




ECC-106-285-REP-08-D

ENVIRONMENTAL SCOPING REPORT

PILOT SUSTAINABLE WATER SUPPLY PROJECT BY MEANS OF DESALINATION, POWERED BY SOLAR TO SUPPLEMENT WATER SUPPLY FOR WALVIS BAY, ERONGO REGION, NAMIBIA

PREPARED FOR

TURNKEY WATER SOLUTIONS

innovent sustainable power for Africa

AUGUST 2020

PO BOX 91193 Windhoek Namibia
Environmental Compliance Consultancy CC
CC/2013/11404

TITLE AND APPROVAL PAGE

Project Name:	Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay, Erongo Region, Namibia.
Project Number	ECC-106-285-REP-08-D
Client Name:	Turnkey Water solutions (Pty) Ltd and InnoVent SAS Joint Venture
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Confidentiality

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EXECUTIVE SUMMARY

In order to ensure water security and sustainability in the context of population and industry demand growth, as well as considering the potential impacts of climate change in Walvis Bay, new innovative solutions for supplementing water supply is required. To augment the water supply and distribution demands, a desalination plant is proposed.

Based on confirmation from hydrogeological studies, seawater will be obtained through five onshore beach wells. The approximate pump capacity of the boreholes will be sufficient to produce 3,900 m3/day or 1,422,000 m3/year of clean water, over a lifespan of twenty years, injected into the existing water network. Brine produced from the desalination plant, will be discharged into the ocean through a pipe system. Two options for the route the pipeline will follow into the ocean were considered in the assessment and presented in section 5 of the report. Option 1 is scoped out of the assessment as a non-viable option and the preferred option 2 or similar option 3 and their impacts are assessed. A proposed solar plant onsite will supply power to the desalination plant and will be connected to the grid with a 2km long 11kV underground cable. The grid connection will act as backup power supply to the plant in the event that the solar farm is not producing. In essence it will be a hybrid power supply designed system.

The proposed project is planned on a 4ha portion of municipal land adjacent to Kuisebmond, Walvis Bay in the Erongo Region of Namibia. Directly adjacent to the project site on its immediate southern periphery is the remainder of Erf 4688, which is proposed to be utilised by Unam. Located along the Atlantic Ocean further south of the project site, Walvis Bay is Namibia's only deep-sea harbour and a gateway for at least two corridor routes to the landlocked countries of southern Africa.

Climatically, the central part of the Namib Desert where Walvis Bay is located, is referred to as Cool Desert. Temperatures are moderate, not often exceeding 30°C or dropping lower than 7°C. Sea temperatures are rarely warmer than 20°C. Overcast days and foggy nights are common, but rainfall is rare (<50 mm per year), extremely variable, patchy, unreliable and marked by a deviation coefficient of about 90%. The central Namib Desert forms geologically part of the Damara Sequence, covered by recent, shallow deposits of unconsolidated, aeolian material. At Walvis Bay the general topography is flat, and the town is bordered by sand dunes on the east and southeast, and the inactive delta of the Kuiseb River and a lagoon to the south. The coastline is sandy, but the elongated permanent sandbank that forms the Pelican Point peninsula protects the bay and forms the only deep sea harbour of Namibia. Part of the Namib Desert Biome, the central coastal area of Namibia has a sparse vegetation cover. Overall terrestrial biodiversity is low, but endemism is moderate to high further inland from the site.

In terms of numbers of birds, the Walvis Bay Ramsar site and Important Bird Area (to the south of the study site) is considered the most important coastal wetland in the Sub-region, and probably one of the three most important coastal wetlands in Africa (Simmons et al. 1998). The area is vitally important for Palearctic waders and flamingos, which make up the majority of numbers. The diversity of 159 bird species for the greater study area is regarded as relatively high for the desert environment. Of the priority species identified, 23 are threatened in Namibia, including 16 species that are also Globally Threatened, and 12 that have some form of migrant status. Twenty-two of these species feed on a diet of marine fish, marine invertebrates or a combination of the two. The project area has no direct influence on the Ramsar site

The aspect of the proposed project which directly interacts with the marine environment is the activities related to the construction of the pipeline underwater to a distance of 372m from the coastline at a less than 5m depth below sea level. The closest pelagic fish species and horse mackerel to the project site is found at a depth of 20m below sea level, which translates to approximately 8 km's from the project site. Therefore the project will exert a negligible magnitude of change to existing fish stocks and its significance to this assessment is low.

This EIA was undertaken using a methodology developed by Environmental Compliance Consultancy (ECC) which is based on the International Finance Corporation (IFC) standard for impact assessments and complies with the Namibian requirements as set out in the EMA. Through the scoping process, a review of the site and surrounding environment was completed by undertaking desktop reviews and verification of site data.

The project site is located on municipal land and uncomplicated service connections to the existing urban infrastructure would be possible. Existing roads will be used to access the site. For the development of the site, the terrain needs to be prepared. Construction related impacts are discussed in the EMP.

The water table over the greatest part of Walvis Bay townlands is shallow, but saline and not extracted for human consumption. The project site is located on the Erongo Groundwater Basin, which is marked by its limited potential and low quality. The potential for contamination from the proposed construction and operational activities to both the Kuiseb and Omdel aquifers is regarded as negligible. For the desalination plant, seawater will be abstracted from five onshore beach boreholes. Measures to mitigate potential impacts to water are addressed in the EMP. However, the presence of any water on the site is solely of a marine origin (Water Associates of Namibia, 2020).

This study has assessed potential, likely, identified and cumulative impacts. It was determined that the likely effects on the marine environment associated with the project were not highly significant, based on the magnitude of change affected on the receptor and the impacts assessed, the duration of potential impacts and the reversibility of effects on the receptor.

The overall potential impact of this proposed project is not considered significant as it does not widely exceed recognised levels of acceptable change, does not threaten the integrity of the receptors, and it is not material to the decision making process. The assessment is considered to be comprehensive and sufficient to identify impacts, and it is concluded that no further assessment is required.

On this basis, it is the opinion of ECC that an environmental clearance certificate could be issued, on conditions that the management and mitigation measures specified in the EMP are implemented and adhered to.

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DEFINITIONS AND ABBREVIATIONS

µPa	Micropascal
ALARP	As Low As Reasonably Practicable
CAPEX	Capital expenditure
CIA	Cumulative Impact Assessment
dB	Decibels
DEA	Directorate of Environmental Affairs
ECC	Environmental Compliance Consultancy
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GDP	Gross Domestic Product
Ha	Hectare
HDPE	High-density polyethylene
I&AP	Interested and Affected Party
IBA	Important Bird Area
IFC	International Finance Corporation
kHz	Kilohertz
Km	Kilometer
kV	Kilovolt
kWp	Kilowatts peak
MAWLR	Ministry of Agriculture, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MVA	Mega Volt Amperes
NBR	Northern Benguela Region
NOSF	National Oil Storage Facility
NTS	Non-Technical Summary
OPEX	Operational expenditure
PV	Photovoltaic
QDS	Quarter Degree Square
RO	Reverse Osmosis
SEL	Sound Exposure Levels
SOP	Standard Operation Procedure
SPL	Sound Pressure Level
TWS	Turnkey Water Solutions

1 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

The purpose of this report is to present the findings of the scoping study for the proposed project. The proposed project is to establish a pilot sustainable water supply project by means of desalination, powered by solar to supplement the water supply for Walvis Bay, Erongo Region, Namibia.

The EIA has been undertaken in terms of the requirements of the Environmental Impact Assessment Regulations, No. 30 of 2012, gazetted under the Environmental Management Act, No.7 of 2007 (referred to herein as the EIA Regulations).

1.2 BACKGROUND OF THE PROPOSED PROJECT

Turnkey Water Solutions (Pty) Ltd and InnoVent SAS Joint Venture intends to establish a pilot desalination plant, powered by solar, to supplement the water supply to Walvis Bay. The proposed project is located on a 4ha portion of Walvis Bay municipal land on Erf 4688 in the Erongo Region, Namibia. The preferred site is located north of Kuisebmond, alongside the existing oil and gas jetty, within close proximity of existing physical infrastructure. The site location is set out in Figure 1. Proposed activities include:

- Producing approximately 3,900 m^3/day of clean water or 1,422,000 m^3/year;
- Installation of 5 beach boreholes (4 fully equipped and one spare);
- On shore beach boreholes fitted with infrastructure for an approximate pump capacity of 150m^3/h;
- A plant and infrastructure lifespan of 20 years;
- Brine discharge rates into the ocean will vary between 294 - 340 m^3/h during normal operations; and
- Power for the plant to be generated on site by a hybrid Photovoltaic (PV) solar plant connected to the grid with an underground 3-phase cable.

This project will improve the water resilience of Walvis Bay, and allow for further development.

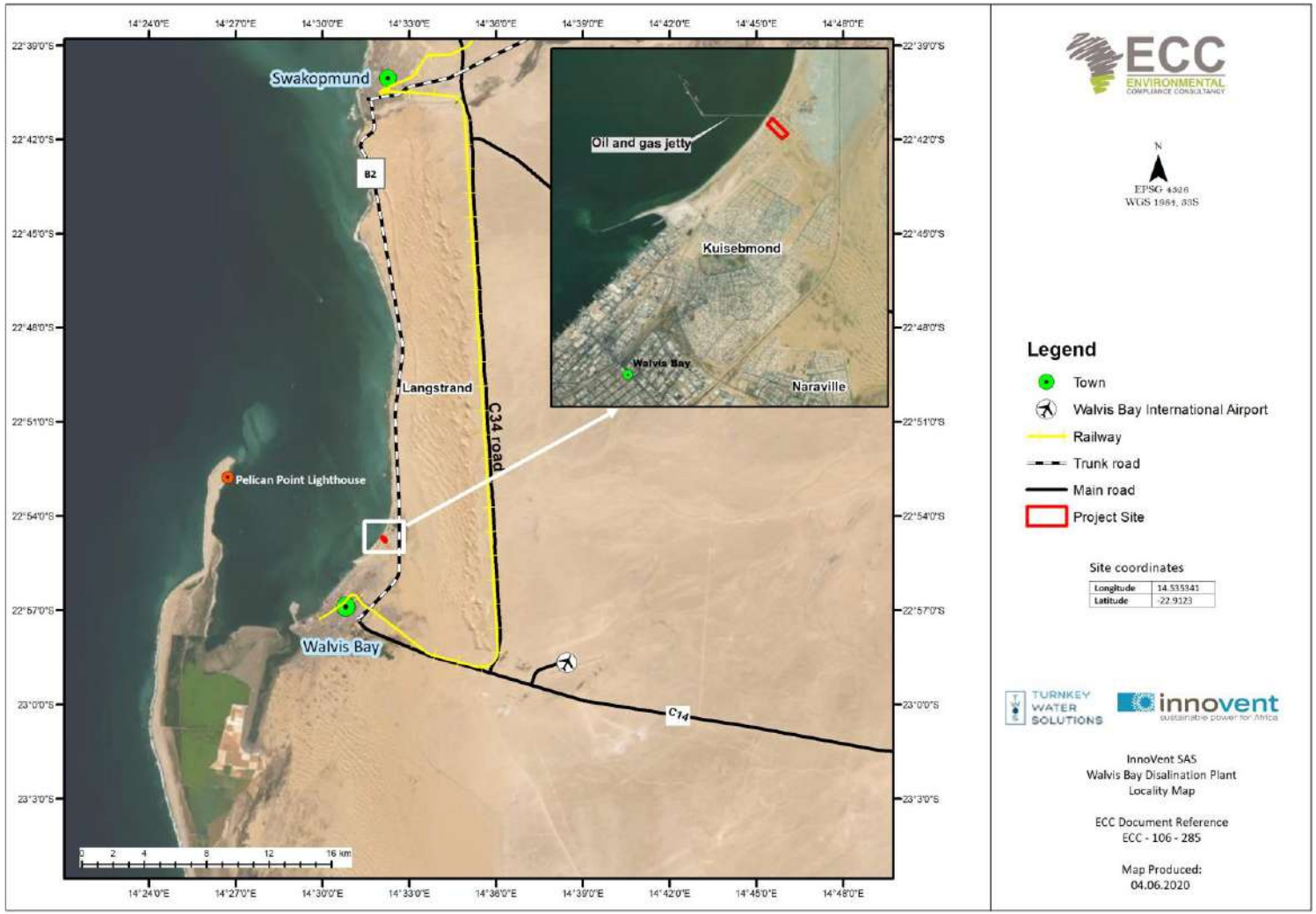


FIGURE 1 – LOCALITY MAP OF THE PROPOSED PROJECT

1.3 SCOPE OF WORK

This scoping report has been prepared by ECC. ECC's terms of reference for the assessment is strictly to address potential effects, whether positive or negative and their relative significance, explore alternatives for technical recommendations and identify appropriate mitigation measures.

This report provides information to the public and stakeholders to aid in the decision-making process for the proposed project. The objectives are to:

- Provide a description of the proposed activities and the site on which the activities are going to be undertaken, and the location of the activities on the site;
- Provide a description of the biophysical environment that may be affected by the activities;
- Identify the laws and guidelines that have been considered in the assessment and preparation of this report;
- Provide details of the public consultation process;
- Describe the need and desirability of the activities;
- Provide a high level of environmental and social impact assessment on feasible alternatives that were considered; and
- Report the assessment findings, identifying the significance of effects.

In addition to the environmental assessment, an EMP (Appendix A) is also required in terms of the Environmental Management Act, No. 7 of 2007. The EMP provides standards and arrangements to ensure that the potential environmental and social impacts are mitigated, prevented and / or minimised as low as reasonably practicable (ALARP) and that statutory requirements and other legal obligations are fulfilled.

The report, plus impact assessment, supported by specialist studies and appendices, will be submitted to the relevant competent authorities and the Directorate of Environmental Affairs (DEA) at the Ministry of Environment, Forestry and Tourism (MEFT) for review as part of the applications for environmental clearance certificate.

1.4 ENVIRONMENTAL CONSULTANCY

ECC, a Namibian consultancy (registration number Close Corporation 2013/11401), has prepared this scoping report and impact assessment on behalf of the proponent. ECC operates exclusively in the environmental, social, health and safety fields for clients across southern Africa, in both the public and private sectors. ECC is independent of the proponent and has no vested or financial interest in the proposed project, except for fair remuneration for professional services rendered.

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

Environmental Compliance Consultancy

PO BOX 91193
Klein Windhoek, Namibia
Tel: +264 81 6697608
Email: info@eccenvironmental.com

1.5 Environmental Requirements

The Environmental Management Act, No. 7 of 2007 stipulates that an environmental clearance certificate is required to undertake listed activities in terms of the Act and its regulations. Listed activities triggered by the proposed project in terms of the Act and its regulations are as follows:

WATER RESOURCE DEVELOPMENT

(8.1) The abstraction of ground or surface water for industrial or commercial purposes

(8.12) The release of brine back into the ocean by desalination plants

INFRASTRUCTURE

(10.1.e) Any structure below the high water mark of the sea

ENERGY GENERATION, TRANSMISSION AND STORAGE ACTIVITIES

(1) The construction of facilities for –

(a) the generation of electricity,

(b) the transmission and supply of electricity

1.6 Report Structure

This report is structured as per the contents set out in Table 1.

TABLE 1 – STRUCTURE OF THE REPORT

SECTION	TITLE	CONTENT
-	Executive summary	Executive summary of the EIA
-	Definitions and abbreviations	A list of definitions and abbreviations used throughout the report
1	Introduction	An introduction of the EIA and background information on the proponent
2	Approach to the Impact Assessment	Provides the assessment methodology applied to the EIA
3	Regulatory framework	Describing the Namibian, international and other relevant environmental regulatory frameworks applicable to the project
4	Project description	Technical description of the project
5	Environmental and Social Baseline	Describing the existing environment through the analysis of the baseline data regarding the existing natural and socio-economic environment
6	Identification and Evaluation of Impacts	Prediction of the potential environmental and social impacts arising from the project, the assessment of impacts including residual impact. The chapter also outlines the proposed management strategies for monitoring commitments to ensure the actual and potential impacts on the environment are minimised to “As Low As Reasonably Practicable” (ALARP), which informs the EMP
7	Impact Assessment Findings and proposed mitigation and management measures	The categorisation of identified impacts and the proposed mitigation and management measures.
8	Environmental Management Plan	A short description of the EMP used to take pro-active action by addressing potential problems before they occur and outline mitigation measures for each impact
9	Conclusion	A synopsis of the main findings of the assessment and recommended action
10	References	A list of references used for this report

SECTION	TITLE	CONTENT
10 - 13	Appendix A - H	– Appendix A: Environmental Management Plan – Appendix B: Non-Technical Summary – Appendix C: Evidence of Public Consultation – Appendix D: ECC CVs – Appendix E: Geotechnical Report – Appendix F: Hydrogeological Report & Risk Assessment – Appendix G: Avifauna Report – Appendix H: Dispersion Modelling & Technical Assessment

2 APPROACH TO THE IMPACT ASSESSMENT

2.1 PURPOSE OF THE ENVIRONMENTAL IMPACT ASSESSMENT

The EIA process in Namibia is governed and controlled by the Environmental Management Act, No. 7 of 2007 and its regulations, No. 30 of 2012, which is administered by the Office of the Environmental Commissioner through the DEA of the MEFT.

The aim of this preliminary assessment is to identify, predict, evaluate and mitigate the potential impacts of the proposed project on the natural and human receiving environment, scope the available data and identify the gaps that need to be filled. The assessment process helps to determine the spatial and temporal scope and identify the assessment methodology which is most applicable for use. In addition the assessment process and subsequent reports are to apply the principles of environmental management to the proposed activities; reduce the negative and increase the positive impacts arising from the project; provide an opportunity for the public to consider the environmental impacts of the proposed project through meaningful consultation; and to provide a vehicle to present the findings of the assessment process to competent authorities for decision making.

2.2 THE ASSESSMENT PROCESS

The EIA methodology applied to this assessment has been developed using the IFC standards and models (IFC, 2012; 2017), in particular Performance Standard 1: '*Assessment and management of environmental and social risks and impacts*' which establishes the importance of:

- Integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- The client's management of environmental and social performance throughout the life of the project.

Furthermore, the Namibian Draft Procedures and Guidance for EIA and EMP (GRN, 2008) as well as the international and national best practice documents to our disposal and over 25 years of combined EIA experience, were also drawn upon in the assessment process.

An impact assessment is a formal process in which the effects of certain types of development on the biophysical, social and economic environments are identified, assessed and reported so that the effects can be taken into account when considering whether to grant development consent or to provide financial support. Final mitigation measures and recommendations are based on the cumulative experience of the consulting team and the client, taking into consideration the potential environmental and social impacts. The process followed through the basic assessment is illustrated in Figure 2 and detailed further in the following sections.

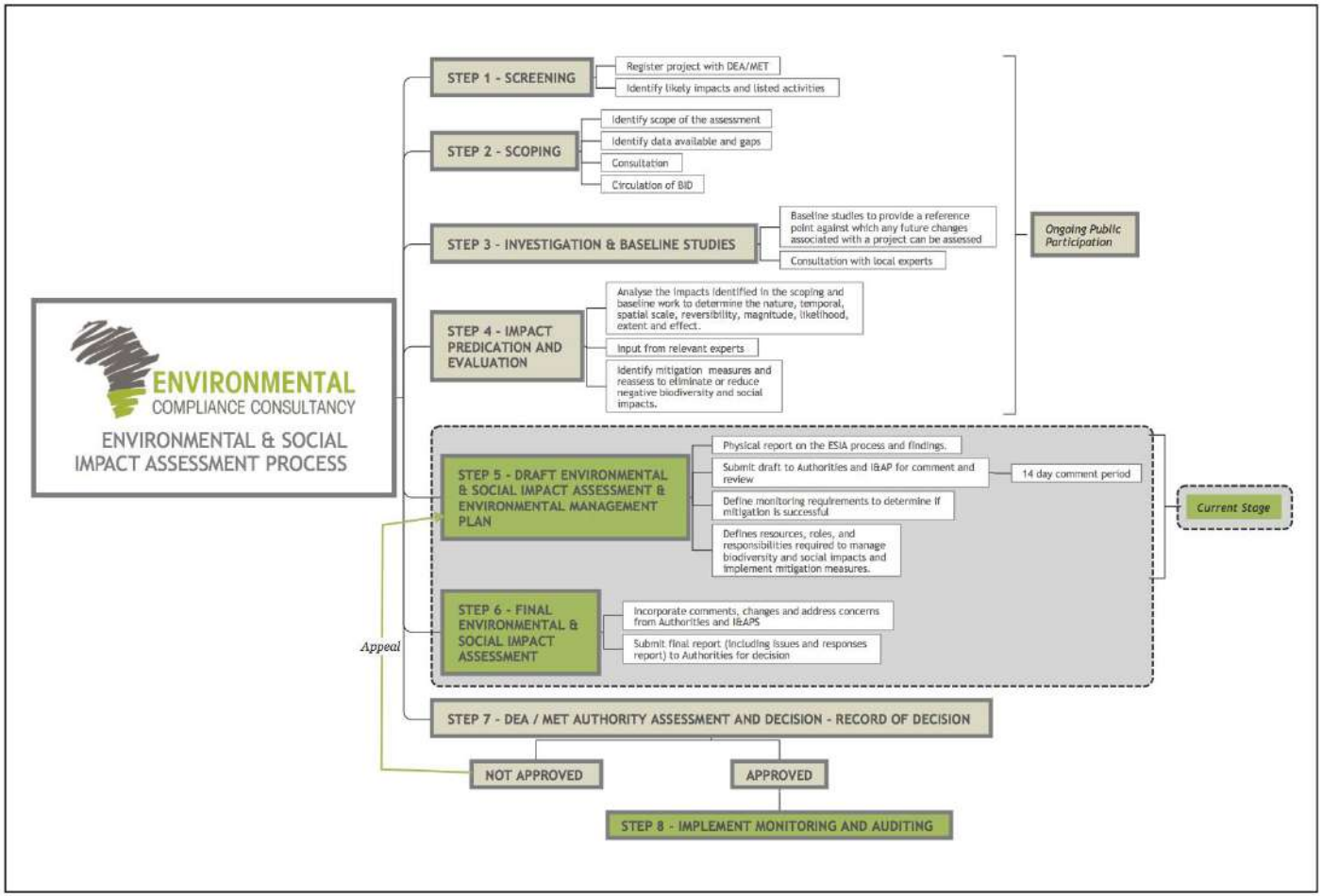


FIGURE 2 – ECC SCOPING PROCESS

2.3 METHODOLOGY FOR THE IMPACT ASSESSMENTS

Desktop studies on the national database are undertaken as part of the scoping stage to get information about the current status of the receiving environment. This provides a baseline where changes that can occur as a result of the proposed project, can be measured. This is then verified through site data collection.

The environmental and social topics that may be affected by the proposed project are described in this document. The baseline focuses on receptors which could be affected by the proposed project.

2.4 SCREENING OF THE PROPOSED PROJECT

The first stages in the EIA process is to register the project with the DEA / MEFT and undertake a screening exercise to determine whether it is considered as a listed activity under the Environmental Management Act, No. 7 of 2007 and its regulations and if significant impacts may arise from the project. The location, scale and duration of project activities will be considered against the receiving environment.

It was concluded that an EIA (e.g. scoping report and EMP) is required, as the proposed project is considered as a listed activity and there may be potential for significant impacts to occur.

2.5 SCOPING OF THE ENVIRONMENTAL ASSESSMENT

The purpose of the scoping stage in the EIA process is to identify the scope of assessment; undertake a high-level assessment to identify potential impacts and to confirm if further investigation is required; to assign the severity of potentially significant effects; and to allocate appropriate mitigation.

This report presents the findings of the scoping phase and high-level assessment, (see also Section 6) and it confirms that no further investigation is required.

2.6 BASELINE STUDIES

Baseline studies are undertaken as part of the scoping stage, which involves collecting all pertinent information from the current status of the receiving environment. This provides a baseline against which changes that occur as a result of the proposed project can be measured.

For the proposed project, baseline information was obtained through a desktop study, focussing on environmental receptors that could be affected by the proposed project, verified through site-specific information. The baseline information is covered in Section 5.

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

The existing environment and social baseline for the proposed project were collected through various methods:

- Desktop studies;
- Consultation with stakeholders; and
- Engagement with Interested and Affected Parties (I&APs). See Appendix C.

2.7 EIA CONSULTATION

Public participation and consultation are requirements stipulated in Section 21 of the Environmental Management Act, No. 7 of 2007 and its regulations for a project that needs an environmental clearance certificate. Consultation is a compulsory and critical component in the EIA process in achieving transparent decision-making and can provide many benefits.

The objectives of the stakeholder engagement process are to:

- Provide information on the project to I&APs: introduce the overall concept and plan
- Clarify responsibility and regulating authorities
- Listen to and understand community issues, concerns and questions
- Explain the process of the EIA and timeframes involved, and
- Establish a platform for ongoing consultation.

2.7.1 INTERESTED AND AFFECTED PARTIES

All relevant authoritative bodies were identified and listed as I&APs, as well as organisations and individuals with an implied interest. Other I&APs were identified through invitations such as the newspaper advertisements and site notices. To all of these stakeholders a formal letter was sent. The letter and the list of registered I&APs are provided in Appendix C.

2.7.2 NON-TECHNICAL SUMMARY

The Non-Technical Summary (NTS) presents a high-level description of the proposed project; sets out the EIA process and when and how consultation is undertaken; and provides contact details for further project-specific inquiries to all registered I&APs. The NTS was distributed to registered I&APs and the NTS can be found in Appendix B.

2.7.3 NEWSPAPER ADVERTISEMENTS

Notices regarding the proposed project and associated activities were circulated in two newspapers namely the 'Namibian' and 'Informante' on the 29th of May and the 5th of June 2020. The purpose of this was to commence the consultation process and enable I&AP's to register an interest with the project. The adverts can be found in Appendix C.

2.7.4 SITE NOTICES

A site notice ensures neighbouring properties and stakeholders are made aware of a proposed project. The notices were set up at strategic points to identify the project site. A copy of the site notice is illustrated in Appendix C.

2.7.5 CONSULTATION FEEDBACK

The I&APs were encouraged to provide constructive input during the consultation periods. Matters of concern raised during the initial round of consultation are presented in Appendix C.

The public review of the Scoping Report and the EMP were set between 20 -28 July 2020. The comments received from the public review of the draft scoping report and EMP and the responses to the comments made are shown in the table below.

Table 2: I&AP and Stakeholder Feedback from the review of the draft reports

No.	Chapter	Section	I&AP / Stakeholder Comment received	Stakeholder details	Response / Clarification
1.	7	7.7	1. An important issue that is not being addressed in the report is the impact of the proposed development on NamWater. NamWater is in process of spending millions on the maintenance and improvement of the water supply system in the Kuiseb River. The water is being supplied to Walvis Bay. Water tariffs are being calculated on a regional scale according to the volume of water that will be supplied from the sources and the total cost that enables NamWater to supply these volumes. 2. It is important that any water supply project be thoroughly discussed with NamWater so that NamWater is aware of such project and that proper planning including tariff calculations, can be done. Is extension on current groundwater scheme still required or is it a waste of money?	Jolanda Kamburona Environmentalist In-Training Water Quality & ES 176 Iscor Street, Northern Industrial Area, Windhoek, Namibia Private Bag 13389, , Namibia Tel: +264 (61) 71-2105, Fax: +264 (61) 71-2097 Cell: +264 81 217 8116 E-mail: KamburonaJ@namwater.com.na	During the public review period (20-28 July 2020), NamWater commented that they are in the planning stage of investing capital to upgrade and improve the current Kuiseb water supply system to augment water capacity to the Walvis Bay town. No technical details were available at the time of this assessment to determine the level of influence such plans could have on water supply to the town in tandem with the current project. Hence, it is treated as a cumulative impact, since it's still in the conception stage and its implementation is unknown. See table 20 below. The current desalination project will contribute a volume likened to a quarter of the current water demand for Walvis Bay and is regarded as a relatively small project
2.	7	7.2 (p66)	We know it's a bit late at this stage, but perhaps you would consider two more changes please, to be included in your final report? 1. In your scoping/assessment report (p63), please could you remove the exclamation mark from the end of the last column in the attached (after … applied subsequently)?	Mike & Ann Scott African Conservation Services E-mail: ecoserve@iway.na	1. Point 1 has been addressed, with the grammatical correction made to the applicable sentence. 2. The section referred to have been kept as is in the report.

No.	Chapter	Section	I&AP / Stakeholder Comment received	Stakeholder details	Response / Clarification
			2. One other change, as indicated in the attached: it seems that it might make more sense to mention/summarise all four of the potential impacts on birds here, rather than to describe only one of the impacts in detail? You are welcome to re-word/shorten the impact significance descriptions, in brackets.		
3.	Appendices additional to the report	Appendix C	(20/07/2020) Received via e-mail. Thank you for sending us the documents regarding the EIA for the proposed desalination. I have however noticed that m name does not appear under 13 Appendix C (I&AP). I will appreciate it if you can please add my name. In the meantime, we will go through the documents and will provide you with the comments prior to the due date.	Kristy Asino (Town Planner) Department of Roads and Building Control, Municipality of Walvis Bay. Civic Centre, Nangolo Mbumba Drive, Walvis Bay, Namibia, Walvis Bay, Namibia Tel: +264 64 201 3339 Fax: +264 64 206 135 E: kasino@walvisbaycc.org.na W: www.walvisbaycc.org.na	Response sent via e-mail on the 20/07/2020) Good afternoon Kristy, Thank you for giving me the heads up on the name entry. I will insert accordingly. This I&APs name and designation was added to the list contained in Appendix C of the report. No further comments were received from the I&AP.
4.	N/A	N/A	(21/07/2020) Received via e-mail. Please forward the BID and all specialist reports to me. Thank you.	Mr. Nicolaas du Plessis Senior Environmentalist Water Quality and Environmental Services 176 Iscor Street, Northern Industrial Area, Windhoek, Namibia Private Bag 13389, Windhoek, Namibia Tel: +264 (61) 71-2093, Fax:	The requested documentation was forwarded to Mr. Du Plessis on the 21/07/2020.

No.	Chapter	Section	I&AP / Stakeholder Comment received	Stakeholder details	Response / Clarification
				+264 (61) 71-2097 Cell: 081 127 9040 E-mail: PlessisN@namwater.com.na	
5.	N/A	N/A	(20/07/2020) Received via e-mail. Thanks for your email and for copies of the Scoping Report and EMP. I will look through the documents and will provide you with any comments before the 28 July due date. Best wishes, Bruce	Mr. Bruce Stewart Town Planner 84 Theo Ben Gurirab Avenue|First Floor CLA Building|Box 2095 Walvis Bay Tel: (064) 280 770|Mobile: 081 170 0960|Email: bruce@sp.com.na	Good afternoon Bruce, Thank you for getting in touch. Yes, we'd appreciate your valuable inputs into the ESIA. Response sent via e-mail on the 20/07/2020) No further commentary was received.

2.8 DRAFT EIA AND EMP

This report and EMP for the project's environmental clearance includes an assessment of the biophysical and social environment which satisfies the requirements of Step 5.

The EIA report documents the findings of the assessment process, provides stakeholders with opportunity to comment and continued consultation and forms part of the environmental clearance application. The EMP provides measures to manage the environmental and social impacts of the proposed project and outlines specific roles and responsibilities to fulfil the plan.

This EIA report focuses on the significant impacts that may arise from the proposed project as described in Step 4. These impacts are discussed in Chapter 7.

This EIA report was issued to stakeholders and I&APs for consultation for a period of 7 days (20/07/2020 – 28/07/2020), meeting the mandatory requirement of 7 days as set out in the Environmental Management Act, No. & of 2007 and its regulations, including the Environmental Impact Assessment Regulations, No. 30 of 2012. The aim of this stage was to ensure all stakeholders and I&APs have the opportunity to provide final comments on the assessment process and findings and register their concerns.

2.9 FINAL EIA AND EMP

All comments received during the I&AP public review period were collated in Section 2.7 of this EIA report. All comments were responded to either through providing an explanation or further information in the response table, or sign posting where information exists, or new information has been included in the EIA report or appendices. Comments have been considered and where they were deemed to be material to the decision making or enhance the EIA and EIA report were incorporated into this EIA report.

The final EIA report and associated appendices will be available to all stakeholders on the ECC website www.eccenvironmental.com. All I&APs will be informed via email.

The EIA report and appendices will be formally submitted to the Office of the Environmental Commissioner, DEA as part of the application to for an environmental clearance certificate.

2.10 AUTHORITY ASSESSMENT AND DECISION MAKING

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

2.11 MONITORING AND AUDITING

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

3 REGULATORY FRAMEWORK

This chapter outlines the regulatory framework applicable to the proposed project. Table 8 provides a list of applicable legislation and relevance to the project.

3.1 NATIONAL LEGISLATION

TABLE 3 – LEGAL COMPLIANCE

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
Constitution of the Republic of Namibia of 1990, as amended	The constitution clearly defines the country's overarching position in relation to the well-being of Namibians, sustainable development and environmental management. The constitution refers that the state shall actively promote and maintain the welfare of the people by adopting policies aimed at the following: *"Maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present, and future; in particular, the Government shall provide measures against the dumping or recycling of foreign nuclear and toxic waste on Namibian territory."*	The proponent is committed to engage the local community for the proposed project by providing local jobs as well as exploring ways of finding benefits and contributing to the development of Namibia.
Environmental Management Act, No. 7 of 2007 and its regulations, including the Environmental Impact Assessment Regulations, No. 30 of 2012	The act aims to promote sustainable management of the environment and the use of natural resources by establishing principles for decision-making on matters affecting the environment. It sets the principles of environmental management as well as the functions and powers of the minister. The act requires certain activities, which may have a detrimental effect on the environment, to obtain an environmental clearance certificate prior to project development. The act states an EIA may be undertaken and submitted as part of the environmental clearance certificate application. The act and its regulations need to be given due consideration to achieve proper waste management and pollution control by means of the cradle to grave responsibility, precautionary principle, the polluter pays principle and the principles of public	This environmental scoping report (and EMP) documents the findings of the environmental assessment undertaken for the proposed project, which will form part of the environmental clearance application. The assessment and report have been undertaken in line with the requirements under the act and associated regulations.

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
	participation and access to information. The MEFT is responsible for the protection and management of Namibia's natural environment. The DEA under the MEFT is responsible for the administration of the EIA process.	
Water Resources Management Act, No. 11 of 2013	This act provides a framework for managing water resources based on the principles of integrated water resource management, i.e. the full array of management, development, protection, conservation, and use of water resources. The Department of Water Affairs within the Ministry of Agriculture, Water and Land Reform (MAWLR) is responsible for the administration of the act. As such the department is responsible for ensuring that Namibia achieves sustainable water resources management by controlling the abstraction of water (also from the ocean), disposal of domestic and industrial effluent, and potable and effluent quality monitoring. This act has not been approved by parliament; however it is best practice to comply with this Act.	The act sets out obligations in order to avoid water pollution and stipulates licence requirements; however, as the act is not enforced (but only applied as best practice); no regulations support the act to stipulate how a licence should be obtained.
Water Act, No. 54 of 1956	The Water Act 54 of 1956 remains in force and this act provides for *"the control, conservation and use of water for domestic, agricultural, urban and industrial purposes; to make provision for the control, in certain respect and for the control of certain activities on or in water in certain areas".* The minister may issue a permit in terms of the regulations 5 and 9 of the government notice R1278 of 23 July 1971 as promulgated under section 30 (2) of the Water Act no. 54 of 1956, as amended to allow the discharge of wastewater and effluent, and to have control over pollution of a stream and water, including seawater. Although the definition of pollution is missing in this act, the act covers potential	The act stipulates obligations to prevent pollution of water. Should waste water be discharged, a permit is required. The act makes pollution of fresh- or seawater a criminal offence. Measures to minimise potential water pollution are contained in the EMP. Abstraction of water from boreholes requires an abstraction permit. Abstraction rates need to be measured and reported to the authorities in accordance with the requirements of this legislation. In addition, monitoring and annual reporting on the environmental impacts of water abstraction is recommendable. Should the project require drilling and abstraction of water from underground sources, an application

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
	marine pollution from land-based sources	should be submitted to the authorities. The Department of Water Affairs are stakeholders for this assessment.
Marine Resources Act, No. 27 of 2000	The act provides for the conservation of the marine ecosystem and the responsible utilisation, conservation, protection and promotion of marine resources on a sustainable basis. It replaces the Sea Fisheries Act 29 of 1992, which in turn replaced the Sea Fisheries Act 58 of 1973. It also replaces the Sea Birds and Seals Protection Act 46 of 1973. The act provides for the establishment of marine reserves and imposes penalties on discharges or deposits of waste or any other polluting matter. The Ministry of Fisheries and Marine Resources (MFMR) is responsible for the administration of the act.	Whilst the construction and operation of the proposed project does not fall under the act, it is recognised that as an indirect consequence of the project, some activities may infer to the act – therefore the EMP considers the relevant guidelines and requirements of the act. The Directorate of Resource Management of the MFMR is a stakeholder for this assessment.
Namibian Ports Authority Act, No. 2 of 1994	The act provides for the establishment of the Namibian ports authority (Namport) to undertake the management and control of ports and lighthouses in Namibia, and the provisions of facilities and services related thereto. According to the act, Namport is responsible for protecting the environment within its demarcated area of control.	Any vessels passing through or activities that take place within the Namport authority area are compelled to comply with Namport regulations, including safety and environmental requirements, and will be licenced. The above is stipulated in the EMP. Also, Namport are stakeholders for this assessment
Seashore Ordinance, No. 37 of 1958	The ordinance provides for the determination of the actual position of the high-water mark and for matters incidental thereto, including surveying. The ordinance is known for an early definition of the seashore, high water and low water marks, which is retained in updated legislation. It is also known for its stipulations about the deposit or discharge of rubbish and the like on the seashore or in the sea within three nautical miles offshore.	In the event that the high-water mark needs to be surveyed, it shall be undertaken in accordance with this ordinance and other relevant Namibian Law. This ordinance has not been used to guide the ESIA process.
Electricity Act, No. 4 of 2007	The act stipulates that any potential generator of electricity must apply for such	The area where the generation activities will take place should be accurately depicted on

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
	a licence from the Electricity Control Board. The application is evaluated and a recommendation is provided to the minister of Mines and Energy, who ultimately makes the decision whether a licence is granted or refused.	a map in the application, as well as proof of right to the land, particulars of the applicant and particulars of the generation station. If the generator is not off-grid, an agreement with NamPower or the regional distributor should be in place. As a listed activity the application requires an EIA.
National Heritage Act, No. 27 of 2004.	The act makes provision for the protection and conservation of places and objects with heritage significance. Section 55 requires the reporting of any archaeological findings to the National Heritage Council after which a permit needs to be issued before the find can be disturbed.	There is potential for heritage objects to be found during the construction activities, therefore the stipulations in the act have been taken into consideration and are incorporated into the EMP. The project shall be compliant with Section 55 of the act.

3.2 POLICIES

TABLE 4: LEGAL COMPLIANCE (POLICIES)

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
National water policy white paper	This document of 2002 forms the basis for the Water Resources Management Act, No. 11 of 2013. The policy provides a framework for the equitable, efficient and sustainable water resource management and stresses the sectoral coordination, integrated planning and management aimed at coping with environmental risks	The projects aim is to work within the ambit of the policy to address Namibia's challenges with its water resources, by providing an alternative to freshwater abstraction from the region's already strained resources.
Towards a coastal policy for Namibia	This Green Paper document of 2009 provides an outline of the key findings of a long-term study on the conservation and management of the Namibian coast. It sets out the coastal policy and the vision for the coast, as well as principals, goals and objectives for coastal governance. It also presents the options for institutional and legal arrangements towards implementing the emerging Namibia Coastal Policy options for coastal governance in Namibia.	The proposed project has been assessed against the Green Paper to ensure the development does not create conflict. Principles of Integrated Coastal Zone Management have been used as guidance, including applying the precautionary approach; the polluter pays principle, and applying transparency.

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
Integrated urban spatial development framework for Walvis Bay	This document of 2014 reviews the current town plan, population projects and social requirements, and sets out a plan to accommodate Walvis Bay's development.	The proposed project is aligned to the framework which, amongst others, states that a full EIA will be required for the proposed project, as wells as public consultation and an EMP.
Vision 2030	Vision 2030 sets out the nation's development programmes and strategies to achieve its national objectives. It sets out eight themes to realise the country's long-term vision and states that the overall goal is to improve the quality of life of the Namibian people to a level in line with the developed world.	The planned project shall meet the objectives of Vision 2030 and shall contribute to the overall goal to ensure the continued supply of safe and reliable drinking water.
Fifth National Development Plan (NDP5)	NDP5 is the fifth in the series of seven five-year national development plans that outline the objectives and aspiration of Namibia's long-term vision as expressed in Vision 2030. NDP5 is structured on the pillars of economic progression, social transformation, environmental sustainability and good governance. It identifies the sustainable production and consumption of water resources as a key development priority.	The proposed project is a development, which forms part of the bigger picture of achieving economic progression, social transformation and environmental sustainability. During the development of the proposal, the principles of NDP5 have been applied where relevant. The information contained in NDP5 has been used to develop the baseline (e.g. population growth predictions and information on different industry sectors, as well as current and future targets).
Draft pollution and waste management bill of 1999	Not promulgated, the bill amalgamates a variety of legislative frameworks in Namibia, regulating pollution in various sectors while promoting sustainable development. The purpose of the bill is to regulate and to prevent the discharge of pollutants to the air, water and land. Discharging or disposing of wastewater and pollutants into any body of water is forbidden without a water pollution licence.	Although not enacted, the bill is applied to ensure that activities potentially giving rise to air and water pollution, noise emissions and solid waste are minimized as far as reasonable practicable and obligations are adhered to.
Aquaculture act, No. 18 of 2002	The act provides guidance on the monitoring of water quality where aquaculture might be affected by any pollution as well as the subsequent regulations that may stem from that.	The project operational guidelines should standardise a procedure for frequent monitoring regimes on plant infrastructure integrity observations and recording as well as frequent monitoring of seawater quality parameters.

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
Labour Act, No. 11 of 2007	Regulations relating to the occupational health and safety provisions of employees at work were promulgated in terms of Section 101 of the Labour Act, No. 6 of 1992 and gazetted in 1997. Accordingly, stringent health and safety policies, including the compulsory use of specific PPE in designated areas to ensure adequate protection against health and safety risks, have to be in place. Proper storage and labelling of hazardous substances are required. Implementing of a comprehensive waste management and disposal policy is necessary - this should include the management and disposal of hazardous substances. Employees in charge of and working with hazardous substances need to be aware of the specific hazardous substances in order not to compromise worker and environmental safety in the event of accidental breakage or spillage. Transport of various hazardous substances requires staff responsible for such transport to be properly trained in the handling of the substance and that adequate safety and emergency response plans are place in case of accidental spillage.	The proposed project will comply with stringent health and safety policies, including the compulsory use of specific PPE in designated areas to ensure adequate protection against health and safety risks. Proper storage and labelling of hazardous substances (i.e. Chlorine) are required. The project will ensure employees in charge of and working with hazardous substances needs to be aware of the specific hazardous substances in order not to compromise worker and environmental safety.
National framework for marine spatial planning in Namibia	This document is a high-level policy statement that provides general guidance for sustainable ocean development in Namibia. It sets out the overall vision for the ocean, along with the goals and principles of marine spatial planning, which was documented in 2018 as a status report. Marine spatial planning is prioritised as a means of achieving a sustainable blue economy for Namibia as part of the development priorities in NDP5.	Sea water abstraction and desalination for the supply to mines, urban use in coastal towns and the processing of fish and fish products is recognized as one of the many uses of Namibia's marine resources. This activity is not highlighted as creating possible conflict with other marine-based sectors and has no significant negative environmental impacts, in general. There is however a need for regular monitoring, control through a permit system and synchrony with sectors such as urban coastal development and environmental protection (MFMR, 2018). Assessment of the proposed project

NATIONAL REGULATORY REGIME	SUMMARY	APPLICABILITY TO THE PROJECT
		includes these aspects through a public consultation process and an EMP.

3.3 PERMITS

Environmental permits, in addition to an environmental clearance certificate, may be needed in order to carry out operations of the project to ensure full compliance with the Namibian law.

The below table contains a list of potential permits that may be required for the operations of the project is tabled below.

TABLE 5 - PERMITS AND LICENSES

PERMIT	RELEVANT AUTHORITY	VALIDITY/DURATION
Wastewater Treatment Plant	Ministry of Agriculture, Water and Land Reform	Permit dependent
Wastewater and Effluent Disposal Exemption Permit	Ministry of Agriculture, Water and Land Reform	Five years
Water Abstraction Permit	Ministry of Agriculture, Water and Land Reform	Permit dependent
Bulk water use licence	Ministry of Agriculture, Water and Land Reform	Permit dependent
Electricity generation licence	Ministry of Mines and Energy	50 years, unless sooner cancelled

4 PROJECT DESCRIPTION

4.1 NEED FOR THE PROPOSED PROJECT

Walvis Bay receives less than 50 millimeters average rainfall per year, making it one of the driest inhabited places on earth. Annual average daily demand for the town is estimated at 18,300 m3/day (GLS, 2020). To meet the current water demand, water is supplied to the municipality from different sources, mainly boreholes in the lower segment of the ephemeral Kuiseb River. A volume of 3,900m3/day or 1,422,000m3/year was indicated as the potential volume for desalination water injection into the water system of Walvis Bay (GLS, 2020).

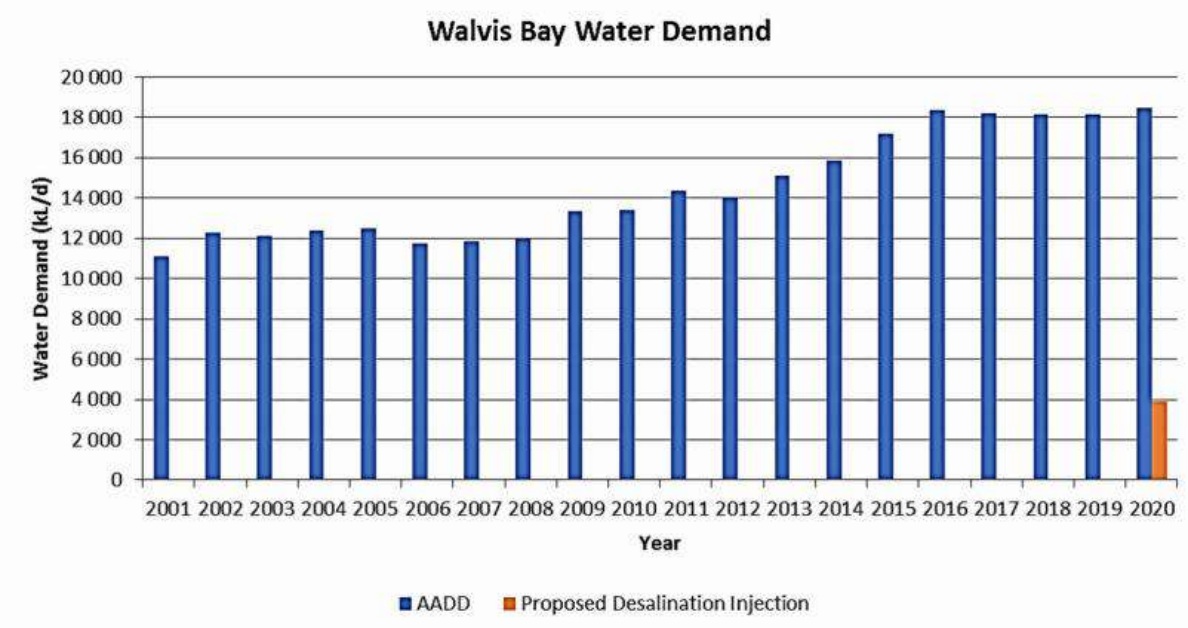


FIGURE 3: HISTORIC WATER DEMAND ANALYSIS FOR WALVIS BAY (SOURCE: GLS, 2020)

Water is an essential resource and the adequate supply of water is a basic human need. As a resource, water needs to be managed to harmonise human and environmental requirements. In order to ensure water security and sustainability in the context of population and industry demand growth, as well as considering the potential impacts of climate change, new innovative solutions for supplementing water supply to Walvis Bay is required.

Daily and seasonal water demands in any urban setting fluctuates and the supply of water at a constant rate is a challenge in every urban place.

On a strategic development level a desalination plant is a preferred solution of water supply to a large zone or a reservoir in a coastal urban set-up because it can produce water at a constant rate and augments water distribution demands (GLS, 2020). Also, the supply of water from a different location and source ensure alternatives to a supply system that is expected to deliver consistently, and will improve the water resilience of Walvis Bay. Not only will the project supplement a sustainable supply of water to Walvis Bay, but it will create employment and act as a catalyst for further development.

4.2 ALTERNATIVES CONSIDERED (PROJECT COMPONENTS)

Although abstraction and desalination of seawater has in general no significant negative environmental impacts (MFMR, 2018), it depends on the quantity abstracted, and the location where abstraction takes place. Many variables are associated with these two main factors. As a result, abstraction and desalination of seawater requires licensing and regular monitoring (MFMR, 2018).

In terms of the law, it is illegal to abstract water, also seawate*r*, without a permit. Water permits are administered by the Department of Water Affairs within the MAWLR. A permit determines the location of abstraction and regulates the amount of water that may be abstracted for an identified purpose. Monitoring and reporting requirements are also stipulated by the permit.

In terms of the Environmental Management Act, No. 7 of 2007 and its regulations, alternatives considered should be analysed and presented in the scoping assessment and EIA report. This requirement ensures that during the design evolution and decision-making process, potential environmental impacts, costs, and technical feasibility have been considered by means of consultation and an iterative environmental assessment, which leads to the best option(s) being identified.

To consider alternatives necessitates specialist studies and for this project a geotechnical study (Omamanya Geotechnical Consultants, 2020), a hydrological study (Water Associates Namibia, 2020) as well as a brine dispersions and dilution model study (WAMTech, 2020). The avifauna specialist study conducted assists the proponent to understand how the proposed project can mitigate potential impacts on the avifauna environment.

4.2.1 PREFERRED SITE LOCATION

Four possible sites were identified as options for the project, three of which were further north from the selected site. The four sites were weighted against each other (Figure 4 below) in terms of the intake potential and discharge options, available land and access to infrastructure (grid connection and water reticulation), lease cost and duration, and safety. Environmental considerations include visual impacts, proximity with sensitive areas and erosion potential.

The selected site which is located approximately 500m north east of extension 17 scored almost one-third more points than the second best site – the main advantages being the availability of municipal land on a long term lease and proximity to the built area and existing infrastructure.

