingestion rates of aquarium-held juvenile rock lobster *Jasus lalandii*. South African Journal of Marine Science 14, 79-88.

BIANCHI, G., CARPENTER, K.E., ROUX, J.-P., MOLLOY, F.J., BOYER, D., BOYER, H.J., 1999. FAO species identification guide for fishery purposes. Field guide to the Living Marine Resources of Namibia, 256 pp.

BIANCHI, G., HAMUKUAYA, H. and O. ALVHEIM, 2001. On the dynamics of demersal fish assemblages off Namibia in the 1990s. *South African Journal of Marine Science* 23: 419-428.

BICCARD, A., CLARK, B.M. & E.A. BROWN, 2016. De Beers Marine Namibia Environmental Monitoring Programme in the Atlantic 1 Mining Licence Area: 2014 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1527/4.

BICCARD, A., CLARK, B.M., BROWN, E.A., DUNA, O., MOSTERT, B.P., HARMER, R.W., GIHWALA, K. & A.G. WRIGHT, 2017. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2015 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1527/4.

BICCARD A, GIHWALA K, CLARK BM, HARMER RW, BROWN EA, MOSTERT BP, WRIGHT AG & A MASOSONKE. 2018. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2016 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1726/1.BIRCH G.F., ROGERS J., BREMNER J.M. and G.J. MOIR, 1976. Sedimentation controls on the continental margin of Southern Africa. *First Interdisciplinary Conf. Mar. Freshwater Res. S. Afr.*, Fiche 20A: C1-D12.

BICCARD, A., K. GIHWALA, B.M. CLARK, E.A. BROWN, B.P. MOSTERT, A. MASOSONKE, C. SWART, S. SEDICK, B. TSHINGANA and J. DAWSON, 2019. De Beers Marine Namibia Environmental Monitoring Programme: Atlantic 1 Mining Licence Area 2017 Benthic Sampling Campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1775/1.

BICKNELL, A.W.J., SHEEHAN, E.V., GODLEY, B.J., DOHERTY, P.D. & M.J. WITT, 2019. Assessing the impact of introduced infrastructure at sea with cameras: A case study for spatial scale, time and statistical power. *Marine Environmental Research,* 147, 126-137.

BIRCH G.F., ROGERS J., BREMNER J.M. and G.J. MOIR, 1976. Sedimentation controls on the continental margin of Southern Africa. *First Interdisciplinary Conf. Mar. Freshwater Res. S. Afr.*, Fiche 20A: C1-D12.

BIRKELAND, C., REIMER, A.A. & J.R. YOUNG, 1976. Survey of marine communities in Panama and experiments with oil. US EPA Research Series, 600/3-76-028.

BLABER, S.J.M. and T.G. BLABER, 1980. Factors affecting the distribution of juvenile estuarine and inshore fish. *J. Fish Biol.,* 17: 143-162.

BLOOM, P. & M. JAGER, 1994. The injury and subsequent healing of a serious propeller strike to a wild bottlenose dolphin (*Tursiops truncatus*) resident in cold waters off the Northumberland coast of England. *Aquatic Mammals*, 20(2: 59-64.

BOMBACE, G., FABI, G., FIORENTINI, L. & S. SPERANZA, 1994. Analysis of the efficacy of artificial reefs located in five different areas of the Adriatic Sea. *Bulletin of Marine Science* **55**: 559-580.

BOYD, A..J. and G.P.J. OBERHOLSTER, 1994. Currents off the west and south coasts of South Africa. *S. Afr. Shipping News and Fish. Ind. Rev.*, **49**: 26-28.

BOYER, D. & H. BOYER 2015. Albatrosses, White-chinned Petrel and Northern Giant-Petrel. In: SIMMONS, R.E., BROWN, C.J. and J. KEMPER (eds). *Birds to watch in Namibia: red, rare and endemic species*. National Biodiversity Programme, Windhoek, Namibia

BRABY, J., 2009. The Damara Tern in the Sperrgebiet: Breeding productivity and the impact of diamond mining. Unpublished report to Namdeb Diamond Corporation (Pty) Ltd.

BRANCH, G.M., 1981. The biology of limpets: physical factors, energy flow and ecological interactions. Oceanography & Marine Biology: An Annual Review 19, 235-380.

BRANCH, G.M. and M. BRANCH, 1981. The Living Shores of Southern Africa. Struik. Cape Town, South Africa.

BRANCH, G.M. and C.L. GRIFFITHS, 1988. The Benguela ecosystem part V: the coastal zone. *Oceanog. Marine Biology: An Annual Rev*iew, **26**: 395-486.

BRANDÃO, A., VERMEULEN, E., ROSS-GILLESPIE, A., FINDLAY, K. & D.S. BUTTERWORTH, 2018. Updated application of a photo-identification based assessment model to southern right whales in South African waters, focussing on inferences to be drawn from a series of appreciably lower counts of calving females over 2015 to 2017. Paper Sc/67B/SH/22 submitted to the scientific Committee of the International Whaling Commission, Bled, Slovenia, May 2018

BREEZE, H., DAVIS, D.S. BUTLER, M. and V. KOSTYLEV, 1997. Distrbution and status of deep sea corals off Nova Scotia. Marine Issues Special Committee Special Publication No. 1. Halifax, NS: Ecology Action Centre. 58 pp.

BROWN, A.C. & F.J. ODENDAAL, 1994. The biology of Oniscid Isopoda of the genus *Tylos*. *Adv. Mar. Biol.*, **30**: 89-153.

BRICELJ, V.M. and R.E. MALOUF, 1984. Influence of algal and suspended sediment concentrations on the feeding physiology of the hard clam *Mercenaria mercenari*a. *Mar. Biol.*, **84**: 155–165.

BRÜCHERT, V., BARKER JØRGENSEN, B., NEUMANN, K., RIECHMANN, D., SCHLÖSSER M. & H. SCHULZ, 2003. Regulation of bacterial sulfate reduction and hydrogen sulfide fluxes in the central Namibian coastal upwelling zone. Geochim. Cosmochim. Acta 67(23), 4505-4518.

BUCHANAN, R.A., R. FECHHELM, J. CHRISTIAN, V.D. MOULTON, B.D. MACTAVISH, R. PITT & S. CANNING. 2006. Orphan Basin controlled source electromagnetic survey program environmental assessment. LGL Rep. SA899. Rep. by LGL Limited and Canning & Pitt Associates Inc., St. John's, NL, for ExxonMobil Canada Ltd., St. John's, NL. 128 p. + appendices.

BULL, A.S. & J.J. KENDALL, Jr., 1994. An indication of the process: offshore platforms as artificial reefs in the Gulf of Mexico. *Bull. Mar. Sci.* **55**: 1086-1098.

BURKHARDT, E., BOEBEL, O., BORNEMANN, H. & C. RUHOLL, 2008. Risk assessment of scientific sonars. Bioacoustics;17(1–3): 235–7.

CAMPBELL, K., 2016. Factors influencing the foraging behaviour of African Penguins (*Spheniscus demersus*) provisioning chicks at Robben Island, South Africa. PhD Thesis, University of Cape Town, pp258.

CARR, A., 1987. Impact of non-degradable marine debris on the ecology and survival outlook of sea turtles. Marine Pollution Bulletin. 18: 352-356.

CARTER, L., BURNETT, D., DREW, S., MARLE, G., HAGADORN, L., BARTLETT-MCNEIL, D. & N. IRVINE, 2009. Submarine Cables and the Oceans – Connecting the World. UNEP-WCMC Biodiversity Series No. 31. ICPC/UNEP/UNEP-WCMC.

CHAPMAN, P. and L.V. SHANNON, 1985. The Benguela Ecosystem. Part II. Chemistry and related processes. *Oceanogr. Mar. Biol. Ann. Rev.*, **23**: 183-251.

CHILD, M.F., ROXBURGH, L., DO LINH SAN, E., RAIMONDO, D. and H.T. DAVIES-MOSTERT, (editors). 2016. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa (https://www.ewt.org.za/Reddata/Order%20Cetacea.html).

CHILDERHOUSE, S. & L. DOUGLAS, 2016. Information Document: Review of multibeam echosounder surveys and potential impacts on marine mammals, Document Reference Number: BPM-16-MDC-Review of multibeam echosounder surveys and marine mammals v1.2.

CHRISTIE, N.D., 1974. Distribution patterns of the benthic fauna along a transect across the continental shelf off Lamberts Bay, South Africa. Ph.D. Thesis, University of Cape Town, 110 pp and Appendices.

CHRISTIE, N.D., 1976. A numerical analysis of the distribution of a shallow sublittoral sand macrofauna along a transect at Lambert's Bay, South Africa. *Transactions of the Royal Society of South Africa*, **42**: 149-172.

CLARK, B.M., 1997a. Variation in surf zone fish community structure across a wave exposure gradient. *Estuarine and Coastal Shelf Science* **44**: 659-674.

CLARK, B.M., 1997b. Dynamics and Utilisation of Surf Zone Habitats by Fish in the South-Western Cape, South Africa. Unpublished PhD Thesis, University of Cape Town.

CLARK, B.M., ATKINSON, L.J., PULFRICH, A., 2005. Sandy Beach and Rocky Intertidal Monitoring Studies in the Bogenfels Mining Licence Area, Namibia. Monitoring Report 2005. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia.

CLARK, B.M., ATKINSON, L.J., STEFFANI, N., PULFRICH, A., 2004. Sandy Beach and Rocky Intertidal Baseline Monitoring Studies in the Bogenfels Mining Licence Area, Namibia. Monitoring Report 2004. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia.

CLARK, B.M., NEL, R., 2002. Baseline survey of sandy beaches in Mining Area 1. Unpublished Report, NAMDEB Diamond Corporation.

CLARK, B.M., PULFRICH, A., ATKINSON, L.J., 2006. Sandy Beach and Rocky Intertidal Monitoring Studies in the Bogenfels Mining Licence Area, Namibia. Monitoring Report 2006. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia. 133pp.

CLARK, B.M., BENNETT, B.A. and S.J. LAMBERTH, 1994. A comparison of the ichthyofauna of two estuaries and their adjacent surf-zones, with an assessment of the effects of beach-seining on the nursery function of estuaries for fish. *South African Journal of Marine Science* **14**: 121-131.

COCKCROFT, A.C, SCHOEMAN, D.S., PITCHER, G.C., BAILEY, G.W.AND D.L. VAN ZYL, 2000. A mass stranding, or 'walk out' of west coast rock lobster, *Jasus lalandii*, in Elands Bay, South Africa: Causes, results and implications. In: VON VAUPEL KLEIN, J.C.and F.R. SCHRAM (Eds), *The Biodiversity Crisis and Crustacea: Proceedings of the Fourth International Crustacean Congress*, Published by CRC press.

COLEY, N.P. 1994. Environmental impact study: Underwater radiated noise. Institute for Maritime Technology, Simon's Town, South Africa. pp. 30.

COLEY, N.P. 1995. Environmental impact study: Underwater radiated noise II. Institute for Maritime Technology, Simon's Town, South Africa. pp. 31.

COMPAGNO, L.J.V., EBERT, D.A. and P.D. COWLEY, 1991. Distribution of offshore demersal cartilaginous fish (Class Chondrichthyes) off the West Coast of southern Africa, with notes on their systematics. *S. Afr. J. Mar. Sci.* 11: 43-139.