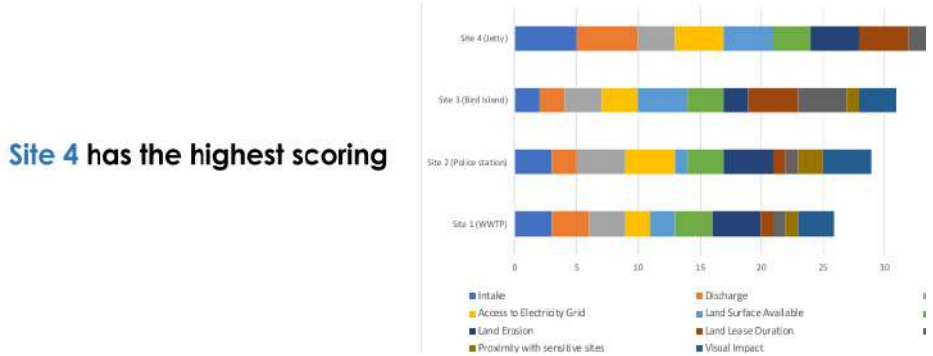


FIGURE 4: SITE SELECTION SCORECARD (TWS, Innosun 2020).

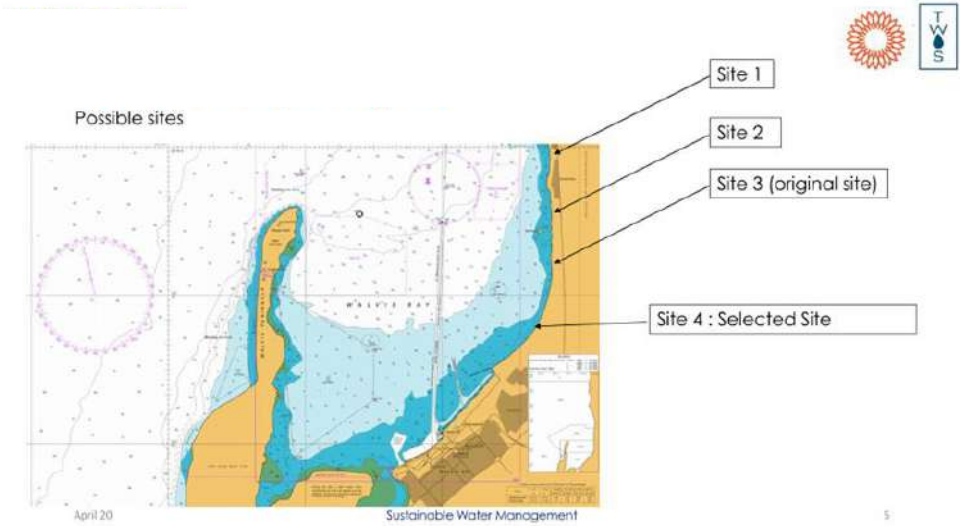


FIGURE 5: CLOSE-UP ALTERNATIVE SITES

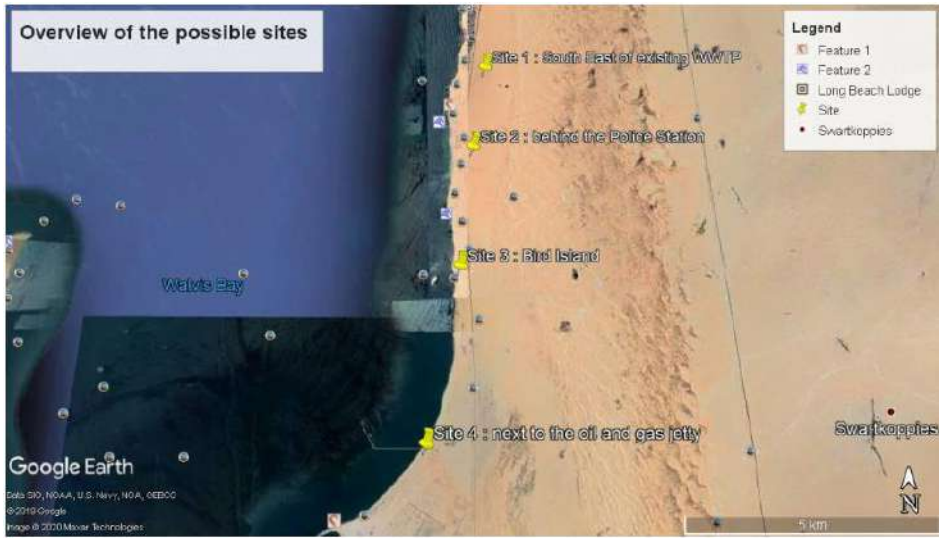


FIGURE 6: ALTERNATIVE SITES INVESTIGATED AND THE SELECTED SITE (Source: TWS, 2020).

4.2.2 BRINE DISCHARGE

The options for brine discharge were weighed against factors such as water depth (bathymetry), physiography of the seabed and coastline (shelter, sloping of the beach), wind regime, tidal variation and sea motion or current (circulation, direction and speed) and the stratification of the water. FIGURE 8 provides perspective on the geographical lay-out and water depth in relation to the proposed site.

Discharging the brine into the surf zone relies on the turbulence and mixing caused by energetic wave conditions, the long shore and cross shore currents and tidal exchanges which will aid the expected rapid mixing, dilution and distribution of the brine discharges (SLR, Aurecon, 2015).

The brine dispersion and dilution model prepared for this project covered amongst others the diurnal (daily) variation of wind, the longshore drift and tidal differences. In shallow water (less than 20m deep) alternating sea (day) and land (night) breezes can have a strong influence on the longshore drift and thus the ability of water to transport suspended material including the discharged brine. The maximum tidal variation in Walvis Bay seldom exceeds 1.8m with an average closer to 1m. Wave height is low – at a water depth of 13m it is not more than 0.3m; mainly as a result of the sheltered bay. Currents are weak, and at a water depth of 5m it rarely exceeds 0.2m/s. Stratification is considered as mild, due to the relative shallow water. As the density of the effluent will be denser than the receiving environment (seawater), the possible effect of stratification is considered insignificant as a result (WAMTech, 2020).

Brine effluent								
Salinity			Effluent temperature			Effluent TSS (assumed negligible)		
min	operation	max	min	operational	max	min	operational	max
51900	55600	58600	12	16	21	0	0	0
51900	55600	58600	12	16	21	0	0	0

FIGURE 7: BRINE EFFLUENT QUALITY

The WAMTech study also covers water quality guidelines to which brine effluent discharge has to comply with, based on recommended target values of the South African Water Quality Guidelines for Coastal Marine Waters in the absence of Namibian specific guidelines.

The study states that the dilution of brine discharge (i.e. reducing the concentration with uncontaminated ambient seawater) have to comply with the guidelines and achieve acceptable concentration levels for recreational human activities along the coastline (full contact, intermediate and non-contact) and maintaining ecosystems functioning. Constituents for the recreational human activities and basic amenities are aesthetics, colour (turbidity) and suspended solids. For maintaining ecosystems functioning, the constituents are temperature, pH, dissolved oxygen, salinity, dissolve nutrients, ammonia and toxic inorganics (WAMTech, 2020).

As there is going to be no other waste item in the brine discharge, only salinity is considered as a critical constituent. Brine effluent discharge must comply with the South African Marine Water Quality Guidelines (WAMTech, 2020).

FIGURE 8:– WATER DEPTH OF THE BAY IN RELATION TO THE BRINE OUTFALL POINT (Source: WAMTech, 2020)

4.2.3 Diffuser Placement Options

Two alternative locations for the brine discharge line were considered, illustrated in Figure 9.

The effectiveness of diffuser operation and therefore its placement is directly linked to the placement of the pipeline it is attached to. Therefore the diffuser and pipeline placement options are discussed in tandem and not separated.

4.2.3.1 OPTION 1

If the discharge line is attached to the existing NamCor jetty, no marine construction would be required. The jetty extends west to a water depth of -5m for 1km on a weak slope of the seabed (1:200), and then to the northwest for about 700m to a water depth of -7m on a slope of 1:350 (WAMTech, 2020). A HDPE (OD 355 PE 100 Class 10) pipeline of 1,150m is considered for this purpose. This option may have contraction and expansion issues though, but eliminates the risks associated with dredging. Additionally, temperature differences may reduce the pipe pressure rating. This option presupposes an agreement with Namcor on the use of their property is exposed to the risk of damages as a result of mooring activities and has implications for the Namcor service road crossing though (TWS, 2020). This option is therefore considered non-viable and scoped out of the assessment and not discussed any further.

FIGURE 9: – ALTERNATIVES FOR THE BRINE DISCHARGE EXIT POINT (SOURCE: WAMTECH, 2020)

4.2.3.2 OPTION 2

If the brine is discharged via a trenched pipeline, construction below the high-water mark of the sea is required. Advantages of a trenched line are as follows:

- The diffuser could be anchored in shallower water,
- Avoids the Namcor property (Jetty), avoiding any possible damages as a result of mooring activities at the jetty.
- A trench will be dug into the seabed of >40m is planned, with a HDPE (OD 355 PE 100 Class 10) pipeline of 560m, of which 372m is into the sea. In the design, provision is made for a

brine storage tank on land using gravitational flow with a capacity of 150m^3. This option implies that the brine discharge pumps can be removed from the power supply design and that overall energy consumption is lowered as a result – having positive impacts on CAPEX, maintenance, OPEX and likely the size of the solar plant (TWS, 2020).

Based on the preference for Option 2, configuration and hydraulic performance requirements are set for the design of the outfall infrastructure (the pipeline and diffuser) in order to achieve acceptable concentration levels and meet dilution targets. With salinity as the only critical constituent, compliance with water quality guidelines is achievable within 10m from the diffuser and within a mixing zone of not more than 200m^2 (WAMTech, 2020). The diffuser for Option 2 was designed to comply with the required dilutions for the range of flow rates between high (533 m3/hr) and low (362 m3/hr) for range of salinities and current velocities.

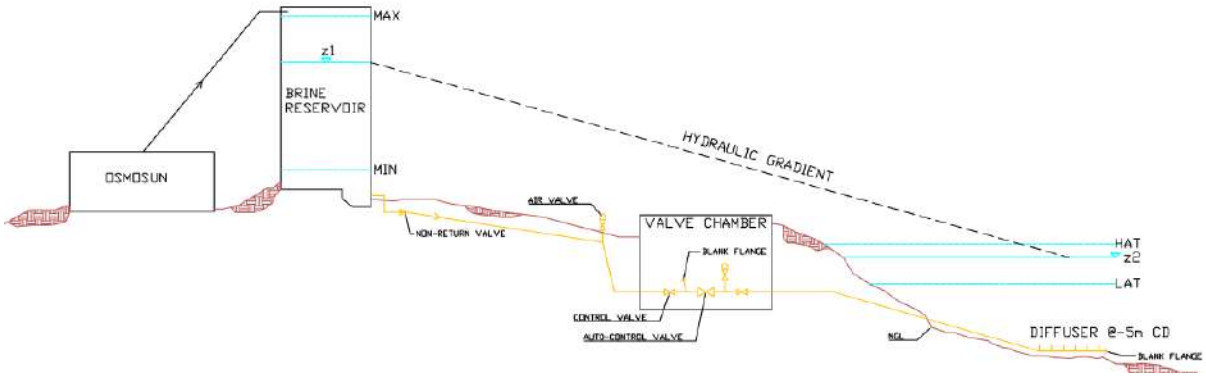


FIGURE 10: CROSS SECTIONAL DIAGRAM OF OPTION 2 PIPELINE ROUTE TOWARD OUTFALL POINT (WMLCoast, 2020)

4.2.3.3 OPTION 3

This option has the exact same design components as option 2 above. It also avoids NamCor property by staying south of the jetty to the -5m depth. Utilises approximately 1060m HDPE pipeline, of which 870m will be in the sea.

4.2.4 SEAWATER ABSTRACTION

In this proposed project seawater will be abstracted through beach boreholes, i.e. no direct intake from the sea will be needed. In this way maintenance would be easier than at sea, lower seawater treatment is required and no marine-based works are required. One of the big advantages of onshore abstraction is that the possibility to impact on marine species is eliminated. All beach boreholes will be located on the project site. Preliminary indications show that ample sea water is found in as little as 1.5m from the surface and that a favorable layer of coarse sand lays around 3-4m deep.

4.2.5 ENERGY NEEDS

As an alternative to its dependency on electricity, power for the plant will be generated onsite by a hybrid PV solar plant connected to the grid with a 2km long 11kV 3-phase underground cable. In this way the plant is less dependent on electricity from fossil fuel and, as a result, will have a lower CO_2

footprint. With its low level energy consumption, the water cost is reduced to enable strong economic competitiveness.

4.2.6 BUILDING DESIGN

The entire premises will be fenced off (1.8 – 2.4m high) and access to the site will be restricted, with one security-controlled entrance on the northern side of the site. Where necessary, low/dim lights and motion-sensor lighting will be installed around the buildings on the site to enhance security.

4.2.7 NO-GO ALTERNATIVE

Should the project not take place, the anticipated environmental impacts from its activities would not occur. The social and economic benefits associated with the project would also not be realised.

There would not be an opportunity to supplement the sustainable water supply of Walvis Bay, a missed opportunity for improving the water resilience of Walvis Bay, and disallowing opportunities for further development that could benefit the local, regional and even the national economy.

4.3 PROPOSED ACTIVITIES AND TECHNICAL DESCRIPTION OF THE PROJECT

The preferred site on Erf 4688 alongside the existing oil and gas jetty, north of Kuisebmond and in close proximity of existing infrastructure enables access through a connecting road / street with the existing street network of Walvis Bay. The proposed site lay-out is indicated in Figure 11. Erf 4688 is already disturbed as a result of development activities (building of houses and streets) on the adjacent land.

A desalination plant building of approximately 400m^2, with storage areas is planned, near the proposed entrance (see Figure 11).

The largest part of the site will be occupied by the solar plant though – mono-axial trackers on which poly-crystalline solar panels (360kWp or larger) are mounted, with wide spacing between the rows of trackers to ensure reduced shading. The solar modules are connected to one another through standard direct current solar module cabling. These strings are combined into larger direct current cabling and inject directly into the control cabinet of the desalination plant. Some of the pumps housed outside of the building will require alternating current power supply, which implies inverters to convert direct current to alternating current.

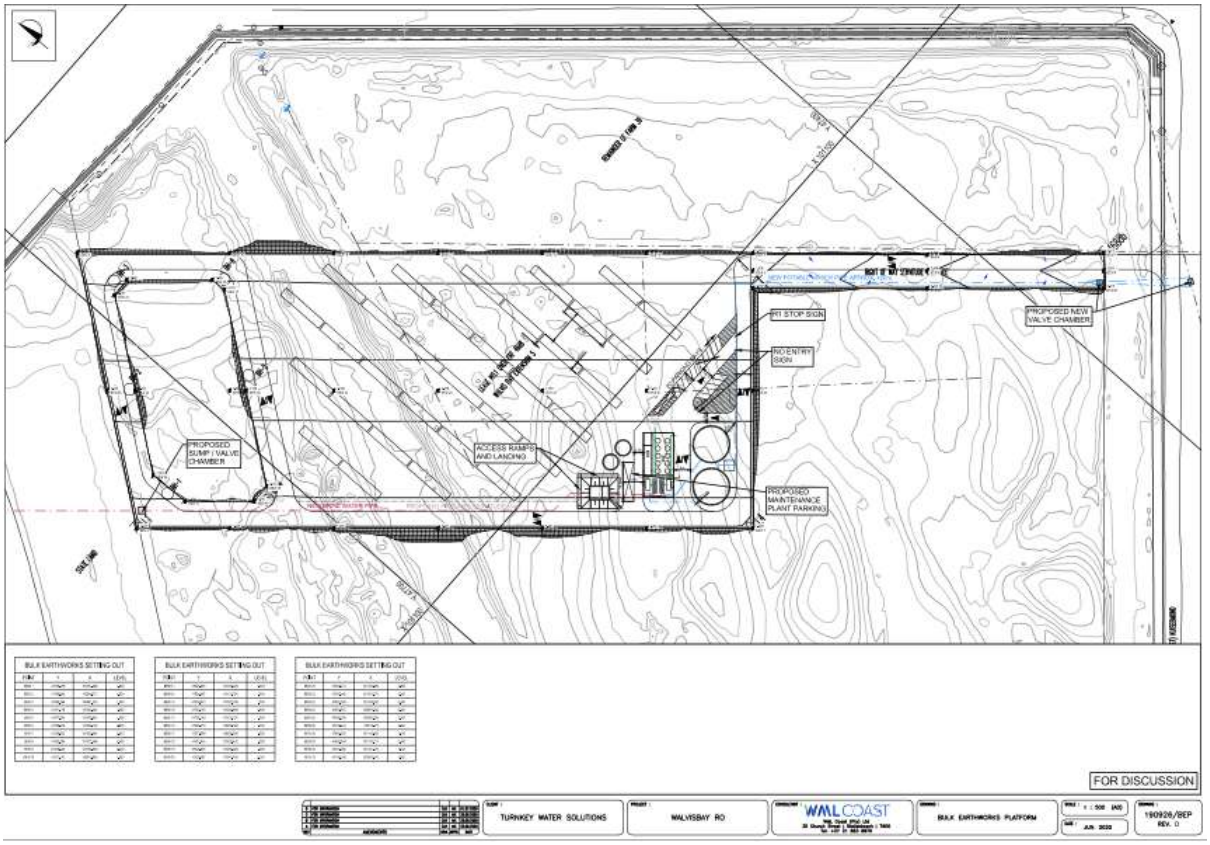


FIGURE 11:– PROPOSED SITE LAYOUT (SOURCE: TWS, 2020)

The solar panels need to be cleaned regularly. The cleaning is done manually with water lightly sprayed onto the panels. It is planned that the cleaning will take over several days, nullifying the possibility of accumulated run-off and forming of puddles.

The solar plant will be connected to the grid. The solar plant is designed to generate up to circa 1400kWp. The grid acts as a back-up for when the solar plant is not producing. Connection to the grid is through Erongo RED's Tutaleni substation, approximately 2 km away. An underground 3-phase cable, able to supply over 1 MVA to the desalination plant at 11kV, provides this connection. This will be stepped down (11kV/0.4kV 1MVA or larger transformer) on the project site and injected into the control cabinet of the desalination plant.

The abstraction boreholes will be placed on the seafront side of the site. Four of the boreholes will be fully equipped and one will be used as a spare. The boreholes will be fitted with infrastructure and the approximate pump capacity is calculated at 150m^3/h. Preliminary indications show that ample seawater is found as little as 1.4m deep (Omamanya Geotechnical Consultants, 2020), to be confirmed with further beach well tests. The concept of the beach wells is illustrated in Figure 6 below.

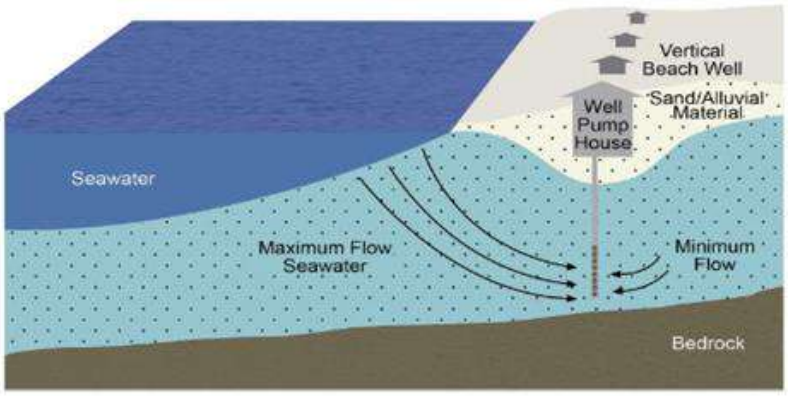


FIGURE 12:– BEACH BOREHOLE CONCEPT FOR THE WATER SUPPLY TO THE PLANT (SOURCE: TWS, INNOSUN 2020)

The planned capacity of the desalination plant is to produce 3,900m^3/day or 1,422,000m^3/year of clean water, over a lifespan of twenty years. It is planned that the desalination plant will inject potable water into a 300mm Ø bulk pipeline. This pipeline will be connected to the existing network and supply water to the northern areas and to the Langstrand reservoir (GLS, 2020).

Brine will be discharged into the ocean, at a salinity of 51, 9 ppt – 58, 6 ppt or an average of 55g/L. Maximum flow discharges are estimated to be 362 - 533 m^3/h. during normal operations. Brine discharge will vary between 294 and 340 m^3/h (WAMTech, 2020).

4.4 SCHEDULE OF ACTIVITIES

Initial meetings between Turnkey Water Solutions (Pty) Ltd and InnoVent SAS Joint Venture and the Walvis Bay Municipality were held in September 2019. At the end of 2019 a technical and budget proposal was submitted to the municipality and a commercial agreement was reached in February 2020.

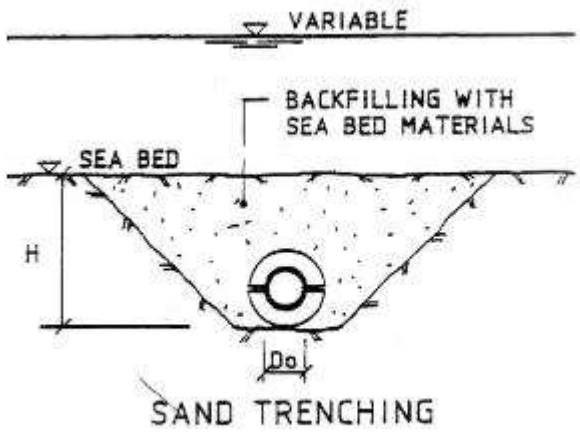
It is planned that construction will start in September 2020 and will be completed before the end of the year when operations will commence.

FIGURE 13:-SCHEDULE OF ACTIVITIES (Source: TWS, Innosun 2020)

4.5 EQUIPMENT

Typically where the water table is high, as in this case, the contractor rents sheet piles which they drive into the sand in stages then utilises an excavator for the trenching. The machinery is available

locally and because piling is expected to be into 'soft' sandy material, it should be easier than digging into dense gravel / rock soil types. See below example of a buried pipeline after trenching.



Outfall system

- Main pipeline:
  - Material: HDPE: 355 mm OD (311.65 mm ID).
  - Length and route: Approximate 600 m, buried between HAT and LAT.
- Diffuser:
  - Depth: -5 m below MSL.
  - Stainless steel with two tapers and 6 ports (2 x 0.075 mm ID, 2 x 0.085 mm ID and 2 x 0.09 mm ID) at 2000 mm intervals.

FIGURE 14:-CROSS SECTIONAL DIAGRAM ILLUSTRATING THE BURIED MARINE PIPELINE (Source: TWS, Innosun 2020).

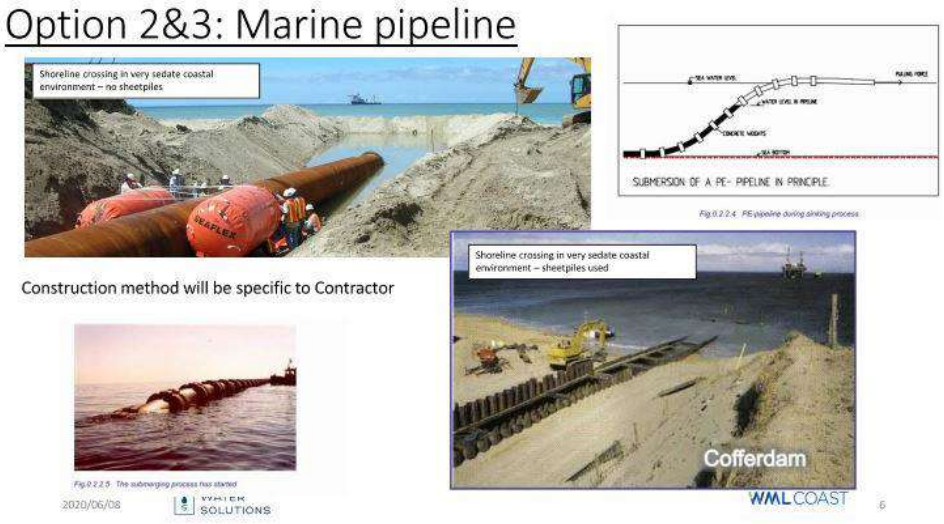


FIGURE 15:-EXAMPLE OF THE CONSTRUCTION METHOD PROPOSED (SOURCE: TWS, INNOSUN 2020)

4.6 WORKERS AND ACCOMMODATION

A team of 90 workers will be employed during construction (TWS, Innosun 2020). Construction is of a general nature with no specialized skills foreseen. The workers will not reside on site but in Walvis Bay, in their own accommodation. The workers will be transported by a contractor shuttle during the construction phase.

A small team of permanent workers (10 people) will be employed during the operational phase.

	Number of jobs created
Special purpose company (20 years)	
Project Manager	1
Admin/invoicing	1
Quality control	1
Operations and maintenance (20 years)	
Plant supervisor	1
Plant operators	3
Security	3
Construction phase (6 months)	
Civil works /building	40
Solar farm	40
Mechanical works / OSMOSUN installation	10

FIGURE 16:-BREAKDOWN OF EMPLOYMENT TYPES GENERATED BY PROJECT (Source: TWS, Innosun, 2020)

4.7 RESOURCE AND WASTE MANAGEMENT

Water will be required for various uses during construction, including human consumption. Water will be sourced from the municipal supply during construction. During operations the plant will produce potable water, which will be injected into the municipal water system and used onsite as well.

Waste will be produced during construction, which will be collected in skips. Items include timber (pallets and crates), plastics and empty containers. It is not foreseen that any hazardous waste will be produced – during construction as well as during operations. All solid waste shall be collected, segregated as far as possible and taken off-site through the municipal refuse removal system.

No sewage connection is required as on/off-site waste management as such, because portable toilets will be utilised.

At Langstrand all sewage is pumped to the septic tank / wetland system in the dunes and again no sewage is discharged into the sea. The only sea outfall is at Dolphin Park, which case the pipe is only used when the swimming pool needs to be backwashed or emptied. Sewage generated at Dolphin Park is treated at the adjacent septic tank system and does not enter the sea.

The proponent will ensure waste transport certificates are in place when sewerage waste is removed from site. No waste shall be discharged or uncontained.

Spent solar panels (solar waste) should be contained on site and sealed off from access by anyone. Spent solar panels should only be disposed of at an appropriate waste disposal facility that has the capacity to extract the cadmium and lead component parts out of the panel safely. Cadmium has the potential to leach into the environment through rain action. Since the project area does not receive rainfall this potential impact is mitigated.

5 ENVIRONMENTAL AND SOCIAL BASELINE

5.1 INTRODUCTION

This section provides an overview of the existing biophysical environment through the analysis of the baseline data regarding the existing natural and socio-economic environment. Desktop studies on the national database are undertaken as part of the scoping stage to get information of the current status of the receiving environment. This provides a baseline where changes that occur as a result of the proposed project can be measured. This section also incorporates consultation and public participation of the proposed project.

5.2 THE PROJECT SITE AND LOCATION

In close proximity of the existing urban infrastructure the proposed project is located on the northern end of Kuisebmond, alongside the existing oil and gas jetty. The site is already disturbed as a result of the many development activities on the adjacent areas.

5.3 SITE AND SURROUNDING ENVIRONMENT

Walvis Bay has developed along the coastline of Namibia due to the fishing industry and in recent years because of the development and use of the harbour. Over time the harbour became increasingly important for Namibia and its neighbours, establishing the town as an important gateway to the Trans-Kalahari and Trans-Caprivi highways.

Development of the town is geographical restricted by the dune belt to the east, the Kuiseb River to the south as well as the lagoon to the southwest. The harbour takes up the majority of the coastline, and is directly bordered by the industrial part of the town. To the south the harbour is bordered by the lagoon and salt works and to the north the coastline is unbuilt. The town has a characteristic grid structure with a large area served with a north-south and east-west street pattern.

The built area of Walvis Bay covers approximately 30km^2. The lower income residential areas are located to the north and northeast, close to the industrial and light industrial parts of town. The central part includes the central business district and low-residential townships. The higher income residential areas are located towards the south of the town.

The B2 main road enters the town from the north, connecting Walvis Bay with Swakopmund and beyond. The Walvis Bay International Airport is located east of the town, behind the dune belt. From the east a gravel road connects Walvis Bay with the Namib-Naukluft Park and further ahead. East of the dune belt is a recently built dual carriage road, the C34, which was built to alleviate the traffic flow on the B2 close to the sea. This road runs parallel to the railway line that connects Walvis Bay with the rest of Namibia (Figure 1).

5.4 CLIMATE

The climate of the central Namib Desert is characterized by predominant southwest winds originating from the quasi-stationary South Atlantic High off the southern Namibian coast. At Walvis Bay the prevalent wind directions are from southwest to southeast, almost 90% of the time (see Figure 7). As a result of the cold Atlantic, temperatures close to the coast are moderate, the humidity is high, and overcast days and foggy nights are common. Climatically this part is referred to as Cool Desert. Daily and seasonal fluctuation in temperature is moderate, not often exceeding 30°C or dropping lower than 7°C. Sea temperatures are rarely warmer than 20°C. On average the warmest month is February and the coolest month August. Walvis Bay is located in an area where the rainfall can be described as extremely variable, patchy, unreliable and is marked by a deviation coefficient of more than 90%. The average annual rainfall is less than 50 mm (Mendelsohn et al., 2002).

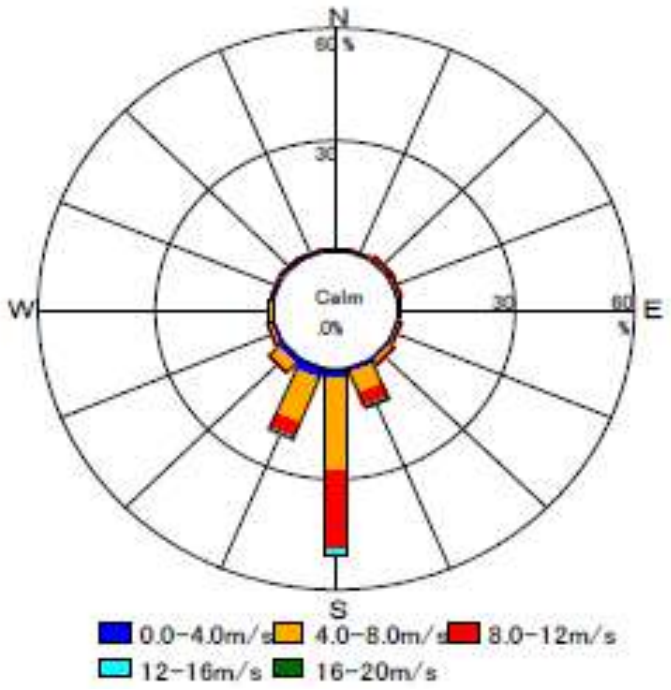


FIGURE 17:– OFFSHORE WIND SPEED AND DIRECTION AT WALVIS BAY (SOURCE: WAMTECH, 2020)

Of particular relevance to this study is the diurnal change of wind, which has an effect on wave action and the transport of material in the water – especially where the seabed is shallow (less than 20m deep). This is also coupled to tide levels. Both aspects were covered in the brine dispersion and dilution model prepared by WAMTech (2020).

Further away from the coast the aridity of the interior becomes increasingly noticeable. Temperatures show wider diurnal and seasonal ranges, rain is the main source of precipitation and exceeding 50 mm per annum, humidity is low and insolation is high. As the distance from the coast increases, the wind speed decreases and its direction become more variable. Occasional east winds blow during winter, as a result of cold sinking air over the interior that flows towards the coast. This

air heats up as it blows towards the coast, and result in the recording of higher temperatures. Except the higher temperatures, east winds are also associated with dusty and dry conditions at the coast.

5.5 GEOLOGY AND GEOMORPHOLOGY

Geologically Walvis Bay forms part of the central zone of the Damara Sequence (between 850 and 600 million years old). This is the part of Namibia underlain by schists, quartzites, meta-greywackes, marbles and calc-silicates. These rocks have been intensely folded and locally have a NNE/SSW strike. Part of the pre-Damaran basement, gneiss and granite lithologies is quite common, and intrude the Damara metasediments as outcrops. Karoo-age dolerite dykes also intrude the Damara metasediments. Formations of the Damara Supergroup are covered by recent, shallow deposits of unconsolidated material, mainly of aeolian origin in the vicinity of Walvis Bay (Mendelsohn et al., 2002). These deposits form part of the central Namib sand sea. Bedrock is found at depths in excess of 30m (Omamanya Geotechnical Consultants, 2020).

To the south of Walvis Bay the dry riverbed and inactive delta of the Kuiseb River forms a stark boundary with the Namib sand sea. North of the river, the dunes continue as a narrow belt towards the Swakop River where it stops (Figure 1). Part of the town is underlain by fluvio-marine deposits, evidence of the times when the delta of the Kuiseb was still active and maintained lagoon-like lakes along the sea.

The coastline of central Namibia is dominated by sandy beaches, interrupted occasionally by rocky outcrops. The coastline constitutes a narrow coastal plain that gradually changes in elevation and surface cover. Close to the beach the surface cover is loose and sandy. In the stretch between Walvis Bay and Swakopmund the narrow dune belt interrupts a gradual transition to the increasingly consolidated and hard surfaces of the gravel plains.

The Walvis Bay area is one of only three west-to-north facing embayments along the Namibian coast that provide shelter from the aggressive wave action from the South Atlantic swell. As a result of the longwave action, sand is continuously moved north and at Walvis Bay this action is fundamental to the existence of the Pelican Point peninsula, an elongated sandbank that protects the harbour from the open Atlantic Ocean (see Figure 1 and 3).

5.6 TOPOGRAPHY AND SOIL

Walvis Bay is characterized by its flat topography. Most of the built area of the town does not exceed 10 m above mean sea level. The highest water reservoir of the town, for example, is at <50 m above mean sea level (GLS, 2020). The terrain generally elevates towards the east where the dune belt forms a stark contrast with the otherwise flat surroundings.

The project site is also marked by its flatness, with a gentle slope to the northwest (i.e. towards the sea) with a gradient of <2%. Minor sand dunes occur on the site.

Gypsum is a surficial sediment forming as a result of the common sulphurous mists blowing off the sea and reacting with the calcareous sediments to form gypsum as a replacement of calcite. Soils have in general a high concentration of salts and hydrogen sulphide, which has an influence on the fog and in return intensifies chemical processes and soil genesis. Petric gypsisols dominate close to the coast, while concrete surfaces characterize soils further inland (Mendelsohn, et al., 2002).

Test pits were excavated on the site as part of the geotechnical assessment of the proposed project. The test holes indicate abundant shellfish shells, an absence of bedrock to a depth of two meters, a shallow perched water table (<1.4m), unstable sidewalls that easily collapse, a loose consistency of the soil, non-cohesive soil properties and a soil profile that is compressible in the in situ state (Omamanya Geotechnical Consultants, 2020).

5.7 HYDROLOGY

Due to the flatness of Walvis Bay, surface water drainage within the built area is almost undefined. After the occasional downpours, surface waters accumulate on the surfaced areas such as streets and drain away slowly.

The Kuiseb River to the south of the town is one of Namibia's most prominent west-flowing rivers. The river can be best described as a seasonal ephemeral river, meaning that it contains water for short periods during the rainy season as a result of sufficient downpours in its headwaters. The river reaches the sea at least once every ten years and flows in most cases a few times during any rainy season. The longitudinal profile of the river shows a flat gradient towards its mouth, resulting an inactive delta that partly underlays the current built area. In the past this delta was responsible for occasional flooding of the built area. A flood barrier was built at Rooibank in the 1960s to prevent flooding of the town.

The Kuiseb River sustains a productive porous aquifer, considered as one of the most productive aquifers in Namibia. The greatest part of Walvis Bay is located on top of this aquifer (Figure 5). As a result the water table underneath the entire town is shallow, less than 1.5m deep, but saline and not extracted for human consumption. The geotechnical assessment of the proposed project shows a shallow, perched water table not deeper than 1.4m and moist soil around 0.75m (Omamanya Geotechnical Consultant, 2020). The direction of the water flow in this aquifer is west and southwest. This aquifer is bordered in the north by the Erongo Groundwater Basin, which is closely associated with waterless gravel plains of the central Namib Desert – marked by its low to very low potential and poor quality.

Water from the alluvial aquifer within the lower segments of the Kuiseb River, upstream from Walvis Bay, is of good quality, with less than 1,000mg/l of dissolved solids (Mendelsohn, et al., 2002). This aquifer in has been used since 1923 to supply water to Walvis Bay. Several new well fields were added over time in the alluvium, which is between 15 and 20m thick. The relative high permeability allows high abstraction rates and relative quick recharges in case of floods. Pressure on this water source is high and on the increase as Walvis Bay grows.

5.7.1 GROUNDWATER

The project proposes that 5 beach boreholes are sunk into the underground from which saltwater will be extracted and fed into the RO plant. The project site is underlain by saltwater which has its source solely from the ocean. No freshwater underground source is found in close proximity to the site.

5.7.2 GROUNDWATER FLOW

A specific groundwater flow could not be determined; hence WAN conclude that the proposed Desalination Plant area is not part of any delineated aquifer system (WAN, 2020). Subsurface run-off from the Tumas riverbed is oriented towards the sea and does not pass the project site.

The main risk for the groundwater resources are spillages or damage to the proposed Desalination Plant and/or the directly north of the Erf located at the national oil storage facility.

5.8 BIODIVERSITY

Walvis Bay forms part of the Namib Desert Biome, subdivided into the central Namib Desert. Vegetation structure is dominated by grassland and dwarf shrubland with a couple of dominant annual grass species. Cover is generally sparse and plant production low. Overall plant diversity is estimated as <50 species, and in total representing not more than 10% of the flora of Namibia. Although not classified as a centre of endemism, endemics occur more inland and include *Arthraerua leubnitziae, Adenia pechuelii*, *Commiphora dinteri*, *C. saxicola*, *C virgate* and *Euphorbia damarana*. Plant endemism is viewed as medium. The flagship plant of the Namib Desert, *Welwitschia mirabilis,* also occurs more inland while the iconic! Nara (*Acanthosicycos horridus*) is more associated with the dunes of the Namib Desert. A few *Aloe* species occur in the central Namib Desert, and are all protected but do not really occur along the coast. The extensive gypsum crusts of the central Namib Desert support the most diverse lichen fields in the world, with many of the rarest and interesting species not officially described (Burke, 2003). More than 100 species are expected to occur. The ephemeral rivers that cross the central Namib Desert are home to a number of common riparian plants. It is estimated that 20 – 39 species plants higher than 1 m occur in the central Namib Desert, not all of which occurs along the coast but more inland. This includes six endemics and several protected species.

The central Namib Desert is fairly rich in arachnids, birds and lichens with the wetlands regarded as important for waders, migrant shorebirds and flamingos. The central Namib Desert is also regarded as relatively low in overall terrestrial biodiversity, but endemism is moderate to high. Large herbivorous mammals are scarce, with overall diversity of large carnivorous mammals determined as four species, with brown hyena (*Hyaena brunnea*) the most important. Springbok and Oryx have the highest density. Overall it is estimated that 54 reptiles, seven amphibians, 42 mammals and 182 bird species (breeding residents) occur, of which a high proportion are endemics (Mendelsohn, et al., 2002).

At least 50% of the expected reptiles are endemic, of which the Rock Monitor (*Varanus albigularis*) is vulnerable, two species are rare and four species have some sort of international conservation status. Six snake species are endemic, 50% of all lizards are endemic, and 13 of the 16 expected geckos are endemic. Three of the expected amphibian species are endemic to Namibia, but classified as of least concern in terms of conservation. Most of Namibia's endemic mammal species are associated with the Namib Desert, especially the transitional zones such as the escarpment and inselbergs, are rock-dwelling and are mostly rodents and small mammals. Two species are classified as vulnerable, and eight species are near threatened. Habitat alteration is regarded as the main

cause of threats to mammals. The house mouse (*Mus musculus*) and the rats *Rattus rattus* and *Rattus norvegicus* are viewed as invasive (UNAM, 2011).

Development and recreation activities are possibly the biggest threats to vertebrate fauna, especially reptiles and ground breeding birds, in the central coastal area of Namibia. Species most likely to be adversely affected by coastal development would be the avian fauna specifically associated with these areas (UNAM, 2011).

In terms of numbers of birds, the Walvis Bay Ramsar site and Important Bird Area (IBA; to the south of the study site) is considered the most important coastal wetland in the Sub-region, and probably one of the three most important coastal wetlands in Africa (Simmons et al. 1998). The area is vitally important for Palearctic waders and flamingos, which make up the majority of numbers. Four other coastal IBAs occur in the vicinity of the study site. The diversity of 159 bird species for the greater study area (QDS 2214Dc) is regarded as relatively high for the desert environment. Of these, 24 species have been short-listed as priority species, according to the following criteria for sensitivity:

- 23 are Threatened in Namibia (Simmons et al. 2015; Brown et al. 2017); of these:
  - two are Critically Endangered (Cape Gannet, Great Crested Grebe)
  - three are Endangered (African Penguin, Cape Cormorant, Bank Cormorant)
  - six are Vulnerable (White-chinned Petrel, Lesser Flamingo, Greater Flamingo, Great White Pelican, Caspian Tern, Hartlaub's Gull)
  - thirteen are Near Threatened (Damara Tern, Maccoa Duck, Crowned Cormorant, Sooty Shearwater, Eurasian Curlew, Red Knot, Chestnut-banded Plover, Curlew Sandpiper, Bar-tailed Godwit, African Oystercatcher, Black-necked Grebe, Peregrine Falcon); of these, Damara Tern is of critical importance in that 98% of its breeding population occurs on the gravel plains and sandy beach areas of the central coastal areas of Namibia (Braby, 2010, 2011). Breeding of this species in the study area is considered unlikely at present, due to increasing disturbance in the area, but should be verified.
- Sixteen of the above species are also Globally Threatened.
- Two species are near-endemic to Namibia (Damara Tern [also Near Threatened, see above], Gray's Lark). A number of species endemic or near-endemic to southern Africa are also found in the area, but are considered of relatively lower conservation priority as their populations occur in a relatively wider area.
- Twelve Red Data species have some form of migrant status (including four Palearctic and seven intra-African migrants). At least 57 species (36%) of the total of 159 species have some form of migrant status.
- Five of the priority species feed primarily on marine fish, nine species feed primarily on marine invertebrates and eight species feed on a combination of the two. The dietary items and feeding of these bird species may potentially be impacted by any changes in the marine environment, including increased salinity.

According to the avifauna specialist study, although the local area of the study site itself is likely to be of relatively lower sensitivity, its proximity to the above sensitive habitats in the greater area and the mobility of the bird species are an important consideration, and a precautionary approach is therefore assumed (Scott & Scott, 2020).

During the construction of the desalination plant and solar PV installation, increased noise, traffic, human presence and other forms of disturbance including heavy machinery are unavoidable. These forms of disturbance have a direct impact, and could cause birds to move from areas of choice to less disturbed but less productive areas, or even to withdraw from the area (i.e. resulting in displacement); road mortalities (and poaching) could also occur. However, these impacts are likely to be temporary in nature. The project site also lies in a semi-industrial location and is already disturbed to some extent. During the operational phase disturbance is also likely, but expected to be at a lower level. The construction of new structures could impact on avifauna movement corridors and patterns, including at night, also resulting in displacement. The potential impact of disturbance is regarded as low, but mitigation of these impacts is fairly unlikely (Scott & Scott, 2020).

5.9 MARINE MAMMALS

The only interaction this project will have with the marine biota is with the construction of its discharge pipeline into the bay, extending about 372m underwater. The bay area is known to receive visits from a number of mammals including dolphins and whales. Whales are migratory creatures and only pass by the bay area occasionally. Dolphins, especially the bottlenose dolphins are more frequent visitors. It is important to note that the bay area is not considered an undeveloped or pristine landscape (Rau, 2017). However, the rich mineralised waters do provide a habitat that attracts marine life to the greater bay area to feed on fish stocks found at a bathymetry of 20m, which translates to about roughly 8km's from the project site. Figure 18 below provides a clear record of the presence of bottlenose dolphins in the project area by the Namibian Dolphin Project. (Source: Elwen et al, 2017).

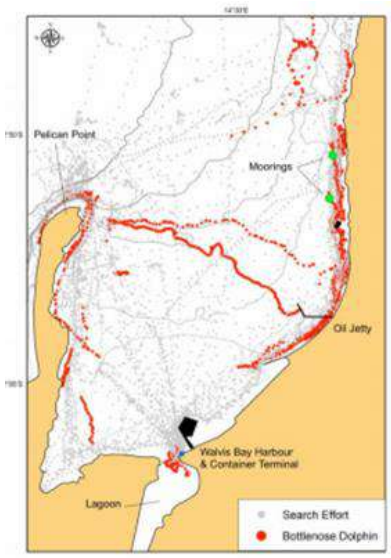


FIGURE 18: MOVEMENT PATHS OF BOTTLENOSE DOLPHINS IN THE PROJECT AREA AND GREATER BAY (Source: Elwen et al, 2017)

Figure 19 below is a depiction of the movement patterns tracked for the humpback whale. Most of its movement is concentrated around pelican point in deeper waters as it migrates northward. Very

little movement occurs along the eastern edge of the bay; therefore the propensity for these mammals to actually traverse the project site's marine component area is very little.

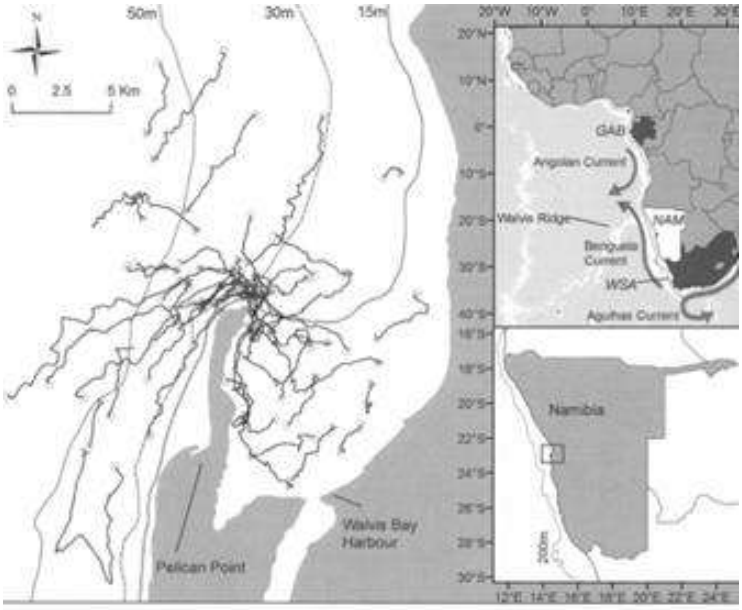


FIGURE 19: HUMPBACK WHALE MOVEMENT PATHS RECORDED (Source: Elwen et al, 2014)

The marine mammals have been exposed to harbour development with the expansion of the container basin, periodic maintenance dredging, regular sea-going traffic and repeated close contact with humans as a consequence of marine tourism cruises. None-the-less, the new development will temporarily add an extra dimension of disturbance and potential threat to the mammals sharing the bay waters (Rau, 2017).

The only activities that may exert an influence on marine mammals are construction related activities that interact directly with the sea. The proposed project will make use of pile driving; using sheets to construct a cofferdam around the submerged pipeline route to place and bury the pipeline in.

The following insertion was extracted from a marine mammal specialist study conducted in 2017 on the potential impacts on these creatures through noise generation activities.

The amount of acoustic energy that an animal experiences as a result of an underwater energy source discharge is expressed as the sound exposure level (SEL), which is a measure of the acoustic intensity. This takes into account the overall acoustic energy impinging on a 2 receiver per unit area within 1 second (dB re 1 µPa -s.). This measurement allows sounds of differing durations to be characterized in terms of energy (Rau, 2017). Sound Pressure Levels (SPL) in water is measured in decibels (dB) relative to a reference pressure of 1 micropascal (1 µPa). The reference distance is 1 m. Thus, the commonly used pressure reference level for underwater acoustics is 1 µPa at 1 m or 1 µPa@1m (Rau, 2017).

A variety of marine life has developed special mechanisms both for emitting and detecting underwater sound. In marine mammals (cetaceans and pinnipeds), sound is used for communication, orientation, predator avoidance and foraging. Sounds range from the 10 Hz low-

frequency calls of Blue Whales to the ultrasonic clicks of more than 200 kHz in certain offshore dolphins and Harbour Porpoises (Rau, 2017).

The response of and/or injury to a marine mammal to an anthropogenic (man-made) sound will depend on numerous factors including the frequency, duration, temporal pattern and amplitude of the sound (peak-peak), the distance from the sound source and whether it is perceived as approaching or moving away (SOCAL-10). The dolphins and Killer Whales found in the Walvis Bay area are mid-frequency cetaceans with hearing between 150 Hz - 160 kHz (Rau, 2017).

While the prey of resident odontocetes (Dolphins and Killer Whales) may be temporarily displaced through stress and avoidance of the construction noise, this would be of limited duration in time and space. Odontocetes have a varied diet and a temporary special shift of one species should not cause any feeding stress (Rau, 2017).

Humpback Whales are transient migrants through the NBR (Northern Benguela Region), and don't come into the Bay itself, it is expected that any pile driving operations will have minimal impact on this species.

Mid-frequency dolphins (Bottlenose, Dusky, Common) and Killer Whales have less sensitive hearing below 1 kHz. Thus, increased ambient noise in the low-frequency spectra may not interfere significantly with their sonar.

They determined that pile driving would not significantly interfere with the detection of biologically important sounds in any of the below listed species used as test subjects in their respective functional frequencies.

Harbour Porpoise – high-frequency cetacean
Bottlenose Dolphin – mid-frequency cetacean
North Atlantic Right Whale – low-frequency cetacean
Harbour Seal – phocid (true seal) higher frequency and hearing sensitivity than otariids (Fur Seals and Sea Lions).

In addition, Dr Rau states that significant sound masking problems were unlikely for all four species assessed, possibly because of the short duration and low duty cycle of pile driving sounds, with respect to masking and hearing impairment.

5.10 Socio-economic Baseline

Walvis Bay is located in the Erongo Region, which is located on the central part of the coast, bordering the Kunene and Otjozondjupa Regions in the north, the Khomas Region to the east and the Hardap Region to the south. The region is named after the Erongo Mountains which dominates the central section of Namibia's escarpment. The region covers a great part of the central Namib Desert, the main reason why this region has a small rural population, and is the region with the second highest percentage of people living in an urban are – 92%. In 2016 the region accommodated 7.8% of the national population total (Namibia Statistics Agency, 2017).

5.10.1 DEMOGRAPHIC PROFILE

Namibia is one of the least densely populated countries in the world (2.8 persons per km^2). Vast areas of Namibia are without people, in contrast to some fairly dense concentrations, such as the central-north and along the Kavango River. Windhoek, the capital, functions as a primate city – not only is it the urban area with the biggest population, but the concentration of private and public head offices attracts Namibians from all parts of the country in search for a better live. National population growth rate is estimated at less than 2%, lower than most African countries. Namibia's population is young - although 57% falls in the age group 15 – 59, 37% of the total population is younger than 15 (Namibia Statistics Agency, 2017). Since 2005 there is a steady improvement in life expectancy, currently estimated at 65 years. In 2018 it was estimated that 50% of all Namibians are urbanized, in other words living in an urban settlement (retrieved from www.worldpopulationreview.com). The last national census was conducted in 2011 and counted 2.1 million Namibians (Namibia Statistics Agency, 2011). An inter-censal demographic survey was conducted in 2016 and estimated the total population at 2.3 million (Namibia Statistics Agency, 2017).

Only the Khomas Region (95%) has a more urbanized population, but due to the bigger size of the Erongo Region the population density is low and only marginally higher (2.9) than the national figure in 2016. The region had a projected total population of 195,652 in 2018, 8% of the total population of Namibia (Namibia Statistics Agency, 2019). Oshiwambo is the most spoken language (44% of all households) followed by Afrikaans (19%). Average household size is 3.1 and the literacy rate is 96% for people older than 15. Living in an urban environment implies better living conditions – 98% of all households have access to safe water, only 13% have no toilet facility, 76% have electricity for lighting and only 15% of all household make use of open fires to prepare food (Namibia Statistics Agency, 2017).

The dominance of Walvis Bay and Swakopmund in the Erongo Region is apparent – most of the region's businesses and industrial activities are registered in these two towns, while Swakopmund functions also as the regional capital and host most of the administrative and governmental headquarters of the region.

The urban population pyramid for Namibia shows a very clear dominance of the age group 20 – 35 as well as for infants (0 – 4 years of age). Not surprisingly, the population of Walvis Bay is also young, most of them in the child-bearing age (Namibia Statistics Agency, 2017).

5.10.2 GOVERNANCE

Namibia is divided into 14 regions, subdivided by 121 constituencies. Erongo Region is divided into seven constituencies and Walvis Bay contains two hereof – Walvis Bay Urban and Walvis Bay Rural. Each region has a regional council, elected during regional elections per constituency. Towns are governed through local authorities, in the form of municipalities.

Although Walvis Bay is the biggest urban area in the Erongo Region, and the industrial hub of the region, the administrative capital of the region is Swakopmund. Walvis Bay is the principal home of Namibia's fishing industry and the town boasts also the only deep sea port of the country, with world-class port facilities and linkages with the rest of Namibia and its neighbours via the Trans-

Kalahari and Trans-Caprivi Highways as a well as a railway. An international airport located outside the town ensures a direct link to the rest of the world.

5.10.3 EMPLOYMENT

The labour force participation rate is the proportion of the economically active population, given as a percentage of the working age portion of the population (i.e. older than 15 years of age). The rate of labour force participation for the Erongo Region was 80.9% compared to the average of 71.2% for Namibia in 2018 (Namibian Statistics Agency, 2019).

In 2018, 53.4% of all working Namibians were employed in the private sector and 21.5% by the state. State-owned enterprises employ a further 7.6% and private individuals 16.6%. Agriculture (combined with forestry and fishing) is the economic sector with the most employees – 23% of all employed persons in Namibia work in this sector. Wages and salaries represented the main income source of 47.4% of households in Namibia (Namibian Statistics Agency, 2019).

Low education levels affects employability and prevents many households to earn a decent income. Of all employed people in Namibia, 63.5% are not higher qualified than junior secondary level (Grade 10 and lower). In total 11.8% of all employed people had no formal education. In total 29.1% of all employed people fall in the category “elementary occupation” and 15.2% in the category “skilled agriculture.

Overall the rate for unemployment is estimated at 33.4% for Namibia, using the broad definition of unemployment. The unemployment rate in rural and urban areas is almost the same – 33.4% in urban areas and 33.5% in rural areas. The highest unemployment rates are found amongst persons with education levels lower that junior secondary. The unemployment rate of persons with no formal education is 28.6%, with primary education 34.6% and with junior secondary education 32.7% (Namibian Statistics Agency, 2019).

Although declining over time, agriculture (combined with forestry and fishing) is the sector that employs most Namibians (23%) and is also the sector with the most employers. It is also the sector that employs the most informal workers in Namibia, calculated at 87.6%. Wages of employees in this sector are lower than all other sectors except for workers in accommodation and food services and domestic work in private households (Namibian Statistics Agency, 2019).

5.10.4 ECONOMIC ACTIVITIES

Key economic activities of Walvis Bay include fishing, fish processing, manufacturing, logistics, marine engineering and storage. Fishing and its related activities has always been the mainstay of the Walvis Bay economy but this sector’s dependence on exports and the cyclical nature of its products due to their seasonality as well as their susceptibility to unpredictable oceanic conditions have often proved to be a source of uncertainty. The emergence of the port as a major economic activity has sustained business development to some degree during recent years. Port facilities handle in excess of 2.5 million tons of cargo annually and the port offers repairs to vessels and rigs of up to 8,000 tons. Apart from cargo handling services, the port offers marine, leasing, storage, and bunker services and several major shipping lines have direct sailings connections to the port.

Mining plays a pivotal role in the economy of Namibia. Since independence, it has consistently been the biggest contributor to Namibia's economy in terms of revenue and accounts for 25% of the country's income. Mining is one of the main contributors to GDP, and one of the largest economic sectors of Namibia. Mining is a pronounced industry in the Erongo Region and the main commodities are uranium (extracted in the Erongo Region), gold, salt and dimension stones.

In addition to the sectors mentioned, the economy of the Erongo Region is dominated by the local economies of Swakopmund and Walvis Bay. In the rural parts of the region extensive livestock farming is a common activity, but intensive farming is also practiced along the lower part of the Swakop River and at Omaruru. Several fresh crops are produced here, mainly for local consumption.

In the Erongo Region 67.5% of all households depend on salaries and wages as the main income (Namibian Statistics Agency, 2019). Exact figures do not exist, but this high percentage can be ascribed to the dominance of the mining, fishing and manufacturing and processing sectors together with the prominence of state departments and the administrative sectors in the Erongo Region. A total of 12.6% of households receive their income from business activities (Namibian Statistics Agency, 2019).

Since 2016 Namibia recorded slow economic growth, registering an estimated growth of only 1.1% in 2016. The primary and secondary industries contracted by 2.0 and 7.8% respectively. During 2017 the economy contracted by 1.7, 0.7 and 1.9% in the first, second and third quarters respectively (Namibian Statistics Agency, 2018). Despite the more positive expectations, the economy retracted to an average growth of not more than 1% annually since 2017.

5.10.5 CULTURAL HERITAGE

No known heritage sites in the vicinity of the specific project area exist. Although it is unlikely that significant archaeological evidence of precolonial occupation will be found in the areas away from the Kuiseb River, mainly due to the absence of fresh water in the immediate area. In cases where heritage sites are suspected, the chance find procedure will be used.

6 IDENTIFICATION AND EVALUATION OF IMPACTS

The key stage of the EIA process is the impact prediction and evaluation stage. This stage is the process of bringing together project characteristics with the baseline environmental characteristics and ensuring all potentially significant environmental and social impacts are identified and assessed. Impact prediction and evaluation involve envisaging the possible changes to the environment as a result of the proposed project. The recognized methodology was applied to determine the magnitude of impact and whether or not the impact was considered significant and thus warrant further investigation. The assessment considers all stages of the project's life cycle that is scoped into the assessment and is presented in this report. It is an iterative process that commences at project inception and runs through to the final design and project implementation (construction and operations). The impact prediction and evaluation stage were undertaken in May and June 2020 and the findings of the assessment are presented in this document.

6.1 INTRODUCTION

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

This chapter provides the following:

- Details on the assessment guidance used to assess impacts
- Lists the limitations, uncertainties and assumptions with regards to the assessment methodology
- Details how impacts were identified and evaluated, and how the level of significance was derived
- Details how mitigation was applied in the assessment and how additional mitigation was identified, and
- Details the Cumulative Impact Assessment (CIA) method.

6.2 ASSESSMENT GUIDANCE

The principal documents used to inform the assessment method are:

- International Finance Corporation standards and models, in particular Performance Standard 1, 'Assessment and management of environmental and social risks and impacts' (International Finance Corporation, 2017) (International Finance Corporation, 2012);
- International Finance Corporation CIA and Management Good Practice Handbook (International Finance Corporation, 2013) and,
- Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008);

6.3 LIMITATIONS, UNCERTAINTIES AND ASSUMPTIONS

The following limitations and uncertainties associated with the assessment methodology were observed:

- Topic specific assessment guidance has not been developed in Namibia. A generic assessment methodology was applied to all topics using IFC guidance and professional judgement;
- Guidance for CIA has not been developed in Namibia, and a single accepted state of global practice has been established. The IFC's guidance document (International Finance Corporation, 2013) has been used for the CIA.

A number of limitations and uncertainties were acknowledged during the EIA process. In line with EIA best practice, assumptions have been made based on realistic worst-case scenarios, thereby ensuring that the worst-case potential environmental impacts are identified and assessed. Table 5 below contains the assumptions and uncertainties identified during the assessment process.

TABLE 6: SUMMARY OF LIMITATIONS, UNCERTAINTIES AND ASSUMPTION OF THE EIA PROCESS

LIMITATION / UNCERTAINTY	ASSUMPTION
Program of activities	Activities involve drilling, preparation of the terrain, trenching and general earthworks, construction and eventual operations. It is assumed that construction activities will span a period of less than six months. Operations are planned to commence immediately after.
Positioning of the boreholes	It is assumed that all five boreholes will be placed within the lease area because of obvious issues related to land use, management and ownership if they are considered outside of the lease area.
Final placement of connecting infrastructure (i.e. access road, pipeline and power line)	The lay-out of connecting infrastructure is predetermined by the existing infrastructure and land use zoning of the areas surrounding the site. It is assumed that the existing infrastructure will not change.
Number of workers and area they will come from	It is planned that teams of temporary workers will be employed during the construction phase and a smaller team of permanent employees during operations. It is assumed that all workers, during both the construction and operational phase reside in Walvis Bay.
Agreements	It is assumed that all agreements regarding connections to existing infrastructure, the use of facilities and support services are in place prior to the commencement of the project.
Expansion and growth	The plant is planned for a lifespan of twenty years. Pending results from this pilot project, the project owner and the Walvis Bay Municipality may consider upscaling and expansion of the project in the future. Expansion could be fractional and incremental, or as a single refurbishment or retrofit to more than double the plant's output capacity. However, the options for spatial expansion are limited, due to the surrounding developments and encroachment of built-up areas.

Where uncertainties exist, a cautious approach has been applied, allowing the worst-case scenario for potential impacts to be identified. Where limitation and uncertainties exist, assumptions have been made and applied during the assessment process. These have been clearly described in the baseline section.

6.4 DETERMINATION OF SIGNIFICANCE

The evaluation and identification of the environmental and social impacts require the assessment of the project characteristics against the baseline characteristics, ensuring all potentially significant impacts are identified and assessed. The significance of an impact is determined by taking into consideration the combination of the sensitivity and importance/value of environmental and social receptors that may be affected by the proposed project, the nature and characteristics of the impact, and the magnitude of potential change. The magnitude of change (the impact) is the identifiable changes to the existing environment which may be negligible, low, minor, moderate, high, or very high; temporary/short term, long-term or permanent; and either beneficial or adverse.

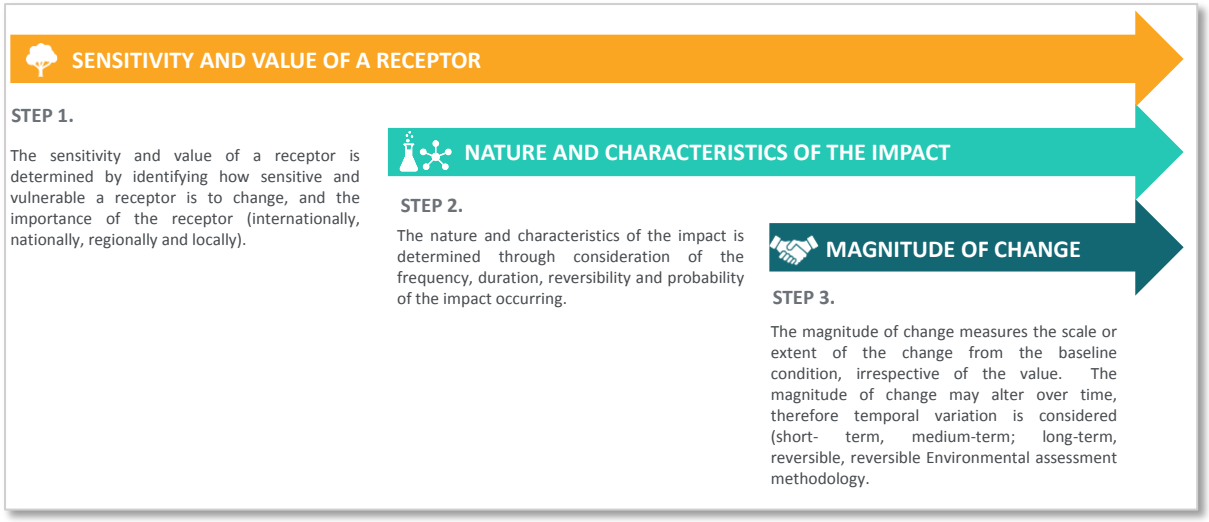


FIGURE 20:- DETERMINATION OF SIGNIFICANCE

The tables below set the description and thresholds used in determining impact significance.

TABLE 7: - NATURE OF IMPACT

NATURE	
Term	**Description**
Beneficial (Positive)	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse (Negative)	An impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.

TABLE 8:- TYPE OF IMPACT

TYPE	
Term	**Description**
Direct	Impacts causing an impact through direct interaction between a planned project activity and the receiving environment/receptors.
Indirect	Impacts that result from other activities that are encouraged to happen as a result / consequence of the Project. Associated with the project and may occur at a later time

	or wider area
Cumulative	Impacts that arise as a result of an impact and effect from the project interacting with those from another activity to create an additional impact and effect

TABLE 9:- REVERSIBILITY OF IMPACT

REVERSIBILITY	
Term	**Description**
Reversible	Impacts are reversible and recoverable in the future
Partly Reversible	Some parts of the impact can be reversed while others remain
Irreversible	Impacts which are not reversible and are permanent

Table 10: - MAGNITUDE OF CHANGE

MAGNITUDE OF CHANGE	
Term	**Description**
None / negligible	Very minor loss or detrimental alteration to one (or maybe more) characteristic, feature or element; or Very minor benefit to, or positive addition of, one (or maybe more) characteristic, feature or element.
Low / Minor	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (or maybe more) key characteristic, feature or element; or Minor benefit to, or addition of, one (or maybe more) key characteristic, feature or element; some beneficial effect on attribute quality or a reduced risk of a negative effect occurring.
Moderate	Loss of resource, but not adversely affecting its integrity; partial loss of/damage to key characteristics, features or elements; or Benefit to, or addition of, key characteristics, features or elements; improvements of attribute quality.
High / Major	Loss of resource, and quality and integrity of resource; severe damage to key characteristics, features or elements; or Large scale or major improvement of resources quality; extensive restoration or enhancement; major improvement of attribute quality.
Very high / unknown	Loss of resource, significantly affecting the long term quality and integrity of a resource; irreparable damage or loss of key characteristics, features or elements; or the magnitude is too great to quantify as it is unknown.

Table 11:- DURATION OF IMPACT

DURATION	
Term	**Description**
Temporary	Transient; a period of less than 1 year
Short term	Impacts that are likely to last for the duration of the activity causing the impact and are recoverable (1-5 years)
Medium term	Impacts that are likely to continue after the activity causing the impact and are recoverable (5-15 years)
Long term	Impacts that are likely to last far beyond the end of the activity causing the damage (greater than 15 years with impact ceasing after decommissioning of the project)
Permanent	Permanent

TABLE 12 - SCALE OF CHANGE

SCALE OF CHANGE - EXTENT / GEOGRAPHIC SCALE	
Term	**Description**
On-site	Impacts that are limited to the boundaries of the proposed project site
Local	Impacts that occur in the local area of influence, including around the proposed site and within the wider community
Regional	Impacts that affect a receptor that is regionally important by virtue of scale, designation, quality or rarity.
National	Impacts that affect a receptor that is nationally important by virtue of scale, designation, quality or rarity.
International	Impacts that affect a receptor that is internationally important by virtue of scale, designation, quality or rarity.

TABLE 13 - PROBABILITY OF CHANGE

PROBABILITY	
Term	**Description**
Improbably (Rare)	The event may occur in exceptional circumstances yet, rarely occurs in the industry. The event could occur once every 100 years
Low probability (Unlikely)	The event has happened elsewhere yet, is unlikely to occur. The event could occur once every 10 years
Medium Probability (Possible)	The event could occur under some circumstances. The event could occur once every 5 years.
High Probability (Likely)	The event is expected to occur. The event could occur twice per year
Definite (Almost certain)	The event will occur. The event could occur once per month

TABLE 14 - SIGNIFICANCE DESCRIPTION

SIGNIFICANCE OF IMPACT	DESCRIPTION
Low – Major (Beneficial) All scores	Impacts are considered to be beneficial to the environment and society:
Low (negative) 0 - 25	Impacts are considered to be local factors that are unlikely to be critical to decision-making.
Minor (negative) 25 - 50	Impacts are considered to be important factors but are unlikely to be key decision-making factors. The impact will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. Impacts are considered to be short-term, reversible and/or localized in extent.
Moderate (negative) 50 - 75	Impacts are considered within acceptable limits and standards. Impacts are long-term, but reversible and/or have regional significance. These are generally (but not exclusively) associated with sites and features of national importance and resources/features that are unique and which, if lost, cannot be replaced or relocated.
Major (negative) 75 - 100	Impacts are considered to be key factors in the decision-making process that may have an impact of major significance, or large magnitude impacts occur to highly valued/sensitive resource/receptors.

	Impacts are expected to be permanent and non- reversible on a national scale and/or have international significance or result in a legislative non- compliance.

TABLE 15:- SENSITIVITY AND VALUE OF RECEPTOR

SENSITIVITY AND VALUE	DESCRIPTION
Low	Of value, importance or rarity on a local scale; and/or not particularly sensitive to change or has considerable capacity to accommodate a change.
Medium	Of value, importance or rarity on a regional scale, and with limited potential for substitution; and/or moderate sensitivity to change, or moderate capacity to accommodate a change.
High	Of value, importance or rarity on an international and national scale, and with very limited potential for substitution; and/or very sensitive to change or has little capacity to accommodate a change.

TABLE 16 – SIGNIFICANCE OF IMAPCT

				Signifance of Impact			
			Signifance of Impact	Impacts are considered to be local factors that are unlikely to be critical to decision-making.	Impacts are considered to be important factors but are unlikely to be key decision-making factors. The impact will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. Impacts are considered to be short-term, reversible and/or localized in extent.	Impacts are considered within acceptable limits and standards. Impacts are long-term, but reversible and/or have regional significance. These are generally (but not exclusively) associated with sites and features of national importance and resources/features that are unique and which, if lost, cannot be replaced or relocated.	Impacts are considered to be key factors in the decision-making process that may have an impact of major significance, or large magnitude impacts occur to highly valued/sensitive resource/receptors. Impacts are expected to be permanent and non- reversible on a national scale and/or have international significance or result in a legislative non- compliance.
	Biophysical	Social		Low	Minor (2)	Moderate (3)	Major (4)
Sensitivity	A biophysical recepeotr that is protected under legislation or internaiton conventions (CITES) listed as rare, threatened or endangered IUCN specidices. Highly valued/sensitive resource/receptors	Those affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.	High (3)	Minor (3)	Moderate (6)	Major (9)	Major (12)
	Of value, importance or rarity on a regional scale, and with limited potential for substitution; and/or Not protected or listed (gloabbally) but may be a rare or threatened species in coutnry; with little reslisence to ecosystem changes, imporant to ecosystem functions, or one under threat or popultion declinet.	Able to adapt with some difficulty and maintain preimpact status but only with a degree of support	Medium (2)	Low (2)	Minor (4)	Moderate (6)	Major (8)
	Not protected or listed as common / abundant; or not crtical to other ecosystems functions	Those affected are able to adapt with relative ease and maintain preimpacrt status. There is no perceptible change to people's livelihood.	Low (1)	Low (1)	Low (2)	Minor (3)	Moderate (4)

To ensure the beneficial impacts are brought out in the assessment, green has been applied to ensure the different type of impact is clear. The description for each level of significance presented in Table 14 was also followed when determining the level of significance of a beneficial impact.

The significance of impacts has been derived by applying the identified thresholds for receptor sensitivity and magnitude of change, as well as the definition of significance. **Moderate and major adverse impacts are considered as significant**. The following thresholds were therefore used to double check the assessment of significance had been applied appropriately; a significant impact would meet **at least one** of the following criteria:

- It exceeds widely recognized levels of acceptable change;
- It threatens or enhances the viability or integrity of a receptor or receptor group of concern; and
- It is likely to be material to the ultimate decision about whether or not the environmental clearance certificate is granted.

6.5 MITIGATION

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

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

1. Actions undertaken by the EIA process that influence the design process, through implementing design measures that would entirely avoid or eliminate an impact or modifying the design through the inclusion of environmental features to reduce the magnitude of change. These are considered as embedded mitigation.
2. Standard practices and other best practice measures for avoiding and minimizing environmental impacts. These are considered as good practice measures.
3. Specified additional measures or follow-up action to be implemented to further reduce adverse impacts that remain after the incorporation of embedded mitigation. These are considered as additional mitigation.

The EIA is an iterative process whereby the outcomes of the environmental assessments inform the project. Considerable mitigation has been built into the proposed project as potentially significant adverse environmental impacts have been identified and design changes have been identified to overcome or reduce them. The EMP (Appendix A) provides the good practice measures and specified additional measures or follow-up action.

Embedded mitigation and good practice mitigation have been taken into account in the assessment. Additional mitigation measures have been identified when the significance of impact requires it and causes the impact to be further reduced. Where additional mitigation has been identified, a final assessment of the significance of impacts (residual impacts) was carried out taking into consideration the additional mitigation.

6.6 CUMULATIVE IMPACTS

6.6.1 CUMULATIVE IMPACT ASSESSMENT METHOD

Cumulative impacts may arise as a result of other project activities or the combination of two or more projects in the project area. The Cumulative Impact Assessment (CIA) has been undertaken by applying the IFC CIA Good Practice Handbook (International Finance Corporation, 2013), which recommended a rapid CIA is undertaken. A rapid CIA takes into consideration the challenges associated with a good CIA process, which includes lack of basic baseline data, uncertainty

associated with anticipated development, limited government capacity, and absence of strategic regional, sectoral or integrated resource planning schemes.

The five-step rapid CIA process has been followed:

- Step 1: Scoping - Determine spatial and temporal boundaries
- Step 2: Scoping - Identify valued environmental and social receptors and identify reasonably foreseeable developments
- Step 3: Determine present condition of valued environmental and social receptors (the baseline)
- Step 4: Evaluation of the significance of the cumulative impacts
- Step 5: Identification of mitigation measures to avoid or reduce cumulative impacts

The following information has been applied to the assessment in line with the above steps and IFC Guidance:

- The spatial and temporal boundaries of the CIA are the extent of the site boundaries and the duration of the decline development and operation phases of the proposed project (up to months from the date of commencement);
- Valued environmental and social receptors that may be affected are those presented in Chapter 5. No additional ones have been identified through this CIA;
- The predicted future conditions of common environmental receptors have been taken into consideration in the assessment;
- The assessment findings presented in Chapter 7 have been applied to the CIA in combination with professional judgment and published environmental assessment reports; and
- A review of mitigation and monitoring measures has been undertaken, with any additional ones identified.

7 IMPACT ASSESSMENT FINDINGS AND PROPOSED MITIGATION MANAGEMENT MEASURES

7.1 INTRODUCTION

This chapter presents the findings of the EIA for the proposed project as per the EIA process, scope and methodology set out in Chapter 2 and Chapter 6. A range of potential impacts have been identified that may arise as a result of the proposed project. The aim of this EIA report is to focus on the significant impacts that may arise as a result of the proposed project. This chapter therefore only considers the significant impacts and or those that may have specific interest to the community and stakeholders. A summary of impacts that are not considered significant is discussed in Section 7.3.

Impacts that are considered significant or are those of interest to the community and stakeholders are as follows:

- Marine Environment: Effects on localised marine ecology at the POD of brine effluent
- Marine Environment: Trenching of a laydown strip to install the discharge pipeline
- Environment: Sea water quality
- Environment: Bird Impacts
- Socio-economic: Employment

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

7.2 IMPACTS NOT CONSIDERED SIGNIFICANT

As a result of an iterative development process, mitigation has been incorporated and embedded into the project, thereby designing out potential environmental and social impacts or reducing the potential impact so that it is not significant. Best practice has also played a role in avoiding or reducing potential impacts. The EMP provides best practice measures, management and monitoring for all impacts.

Impacts that have been assessed as not being significant are summarised in Table 15 below and not discussed further.

TABLE 17 - IMPACTS NOT CONSIDERED SIGNIFICANT

The listed impacts below are of a non-significant nature and do not render any threat to the environment in a way that adversely challenges the resilience of it to continue in its modified form.

ENVIRONMENT OR SOCIAL TOPIC	POTENTIAL IMPACT	SUMMARY OF ASSESSMENT FINDINGS
Air Quality	The operations of the proposed project facility may discharge air pollution.	During operation, minimal activities will discharge some form of air pollution into the atmosphere and negligibly affect the ambient air quality of the vicinity. Power generation will not include any combustion of fossil fuels, but rather make use of renewable solar radiation to power the plant. Dust has been included in the assessment, due to the risk it poses during construction.
Climate change adaptation	The potential for climate change to impact the proposed project – i.e. sea level rises and storm surges.	The proposed project facility will not be adversely affected by potential climate change impacts, due to the fact that effective mixing of discharged brine effluent from the plant requires an "energetic" marine environment for brine dispersal.
Climate change cause / contribute to	The proposed project contributing to climate change through the emissions of greenhouse gasses.	The proposed project is considered to be of a relatively small size, with construction envisioned to be completed after two months only from inception. The proposed project will implement energy efficiency technologies and will be built to consider that i.e. use of solar radiation to power plant operations, utilising gravitational pull brine discharge pipeline infrastructure. Utilising LED light bulbs throughout the building and its boundaries.
Groundwater	The proposed project impacting the quality of groundwater through spillages.	The hydrogeological specialist study concluded that the site is underlain only by seawater. There are no connecting underground freshwater aquifers in the vicinity or in close proximity to the project site. Abstraction rates also do not allow for any change to the hydrodynamics of the groundwater due to its size and the nature of groundwater.

ENVIRONMENT OR SOCIAL TOPIC	POTENTIAL IMPACT	SUMMARY OF ASSESSMENT FINDINGS
Pollution of marine environment	The proposed project contributing to the pollution of the coastline through incorrect disposal of domestic waste and other hazardous hydrocarbon waste.	The proposed project will unlikely create a situation whereby domestic waste disposal is allowed to be discarded into the ocean from the site. The EMP details legislative requirements and best practice methods of proper waste disposal and is not discussed herein any further.
Cultural heritage	Potential to uncover heritage remains during project activities.	Findings are unlikely as the site has been studied and known heritage sites are mapped and protected for the project area. The site also has a tried and tested chance find procedure in place in the very unlikely event a heritage item is discovered.
Vegetation	Vegetation loss due to construction activities on site	The proposed project area is located on an already disturbed plot, with no real vegetation value that could be impacted upon.
Visual amenity and sense of place	Potential changes to the visual landscape by introducing the desalination plant	The construction and operation of the desalination plant will be within the existing semi industrial area of Walvis Bay and directly south adjacent of the NamCor National Oil Storage Facility including its land based pipeline network and jetty. No obtrusive building design will be used. The desalination plant and solar farm will effectively screen a portion of the NOSF from a southern viewpoint. Given the limited impact on the community, there will be no notable change in the sense of place or visual amenity to the site.
Noise and Vibration: Humans	Potential for vibrations from construction machinery to follow fault paths and cause vibration on surface and distance. Noise impacts to neighbours.	The potential for marine construction to generate noise that will impact neighbours adversely (nuisance impact) is extremely unlikely given the distance of the operations to the nearest sensitive receptor. Marine construction operations are quieter than open pit mining and therefore the addition of the underground mining method is unlikely to cause any noise concern for neighbours.

ENVIRONMENT OR SOCIAL TOPIC	POTENTIAL IMPACT	SUMMARY OF ASSESSMENT FINDINGS
Noise and Vibration: Marine Mammals	Noise impacts to marine mammals present in the bay waters while pile driving is ongoing during construction	It is generally considered that intense anthropogenic noise has adverse effects on marine organisms and mammals. However, there is no conclusive evidence of a link between construction noise and marine mammal mortality (Rau, 2017). The noise generated from construction activities are not considered intense and significant. Mitigation measures have been employed to reduce the perceived level of magnitude of change to the marine environment during construction.
Noise and disturbance Birds	Noise and disturbance impacts to birds	During the construction of the desalination plant and solar PV installation, increased noise, traffic, human presence and other forms of disturbance including heavy machinery are unavoidable. These forms of disturbance have a direct impact, and could cause birds to move from areas of choice to less disturbed but less productive areas, or even to withdraw from the area (i.e. resulting in displacement); road mortalities (and poaching) could also occur. However, these impacts are likely to be temporary in nature. The development area also lies in a semi-industrial location and is already disturbed to some extent. During the operational phase disturbance is also likely, but expected to be at a lower level. The construction of new structures could impact on avifauna movement corridors and patterns, including at night, also resulting in displacement. However, the potential impact of disturbance is regarded as low, but mitigation of these impacts is fairly unlikely.
Cadmium leachate from waste solar panels	Potential pollution of the receiving environment from cadmium leaching from waste/broken solar panels due to rain action	Although elements like cadmium and lead could potentially be present in solar panel structures as component parts, these elements can only pose a threat when allowed to leach into the environment due to rain action over a

ENVIRONMENT OR SOCIAL TOPIC	POTENTIAL IMPACT	SUMMARY OF ASSESSMENT FINDINGS
		long duration of time. The project area is located in a rain scarce environment already, therefore the significance of this impact is low and the magnitude of change from this impact is deemed as negligible. The proponent should make use of responsible procurement means to source the most environmentally friendly product. The selection of Poly-Crystalline panels greatly reduces the frequency of spent panels when compared to thin-filmed module technology.
Attraction of birds to new, artificial habitats, including infrastructure, for perching/ roosting/ nesting	Birds may be attracted to new, artificially created habitats for perching, roosting and/or nesting, including on solar PV panel arrays, roofing and fencing. Bird guano could result in pollution of the roosting surfaces.	Food wastes should be disposed of effectively, to avoid attracting scavengers such as gulls and crows. No further mitigation is recommended at this stage. However, should the results of monitoring indicate a need, mitigation measures should be applied subsequently

7.3 Scoping Assessment Findings

When undertaking the scoping exercise, the design of the proposed project and best practice measures were considered to ensure the likely significant effects and any required additional mitigation measures were identified. A summary of the potential impacts and mitigation and / or control measures are discussed below. The following topics were considered during the scoping phase:

- Environment – Soil, water, marine, avifauna
- Socio-economics (employment, demographics, and land-use)

This section sets out the findings of the scoping assessment phase. Activities that could be the source of an impact have been listed, followed by receptors that could be affected. The pathway between the source and the receptor has been identified where both are present. Where an activity and / or receptor have not been identified, an impact is unlikely, thus no further assessment or justification is provided. Where the activity, receptor and pathway have been identified, a justification has been provided documenting if further assessment is required or not required.

Due to the nature and localised scale of the project, and the environmental context, the potential environmental and social effects are limited and unlikely to be significant. The only area where uncertainty remained during the scoping phase was the potential cumulative effects on human receptors from the increase in noise levels and visual impacts, including air pollution. The receptors are mainly the immediate neighbours, although noise and movements may have a temporary effect on some organisms as well.

7.4 SOCIO-ECONOMIC ENVIRONMENT

The term socio-economic impact assessment embraces both social impacts and economic impacts. Economic impacts include issues such as employment, changes in economic activity such as tourism, and increased expenditure. The significant economic impact or impact that holds specific interest to the community and stakeholders is employment creation and is summarised in this section.

EMPLOYMENT

Whilst Namibia has a high unemployment rate, the Erongo Region has one of the highest employment rates in Namibia. In Walvis Bay, the majority of employment is through Harbour operations, the fishing industry and the processing of sea salt. The national value and sensitivity of employment is considered to be high as it is of importance to the country.

7.4.1 DIRECT EMPLOYMENT: CONSTRUCTION

Approximately 100 jobs will be generated during the construction phase. The proponent will employ Namibians wherever possible and feasible to fulfil the roles. Construction works will take approximately six months to complete; therefore the beneficial impact of creating 100 temporary jobs will result in a temporary impact with a low magnitude of change. A low beneficial impact on the community and economy is therefore expected.

7.4.2 DIRECT EMPLOYMENT: OPERATION

Approximately 10 skilled-level jobs will be created in the operational stage as a direct result of the project, with the anticipated creation of downstream jobs such as consultancy services, and contractor works expected throughout the 20 year lifespan of the plant at current capacity. As above, the proponent will employ Namibians wherever possible and feasible. The magnitude of change during operation is considered as low, but has long term impacts thereby resulting in a minor beneficial impact on the community and economy.

7.4.3 SUMMARY OF EMPLOYMENT IMPACTS

TABLE 18: – IMPACTS ON EMPLOYMENT TO THE WALVIS BAY INHABITANTS

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction works - general	– Community – Job seekers – Local economy	Creation of 100 jobs over a 6 months period	Beneficial Direct Regional Short Term Reversible	Medium	Minor	Beneficial Minor (9)
Operations of the proposed project	– Community – Job seekers – Local economy	Creation of 10 jobs	Beneficial Direct Regional Long Term Reversible	Medium	Low	Beneficial Low (9)
Downstream job creation	– Community – Job seekers – Local economy	Creation of additional job opportunities throughout the 20 year duration of the project.	Beneficial Indirect Local Long Term Reversible	Medium	Minor	Beneficial Minor (9)

7.5 MARINE ENVIRONMENT

7.5.1 IMPACT TO THE MARINE ENVIRONMENT: BRINE DISCHARGE

The potential impact to the receiving marine environment in terms of pollution are summarised in this section. Impacts will be categorised according to receptor which will directly be influenced by the project.

The below insertion speaks to the dispersion rate of the brine with seawater upon release from the diffuser in the operational phase of the project. The information was referenced from the dispersion modelling specialist study conducted by WAMTech, 2020.

- **Required dilutions were achieved during the initial dilution process within 10 m upon effluent release from the diffuser** (WAM, 2020). See below images of test results
- "Mixing zone" (sacrificial area) is < 200 m2.

Effluent flows and quality

- The discharge of the brine effluent will be intermittent gravity flow from an elevated brine reservoir with discharge rates varying between 533 m3/hr and 362 m3/hr.
- At this stage the quality of the effluent relates to salinity only (51.9 ppt, 55.6 ppt and 58.6 ppt).

Required dilutions Results

The three effluent scenarios (salinity concentrations of 51.9 ppt, 55.6 ppt and 58.6 ppt) require dilutions of 12, 14 and 16 respectively and returned to ambient levels within 10m after release into the sea.

The plant will discharge approximately between 362m³/hr to 533m³/hr of concentrated brine into the receiving ambient seawater. Effective discharge dispersion from the point of release at diffuser will ensure that the plume will be dispersed within a 10m² radius from diffuser, only taking up 10% of the allowable sacrificial area for brine disposal which is set at 200m² (from discharge point), according to the South African Water Quality Guidelines (WAMTech, 2020).

The magnitude of change during operation is considered as low, even with the long term dispersion of the brine, thereby resulting in a minor adverse impact to the marine environment as long as correct discharge volumes and velocities are maintained.

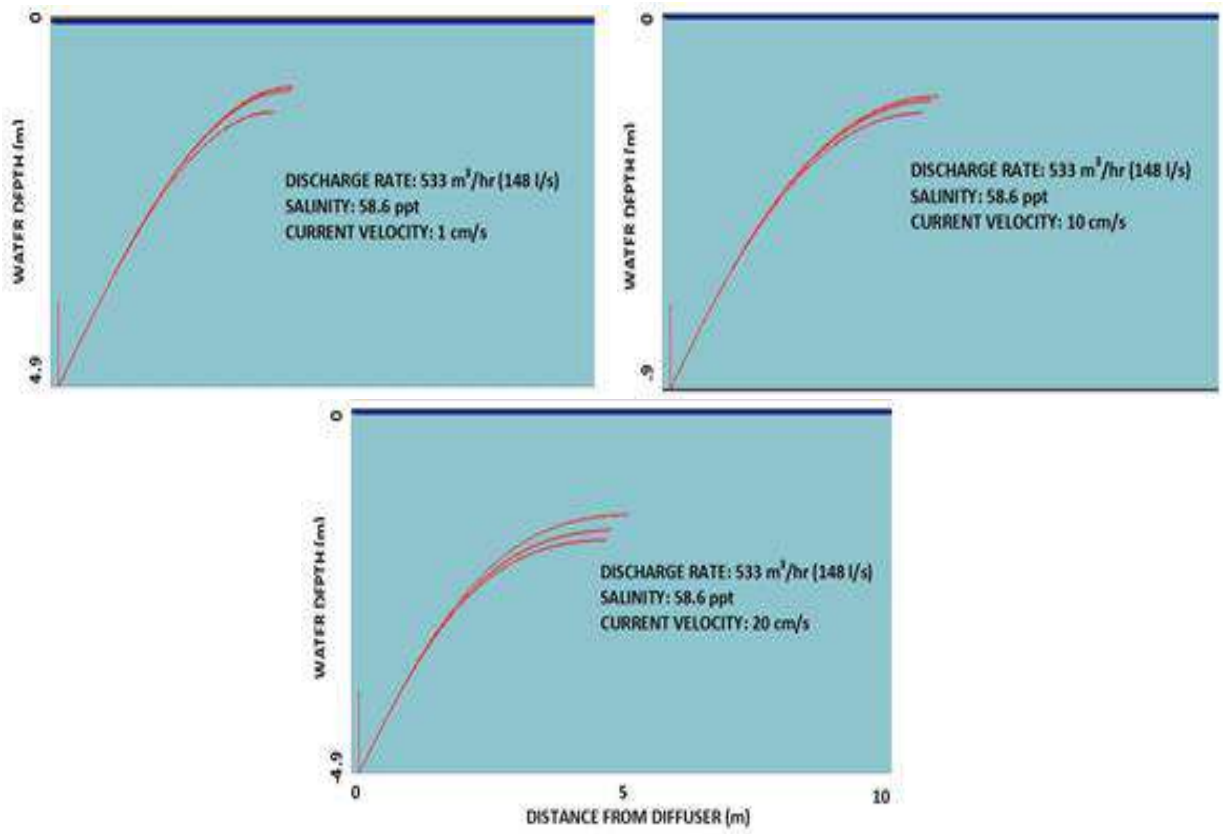


FIGURE 11: THRE TEST SCENARIOS OF BRINE DISCHARGE AT DIFFERENT DEPTHS AND VELOCITIES.

TABLE 19: IMPACTS ON THE MARINE ENVIRONMENT (RECEPTOR)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Mitigation measures proposed	Significance of impact
Construction works on pipeline – Trenching	– Seabed sediments – Water Quality (turbidity)	Sediment displacement from trenching (at the shore-crossing and offshore pipe laying) and pile sheet installations	Adverse Direct Local Temporary Reversible	Low	Minor	• Contingency plans and mitigation measures must be specified and incorporated into clauses in the construction contract documents. • These clauses must include alternatives for ensuring minimum impact, monitoring programmes for the duration of the construction phase, mitigation measures, and specifications for reinstatement and rehabilitation (especially for the shore-crossing of the pipeline).	Low (2)
Input and output Pipeline/ Pump leakages during Operation of the proposed project	– Off shore sea	Leakage of abstracted seawater from pipes in the event of a breakdown	Adverse Direct Local Temporary Reversible	Low	Minor	• Implement a system inspection regime In collaboration with the competent authority, implement procedures in case of accidents or failure of the system to perform to expected standards	Minor Low (2)
Brine Effluent discharge into sea during operation of the project	– Water Quality (Salinity)	Creation of dispersal plumes of brine into ambient seawater environment into a sacrificial mixing zone of 200m²	Adverse Direct Local Long term Reversible	Low	Minor	• Install a data logging system which monitors continuous conductivity, salinity and temperature readings measured against predetermined sample frequencies and flow rates, and able to indicate detectable deviations • Implement a system inspection regime • In collaboration with the competent authority, implement procedures in case of accidents or failure of the system to perform to expected standards	Low Minor (2)

7.6 BIRDS: COLLISIONS OF BIRDS ON SOLAR PV AND ASSOCIATED STRUCTURES

7.6.1 CONSERVATION SIGNIFICANCE OF THE GREATER STUDY AREA FOR BIRDS

In terms of numbers of birds, the Walvis Bay Ramsar site and Important Bird Area (IBA; to the south of the study site) is considered the most important coastal wetland in the Sub-region, and probably one of the three most important coastal wetlands in Africa (Simmons et al. 1998). The area is vitally important for Palearctic waders and flamingos, which make up the majority of numbers. Four other coastal IBAs occur in the vicinity of the study site.

In terms of criteria for sensitivity for solar sites (Jenkins et al. 2017), the Walvis Bay wetlands complex (i.e. the broader impact zone) would qualify as a site of high sensitivity in terms of the following criteria: 1) avifaunal habitat (e.g. a wetlands, nesting or roost sites) of regional or national significance, 2) a population of a priority species that is of regional or national significance, and/or 3) a bird movement corridor that is of regional or national significance, and 4) a protected area and/or Important Bird and Biodiversity Area.

7.6.2 SENSITIVITY OF BIRD INTERACTIONS WITH SOLAR SITES

A collision occurs when a bird in mid-flight does not see an overhead structure until it is too late to take evasive action. In the present development, bird collisions are possible on solar PV panels and associated structures such as fencing, as well as on other power supply structures. Birds may be injured or killed by collisions, which is thus a direct and permanent impact.

It is thought that collision trauma with solar PV panels may be associated with polarised light pollution and/or with waterbirds mistaking large arrays of PV panels as wetlands – the so-called "lake effect" (Horvath et al. 2009; Lovich and Ennen 2011; H.T. Harvey and Associates 2014; Kagan et al. 2014; Walston et al. 2016; in Jenkins et al. 2017). However, the likelihood and nature of the above lake effect as an impact is still unproven (S Ralston-Paton pers. comm. 2020); the precautionary principle should thus apply, and post-construction monitoring would therefore be essential (see below). Should collisions on solar PV panels take place on a regular basis, the impacts would be permanent and would need to be mitigated.

The risk of collisions on other power supply structures has been obviated by the proposed use of underground supply cables to connect the development to the grid. Step-down structures/ transformers will also be enclosed.

Artificial lighting may impact on night-flying birds, including many migrant species in the area, and cause disorientation and/or collisions on structures.

The local area of the study site itself is likely to be of relatively lower sensitivity compared to the greater area beyond the boundary of the project site. The magnitude of change to the avifaunal environment is considered to be minor which translates to a low significance in terms of its impact.

The below assessment deals with the potential fatal interaction (collision) of birds utilising the movement corridors between wetland habitats on solar PV panels and associated infrastructure.

TABLE 20: BIRD IMPACT FROM POTENTIAL INTERACTION WITH THE PLANNED SOLAR FARM

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Mitigation measures proposed	Significance of impact
Collisions of birds with SOLAR PANELS and other infrastructure in flight	− Birds in flight	Birds may be injured or killed by collisions	Adverse Direct Minor On-site Temporary Irreversible	Low	Minor	• Contingency plans and mitigation measures must be specified and incorporated in clauses in the construction contract documents. • These clauses must include alternatives for ensuring minimum impact, monitoring programmes for the duration of the construction phase, mitigation measures, and specifications for reinstatement and rehabilitation (especially for the shore-crossing of the pipeline). • All lighting should be shielded downwards, and should avoid direct illumination on the panels and in the surrounding areas. • Should bird collisions on the solar panels become a problem, the overall surface area could be subdivided by marking the panels with a white grid pattern, to avoid the creation of a large, continuous reflective surface. This would help reduce the chances of the panel array being perceived as a water body or one continuous mass. • If monitoring shows repeat collisions of nocturnal fliers, e.g. flamingos, some form of nocturnally visible marking can be investigated. The possibility of using a design that enables the tilting of the panels when not in use at night could also be investigated.	Low (2)

7.7 Further Consideration: Cumulative Impacts

Effective brine disposal hinges on accurate formulas developed for the treatment of intake seawater and disposal of the concentrated brine, as well as the accurate rates of velocities of discharge which is dependent on the right amount of volume discharged per second. It is evident from the literature that the ambient seawater quality (which varies over time) reflects the standard to be adhered to whenever effluent is introduced; therefore the project operational team has the responsibility to monitor fluctuations in ambient seawater quality to ensure their internal formula calculations remain effective. There is a potential cumulative effect of altered ecological processes to the bay area whenever discharge qualities are above the recognised and accepted standards, coupled with an increase in all other bay operators discharging their own waste into the bay waters.

For the duration of the proposed project, frequent monitoring of discharged brine is essential to maintain adequate dispersal rates. Regular maintenance of physical infrastructure need also take priority with project management.

During the public review period (20-28 July 2020), NamWater commented that they are in the planning stage of investing capital to upgrade and improve the current Kuiseb water supply system to augment water capacity to the Walvis Bay town. No technical details were available at the time of this assessment to determine the level of influence such plans could have on water supply to the town in tandem with the current project. Hence, it is treated as a cumulative impact, since it's still in the conception stage and its implementation is unknown. See table 20 below. The current desalination project will contribute a volume likened to a quarter of the current water demand for Walvis Bay and is regarded as a relatively small project.

Through the application of the EIA methodology presented in Section 2 the conclusion of the assessment is that with additional mitigation measures during the operational phase, the significance of effect is expected to be minor. No additional studies are considered necessary to further assess this impact.

TABLE 21 – SUMMARY OF CUMULATIVE EFFECTS

ACTIVITY	RECEPTOR	IMPACT	NATURE OF IMPACT	VALUE & SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF IMPACT
Brine Discharge of incorrect concentrations and volumes throughout the lifespan of the plant	Sea	Pollution of seawater causing an adverse Impact to marine biota	Adverse Cumulative Partly reversible Short term Local Definite	Medium	Moderate	**Moderate (6)**
Contingency Water Supply plans to Walvis Bay by NamWater	Community	Additional water supply	Beneficial Cumulative Reversible Long term Regional Possible	Medium	Moderate	**Moderate (6)**

The following additional mitigation measures have been identified and shall be communicated to the proponent to ensure cumulative effects are minimised as reasonably practicable.

- Effective and persistent monitoring of all physical and chemical processes related to the treatment of seawater and disposal of brine back into the sea.
- Data collection of infrastructure integrity to avoid prolonged downtime and environmental degradation.
- Specific activities that may generate dust and impact on residents shall be avoided during high wind events.
- All vehicles and machinery / equipment to be shut down or throttled back between periods of use.
- Restrict construction activities to daytime hours (7 am to 5 pm weekdays and 7 am until 1 pm on Saturday),
- Maintain good housekeeping
- Continuous engagement with residents to identify any concerns or issues, and appropriate mitigation and management measures agreed upon

The potential impact therefore is not considered significant as it does not widely exceed recognised levels of acceptable change, does not threaten the integrity of the receptors, nor is it material to the decision making.

8 ENVIRONMENTAL MANAGEMENT PLAN

The EMP for the proposed project is presented in Appendix A. It provides management options to ensure the impacts of the proposed project are minimised. An EMP is a tool used to take pro-active action by addressing potential problems before they occur. This should limit the corrective measures needed, although additional mitigation measures might be included if necessary. The management measures should be adhered to during all stages of the construction and operational activities. All persons involved and partaking in the proposed activities should be made aware of the measures outlined in the EMP to ensure activities are conducted in an environmentally sound manner.

The objectives of the EMP are:

- To include all components of the development and operations of the project
- To prescribe the best practicable control methods to lessen the environmental impacts associated with the project
- To monitor and audit the performance of operational personnel in applying such controls, and
- To ensure that appropriate environmental training is provided to responsible operational personnel.

9 CONCLUSION

The environmental assessment that was undertaken for the proposed project followed ECC's EIA methodology to identify if there is potential for significant effects to occur as a result of the proposed project. Through the scoping process, the most significant effect identified is the cumulative effect of incorrect brine disposal into the waters of the bay area, either through altered chemical processes or uncontrolled loss of infrastructure integrity. All other social and environmental receptors were scoped out as requiring further assessment as it was unlikely that there would be significant effects. Through further analysis and identification of mitigation and management methods, the assessment concludes that the likely significance of effects on the terrestrial and marine environment to be minor. Various best practice and mitigation measures have been identified to avoid and reduce effects as far as reasonably practicable, as well as to ensure the environment is protected and unforeseen effects are avoided.

On this basis, it is of the opinion of ECC that an environmental clearance certificate could be issued, on conditions that the management and mitigation measures specified in the EMP are implemented and adhered to.

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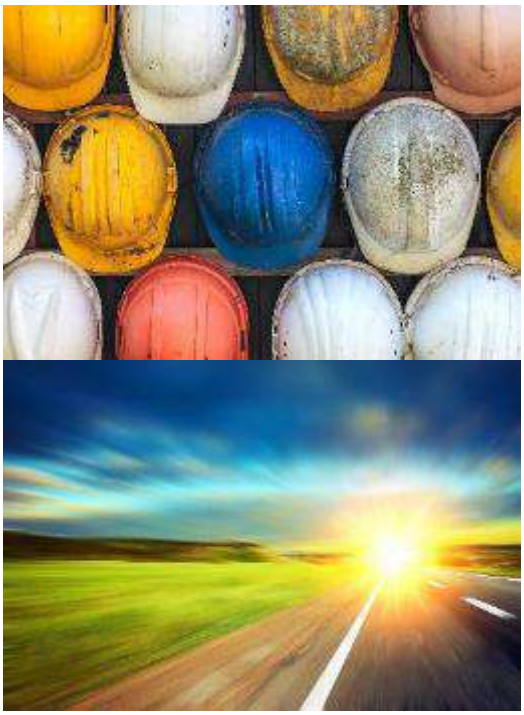
APPENDIX A – EMP

APPENDIX B – NON-TECHNICAL SUMMARY


ECC-106-285-NTS-03-D

NON-TECHNICAL SUMMARY FOR

A PILOT SUSTAINABLE WATER SUPPLY PROJECT BY MEANS OF DESALINATION, POWERED BY SOLAR TO SUPPLEMENT WATER SUPPLY FOR WALVIS BAY

PREPARED FOR

TURNKEY WATER SOLUTIONS

innovent sustainable power for Africa

MAY 2020

NON-TECHNICAL SUMMARY

PILOT SUSTAINABLE WATER SUPPLY PROJECT BY MEANS OF DESALINATION, POWERED BY SOLAR TO SUPPLEMENT WATER SUPPLY FOR WALVIS BAY ERONGO REGION, NAMIBIA

1 PURPOSE OF THIS DOCUMENT

The purpose of this Non-Technical Summary (NTS) is to provide Interested and Affected Parties (I&APs) a background to the proposed project and to invite I&APs to register as part of the Environmental and Social Impact Assessment (ESIA) process.