CONNELL, S.D., 2001. Urban structures as marine habitats: an experimental comparison of the composition and abundance of subtidal epibiota among pilings, pontoons and rocky reefs. *Marine Environmental Research* **52**: 115-125.

CONNELL, S.D. & T.M. GLASBY, 1999. Do urban structures influence local abundance and diversity of subtidal epibiota? A case study from Sydney Harbour. *Marine Environmental Research* **47**: 373-387.

CONNELL, S.D. & R.O. SLAYTER, 1977. Mechanisms of succession in natural communities and their role on community stability and organisation. *American Naturalist* **111**: 1119-1144.

CONSTANTINE, R., 2001. Increased avoidance of swimmers by wild bottlenose dolphins (Tursiops truncatus) due to long-term exposure to swim-with-dolphin tourism. *Marine Mammal Science* 17: 689-702.

COPPING, A. & L. HEMERY, 2020. OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World. **Ocean Energy Systems (OES).**

COWI, 2003. Walvis Bay Local Agenda 21 Project. Coastal area study. Intensive monitoring campaign. Municipality of Walvis Bay, Danida and COWI Consulting Engineers. April 2003.

CRAWFORD, R.J.M., SHANNON, L.V. & D.E. POLLOCK, 1987. The Benguela ecosystem. 4. The major fish and invertebrate resources. *Oceanogr. Mar. Biol. Ann. Rev.*, **25**: 353 - 505.

CROFT, B. & B. Li, 2017. Shell Namibia Deepwater Exploration Drilling: Underwater Noise Impact Assessment. Prepared by SLR Consulting Australia Pty Ltd. for SLR Consulting (Cape \Town) Pty Ltd. 19pp.

CRUIKSHANK, R.A., 1990. Anchovy distribution off Namibia deduced from acoustic surveys with an interpretation of migration by adults and recruits. *S. Afr. J. Mar. Sci.*, **9**: 53-68.

CSIR, 1989. A Study of Some of the Physical and Biotic Processes Affecting Dredging within the Walvis Bay Lagoon. Stellenbosch. CSIR Report EMA-C 891009.

CSIR, 1992. Sedimentation History and Present State of the Walvis Bay Lagoon. Stellenbosch. CSIR Report EMAS-C 92040 (Unpublished). 92pp.

CSIR, 1996. Elizabeth Bay monitoring project: 1995 review. *CSIR Report ENV/S-96066.*

CSIR, 1998. Environmental Impact Assessment for the Proposed Exploration Drilling in Petroleum Exploration Lease 17/18 on the Continental Shelf of KwaZulu-Natal, South Africa. CSIR Report ENV/S-C 98045.

CSIR, 2002. A decision support tool: Operational time for the Namdeb inshore mining project. CSIR Report ENV-S-C 2002-120.

CSIR, 2005. Sedimentation of the Small-Craft Harbour at Swakopmund. CSIR Report ENV-S-C 2005-004, submitted to Desert Child and Windhoek Consulting Engineers, April 2005.

CSIR, 2009. Marine Environmental Impact Assessment for the Seawater Intake Structure and Brine Disposal System of the Proposed Desalination Plant North of Swakopmund. Prepared for Namwater.

CURRIE, H., GROBLER, K., KEMPER, J., (eds) 2009. Namibian Islands' Marine Protected Area. Ministry of Fisheries and Marine Resources, Namibia. http://www.nacoma.org.na/ key_Activities/Marine Protected Areas.htm.

DALY, M.A., MATHIESON, A.C., 1977. The effects of sand movements on intertidal seaweeds and selected invertebrates at Bound Rock, New Hampshire. Marine Biology 43, 45-55.

DANNHEIM, J., BERGSTRÖM, L., BIRCHENOUGH, S.N.R., BRZANA, R., BOON, A.R., COOLEN, J.W.P., DAUVIN, J.-C., DE MESEL, I., DERWEDUWEN, J., GILL, A.B., HUTCHISON, Z.L., JACKSON, A.C., JANAS, U., MARTIN, G., RAOUX, A., REUBENS, J., ROSTIN, L., VANAVERBEKE, J., WILDING, T.A., WILHELMSSON, D. & S. DEGRAER, 2019. Benthic effects of offshore renewables: identification of knowledge gaps and urgently needed research. *ICES Journal of Marine Science*

DAVID, J.H.M, 1989., Seals. In: Oceans of Life off Southern Africa, Eds. Payne, A.I.L. and Crawford, R.J.M. Vlaeberg Publishers. Halfway House, South Africa.

DE DECKER, A.H., 1970. Notes on an oxygen-depleted subsurface current off the west coast of South Africa. *Invest. Rep. Div. Sea Fish. South Africa*, **84**, 24 pp.

DEFEO, O. & A. McLACHLAN, 2005. Patterns, processes and regulatory mechanisms in sandy beach macrofauna: a multi-scale analysis. Marine Ecology Progress Series 295, 1-20.

DE ROCK, P., ELWEN, S.H., ROUX, J-P., LEENEY, R.H., JAMES, B.S., VISSER, V., MARTIN, M.J. & T. GRIDLEY, 2019. Predicting large-scale habitat suitability for cetaceans off Namibia using MinxEnt. *Marine Ecology Progress Series*, 619: 149-167.

DESPREZ, M., 2000. Physical and biological impact of marine aggregate extraction along the French coast of the Eastern English Channel: short-and long-term post-dredging restoration. *ICES Journal of Marine Science* **57**: 1428–1438.

DETHIER, M.N., 1984. Disturbance and recovery in intertidal pools: maintenance of mosaic patterns. Ecological Monographs 54, 99-118

DINGLE, R.V., 1973. The Geology of the Continental Shelf between Lüderitz (South West Africa) and Cape Town with special reference to Tertiary Strata. *J. Geol. Soc. Lond.*, **129**: 337-263.

DONN, T.E. & A.C.COCKCROFT, 1989. Macrofaunal community structure and zonation of two sandy beaches on the central Namib coast, South West Africa/Namibia. Madoqua 16, 129-135.

DOUGLAS, A.B., CALAMBOKIDIS, J., RAVERTY, S., JEFFRIES, S.J., LAMBOURN, D.M.& S.A. NORMA, 2008. Incidence of ship strikes of large whales in Washington State. J*ournal of the Marine Biological Association of the United Kingdom* 88: 1121-1132.

DRAKE, D.E., CACCHIONE, D.A. and H.A. KARL, 1985. Bottom currents and sediment transport on San Pedro Shelf, California. *J. Sed. Petr.*, **55**: 15-28.

DUGAN J.E., HUBBARD, D.M., MCCRARY, M.D. and M.O. PIERSON, 2003. The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California. *Estuarine, Coastal and Shelf Science*, **58S**: 133-148.

DUNA, O., CLARK, B.M., BICCARD, A., HUTCHINGS, K., HARMER, R., MOSTERT, B., BROWN, E., MASSIE, V., MAKUNGA, M., DLAKU, Z. & A, MAKHOSONKE, 2016. Assessment of mining-related impacts on macrofaunal benthic communities in the Northern Inshore Area of Mining Licence Area MPT 25-2011 and subsequent recovery. Technical Report. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (PTY) Ltd. Report no. 1646/1.

DUNCOMBE RAE, C.M., 2005. A demonstration of the hydrographic partition of the Benguela upwelling ecosystem at 26°40'S. *Afr. J. mar. Sci.*, **27(3)**: 617–628.

DUNDEE, B.L., 2006. *The diet and foraging ecology of chick-rearing gannets on the Namibian islands in relation to environmental features: a study using telemetry*. MSc thesis, University of Cape Town, South Africa.

DUNHAM, A., PEGG, J. R., CAROLSFELD, W., DAVIES, S., MURFITT, I. & J. BOUTILLIER, 2015. Effects of submarine power transmission cables on a glass sponge reef and associated megafaunal community. *Marine Environmental Research,* 107, 50-60.

DWYER, K.L., RYDER, C.E., PRESCOTT R., 2003. Anthropogenic mortality of leatherback sea turtles in Massachusetts waters. p. 260. *In*: J.A. Seminoff (compiler). Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

EKAU, W. & H. M. VERHEYE, 2005. Influence of oceanographic fronts and low oxygen on the distribution of ichthyoplankton in the Benguela and southern Angola currents. *Afr. J. mar. Sci.*, **27(3)**: 629–639.

ELLINGSEN, K.E., 2002. Soft-sediment benthic biodiversity on the continental shelf in relation to environmental variability. *Marine Ecology Progress Series*, **232**: 15-27.

ELLIS, D.V., 1996. Practical mitigation of the environmental effect of offshore mining. Offshore Technology Conference, Houston Texas, 6-9 May 1996.

ELLIS, D.V., 2000. Effect of Mine Tailings on the Biodiversity of the Seabed: Example of the Island Copper Mine, Canada. In: SHEPPARD, C.R.C. (Ed), Seas at The Millennium: An Environmental Evaluation. Pergamon, Elsevier Science, Amsterdam, pp. 235-246.

ELLIS, D.V. & R.H.T. GARNETT, 1996. Practical Mitigation of the Environmental Effect of Offshore Mining. *Proc. Offshore Technology Conference, Houston Texas, 6-9 May 1996*: 611-615.

ELLIS, M.S., WILSON-ORMOND, E.A. & E.N. POWELL, 1996. Effects of gas-producing platforms on continental shelf macroepifauna in the northwestern Gulf of Mexico: abundance and size structure. *Can. J. Fish. Aquat. Sci.*, **53**: 2589-2605.

ELVIN, S.S. & C.T. TAGGART, 2008. Right whales and vessels in Canadian waters. *Marine Policy* 32 (3): 379-386.

ELWEN, S.H., GRIDLEY, T., ROUX, J.-P., BEST, P.B. and M.J. SMALE, 2013. Records of Kogiid whales in Namibia, including the first record of the dwarf sperm whale (*K. sima*). *Marine Biodiversity Records*. 6, e45 doi:10.1017/S1755267213000213.

ELWEN, S.H. & R.H. LEENEY, 2010. Injury and Subsequent Healing of a Propeller Strike Injury to a Heaviside's dolphin (*Cephalorhynchus heavisidii*). *Aquatic Mammals* 36 (4): 382-387.

ELWEN, S.H. & R.H. LEENEY, 2011. Interactions between leatherback turtles and killer whales in Namibian waters, including predation. *South African Journal of Wildlife Research,* **41(2)**: 205-209.

ELWEN, S.H. MEŸER, M.A.M, BEST, P.B., KOTZE, P.G.H, THORNTON, M. and S. SWANSON, 2006. Range and movements of a nearshore delphinid, Heaviside's dolphin *Cephalorhynchus heavisidii* a determined from satellite telemetry. *Journal of Mammalogy*, **87(5)**: 866–877.

ELWEN, S.H., SNYMAN, A., LEENEY, R.H., 2011. Report of the Namibian Dolphin Project 2010: Ecology & conservation of coastal dolphins in Namibia. Submitted to the Ministry of Fisheries & Marine Resources, 27 Feb 2011. 36 pp. & 5 appendices.

ELWEN S.H., THORNTON M., REEB D. and P.B. BEST, 2010. Near-shore distribution of Heaviside's (*Cephalorhynchus heavisidii*) and dusky dolphins (*Lagenorhynchus obscurus*) at the southern limit of their range in South Africa. *African Journal of Zoology* 45: 78-91.

ELWEN, S.H., TONACHELLA, N., BARENDSE, J,. COLLINS, T.J.Q., BEST, P.B., ROSENBAUM, H.C., LEENEY, R.H. and T. GRIDLEY. 2014. Humpback Whales off Namibia: Occurrence, Seasonality, and a Regional Comparison of Photographic Catalogs and Scarring. Journal of Mammalogy, 95 (5): 1064–76. doi:10.1644/14-MAMM-A-108.

EMANUEL, B.P., BUSTAMANTE, R.H., BRANCH, G.M., EEKHOUT, S. and F.J. ODENDAAL, 1992. A zoogeographic and functional approach to the selection of marine reserves on the west coast of South Africa. *S. Afr. J. Mar. Sci.*, **12**: 341-354.

EMEIS, K.-C., BRÜCHERT, V., CURRIE, B., ENDLER, R., FERDELMAN, T., KIESSLING, A., LEIPE, T., NOLI-PEARD, K., STRUCK, U., VOGT, T., 2004. Shallow gas in shelf sediments of the Namibian coastal upwelling ecosystem. Continental Shelf Research 24, 627-642.

ENGLEDOW, H.R. & J.J. BOLTON, 1994. Seaweed alpha-diversity within the lower eulittoral zone in Namibia: the effects of wave action, sand inundation, mussels and limpets. *Bot. Mar.*, **37**: 267-276.

FAO, 2009. International Guidelines for the Management of Deep-Sea Fisheries in the High Seas. SPRFMO-VI-SWG-INF01

FECHHELM, R.G., GALLAWAY, B.J., HUBBARD, G.F., MACLEAN, S. & L.R. MARTIN, 2001. Opportunistic sampling at a deep-water synthetic drilling fluid discharge site in the Gulf of Mexico. *Gulf of Mexico Science*, **2**: 97-106.

FEGLEY, S.R., MACDONALD, B.A. and T.R. JACOBSEN, 1992. Short-term variation in the quantity and quality of seston available to benthic suspension feeders. *Estuar. Coast. Shelf Sci.*, **34**: 393–412.

FIELD, J.G. and C.L. GRIFFITHS, 1991. Littoral and sublittoral ecosystems of southern Africa. In: Mathieson AC,. Nienhuis PH (eds.): Ecosystems of the World 24: Intertidal and Littoral Ecosystem.. Elsevier, Amsterdam. Pp. 323-346.

FINDLAY, K.P., 1996. The impact of diamond mining noise on marine mammal fauna off southern Namibia. In: Environmental Evaluation Unit Report, Impacts of deep sea diamond mining, in the Atlantic 1 mining licence area in Namibia, on the natural systems of the marine environment. EEU Unpublished Report No. 11/96/158.

FINDLAY K.P., BEST P.B., ROSS G.J.B. and V.C. COCKROFT. 1992. The distribution of small odontocete cetaceans off the coasts of South Africa and Namibia. *S. Afr. J. Mar. Sci.* 12: 237-270.

FLACH, E. & L. THOMSEN, 1998. Do physical and chemical factors structure the macrobenthic community at a continental slope in the NE Atlantic? *Hydrobiologia,* **375/376**: 265-285.

FOELL, E. J., THIEL, H. and G. SCHRIEVER, 1990. DISCOL: A long-term, large-scale disturbance recolonization experiment in the abyssal eastern tropical South Pacific Ocean. *Proc. Offshore Technol. Conf., Houston, OTC*, Paper 6328: 497-503.

FOELL, E.J., THIEL, H. and G. SCHRIEVER, 1992a. DISCOL: A long-term, large-scale, disturbance-recolonization experiment in the abyssal eastern tropical South Pacific Ocean. *Mining Engineering*, January 1992: pp. 90-94.

FOELL, E.J., SCHRIEVER, G., BLUHM, H., BOROWSKI, C., BUSSAU, C. and H. THIEL, 1992b. Disturbance and Recolonization Experiment in the Abyssal South Pacific Ocean (DISCOL): An Update. *Proceedings of the 24th Annual Offshore Technology Conference,Houston, Texas*, May 4-7, 1992, pp. 25-34.

GIHWALA, K., BICCARD, A., CLARK, B.M., BROWN, E.A., MAKHOSONKE, A., SWART, C. & B. TSHINGANA, 2018. De Beers Marine Namibia Environmental Monitoring Programme: Mining-related impacts in mining license area MPT 25-2011 and subsequent recovery. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1800/1.

GIHWALA, K., BICCARD, A., CLARK, B.M., BROWN, E.A., MAKHOSONKE, A., SWART, C. & B. TSHINGANA, 2019. Mining-related impacts to soft bottom benthic habitats and associated macrofauna assemblages in mining license area SASA 2C and subsequent recovery. Report prepared for De Beers Group of Companies by Anchor Environmental Consultants (Pty) Ltd. Report no. 1800/1.

GOODING, S., BLACK, K., BOYDE, P. & S. BOYES, 2012. Environmental Impact of Subsea Trenching Operations, Offshore Site Investigation and Geotechnics: Integrated Technologies - Past, Present, and Future, 12-14 Sept. 2012. Society of Underwater Technology, London, pp. 213–221.

GOOLD, J. & R. COATES, 2001. Acoustic Monitoring of Marine Wildlife. Seiche.Com Ltd. 182pp.

GOOSEN, A.J.J., GIBBONS, M.J., MCMILLAN, I.K., DALE, D.C. and P.A. WICKENS, 2000. Benthic biological study of the Marshall Fork and Elephant Basin areas off Lüderitz. Prepared by De Beers Marine (Pty) Ltd. for Diamond Fields Namibia, January 2000. 62 pp.

GORDON, J. & A. MOSCROP, 1996. Underwater noise pollution and its significance for whales and dolphins. pp 281-319 In SIMMONDS. M.P. and HUTCHINSON, J.D. (eds.) The conservation of whales and dolphins. John Wiley and Sons, London.

GRANNIS, B.M., 2005. Impacts of Mobile Fishing Gear and a Buried Fiber-optic Cable on Soft-sediment Benthic Community Structure. The Graduate School. The University of Maine, p. 73

GRÉMILLET, D., LEWIS, S., DRAPEAU, L., VAN DER LINGEN, C.D., *et al.* 2008. Spatial match-mismatch in the Benguela upwelling zone: should we expect chlorophyll and seasurface temperature to predict marine predator distributions? *J Appl. Ecol.*, 45: 610–621

GRIFFITHS, M.H., HEEMSTRA, P.C., 1995. A contribution to the taxonomy of the marine fish genus *Argyrosomus* (Perciformes: Sciaenidae), with descriptions of two new species from southern Africa. Ichthyol. Bull., J.L.B. Smith Inst. Ichthyol. No. 65, 40 p

HALL, S.J., 1994. Physical disturbance and marine benthic communities: life in unconsolidated sediments. *Oceanography and Marine Biology: An Annual Review*, **32**: 179-239.

HALL, S.J. & M.J.C. HARDING, 1997. Physical disturbance and marine benthic communities: the effects of mechanical harvesting of cockles on non-target benthic infauna. *J. Appl. Ecol.*, **34**: 497–517.

HAMPTON, I., 2003. Harvesting the Sea. In: MOLLOY, F. and T. REINIKAINEN (Eds), 2003. Namibia's Marine Environment. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Namibia, 31-69.

HANSEN. F.C., CLOETE. R.R., VERHEYE, H.M., 2005. Seasonal and spatial variability of dominant copepods along a transect off Walvis Bay (23ºS), Namibia. African Journal of Marine Science 27, 55-63.

HASTIE, G.D., WILSON, B., TUFFT, L.H. & P.M. THOMPSON, 2003. Bottlenose dolphins increase breathing synchrony in response to boat traffic. *Marine Mammal Science* 19: 74-84.

HAWKINS, S.J. & R.G. HARTNOLL, 1983. Grazing of intertidal algae by marine invertebrates. *Oceanogr. Mar. Biol. Ann. Rev.*, **21**: 195-282.

HAYS, G.C. HOUGHTON, J.D.R., ISAACS, C. KING, R.S. LLOYD, C. and P. LOVELL, 2004. First records of oceanic dive profiles for leatherback turtles, *Dermochelys coriacea*, indicate behavioural plasticity associated with long-distance migration. *Animal Behaviour,* **67**: 733-743.

HEATH, J., 2001. Benign use of the seabed by telecommunications cables. AP11 from Copenhagen Plenary, pp6.

HERRMANN, C., KRAUSE, J. Chr., TSOUPIKOVA, N. and K. HANSEN, 1999. Marine Sediment extraction in the Baltic Sea. Status Report. Baltic Sea Env. Proc., 76. 29 pp.

HUECKEL, G.J., BUCKLEY, R.M. & B.L. BENSON, 1989. Mitigating rocky habitat loss using artificial reefs. *Bulletin of Marine Science* **44**: 913-922.

HOLNESS, S., KIRKMAN, S., SAMAAI, T., WOLF, T., SINK, K., MAJIEDT, P., NSIANGANGO, S., KAINGE, P., KILONGO, K., KATHENA, J., HARRIS, L., LAGABRIELLE, E., KIRCHNER, C., CHALMERS, R. and M. LOMBARD, 2014. Spatial Biodiversity Assessment and Spatial Management, including Marine Protected Areas. Final report for the Benguela Current Commission project BEH 09-01.

HOLTZHAUZEN, J.A., 2000. Population dynamics and life history of westcoast steenbras *Lithognathus aureti* (Sparidae), and management options for the sustainable exploitation of the steenbras resource in Namibian waters. PhD Thesis, University of Port Elizabeth: 233 pages.

HOLTZHAUSEN, J.A., CAMARADA, T.G., 2007. Migratory Behaviour and Assessment of the Bronze Whaler (*Carcharhinus brachyurus*), Final Report: BCLME Project Number LMR/CF/03/16.

HOLTZHAUSEN, J.A., KIRCHNER, C.H., VOGES, S.F., 2001. Observations on the linefish resources of Namibia, 1999-2000, with special reference to West Coast steenbras and silver kob. South African Journal of Marine Science 23, 135-144.

HOVLAND, M., VASSHUS, S., INDREEIDE, A., AUSTDAL, L. and Ø. NILSEN, 2002. Mapping and imaging deep-sea coral reefs off Norway, 1982-2000. *Hydrobiol*. **471**: 13-17.

HOWARD, J.A.E., JARRE, A., CLARK, A.E. and C.L. MOLONEY, 2007. Application of the sequential t-test algorithm or analyzing regime shifts to the southern Benguela ecosystem. *African Journal of Marine Science* 29(3): 437-451.

HURME, A.K. & E.J. PULLEN, 1988. Biological effects of marine sand mining and fill placement for beach replenishment: Lessons for other uses. *Mar. Min.*, **7**: 123-136.

IGLESIAS, J.I.P., URRUTIA, M.B., NAVARRO, E., ALVAREZ-JORNA, P., LARRETXEA, X., BOUGRIER, S. and M. HERAL, 1996. Variability of feeding processes in the cockle Cerastoderma edule (L.) in response to changes in seston concentration and composition. J. Exp. Mar. Biol. Ecol., 197: 121–143.

INTERNATIONAL WHALING COMMISSION (IWC), 2012. Report of the Scientific Committee. Annex H: Other Southern Hemisphere Whale Stocks Committee 11–23.

JAMES, M.C., OTTENSMEYER, C.A., MYERS, R.A., 2005. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: new directions for conservation. Ecology Letters 8: 195-201.

JARAMILLO, E., MCLACHLAN, A. & J. DUGAN, 1995. Total sample area and estimates of species richness in exposed sandy beaches. *Marine Ecology Progress Series* **119**: 311-314.