The proposed project is to develop a pilot sustainable water project by means of desalination, powered by solar to supplement water supply for Walvis Bay.

Through registering for the project, all I&APs will be kept informed throughout the ESIA process and a platform for participation will be provided to submit comments/recommendations pertaining to the project.

This NTS includes the following information on:

- The proposed project and location;
- The necessity of the project, benefits or adverse impacts anticipated;
- The alternatives to the project have been considered and assessed;
- How the ESIA process works;
- The public participation process and how to become involved; and
- Next steps and the way forward.

2 DESCRIPTION OF PROPOSED PROJECT

Environmental Compliance Consultancy (ECC) has been engaged by the proponent a Joint Venture (JV) between Turnkey Water Solutions (Pty) Ltd and Innovent SAS to undertake an ESIA and an

Environmental Management Plan (EMP) in terms of the Environmental Management Act, 2007 and its regulations. An environmental clearance application will be submitted to the relevant competent authorities; the Ministry of Environment, Forestry and Tourism (MEFT).

2.1 LOCATION

The proposed project is located on a 4ha portion of Walvis Bay municipal land on Erf 4688 in the Erongo Region, Namibia. The preferred site is located on a semi-industrial location alongside the existing oil and gas jetty. The preferred site location is set out in figure 1.

2.2 WHY IS THE PROJECT NEEDED

Walvis Bay receives only 13.2 millimeters (0.52 in) average precipitation per year, making it one of the driest cities on earth. Water requirements of the town are currently 7 000 000 m3/year (20 000 m3/day).
To meet the current water demand water is supplied to the Municipality from different sources, mainly boreholes.

In order to ensure water security and sustainability in the context of population and industry demand growth, as well as climate change new innovative solutions for supplementing water supply to Walvis Bay is required.

2.3 WHAT IS PROPOSED

This project aims to supply the Walvis Bay Municipality with an alternative clean and reliable water supply, through the use of innovative technology by means of a solar powered desalination plant. The project design components include:

- Producing approximately 3,900 m3/day of clean water or 1,422,000 m3/year;
- Installation of 5 beach boreholes (4 fully equipped and one spare);
- On shore beach boreholes fitted with infrastructure for an approximate pump capacity of 150m3/h;
- A plant and infrastructure lifespan of 20 years;
- Brine discharge rates into the ocean will vary between 294 - 340 m3/h during normal operations; and
- Power for the plant to be generated on site by a hybrid Photovoltaic (PV) solar plant connected to the grid with an underground 3-phase cable.

This project will improve the water resilience of Walvis Bay, and allow for further development.

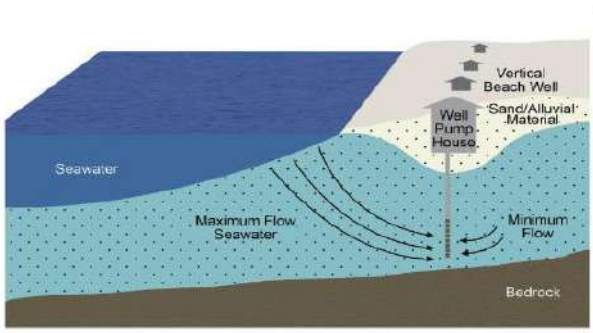


Figure 22 - Beach Borehole Concept for Water Supply to Plant

Figure 21 - Proposed Site Layout

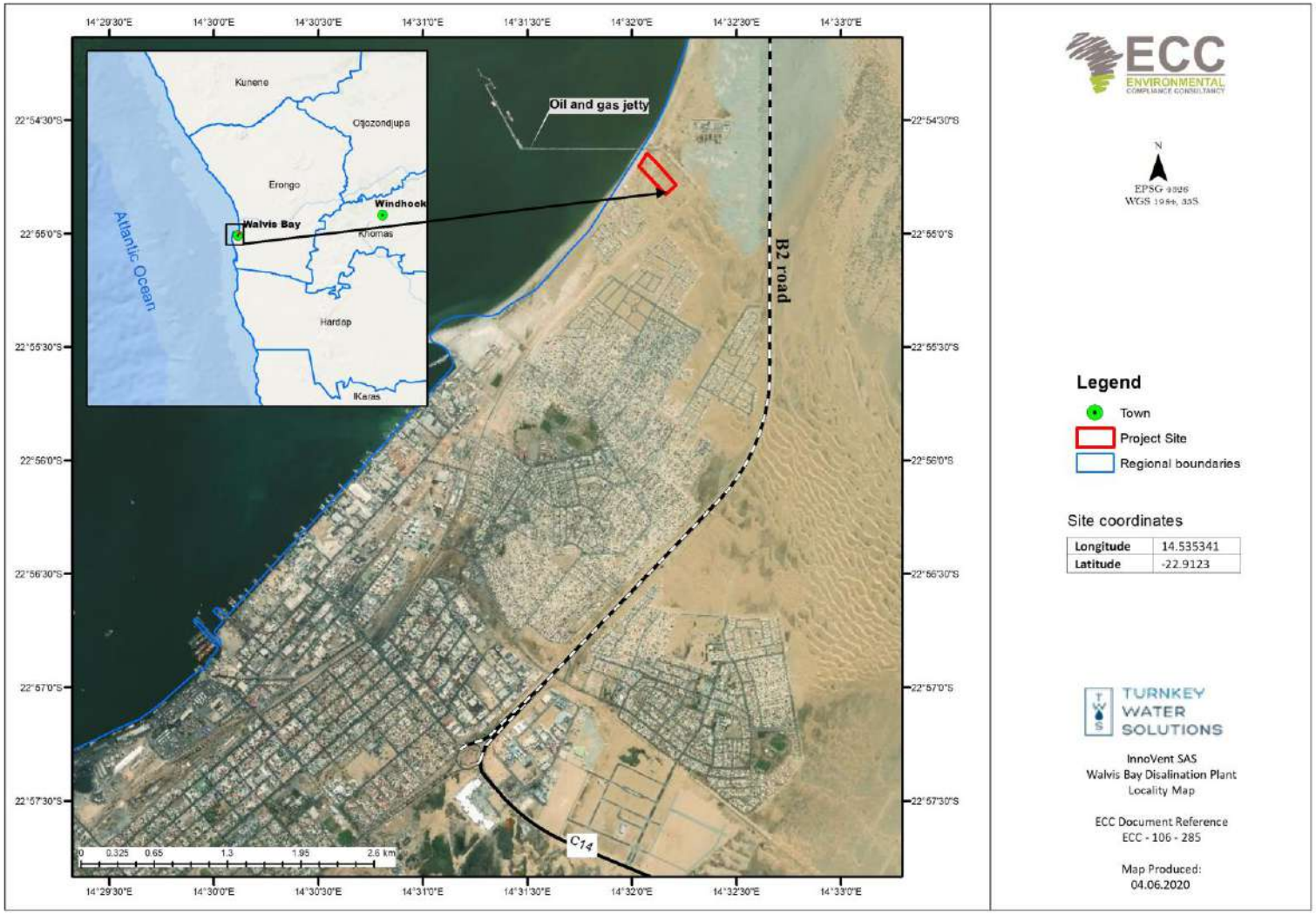


FIGURE 23 – LOCATION MAP OF THE PROPOSED PROJECT

2.4 POTENTIAL IMPACTS OF THE PROJECT

2.4.1 SOCIO-ECONOMIC

The potential social impacts are anticipated to be positive as the project will not only produce approximately 100 new jobs, but it will contribute to the sustainable water supply for Walvis Bay.

The proposed project location has been selected due to its access to existing infrastructure, the existing disturbed site, and importantly is not in proximity to sensitive receptors who may have visual amenity concerns with a new project.

Furthermore as the project is positively contributing to water security the potential flow on positive socio economic effects of the project could include the ability for further development of Walvis Bay.

2.4.2 ENVIRONMENTAL

The potential environmental impacts that will be assessed as part of this ESIA include:

- Brine discharge modelling;
- Avian impact assessment; and
- Hydrogeological investigations for the beach boreholes; and
- A Geotechnical report.

3 CONSIDERATION OF ALTERNATIVES

Best practice environmental assessment methodology calls for consideration and assessment of alternatives to a proposed project.

The project has conducted an alternative assessment evaluating other potential project sites. Four alternative sites were investigated that assessed numerous project elements including but not limited to:

- Intake locations;
- Access to existing infrastructure;
- Proximity to sensitive sites;
- Land availability; and
- Access to municipal water infrastructure.

Further to the initial assessment and during the ESIA process, alternatives considered will take the form of optimisation and efficiency to reduce potential effects through an iterative process including plant design and project improvements.

4 THE ENVIRONMENTAL ASSESSMENT PROCESS

This ESIA, conducted by ECC, is undertaken in terms of the Environmental Management Act, 2007 and its regulations. The process followed in this EIA is set out in the flowchart in figure 2.

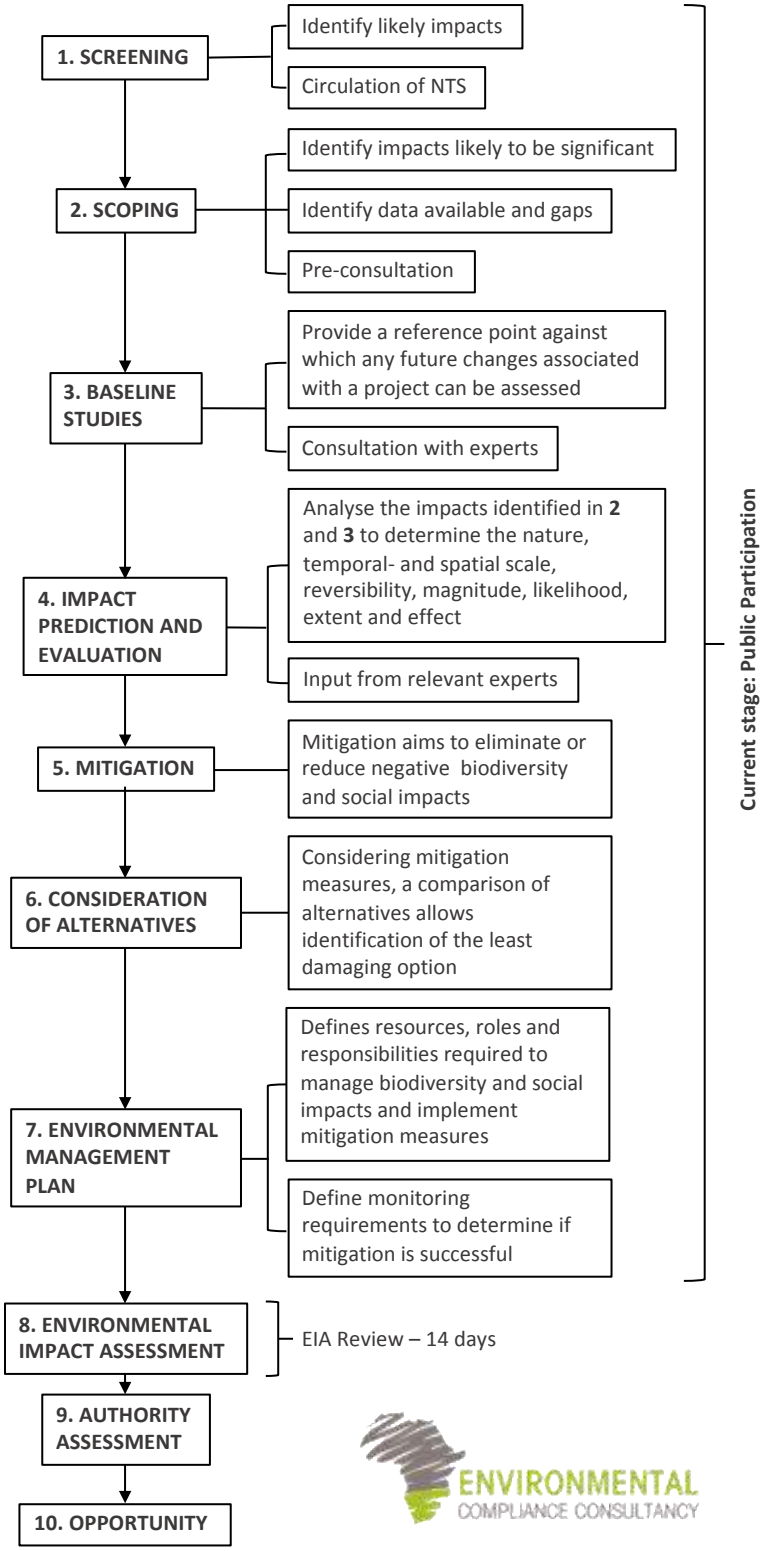


FIGURE 24 - FLOWCHART OF THE ENVIRONMENTAL ASSESSMENT PROCESS

4.1 SCREENING

A review of the proposed project screening findings against the listed activities was conducted; the findings of which are summarised below:

ENERGY GENERATION, TRANSMISSION AND STORAGE ACTIVITIES

1. The construction of facilities for -
(a) the generation of electricity;
(b) the transmission and supply of electricity;

WATER RESOURCE DEVELOPMENTS

8.1 The abstraction of groundwater and surface water industrial or commercial purposes
8.12 The release of brine back into the ocean by desalination plants.

INFRASTRUCTURE

(10.1.e) Any structure below the high water mark of the sea

4.2 BASELINE STUDIES

For the proposed project, baseline information will be obtained through a series of specialist studies combined with desk-based studies and site verification.

The ESIA will focus on the environmental receptors that could be affected by the proposed project. ECC will also engage with stakeholders, I&APs and the proponents to seek input into the assessment.

4.3 IMPACT ASSESSMENT

Impacts will be assessed using the ECC EIA methodology. The EIA will be conducted in terms of the Environmental Management Act, 2007 and its regulations. ECC's methodology for impact assessments was developed using IFC standards in particular Performance Standard 1 'Assessment and management of environmental and social risks and impacts' (IFC 2012, 2017) and Namibian Draft Procedures and Guidance for EIA and EMP (GRN, 2008) including international and national best practice with over 25 years of combined EIA experience.

4.4 ENVIRONMENTAL MANAGEMENT PLAN

An EMP shall be developed for the proposed project setting out auditable management actions for the project to ensure careful and sustainable management measures are implemented for their activities in respect of the surrounding environment and community.

4.5 PUBLIC PARTICIPATION AND ADVERTISING

Public participation is an important part of the EIA process; it allows the public and other stakeholders to raise concerns or provide valuable local environmental knowledge that can benefit the assessment, in addition it can aid the design process. This project is currently at the scoping phase and public participation phase.

At this phase ECC will perform the following:

- Identify key stakeholders, authorities, municipalities, environmental groups and interested or affected members of the public, hereafter referred to as I&APs
- Distribute the NTS for the proposed project (this document)
- Advertise the environmental application in two national newspapers
- Place notices on-site at or near the boundary
- If required host a public meeting to encourage stakeholder participation and engagement, and provide details of issues identified by the environmental practitioner, stakeholders and I&APs
- Record all comments of I&APs and present such comments, as well as responses provided by ECC, in the comments and responses report, which will be included in the scoping report that shall submitted with the application, and
- Circulate I&AP comments to the project team for consideration of project design.

Comments must be submitted in writing and can be emailed using the details in the contact us section below.

CONTACT US

We welcome any enquiries regarding this document and its content. Please contact:

Environmental Compliance Consultancy (ECC)

info@eccenvironmental.com

Tel: +264 816 697 608

www.eccenvironmental.com

At ECC we make sure all information is easily accessible to the public.

Follow us online to be kept up to date:

APPENDIX C – EVIDENCE OF PUBLIC CONSULTATION

List of registered stakeholders

Name of Stakeholder	Institution / Interest / Relevance	Means of communication
Mr Timoteus Mufeti	Environmental Commissioner, Directorate of Environmental Affairs, Ministry of Environment, Forestry and Tourism	Registered letter
Mr John Titus	Director: Energy, Directorate Energy, Ministry of Mines and Energy	Registered letter
Mr Percy Misika	Executive Director, Ministry of Agriculture, Water and Land Reform	Registered letter
Ms Maria Amakali	Director: Water Affairs, Directorate of Water Resource Management, Ministry of Agriculture, Water and Land Reform	Registered letter
Dr Moses Maurihungirire	Executive Director, Ministry of Fisheries and Marine Resources	Registered letter
Dr Anja Kreiner	Chief Fisheries Biologist, Directorate Resource Management, Subdivision Environment, Ministry of Fisheries and Marine Resources	Email; phone
Mr Coenie Koegelenberg	Chief Business Unit, Coastal, NamWater	Email; phone
Mr Saltiel Shaanika	Business Unit Coastal	Email
Mr NP du Plessis and team	Senior Environmentalist, NamWater	Email
Mr Nico Gabrielsen	Power Station Superintendent Paratus and Anixas, Department Technical And Operations, NamPower	Email; phone
Mr. Elzevir Gelderbloem	Executive Port Authority and Port Engineer, Walvis Bay Port Authority, Namport	Email
Mr Stefanus Gariseb	Namport	Email
Mr Ellis Eugumbo	Terminal Manager, NamCor	Email; phone
Mr Knowledge Ipinge	Councillor: Walvis Bay Urban Constituency, Erongo Regional Council	Registered letter
Mr John Esterhuizen	General Manager: Water, Waste and Environmental Management, Walvis Bay Municipality	Email; phone
Mr Andre Burger	General Manager: Roads and Building Control, Walvis Bay Municipality	Email
Nangula Amutenya	Environmental Management Section, Walvis Bay Municipality	Email
Vazembua Tjizoo	Walvis Bay Salt Refiners	Email
Mr Peter Bridgeford	Coastal Environmental Trust of Namibia	Email
Dr Simon Elwen	Namibian Dolphin Project	Email

Name of Stakeholder	Institution / Interest / Relevance	Means of communication
Mr Bruce Stewart	Stewart Planning, Town and Regional Planners, Walvis Bay	Email
Mr Alex Busch	Aqua Services and Engineering	Email; phone
Ms Daniela Bramwell	Private	Email
Mr Buddy Bramwell	Private	Email
Mr Titus Shaanika	Private	Email
Mr. Victor Miti Libuku	WALVIS BAY TOWN MUNICIPALITY	Email
Ms Kristofina Asino	WALVIS BAY TOWN MUNICIPALITY	Email
Mr Chris Stöck	AQUA SERVICES AND ENGINEERING	Email
Ms Jolana Kamburona	NAMWATER	Email

LETTER TO STAKEHOLDERS

REFERENCE: ECC-105-235-LET-05-A
9 June 2020

Identified Stakeholder and or Potentially Interested Party for:
Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay, Erongo Region Namibia

Dear Sir or Madam:

RE: NOTIFICATION OF ENVIRONMENTAL ASSESSMENT FOR PILOT SUSTAINABLE WATER SUPPLY BY MEANS OF DESALINATION, POWERED BY SOLAR TO SUPPLEMENT WATER SUPPLY FOR WALVIS BAY, ERONGO REGION, NAMIBIA

Environmental Compliance Consultancy (ECC) has been engaged by Turnkey Water Solutions (Pty) Ltd and Innovent SAS Joint Venture, the Proponent, to act on their behalf for the application of an environmental clearance certificate for a pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay, Erongo Region Namibia. The exact location of the project is visible on the map hereto attached.

ECC is conducting the Environmental Impact Assessment (EIA) in terms of the Environmental Management Act, No. 7 of 2007 and will be submitted to the competent authority and the Ministry of Environment, Forestry and Tourism for a record of decision.

The proposed project is to supply water by means of desalination, powered by solar to supplement water supply for Walvis Bay, Erongo Region Namibia. By ensuring a sustainable water supply, the project may contribute to further development of Walvis Bay and create approximately 100 new jobs. As part of the proposed project, the following activities are envisaged, which shall be confirmed, as the assessment is refined:

- Installation of five beach wells, fitted with infrastructure for an approximate pump capacity of 150m^3/h;
- A plant and infrastructure lifespan of 20 years;
- Brine discharge into the ocean which will vary between 294 and 340 m^3/h;
- Marine construction may not be required if the existing jetty can be used; and
- Power for the plant to be generated on-site by a hybrid photovoltaic (PV) solar plant connected to the grid.

This letter is intended to engage stakeholders and potentially Interested and Affected Parties (I&APs) of the project and provide a communication channel to ECC for the project. You have been identified

as either a stakeholder, interested or affected party; therefore ECC wishes to inform you of how you can become involved in the project.

Public participation is an important part of the EIA process, as it allows public and stakeholders to obtain information about the proposed project. Public participation occurs at various stages throughout a project lifecycle including:

- Advertising in newspapers;
- Distributing a Non-Technical Summary (NTS) to identified stakeholders and I&APs;
- Registered I&APs will also be informed of the available draft scoping report for a 14-day comment and review period, during this period I&APs will have the opportunity to review the draft document and raise any issues or concerns, and
- Stakeholders and I&APs who wish to register as an I&AP must do so on the ECC website as per the link provided below: https://eccenvironmental.com/projects/

If you are unable to complete the registration form online please email info@eccenvironmental.com and request an electronic copy of the form that you can complete, sign, scan and return via email to info@eccenvironmental.com to register as an I&AP for the project.

ECC values community input and participation in our projects and we look forward to working with you as the project develops.

The NTS can also be obtained from our website and provides a brief overview of the proposed project https://eccenvironmental.com/projects/

Should you have any questions or require additional information please do not hesitate to contact either of us.

Yours sincerely,

Stephan Bezuidenhout
Environmental Compliance Consultancy
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Email: stephan@eccenvironmental.com

Jessica Bezuidenhout Mooney
Environmental Compliance Consultancy
Office: +264 81 669 7608
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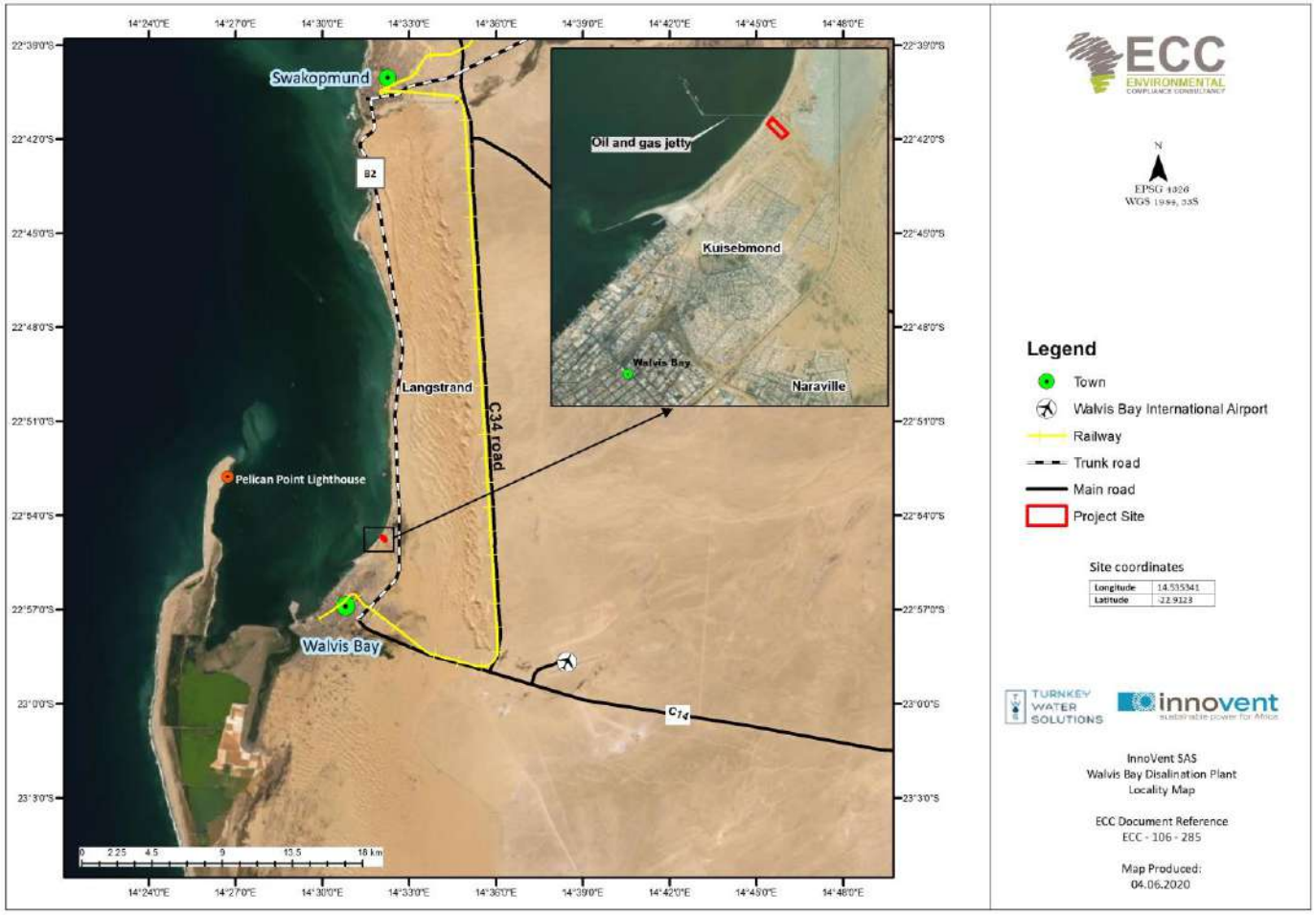
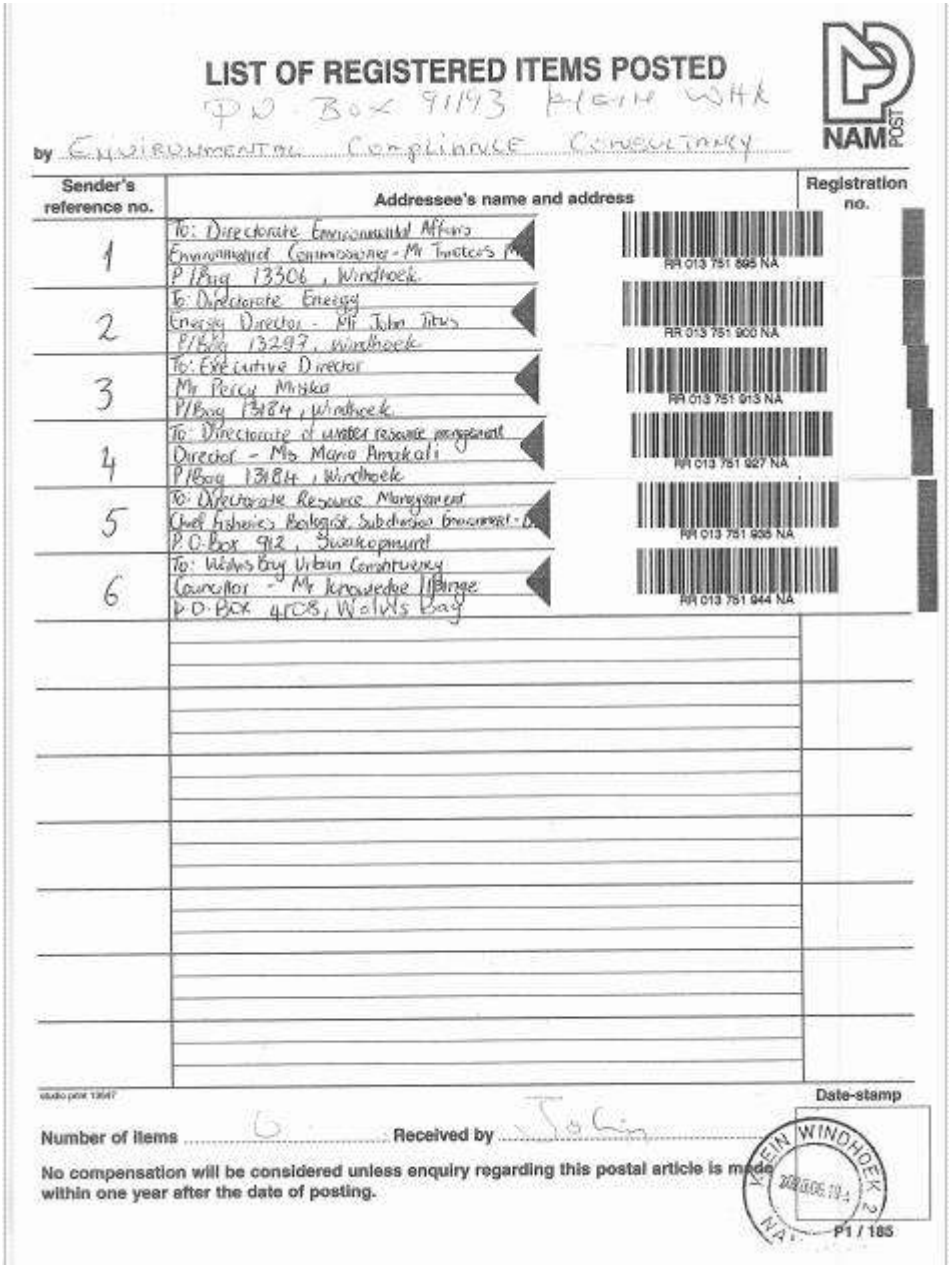


FIGURE 25 - LOCALITY MAP OF THE PROPOSED PROJECT

CONCERNS RAISED BY STAKEHOLDERS FROM INITIAL PUBLIC PARTICIPATION CONDUCTED.

Name of stakeholder	Concern / Comment
Bruce Stewart	LOCATION I am not sure if the local area can be described as a semi-industrial location. The site is identified for residential development in terms of the IUSDF, the Council's long term plan. It is, in my opinion, prime residential land and the last available beachfront site available for (residential) development.
	The description of the water volumes is confusing as it ranges from /day, /year, /hour – is it not possible to be consistent for comparison purposes? For example it is not clear to me the relationship between total production @ 162m³/hour, pump capacity @ 600m³/hour and brine discharge @ 340m³/hour
	Are the 100 jobs, permanent jobs or construction jobs?
	Not in proximity to sensitive receptors? This is a predominantly residential area (as in 1 above); is the residential area not a sensitive receptor?
	General comments: a. I understand that the land is owned by the Council. Is there a Council resolution in support of the proposed desalination project? b. Is solar power an option on the beachfront due to the potential of regular fog? c. The Council is busy investigating the treatment of purified effluent to potable water. Is this Council project likely to affect the viability/demand for desalinated water? d. Reference is made to four alternative sites that were considered. Please provide details of these four alternative sites. e. I realise that hydrological investigations will be undertaken which will probably determine the quality of the available water for desalination. Have any preliminary investigations been undertaken? (I understand that the site is on reclaimed land and probably at the original mouth of the Kuiseb River which may also affect water quality.) f. Is there any preliminary indication of the cost of the desalinated water relative to the current cost of potable water? g. Is the desalination plant modular that will allow for future growth/expansion? If so, is the site large enough for future growth?
Stefanus Gariseb (Namport)	The proposed area lies adjacent to the North Port Development.
	Brine discharge is our concern, along with dispersion models to be generated.
Vazembua Tjizoo (Walvis Bay Salt Refiners)	WBSR will not be affected directly by proposed plant except for the water quality that will come into the systems. WBSR is busy with a project to build and operate a RO/PV plant and the proposed plant will have an impact on these future plans if constructed. It is always good to be on top of what is happing in the Walvis Bay area and to understand what the concerns are.
Daniela Bramwell	This project is of special interest to me as I am studying Sustainable Development and I feel this project has particular interest in that field. I would be very interested to find out more about the policies and key role-players in the project as well as what kinds of regulations are in place with regards to waste management and impact studies that have been conducted.
Buddy Bramwell	I would like to know what the process will entail and whether the filtering systems for the sea water are adequate to ensure a clean supply of salt water for desalination
Titus Shaanika	How many will this project ensure that capacity building in terms of special and

	general skills development? The discharge into the sea how will this affect the popular independence beach.



LIST OF REGISTERED ITEMS POSTED

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by Environmental Compliance Consultancy

NAMPOST

Sender's reference no.	Addressee's name and address	Registration no.
1	To: Directorate Environmental Affairs Environmental Commissioner - Mr Theodor [illegible] P/Bag 13306, Windhoek	RR 013 751 895 NA
2	To: Directorate Energy Energy Director - Mr John Titus P/Bag 13297, Windhoek	RR 013 751 900 NA
3	To: Executive Director Mr Percy Misika P/Bag 13184, Windhoek	RR 013 751 913 NA
4	To: Directorate of water resource management Director - Ms Maria Amakali P/Bag 13184, Windhoek	RR 013 751 927 NA
5	To: Directorate Resource Management Chief Fisheries Biologist Subdirector Environment - D[illegible] P.O.Box 912, Swakopmund	RR 013 751 935 NA
6	To: Walvis Bay Urban Constituency Councillor - Mr Ignatius Uiringe P.O.Box 4108, Walvis Bay	RR 013 751 944 NA

Date-stamp

Number of items 6 Received by [illegible]

No compensation will be considered unless enquiry regarding this postal article is made within one year after the date of posting.

KLEIN WINDHOEK 2 NAM 28.05.19

P1 / 185

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OOSIKOLA DHA TAMEKE ... Oobundi dhaanasikola yomondondo onti-11 nonti-12 odha li dha tameke mEtitatu.

Ethano: Garwin Beukes

INVITATION TO COMMENT ON THE DRAFT ONDANGWA TOWN PLANNING AMENDMENT SCHEME NO. 8 DOCUMENTS

For any further inquiries on this matter please contact:

Stubenrauch Planning Consultants

Ondangwa Town Council

Omulandithi gomomapandaanda a monithwa oshiponga kopolisi

ECC ENVIRONMENTAL COMPLIANCE CONSULTANCY

NOTICE OF ENVIRONMENTAL ASSESSMENT & PUBLIC PARTICIPATION PROCESS FOR A PIECE SUSTAINABLE WATER SUPPLY PROJECT BY MEANS OF DESALINATION

TURNKEY WATER SOLUTIONS

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ELI MOOMBETE ... Methano ndika otamu monika omulandithi David Shaambo ngoka a li a dhengaguliwa kaapolisi mOvenduka mOmaandanagazi ko.

THE NAMIBIAN SPORT Friday 29 May 2020 31

Encounters with Alele, a tribute

• ISACK HAMATA

FOOTBALL has given me the opportunity to meet many wonderful people, players and fans from all walks of life, all over the country.

One of those is Nathanael Alweendo Kapiale. They nicknamed him 'Gullit', 'Dominic', 'Alele' and a couple others, but he preferred 'Zico'.

It was a pleasure to know some of the country's top footballers, and as fate would have it, I was properly positioned as a visiting Donkerhoek (Shaandambala) resident to meet many players who first played for African Blizzards and later Tigers.

Alele was one of those whose football careers I would passionately follow.

Our first encounter was in the March school holiday of 1980. My friend Colin Namene and I were visiting disco houses in the Gedjambo settlement. We spent some time at a particular house in Katutura and danced to the music blaring from the speakers.

Alele was dancing next to us.

He seemed to know all the latest dancing styles, and in the process we bumped into each other. He said to me: "Hei, dans mooi, jong."

I responded: "Hei, saartjie. Wie is jy om vir my te sê hoe ek moet dans?"

This is an incident we would laugh about much later. We would have another encounter two years later during yet another school holiday.

I teased and rubbed him and his friend Teenage Iyambo up the wrong way and they decided to show me who was boss.

I had heard that besides being an excellent footballer, Teenage was also a boxer, and he had a short fuse. The thought of being pummelled kept me in the house for hours on end.

One day I decided enough is enough. Alele was sent to watch me. I spotted him through a curtain as he passed the house. I grabbed a knife from the kitchen and went to sharpen it outside, in full view of the passers-by. That act alone must have sent shivers down his spine.

He went back and reported what he had seen. The mission to discipline me was aborted there and then.

Gradually we would become well acquainted with each other, and over time he became one of my many older brothers, on top of being someone whose football skills I admired.

Despite our improved relationship, we would be on opposite ends once again when Tigers lost their lucrative United Africa sponsorship.

Many of us became directly involved in the day-to-day administration of the team.

The players were used to be driven to and from training and official matches, slept in hotels during camping, had a sponsored haircut every other week and received their salaries on time.

However, without a sponsor, things were getting tougher, and results on the field were also not providing any comfort.

Tigers kept sliding down the league table after every weekend's matches and we started flirting with relegation. That did not sit well with supporters who visited the training field.

Alele refused to be a diplomat.

In no uncertain terms he issued the following instruction: "Sit net ons span terug waar julle dit gekry het, dan loop julle weg."

Thankfully, the team survived relegation and acquired a new sponsor for the next season.

In the intervening years our relationship would grow.

During his time as a game warden, Alele would take me on after-noon game drives atop the Waterberg Mountain.

I was amazed at how quickly he adapted to the bush environment.

From a football perspective, Alele was one of the greatest Namibian midfielders of his generation. The number of matches he played stretches into the hundreds, but out of all of those, the one that stands out is a mid-1990 semi-final clash against Black Africa at Windhoek's Independence Stadium.

As fate would have it, Alele was injured and was not eligible for selection that day. The coach nevertheless included him in the match day squad. As soon as the match kicked off, Black Africa stormed to what seemed to be an unassailable 2-0 lead.

Things were not looking up for Tigers, and clearly they were in need of someone to stir up things in the middle of the park.

The Tigers coach decided to take a gamble and ordered Alele to the cloakroom to get dressed. As soon as he settled in, Alele started conducting the orchestra and in no time, Tigers were level at 2-all.

Unfortunately, Tigers lost on penalties and were dumped from the Cup, but Alele etched his name on the hearts of the die-hard Ingwe fans, and those from opposing teams learned to respect him more.

After his retirement from football, he continued to staunchly support Tigers and never failed to attend its home matches.

He has departed from the game of life, but has left us with fond memories we will cherish forever.

God bless you, Zico.

Everyone in the football community owes you gratitude.

Go well, our friend, our football hero.

RIP ... Alele Kapiale will be remembered as one of the country's most gifted players.

Photo: Contributed

firm but fair

Informanté

HOME NEWS BUSINESS ENVIRONMENT ENTERTAINMENT SPORTS OPINION CLASSIFIEDS TENDERS INFORMANTE RADIO

Project: Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay Erongo Region, Namibia.

Proposed Activity: The proposed activities include: producing approximately 3900 m³/day of clean water or 1,422,000 m³/year, installation of 5 beach wells (4 fully equipped and one spare), on shore beach wells fitted with infrastructure for an approximate pump capacity of 150m³/h, a plant and infrastructure lifespan of 20 years, brine discharge into the ocean will vary between 194 - 340 m3/h during normal operations, marine construction may not be required if the existing jetty can be used; and power for the plant to be generated on site by a hybrid Photovoltaic (PV) solar plant connected to the grid. This project will improve the water resilience of Walvis Bay, and allow for further development.

Application for Environmental Clearance Certificate: In terms of the Environmental Management Act, No. 7 of 2007, ECC on behalf of the Joint Venture between Turnkey Water Solutions (Pty) Ltd and Innovent SAS is required to apply for environmental clearance to the competent authorities and the Ministry of Environment, Forestry and Tourism for the above-mentioned project.

Purpose of the review and comment period: The purpose of the review and comment period is to

ECC ENVIRONMENTAL

NOTICE OF ENVIRONMENTAL ASSESSMENT & PUBLIC PARTICIPATION PROCESS FOR A PILOT SUSTAINABLE WATER SUPPLY PROJECT BY MEANS OF DESALINATION, POWERED BY SOLAR TO SUPPLEMENT WATER SUPPLY FOR WALVIS BAY, ERONGO REGION, NAMIBIA

Environmental Compliance Consultancy CC (ECC) hereby gives notice to the public that an application for an environmental clearance certificate in terms of the Environmental Management Act, No. 7 of 2007 will be made as per the following:

Applicant:	Joint Venture between Turnkey Water Solutions (Pty) Ltd and Innovent SAS
Environmental Assessment Practitioner (EAP):	Environmental Compliance Consultancy
Location:	Erongo Region, Namibia

Project: Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay Erongo Region, Namibia.

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Purpose of the review and comment period: The purpose of the review and comment period is to present the proposed project and to afford Interested and Affected Parties (I&APs) an opportunity to comment on the project to ensure that all issues and concerns are captured and considered in the assessment.

Review period: The review and comment period is effective from 29th May 2020 – 19th June 2020.

How you can participate: ECC is undertaking the required environmental assessment and public participation process in terms of the Act. I&APs and stakeholders are required to register for the project at https://eccenvironmental.com/projects/

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Location	Frequencies
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Otjiwarongo	105.5
Coastal	107.3

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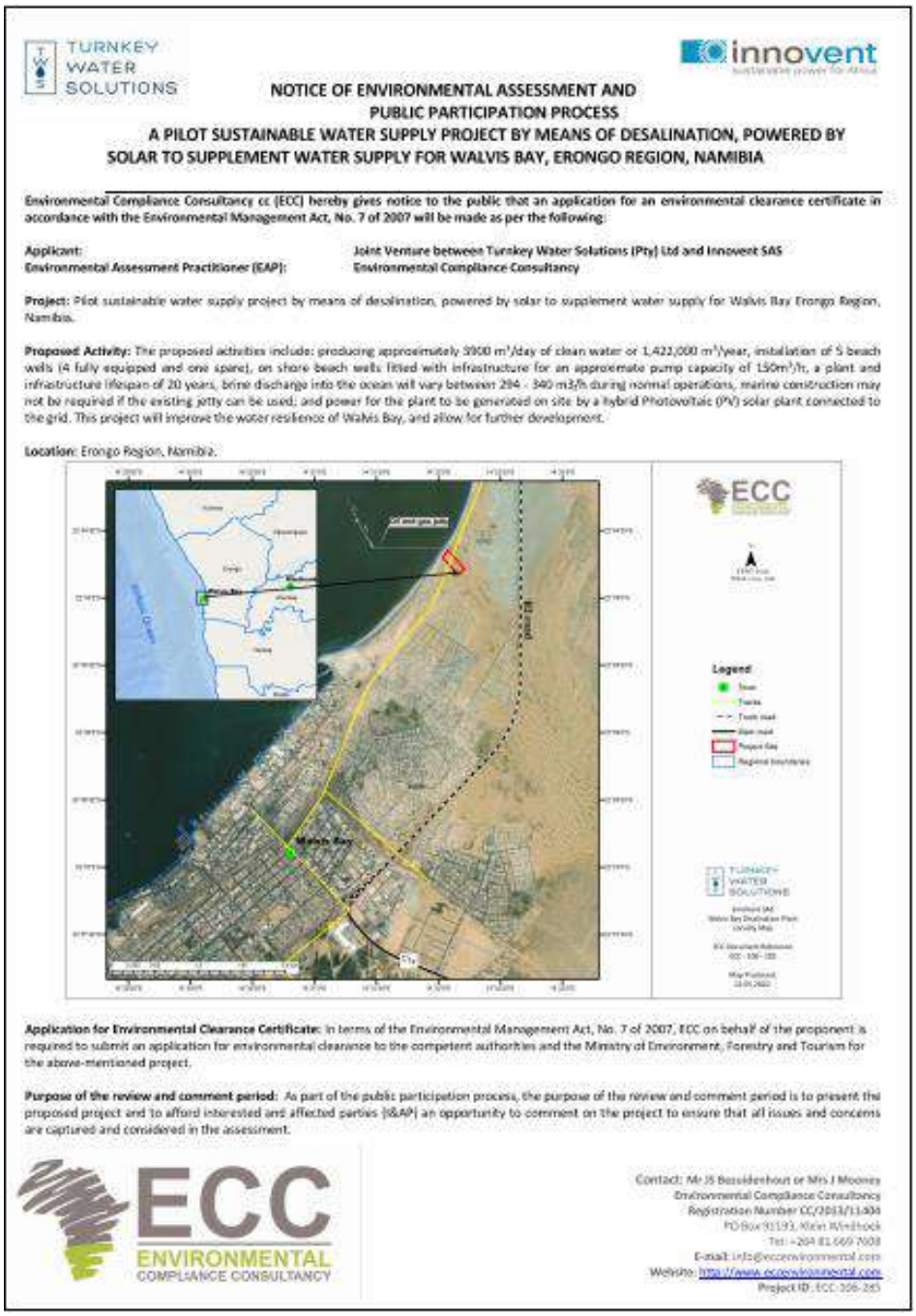

TURNKEY WATER SOLUTIONS

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NOTICE OF ENVIRONMENTAL ASSESSMENT AND PUBLIC PARTICIPATION PROCESS

A PILOT SUSTAINABLE WATER SUPPLY PROJECT BY MEANS OF DESALINATION, POWERED BY SOLAR TO SUPPLEMENT WATER SUPPLY FOR WALVIS BAY, ERONGO REGION, NAMIBIA

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Environmental Assessment Practitioner (EAP): Environmental Compliance Consultancy

Project: Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay Erongo Region, Namibia.

Proposed Activity: The proposed activities include: producing approximately 5900 m^3/day of clean water or 1,422,000 m^3/year, installation of 5 beach wells (4 fully equipped and one spare), on shore beach wells fitted with infrastructure for an approximate pump capacity of 150m^3/h, a plant and infrastructure lifespan of 20 years, brine discharge into the ocean will vary between 284 - 340 m3/h during normal operations, marine construction may not be required if the existing jetty can be used; and power for the plant to be generated on site by a hybrid Photovoltaic (PV) solar plant connected to the grid. This project will improve the water resilience of Walvis Bay, and allow for further development.

Location: Erongo Region, Namibia.

Application for Environmental Clearance Certificate: In terms of the Environmental Management Act, No. 7 of 2007, ECC on behalf of the proponent is required to submit an application for environmental clearance to the competent authorities and the Ministry of Environment, Forestry and Tourism for the above-mentioned project.

Purpose of the review and comment period: As part of the public participation process, the purpose of the review and comment period is to present the proposed project and to afford interested and affected parties (I&AP) an opportunity to comment on the project to ensure that all issues and concerns are captured and considered in the assessment.

ECC ENVIRONMENTAL COMPLIANCE CONSULTANCY

Contact: Mr JS Bezuidenhout or Mrs J Mooney
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PO Box 91193, Klein Windhoek
Tel: +264 81 669 7018
E-mail: info@eccenvironmental.com
Website: http://www.eccenvironmental.com
Project ID: ECC 106-285

APPENDIX D – ECC CV'S

APPENDIX E – GEOTECHNICAL REPORT

APPENDIX F – HYDROGEOLOGICAL REPORT

APPENDIX G – AVIFAUNA SPECIALIST STUDY

APPENDIX H – BRINE DISPERSION MODELLING TECHNICAL ASSESSMENT

GEOTECHNICAL REPORT

Proposed New Desalination Plant, Walvis Bay, Namibia

26 May 2020

PREPARED BY:
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PREPARED FOR:
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Welgemoed, Cape Town
South Africa

Ref: 150-326: Geotechnical\Turnkey Water Solutions\Walvis Bay Desalination Project\Report\26/05/2020 Rev 0

Report review history:

Revision No	Date	Prepared by:	Reviewed by:
0	01/06/2020	D. Peters BSc Hons Geology	D.McDonald Reg.Eng.Tech. (MD)
			

Authors & Reviewers Qualifications and Affiliations:

Dennis McDonald holds a national diploma in Civil Engineering and has been trained as a Civil Engineering Technician covering project management, civil and structural design, contracts management, survey, laboratory management, investigations and testing, geotechnical investigations and report writing. He has 44 years' combined experience, with 22 years managing his own civil SANAS Accredited Engineering Laboratories and Geotechnical Consultancy in the Southern Cape and Eastern Cape of South Africa. Dennis McDonald is registered with the Engineering Council of South Africa (ECSA) as a Registered Engineering technician # 2000 400 58, the South African Institute of Civil Engineers (SAICE), the Institute of Municipal Engineers of South Africa (IMESA), SABITA and SAT.

Dirk Peters holds an Honours Bachelor of Science (Geology) degree. He is currently undergoing in-service training as a Natural Scientist practicing Engineering Geology. He has 4 years' of experience in Engineering Geology and is currently in the process of registering for a Pr.Sci.Nat.

Declaration of Independence:

The authors of this report are independent professional consultants with no vested interest in the project, other than remuneration for work associated with the compilation of this report.

General limitations:

1. The investigation has been conducted in accordance with generally accepted engineering practice, and the opinions and conclusions expressed in the report are made in good faith based on the information at hand at the time of the investigation.
2. The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result or either natural processes or human activity. In addition, advancements in the practice of geotechnical engineering and changes in applicable practice codes may affect the validity of this report. Consequently, this report should not be relied upon after an eclipsed period of one year without a review by this firm for verification of validity. This warranty is in lieu of all other warranties, either expressed or implied.
3. Unless otherwise stated, the investigation did not include any specialist studies, including but not limited to the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.
4. The investigation is conducted within the constraints of the budget and time and therefore limited information was available. Although the confidence in the information is reasonably high, some variation in the geotechnical conditions should be expected during and after construction. The nature and extent of variations across the site may not become evident until construction. If variations then become apparent this could affect the proposed project, and it may be necessary to re-evaluate recommendations in this report. Therefore, it is recommended that Omamanya Geotechnical Consultants and Laboratory Services is retained to provide specialist geotechnical engineering services during construction in order to observe compliance with the design concepts, specifications and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction. Any significant deviation from the expected geotechnical conditions should be brought to the author's attention for further investigation.
5. The assessment and interpretation of the geotechnical information and the design of structures and services and the management of risk is the responsibility of the appointed engineer.

Table of Contents

List of Appendices

1. Introduction

1.1. Background Information

Omamanya Geotechnical Consultants was formally appointed in writing on 28 April 2020 by Mr. Patrice Boyer of Turnkey Water Solutions (Pty) Ltd. to conduct a Geotechnical Investigation for the proposed new desalination project located in Walvis Bay, Namibia (**Figure 1**). The investigation was conducted on 07 May 2020.