JENSEN, A.S. & G.K. SILBER, 2003. Large whale ship strike database. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/OPR 25. 37 pp.

JOHNSSON, A. & S. RAMSTAD, 2004. Seabed Logging Environmental Study: Possible Biological Effects of Electromagnetic Fields on Marine Life. Report to EMGS, Norwegian University of Science and Technology. pp 34

JOINT NATURE CONSERVATION COMMITTEE (JNCC), 2017. JNCC guidelines for minimising the risk of injury to marine mammals from geohysical surveys. August 2017. 28pp.

KAISER, M.J., HILL, A.S., RAMSAY, K., SPENCER, B.E., BRAND, A.R., VEALE, L.O., PRUDDEN, K., REES, E.I. S., MUNDAY, B.W., BALL, B. & S.J. HAWKINS, 1996. Benthic disturbance by fishing gear in the Irish Sea: a comparison of beam trawling and scallop dredging. *Aquatic Cons.*, **6**: 269–285.

KAMSTRA, 1985. Environmental features of the southern Benguela with special reference to the wind stress. In: South African Ocean Colour and Upwelling Experiment. Shannon L.V. (Ed.), Sea Fisheries Research Institute, Cape Town, p13-27.

KEMPER, J., UNDERHILL, L.G., CRAWFORD, R.J.M., KIRKMAN, S.P., 2007. Revision of the conservation status of seabirds and seals breeding in the Benguela Ecosystem. In: Kirkman, S.P. (ed). Final Report of the BCLME (Benguela Current Large Marine Ecosystem) Project on Top Predators as Biological Indicators of Ecosystem Change in the BCLME: 325-342. Avian Demography Unit, University of Cape Town, Cape Town, South Africa

KENDALL, M.A. and S. WIDDICOMBE, 1999. Small scale patterns in the structure of macrofaunal assemblages of shallow soft sediments. *Journal of Experimental Marine Biology and Ecology*, **237**:127-140.

KENNY, A.J. & H.L. REES, 1994. The effects of marine gravel extraction on the macrobenthos: Early post-dredging recolonisation. *Mar. Pollut. Bull.*, **28**: 442-447.

KENNY, A.J. & H.L. REES, 1996. The effects of marine gravel extraction on the macrobenthos: results 2 years postdredging. *Mar. Pollut. Bull.*, **32**: 615–622.

KENNY, A.J., REES, H.L., GREENING, J. and S. CAMPBELL, 1998. The effects of marine gravel extraction on the macrobenthos at an experimental dredge site off north Norfolk, U.K. (Results 3 years post-dredging). *ICES CM 1998/V*:14, pp. 1-8.

KENSLEY, B., 1978, Interaction between coastal processes and lagoonal fauna between Walvis Bay and Lüderitzbucht, South-West Africa. *Madoqua* **11**(1):55-60.

KENSLEY, B.F. & M.J. PENRITH, 1977. Biological survey of Sandvis 1, introduction and faunal list. Madoqua 10(3), 181-190.

KIRCHNER, C.H., 2001. Fisheries regulations based on yield per recruit analysis for the linefish silver kob *Argyrosomus inodorus* in Namibian waters. Fisheries Research 52, 155–167.

KIRCHNER, C.H., SAKKO, A., BARNES, J.I., 2000. Estimation of the economic value of the Namibian recreational rock-and-surf fishery. South African Journal of Marine Science 22, 17-25.

KIRKMAN, S.P., OOSTHUIZEN, W.H., MEYER, M.A., KOTZE, P.G.H., ROUX, J-P. UNDERHILL L.G., 2007, Making sense of census and dealing with missing data: trends in pup counts of Cape fur seal *Arctocephalus pusillus pusillus* for the period 1972-2004, African Journal of Marine Science, 29(2),

KIRKMAN, S.P., MEYER, M.A. & M. THORNTON, 2010. False Killer Whale Pseudorca crassidens mass stranding at Long Beach on South Africa's Cape Peninsula, 2009. *African Journal of Marine Science* 31 (1): 167–70. doi:10.2989/1814232X.2010.481168.

KIRKMAN, S.P., YEMANE, D., OOSTHUIZEN, W.H., MEYER, M.A., KOTZE, P.G.H, SKRYPZECK, H., VAZ VELHO, F. and L.G. UNDERHILL, 2012. Spatio-temporal shifts of the dynamic Cape fur seal population in southern Africa, based on aerial censuses (1972-2009). *Marine mammal Science*, doi: 10.1111/j.1748-7692.2012.00584.x

KOGAN, I., PAULL, C.K., KUHNZ, L.A., BURTON, E.J., VON THUN, S., GARY GREENE, H. & J.P. BARRY, 2006. ATOC/Pioneer Seamount cable after 8 years on the seafloor: observations, environmental impact. Continent. Shelf Res., 26: 771–787.

KOPER, R.P & S. PLÖN, 2012. The potential impacts of anthropogenic noise on marine animals and recommendations for research in South Africa. EWT Research & Technical Paper No. 1. Endangered Wildlife Trust, South Africa.

KRAUS, C. & L. CARTER, 2018. Seabed recovery following protective burial of subsea cables – Observations from the continental margin. Ocean Engineering, 157: 251-261.

KUHNZ, L.A., BUCK, K., LOVERA, C., WHALING, P.J. & J.P. BARRY, 2015. Potential Impacts of the Monterey Accelerated Research System (MARS) Cable on the Seabed and Benthic Faunal Assemblages. MARS Biological Survey Report. Monterey Bay Aquarium Research Institute, pp33.

KREINER, A., BOLTON, J., BRANCH, G., LIMA, F., REDDY, M., SERRÃO, E. & M. THOMAS, 2019a. Report: Coastal Biodiversity Surveys – Survey 1. Subdivision Environment, National Marine Information and Research Centre, Ministry of Fisheries and Marine Resources, Namibia, 51p.

LAIRD, M.C., HUTCHINGS, K., NALUSHA, S.H. & B.M. CLARK, 2018. *Marine Ecology Report for the National Oil Storage Facilities Project, Walvis Bay*. Report No. 1790/4 prepared by Anchor Environmental Consultants (Pty) Ltd and Green Team Consultants CC for Om'kumoh AIJ JV. 95 pp.

LAIST, D. W., KNOWLTON, A. R., MEAD, J. G., COLLET, A. S. & M. PODESTA, 2001. Collisions between ships and whales. *Mar. Mamm. Sci.* 17, 35–75.

LAMBERTH, S.J., VAN NIEKERK, L., HUTCHINGS, K., 2008. Comparison of, and the effects of altered freshwater inflow on, fish assemblages of two contrasting South African estuaries: the cool-temperate Olifants and the warm-temperate Breede. *African Journal of Marine Science* 30: 311-336.

LANE, S.B. and R.A. CARTER, 1999. *Generic Environmental Management Programme for Marine Diamond MIning off the West Coast of South Africa.* Marine Diamond Mines Association, Cape Town, South Africa. 6 Volumes.

LASIAK, T.A. 1981. Nursery grounds of juvenile teleosts: evidence from surf zone of King's beach, Port Elizabeth. *S. Afr. J. Sci.*, **77**: 388-390.

LE ROUX, L., 1998. Research on Deepsea Red Crab after more than 20 years of Exploitation. *Namibia Brief*, **20**: 126-128.

LEVIN, L.A., 2003. Oxygen minimum zone benthos: adaptation and community response to hypoxia. *Oceanography and Marine Biology: an Annual Review,* **41**: 1-45.

LEVIN, L.A., WHITCRAFT, C.R., MENDOZA, G.F., GONZALEZ, J.P. & G. COWIE, 2009. Oxygen and organic matter thresholds for benthic faunal activity on the Pakistan margin oxygen minimum zone (700 – 1100 m). *Deep-Sea Reserach II,* **56**: 449-471.

LEVIN, L.A., GAGE, J.D., MARTIN, C. & P.A. LAMONT, 2000. Macrobenthic community structure within and beneath the oxygen minimum zone, NW Arabian Sea. *Deep-Sea Res. Pt. II*, **47**: 189–226.

LI, B. & D. LEWIS, 2020. TEPSA Block South Outeniqua Seismic and Sonar Surveys: Sound Transmission Loss Modelling. Prepared by SLR Consulting Australia Pty Ltd for SLR Cosulting (Cape Town) on behalf of Total Exploration and Production B.V. pp61.

LITTLER, M.M., MARTZ, D.R. & D.S. LITTLER, 1983. Effects of recurrent sand deposition on rocky intertidal organisms: importance of substrate heterogeneity in a fluctuating environment. *Mar. Ecol. Prog. Ser.*, **11**: 129-139.

LONGHURST, A. R., 2006. Ecological Geography of the Sea. 2nd edition. Academic Press, San Diego. pp. 560.

LOPEZ-JAMAR, E., FRANCESCH, O., DORRÍO, A.V. and S. PARRA, 1995. Long-term variation of the infaunal benthos of La Coruña Bay (NW Spain): results from a 12-year study (1982-1993). *Sci. Mar.*, **59**: 49-61.

LOUW, D.C., 2008. Internal memorandum. Phytoplankton Bloom along the Namibian Coast. Ministry of Fisheries & Marine Resources: Directorate of Resource Management. Date: 10/03/2008.

LUTCAVAGE, M.E., PLOTKIN, P., WITHERINGTON, LUTZ, P.L., 1997. Human impacts on sea turtle survival. *In*: The Biology of Sea Turtles, Vol. 1. P.L. Lutz and J. Musick (eds.) CRC Press, Boca Raton, Fla. pp. 387-410.

LUTZ, P.L., ALFARO-SHULMAN, A.A., 1991. The effects of chronic plastic ingestion on green sea tutles. Report NOAASB21-WCH06134, U.S. Dept. of Commerce, Miami, FL.

LUDYNIA, K., 2007. *Identification and characterisation of foraging areas of seabirds in upwelling systems: biological and hydrographic implications for foraging at sea.* PhD thesis,

LURTON, X., 2015. Modelling of the sound field radiated by multibeam echosounders for acoustical impact assessment. Applied Acoustics, 101: 201-221.

LURTON, X. & S. DERUITER, 2011. Sound radiation of seafloor-mapping echosounders in the water column, in relation to the risks posed to marine mammals. Int. Hydrogr. Rev., 6: 7–18.

LUSSEAU, D., 2004. The hidden cost of tourism: Effects of interactions with tour boats on the behavioral budget of two populations of bottlenose dolphins in Fiordland, New Zealand. Ecology and Society 9 (1): Part. 2.

LUSSEAU, D., 2005. Residency pattern of bottlenose dolphins *Tursiops* spp. in Milford Sound, New Zealand, is related to boat traffic. Marine Ecology Progress Series 295: 265-272.

LUSSEAU, D., BAIN, D.E., WILLIAMS, R. & J.C. SMITH, 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. *Endangered Species Research* 6: 211-221.

LYNAM, C.P., GIBBONS, M.J., AXELSEN, B.A., SPARKS, C.A.J., COETZEE, J., HEYWOOD, B.G., BRIERLEY, A.S., 2006. Jelly Fish overtake fish in a heavily fished ecosystem. Curr. Biol. 16, 492–493.

MacISSAC, K., BOURBONNAIS, C., KENCHINGTON, E.D., GORDON JR. and S. GASS, 2001. Observations on the occurrence and habitat preference of corals in Atlantic Canada. *In:* (eds.) J.H.M. WILLISON, J. HALL, S.E. GASS, E.L.R. KENCHINGTON, M. BUTLER, and P. DOHERTY. Proceedings of the First International Symposium on Deep-Sea Corals. Ecology Action Centre and Nova Scotia Museum, Halifax, Nova Scotia.

MACLEOD, A.K., STANLEY, M.S., DAY, J. G. & E.J. COOK, 2016. Biofouling community composition across a range of environmental conditions and geographical locations suitable for floating marine renewable energy generation. *Biofouling,* 32(3), 261-276.

MacLEOD, C.D. & A. D'AMICO, 2006. A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. *Journal of Cetacean Research and Management* **7(3)**: 211–221.

MacPHERSON, E. and A. GORDOA, 1992. Trends in the demersal fish community off Namibia from 1983 to 1990. *South African Journal of Marine Science* **12**: 635-649.

MARSHALL, D.J. & C.D. McQUAID, 1993. Differential physiological and behavioural responses of the intertidal mussels, *Choromytilus meridionalis* (Kr.) and *Perna perna* L., to exposure to hypoxia and air: a basis for spatial separation. *J. Exp. Mar. Biol. Ecol.*, **171**: 225-237.

MATE, B.R., BEST, P.B., LAGERQUIST, B.A. and M.H. WINSOR, 2011. Coastal, offshore and migratory movements of South African right whales revealed by satellite telemetry. *Marine Mammal Science*, **27(3)**: 455-476.

MATE, B.R., LAGERQUIST, B.A., WINDSOR, M., GERACI, J. and J.H. PRESCOTT, 2005. Movements and dive habits of a satellite-monitoring longfinned pilot whales (*Globicephala melas*) in the northwet Atlantic. *Marine Mammal Science* **21(10)**: 136-144.

MATTHEWS, S.G. and G.C. PITCHER, 1996. Worst recorded marine mortality on the South African coast. In: YASUMOTO, T, OSHIMA, Y. and Y. FUKUYO (Eds), *Harmful and Toxic Algal Blooms*. Intergovernmental Oceanographic Commission of UNESCO, pp 89-92.

MAURER, D.L., LEATHEM, W., KINNER, P. and J. TINSMAN, 1979. Seasonal fluctuations in coastal benthic invertebrate assemblages. *Est. Coast. Shelf Sci.*, **8**: 181-193.

MAURIHUNGIRIRE, M., GRIFFIN, K., 1998. Mariculture- a Namibian Perpective. Namibia Brief 20, 134-135.

McCAULEY, R.D. 1994. Seismic surveys. In: Swan, J.M., Neff, J.M., Young, P.C. (Eds.). Environmental implications of offshore oil and gas development in Australia - The findings of an Independent Scientific Review. APEA, Sydney, Australia, 695 pp.

McLACHLAN, A., 1980. The definition of sandy beaches in relation to exposure: a simple rating system. *S. Afr. J. Sci.*, **76**: 137-138.

McLACHLAN, A., 1985. The ecology of two sandy beaches near Walvis Bay, Madoqua 14(2), 155-163.

McLACHLAN, A., 1986. Ecological surveys of sandy beaches on the Namib coast. Report No. 13, Institute for Coastal Research, University of Port Elizabeth, Port Elizabeth, 135 pp.

McLACHLAN, A. & A.C. BROWN, 2006. *Ecology of sandy shores*, Academic Press, Burlington, MA, USA.

McLACHLAN, A., DE RUYCK, A., 1993. Survey of sandy beaches in Diamond Area 1. A report to Consolidated Diamond Mines, Oranjemund, Namibia.

McLACHLAN, A., JARAMILLO, E., DONN, T.E. and F. WESSELS. 1993. Sandy beach macrofauna communities and their control by the physical environment: a geographical comparison. *Journal of coastal Research, Special Issue*, **15**: 27-38.

McQUAID, C.D. and G.M. BRANCH, 1985. Trophic structure of rocky intertidal communities: response to wave action and implications for energy flow. *Mar. Ecol. Prog. Ser.,* **22**: 153-161.

McQUAID, C.D., BRANCH, G.M. & A.A. CROWE, 1985. Biotic and abiotic influences on rocky intertidal biomass and richness in the southern Benguela region. South African Journal of Zoology 20, 115-122.

McQUAID, C.D. & K.M. DOWER, 1990. Enhancement of habitat heterogeneity and species richness on rocky shores inundated by sand. *Oecologia* **84**: 142-144.

MECENERO, S., ROUX, J-P., UNDERHILL, L.G. & M.N.BESTER, 2006. Diet of Cape fur seals *Arctocephalus pusillus pusillus* at three mainland breeding colonies in Namibia. 1. Spatial variation. *African Journal of Marine Science* **28**: 57-71.

MEIßNER, K., SCHABELON, H., BELLEBAUM, J. & H. SORDYL, 2006. Impacts of submarine cables on the marine environment - a literature review. Institut für Angewandte Okosystemforschung, Neu Broderstorf 88. Germany.

MEYER, W.F., EWART-SMITH, C., NEL, R., CLARK, B.M., 1998. Ecological impact of beach diamond mining on beach, rocky intertidal and surf zone biological communities in the Sperrgebiet, Namibia. Phase 1 – baseline surveys. AEC Unpublished Report. 77 pp.

MFMR, 2008. Ministry of Fisheries & Marine Resources: Directorate of Resource Management. Monthly Marine Environmental Update. March 2008. No. 03/2008. Compiled by C.H. Bartholomae.

MODDE, T. 1980. Growth and residency of juvenile fishes within a surf zone habitat in the Gulf of Mexico. *Gulf Research Reports*, **6**: 377-385.

MOLLOY, F., REINIKAINEN T., (Eds), 2003. Namibia`s Marine Environment. Directorate of Environmental Affairs, Ministry of Environment & Tourism, Namibia, 160 pp.

MONTEIRO, P.M.S. and A.K. VAN DER PLAS, 2006. Low Oxygen Water (LOW) variability in the Benguela System: Key processes and forcing scales relevant to forecasting. In: SHANNON, V., HEMPEL, G., MALANOTTE-RIZZOLI, P., MOLONEY, C. and J. WOODS (Eds). *Large Marine Ecosystems*, Vol. 15, pp 91-109.

MORANT, P.D., 2006. Environmental Management Programme Report for Exploration/Appraisal Drilling in the Kudu Gas Production Licence No 001 on the Continental Shelf of Namibia. Prepared for Energy Africa Kudu Limited. CSIR Report CSIR/NRE/ECO/2006/0085/C.

MORTON, J.W., 1977. Ecological effects of dredging and dredge disposal: a literature review. Tech. Papers. *U.S. Fish Wildl. Serv.*, **94**: 1-33.

NASHIMA, F.P., 2013. Structure and composition of intertidal communities at exposed and sheltered habitat, Central Namibian Coast. Journal of Agriculture and Biodiversity Research 2(3): 67-72.

NEL, R., EWART-SMITH, C., MEYER, W.F., CLARK, B.M., 1997. Macrofauna baseline study of three pocket-beaches in the Sperrgebiet, Namibia. AEC Unpublished Report. 23pp.

NEL, R. & A. PULFRICH, 2002. An assessment of the impacts of beach mining operations on beach macrofaunal communities between the Sout River and Olifants River mouth. Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd. September 2002, 38pp.

NEL, P., PULFRICH, A. and A.J. PENNEY, 2003. Impacts of beach mining operations on sandy beach macrofaunal communities on the beaches of Geelwal Karoo, Report by Pisces Environmental Services (Pty) Ltd prepared for Trans Hex Operations (Pty) Ltd, Cape Town.

NELSON, G., 1989. Poleward motion in the Benguela area. In: Poleward Flows along Eastern Ocean Boundaries. NESHYBA *et al.* (eds) New York; Springer: 110-130 (Coastal and Estuarine Studies 34).

NELSON G. and L. HUTCHINGS, 1983. The Benguela upwelling area. *Prog. Oceanogr.*, 12: 333-356.

NEWELL, R.C., SEIDERER, L.J. & D.R. HITCHCOCK, 1998. The impact of dredging work in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanogr. Mar. Biol. Ann. Rev.*, **36**: 127–178.

NEWMAN, G.G. and D.E. POLLOCK, 1971. Biology and migration of rock lobster *Jasus lalandii* and their effect on availability at Elands Bay, South Africa. *Investl. Rep. Div. Sea Fish. S. Afr.*, **94**: 1-24.

NOAA, 2005. Final Environmental Analysis of Remediation Alternatives for the Pacific Crossing-1 North and East Submarine Fiber-optic Cables in the Olympic Coast National Marine Sanctuary. National Oceanographic and Atmospheric Administration, 77 pp plus appendix. http://sanctuaries.noaa.gov/library/alldocs.html

NRC (NATIONAL RESEARCH COUNCIL). 1990. Decline of the sea turtles: causes and prevention. National Academy Press, Washington, D.C.

NRC, 2003. Ocean noise and marine mammals. National Academy Press, Washington, DC.

OLIVIER, J., 1992. Aspects of the climatology of fog in the Namib. *SA geographer* **19(2)**: 107-125.

OLIVIER, J., 1995. Spatial fog distribution pattern in the Namib using Meteosat images. *J. Arid Environments,* **29**: 129-138.

OOSTHUIZEN W.H., 1991. General movements of South African (Cape) fur seals *Arctocephalus pusillus pusillus* from analysis of recoveries of tagged animals. *S. Afr. J. Mar. Sci.*, **11**: 21-30.

PANIGADA, S., PESANTE, G., ZANARDELLI, M., CAPOULADE, F., GANNIER, A. & M.T. WEINRICH, 2006. Mediterranean fin whales at risk from fatal ship strikes. *Marine Pollution Bulletin* 52 (10): 1287-98.

PARKINS, C.A. and J.G.FIELD, 1998. The effects of deep sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1997. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town. pp. 44.

PARRY, D.M., KENDALL, M.A., PILGRIM, D.A. and M.B. JONES, 2003. Identification of patch structure within marine benthic landscapes using a remotely operated vehicle. *J. Exp. Mar. Biol. Ecol.,* **285–286**: 497–511.

PAYNE, A.I.L. and R.J.M. CRAWFORD, 1989. *Oceans of Life off Southern Africa.* Vlaeberg, Cape Town, 380 pp.

PENNEY, A.J., KROHN, R.G. and C.G. WILKE. 1992. A description of the South African tuna fishery in the southern Atlantic Ocean. *ICCAT Col. Vol. Sci. Pap.* XXIX(1) : 247-253.

PENNEY, A.J., PULFRICH, A., ROGERS, J., STEFFANI, N. and V. MABILLE, 2007. *Project: BEHP/CEA/03/02: Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities on the BCLME Region.* Final Report to the BCLME mining and petroleum activities task group. December 2007. 410pp.

PENRY, G.S., 2010. *Biology of South African Bryde's whales*. PhD Thesis. University of St Andrews, Scotland, UK.

PERRY, C., 1998. A review of the impacts of anthropogenic noise on cetaceans. Document SC/50/E9 submitted to the scientific committee of the International Whaling Commission, Muscat, Oman, 1998. 28 pp + 8 pp appendices.

PERRY, J., 2005. Environmental Impact Assessment for Offshore Drilling the Falkland Islands to Desire Petroleum Plc. 186pp.

PETERSON, C.H., LANEY, W. & T. RICE, 2001. Biological impacts of beach nourishment. Workshop on the Science of Beach Renourishment, May 7-8, 2001. Pine Knoll Shores, North Carolina.