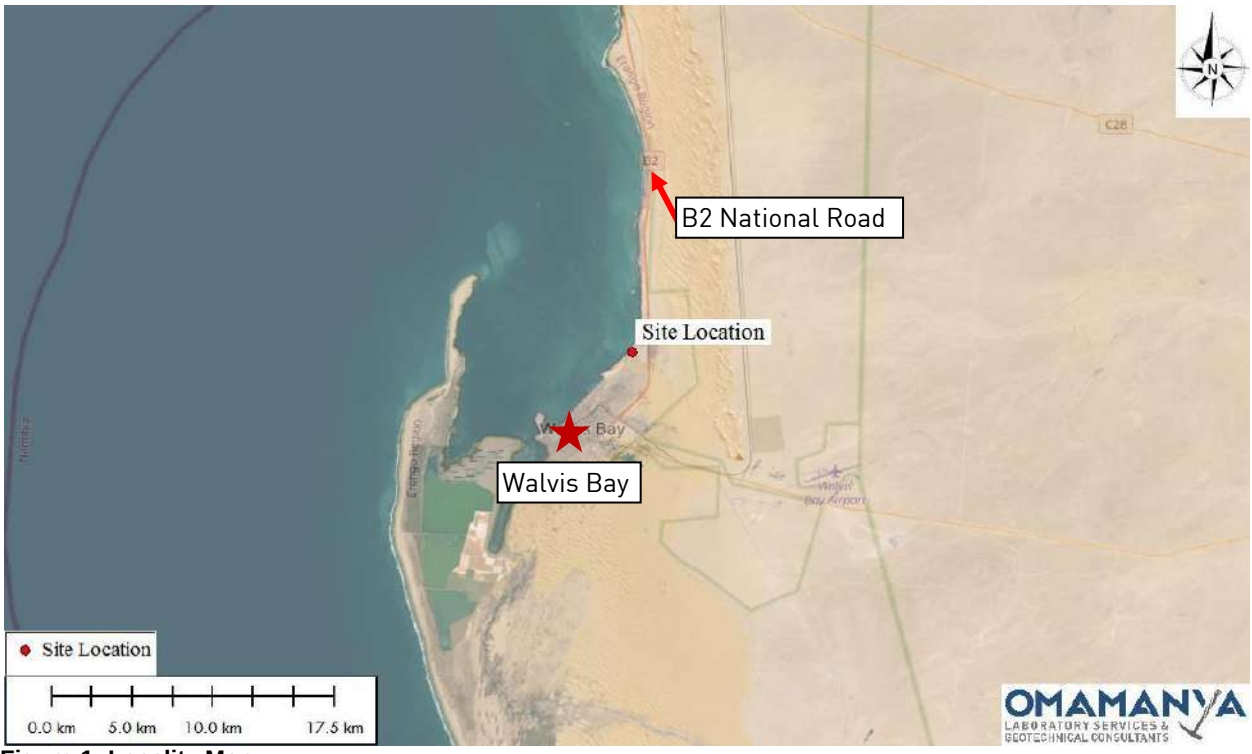

Figure 1: Locality Map

1.2. Terms of Reference

The objective of the geotechnical investigation is to determine the engineering properties of the soil(s) and/or rock(s) underlying the site, including the identification of potential problem soils and the presence of an underground water table. A short detailed geotechnical report has been composed with emphasis on bearing capacity, perched water level, soil and/or rock profiles, and laboratory test results. Recommendations have been made to assist in the design of suitable foundation(s) for the proposed structure(s) and access road(s).

1.3. Available Information

- 1:1 000 000 Geological Map of Namibia;
- 1:250 000 Geological Map of Walvis Bay
- Global Mapper;

- Google Earth;

2. Site Descriptions

The site is located approximately 500m north east of extension 17 in Walvis Bay, directly south of the new harbour jetty, and is accessible via an existing gravel road that dissects the site from south to north (**Figure 2**). The site is on a vacant piece of land, and occasional small shrubs and minor sand dunes occur in the area.

The site has a very gentle slope to the north-west (toward the ocean) with an approximate gradient of <2% and drainage is expected to be poor.

The region experiences a desert climate. Rainfall is scarce with an average annual rainfall of 11mm, although misty mornings are commonplace. An annual average temperature of 16.6°C is recorded with a Weinert N-value of >10.

Figure 2: Site Layout and Test Pit Positions

3. Regional Geology

The majority of the central coastal region is covered by relatively young sediments that form part of the visually impressive “Namib Sand Sea” dunes (QGb), the latter found north, east and south of Walvis Bay. The town of Walvis Bay is underlain by fluvio-marine deposits, which in turn is underlain by bedrock at depths in excess of 30m below natural ground level (NGL) (**Figure 3**).

A shallow perched water table is commonly found throughout the Walvis Bay area and is as shallow as 1,0m below ngl, depending on the location of the site.

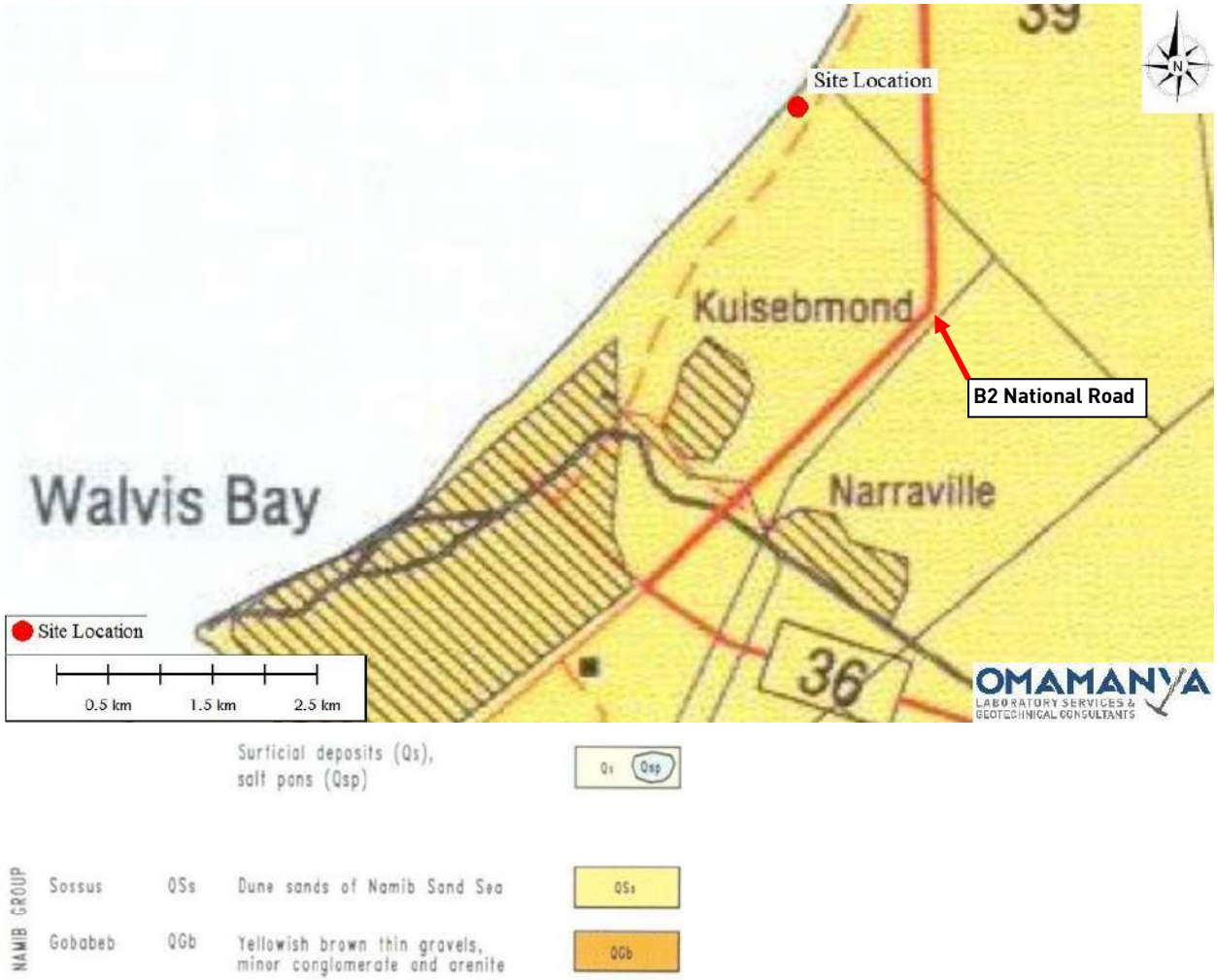

Figure 3: Regional Geology of Walvis Bay and Surrounding Area

4. Site Investigations

Six (6) test pits were excavated across the site using a New Holland B90 4x4 backactor at the positions shown in **Figure 2**. The upper 0.50m of the test pits were profiled from inside the test pit, while the rest of the test pits were profiled from the surface due to sidewall instability. The test pits were profiled according to the Guidelines for Soil and Rock Logging in South Africa (Brink & Bruin, 2002). In addition to the test pits, 2m deep Dynamic Cone Penetrometer (DCP) tests were carried out from natural ground level (*NGL*) at each test pit position to determine the in situ soil consistency and bearing capacity, as per (Paige-Green & Du Plessis, 2009)**.** Disturbed soil samples were taken from the different soil horizons to determine the soils mechanical properties, tested by Omamanya Laboratory Services (SADCAS/ISO 17025 Accredited), and Analytical Laboratory Services (ALS) in Windhoek, the latter to determine the chemical properties.

The soil profiles and photographs are included in **Appendix 1** and **2** respectively, the laboratory test results are included in **Appendix 3** and DCP Test Results are included in **Appendix 4** of this report.

5. Results of the Investigation

5.1. Site Soil & Rock Types

The soil underlying the site is similar in nature, with variations in thickness of soil layers between the test pits. A generalized soil profile as per WTP01 is described below:

0.00 - 0.40: Slightly moist, dark brown, loose, intact, sand. Aolian

0.40 - 2.00: Moist to wet, light brown, loose to medium dense, intact, sand. Fluvio Marine

2.00+: Wet, light brown, loose to medium dense, intact, sand. Fluvio Marine

NOTES:

1. Digging of the test hole was terminated at 2.00m due to the collapse of sidewalls and PWT.

2. A perched water table (PWT) was encountered at 1.40m below NGL.

3. No samples taken.

4. Sidewalls extremely unstable throughout the test hole.

5. Abundant shellfish shells were found throughout the test hole depth.

No backactor refusal or bedrock was encountered in any of the test pits. Water seepage was encountered in all of the test pits, with the exception of WTP06, at the respective levels as indicated in **Appendix 1** and **Table 7**.

The consistency of the soil on site was mostly loose and the layers tended to collapse upon excavation, indicating non-cohesive soil properties. Due to the loose consistency, the entire soil profile is considered to be compressible in the *in situ* state.

5.2. Moisture/Density Relationship and CBR

Representative soil samples from the test pits were collected for Mod/CBR/Road Indicator tests in order to determine the subgrade potential for the proposed roads and foundations in terms of TRH14, or as general fill material under and around structures. The results of the tests are summarized in **Table 1.**

Table 1: CBR Test Result Summary

Test Pit No	Sample Depth (m)	CBR at					Swell (%)	PI (%)	GM	MDD/ OMC	TRH14 Class	AASHTHO
		100%	98%	95%	93%	90%						
WTP04	0.00 – 0.80	15	13	10	7	5	0.01	NP	1.17	1782/8.1	G10	A-2-4

WTP05	1.20 – 2.50	10	9	8	6	4	0.01	NP	1.29	1757/5.3	G10	A-3 / A-2-4

The in situ material to an average depth of 1.85m is consistent in structure and type and is classified as a G10 quality material. The samples are non-plastic (NP) and are representative of the sandy material observed in all six of the test pits (**Appendix 1**).

5.3. Grading, Atterberg Limits and Potential Expansiveness

A representative soil sample from WTP05 was collected for a Foundation Indicator test to determine the sieve analysis (to 0.002mm), Atterberg limits, potential expansiveness and the suitability of the material as structural founding mediums and road layer works. A summary of the results are shown in **Table 2**.

Table 2: Grading, Atterberg Limits and Potential Expansiveness

Test Pit No	Sample Depth (m)	Atterberg Limits			Clay (%)	Silt (%)	Sand (%)	Gravel (%)	AASHTO System	PE 1	USCS 2
		LL (%)	PI (%)	LS (%)							
WTP05	1.30	NP	NP	0	14	10	75	1	A-2-4	Low	SM

1 Potential expansiveness (based on Skemptons system) **2 Unified Soil Classification System**

The summarised test results in **Table 2** indicate that the soils can be classified as “SM“ according to the Unified Soil Classification (ASTM D 2487-06) system in the following category:

- **SM:** This is defined as coarse grained soils with more than 50% retained on the 0.075mm sieve, % sand > % gravel with >12% fines and <15% gravel, fines = ML or MH; Thus a **silty clayey sand.**

The plasticity index (PI) is Non-Plastic (NP) and the overall potential expansiveness of the site soils are considered “low” according to the Van Der Merwe classification, with a total heave of less than 5.0mm (C classification NHBRC) anticipated. The current in situ conditions will however experience consolidation under imposed large loads.

5.4. In situ Tests

5.4.1 Dynamic Cone Penetration (DCP) Test Results

The DCP test results are summarized in **Table 3** and the full test results are included in **Appendix 4**. The calculated safe bearing capacities from the field DCP tests are tabulated in **Table 3: Part 1 - 2**.

Table 3 Part 1 of 2: DCP Results and estimated bearing capacity on in-situ material – Golf Course.

Depth below Natural Ground Level (mm)	DCP01		DCP02		DCP03	
	DN (mm/ blow)	*Calculated safe Bearing Capacity (kPa)	DN (mm/ blow)	*Calculated safe Bearing Capacity (kPa)	DN (mm/ blow)	*Calculated safe Bearing Capacity (kPa)
0 – 250	63	17	13	86	20	55
250-500	81	13	14	79	20	55
500-750	81	13	26	43	14	79
750-1000	81	13	42	26	12	93
1000-1250	65	17	50	22	17	65
1250-1500	38	29	50	22	27	41
1500-1750	26	43	41	27	32	34
1750-2000	33	33	42	26	32	34

*** (Paige-Green & Du Plessis, 2009) FoS = 3**

Table 3 Part 2 of 2: DCP Results and estimated bearing capacity on in-situ material - Namport.

Depth below Natural Ground Level (mm)	DCP04		DCP05		DCP06	
	DN (mm/ blow)	*Calculated safe Bearing Capacity (kPa)	DN (mm/ blow)	*Calculated safe Bearing Capacity (kPa)	DN (mm/ blow)	*Calculated safe Bearing Capacity (kPa)
0 – 250	29	38	35	31	13	86
250-500	19	58	35	31	16	69
500-750	23	48	41	27	30	37
750-1000	43	26	41	27	42	26
1000-1250	44	25	42	26	42	26
1250-1500	51	22	42	26	25	44
1500-1750	51	22	36	31	17	65
1750-2000	40	28	17	65	17	65

*** (Paige-Green & Du Plessis, 2009) FoS = 3**

The tabulated and calculated safe bearing capacities vary across the site and are discussed below in Chapter 5.5 of this report. The DCP results should not be viewed in isolation, but rather in conjunction with the soil profiles and laboratory test results.

5.5. Bearing Capacity and Settlement

Table 4 below summarises the estimated DCP safe bearing capacities of the average depths of the respective in situ layers.

Table 4: Estimated Safe Bearing Capacity of in situ soils

Average Depth (m)	Material	Estimated safe bearing capacity (kPa)
0.0 – 0.75	Aeolian	20
0.75 – 2.20	Fluvio-marine	40
>2.20	Fluvio-marine	65

FoS = 3

The in situ soil consistencies within the bulb of influence below the foundations range from loose to medium dense, and thus indicate compressible soil horizons. Large and/or variable independent design loads transferred to the in situ founding levels may lead to moderate to large, and/or differential settlements taking place, and it is therefore recommended that low loads equitable to those in **Table 3** be either spread over a larger footing area(s) at founding level to create an even load distribution, or that adequate soil improvements are carried out to enhance the bearing capacities for higher loads.

6. pH and Electrical Conductivity (EC)

Representative samples were taken from the test pits and tested for pH and Electrical Conductivity by Analytical Laboratory Services (ALS) in Windhoek. It must be noted that Walvis Bay has a highly aggressive environment. The results are provided in **Table 5**.

Table 5: pH and Electrical Conductivity (EC) Results

Test Pit	Depth (m)	EC (S/m)	pH
WTP04	0.00 – 0.80	0.792	8.6
WTP05	1.20 – 2.50	0.798	8.7

Corrosion of metallic pipe fittings/construction materials are negatively influenced by a low or high pH, and a high electrical conductivity (indicating high concentration of dissolved salts in the soils). The influence of pH and electrical conductivity on the corrosiveness of soil is explained in **Table 6** (NBRI Report 642, CSIR 1987).

Table 6: Influence of pH and conductivity on the corrosiveness of soil

pH	Conductivity (S/m)	Corrosiveness
6-8	<0.1	Non corrosive
5-6 or 8-9	0.1-0.3	Mildly corrosive
4-5 or 9-10	0.3-0.5	Corrosive
<4 or >10	>0.5	Highly corrosive

The results shown in **Table 5** indicate alkaline soils with high electrical conductivity ranging from 0.792 to 0.798 S/m. Corrosion of metallic pipe fittings/construction materials are negatively influenced by a low or high pH, and a high electrical conductivity indicating high concentration of dissolved salts in the soils.

The electrical conductivity of the samples is highly corrosive and the design engineer is advised to consider specially coated metal/UPVC/HDPE pipes and fittings and provide adequate concrete cover to reinforcing in structural members and foundations.

7. Groundwater and Permeability

The in situ moisture content varies from slightly moist in the upper 0,75m changing with depth to moist and eventually wet/saturation at the water table level.

The perched water table is slightly influenced by the site's close proximity to the adjacent oceans tidal ebb and flow, and was logged as follows.

Table 7: Perched Water Table (PWT) depths below NGL

Test Pits	PWT Depths (m)
WTP01	1.40
WTP02	1.70
WTP03	1.20
WTP04	1.40
WTP05	1.50
WTP06	No PWT encountered

The perched water table naturally occurs at or below the proposed soil improvement invert level (refer to **Recommendations**).

8. Excavation Characteristics

The in situ soils can be classified as "soft" and excavations are easily carried out either by hand or backactor to the excavated average depth of 2.2m below the NGL.

Test pit sidewalls were unstable during test pit excavations, and the soil is non-cohesive due to the lack of clay cohesion. Sidewall instability is expected during excavations and it is recommended that all excavations exceeding a depth of 1,0m should be trimmed/battered back at an angle no more than 30-45˚ to the horizontal, or using lateral support systems acceptable to the industry to meet national safety standards. All proposed excavations must be a minimum of 3.0m away from existing structures to prevent soil movement in their vicinity.

The slope stability should be continuously assessed during construction and slope stabilization (sand bagging, cement stabilised sand, etc.) may be necessary in some sections of the excavation where variable soft-medium-hard depths are exposed.

9. Recommendations

The following recommendations are provided as guidelines based on the information gained from the investigation. Although the confidence in the information is high, some localized in situ variation may be expected between the individual data points and the design engineers should take cognizance of this. The design of structures and services remains the responsibility of the appointed engineers. Any significant deviation from the expected conditions must be reported to the authors of the geotechnical report for further investigation/comment.

9.1. Foundation Recommendations

Based on the data gathered from the test pits and DCP tests, the in situ soils are not considered adequate for load bearing capacities on foundations exceeding ~40kPa as such pressures may lead to intolerable amounts of settlement and ultimately bearing capacity failure (depending on the variable pressures exerted). The following soil improvement techniques are therefore recommended for the engineers' discretion.

This method entails the excavation of the in situ soil and replacement thereof, either through compaction of the excavated natural in situ soils, or compaction of cement stabilized excavated soil (C4). Imported G7/G6/G5 materials with PI's less than 6 must be considered to make up the shortfall in the compacted in situ material (±35% compacted loss in loose volume of sand). This method will provide a uniform and stable engineered platform of ±1.2m thickness for structures.

- The final engineered level(s) of the proposed platform(s) is unknown, but
- Remove by cutting the in situ materials to stockpile to ±1.2 m depth across the entire footprint of the proposed structure(s). Excavations to be in a 1:1 ratio (1 vertical to 1 horizontal) beyond the external periphery of said structural footings, or use sandbags to achieve a closer to vertical containment of the excavation. The natural angle of repose of sand is 30-32^{o}.
- Use vibratory compaction on the fully excavation surface until the perched water table rises to the excavated surface to achieve consistent hydraulic compaction throughout.
- Then lay Kaytech A3 as per suppliers specifications to the full extent of the excavated area (1v:1h rule beyond foundation(s) periphery), followed by replacing the excavated sandy soil from the cut to stockpile source, compacted to 98-100% of MDD, fully saturated in 200-300mm layer thicknesses. Note that instability of the saturated sand will occur, but stability will soon return as layers are added above. Compact using a 2.5-8 ton vibratory roller depending on layer thicknesses to be compacted.
- Finally make up the ±35% compacted loss in the loose sand volume to final level(s) with either G5, G6, or G7 quality material (decision is cost based from local quarries or approved and tested borrow area in the vicinity), with PI's <6 and compacted to at least 95% Mod AASHTO (to within 2.0-3.0% moisture below OMC), in compacted layers of 150mm thickness using an 8 ton vibratory roller. This will also serve as an all-purpose work surface. Proposed **Bearing Pressure = 350kPa.**
- Construct lightly reinforced structural foundations as per Engineers' details into the soil raft, with reservoirs onto the raft.

OR

- Carry out excavations and procedures as described above which include bullets 1-5 to a depth of 900mm below the design platform level(s);
- Then mix the excavated sand in stockpile with 5-8% cement (by mass of MDD to achieve a C4 quality material) compacted to 98% of MDD (to within 1.0-2.0% moisture below OMC) in layers of ≤150mm thickness., or
- For the ±35% compacted loss in loose sand volume a local gypcrete material may be considered with a G5, G6, or G7 gravel capping as a work surface (decision is cost based) from an approved and tested borrow area or quarry in the vicinity;
- It is suggested that a G5, or G6 capping layer be placed as an all-purpose work surface, compact to a minimum of 95% of Mod AASHTO density (to within 2.0-3.0% moisture below OMC) in a 150mm layer. Proposed **Bearing pressure = 475kPa.**
- Construct lightly reinforced structural foundations as per Engineers' details into the soil raft, with reservoirs onto the raft.

OR

- Remove by cutting the in situ materials to stockpile to ±0.5 m depth across the entire footprint of the proposed structure(s). Excavations to be in a 1:1 ratio (1 vertical to 1 horizontal) beyond the external periphery of said structural footings;
- Using a 10 ton vibratory roller compact the excavated platform(s) with approximately 8 passes, or until a consistent ≤20mm/blow penetration depth to 1.0m is achieved by DCP method;
- replace the excavated sandy soil from the cut to stockpile source in 200-300mm layers, compacted to 98-100% of MDD;
- Finally make up the ±35% compacted loss in the loose sand volume to final level(s) with either G5, G6, or G7 quality materials (decision is cost based from local quarries or approved and tested borrow area in the vicinity), with PI's <6 and compacted to at least 95% Mod AASHTO (to within 2.0-3.0% moisture below OMC), in compacted layers of 150mm thickness This will also serve as an all-purpose work surface. Proposed **Bearing Pressure = 250kPa.**
- Construct a reinforced structural raft foundation as per Engineers' details.

General:

- All foundations are to be inspected by an engineer or appointed responsible person prior to foundations being cast;
- All materials and quality control is to be tested by an accredited laboratory;
- Adequately clean, wet and compact all foundations prior to casting any concrete;
- Adequate site drainage is required to avoid ponding of water around structures;

- External water taps should be located well away from any structure(s) with adequate drainage away from structures;
- Ensure the safety of construction workers from excavation sidewall collapse.

9.2. Roadwork Recommendations

Roadworks for access/exit roads and parking areas need no special attention other than:

- By excavating the *in situ* materials to roadbed lines and levels, followed by
- Ripping, saturating and compacting the roadbed/selected subgrade material to 150mm depth, compacted to a minimum of 98% of Mod. AASHTO density, followed by;
- Importing 150mm subbase G5 material and compact to a minimum of 95% of Mod. AASHTO density, then by
- Placing 60/80mm interlock pavers (25/35mPa) in a herringbone pattern at 45 degrees to the road center line on 15-20mm bedding sand to SABS 1200 MJ.

It is recommended that a geotechnical/engineering specialist carry out regular inspections throughout the earthworks and foundation phases in order to re-assess conditions as the works proceed.

10. Conclusions

Although the tests are position specific, this investigation has sought to highlight potential founding and excavation difficulties and does not obviate variable ground conditions and isolated zones of poor imported soils/rock material not identified in this report. It is recommended that a competent person(s) manage safety and inspect foundation excavations in order to verify that no significant variability exists between the findings of this report and the exposed materials.

It is recommended that the structural engineer thoroughly review the information provided in the report and carefully weigh up the costs and risks associated with the recommended design approach.

11. References

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Appendix 1:

Soil Profiles

OMAMANYA
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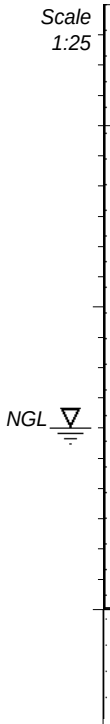
Turnkey Water Solutions
Walvis Bay Desalination Project

HOLE No: wTP01
Sheet 1 of 1

JOB NUMBER: 150-326



0.00 Slightly moist, dark brown, loose, intact, sand.**AOLIAN**

0.40 Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

2.00 Very Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

NOTES

1) Digging of test hole terminated at 2.00m due to collapsing sidewalls filling up test hole continuously.
2) Perched Water Table encountered at 1.40m below NGL.
3) No samples taken.
4) Sidewalls extremely unstable throughout test hole.
5) Abundant shellfish shells throughout test hole.

CONTRACTOR : Coastal Hire & Sales
MACHINE : New Holland B90
DRILLED BY : Abed
PROFILED BY : DP

INCLINATION : Vertical
DIAM : Trench
DATE : 07/05/2020
DATE : 11/05/2020

ELEVATION : 4.53m
X-COORD : E 14° 32' 04.6"
Y-COORD : S 22° 54' 40.1"

HOLE No: wTP01

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

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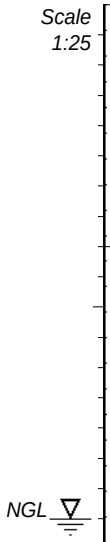
Turnkey Water Solutions
Walvis Bay Desalination Project

HOLE No: WTP02
Sheet 1 of 1

JOB NUMBER: 150-326



0.00 Slightly moist, dark brown, loose, intact, sand.**AOLIAN**

0.80 Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

2.50 Very Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

NOTES

1) Digging of test hole terminated at 2.50m due to collapsing sidewalls filling up test hole continuously.
2) Perched Water Table encountered at 1.70m below NGL.
3) No samples taken.
4) Sidewalls extremely unstable throughout test hole.
5) Abundant shellfish shells throughout test hole.
6) 2 small dunes approximately 5m to the east of test hole.

CONTRACTOR : Coastal Hire & Sales
MACHINE : New Holland B90
DRILLED BY : Abed
PROFILED BY : DP

INCLINATION : Vertical
DIAM : Trench
DATE : 07/05/2020
DATE : 11/05/2020

ELEVATION : 3.622m
X-COORD : E 14° 32' 03.3"
Y-COORD : S 22° 54' 42.3"

HOLE No: WTP02

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

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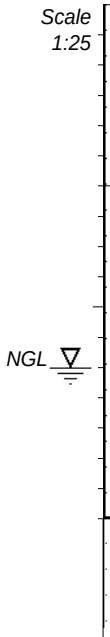
Turnkey Water Solutions
Walvis Bay Desalination Project

HOLE No: WTP03
Sheet 1 of 1

JOB NUMBER: 150-326



0.00 Slightly moist, dark brown, loose, intact, sand.**AOLIAN**

0.60 Moist becoming very moist, light brown, loose, intact, sand.**FLUVIO MARINE**

1.70 Very Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

NOTES

1) Digging of test hole terminated at 1.70m due to collapsing sidewalls filling up test hole continuously.
2) Perched Water Table encountered at 1.20m below NGL.
3) No samples taken.
4) Sidewalls extremely unstable throughout test hole.
5) Abundant shellfish shells throughout test hole.

CONTRACTOR : Coastal Hire & Sales
MACHINE : New Holland B90
DRILLED BY : Abed
PROFILED BY : DP

INCLINATION : Vertical
DIAM : Trench
DATE : 07/05/2020
DATE : 11/05/2020

ELEVATION : 4.33m
X-COORD : E 14° 32' 07.8"
Y-COORD : S 22° 54' 43.3"

HOLE No: WTP03

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

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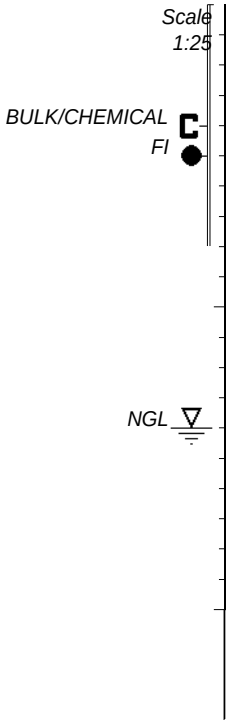
Turnkey Water Solutions
Walvis Bay Desalination Project

HOLE No: WTP04
Sheet 1 of 1

JOB NUMBER: 150-326



0.00 — Moist, dark brown, loose, intact, sand.**AOLIAN**

0.80 — Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

2.00 — Very Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

NOTES

1) Digging of test hole terminated at 2.00m due to collapsing sidewalls filling up test hole continuously.
2) Perched Water Table encountered at 1.40m below NGL.
3) BULK/CHEMICAL sample taken from 0.00--0.80m.
4) FI sample taken at 0.50m.
5) Sidewalls extremely unstable throughout test hole.

CONTRACTOR : Coastal Hire & Sales
MACHINE : New Holland B90
DRILLED BY : Abed
PROFILED BY : DP

INCLINATION : Vertical
DIAM : Trench
DATE : 07/05/2020
DATE : 11/05/2020

ELEVATION : 3.03m
X-COORD : E 14° 32' 06.7"
Y-COORD : S 22° 54' 45.9"

HOLE No: WTP04

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

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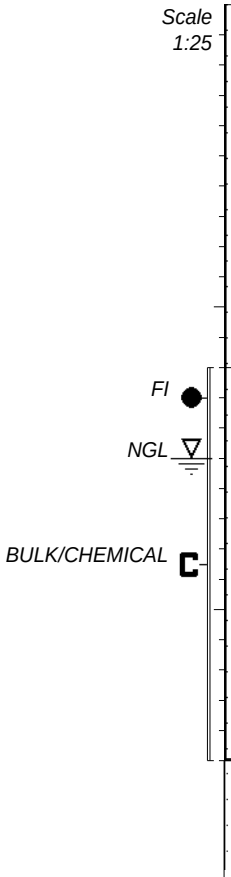
Turnkey Water Solutions
Walvis Bay Desalination Project

HOLE No: WTP05
Sheet 1 of 1

JOB NUMBER: 150-326



0.00 Slightly moist, dark brown, loose, intact, sand.**AOLIAN**

1.20 Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

2.50 Very Moist, light brown, loose, intact, sand.**FLUVIO MARINE**

NOTES

1) Digging of test hole terminated at 2.50m due to collapsing sidewalls filling up test hole continuously.
2) Perched Water Table encountered at 1.50m below NGL.
3) BULK/CHEMICAL sample taken from 1.20--2.50m.
4) FI sample taken at 1.30m.
5) Sidewalls extremely unstable throughout test hole.

CONTRACTOR : Coastal Hire & Sales
MACHINE : New Holland B90
DRILLED BY : Abed
PROFILED BY : DP

INCLINATION : Vertical
DIAM : Trench
DATE : 07/05/2020
DATE : 11/05/2020

ELEVATION : 3.00m
X-COORD : E 14° 32' 10.8"
Y-COORD : S 22° 54' 46.4"

HOLE No: WTP05

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

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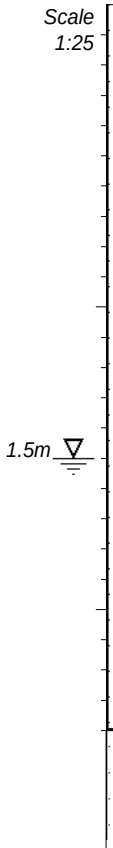
Turnkey Water Solutions
Walvis Bay Desalination Project

HOLE No: WTP06
Sheet 1 of 1

JOB NUMBER: 150-326

Scale 1:25



0.00 Slightly moist, light brown, loose, intact, sand.**FLUVIO MARINE**

2.40 Slightly moist, light brown, loose, intact, sand.**FLUVIO MARINE**

NOTES

1) Digging of test hole terminated at 2.40m due to collapsing sidewalls filling up test hole continuously.

2) No perched water table encountered, but test hole elevated approximately 1.5m above surrounding area.

3) No samples taken.

4) Sidewalls extremely unstable throughout test hole.

CONTRACTOR : Coastal Hire & Sales
MACHINE : New Holland B90
DRILLED BY : Abed
PROFILED BY : DP

INCLINATION : Vertical
DIAM : Trench
DATE : 07/05/2020
DATE : 11/05/2020

ELEVATION : 4.51m
X-COORD : E 14° 32' 09.4"
Y-COORD : S 22° 54' 48.4"

HOLE No: WTP06

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

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LABORATORY SERVICES & GEOTECHNICAL CONSULTANTS

Turnkey Water Solutions
Walvis Bay Desalination Project

LEGEND
Sheet 1 of 1

JOB NUMBER: 150-326

		SAND	{SA04}
1.5 ▽		WATER TABLE REST LEVEL/perched water table	{SA36}
Name ●		DISTURBED SAMPLE	{SA38}
Name C		CHEMICAL SAMPLE	{SA39}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : DP
SETUP FILE : STANDARD.SET

DATE : 15/05/2020 11:52
TEXT : ..nProjectSoilProfiles.txt

LEGEND
SUMMARY OF SYMBOLS

Appendix 2:

Test Pit Photographs

WTP 01

WTP 01

WTP 02

WTP 02

WTP 03

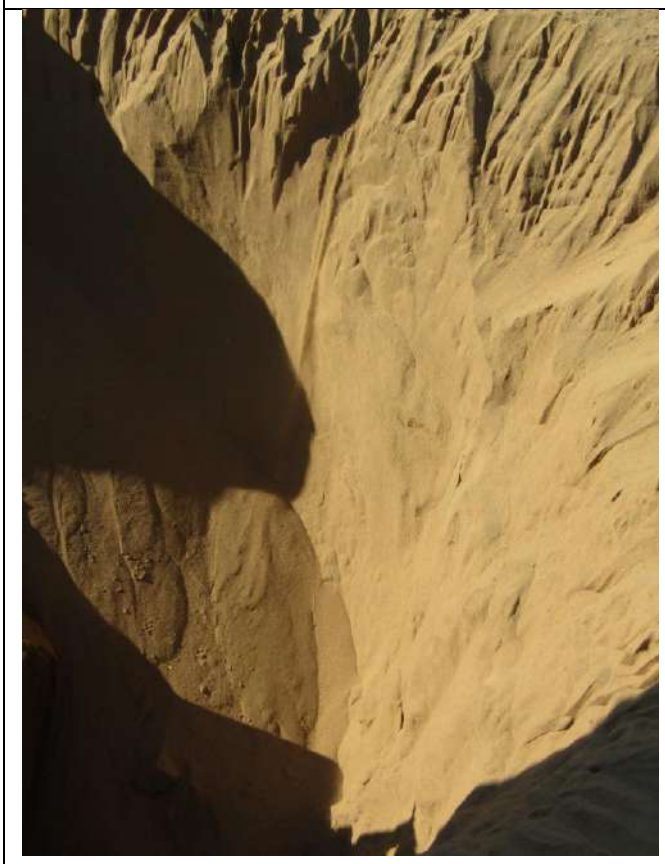
WTP 03

WTP 04

WTP 04

WTP 05

WTP 05



WTP 06

WTP 06

Appendix 3:

Laboratory & Field Test Results

Appendix 3.1:

MOD/CBR Results

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

SADCAS TEST-3 0002

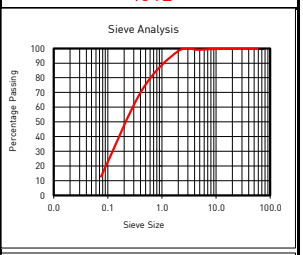
Customer:	Turnkey Water Solutions 119 Komm'ssaris Street Welgemoed, Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	14-05-2020
		Date Reported:	18-05-2020
		Req. Number:	150-326
Attention:	Alex Delle Donnie	No. of Pages:	

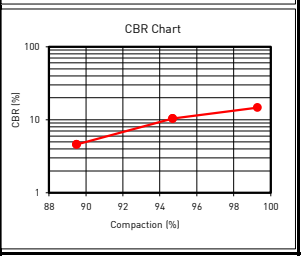
TEST REPORT

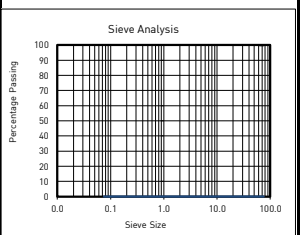
CALIFORNIA BEARING RATIO - (TMH 1 Method A1(a),A2,A3,A4,A5,A7,A8)

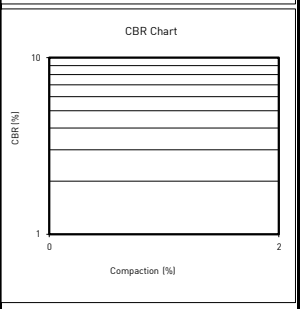
Material Indicators							
Sample Position (SV)		WTP 04	**TRH 14**				
Depth (mm)		0-800	**G10 Subgrade**				
Sample No.:		**4812**					
Materials Description	Source	Insitu					
	Colour	Dark Brown					
	Soil Type	Sand					
	Classification	Insitu					
Max. Stone size in hole (mm)				Opinion			
Percentage Passing	75.0mm	100					
	63.0mm	100					
	53.0mm	100					
	37.5mm	100					
	26.5mm	100					
	19.0mm	100					
	13.2mm	100					
	4.75mm	99					
	2.00mm	98					
	0.425mm	72					
	0.075mm	12.9					
Soil Mortar & Constants							
Grading Modulus		1.17					
Coarse Sand <2.0 >0.425		27.2					
Med.	<0.250 >0.150	59.7					
Silt	<0.075	13.1					
Liquid Limit (%)		NP					
Plasticity Index (%)		NP					
Linear Shrinkage (%)		0.0					
CBR / Density Relationship							
Mould A	Max Dry Density (kg/m^3)	1782					
	Opt Moisture Content (%)	8.1					
	Mould Moisture Con. (%)	7.7					
	MDD Mould A	99.3					
	Swell (%)	0.01	1.5	✓			
Mould B	Mould B	94.7					
	Swell (%)	0.02					
Mould C	Mould C	89.5					
	Swell (%)	0.04					
CBR	@ 100%	15					
	@ 98%	13					
	@ 95%	10					
	@ 93%	7					
	@ 90%	5	3	∗			
Insitu Moisture Content (%)							
Soil Classification Achieved By The Material							
TRH 14		G10 Subgrade					
AASTHO System		A-2-4					
Unified System		SM					

4812

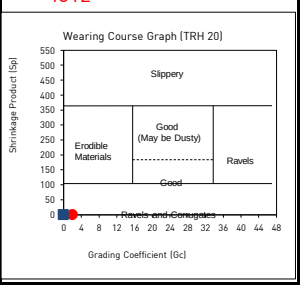








4812



Specimens sampled by Omamanya Lab according to sampling Plan TMH 5 Methods MB1 & MC1

- Specimens sampled by : Dirk Peters
- The weather conditions are such that there is no detrimental effect on the sample taken.
- Deviation: Mould B has been compacted using a hammer weighing 4.536kg, with a falling height of 457.2mm, 5 layers 25 blows.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

1. This report (with attachments) is the correct record of all measurements made, and may not be reproduced other than with full written approval from the Members of Omamanya Laboratory Services (Pty) Ltd.
2. Measuring Equipment, traceable to National Standards is used where applicable. Results reported in this Test Report relate only to the items tested and are an indication only of the sample provided and / or taken.
3. Certain information contained in this report or provided separately is being offered in good faith but, in the circumstances pertaining to the type of information furnished, no guarantee can be given that all the information is necessarily correct or representative of the in-situ conditions.
4. The Opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained.The complaint (✓) non-complaint (×) and uncertain (∗) opinion indicators are based on an estimation of approximate 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2017 with reference to ISO 17025:2005 (E) Items 5.4.6.2 & 5.10.3.1 (c)

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

SADCAS TEST-3 0002

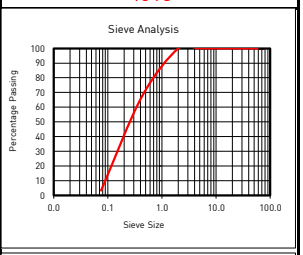
Customer:	Turnkey Water Solutions 119 Komm'ssaris Street Welgemoed, Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	14-05-2020
		Date Reported:	18-05-2020
		Req. Number:	150-326
Attention:	Alex Delle Donnie	No. of Pages:	

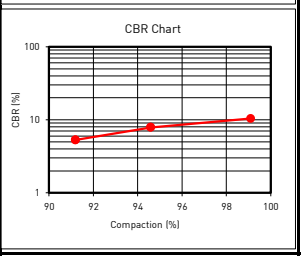
TEST REPORT

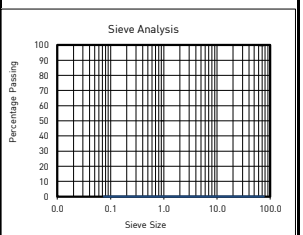
CALIFORNIA BEARING RATIO - (TMH 1 Method A1(a),A2,A3,A4,A5,A7,A8)

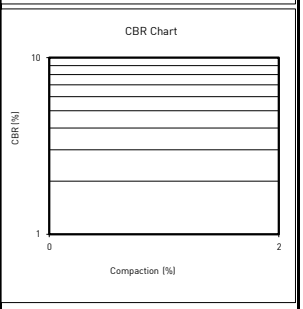
Material Indicators							
Sample Position (SV)		WTP 05	**TRH 14**				
Depth (mm)		1200-2500	**G10 Subgrade**				
Sample No.:		**4813**					
Materials Description	Source	Insitu					
	Colour	Light Brown					
	Soil Type	Sand					
	Classification	Insitu					
Max. Stone size in hole (mm)				Opinion			
Percentage Passing	75.0mm	100					
	63.0mm	100					
	53.0mm	100					
	37.5mm	100					
	26.5mm	100					
	19.0mm	100					
	13.2mm	100					
	4.75mm	100					
	2.00mm	100					
	0.425mm	67					
	0.075mm	3.4					
Soil Mortar & Constants							
Grading Modulus		1.29					
Coarse Sand <2.0 >0.425		32.8					
Med.	<0.250 >0.150	63.8					
Silt	<0.075	3.4					
Liquid Limit (%)		NP					
Plasticity Index (%)		NP					
Linear Shrinkage (%)		0.0					
CBR / Density Relationship							
Mould A	Max Dry Density (kg/m^3)	1757					
	Opt Moisture Content (%)	5.3					
	Mould Moisture Con. (%)	5.1					
	MDD Mould A	99.1					
	Swell (%)	0.01	1.5	✓			
Mould B	Mould B	94.6					
	Swell (%)	0.02					
Mould C	Mould C	91.2					
	Swell (%)	0.04					
CBR	@ 100%	10					
	@ 98%	9					
	@ 95%	8					
	@ 93%	6					
	@ 90%	4	3	✳			
Insitu Moisture Content (%)							
Soil Classification Achieved By The Material							
TRH 14		G10 Subgrade					
AASTHO System		A-3 / A-2-4					
Unified System		SP					

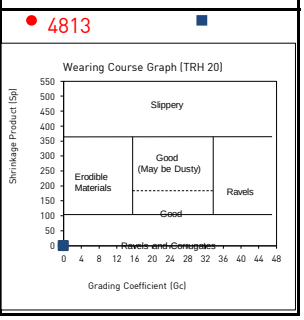
4813











Specimens sampled by Omamanya Lab according to sampling Plan TMH 5 Methods MB1 & MC1

- Specimens sampled by : Dirk Peters
- The weather conditions are such that there is no detrimental effect on the sample taken.
- Deviation: Mould B has been compacted using a hammer weighing 4.536kg, with a falling height of 457.2mm, 5 layers 25 blows.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

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4. The Opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained.The complaint (✓) non-complaint (×) and uncertain (✳) opinion indicators are based on an estimation of approximate 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2017 with reference to ISO 17025:2005 (E) Items 5.4.6.2 & 5.10.3.1 (c)

Appendix 3.2:

Foundation Indicator Results

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

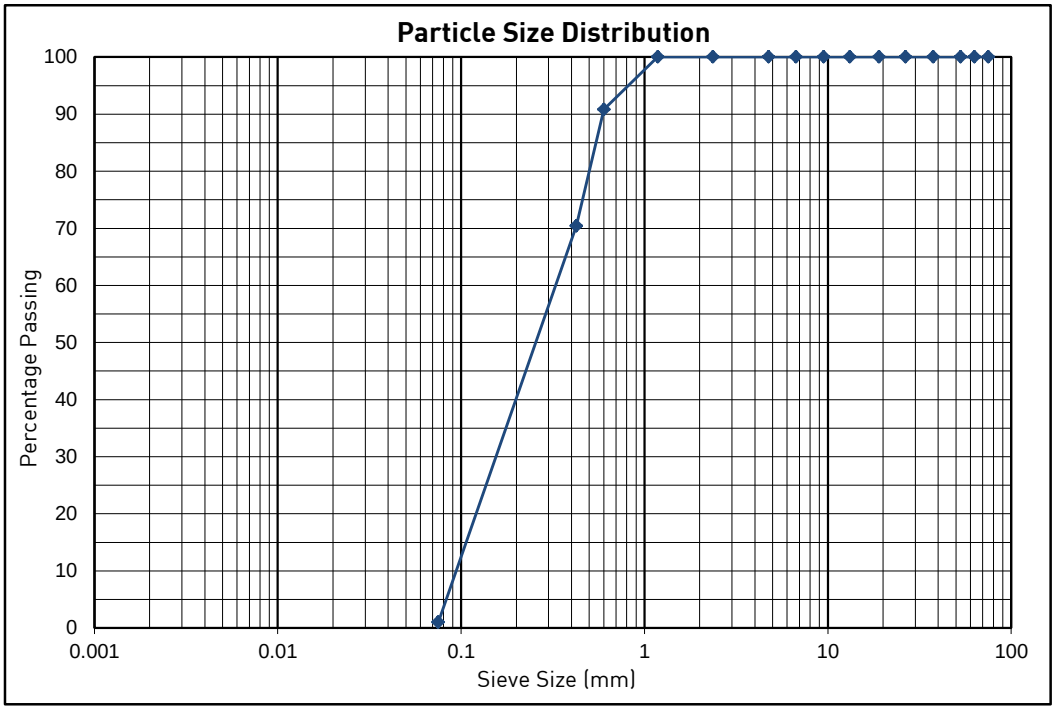
Customer:	Turnkey Water Solutions 119 Komm'ssaris Street Welgemoed, Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	14-05-2020
		Date Reported:	15-05-2020
		Req. Number:	150-326
Attention:	Alex Delle Donnie	No. of Pages:	1/1

TEST REPORT

FOUNDATION INDICATOR - (SANS 3001 GR3) & (ASTM Method D422)

Sample Position (SV)		WTP 04
Depth (mm):		500
Sample No.:		4812
Materials Description	Source	Insitu
	Colour	Dark Brown
	Soil Type	Sand
	Classification	Insitu

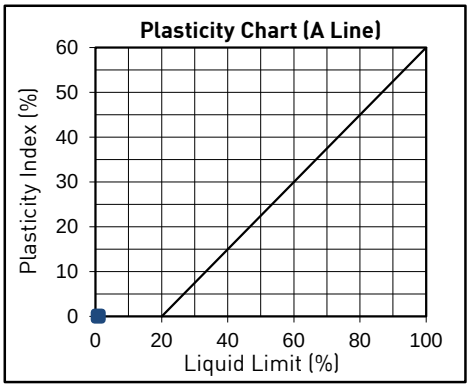
Sieve Size	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	100
0.600	91
0.425	70
0.075	1
#N/A	#DIV/0!
#N/A	#DIV/0!
#N/A	#DIV/0!
#N/A	#DIV/0!
#N/A	#DIV/0!
#N/A	#DIV/0!
#N/A	#DIV/0!
#N/A	#DIV/0!

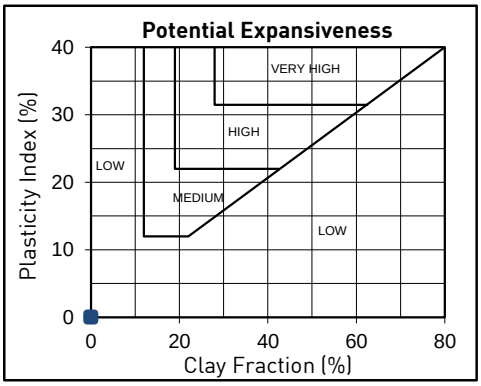


Liquid Limit (%)	NP
Plasticity Index (%)	NP
Linear Shrinkage (%)	0
Moisture Content (%)	

% Clay	#DIV/0!
% Silt	#DIV/0!
% Sand	#DIV/0!
% Gravel	#DIV/0!