PETERSON, C.H., HICKERSON, D.H.M. and G.G. JOHNSON, 2000. Short-Term Consequences of Nourishment and Bulldozing on the Dominant Large Invertebrates of a Sandy Beach. *J. Coast. Res.*, **16(2)**: 368-378.

PIDCOCK, S., BURTON, C. and M. LUNNEY, 2003. The potential sensitivity of marine mammals to mining and exploration in the Great Australian Bight Marine Park Marine Mammal Protection Zone. An independent review and risk assessment report to Environment Australia. Marine Conservation Branch. Environment Australia, Canberra, Australia. pp. 85.

PITCHER, G.C., 1998. *Harmful algal blooms of the Benguela Current*. IOC, World Bank and Sea Fisheries Research Institute Publication. 20 pp.

PLÖN, S., 2004. The status and natural history of pygmy (*Kogia breviceps*) and dwarf (*K. sima*) sperm whales off Southern Africa. PhD Thesis. *Department of Zoology and Entomology* (Rhodes University), p. 551.

POLLOCK, D.E. & L.V. SHANNON, 1987. Response of rock-lobster populations in the Benguela ecosystem to environmental change – a hypothesis. South African Journal of Marine Science 5, 887-899.

PORTER-SMITH, R., HARRIS, P.T., ANDERSEN, O.B., COLEMAN, R., GREENSLADE, D. & C.J. JENKINS, 2004. Classification of the Australian continental shelf based on predicted sediment threshold exceedance from tidal currents and swell waves. Mar. Geol., 211: 1–20.

POTTER, I.C., BECKLEY, L.E., WHITFIELD, A.K. and R.C.J. LENANTON, 1990. Comparisons between the roles played by estuaries in the life cycles of fishes in temperate Western Australia and southern Africa. *Environ. Biol. of Fishes*, **28**: 143-178.

POTTS, W.M., SAUER, W.H.H., HENRIQUES, R., SEQUESSEQUE, S., SANTOS, C.V., SHAW, P.W., 2010. The biology, life history and management needs of a large sciaenid fish, *Argyrosomus coronus* in Angola. *African Journal of Marine Science* 32 (2): 247 —258.

PULFRICH, A., 1998. Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities in the Kerbe Huk area, Namibia. Report to NAMDEB Diamond Corporation (Pty) Ltd, 29pp.

PULFRICH, A., 2007. Intertidal sandy beach communities at Wlotzkasbaken, Namibia. Trekkopje desalination plant: baseline monitoring report. Prepared by Pisces Environmental Services for Turgis Consulting (Pty) Ltd, pp. 38 + Appendix.

PULFRICH, A., 2015. Invertebrate macrofaunal communities of the beaches north of Swakopmund. Baseline Field Survey Report. Prepared for Gecko Namibia, August 2015. pp30.

PULFRICH, A., ATKINSON, L.J., 2007. Monitoring environmental effects of sediment discharges from the Marine Dredging Treatment Plant on sandy beach and rocky intertidal biota in Mining Area 1, Namibia. Prepared for NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 85pp.

PULFRICH, A. & G.M. BRANCH, 2014. Effects of sediment deposition from Namibian diamond mines on intertidal and subtidal rocky-reef communities and the rock lobster *Jasus lalandii*. *Estuarine, Coastal and Shelf Science*, 150: 179-191.

PULFRICH, A., CLARK, B.M., BICCARD, A., LAIRD, M., HUTCHINGS, K., 2014. Survey of Sandy-Beach Macrofaunal Communities on the Sperrgebiet Coastline: Consolidated Beach Monitoring Report – 2014. *Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia*. 191pp.

PULFRICH, A. & K. HUTCHINGS, 2019. Sandy-Beach Macrofaunal Communities on the Sperrgebiet Coastline: Consolidated Beach Monitoring Report – 2019. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia. 159pp.

PULFRICH, A., HUTCHINGS, K., A. BICCARD and CLARK, B.M., 2015. Survey of Sandy-Beach Macrofaunal Communities on the Sperrgebiet Coastline: Consolidated Beach Monitoring Report – 2015. *Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia*. 186pp.

PULFRICH, A., NEL, P. & A.J PENNEY, 2004. Impacts of Beach Mining Operations on Sandy Beach Macrofaunal Communities on the Beaches of Geelwal Karoo: 2004 Beach Survey. Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd. October 2004, 42pp.

PULFRICH, A., PARKINS, C.A. and G.M. BRANCH, 2003a. The effects of shore-based diamond-diving on intertidal and subtidal biological communities and rock lobsters in southern Namibia. *Aquatic Conservation: Marine & Freshwater Ecosystems* **13**: 257-278.

PULFRICH, A., PARKINS, C.A., BRANCH, G.M., BUSTAMANTE, R.H. and C.R. VELÁSQUEZ, 2003b. The effects of sediment deposits from Namibian diamond mines on intertidal and subtidal reefs and rock-lobster populations. *Aquatic Conservation: Marine & Freshwater Ecosystems* **13**: 233-255.

PULFRICH, A. and A.J. PENNEY, 1999. The effects of deep-sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1998. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town and Pisces Research and Management Consultants CC. pp 49.

PULFRICH, A., PENNEY, A.J., 1998. Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities in the Zweispitz area, Namibia. Report to NAMDEB Diamond Corporation (Pty) Ltd, 33pp.

PULFRICH, A., PENNEY, A.J. 1999b. Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities near Lüderitz, Namibia. Final Report to NAMDEB Diamond Corporation (Pty) Ltd, 33pp.

PULFRICH, A., PENNEY, A.J. 2001. Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities near Lüderitz, Namibia. Phase III. Report to NAMDEB Diamond Corporation (Pty) Ltd, 50pp.

PULFRICH, A., PENNEY, A.J., BRANDÃO, A., BUTTERWORTH, D.S. and M. NOFFKE, 2006. Marine Dredging Project: FIMS Final Report. Monitoring of Rock Lobster Abundance, Recruitment and Migration on the Southern Namibian Coast. *Prepared for De Beers Marine Namibia, July 2006*. 149pp.

PULFRICH, A., STEFFANI, N., 2008. Report on Swakopmund Field Survey - Marine Baseline Assessment. In: CSIR 2009. Environmental Impact Assessment for the Proposed Desalination Project at Mile 6 near Swakopmund, Namibia, Draft EIA Report, CSIR Report No. CSIR/CAS/EMS/ER/2009/0015/A, Stellenbosch.

RELINI, G., ZAMBONI, N., TIXI, F. & G. TORCHIA, 1994. Patterns of sessile macrobenthos community development on an artificial reef in the Gulf of Genoa (northwestern Mediterranean). *Bulletin of Marine Science* **55**: 745-771.

RICHARDSON, W.J., GREENE, C.R., MALME, C.I. and THOMSON, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA.

ROEL, B.A., 1987. Demersal communities off the west coast of South Africa. *South African Journal of Marine Science* **5**: 575-584.

ROGERS, J., 1977. *Sedimentation on the continental margin off the Orange River and the Namib Desert.* Unpubl. Ph.D. Thesis, Geol. Dept., Univ. Cape Town. 212 pp.

ROGERS, J., 1979. Dispersal of sediment from the Orange River along the Namib Desert coast. *S. Afr. J. Sci.*, **75**: 567 (abstract).

ROGERS, J. and J.M. BREMNER, 1991. The Benguela Ecosystem. Part VII. Marine-geological aspects. *Oceanogr. Mar. Biol. Ann. Rev.*, **29**: 1-85.

ROMER, G.S., 1988. Fishes. In: McLachlan A. (Ed,).Ecological surveys of sandy beaches of the Namib coast. Institute for Coastal Research Report no. 13. University of Port Elizabeth.

ROSE, B. & A. PAYNE, 1991. Occurrence and behavior of the Southern right whale dolphin *Lissodelphis peronii* off Namibia. *Marine Mammal Science* **7**: 25-34.

ROSENBAUM, H.C., POMILLA, C., MENDEZ, M., LESLIE, M.S., BEST, P.B., FINDLAY, K.P., MINTON, G., ERSTS, P.J., COLLINS, T., ENGEL, M.H., BONATTO, S., KOTZE, P.G.H., MEŸER, M., BARENDSE, J., THORNTON, M., RAZAFINDRAKOTO, Y., NGOUESSONO, S., VELY, M. and J. KISZKA, 2009. Population structure of humpback whales from their breeding grounds in the South Atlantic and Indian Oceans. *PLoS One*, **4 (10)**: 1-11.

ROSENBAUM, H.C., MAXWELL, S., KERSHAW, F. and B.R. MATE, 2014. Long-range movement of humpback whales and their overlap with anthropogenic activity in the South Atlantic Ocean. *Conservation Biology*, 28(2): 604-615.

ROSS, G.J.B., 1979. Records of pygmy and dwarf sperm whales, genus *Kogia*, from southern Africa, with biological notes and some comparisons. *Annals of the Cape Province Museum (Natural History)* **11**: 259-327.

ROUX, J-P., BEST, P.B. and P.E. STANDER. 2001. Sightings of southern right whales (*Eubalaena australis*) in Namibian waters, 1971-1999. *J. Cetacean Res. Manage.* (Special Issue). 2: 181-185.

ROUX, J-P., BRADY, R. and P.B. BEST, 2011. Southern right whales off Namibian and their relationship with those off South Africa. Paper SC/S11/RW16 submitted to IWC Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

ROUX, J-P., BRADY, R. & P.B. BEST, 2015. Does disappearance mean extirpation? The case of right whales off Namibia. Marine Mammal Science 31(3): 1132-1152.

SALOMAN, C.H., NAUGHTON, S.P. & J.L. TAYLOR, 1982. Benthic community response to dredging borrow pits, Panama City Beach, Florida. *U.S. Army, Corps of Engineers, Coastal Engineering Research Centre, Miscellaneous Report*, **82-3**: pp. 139.

SAN (South African Navy), 2020. South African Tide Tables, Hydrographer, South African Navy, Private Bag X1, Tokai 7966, 260pp.

SANTOS, C., 1993. A multivariate study of biotic and abiotic relationships in a subtidal algal stand. *Marine Ecology Progress Series* **94**: 181-190.

SCHIEL, D.R. and M.S. FOSTER, 1986. The structure of subtidal algal stands in temperate waters. *Oceanography & Marine Biology: An Annual Review* **24**, 265-307.

SCHOEMAN, D.S., McLACHLAN, A. & J.E. DUGAN, 2000. Lessons from a Disturbance Experiment in the Intertidal Zone of an Exposed Sandy Beach. *Estuar. Coast. Shelf Sci.*, **50(6)**: 869-884.

SCHRATZBERGER, M., REES, H.L. and S.E. BOYD, 2000a. Effects of simulated deposition of dredged material on structure of nematode assemblages - the role of burial. *Mar. Biol.*, **136**: 519-530.

SCHRATZBERGER, M., REES, H.L. and S.E. BOYD, 2000b. Effects of simulated deposition of dredged material on structure of nematode assemblages - the role of contamination. *Mar. Biol.*, **137**: 613-622.

SCHRATZBERGER, S. & R. WARWICK, 1999. Differential effects of various types of disturbances on the structure of nematode assemblages: an experimental approach. *Mar. Ecol. Prog. Ser.*, **181**: 227–236.

SCHRIEVER, G., AHNERT, A., BLUHM, H., BOROWSKI, C. and H. THIEL, 1997. Results of the large scale deep-sea environmental impact study DISCOL during eight years of investigation. *Proc. 7th ISOPE Conf., Honolulu, USA*: 438-444.