Unified Soil Classification	
AASHTO Soil Classification	A-3 / A-2-4





Specimens sampled by Omamanya Lab according to sampling Plan TMH 5 Methods MB1 & MC1

Specimens sampled by : Dirk Peters

No fines in the sample to conduct hydrometer test

Janco Potgieter
Signatory
For Omamanya Laboratory Services (Pty) Ltd

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

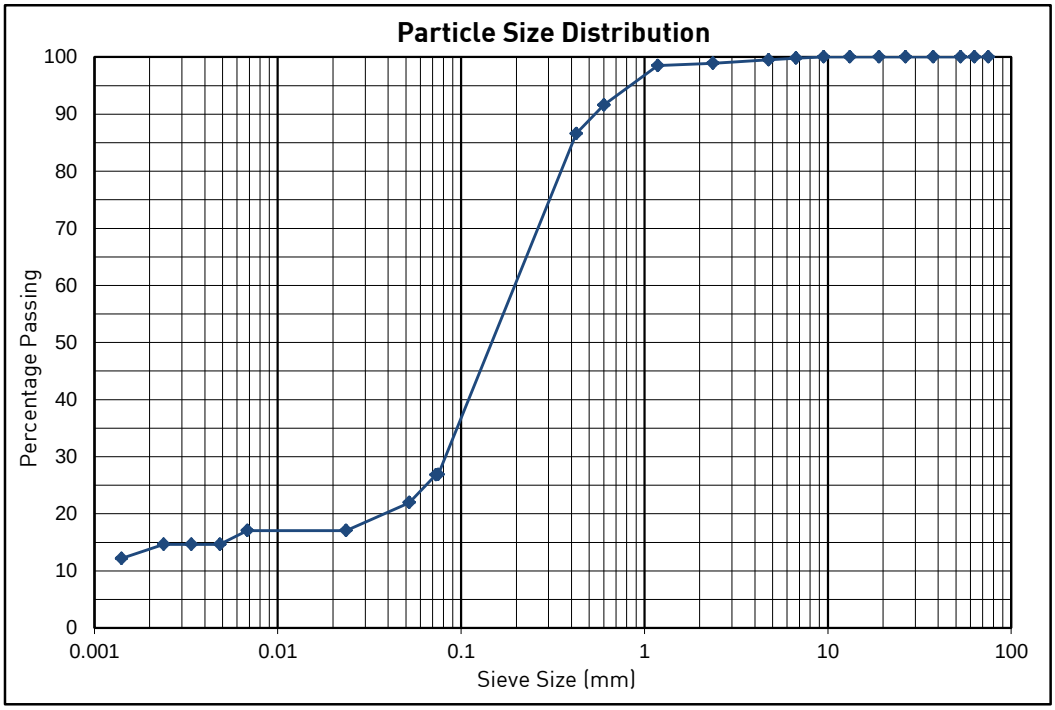
Customer:	Turnkey Water Solutions 119 Komm'ssaris Street Welgemoed, Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	14-05-2020
		Date Reported:	15-05-2020
		Req. Number:	150-326
Attention:	Alex Delle Donnie	No. of Pages:	1/1

TEST REPORT

FOUNDATION INDICATOR - (SANS 3001 GR3) & (ASTM Method D422)

Sample Position (SV)		WTP 05
Depth (mm):		1300
Sample No.:		4813
Materials Description	Source	Insitu
	Colour	Light Brown
	Soil Type	Sand
	Classification	Insitu

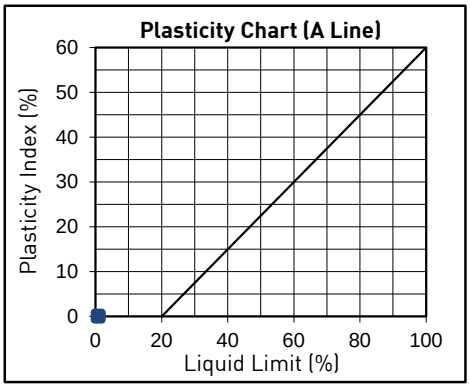
Sieve Size	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	99
1.18	99
0.600	92
0.425	87
0.075	27
0.073	27
0.052	22
0.024	17
0.007	17
0.005	15
0.003	15
0.002	15
0.001	12

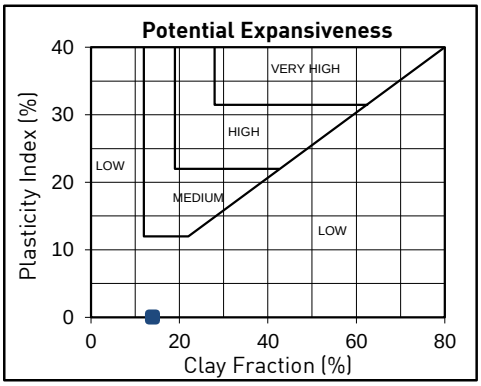


Liquid Limit (%)	NP
Plasticity Index (%)	NP
Linear Shrinkage (%)	0
Moisture Content (%)	

% Clay	14
% Silt	10
% Sand	75
% Gravel	1

Unified Soil Classification	SM
AASHTO Soil Classification	A-2-4





Specimens sampled by Omamanya Lab according to sampling Plan TMH 5 Methods MB1 & MC1

Specimens sampled by : Dirk Peters

Janco Potgieter
Signatory
For Omamanya Laboratory Services (Pty) Ltd

Appendix 3.3:

pH & EC Results

Analytical Laboratory Services
OUR QUALITY IS IN THE DETAIL

analab@mweb.com.na • Tel. +264 61 210 132 Fax +264 61 210 058
71 Newcastle Street • PO Box 86782 • Eros • Windhoek • Namibia

TEST REPORT

To: **Omamanya Laboratory Services (Pty) Ltd.**
P O Box 11598
Windhoek

Attn: Ms A. Loftie-Eaton

e-mail: **admin@omamanya.go.na**

Date received: **14-May-20**
Date analysed: **19-May-20**
Date reported: **19-May-20**

Your Reference: verbal
Lab Reference: I200740

Lab No.	Type of Test: / Sample	pH	Electrical conductivity
	Method Reference:	TMH 1 A20	TMH 1 A21T
	Units:		mS/m
1	**WalvisBay desalination A WTP 04**	**8.6**	**792**
2	**WalvisBay desalination B WTP 05**	**8.7**	**798**

Remark

Silke Rügheimer
Laboratory Manager

Appendix 3.4:

DCP Results

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

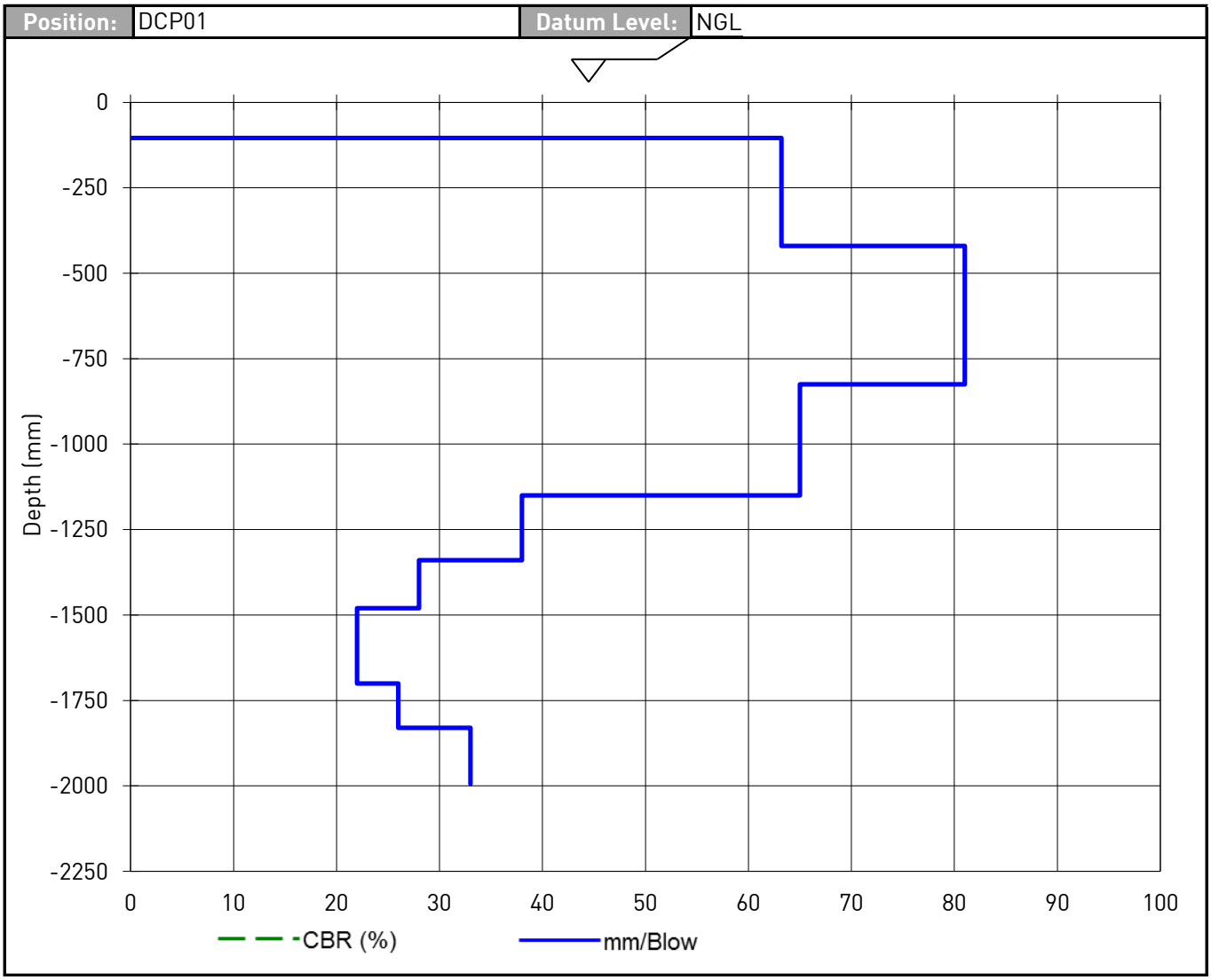
6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

SADCAS TEST-3 0002

Customer:	Turnkey Water Solutions 119 Kommissaris Street Welgemoed Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	08/05/2020
		Date Reported:	08/05/2020
		Req. Number:	150-326
Attention:	Alex Delle Donne	No. of Pages:	1 of 6

DYNAMIC CONE PENETROMETER (DCP) - (TMH 6 Method ST6)

Position:	DCP01	Datum Level:	NGL



To achieve kN/m2 (kPa) value, multiply bearing pressure values off graph by 10.

. Standard TPA - DCP/CBR/Bearing Pressure relationship graph used. The engineer is responsible for acceptance of this graph relationship.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

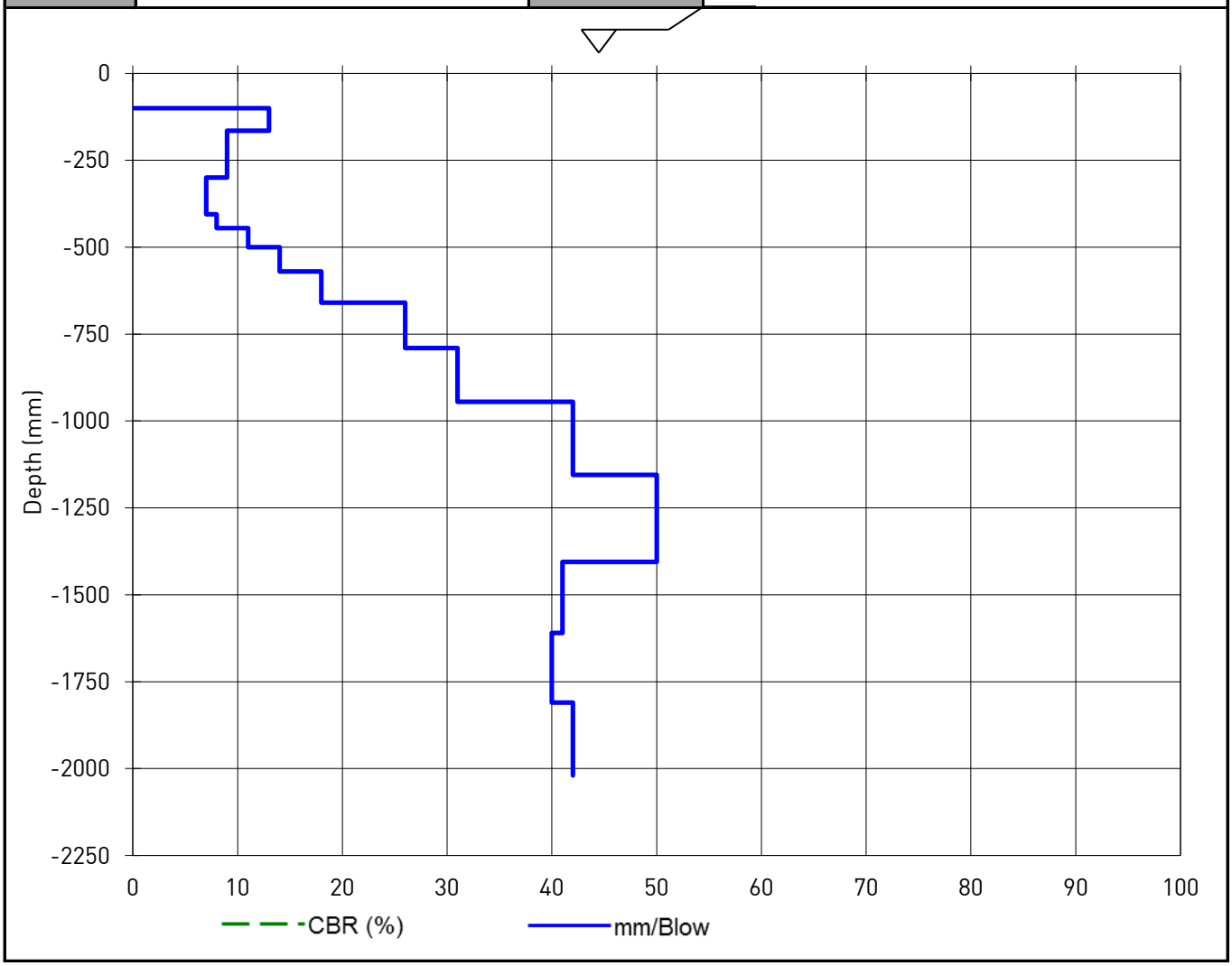
6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

SADCAS TEST-3 0002

Customer:	Turnkey Water Solutions 119 Kommissaris Street Welgemoed Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	08/05/2020
		Date Reported:	08/05/2020
		Req. Number:	150-326
Attention:	Alex Delle Donne	No. of Pages:	2 of 6

DYNAMIC CONE PENETROMETER (DCP) - (TMH 6 Method ST6)

Position:	DCP02	Datum Level:	NGL



To achieve kN/m2 (kPa) value, multiply bearing pressure values off graph by 10.

. Standard TPA - DCP/CBR/Bearing Pressure relationship graph used. The engineer is responsible for acceptance of this graph relationship.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

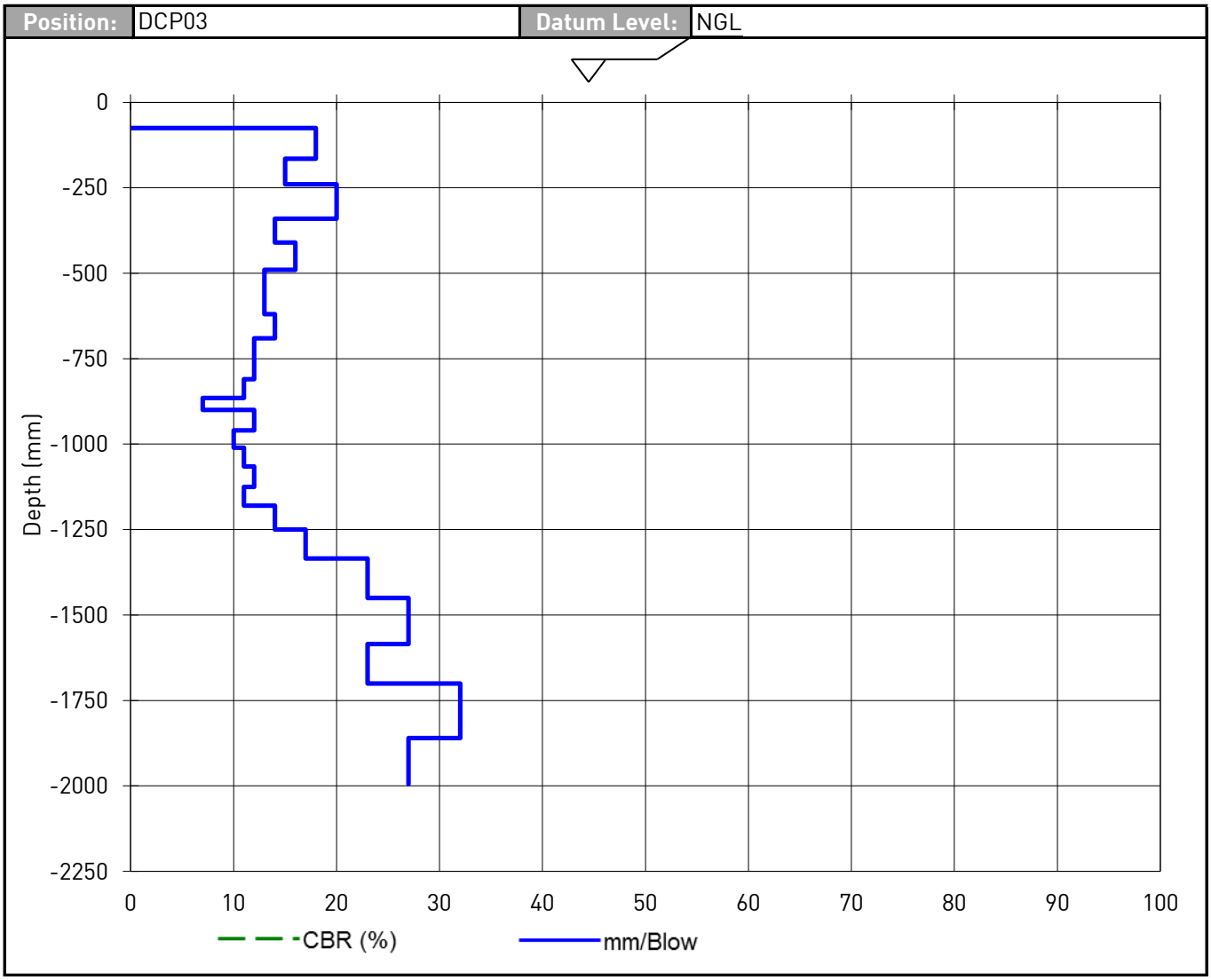
6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

SADCAS TEST-3 0002

Customer:	Turnkey Water Solutions 119 Kommissaris Street Welgemoed Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	08/05/2020
		Date Reported:	08/05/2020
		Req. Number:	150-326
Attention:	Alex Delle Donne	No. of Pages:	3 of 6

DYNAMIC CONE PENETROMETER (DCP) - (TMH 6 Method ST6)

Position:	DCP03	Datum Level:	NGL



To achieve kN/m2 (kPa) value, multiply bearing pressure values off graph by 10.

. Standard TPA - DCP/CBR/Bearing Pressure relationship graph used. The engineer is responsible for acceptance of this graph relationship.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

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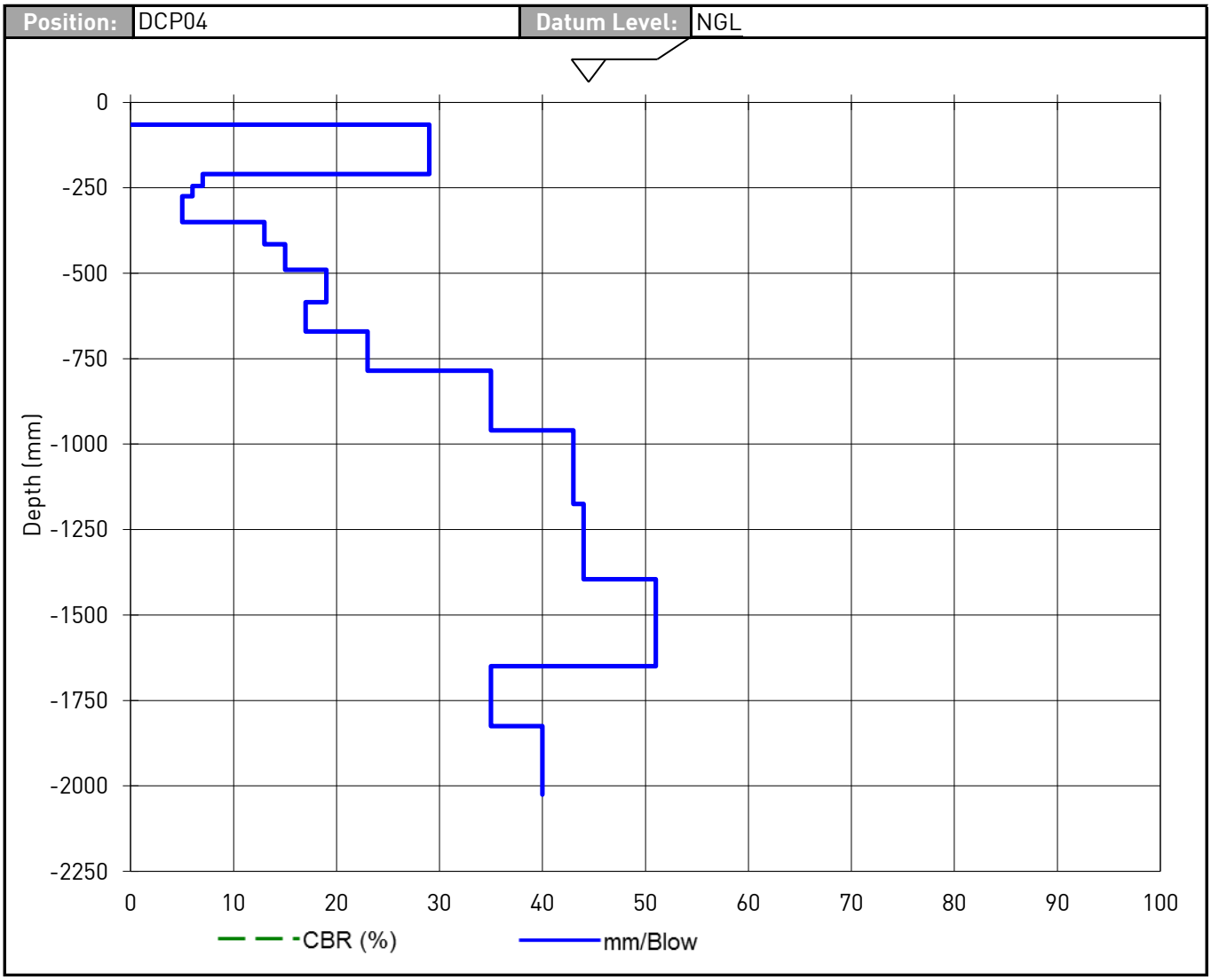
SADCAS TEST-3 0002

Customer:	Turnkey Water Solutions 119 Kommissaris Street Welgemoed Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	08/05/2020
		Date Reported:	08/05/2020
		Req. Number:	150-326
Attention:	Alex Delle Donne	No. of Pages:	4 of 6

DYNAMIC CONE PENETROMETER (DCP) - (TMH 6 Method ST6)

Position:	DCP04	Datum Level:	NGL



To achieve kN/m2 (kPa) value, multiply bearing pressure values off graph by 10.

. Standard TPA - DCP/CBR/Bearing Pressure relationship graph used. The engineer is responsible for acceptance of this graph relationship.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

Omamanya Laboratory Services (Pty) Ltd

Geotechnical Consultants & Laboratory Services

Reg No.: 2007/0158

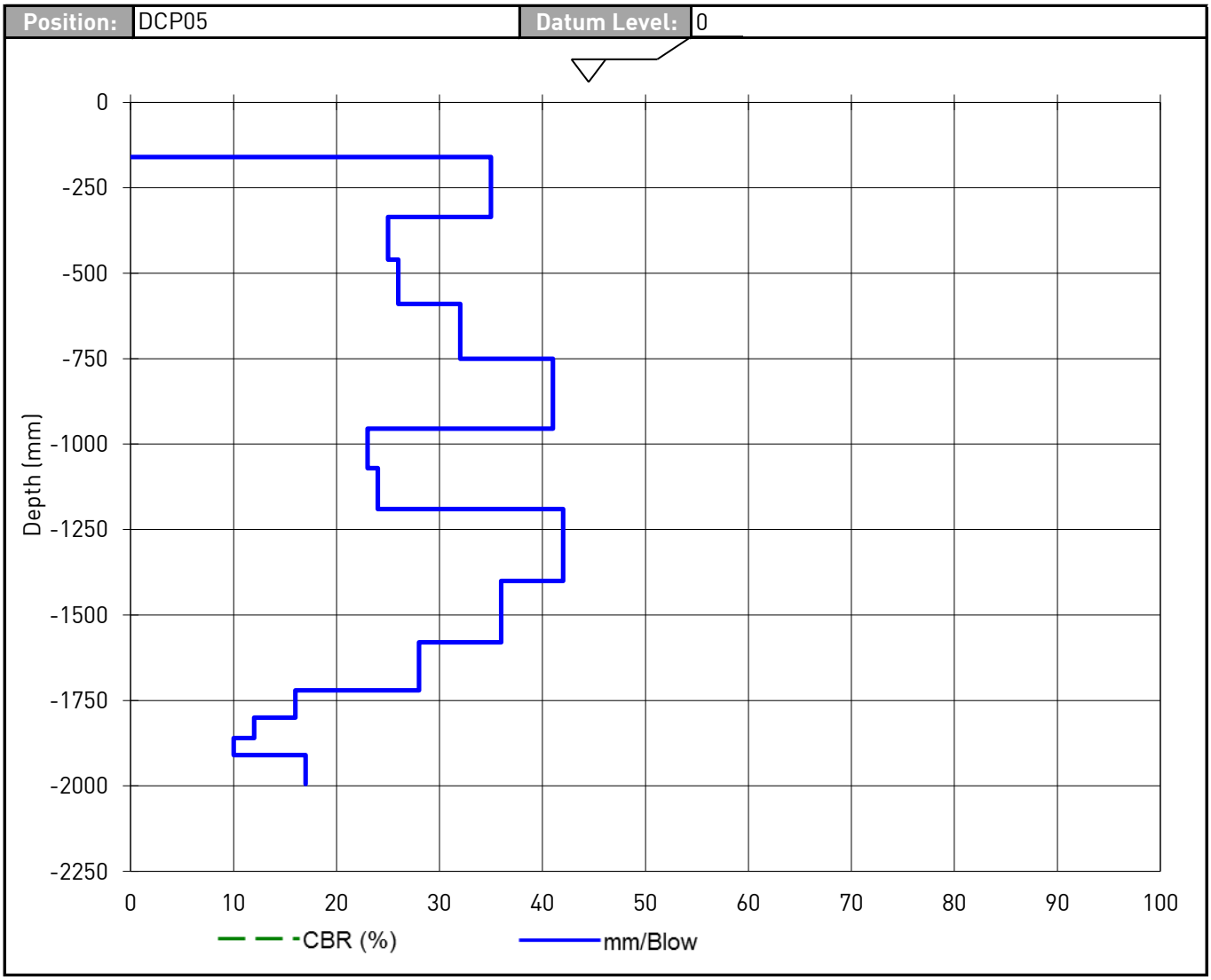
6 Van Der Bijl Street Windhoek Namibia | **Tel:** +264 61 245 103/6 | **Fax:** +264 61 245 101 | **E-mail:** admin@omamanya.go.na

SADCAS TEST-3 0002

Customer:	Turnkey Water Solutions 119 Kommissaris Street Welgemoed Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	08/05/2020
		Date Reported:	08/05/2020
		Req. Number:	150-326
Attention:	Alex Delle Donne	No. of Pages:	5 of 6

DYNAMIC CONE PENETROMETER (DCP) - (TMH 6 Method ST6)

Position:	DCP05	Datum Level:	0



To achieve kN/m2 (kPa) value, multiply bearing pressure values off graph by 10.

. Standard TPA - DCP/CBR/Bearing Pressure relationship graph used. The engineer is responsible for acceptance of this graph relationship.

Janco Potgieter
Technical Signatory
For Omamanya Laboratory Services (Pty) Ltd

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SADCAS TEST-3 0002

Customer:	Turnkey Water Solutions 119 Kommissaris Street Welgemoed Cape Town South Africa	Project:	Walvis Bay Desalination Project
		Date Received:	08/05/2020
		Date Reported:	08/05/2020
		Req. Number:	150-326
Attention:	Alex Delle Donne	No. of Pages:	6 of 6

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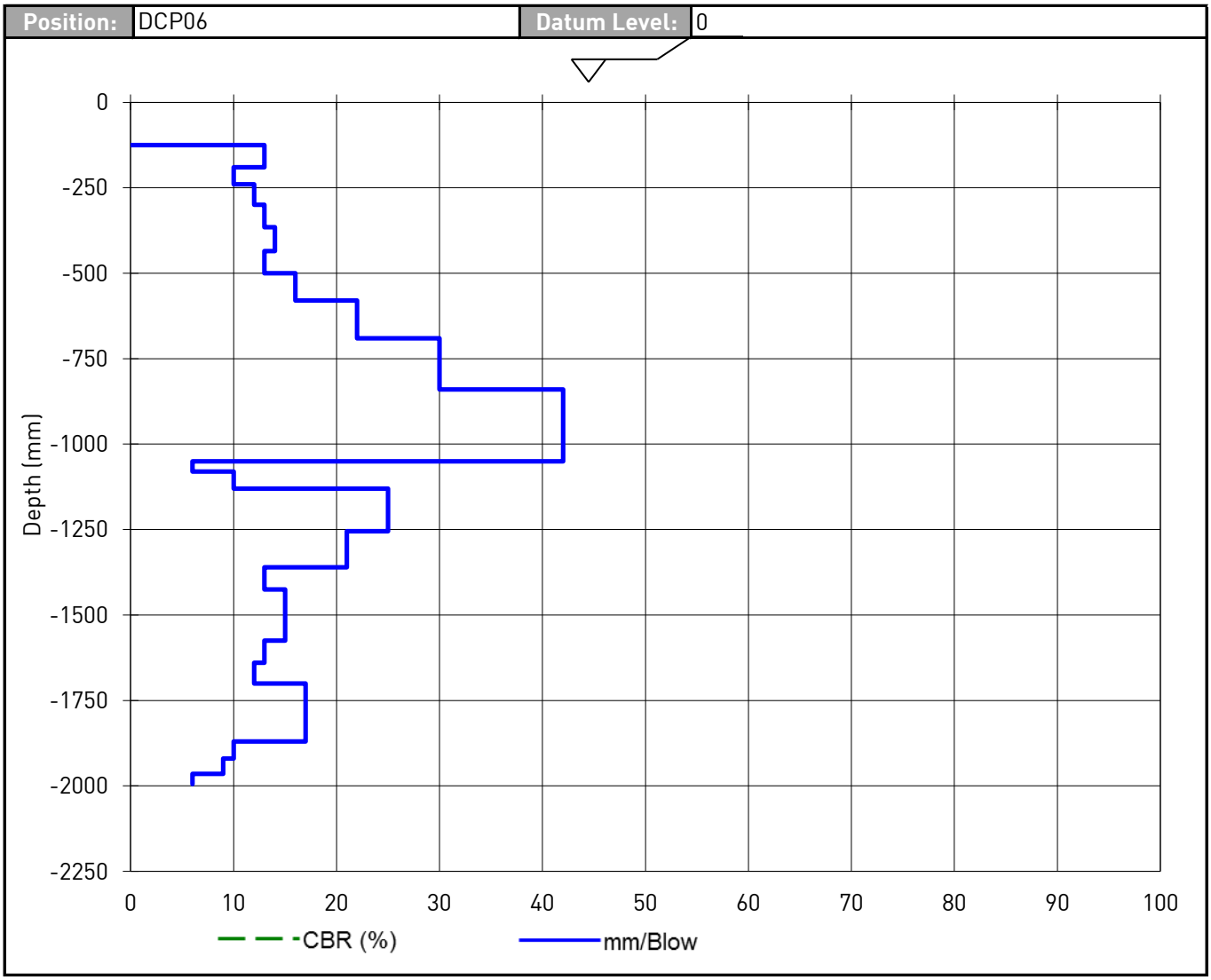

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WATER ASSOCIATES NAMIBIA

water - environment - engineering

Environmental Impact Assessment for Proposed Desalination Plant, Walvis Bay

Hydrogeological Report and Risk Assessment

WA Project No.: 2020/03

WA Report No.: 2020/03/0001

June 2020

Water Associates Namibia Pty

Windhoek, Namibia

Information

Title:	Hydrogeological Report and Risk Assessment for proposed Desalination Plant , Walvis Bay
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1 Introduction and Scope

Water Associates Namibia (Pty) Ltd (WAN) was appointed by Turnkey Water Solutions (PTY) Ltd in April 2020, to conduct a hydrogeological report and risk assessment for the development of a Desalination Plant in Walvis Bay.

The scope of work included:

- A desk study for existing hydrogeological information.
- A risk assessment on the impact of the proposed Desalination Plant on the groundwater regime, quality and water supply (EIA Input).
- Recommendations for the drilling and installation of the proposed boreholes for water supply to the Desalination Plant (Terms of Reference).

2 Background

The project, co-developed by Turnkey Water Solutions (TWS) and InnoSun, is aiming to supply the Walvis Bay Municipality with an alternative clean and reliable water source. This will be achieved by the installation and commissioning of innovative and comprehensive water desalination solutions that are sustainable, scalable and decentralised.

The plant aims to supply about 1,400,000 m3/year of potable water from the Desalination Plant into the municipal water distribution network. This accounts for only a small percentage of the total water demand in the area but will provide valuable commercial data for future renewable water supply studies and projects.

With very close proximity to the beach, there is a strong possibility that beach wells will offer a successful intake solution. Seawater will be supplied to the reverse osmosis plant via a total of 4 production and 1 standby boreholes. The capacity of the borehole pumps will be a minimum of 120 m3/hr.

2.1 Description of Project Area

Walvis Bay is the hub of Namibia`s fishing industry and an important logistical port for the Southern African Region providing port facilities for the import and export of cargo for the Namibia, Botswana, Zambia and the Democratic Republic of the Congo. Walvis Bay and its port was previously a South African enclave that was handed over to Namibia in 1993.

It has a growing population of at least 80,000 people and the current water demand for domestic and industrial use is approximately 5 Mm3/a. At the present time, Walvis Bay is solely dependent on groundwater supplied by NamWater, the national bulk water supply utility from the Kuiseb River

Groundwater scheme and is currently not receiving water from the Omdel Groundwater scheme nor the Orano Desalination Plant.

Figures 1 to 4 show the location of the proposed Desalination Plant and the location of beach-wells to be drilled on the site. The boreholes for saline water intake to the plant will be drilled as close to the beach as is practical on Erf 4688. The distance between the wells is limited by the size of the Erf and each will be approximately 10 to 20 m apart.

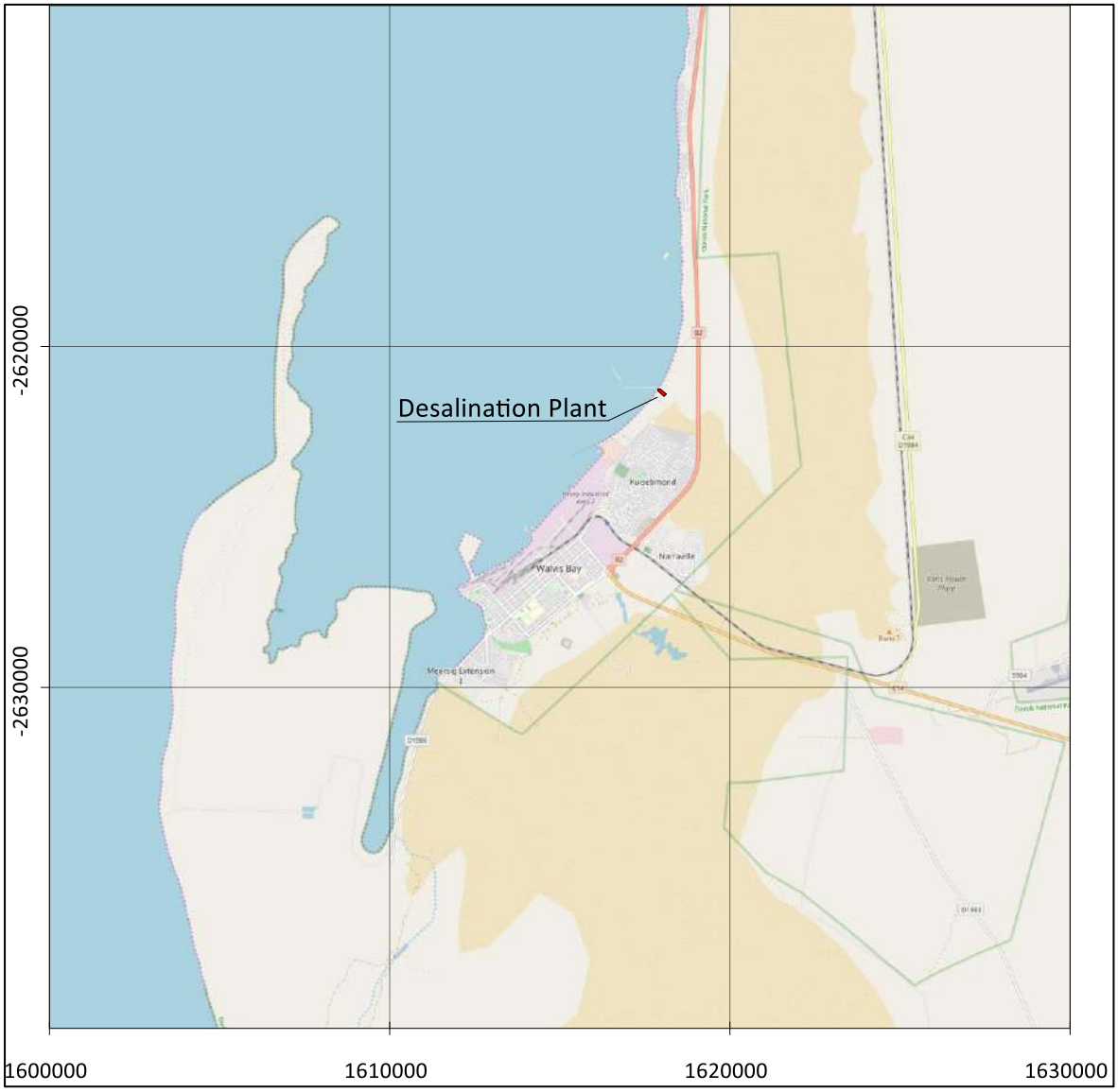

Figure 1: Location of Desalination Plant (Map Source: OSM).

Figure 2: Walvis Bay/ Kuisebmond Area *and the location of the proposed Desalination Plant (Map Source: OSM).*

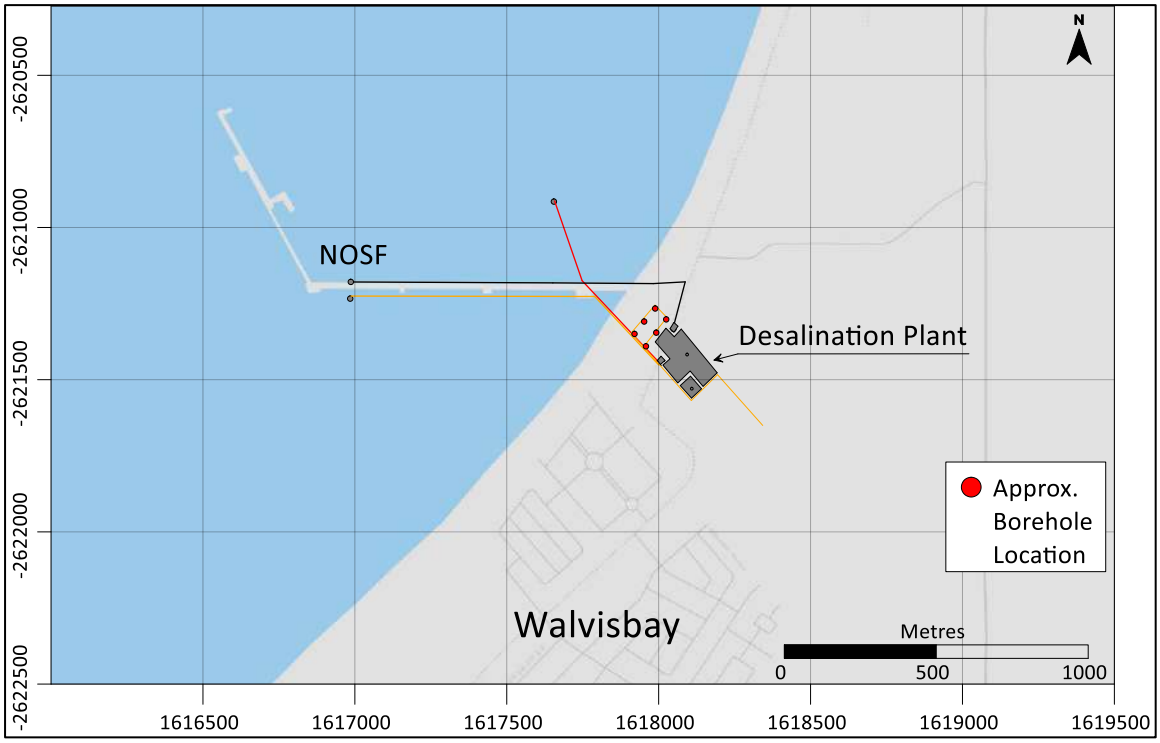

Figure 3: Location of ERF4688, Walvis Bay and layout of Desalination Plant (Map Source: OSM).

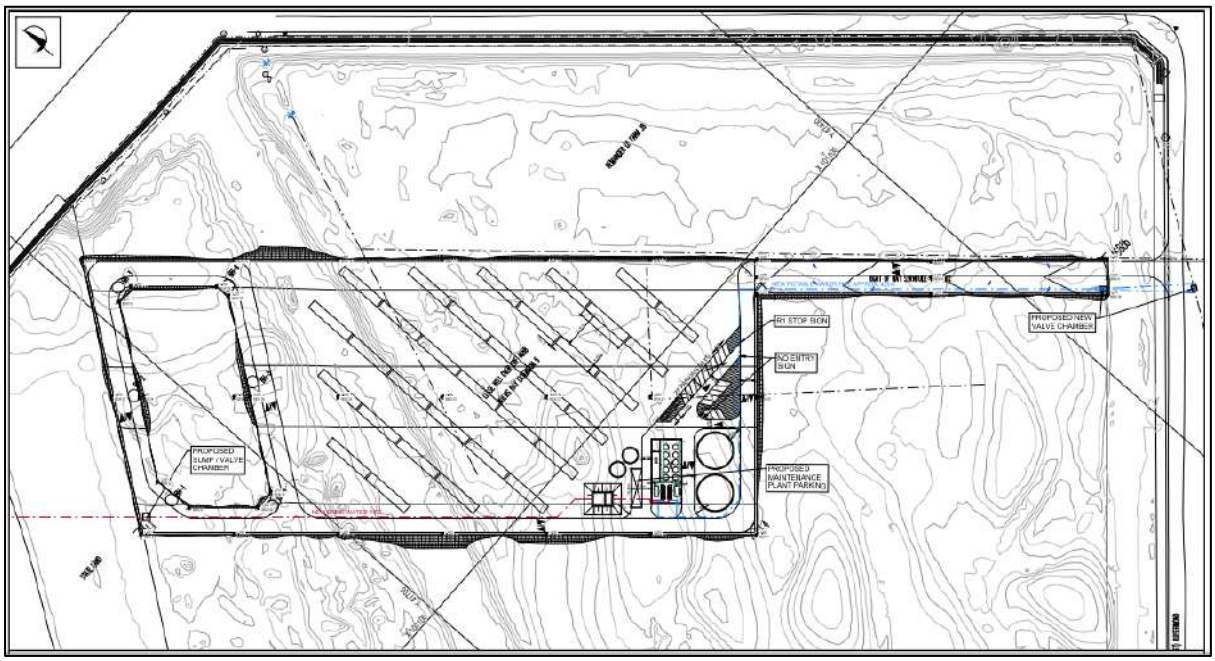

Figure 4:Proposed detailed layout of Desalination Plant in Walvis Bay (Image derived from Turnkey Solutions)

It is assumed that the site will be located in an area where the underground sediments consist of deposits from the Tumas river bed (Sand to Gravel), beach sediments (fines to gravel) and possibly Sabkha deposits (fine-medium size coarse sand with organic content and gypsum) which stretch from the inside of the recent beach ridge to the dune area.

It is expected, that the site groundwater will be of saline to brackish quality. If the Tumas river bed is tapped by the drilling, an influence of freshwater sub-surface run-off is possible. The thickness of the sediments above the basement is unknown.

2.2 Potential Risk of Contaminants to Groundwater from Seawater Desalination Plant

Environmental issues related to desalination are a major factor in the design and implementation of desalination technologies. An acceptable Desalination Plant is expected to meet environmental regulations; be cost-effective in terms of construction, operation and management, as well as the costs associated with monitoring and permit fees. Some major environmental concerns include issues related to location of Desalination Plants and water intake structures, and concentrate management and disposal.

The potential contamination of groundwater aquifers in the proximity of Desalination Plants can be an environmental concern. There is a risk of polluting the groundwater from the drilling process when installing feedwater pumps. Leakage from pipes that carry feedwater into the Desalination Plant and

highly concentrated brine out of the plant may percolate underground and cause damage to groundwater aquifers. Furthermore, pumping saline groundwater can turn the natural flow gradient and influence adjacent freshwater aquifers by salt water intrusion.

To prevent this, plants should consider the installation of monitoring devices in wells for the operation and any observation boreholes in the surrounding area. This will provide an early warning to any changes in the condition of the groundwater flow regime and water quality.

3 The Approach to Risk Assessment

The risk assessment follows a three-step approach:

1. Water resources situation – First Stage of the Risk Assessment

   This report is essentially a desk-study, where a preliminary site assessment takes place, using all readily available information. The research should include published maps. However, the most important information is the assessment of the groundwater vulnerability and information about drinking water supply boreholes and groundwater-fed surface water.

   For the proposed Desalination Plant, an assessment and review of the possible hazards will be made together with potential pathways and receptors.

2. Detailed assessment of the potential impact on water resources – Second Stage of the Risk Assessment

   The detailed risk assessment includes the evaluation of the hydrogeological conditions on site and the conceptualisation of the hydrogeological conditions for the specific development site.

3. Specific recommendations for the development site – Third Stage of the Risk Assessment

   Recommendations will be made for the improvement of the proposed Desalination Plant to minimise or avoid negative impact.

   If any impact on the groundwater resources is foreseen as a result of 1) and 2), a detailed groundwater balance model should be developed.

4 Legislative Framework

This report is mainly based on the following relevant Namibian guidelines and official regulations:

- Environmental Impact Assessment Regulations, 2012, Government Gazette of the Republic of Namibia

5 Water Supply Situation in Walvis Bay

The Erongo region on the central coastal area of Namibia currently consumes about 15-16 Mm^3/a of treated water supplies (this includes Walvis Bay Municipality, NamWater, EIA Desalination Plant, EMP Swakopmund) according to SEA BGR 2009. The sustainable amount of potable groundwater is in the range of 8-9 Mm^3/a for the Kuiseb and Omdel aquifers (BGR 1998 and Van Wyk 2012). Currently 14.5 Mm^3/a of groundwater is abstracted from these two aquifers and together with the current capacity of the existing Orano Desalination Plant means that a total of 28.3 Mm^3/a is available to meet demand in the Erongo region.

Most of the water supplies in the Erongo region are sourced from alluvial aquifers in the Kuiseb and Omaruru Rivers. The uranium deposits of the Erongo region have become increasingly economically viable. At present, the existing mine at Rössing is expanding, while new mines have been or are being developed at Husab and Valencia, with several others for example at Trekkopje and Langer Heinrich which may come back on stream in the future. All these mines demand water supplies and the current groundwater supplies are insufficient to meet the anticipated requirements. The Husab mine opened in April 2014 with an initial demand of 7 Mm^3/a during the production phase (2016). Husab Mine is planning to obtain future supplies from Areva's Desalination Plant at Wlotzkasbaken.

Water for domestic and industrial use is abstracted from the Omdel aquifer situated in the ephemeral Omaruru River, inland of Henties Bay, as well at the Kuiseb aquifer in the lower Kuiseb River (see Figure 3). These aquifers are recharged by runoff from the central highlands.

The current abstraction rate from these two aquifers is unsustainable, as rising demands from mining and associated developments have taken their toll. The current abstraction from the two aquifers provides an average of 9.8 Mm^3/a of water for domestic and non-mining purposes and a further 4.6 Mm^3/a by the mining industry. This exceeds the calculated sustainable yield of 12 Mm^3/a per annum by NamWater (compared with 8.3 M m^3/a based on calculations by BGR and MAWLR). This means that the level of water in the aquifers is slowly declining particularly with the heavy reliance on above-average rainfall years of effective recharge to the aquifers.

The Ministry of Mines and Energy (MME) placed a restriction on the use of groundwater for uranium mining, requiring mines to use desalinated water for their operations. This approach is likely to ease the current abstraction pressure on the coastal aquifers.

Over the past 10 years, the water demand for domestic and non-mining purposes at the coastal towns has increased particularly with the development at Walvis Bay and to a lesser extent at Swakopmund.

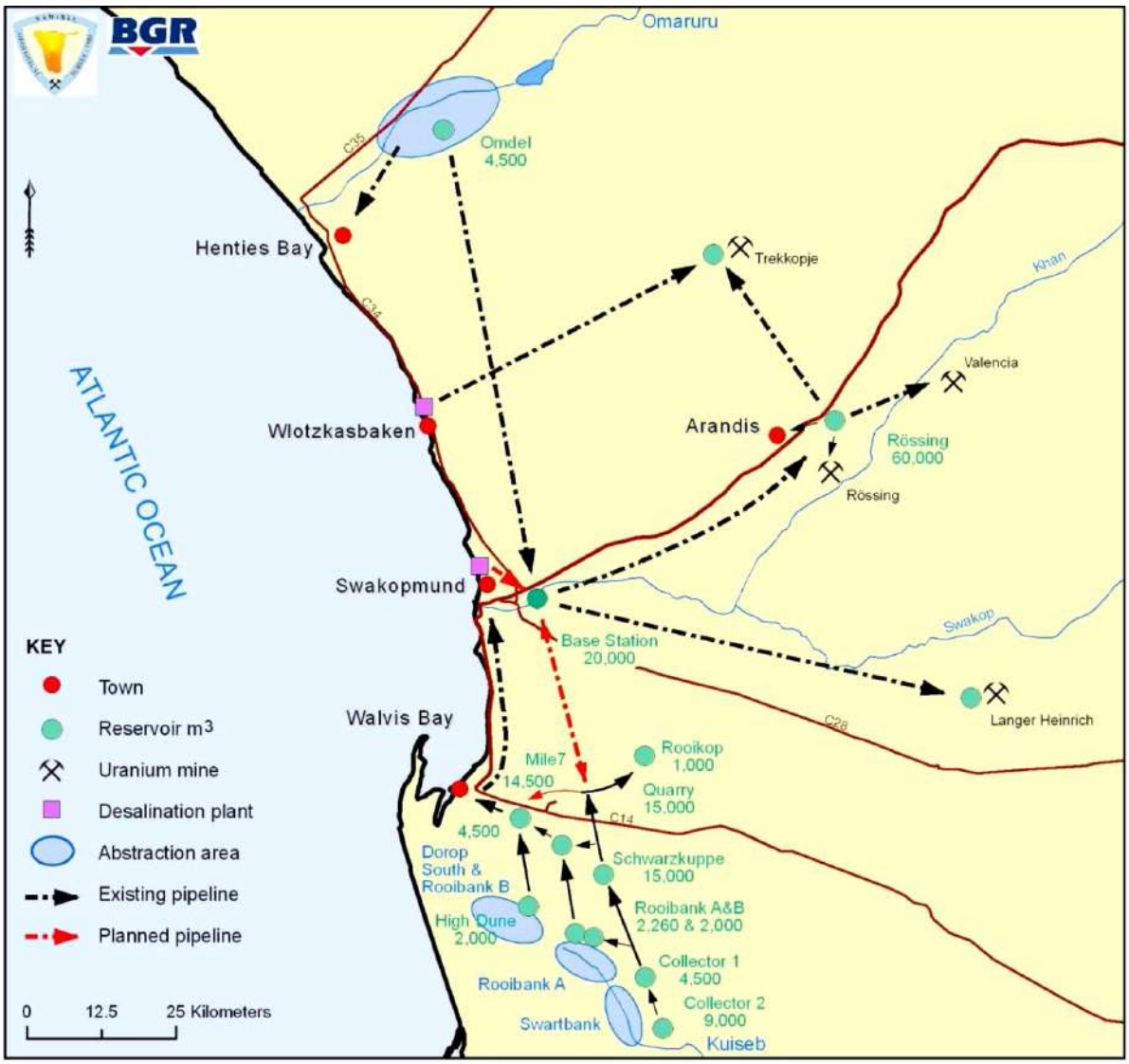

Figure 5: Groundwater Supply Scheme at the Erongo Coast (GSN/ BGR, SEMP Report).