SEAPY, R.R. & M.M. LITTLER, 1982. Population and species diversity fluctuations in a rocky intertidal community relative to severe aerial exposure and sediment burial. *Mar. Biol.,* **71**: 87-96.

SEIDERER, L.J. & R.C. NEWELL, 2000. TRANS HEX-SEACORE Mobile Dredging Platform Environmental Impact of Mining Trials at Greenbank Cove, Cornwall, U.K. July-August 2000. Marine Ecological Surveys Limited report to Transhex Group, August 2000, pp. 45.

SHANNON, L.J., C.L. MOLONEY, A. JARRE and J.G. FIELD, 2003. Trophic flows in the southern Benguela during the 1980s and 1990s. *Journal of Marine Systems*, **39**: 83 - 116.

SHANNON, L.V., 1985. The Benguela Ecosystem. Part 1. Evolution of the Benguela, physical features and processes. *Oceanogr. Mar. Biol. Ann. Rev.*, **23**: 105-182.

SHANNON, L.V. & F.P. ANDERSON, 1982. Application of satellite ocean colour imagery in the study of the Benguela Current system. *S. Afr. J. Photogrammetry, Remote Sensing and Cartography*, **13(3)**: 153-169.

SHANNON, L.V. and G. NELSON, 1996. The Benguela: Large scale features and processes and system variability. In: *The South Atlantic: Present and Past Circulation.* WEFER, G., BERGER, W. H., SIEDLER, G. and D. J. WELLS (eds.). Berlin; Springer: 163-210.

SHANNON L.V. and S. PILLAR, 1985. The Benguela Ecosystem III. Plankton. *Oceanography and Marine Biology: An Annual Review*, **24**: 65-170.

SHANNON, L.V. and M.J. O'TOOLE, 1998. BCLME Thematic Report 2: Integrated overview of the oceanography and environmental variability of the Benguela Current region. Unpublished BCLME Report, 58pp

SHAUGHNESSY P.D., 1979. Cape (South African) fur seal. In: Mammals in the Seas. *F.A.O. Fish. Ser.*, 5, **2**: 37-40.

SHEARS, N.T. & N.R. USMAR, 2006. The role of the Hauraki Gulf Cable Protection Zone in protecting exploited fish species: De facto marine reserve? Department of Conservation Research and Development Series 253, 27 pp

SHEEHAN, E.V., CARTWRIGHT, A.Y., WITT, M.J., ATTRILL, M.J., VURAL, M. & L.A. HOLMES, 2018. Development of epibenthic assemblages on artificial habitat associated with marine renewable infrastructure. *ICES Journal of Marine Science*.

SHERWOOD, J., CHIDGEY, S., CROCKETT, P., GWYTHER, D., HO, P., STRONG, D., WHITELY, B. & A. WILLIAMS, 2016. Installation and operational effects of a HVDC submarine cable in a continental shelf setting. Bass Strait Journal of Ocean Engineering and Science, 1: 337–353.

SHILLINGTON, F. A., PETERSON, W. T., HUTCHINGS, L., PROBYN, T. A., WALDRON, H. N. and J. J. AGENBAG, 1990. A cool upwelling filament off Namibia, South West Africa: Preliminary measurements of physical and biological properties. *Deep-Sea Res.*, **37 (11A)**: 1753-1772.

SIMMONS, R.E., BARNES, K.N. JARVIS, A.M., ROBERTSON, A., 1999. Important Bird Areas in Namibia. Research Discussion Paper No. 31. DEA of MET, 68pp.

SIMMONS, R.E., BROWN, C.J. & J. KEMPER, 2015. *Birds to watch in Namibia: red, rare and endemic species*. Ministry of Environment and Tourism and Namibia Nature Foundation, Windhoek

SINK, K., HOLNESS, S., HARRIS, L., MAJIEDT, P., ATKINSON, L., ROBINSON, T., KIRKMAN, S., HUTCHINGS, L., LESLIE, R., LAMBERTH, S., KERWATH, S., VON DER HEYDEN, S., LOMBARD, A., ATTWOOD, C., BRANCH, G., FAIRWEATHER, T., TALJAARD, S., WEERTS, S., COWLEY, P., AWAD, A., HALPERN, B., GRANTHAM, H. and T. WOLF, 2012. National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine and Coastal Component. South African National Biodiversity Institute, Pretoria.

SKOV, H., BLOCH, R., STUER-LAURIDSEN, F., UUSHONA, D., 2008. Strategic Environmental Assessment (SEA) for the coastal areas of the Erongo and Kunene Regions, Prepared for Namibian Coast Conservation and Management Project (NACOMA) 172pp.

SLATTERY, M. & D. BOCKUS, 1997. Sedimentation in McMurdo Sound, Antarctica: A disturbance mechanism for benthic invertebrates. Polar Biology 18(3): 172-179.

SLR CONSULTING AUSTRALIA, 2019. Proposed Offshore Exploration Drilling in PEL83, Orange Basin, Namibia. Underwater Noise Preliminary Modelling Prediction and Impact Assessment. Prepared for SLR Consulting (Namibia)(Pty) Ltd. July 2019. 47pp.

SMALE, M.J., ROEL, B.A., BADENHORST, A. and J.G. FIELD, 1993. Analysis of demersal community of fish and cephalopods on the Agulhas Bank, South Africa. *Journal of Fisheries Biology* 43:169-191.

SMITH, G.G and G.P. MOCKE, 2002. Interaction between breaking/broken waves and infragravity-scale phenomena to control sediment sediment suspension and transport in the surf zone. *Marine Geology*, **187**: 320-345.

SNELGROVE, P.V.R. & C.A. BUTMAN, 1994. Animal-sediment relationships revisited: cause versus effect. *Oceanography & Marine Biology: An Annual Review*, **32**: 111-177.

SOUTHALL, B.L., FINNERAN, J.J., REICHMUTH, C., NACHTIGALL, P.E., KETTEN, D.R., BOWLES, A.E., ELLISON, W.T., NOWACEK, D.P. & P.L. TYACK, 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

SSEMAKULA, M., 2010. A Comparative Study on the Distribution and Relative Abundance of the Dominant Macro-Fauna found on the Rocky Shore of the Namibian Coastline between Walvis Bay and Swakopmund. Unpublished BSc. Report, University of Namibia, pp61.

STAGE, J., KIRCHNER, C.H., 2005. An economic comparison of the commercial and recreational linefisheries in Namibia. African Journal of Marine Science 27, 577-584.

STEFFANI, N., 2007a. Biological Baseline Survey of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area off Pomona for the Marine Dredging Project. *Prepared for De Beers Marine Namibia (Pty) Ltd*. pp. 42 + Appendices.

STEFFANI, N., 2007b. Biological Monitoring Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Bogenfels. 2005 Survey. *Prepared for De Beers Marine Namibia (Pty) Ltd.* pp. 51 + Appendices.

STEFFANI, N., 2009a. Biological monitoring surveys of the benthic macrofaunal communities in the Atlantic 1 Mining Licence Area and the inshore area - 2006/2007. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 81 + Appendices.

STEFFANI, C.N., 2009b. *Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the De Beers ML3 Mining Licence Area - 18 Months Post-mining.* Prepared for De Beers Marine (South Africa), 47pp.

STEFFANI, N., 2009c. Baseline Study on Benthic Macrofaunal Communities in the Inner Shelf Region and Assessment of Mining Impacts off Chameis. November 2009. Prepared for Namdeb. pp. 45 + Appendices.

STEFFANI, C.N., 2010a. Biological monitoring surveys of the benthic macrofaunal communities in the Atlantic 1 Mining Licence Area - 2008. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 40 + Appendices.

STEFFANI, C.N., 2010b. Benthic grab monitoring survey in the Atlantic 1 Mining Licence Area -2009- sediment composition. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 19 + Appendix.

STEFFANI, C.N., 2010c. *Assessment of mining impacts on macrofaunal benthic communities in the northern inshore area of the De Beers Mining Licence Area 3 – 2010* . Prepared for De Beers Marine (South Africa). pp 30 + Appendices.

STEFFANI, N., 2011. Environmental Impact Assessment for the dredging of Marine Phosphate Enriched Sediments from Mining Licence Area No. 170. Specialist Study No. 1c: Marine Benthic Specialist Study for a Proposed Development of Phosphate Deposits in the Sandpiper Phosphate Licence Area off the Coast of Central Namibia. Prepared for Namibian Marine Phosphate (Pty) Ltd. November 2011. 72 pp.

STEFFANI, C.N., 2012a. *Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the ML3 Mining Licence Area - 2011.* Prepared for De Beers Marine (South Africa), July 2012, 54pp.

STEFFANI, C.N., 2012b. Assessment of mining impacts on macrofaunal benthic communities in the northern inshore area of mining licence area 3.

STEFFANI, C.N., 2014. Assessment of mining impacts on macrofaunal benthic communities in the northern inshore area of mining licence area MPT 25-2011.

STEFFANI, C.N. and A. PULFRICH, 2004a. *Environmental Baseline Survey of the Macrofaunal Benthic Communities in the De Beers ML3/2003 Mining Licence Area.* Prepared for De Beers Marine South Africa, April 2004., 34pp.

STEFFANI, N. and A. PULFRICH, 2004b. The potential impacts of marine dredging operations on benthic communities in unconsolidated sediments. Specialist Study 2. Specialist Study for the Environmental Impact Report for the Pre-feasibility Phase of the Marine Dredging Project in Namdeb's Atlantic 1 Mining Licence Area and in the nearshore areas off Chameis. Prepared for PISCES Environmental Services (Pty) Ltd, September 2004.

STEFFANI, C.N. and A. PULFRICH, 2007. Biological Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Lüderitz 2001 – 2004 Surveys. *Prepared for De Beers Marine Namibia, March 2007*, 288pp.

STUART, C.T., 1975. Marine fauna collected at Sandwich Harbour, Namibia Desert Park, South West Africa. Madoqua Series II 4, 101-102.

SWANSON, J.C., GALAGAN, C. & T. ISAJI, 2006. Transport and fate of sediment suspended from jetting operations for undersea cable burial. OCEANS 2006 1–6.

TAORMINA, B., BALD, J., WANT, A., THOUZEAU, G., LEJART, M., DESROY, N., & A. CARLIER, 2018. A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. *Renewable and Sustainable Energy Reviews*, 96, 380-391.

TARR, J.G., GRIFFITHS, C.L. & R. BALLY, 1985. The ecology of three sandy beaches on the Skeleton Coast of South West Africa, Madoqua 14(3), 295-304.

THIEL, H. & G. SCHRIEVER, 1994. Environmental Consequences of using the Deep Sea – exemplified by mining of polymetallic nodules. *Nord-Süd Aktuell*, **8**: 404-408.

THOMISCH, K., 2017. Distribution patterns and migratory behavior of Antarctic blue whales. *Reports on Polar and Marine Research* 707: pp194. doi:10.2312/BzPM_0707_2017

THOMISCH, K., BOEBEL, O', CLARK, C.W., HAGEN, W., SPIESECKE, S., ZITTERBART, D.P. and I. VAN OPZEELAND, 2016. Spatio-temporal patterns in acoustic presence and distribution of Antarctic blue whales *Balaenoptera musculus intermedia* in the Weddell Sea. doi: 10.3354/esr00739.