5.1 Water Supply from the Kuiseb Aquifer

Walvis Bay is dependent on the aquifer in the nearby Kuiseb river for its fresh water supply which has been growing rapidly particularly over the past two years. A number of pipelines and reservoirs connect the aquifer with the town's final, 10 ML reservoir at Mile 7. The Kuiseb, one of 12 Namibian ephemeral rivers flowing into the Atlantic Ocean, has experienced severe flooding on four occasions over the past decade.

The consumption of water by Walvis Bay Municipality over the past decade has remained fairly constant at around 4,5 Mm^3/a or 12,500 m^3/day which equates to an average hourly consumption of 520 m^3. The low increase in water consumption, despite the annual growth in population and economic activity was probably due to a combination of annual tariff increases and artificial restrictions by the local authority in order to secure sufficient reservoir backup. Over the past two years, the demand has now increased to around 650 m^3/hr, on average.

Over the past decade, it has become obvious that, whether as a result of climate change or not, erratic rainfall in the catchment area has increased dramatically, resulting in more frequent flooding of the Lower Kuiseb where the boreholes are located in the river bed. Above normal rainfall and resultant floods, exceed the design capacities and robustness of the infrastructure and water supply disruptions have become a regular occurrence.

The sustainable yield of the Kuiseb aquifer is estimated by NamWater at around 7.2 Mm^3/a but after the recent recharge events, this figure may be as high as 10 Mm^3/a. Walvis Bay currently consumes around 5.5 Mm^3/a. This effectively leaves a "surplus" of between 2.2 and 4.5 Mm^3/a which enables NamWater to supply water from the Kuiseb aquifer to consumers to the north, such as the town of Swakopmund.

Contradictory to these estimates, in 1998, the Federal Institute for Geosciences and Natural Resources (BGR) calculated a lower sustainable yield of 3.8 Mm^3/a for the Lower Kuiseb aquifer with a recommendation to reduce water abstraction from 5.3 Mm^3/a in 1998 to 3.8 Mm^3/a over the subsequent 25 years.

Currently, a 800mm pipeline links the Swartbank water abstraction scheme in the Kuiseb river with Swakopmund and some of the mines in the Namib Desert. This is a gravity fed pipeline, supplying water in a northerly direction only. The flow is currently not reversible in the opposite direction, so should there be any water supply interruptions in the Kuiseb, water cannot be supplied to Walvis Bay from this scheme.

6 Recent and Palaeo-Drainage Systems in the Walvis Bay Area

The main surface water drainage systems in Walvis Bay area comprise the non-perennial Kuiseb river and the Tumas river (see Figure 6).

Evaluation of aero-geophysical data by the DWAF/BGR project (Plöthner et al., 1995) revealed that besides the current surface water drainage channels, various Kuiseb river palaeo-channels are present. Most of these channels are covered by Namib Dune sands and are most likely to be inactive drainage structures. Nevertheless, there may well be some potential in these freshwater yielding channels.

None of the existing Kuiseb river surface water drainage channels are directed towards or connected with the proposed Desalination Plant site. Because of the distance and the flow direction, no risk canbe expected from the proposed Desalination Plant site to cause pollution of the current Kuiseb river surface water drainage channels or the palaeo-channels.

It might be that the planned beach boreholes tap the alluvial beds of the Tumas river. Hence the location is exactly at the mouth of the Tumas river bed at the Walvis Bay lagoon, it is expected that the pumped water will be solely saline water from the lagoon draining through the beach and alluvial sediments to the proposed boreholes.

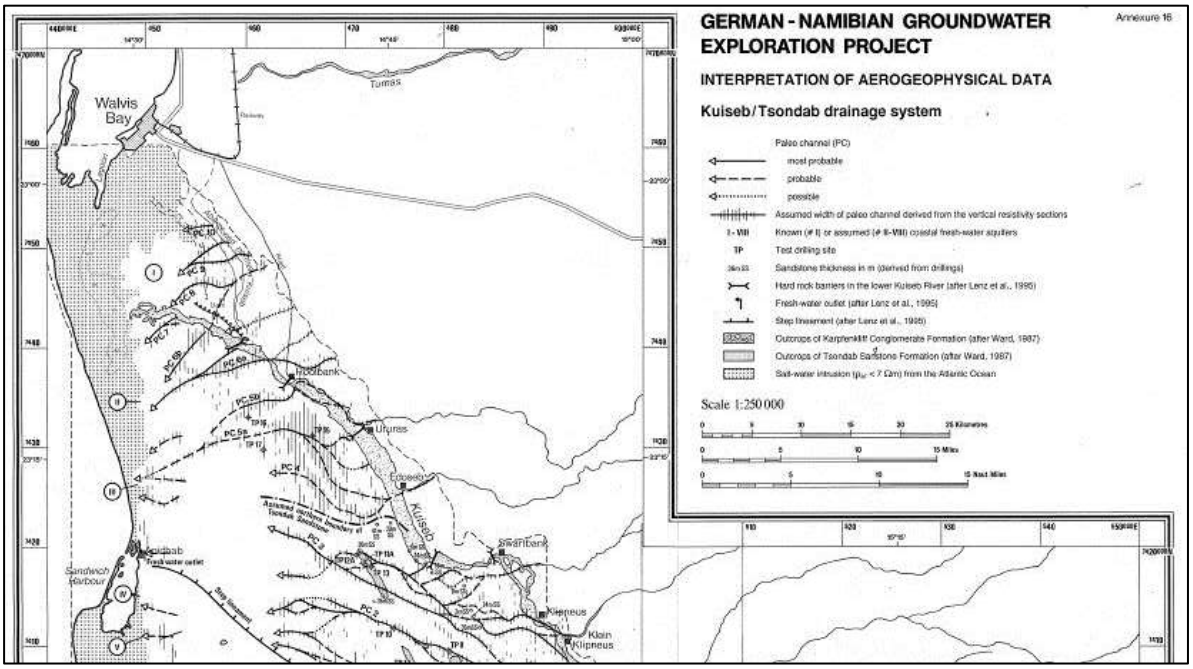

Figure 6: Kuiseb / Tsondab, Tumas surface water and groundwater drainage system, BGR, 1995

7 Meteorological factors and local recharge of groundwater

Meteorological records of average temperatures in Walvis Bay are an annual high in the range of 18 to 22° Celsius and an annual low of 10 to 16° Celsius.

Rainfall does normally not occur. The only source of precipitation is fog which often moves inland. Recharge from the fog is unlikely to occur due to direct evapotranspiration from solar radiation.

Recharge of the alluvial aquifers can only occur from the occasional surface run-off into the river beds. There is always a steady flow of groundwater to the ocean hence the rivers still continue to drain into the ocean.

In the last decade, the Kuiseb alluvial aquifer received its main recharge from flood run-off events in the hydrological year of 2011/2012 when exceptional recharge rates were experienced. Since then, the water table has been continuously falling due to droughts in the upper catchment area were rainfall events did not provide sufficient precipitation to form little or no run-off.

8 Geomorphological, Geological and Hydrogeological Assessment

8.1 General Geomorphology and Geology

All beaches consist of sediment, which can range in size from sand up to cobbles and boulders. The finer sand result in very low gradient (~1°) beaches while cobbles may be stacked as steep as 20°.Most beaches with fine to medium sand have a swash zone gradient between 1–8°.

In the mid latitudes, most beaches are composed of siliceous or quartz sand grains derived from erosion.

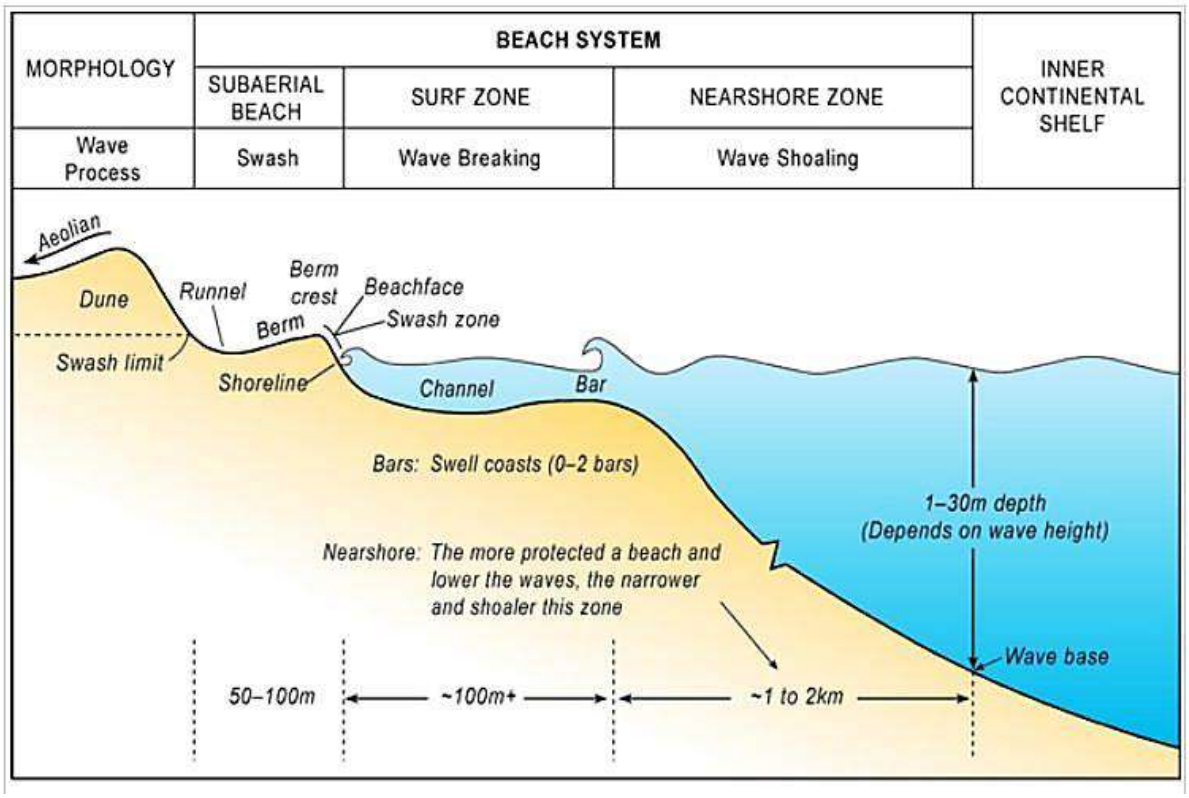

Figure 7: An idealized cross-section of a wave-dominated beach system consisting of the swash zone which contains the subaerial or 'dry' beach (runnel, berm, and beach face) and is dominated by swash processes; the energetic surf zone (bars and channels) with its breaking waves and surf zone currents; and the nearshore zone extending out to wave base where waves shoal building a concave upward slope (after Short & Woodroffe, 2009).

The proposed Desalination Plant site is located at the so-called Berm area and might be a barrier beach with a Sabkha Salt Flat (Lagoon Sediments) close to the northern Narraville housing extension. Previous investigations show only sandy sediments with a very low gradient to the seaward side.

The study of aerial and satellite images together with the observations made during a field visit revealed very specific geological and hydrogeological conditions. After the field visit and on-site assessment the following explanation about the occurrence of water and the specific geological conditions were made as follows:

- The uppermost sediments at the proposed Desalination Plant site are quartzitic sands from aeolic and marine origin. Deeper seated fluviatile sands or gravels from the Tumas riverbed could not be identified.

- Water from trench works at northern Narraville area shows hypersaline conditions of the groundwater.

- There is no indication of the location of basement rocks at the site.

- An online research on the adjacent Oil Storage Facility and its jetty installation show that pillars of around 10-20 m lengths were installed into the underground close to the proposed Desalination Plant site. This in turn indicates the high possibility of unconsolidated sediments upto a depth of 20m below ground.

- Excavations to the north of Narraville show a thin layer of aeolic sediments. These are dune sediments which were blown inland onto the harder or more muddy surfaces below. These aeolic sediments change in thickness and deposits maybe a few centimetres thick, and up to 7 metres in places. Below, a sandy layer high in organics, gypsum and salt was identified. This is a typical first stage sequence of a "Sabkha" environment. Sediments of sand and gypsum nodules are expected below the Sabkha formation.

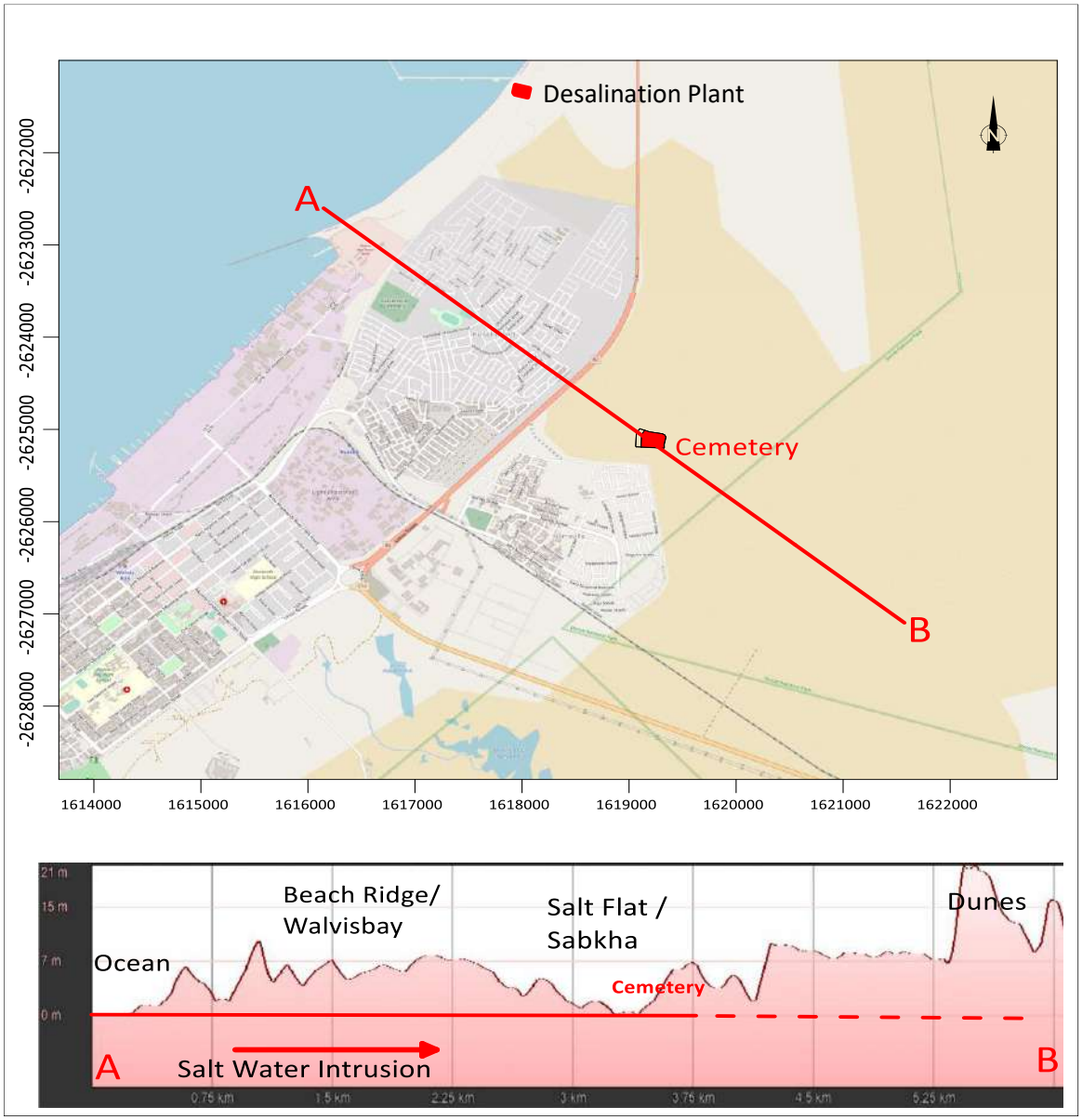

Figure 8: Cross section through the northern part of Walvis Bay, *from A : Ocean to B: Dunes in the South East. The Cross section shows that the salt flat is at Ocean level.*

8.1.1 Sabkha Geology

Coastal Sabkha environments are normally located in the upper intertidal to supratidal zone of arid coastlines and strongly influenced by water of a marine origin.

The saline pan at Narraville, in particular, is the remains of a lagoon indirectly filled with siliciclastic sand of aeolian origin, originating from large sand dunes. The flatness is controlled by the content of capillary moisture from the water table, which is only about 30-80 cm below the surface, keeping the sand damp and firm and preventing it from being blown away. Any higher dryer sand can be moved away by deflation.

Below the aeolic sediments microbial mats are present with a thickness of at least 1 m. In such cases, shells of mollusks indicate that there was a connection to the sea during recent historical times.

9 Hydrogeology

9.1 Hydrogeological Desk Study based on Previous Hydrogeological Studies

The main features relating to the hydrogeology of the Delta and Walvis Bay area are summarised in this section of the report. The overview about the main aquifers in the Walvis Bay area was mainly derived from the report by van Wyk, B. and Christelis. C, 2017.

See below the relevant information concerning the hydrogeological conditions:

- Figure 9 below shows the position of the main well fields and suggested potential groundwater areas for further development. It is also identifies the saline area and the location of the proposed Desalination Plant site.
- The greatest aquifer thickness closest to the proposed Desalination Plant site is at Dorob North and Dorob South, with values ranging between 30 m and 70 m.
- The aquifer thickness in the area of the Rooibank B abstraction site on the eastern edge of the aquifer has an approximate thickness of 20 m.
- Dorob North and Dorob South are characterised by high aquifer transmissivities (ca. 100 to 400 m^2/day). They are separated by a distinct zone of silty sediments with low transmissivities (< 30 m^2/day).
- Groundwater head contours in the west and in Dorob North show a low gradient in the absence of any well abstraction.
- Groundwater flows within the Delta aquifer are influenced by compartments that are formed by bedrock highs and/or by low permeable sediments that limit the hydraulic interconnectivity.
- The calculated stored groundwater resource is approx. 750 -800 Mm^3 from which only about 15% (110-130 Mm^3) is situated above sea level.
- The sustainable yield estimates are 2.79 Mm^3/a for the Delta section and 2.5 Mm^3/a channel section. This amounts to a combined yield of 5.3 Mm^3/a.

- van Wyk, B. and Christelis. C, 2017 suggested that the Tumas River bed might yield a potential for groundwater exploration. This river is located to the North of Walvis Bay.

The general groundwater flow directions clearly indicate that the risk of pollution from the proposed Desalination Plant is unlikely to have any effect on the current abstraction schemes from the Kuiseb aquifer and possible abstraction from the upper part of the Tumas river bed.

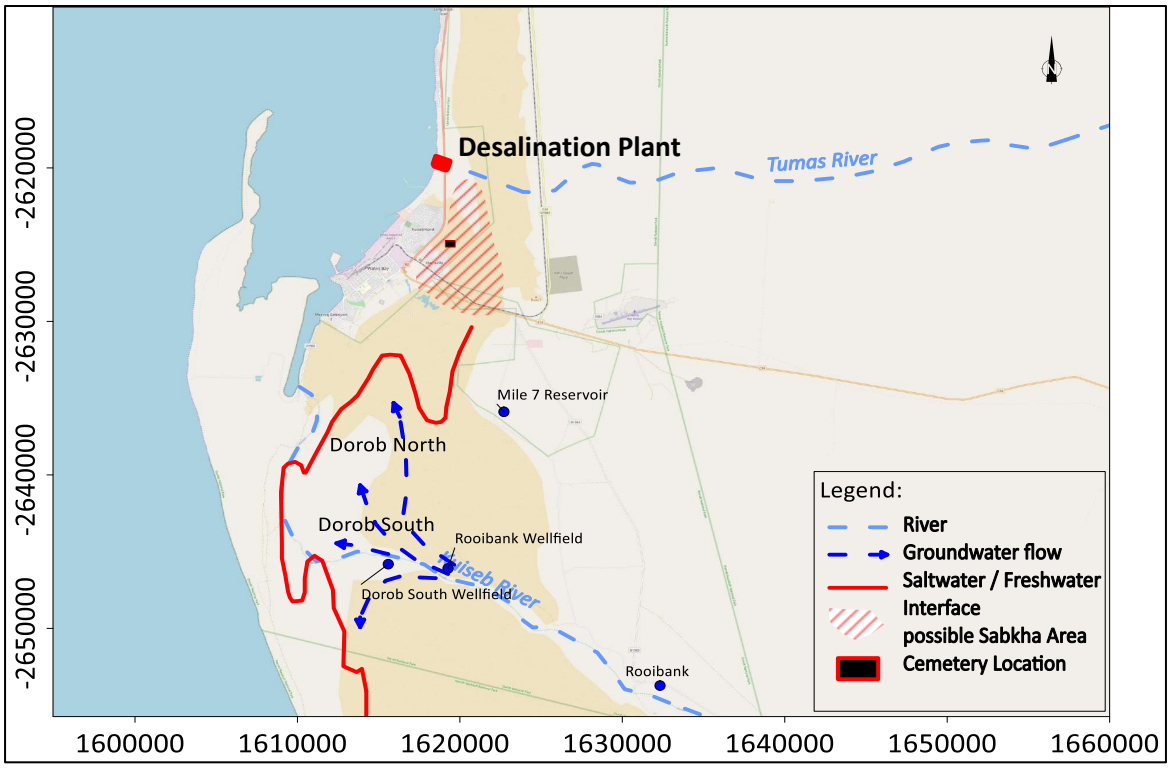

Figure 9: Position of the main well fields and suggested potential groundwater areas

9.2 Groundwater level fluctuation and flow

Fresh groundwater originating from the alluvial Kuiseb aquifer or palaeo-channels is not present at site. The water is of marine origin.

Tides along the Namibian coast are semi-diurnal with a maximal tidal range of 2 m. The main tidal movement is offshore to onshore. The resultant tidal currents are small and negligible compared to the dominant northerly movement of the Benguela. At Narraville, the tidal influence was observed to be upto a maximum range of 50 cm.

Flow is oriented towards the sea during low tide and landward during high tide. A specific groundwater flow could not be determined; hence WAN conclude that the proposed Desalination Plant area is not part of any delineated aquifer system. Subsurface run-off from the Tumas riverbed is oriented towards the sea.

9.3 Freshwater/Saltwater Interface

Figure 8 above shows the freshwater/saltwater Interface which was investigated in detail in later studies on the Dorob aquifer. Unfortunately, borehole data from that area could not be retrieved from the groundwater database at the Ministry of Agriculture, Water and Land Reform and so the current location freshwater/saltwater Interface could not be updated.

Consequently, it is highly likely that Figure 9 shows a more precise location of the Freshwater /Saltwater Interface in the area of Walvis Bay. With this in mind, it is most likely that the proposed Desalination Plant is located in a high saline area. High salt concentrations are the result of seawater intrusion into that area.

Strong evidence supporting this conclusion is drawn from site observations made in deep excavation sewerage scheme trenches close to the proposed Desalination Plant site.

9.4 Groundwater Quality

Saltwater is present at the proposed Desalination Plant location. The water quality is not suitable for human consumption and can be described in the salt flats as hyper-saline due to evaporation and accumulation of salt.

There is no freshwater resources deterioration expected by any seepage from the proposed site hence the present groundwater is solely of marine origin.

9.5 Vulnerability of the groundwater resource and possible risks of pollution

Due to low precipitation rates, pollution from surface runoff and seepage into the underground is very limited. The main risk for the groundwater resources are spillages or damage to the proposed Desalination Plant and/or the directly North of the Erf located at the national oil storage facility. Besides townland development, the main industrial facility in the vicinity is the newly developed national oil storage facility (NOSF) and associated pipeline system. Any spillages at this facility could cause a risk of long-term damage to the whole underground groundwater at the proposed Desalination Plant site.

Information on NOSF:

“The project consists of an Oil Tanker Jetty, onshore facilities, pipelines and Tank Farm. The marine structure comprises a 1.7 km long trestle, two 60,000 DWT berths, two tug berths and other infrastructures. It can accommodate the operation of 10,000 to 60,000 DWT oil tankers. The Access Channel to the Marine facility is 6.43 km long, 180 m wide and 16.5 m deep comprising a total dredging volume of about 8.9M m3 (Information derived from contractor A1V2 website : https://www.a1v2.pt/, accessed in June 2020).”

9.6 Proximity to Water Resources for Water Supply

Any future anticipated water abstraction scheme from the proposed Desalination Plant is more than 10 km away. Groundwater flows at the site are not oriented to these possible water supply schemes. Therefore, there is no pollution risk to existing or any potential groundwater schemes.

10 Summary of the Potential Groundwater Risk from the Proposed Desalination Plant Site

A summary of the key points relating to potential groundwater risk from the proposed Desalination Plant site is as follows:

- None of the surface water drainage channels is directed into the proposed Desalination Plant area except the Tumas river bed which is not a water supply source or will be negatively impacted by abstraction from the proposed Desalination Plant.
- Because of the distance of any other surface water features with respect to the proposed Desalination Plant site and the flow direction of these features, there is no risk that the proposed Desalination Plant will pollute surface water or groundwater in the palaeo-channels.
- The general groundwater flow direction of the first stage risk assessment indicates that a risk of pollution from the proposed Desalination Plant would have no effect on the current abstraction schemes at the Kuiseb aquifer.
- Fresh groundwater originating from the alluvial Kuiseb aquifer or palaeo-channels is not present at the proposed site. The origin of any water at the site is solely of a marine origin.
- There is no freshwater resource deterioration expected by any seepage from the proposed Desalination Plant site because the present groundwater is of marine origin.
  The only possible future water supply abstraction scheme is more than 10 km away from the proposed Desalination Plant site. Groundwater flows will not be directed towards these possible water supply schemes. Therefore, there is no pollution risk to any existing and potential future groundwater schemes.

11 Desalination Plant Development Recommendations

It is recommended to install water level and conductivity measurement devices using a real time monitoring network setup at the abstraction boreholes to be able to react to unexpected drawdown due to extreme tidal events and water quality issues due to natural or accidental change of the conditions at the site.

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Environmental and Social Impact Assessment

Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay, Erongo Region, Namibia

Baseline/scoping and assessment: Avifauna

Prepared by:

African Conservation Services cc

Prepared for:

Environmental Compliance Consultancy

July 2020

Name of project	**Environmental and Social Impact Assessment:** **Pilot sustainable water supply project by means of desalination, powered by solar to supplement water supply for Walvis Bay, Erongo Region, Namibia** **Baseline/scoping and assessment: Avifauna**
Principal client	Turnkey Water Solutions (Pty) Ltd and Innovent SAS
Lead Environmental Assessment Practitioner	Environmental Compliance Consultancy (ECC) PO Box 91193, Klein Windhoek, Namibia Email: stephan@eccenvironmental.com Tel. +264 81 262 7872 / +264 81 669 7608 Representative: Stephan Bezuidenhout
Sub-consultant (Avifauna)	African Conservation Services cc PO Box 2604, Swakopmund Namibia Cell: +264 81 284 5130 Email: ecoserve@iway.na Representatives: Dr Ann Scott and Mike Scott
Report date	Draft 1: 5 July 2020 Draft 2: 7 July 2020 Draft 3: 14 July 2020 Draft 4: 20 July 2020

Executive summary

Turnkey Water Solutions (Pty) Ltd and Innovent SAS (a Joint Venture) propose to develop a pilot sustainable water supply by means of desalination, powered by solar, to supplement the water supply for the Walvis Bay Municipal area on the coast of the Erongo Region, Namibia. Environmental Compliance Consultancy (ECC) has been engaged to undertake an Environmental and Social Impact Assessment (ESIA) and compile an Environmental Management Plan (EMP) in terms of the Environmental Management Act, 2007 and its regulations. The present Avifauna Baseline/Scoping and Assessment Study forms part of the above ESIA.

The project has already conducted an assessment evaluating four potential alternative sites. The preferred site is in a semi-industrial location alongside the existing oil and gas pipeline jetty for the Liquid Bulk Terminal at the Port of Walvis Bay. Power for the plant will be generated on site by a solar photovoltaic (PV) plant, designed to circa 1400 kWp and connected to the grid. The grid connection will be through the Erongo RED Tutaleni Substation, by means of an underground three-phase cable. The step-down transformer will be housed in a container enclosure.

The desalination plant will discharge brine along or near the existing jetty. The impacted area in the ocean is estimated to be within 10-20 m of the diffuser. The brine salinity will range from 51.9 – 58.6 ppt (compared to 34.5 ppt for normal sea water). Three brine discharge pipeline designs are being considered to suit the dispersion model diffuser design, namely a jetty outfall (Option 1) and two buried marine pipelines (Options 2 & 3). With mitigation, the salinity of the brine discharge is expected to range from 32 – 36 ppt, i.e. salinities within the acceptable range recommended by the South African water quality guidelines for coastal marine waters.

The purpose of the avifauna study is to provide an understanding of the potential risks to birds with the proposed development and to serve as a basis for the recommendations of mitigation for such risks and the monitoring programme for the Environmental Management Plan. The study takes the form of a desk-top assessment of the bird habitats and their likely avifauna and its sensitivity in terms of the proposed development. A proposed site visit was not possible at this stage, due to Covid-19 restrictions on travel.

The SEIA methodology applied has been developed using the International Finance Cooperation (IFC) standards and models; Namibian (draft) procedures and guidance for EIA and EMP; and international and national best practice. In particular, the approach to the assessment of the solar photovoltaic (PV) aspects is based on the Best Practice Guidelines compiled by the Birds and Renewable Energy Specialist Group (BARESG), convened by BirdLife South Africa and the Endangered Wildlife Trust (Jenkins, Ralston-Paton, Smit-Robinson 2017).

The study area falls within the Namib Desert biome, with a hyper arid desert environment. The major avifauna habitat component is a group of aquatic habitats that comprise the Walvis Bay Important Bird Area, including the Walvis Bay Lagoon and wetland complex, the municipal sewage ponds, Bird Rock (an artificial guano platform) and the coast. The avifauna habitats in the greater study area may be considered as being of high sensitivity in terms of the high conservation status of two officially Protected Areas, two Ramsar sites, and five Important Bird Areas. This sensitivity is due largely to the varied, extensive and favourable aquatic habitats in the arid coastal desert environment. In view of the above criteria, the greater area would also qualify as a site of high sensitivity as a solar PV development site. Within the local study site, three main marine habitat types are represented, namely sandy intertidal habitats, rocky intertidal habitats and the Atlantic Ocean itself. An extensive dune system and gravel plain habitats lie on the coast and east of the site. Although the local area of the study site itself is likely to be of relatively lower sensitivity, its proximity to the above sensitive habitats in the greater area and the mobility of the bird species are an important consideration, and a precautionary approach is therefore indicated.

The bird checklist for the relevant quarter degree square and three pentads (SABAP1 and SABAP2 data) comprises 159 species, or 24% of the 676 species currently recorded in Namibia; this diversity is regarded as relatively high for the desert environment.

The present scoping and assessment are directed towards 24 shortlisted priority species, namely those that have a high biological significance, i.e. primarily Red Data species and/or species endemic or near-endemic to Namibia, as well as species with migrant status. Further factors taken into consideration include recorded breeding activity in the area, feeding and diet, and general and local abundance as represented by available atlassing data.

Of these priority species:

- 23 are threatened in Namibia, namely
  - two that are Critically Endangered (Cape Gannet, Great Crested Grebe)
  - three are Endangered (African Penguin, Cape Cormorant, Bank Cormorant)
  - six are Vulnerable (White-chinned Petrel, Lesser Flamingo, Greater Flamingo, Great White Pelican, Caspian Tern, Hartlaub's Gull)
  - thirteen are Near Threatened (Damara Tern, Maccoa Duck, Crowned Cormorant, Sooty Shearwater, Eurasian Curlew, Red Knot, Chestnut-banded Plover, Curlew Sandpiper, Bar-tailed Godwit, African Oystercatcher, Black-necked Grebe, Peregrine Falcon)
- Sixteen of the above species are also Globally Threatened.
- Two species are near-endemic to Namibia (Damara Tern [Near Threatened, see above], Gray's Lark).
- Twelve Red Data species have some form of migrant status (including four Palearctic and seven intra-African migrants). At least 57 species (36%) of the total of 159 species have some form of migrant status.
- Five of the priority species feed primarily on marine fish, eight species feed on a combination of fish and invertebrates and nine species feed primarily on invertebrates. The dietary items and feeding of these bird species may potentially be impacted by any changes in the marine environment, including increased salinity.

Within the greater study area, Red Data bird species that have been recorded as breeding within the Walvis Bay wetland complex include Greater Flamingo, Caspian Tern and Damara Tern. The lagoon area is also important as a nursery area, e.g. for African Oystercatcher and Caspian Tern. Breeding has been also recorded at sites such as the Walvis Bay Sewage Ponds, Bird Island Guano Platforms and Mile 4 Saltworks area for Cape Cormorant, Crowned Cormorant, Maccoa Duck, Lesser Flamingo, Hartlaub's Gull, Great White Pelican, Chestnut-banded Plover and Damara Tern.

The proximity of the wetlands complex to a major port and its associated activities gives rise to a suite of potential threats, chiefly in the form of increasing disturbance (including noise and light) from human activities, particularly the port; and of habitat alteration. The cumulative impacts of the above threats are also likely to be influenced by the effects of climate change on these coastal systems.

Four main potential impacts have been identified for the proposed project. These are:

- Disturbance of birds due to noise, traffic and other forms of disturbance during construction or operation (significance of impact: pre-mitigation – low [2]; post-mitigation: low [2]);
- Collisions of birds on solar PV panels and associated infrastructure (significance of impact: pre-mitigation – low [2]; post-mitigation: low [1]);
- Impacts on bird habitat, including increased salinity from brine discharge, and pollution caused by spillages (significance of impact: pre-mitigation – moderate [6]; post-mitigation: minor [4]); and

- Attraction of birds to new, artificial habitats, including infrastructure, for perching/roosting (significance of impact: pre-mitigation – low [1]).

Recommendations are provided for the mitigation and management of potential impacts. Apart from the standard requirements, the effective management of the brine discharge is considered to be of critical importance.

Ongoing monitoring for any impacts on avifauna is also considered essential. This includes pre- and post-construction monitoring for the solar PV facility.

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Abbreviations, acronyms and glossary of terms

AEWA	African-Eurasian Migratory Waterbird Agreement
CBD	Convention on Biological Diversity
CETN	Coastal Environmental Trust of Namibia
CMS	Convention on Migratory Species
ECC	Environmental Compliance Consultancy
EMP	Environmental Management Plan
endemic	Occurring within a restricted range
endemic status categories:	
	End = endemic, NEnd = near-endemic, Nam = Namibia
ESIA	Environmental and Social Impact Assessment
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
IUCN Red List Categories:	
	LC Least Concern
	NT Near Threatened
	VU Vulnerable
	EN Endangered
	CE Critically Endangered
	EW Extinct in the Wild
	EX Extinct
	G Global status
NAD	Namibian Avifaunal Database
pentad	A 5-minute x 5-minute coordinate grid (about 9 km north-south and 7 km east-west) super-imposed over the continent for spatial reference; nine pentads make up one Quarter Degree Square
PV	Photovoltaic
QDS	Quarter degree square
residency categories for birds:	
	Res = resident, nom = nomadic, mig = migrant, vag = vagrant, Ra = rare, intra-Afr = intra-African, Pal = Palearctic
SABAP	Southern African Bird Atlas Project (SABAP1 & SABAP2)

1 Introduction

1.1 Background

The proposed project is to develop a pilot sustainable water supply by means of desalination, powered by solar, to supplement the water supply for the Walvis Bay Municipal area on the coast of the Erongo Region, Namibia (ECC 2020; Figure 1). The project is a Joint Venture (JV) between Turnkey Water Solutions (Pty) Ltd and Innovent SAS (Anon. 2020a).

The project is deemed necessary as Walvis Bay receives an average of only 13.2 mm of precipitation per year, making it one of the driest cities on earth. The water requirements of the town are currently 7,000,000 m^3/year (20,000 m^3/day). To meet the current water demand, water is supplied to the Municipality from different sources, mainly boreholes. In order to ensure water security and sustainability in the context of population and industry demand growth, as well as climate change, innovative solutions are required for supplementing the water supply to Walvis Bay.

This project aims to supply the Walvis Bay Municipality with an alternative clean and reliable water supply, through the use of innovative, renewable technology by means of a solar powered desalination plant. The project will thus improve the water resilience of Walvis Bay, and allow for further development.

Environmental Compliance Consultancy (ECC) has been engaged by the above proponent to undertake an Environmental and Social Impact Assessment (ESIA) and an Environmental Management Plan (EMP) in terms of the Environmental Management Act, 2007 and its regulations. The present Avifauna Baseline/Scoping and Assessment Study forms part of the above ESIA.

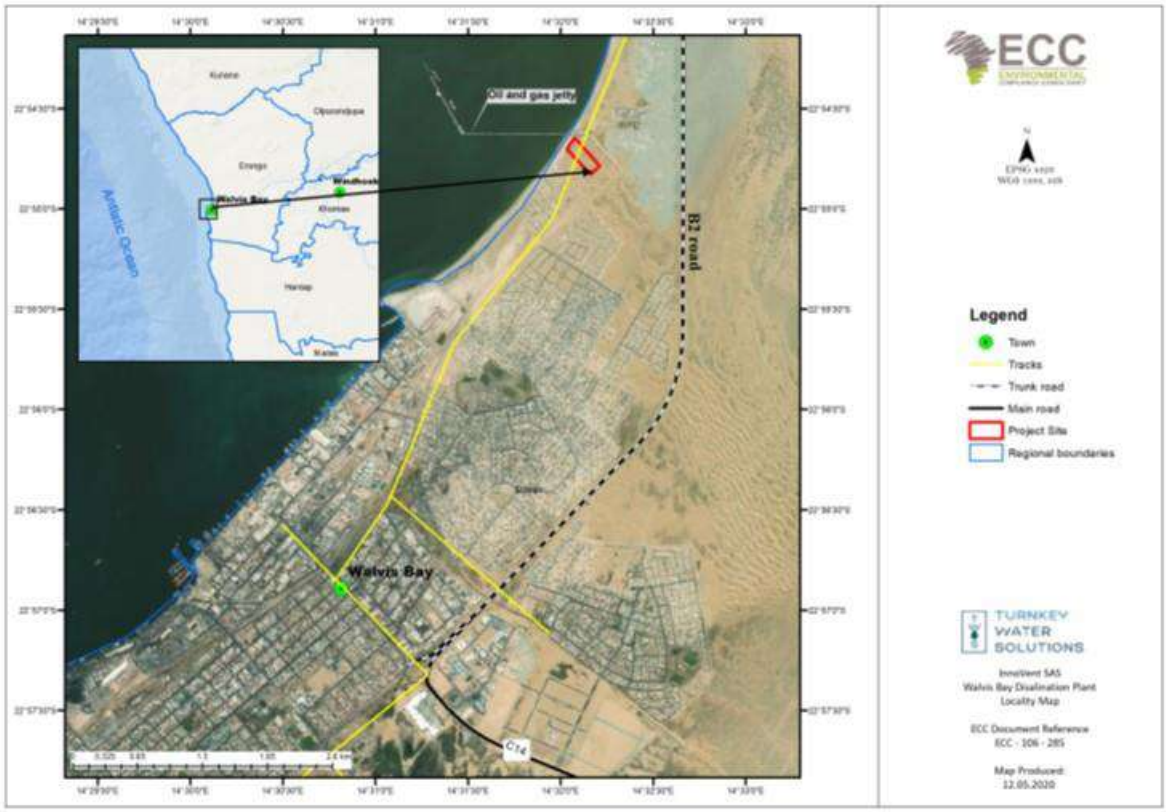


Figure 1. The project location on the coast at Walvis Bay in the Erongo Region, Namibia (ECC).

1.2 Project description

The technical information below is based on various inputs as supplied by Turnkey Water Solutions and Innovent SAS (Anon. 2020a), WAMTechnology cc (Anon. 2020b), Environmental Compliance Consultancy (ECC 2020) and other consultants for the project.

The preferred project site is located on a portion of Erf 4688 on Walvis Bay Municipal land (Figure 1, 2 and 3). It is located on a semi-industrial location alongside the existing oil and gas pipeline jetty for the Liquid Bulk Terminal at the Port of Walvis Bay. The project layout is shown in Figure 4.

Figure 2. The project site (orange marker) in relation to the Port of Walvis Bay and the adjoining environment (based on a Google Earth map).

Figure 3. The proposed project site, adjacent to the oil and gas pipeline structure for the Liquid Bulk Terminal at the Port of Walvis Bay.

Figure 4. General layout of the Walvis Bay Desalination Plant, also showing three alternatives for the brine discharge pipeline designs, namely Option 1: Jetty outfall; and Options 2 & 3: Marine pipelines (buried).

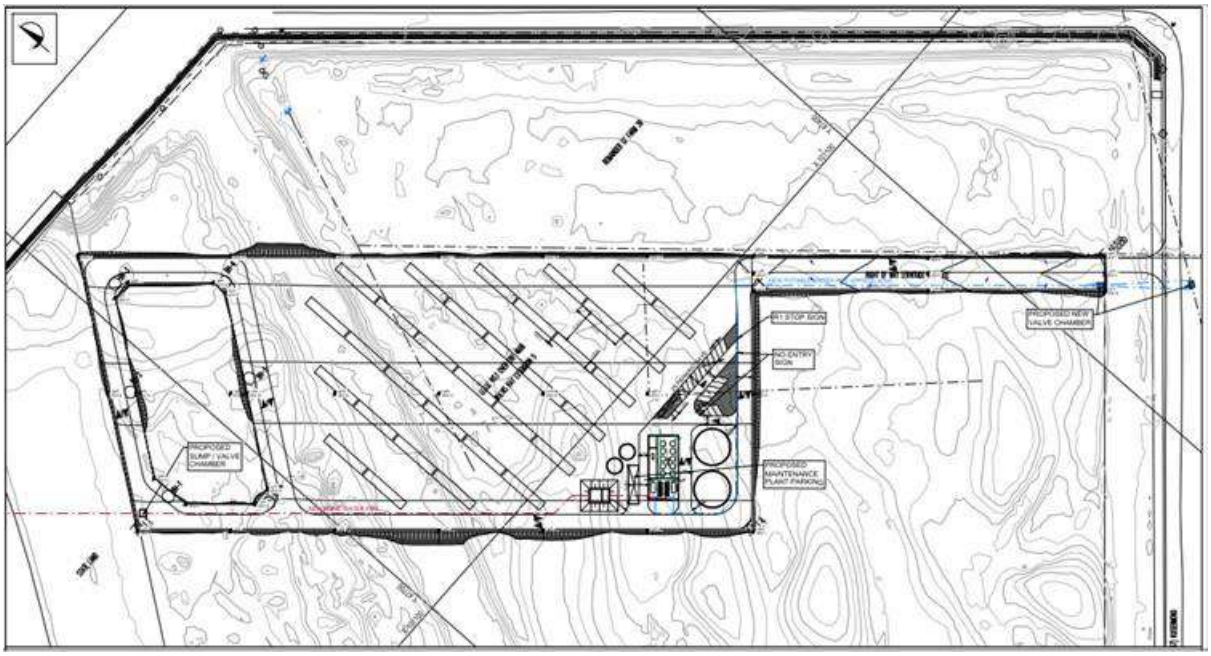


Figure 5. Site (platform) layout of the Walvis Bay Desalination Plant, including preliminary solar panel layout.

Project design components

The general project design components include the following (see above for references for information):

- Total project footprint size (including solar panel array) is 4 ha.
- Production of approximately 3,900 m^3/day of clean water or 1,422,000 m^3/year is envisaged.
- Installation of (currently) five beach boreholes/wells, including one as standby; however, more boreholes (up to eight in total) may eventually be required.
- On-shore beach wells are fitted with infrastructure for a pump capacity of approx. 150 m^3/h.
- Marine construction will be required, but no blasting.
- The building roof will be typical light weight metal sheeting (IBR), at a slope of approximately 15 degrees.
- Some lighting may be installed around the building that will be switched on throughout the evenings; elsewhere in the park the perimeter and certain key locations may have motion sensor lights installed to allow for enhanced security; overall, limited lighting will be noticeable that exceeds basic street lighting.
- The park will have a boundary fence 1.8 – 2.4 m high for security.
- The expected lifespan of the currently proposed plant and infrastructure will be 25 years.

Power components

- Power for the plant will be generated on site by a solar photovoltaic (PV) plant, connected to the grid (Erongo RED); the plant will be powered through solar PV as well as the grid (i.e. a hybrid solar and grid electricity system); the grid will act as a back-up for when the solar plant is not producing.
- The solar plant is designed to *circa* 1400 kWp (kilowatts peak).
- The grid connection will be through the Erongo RED Tutaleni Substation, approximately 2 km away from the plant; this grid connection will be an underground three-phase cable, able to supply over 1 MVA (Mega Volt Amp) to the water processing plant at 11 kV (kilovolt); this will be stepped down (11kv/0.4kV 1MVA or larger transformer) on the project site and injected into the water plant's control cabinet; the step-down transformer will be housed in a container enclosure, therefore with no risk to perching birds.
- The solar power system is made up of mono-axial trackers with mounted poly crystalline panels (360 wp [watt peak] or larger) (see Figure 5 for preliminary solar panel layout, and Figure 6 for example of typical solar PV array); the trackers on which the solar modules are mounted will occupy a large portion of the 4 ha site, with large spacing between the tracker rows or tables to ensure reduced shading while the tracking takes place through the day.
- The modules are connected to one another through standard DC (direct current) solar module cabling; these strings will then be combined into larger DC cabling and inject DC current directly into the water processing plant's control cabinet.
- Some of the pumps housed outside the main processing plant building will, however, require an AC (alternating current) power supply, which will require inverters to convert DC to AC.
- Panel cleaning will use minimal water, i.e. not enough to create ponding; the only observable impact will be a line of drop marks in the sand below the lower edge of the panels, similar to what can be expected after a light rain; the cleaning would take place over several days, nullifying the risk of the volume of water becoming a pond.

Effluent including brine discharge

- The desalination plant will discharge brine along or near the existing oil and gas jetty (see below for three alternative outfall options being considered).

- Brine discharge into the ocean is estimated at 294 - 340 m^3/h.
- The impacted area in the ocean is estimated to be within 20 m of the diffuser.
- Brine salinity will range from 51.9 – 58.6 ppt (parts per thousand), effluent temperature 12 - 21°C, effluent TSS (total suspended solids) assumed negligible (at this stage the only constituent in the brine effluent that is considered as critical is salinity).
- With mitigation, the salinity of the brine discharge is expected to range from 32 – 36 ppt, i.e. salinities within the acceptable range recommended by the South African water quality guidelines for coastal marine waters (Department of Water Affairs and Forestry/DWAF 1995 in Anon. 2020b).

Figure 6. Typical solar photovoltaic panel array at the Witsand Solar Desalination Plant in South Africa (https://www.osmosunwater.solutions/en/project/osmosun-16-sw-witsand-solar-desalination-south-africa/; http://www.hessequa.gov.za/witsand-solar-desalination-plant/)

Project alternatives

Best practice environmental assessment methodology calls for the consideration and assessment of alternatives to a proposed project. For the present project, these include alternative for sites, and for outfall options.

Sites

The project has already conducted an assessment evaluating four potential alternative sites (Figure 7, Anon. 2020a) in terms of numerous project elements, including but not limited to:

- Intake locations
- Access to existing infrastructure
- Proximity to sensitive sites
- Land availability
- Access to municipal water infrastructure

Of the above-mentioned four sites, alternative No. 4 is the go-ahead option for the present assessment.

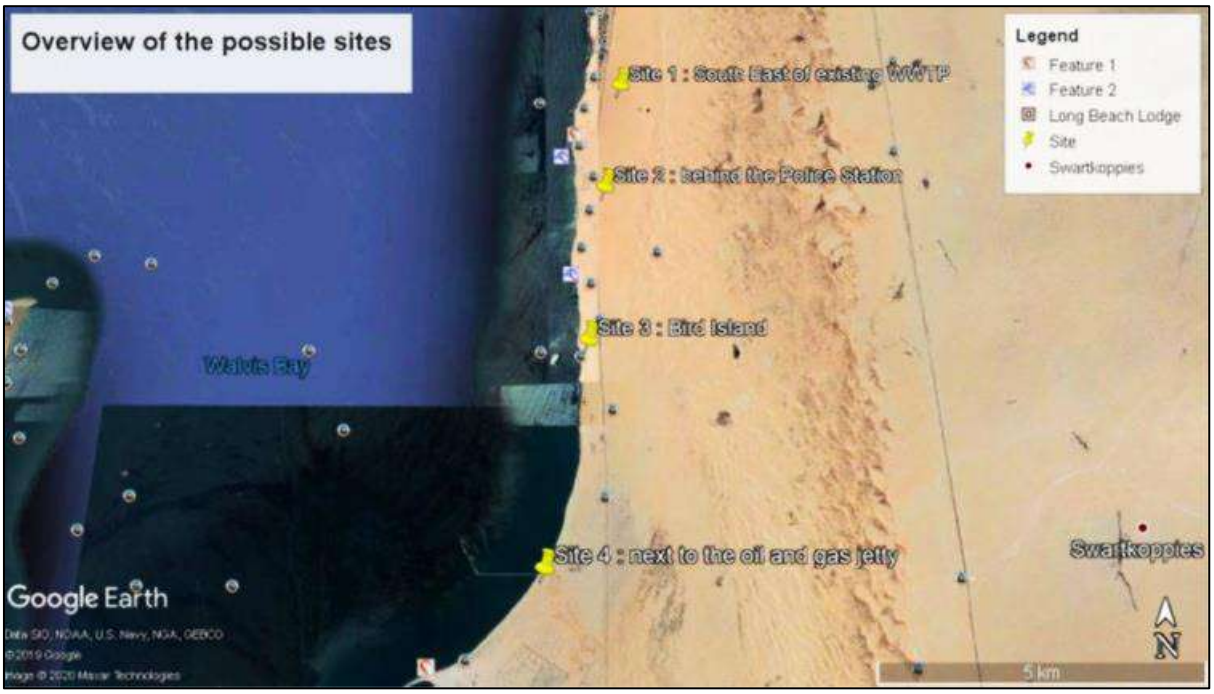


Figure 7. Overview of four possible alternative sites for the project, showing the preferred option in the south (No. 4) (Anon. 2020a) (based on a Google Earth map).