TIMONIN, A.G., ARASHKEVICH, E.G., DRITS, A.V., SEMENOVA, T.N., 1992 Zooplankton dynamics in the northern Benguela ecosystem, with special reference to the copepod Calanoides carinatus. In Benguela Trophic Functioning. Payne, A. I. L., Brink, K. H., Mann, K. H. and R. Hilborn (Eds). S. Afr. J. mar. Sci. 12, 545–560.

TJIPUTE, M., SHUULUKA, D., 2006. Zoobenthos survey in the Walvis Bay Lagoon. University of Namibia, Windhoek. Report to the Municipality of Walvis Bay.

UTNE-PALM, A.C., SALVANES, A.G.V., CURRIE, B., KAARTVEDT, S., NILSSON, G.E., BRAITHWAITE, V.A., STECYK, J.A.W., HUNDT, M., V.D. BANK, M., FLYNN, B., SANDVIK, G.K., KLEVJER, T.A., SWEETMAN, A.K., BRÜCHERT, V., PITTMAN, K., PEARD, K.R., LUNDE, I.G., STRANDABØ, R.A.U., GIBBONS, M.J., 2010. Trophic structure and community stability in an overfished ecosystem. Science, 329: 333-336.

VAN DALFSEN, J.A., ESSINK, K., TOXVIG MADSEN, H., BIRKLUND, J., ROMERO, J. and M. MANZANERA, 2000. Differential response of macrozoobenthos to marine sand extraction in the North Sea and the Western Mediterranean. *ICES J. Mar. Sci.,* **57**: 1439–1445.

VAN DER BANK, M.G., UTNE-PALM, A.C., PITTMAN, A., SWEETMAN, A.K., RICHOUX, N.B., BRÜCHERT, V., GIBBONS, M.J., 2011. Dietary success of a 'new' key fish in an overfished ecosystem: evidence from fatty acid and stable isotope signatures. Mar. Ecol. Prog. Ser. 428: 219-233.

VAN DER MERWE, D. & D. VAN DER MERWE, 1991. Effects of off-road vehicles on the macrofauna of a sandy beach. *S. Afr. J. Sci.*, **87**: 210-213.

VAN DER VEER, H.W., BERGMAN, M.J.N. and J.J. BEUKEMA, 1985. Dredging activities in the Dutch Wadden Sea: effects on macrobenthic fauna. *Neth. J. Sea Res.*, **19**: 183–190.

VAN TAMELEN, P.G., 1996. Algal zonation in tidepools: experimental evaluation of the roles of physical disturbance, herbivory and competition. Journal of Experimental Marine Biology & Ecology 201, 197-231.

VISSER, G.A., 1969. Analysis of Atlantic waters off the coast of southern Africa. *Investigational Report Division of Sea Fisheries, South Africa*, 75: 26 pp.

WALDRON, F.W., 1901. On the appearance and disappearance of a mud island at Walfish Bay. Transactions of the South African Philosophical Society 11(1), 185-194.

WANT, A., CRAWFORD, R., KAKKONEN, J., KIDDIE, G., MILLER, S., HARRIS, R.E. & J.S. PORTER, 2017. Biodiversity characterisation and hydrodynamic consequences of marine fouling communities on marine renewable energy infrastructure in the Orkney Islands Archipelago, Scotland, UK. *Biofouling,* 33(7), 567-579.

WARD, L.G., 1985. The influence of wind waves and tidal currents on sediment resuspension in Middle Chesapeake Bay. *Geo-Mar. Letters*, **5**: 1-75.

WARWICK, R.M., GOSS-CUSTARD, J.D., KIRBY, R., GEORGE, C.L., POPE, N.D. & A.A. ROWDEN, 1991. Static and dynamic environmental factors determining the community structure of estuarine macrobenthos in SW Britain: why is the Severn estuary different? *J. Appl. Ecol.* **28**: 329–345.

WEEKS, S.J., CURRIE, B., BAKUN, A. K.R. PEARD, 2004. Hydrogen sulphide eruptions in the Atlantic Ocean off southern Africa: implications of a new view based on SeaWiFS satellite imagery. Deep-Sea Research I 51,153-172.

WEIR, C.R., 2011. Distribution and seasonality of cetaceans in tropical waters between Angola and the Gulf of Guinea. *African Journal of Marine Science* **33(1)**: 1-15.

WEIR, C.R., COLLINS, T., CARVALHO, I. and H.C. ROSENBAUM, 2010. Killer whales (*Orcinus orca*) in Angolan and Gulf of Guinea waters, tropical West Africa. *Journal of the Marine Biological Association of the U.K.* **90**: 1601–1611.

WHITEHEAD, H., 2002. Estimates of the current global population size and historical trajectory for sperm whales. *Marine Ecology Progress Series*, **242**: 295-304.

WITHERINGTON, B.E., MARTIN R.E., 2000. Understanding, assessing and resolving light-pollution problems on sea turtle nesting beaches, 2nd ed. Rev. Florida Marine Research Institute Technical Report TR-2.73 pp.

WITT, M.J., BONGUNO, E.A., BRODERICK, A.C., COYNE, M.S., FORMIA, A., GIBUDI, A., MOUNGUENGUI, G.A., MOUSSOUNDA, C., SAFOU, M., NOUGESSONO, S., PARNELL, R.J., SOUNGUET, G.-P., VERHAGE, S., GODLEY, B.J., 2011. Tracking leatherback turtles from the world's largest rookery: assessing threats across the South Atlantic. *Proceedings of the Royal Society* B. doi:10.1098/rspb.2010.2467

WITZELL, W.N., 1999. Distribution and relative abundance of sea turtles caught incidentally by the U.S. pelagic longline fleet in the western North Atlantic Ocean, 1992-1995. *Fisheries Bulletin* **97**: 200-211.

YATES, M.G., GOSS-CUSTARD, J.D., MCGRORTY, S.M., LAKHANI, DIT DURRELL, S.E.A., LEVIT, CLARKE, R.T., RISPIN, W.E., MOY, I., YATES, T., PLANT, R.A., FROST, A.J., 1993. Sediment characteristics, invertebrate densities and shorebird densities on the inner banks of the Wash. *J. Appl. Ecol.* **30**: 599–614.

ZAJAC, R.N., LEWIS, R.S., POPPE, L.J., TWICHELL, D.C., VOZARIK, J., and M.L. DIGIACOMO-COHEN, 2000. Relationships among sea-floor structure and benthic communities in Long Island Sound at regional and benthoscape scales. *J. Coast. Res.,* **16**: 627–640.

ZOUTENDYK, P., 1992. Turbid water in the Elizabeth Bay region: A review of the relevant literature. CSIR Report EMAS-I 92004.

ZOUTENDYK, P., 1995. Turbid water literature review: a supplement to the 1992 Elizabeth Bay Study. CSIR Report EMAS-I 95008.

ZOUTENDYK, P. & I.R. DUVENAGE, 1989. Composition and biological implications of a nepheloid layer over the inner Agulhas Bank near Mossel Bay, South Africa. *Trans. Roy. Soc. S. Afr.*, **47**: 187-197.

Curriculum Vitae

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Dr Andrea Pulfrich is the founder, director, sole employee and share holder of Pisces Environmental Services (Pty) Ltd. The company was established in January 1998 to help fill the growing need for an expert interface between users of the coastal and marine environment and the various national and provincial management authorities. Since then, PISCES has been providing a wide range of information, analyses, environmental assessments, advice and management recommendations to these user groups, particularly the South African and Namibian marine diamond mining and hydrocarbon industries.

Personal Details

Born:	Pretoria, South Africa on 11 August 1961
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Academic Qualifications

- BSc (Zoology and Botany), University of Natal, Pietermaritzburg, 1982
- BSc (Hons) (Zoology), University of Cape Town, 1983
- MSc (Zoology), University of Cape Town, 1987
- PhD, Department of Fisheries Biology of the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany, 1995

Membership in Professional Societies

- South African Council for Natural Scientific Professions (Pr.Sci.Nat. No: 400327/06)
- South African Institute of Ecologists and Environmental Scientists
- International Association of Impact Assessment (South Africa)

Employment History and Professional Experience

1998-present: Director: Pisces Environmental Services (Pty) Ltd. Specifically responsible for environmental impact assessments, baseline and monitoring studies, marine specialist studies, and environmental management programme reports.

1999: Senior researcher at the University of Cape Town on contract to Namdeb Diamond Corporation and De Beers Marine South Africa; investigating and monitoring the impact of diamond mining on the marine environment and fisheries resources; experimental design and implementation of dive surveys; collaboration with fishermen and diamond divers; deep water benthic sampling, sample analysis and macrobenthos identification.

1996-1999: Senior researcher at the University of Cape Town, on contract to the Chief Director: Marine and Coastal Management (South African Department of Environment Affairs and Tourism); investigating and monitoring the experimental fishery for periwinkles on the Cape south coast; experimental design and implementation of dive surveys for stock assessments; collaboration with fishermen; supervision of Honours and Masters students.

1989-1994: Institute for Marine Science at the Christian-Albrechts University of Kiel, Germany; research assistant in a 5 year project to investigate the population dynamics of mussels and cockles in the Schleswig-Holstein Wadden Sea National Park (employment for Doctoral degree); extensive and intensive dredge sampling for stock assessments, collaboration with and mediation between, commercial fishermen and National Park authorities, co-operative interaction with colleagues working in the Dutch and Danish Wadden Sea, supervision of Honours and Masters projects and student assistants, diving and underwater scientific photography. Scope of doctoral study: experimental design and implementation of a regular sampling program including: (i) plankton sampling and identification of lamellibranch larvae, (ii) reproductive biology and condition indices of mussel populations, (iii) collection of mussel spat on artificial collectors and natural substrates, (iv) sampling of recruits to the established populations, (v) determination of small-scale recruitment patterns, and (vi) data analysis and modelling. Courses and practicals attended as partial fulfilment of the degree: Aquaculture, Stock Assessment and Fisheries Biology, Marine Chemistry, and Physical and Regional Oceanography.

1988-1989: Australian Institute of Marine Science; volunteer research assistant and diver; implementation and maintenance of field experiments, underwater scientific photography, digitizing and analysis of stereo-photoquadrats, larval culture, analysis of gut contents of fishes and invertebrates, carbon analysis.

1985-1987: Sea Fisheries Research Institute of the South African Department of Environment Affairs and Tourism: scientific diver on deep diving surveys off Cape Agulhas; censusing fish populations, collection of benthic species for reef characterization.

South African National Research Institute of Oceanography and Port Elizabeth Museum: technical assistant and research diver; quantitative sampling of benthos in Mossel Bay, and census of fish populations in the Tsitsikamma National Park.

University of Cape Town, Department of Zoology and Percy Fitzpatrick Institute of African Ornithology; research assistant; supervisor of diving survey and collection of marine invertebrates, Prince Edward Islands.

1984-1986: University of Cape Town, Department of Zoology; research assistant (employment for MSc Degree) and demonstrator of first year Biological Science courses. Scope of MSc study: the biology, ecology and fishery of the western Cape linefish species *Pachymetopon blochii*, including (i) socio-economic survey of the fishery and relevant fishing communities, (ii) collection and analysis of data on stomach contents, reproductive biology, age and growth, (iii) analysis of size-frequency and catch statistics, (iv) underwater census, (v) determination of hook size selectivity, (vi) review of historical literature and (vii) recommendations to the Sea Fisheries Research Institute of the South African Department of Environment Affairs and Tourism for the modification of existing management policies for the hottentot fishery.