Outfall options

Three alternatives are being considered for the brine outfall pipeline (Figure 8):

Option 1: Jetty outfall

- WAMTech/WML hybrid system
- SANS 4427 HDPE is compatible with outdoor installations
    - Contraction and expansion issues
    - Temperature reduces pipe pressure rating
- NAMCOR service road crossing
- Pipeline side supports at close intervals
- 1150m of HDPE pipeline

Option 2: Marine pipeline (route 1)

- [1] elevated brine tank -> [2] valve chamber below LAT -> [3] trenched pipeline below LAT -> [4] WAMTech diffuser at -5m CD
- Requires trenching in sea (minimum of 40m)
- Falls within **NAMCOR harbour area**
- Approx. 560m HDPE pipeline, 370m in the sea

Option 3: Marine pipeline (route 2)

- Exact design components of Option 2
- This route avoids the NAMCOR property by staying south of the Jetty to -5m CD
- Approx. 1060m HDPE pipeline, of which 870m is in the sea

Further to the initial assessment and during the ESIA process, alternatives considered will take the form of optimisation and efficiency to reduce potential effects through an iterative process, including plant design and project improvements.

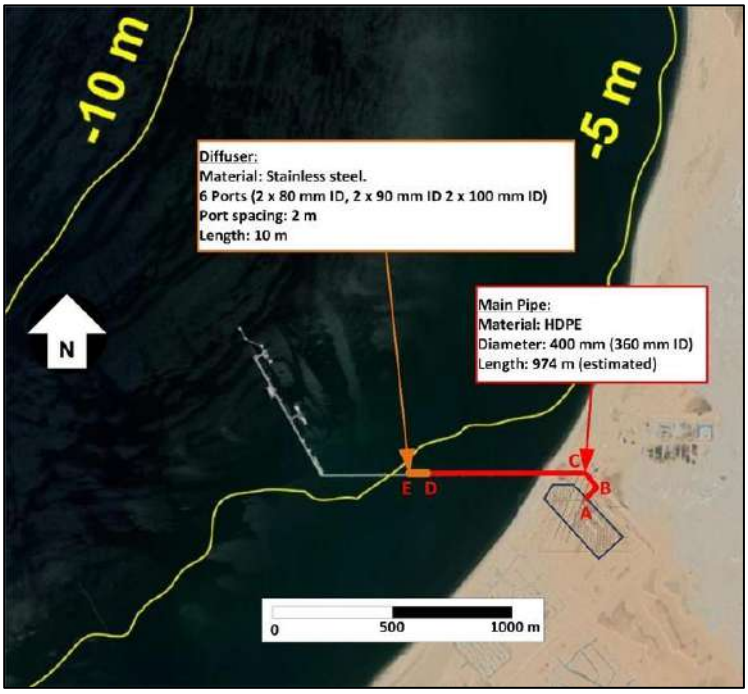


Figure 8. Option 1 location of the brine outfall pipeline (Anon. 2020b) (also see Figure 4).

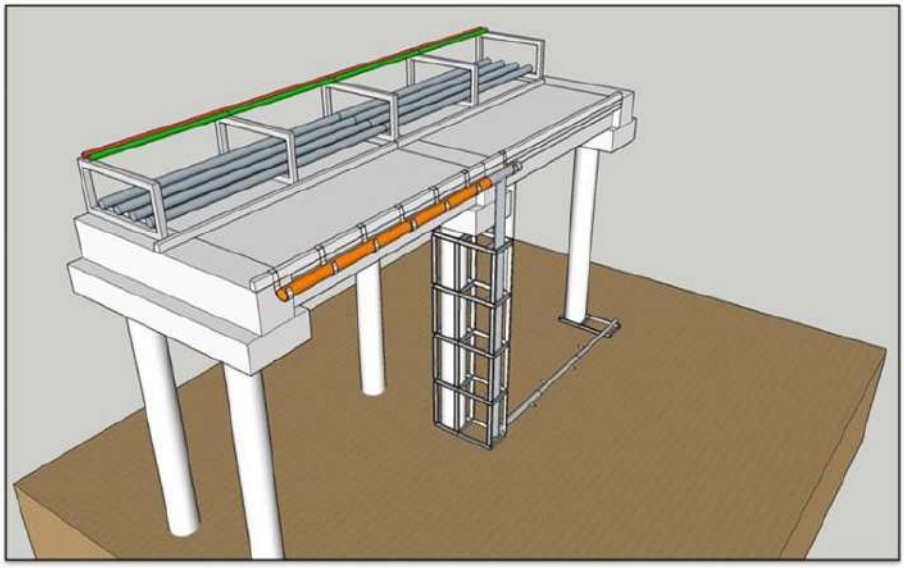
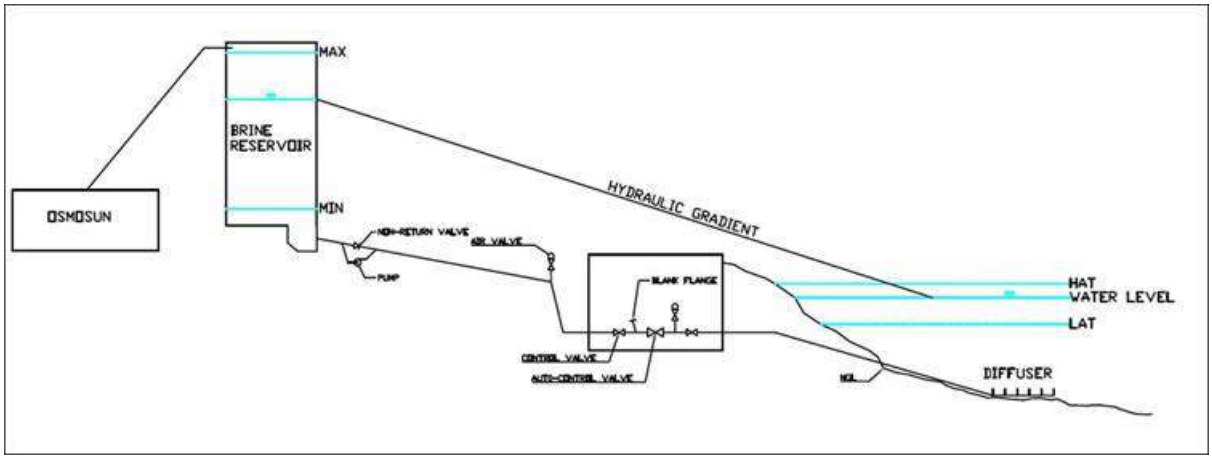


Figure 9. Details for the brine outfall pipeline, Option 1: Jetty outfall (orange).



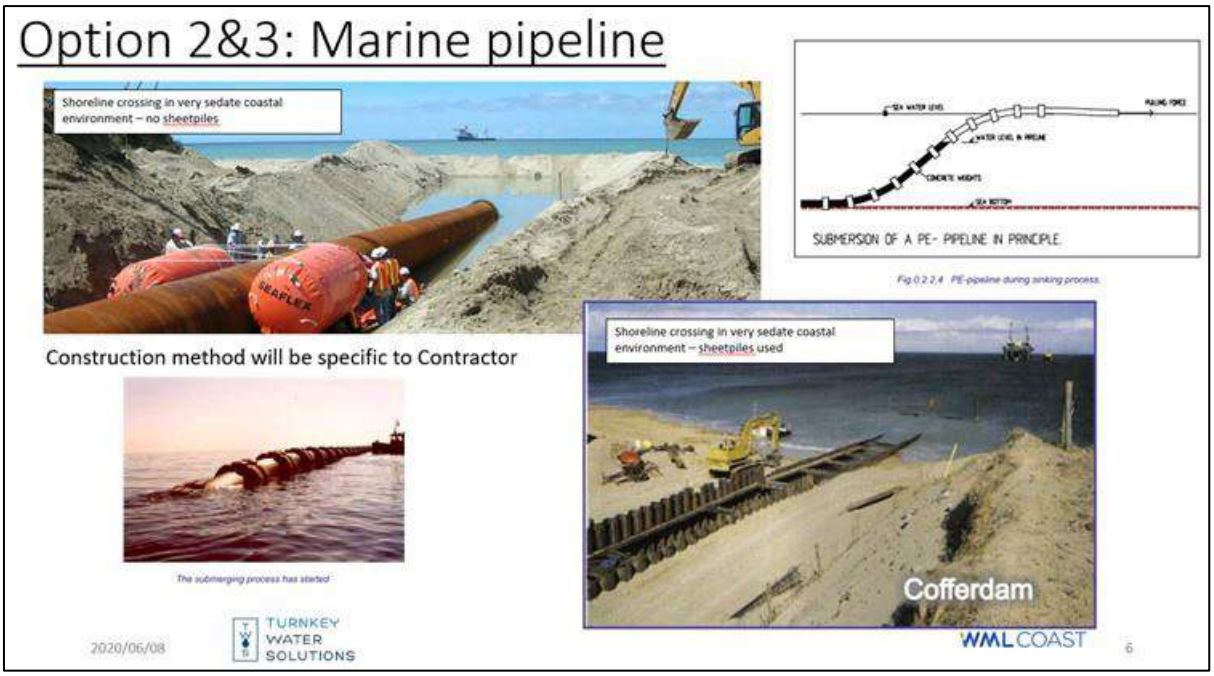


Figure 10 a and b. Details for the brine outfall pipeline, Option 2: Marine pipeline (buried).

1.3 Potential impacts

Potential environmental impacts that will be assessed as part of the ESIA include:

- Brine discharge modelling;
- Impacts on bird species, including disturbance/habitat loss, and taking into account potential effects of the brine discharge on food sources for birds in the area; and
- Hydrogeological investigations for the beach wells.

2 Approach and methodology

2.1 Terms of reference

As part of the Environmental and Social Impact Assessment (ESIA), the purpose of the avifauna baseline/scoping and impact assessment study for the proposed pilot sustainable water supply project by means of desalination, powered by solar to supplement the water supply for Walvis Bay, is to provide an understanding of the potential risks to birds with the proposed development and to serve as a basis for the recommendations of mitigation for such risks and the monitoring programme for the Environmental Management Plan (EMP).

In particular, the study will include consideration of the following aspects:

- Hybrid solar and grid electricity
- Solar plant designed to circa 1400kWp (1400 kW or 1.4 MW peak power)
- Likely grid connection will be to the Erongo RED Tutaleni Substation
- A 2 km long 11 kV underground cable will connect the plant to the grid
- The desalination will discharge brine along the existing oil and gas jetty and, based on the results of a separate brine modelling study, the potential effects the brine could have on food sources for birds in the area will be factored into the avian assessment

2.2 General approach and methodology

The study takes the form of a desk-top assessment of the bird habitats and their likely avifauna and its sensitivity in terms of the proposed development. A site visit was proposed, to support the desk study, but was not possible due to the Covid-19 restrictions on travel in the region.

Two sources of bird distribution data were used. The primary data, for the first Southern African Bird Atlas Project (SABAP1; Harrison, Allan, Underhill, Herremans, Tree, Parker, Brown 1997), were gathered during 1987-1992. This information is available on the comprehensive Namibian Avifaunal Database (NAD 2020; www.biodiversity.org.na), which includes all available information on birds in Namibia including SABAP1 data, nest record cards, wetland bird counts, Raptor Road Counts for Namibia and museum specimens. SABAP1 data are recorded on a quarter degree square (QDS) basis and are extremely comprehensive, although the information dates back to 1992.

A follow-up Southern African Bird Atlas Project (SABAP2) was initiated in South Africa in 2007 and in Namibia in 2012 (http://sabap2.adu.org.za). This information comprises more recent distribution data on a finer scale (in units termed pentads, or 5-minute x 5-minute coordinates; nine pentads make up one quarter degree square [QDS]). Although the distribution data are at a finer scale, the data collected to date for Namibia are still patchy and not yet as extensive as those for SABAP1; in particular, the study area is poorly atlassed in parts, and the results should be interpreted with caution. It is therefore advisable to use a combination of SABAP1 and SABAP2 data.

The bird checklist for the present study (Appendix 1) is based on SABAP1 data for the primary QDS 2214DC (Figure 11), supplemented by available SABAP2 data for three pentads that fall within the above QDS and lie on the coast in the study area (namely pentads 2245_1430 [12 full protocol or FP cards], 2259_1430 [eight FP cards] and 2255_1430 [26 FP cards]). Note that QDS 2214DC includes the greater study area, with both coastal (aquatic) and inland (desert) habitats.

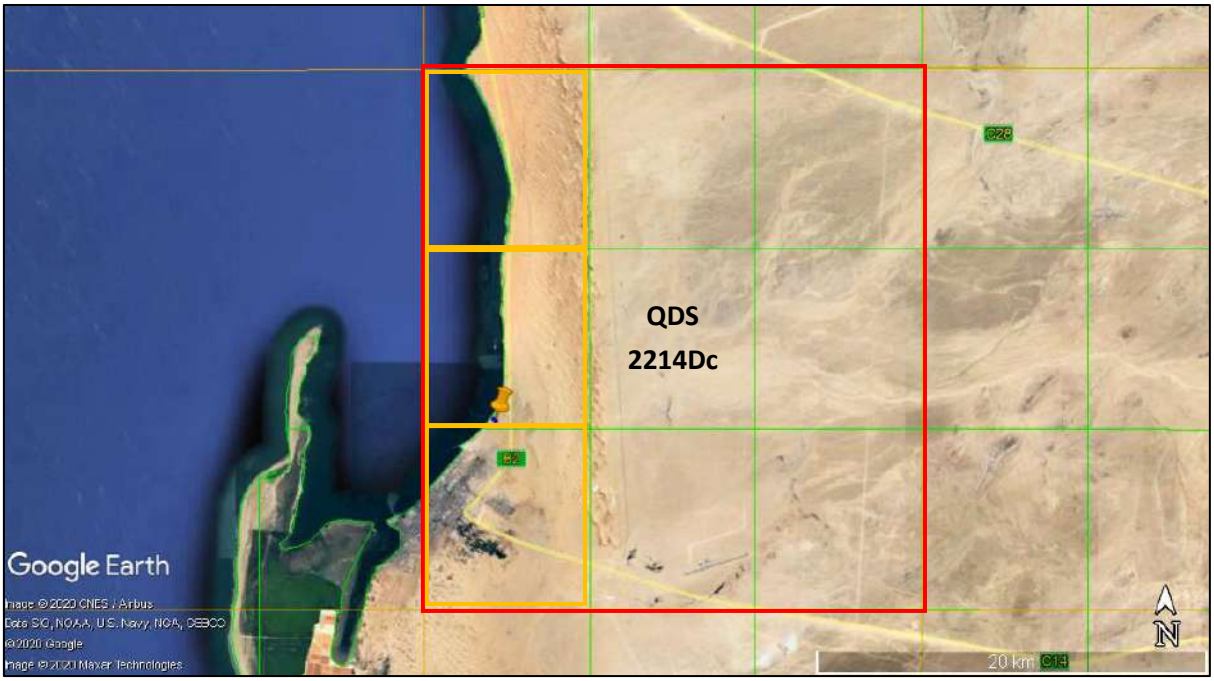


Figure 11. The bird checklist for the study area is based primarily on bird data recorded for Quarter Degree Square (QDS) 2214DC (red; SABAP1 data), and supplemented by comprehensive data (including full protocol cards) recorded for three pentads (orange): 2245_1430 (top), 2250_1430 (centre) and 2255_1430 (bottom; SABAP2 data).

Other sources of information include the Environmental Information Service (EIS; www.the-eis.com), the Red Data Book for Birds in Namibia (Simmons, Brown, Kemper 2015), other published sources (e.g. Chittenden, Davies, Weiersbye 2016), the global International Union for the Conservation of Nature (IUCN) Red Data list for birds (www.iucnredlist.org; IUCN 2020); discussions with local birders; and both the authors' 35+ years of experience of working together on and observing birds in southern Africa, including in Namibia. The above sources were used to compile one combined checklist for the study area.

Potential sensitivities of the avifaunal environment were assessed according to standard criteria, i.e. in the context of protected/conservation status; and major topographical features including wetland habitats (EIS 2020). Avifaunal habitats that are limited in the present context were identified, in particular aquatic habitats.

Although the above checklist for the greater area provides a broad perspective, the focus for this study is on "priority species" (i.e. Red Data, endemic and/or migrant) species. Potential sensitivities of the bird species were assessed in terms of criteria that include bird species diversity (according to recorded distribution data, see above); the most recent Red Data status, both on a national scale (Simmons et al. 2015; and an update by Brown, Mendelsohn, Thomson, Boorman 2017) and global scale (IUCN 2020; see above); uniqueness or endemism/near-endemism to Namibia (i.e. having ≥90% of their global population in this country) (Simmons et al. 2015; Brown et al. 2017); residency/migrant status; any indication of abundance (full protocol reporting rates of over 60% for SABAP2 pentads, see Figure 11); any breeding recorded in the area (focusing on Red Data and endemic species); type of diet and feeding habits; known sensitivity to impacts; and other ecological aspects.

The criteria for the assessment of impacts are outlined below.

Gaps in baseline data were identified where applicable, and an indication of the confidence levels is provided. Recommendations were made for any future work in terms of the EIA process, if required.

2.3 Impact assessment methodology

2.3.1 General methodology

The EIA methodology applied to this SEIA has been developed using the International Finance Cooperation (IFC) standards and models, in particular Performance Standard 1, 'Assessment and management of environmental and social risks and impacts' (International Finance Corporation, 2017) (International Finance Corporation 2012); Namibian draft procedures and guidance for EIA and EMP (Republic of Namibia 2008); international and national best practice; and over 25 years of combined EIA experience (ECC 2020).

EIA determination of significance

The significance of an impact was determined by taking into consideration the combination of the sensitivity and importance/value of environmental and social receptors that may be affected by the proposed project, the nature and characteristics of the impact, and the magnitude of potential change. The magnitude of change (the impact) is the identifiable changes to the existing environment which may be direct or indirect; temporary/short term, long-term or permanent; and either beneficial or adverse. These are described as follows and thresholds are provided in Table 1, 2 and 3.

- The **sensitivity and value of a receptor** are determined by identifying how sensitive and vulnerable a receptor is to change, and the importance of the receptor (internationally, nationally, regionally and locally).
- The **nature and characteristics of the impact** are determined through consideration of the frequency, duration, reversibility and probability and the impact occurring.
- The **magnitude of change** measures the scale or extent of the change from the baseline condition, irrespective of the value. The magnitude of change may alter over time, therefore temporal variation is considered (short-term, medium-term; long-term, reversible, irreversible or permanent).

TABLE 1 - SENSITIVITY AND VALUE OF RECEPTOR

SENSITIVITY AND VALUE	DESCRIPTION
High	Of value, importance or rarity on an international and national scale, and with very limited potential for substitution; and/or very sensitive to change or has little capacity to accommodate a change.
Medium	Of value, importance or rarity on a regional scale, and with limited potential for substitution; and/or moderate sensitivity to change, or moderate capacity to accommodate a change.
Low	Of value, importance or rarity on a local scale; and/or not particularly sensitive to change or has considerable capacity to accommodate a change.

TABLE 2 - NATURE OF IMPACT

NATURE	DESCRIPTION
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.
Direct	Impacts causing an impact through direct interaction between a planned project activity and the receiving environment/receptors.
Indirect	Impacts that result from other activities that are encouraged to happen as a result / consequence of the Project. Associated with the project and may occur at a later time or wider area
Extent / Geographic Scale	
On-site	Impacts that are limited to the boundaries of the proposed project site
Local	Impacts that occur in the local area of influence, including around the proposed site and within the wider community
Regional	Impacts that affect a receptor that is regionally important by virtue of scale, designation, quality or rarity.
National	Impacts that affect a receptor that is nationally important by virtue of scale, designation, quality or rarity.
International	Impacts that affect a receptor that is internationally important by virtue of scale, designation, quality or rarity.
Duration	
Short-term	Impacts that are likely to last for the duration of the activity causing the impact and are recoverable
Medium-term	Impacts that are likely to continue after the activity causing the impact and are recoverable
Long-term	Impacts that are likely to last far beyond the end of the activity causing the damage but are recoverable over time
Reversibility	
Permanent /Irreversible	Impacts which are not reversible and are permanent
Temporary / Reversible	Impacts are reversible and recoverable in the future
Likelihood	
Certain	The impact is likely to occur
Likely	The impact is likely to occur under most circumstances
Unlikely	The impact is unlikely to occur

TABLE 3- MAGNITUDE OF CHANGE

MAGNITUDE OF CHANGE	DESCRIPTION
Major	Loss of resource, and quality and integrity of resource; severe damage to key characteristics, features or elements; or Large-scale or major improvement of resources quality; extensive restoration or enhancement; major improvement of attribute quality.
Moderate	Loss of resource, but not adversely affecting its integrity; partial loss of/damage to key characteristics, features or elements; or Benefit to, or addition of, key characteristics, features or elements; improvements of attribute quality.

Minor	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (or maybe more) key characteristic, feature or element; or Minor benefit to, or addition of, one (or maybe more) key characteristic, feature or element; some beneficial effect on attribute quality or a reduced risk of a negative effect occurring.
Negligible	Very minor loss or detrimental alteration to one (or maybe more) characteristic, feature or element; or Very minor benefit to, or positive addition of, one (or maybe more) characteristic, feature or element.

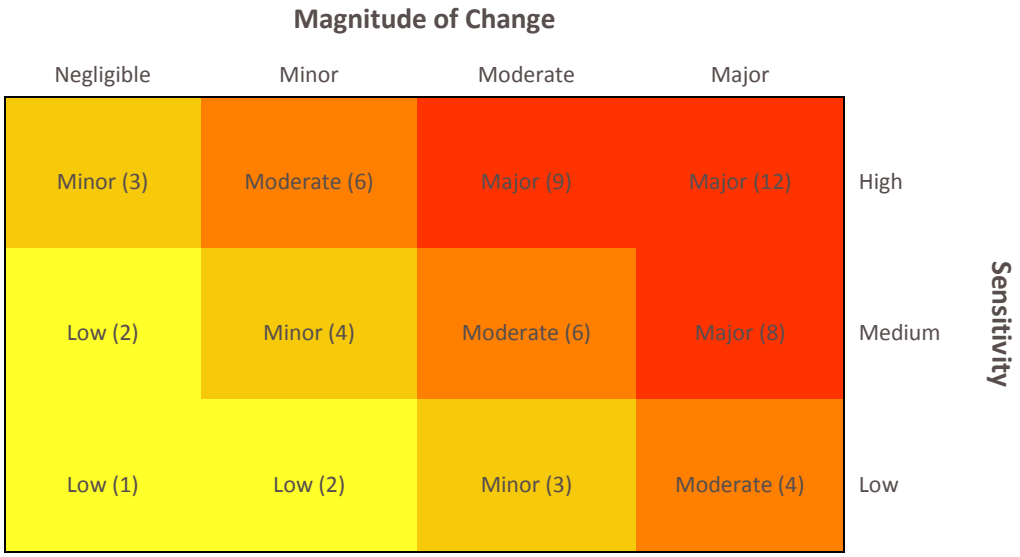
A level of certainty has also been applied to the assessment to demonstrate how certain the assessment conclusions are and where there is potential for misinterpretation or a requirement to identify further mitigation measures, thereby adopting a precautionary approach. Where there is a low degree of certainty, monitoring and management measures can be implemented to determine if the impacts are worse than predicted and support the identification of additional mitigation measures through the lifetime of the proposed project. Table 4 provides the levels of certainty applied to the assessment, as well as a description.

TABLE 4 – LEVEL OF CERTAINTY

LEVEL OF CERTAINTY	DESCRIPTION
High	– Likely changes are well understood – Design/information/data used to determine impacts is very comprehensive – Interactions are well understood and documented – Predictions are modelled, and maps based on interpretations are supported by a large volume of data, and – Design/information/data has very comprehensive spatial coverage or resolution.
Medium	– Likely changes are understood – Design/information/data used to determine impacts include a moderate level of detail – Interactions are understood with some documented evidence – Predictions are modelled but not yet validated and/or calibrated, and – Mapped outputs are supported by a moderate spatial coverage or resolution.
Low	– Interactions are currently poorly understood and not documented. – Predictions are not modelled, and the assessment is based on expert interpretation using little or no quantitative data. – Design is not fully developed, or information has poor spatial coverage or resolution.

The significance of impacts has been derived using professional judgment and applying the identified thresholds for receptor sensitivity and magnitude of change (as discussed above) and guided by the matrix presented in Table 5. The matrix is applicable for impacts that are either positive or negative. The distinction and description of significance and whether the impact is positive, or negative is provided in Table 6.

TABLE 5 - GUIDE TO SIGNIFICANCE RATINGS



Significance is not defined in the Namibian EIA Regulations, however the Draft Procedure and Guidance for EIA and EMP states that the significance of a predicted impact depends upon its context and intensity. Accordingly, definitions for each level of significance have been provided in Table 6. These definitions were used to check the conclusions of the assessment of receptor sensitivity, nature of impact and magnitude of impact was appropriate.

TABLE 6– SIGNIFICANCE DESCRIPTION

SIGNIFICANCE OF IMPACT	DESCRIPTION
Major (negative)	Impacts are considered to be key factors in the decision-making process that may have an impact of major significance, or large magnitude impacts occur to highly valued/sensitive resource/receptors. Impacts are expected to be permanent and non-reversible on a national scale and/or have international significance or result in a legislative non- compliance.
Moderate (negative)	Impacts are considered within acceptable limits and standards. Impacts are long-term, but reversible and/or have regional significance. These are generally (but not exclusively) associated with sites and features of national importance and resources/features that are unique and which, if lost, cannot be replaced or relocated.
Minor (negative)	Impacts are considered to be important factors but are unlikely to be key decision-making factors. The impact will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. Impacts are considered to be short-term, reversible and/or localized in extent.
Low (negative)	Impacts are considered to be local factors that are unlikely to be critical to decision-making.
Low – Major (Beneficial)	Impacts are considered to be beneficial to the environment and society:

The colour green has been applied to highlight positive impacts over negative impacts shown in shades of yellow, orange and red. The description for each level of significance presented in Table 6 was also followed when determining the level of significance for a beneficial impact.

The level of significance of impacts has been derived using professional judgment and applying the identified thresholds for receptor sensitivity and magnitude of change, as well as the definition for significance. It most instances, moderate and major adverse impacts are considered as significant, and however, there may be some instances where impacts are lower than this but are still considered to be significant. The following thresholds were therefore used to double check the assessment of significance had been applied appropriately; a significant impact would meet at least one of the following criteria:

- It exceeds widely recognized levels of acceptable change
- It threatens or enhances the viability or integrity of a receptor or receptor group of concern, and
- It is likely to be material to the ultimate decision about whether or not the environmental clearance certificate is granted.

2.3.2 Methodology for assessing impacts of solar photovoltaic (PV) developments

Solar photovoltaic (PV) developments are still relatively new in Namibia, and the impacts on avifauna in this country are as yet little documented. As the precautionary principle therefore applies, the approach to the assessment of the solar photovoltaic (PV) aspects is based on the Best Practice Guidelines compiled by the Birds and Renewable Energy Specialist Group (BARESG), convened by BirdLife South Africa and the Endangered Wildlife Trust, (Jenkins, Ralston-Paton, Smit-Robinson 2017).

The development of renewable energy options is supported in principle; however, the above authors mention that experiences in other parts of the world suggest that, like many other energy sources, solar power may affect birds in different ways, including through the alteration of habitat, the displacement of populations from preferred habitat, and collision mortality associated with elements of the solar hardware and ancillary infrastructure. As yet, the nature and implications of these effects are poorly understood (DeVault et al. 2014; Visser 2016; Jenkins et al. 2017). In addition, recent findings at facilities in North America suggest that collision mortality impacts at solar PV plants may be underestimated, particularly in terms of collision trauma with PV panels; this is perhaps associated with polarised light pollution and/or with waterbirds mistaking large arrays of PV panels as wetlands (the so-called "lake effect") (Jenkins et al. 2017). However, a recent study on assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa (Visser et al. 2018) did not produce any evidence of such a lake effect (although carried out over a very short period); and although there has been little other rigorous monitoring at solar PV sites in South Africa, no reports have been received as yet to suggest it has been a problem (S Ralston-Paton pers. comm. 2020).

In view of the above uncertainties, it is therefore considered essential that sufficient, project- and site-specific data are gathered to both inform the avifaunal impact assessment process and build our understanding of the impacts and potential mitigation measures.

The Birds and Renewable Energy Specialist Group (BARESG), convened by BirdLife South Africa and the Endangered Wildlife Trust, proposes the following guidelines and monitoring protocols for evaluating utility-scale solar energy development proposals (Jenkins et al. 2017). The approach is based on a tiered assessment process and includes:

- Preliminary avifaunal assessment;
- Data collection;
- Impact assessment; and

- Monitoring.

A summary of the recommended assessment regimes in relation to proposed solar energy technology, project size, and likely risk is provided in Table 7.

Table 7. Recommended avian assessment regimes in relation to proposed solar energy technology, project size, and known impact risks (Jenkins et al. 2017).

Type of technology	Size[1]	Avifaunal sensitivity[2]		
		Low	Medium	High
All solar developments except CSP power tower	Small (<30 ha)	Regime 1	Regime 1	Regime 2
	Medium (30-150 ha)	Regime 1	Regime 2	Regime 2
	Large (>150 ha)	Regime 2	Regime 2	Regime 3
CSP power tower (not applicable in this case)	All	Regime 3		

Regime 1: One site visit (peak season); minimum 1-5 days.
Regime 2: Pre- and post-construction; minimum 2-3 x 3-5 days over 6 months (including peak season); carcass searches.
Regime 3: Pre- and post-construction; minimum 4-5 x 4-8 days over 12 months; carcass searches.

[1] For multi-phased projects, the aggregate footprint of all the phases should be used. At 3ha per MW, *Small = < 10 MW*, Medium = 10-50 MW, Large = > 50MW.

[2] The avifaunal sensitivity is based on the number of priority species present, or potentially present, the regional, national or global importance of the affected area for these species (both individually and collectively), and the perceived susceptibility of these species (both individually and collectively) to the anticipated impacts of development. For example, an area would be considered to be of *high avifaunal sensitivity if one or more of the following is found (or suspected to occur) within the broader impact zone: 1) avifaunal habitat (e.g. a wetlands, nesting or roost sites) of regional or national significance, 2) a population of a priority species that is of regional or national significance, and/or 3) a bird movement corridor that is of regional or national significance, and 4) a protected area and/or Important Bird and Biodiversity Area*. An area would be considered to be of medium avifaunal sensitivity if it does not qualify as high avifaunal sensitivity, but one or more of the following is found (or suspected to occur) within the broader impact zone 1) avifaunal habitat (e.g. a wetland, nesting or roost sites) of local significance, 2) a locally significant population of a priority species, 3) a locally significant bird movement corridor. An area would be considered to be of low avifaunal sensitivity if it is does not meet any of the above criteria.

To streamline the impact assessment process, a shortlist of priority species should be drawn up during the preliminary assessment, as a primary focus of subsequent monitoring and assessment.

As the size of the development is small (4 ha / 2 MW) but the avifaunal sensitivity of the study area is considered medium - high (see above), a Regime 2 approach to the assessment would be required.

For baseline data collection work, Regime 3 would require periodic surveys conducted frequently enough to adequately sample all major variations in environmental conditions, with no fewer than four surveys spanning all four seasons. Regime 2 would require the same data collection, but at a lower frequency (six months; see above). Variables measured/mapped on each survey should include (i) density estimates for small terrestrial birds (in most cases not priority species, but potentially affected on a landscape scale by multiple developments in one area), (ii) census counts, density estimates or abundance indices for large terrestrial birds and raptors, (iii) occupancy/numbers/ breeding success at any focal species sites, (iv) bird numbers at any focal sites (e.g. wetlands, within a variable distance of the proposed project, depending on the size and relative importance of the

wetland, or other any other sensitive avifaunal habitats, and (v) full details of any incidental sightings of priority species.

In terms of the proximity of the site to the Walvis Bay wetlands complex, the requirements for any further baseline data collection also to take into account the comprehensive data already available from long term bird counts by the Coastal Environmental Trust Namibia (CETN) for the area.

Post-construction monitoring should effectively duplicate the above baseline data collection work.

2.4 Limitations and assumptions

Limitations

- Due to the Covid-19 restrictions on travel in the region, the proposed site visit was not possible at the time of writing. This limitation was addressed by the amount of available information on the area and project, and by including at least 2 - 4 site visits in the future, as part of the pre- and post-construction monitoring.
- The difficulty in obtaining confirmed records of bird flight paths, especially at night, is a limitation to the assessment of the potential impacts of any new structure, including the proposed solar PV facility.
- It is possible that collision mortality impacts at solar PV plants may be underestimated, particularly in terms of collision trauma with PV panels; the precautionary principle therefore applies until such time as further data become available, in view of the relative sensitivity of the bird species in the area.

Assumptions

- Combined SABAP1 and SABAP2 data and the other above-mentioned data sources provide a representative indication of the bird species likely to occur in the study area at present.
- It is assumed that the levels of disturbance from the surrounding port activities in the vicinity of the study site will be maintained at the present level (or an increased level) for the life of the project; these levels of activity could possibly act as a deterrent for some bird species, e.g. to discourage perching on the infrastructure.

3 Legislation and international conservation agreements

A full (formal) assessment study of the impacts of the proposed development on the avifauna and its habitats is required under Namibia's Environmental Management Act, No. 7 of 2007 (EMA; Anon. 2012), as part of the Environmental and Social Impact Assessment (ESIA) Application process.

The conservation of terrestrial birds in Namibia is governed by the Nature Conservation Ordinance of 1975. This Ordinance is expected to be replaced by the Wildlife and Protected Areas Management Act in the near future (latest draft 2018). The list of Specially Protected Birds according to this legislation is based on the Namibian Red Data Book (Simmons et al. 2015), and the Namibian Red Data categories in the latter document and an update (Brown et al. 2017) are used in the present report.

The study area is adjacent to, but does not lie within, an officially protected area, namely the Dorob National Park, proclaimed in 2010 under the above Namibian Nature Conservation Ordinance of 1975.

On an international level, Namibia is a signatory to the international Convention on Biological Diversity (CBD; Rio de Janeiro, 1992), a legally binding instrument for the global conservation and sustainable use of biological diversity.

Namibia became a signatory to the Convention on Wetlands of International Importance especially as a Waterfowl Habitat (the "Ramsar" Convention of 1971) in 1995, under which such wetland sites receive special protection status. The Walvis Bay Wetlands was proclaimed as a Ramsar site and Wetland of International Importance in 1995, together with three other sites (Kolberg, undated; also see below); this site conforms to five of the eight requisite criteria for such a site. More recently, a fifth site was proclaimed in Namibia.

The Convention on Migratory Species (CMS 2011) has developed an inter-governmental treaty known as the African-Eurasian Migratory Waterbird Agreement (AEWA). Namibia is classed as a range state but, although guided by the principles of AEWA, is not yet a contracting party to this international agreement.

The adjacent Walvis Bay wetland area to the south of the study site is classified as an Important Bird Area (IBA N014; Simmons, Boix-Hinzen, Barnes, Jarvis, Robertson 1998; see below). The 30 Km Beach: Walvis-Swakopmund IBA (N013) is a narrow coastal strip to the north of the study site. IBAs are sites regarded as being of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level, selected according to stringent criteria (Barnes 1998). However, not all IBAs have official protection.

The approach to the assessment of the solar photovoltaic (PV) aspects in the present study is based on the Best Practice Guidelines compiled by the Birds and Renewable Energy Specialist Group (BARESG), convened by BirdLife South Africa and the Endangered Wildlife Trust, (Jenkins et al. 2017).

4 Baseline description

4.1 Avifaunal environment

4.1.1 General

The proposed development site is at the port city of Walvis Bay on the central coast in the west of Namibia (Figure 1 and 2).

The greater study area is located on the ephemeral Kuiseb River delta and lies on the edge of the Central-western Plains and Namib Sand Sea landscapes (Mendelsohn, Jarvis, Roberts, Robertson 2002; EIS 2020).

4.1.2 Climate and vegetation habitats

The desert environment is hyper arid, with average annual temperatures of <16-18° and an average annual rainfall of <50 mm (Mendelsohn et al. 2002). Humidity levels are often high, and coastal fog is a critical source of water for many plants and animals.

The dominant wind direction is from the south, with average wind speeds of up to 30 km per hour.

The study area falls within the Namib Desert biome (Mendelsohn et al. 2002). The vegetation type is classed as Southern Desert, with dune sands as dominant soils, the dominant vegetation structure being grassland and dwarf shrublands. The vegetation cover on the coast is sparse.

4.1.3 Topography and habitats in relation to birds

The major avifauna habitat component is a group of aquatic habitats that comprise the Walvis Bay Important Bird Area (IBA; see below) (Figure 12). These are described as including the wetlands south and west of the town, comprising the natural areas of the Walvis Bay Lagoon (Figure 13) and including intertidal mudflats and the eastern half of a 10 km-long north-south sand spit, Pelican Point; this spit provides protection for the bay from Atlantic swells (Simmons et al. 1998). The lagoon lies at the southern end of the open water. The four main waterbird habitats within the Walvis Bay wetland complex comprise the sandy shoreline, intertidal mudflats, shallow sheltered water, and constructed saltpans (Wearne & Underhill 2005). These habitats are all important to a diversity of bird species, to different degrees, for feeding, roosting and other activities.

East of the town, the Walvis Bay sewage ponds (Figure 14) form a further important bird habitat within this aquatic system, with reedbeds and an enriched environment.

Within the present study site, three main marine habitat types are represented, namely sandy intertidal habitats, rocky intertidal habitats and the Atlantic Ocean itself (Figure 15 and 16). An extensive dune system and gravel plain habitat lies on the coast and east of the site.

Some 3.5 km north of the study site lies Bird Rock, a large artificial guano platform built during the 1930s (Underhill undated) (Figure 17 and 18). About 99% of the birds that occur on the platform are Cape Cormorants, and the platform is an important breeding site for the species. Some 150-200 pairs of Great White Pelican and 700 pairs of White-breasted Cormorant also breed on the site, while about 100 pairs of Crowned Cormorant breed and roost on the supports underneath the platform. Other bird species that have been recorded on Bird Island include Kelp Gull, Hartlaub's Gull and Grey-headed Gull (although not breeding). Greater Flamingo sometimes roost on the platform in flocks of up to 150 birds. Black Oystercatcher and Ruddy Turnstone and other waders occasionally visit the site.

Figure 12. Aquatic habitats in the greater study area, including the Walvis Bay lagoon and wetland complex, Walvis Bay sewage ponds and Bird Island, in relation to the project site (based on a Google Earth image).

Figure 13. The extensive Walvis Bay lagoon and wetland complex.

Figure 14. The Walvis Bay sewage ponds.

Figure 15. Mixed sandy and rocky coast in the area to the north of the study site at the Port of Walvis Bay.

Figure 16. Greater Flamingo feeding in the rocky intertidal habitat on the coast near Bird Island.

Figure 17. Bird Island, an artificial guano platform to the north of the study site.

Figure 18. Bird Island provides an artificial roosting site (and in some cases, breeding site) for cormorants, Great White Pelican, flamingos and other species.

4.1.4 Area protection in relation to the study area

The protection status of the greater study area is relatively high (Figure 19).

Figure 19. Formally protected areas (National Parks; brown) and coastal Important Bird Areas (IBAs: N; red and blue) in relation to the study area (Google earth map generated by the EIS 2020).

National Parks

The study area lies adjacent to an officially protected area, namely the extensive Dorob National Park (DNP) which was proclaimed in 2010 under the Namibian Nature Conservation Ordinance of 1975 (Figure 19). The DNP lies adjacent to the Namib Naukluft National Park (NNNP) to the east and south.

Ramsar site

Two important coastal wetlands, i.e. the Walvis Bay Wetlands and Sandwich Harbour (55 km to the south), occur in the general area (Simmons, Boix-Hinzen, Barnes, Jarvis, Robertson 1998; Wearne & Underhill 2005; Kolberg undated).

Both the above sites have been proclaimed as Ramsar sites. The main aims of the Convention on Wetlands of International Importance, 1971, or "Ramsar Convention" (Ramsar 1971) are to prevent the loss and degradation of wetlands worldwide and to ensure that they are used wisely and sustainably, while conserving their biodiversity values and ecosystem services (Ramsar 1971, Bethune 2007). To date five Ramsar sites have been proclaimed in Namibia.

Limited in terms of their location on the arid Namib Desert coast, the above two wetlands are considered the single-most important wetlands in southern Africa in terms of avian biomass and diversity (Williams 1987; Simmons et al. 1998; Wearne and Underhill 2005; Simmons 2017). This exceptional status is ascribed to strong upwelling cells that bring nutrient-rich waters to the coast, increasing primary productivity in these areas and supporting a rich and abundant avian birdlife that is dominated by wading birds. Regular counts of birds at the Walvis Bay Wetlands Ramsar site vary from 37,000 to well over 100,000 individuals, with peak counts per species indicating annual use by

up to 150,000 wetland birds; these are mainly migratory species but also some resident breeding birds (Simmons et al. 1998; Kolberg 2016; Kolberg undated). The Walvis Bay Wetlands Ramsar site conforms to five of the nine requisite criteria for such a site, including holding at least 25 wetland bird species that reach or exceed the requisite 1% of the African fly-way population (i.e. the full migration range for the population).

Important Bird Areas

Several Important Bird Areas (IBAs; Simmons et al. 1998) are situated in the greater study area (Figure 19). IBAs are sites of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level (Barnes 1998); however, not all IBAs enjoy official protection. Twenty-one sites are designated as IBAs in Namibia.

The IBAs are as follows:

- N011 Namib Naukluft Park
- N012 Mile 4 Saltworks
- N013 30 Km Beach: Walvis-Swakopmund
- N014 Walvis Bay
- N015 Sandwich Harbour

The Walvis Bay IBA is 4,000 ha in size and classed as a top-level Global IBA (A1, A4i, iii), Ramsar site (Simmons et al. 1998). In terms of numbers of birds, it is considered the most important coastal wetland in the Sub-region, and probably one of the three most important coastal wetlands in Africa (Simmons et al. 1998; see above). Most birds (90% by number) that use the wetland in summer are non-breeding intra-African and Palearctic migrants. The area is vitally important for Palearctic waders and flamingos, which make up the majority of numbers. Between 80-90% of the Sub-region's flamingos winter here, utilising especially the evaporation ponds of the saltworks, or at Sandwich Harbour (IBA N015) to the south. As many as 25 species occur in numbers exceeding the IBA criterion for 1% of the biogeographical population (Wearne & Underhill 2005; Simmons 2017).

4.1.5 Conclusions on the sensitivity of the avifaunal habitat

In terms of the above criteria, the avifauna habitats in the greater study area may be considered as being of high sensitivity in terms of the high conservation status of two officially Protected areas, two Ramsar sites, and five Important Bird Areas. This sensitivity is due largely to the varied, extensive and favourable aquatic habitats in the arid coastal desert environment.

In terms of criteria for sensitivity for solar sites (Jenkins et al. 2017; see 2.3.1 and Table 7 above), the Walvis Bay wetlands complex (i.e. the broader impact zone) would qualify as a site of high sensitivity in terms of the following criteria: 1) avifaunal habitat (e.g. a wetlands, nesting or roost sites) of regional or national significance, 2) a population of a priority species that is of regional or national significance, and/or 3) a bird movement corridor that is of regional or national significance, and 4) a protected area and/or Important Bird and Biodiversity Area.

Although the local area of the study site itself is likely to be of relatively lower sensitivity, its proximity to the above sensitive habitats in the greater area and the mobility of the bird species are an important consideration, and a precautionary approach is therefore indicated.

4.2 Sensitivities in terms of bird species

Combined long term and more recent SABAP data (see below) were used to produce an overall bird checklist for the study area (Appendix 1). Sensitivities of the bird species in the area are discussed below, according to relevant criteria.

Although terrestrial species are also well represented in the broader area, the focus is on aquatic species recorded in the coastal habitats in the study area.

Note that the risk assessment for this study is directed towards "priority species", or species with a high biological significance, i.e. primarily Red Data species (including those with migrant status) and/or Namibian endemic or near-endemic species. These also include species recorded as breeding within the (greater) study area. However, a number of other non-Red Data/non-endemic bird species are also likely to be affected in similar ways by any impacts, in particular the migrant species. Based on the above checklist, a provisional shortlist of priority species was compiled (see below).

4.2.1 Bird species diversity and abundance

The overall bird checklist of 159 species represents the combined SABAP1 and SABAP2 data for QDS 2214Dc and three relevant pentads (2245_1430 [12 full protocol cards], 2250_1430 [8 full protocol cards], 2255_1430 [26 full protocol cards]). This total comprises 24% of the 676 species currently recorded in Namibia (Brown et al. 2017), a diversity that is regarded as relatively high for the desert environment. The above combined long term data are considered to provide a good reflection of potential bird diversity for the study site, particularly as the more recent SABAP2 data are well represented.

Much of the above data has been collected in conjunction with regular bird counts that have been undertaken by the Coastal Environmental Trust Namibia (CETN) at the Walvis Bay wetland complex for over 30 years (Williams 1987; Wearne & Underhill 2005; Bridgeford 2013; Kolberg 2016; Simmons 2017). Total counts for the Walvis Bay wetland complex (during 60 annual summer and winter counts, from 1992 – 2016) are documented in a recent summary of wetland bird counts in Namibia, where a total of 85 species has been recorded (Kolberg 2016). The highest single count for this period was 242,907 birds (January 2004) and the highest number of species recorded on any one count, 55 (January 1999).

However, this productive habitat is under threat. A recent EIA avifauna study for the Walvis Bay Waterfront Development (Simmons 2017) has raised serious concerns about the health of the lagoon environment and its sustainability as an avifauna habitat, with 20-year declines being indicated in numbers of the majority of species (11 of 14 species) in the lagoon itself, and this is ascribed to ongoing anthropogenic activities around the lagoon (resulting in sedimentation, wind-borne sand, reduced tidal flushing and pollution), that have compromised the lagoon environment (Simmons 2017). The lagoon now supports only 11,670 waders or 12% of the current migrant wader population - an overall 42% drop in abundance in 20 years.

4.2.2 Red Data status

The bird checklist of 159 species includes 25 species (16%) that are threatened in Namibia (Brown et al. 2017). This represents 29% of the 85 species that are on the above current Namibian Red List.

Of these 25 species, two are Critically Endangered, four are Endangered, six are Vulnerable and thirteen Near Threatened (Table 1). Eighteen of these species are also Globally Threatened (IUCN 2020). It should be noted that wetland birds – and coastal and marine birds – have been identified as two of four major groups of threatened birds in Namibia (Simmons et al. 2015).

These species are listed as follows:

- Cape Gannet (Critically Endangered, also Globally Endangered)
- Great Crested Grebe (Critically Endangered)

- African Penguin (Endangered, also Globally Endangered)
- Cape Cormorant (Endangered, also Globally Endangered)
- Bank Cormorant (Endangered, also Globally Endangered)
- Ludwig's Bustard (Endangered, also Globally Endangered)

- White-Chinned Petrel (Vulnerable, also Globally Vulnerable)
- Lesser Flamingo (Vulnerable, also Globally Near Threatened)
- Greater Flamingo (Vulnerable)
- Great White Pelican (Vulnerable)
- Caspian Tern (Vulnerable)
- Hartlaub's Gull (Vulnerable)

- Damara Tern (Near Threatened, also Globally Vulnerable)
- Maccoa Duck (Near Threatened, also Globally Vulnerable)
- Crowned Cormorant (Near Threatened, also Globally Near Threatened)
- Sooty Shearwater (Near Threatened, also Globally Near Threatened)
- Eurasian Curlew (Near Threatened, also Globally Near Threatened)
- Red Knot (Near Threatened, also Globally Near Threatened)
- Chestnut-banded Plover (Near Threatened, also Globally Near Threatened)
- Curlew Sandpiper (Near Threatened, also Globally Near Threatened)
- Bar-tailed Godwit (Near Threatened, also Globally Near Threatened)
- African Oystercatcher (Near Threatened, also Globally Near Threatened)
- Kori Bustard (Near Threatened, also Globally Near Threatened)
- Black-necked Grebe (Near Threatened)
- Peregrine Falcon (Near Threatened) (recently recorded in SABAP 2 data)

Note that Ludwig's Bustard and Kori Bustard are not expected to occur in the study area, and are not discussed further.

4.2.3 Endemism

Endemism, or having a limited/restricted distribution, renders populations more vulnerable to threats. In the study area the level of endemism to Namibia is low; three species on the checklist (Appendix 1) are near-endemic to Namibia, with ≥90% of population being found within Namibia (namely Damara Tern, Gray's Lark and Rüppell's Korhaan). Of the above, Damara Tern is found in aquatic and adjacent habitats within the greater study area, but the occurrence of Gray's Lark (with its habitat-specific requirements for sparsely vegetated gravel plains, including drainage lines/washes) would need to be confirmed. Rüppell's Korhaan is not expected to occur in the study area.

A number of species endemic or near-endemic to southern Africa are also found in the area, but are considered of relatively lower conservation priority as their populations occur in a relatively wider area.

4.2.4 Residency and migrant status

The bird checklist includes a high proportion (at least 57 species or 36%) with some form of migrant status (Appendix 1; Chittenden et al. 2016). Of these, 13 species also have Red Data status, as follows:

- Four non-breeding Palearctic migrants: Curlew Sandpiper, Eurasian Curlew, Bar-tailed Godwit, Red Knot
- Seven intra-African migrants: Greater Flamingo, Lesser Flamingo, Great White Pelican, Chestnut-banded Plover, Black-necked Grebe, Damara Tern, Caspian Tern
- One migrant: White-chinned Petrel
- One partial migrant: Ludwig's Bustard

As well as the above, many/most other species also show nomadic habits and/or make local movements.

4.2.5 Breeding birds

Within the greater study area, Red Data bird species that have been recorded as breeding within the Walvis Bay wetland complex include Greater Flamingo (breeding attempt in the saltpans in the south of the complex in 2019; C Feris pers. comm. 2019), Caspian Tern (e.g. breeding attempt in the saltpans to the west, R Braby pers. comm. and pers. obs. 2004), Damara Tern (older records from 2007 – 2009 of 8-15 pairs at Donkey Bay, Pelican Point; Braby 2011; breeding at present considered unlikely due to disturbance in the area – P Bridgeford pers. comm. 2019 – but should be verified). The lagoon area is also important as a nursery area, e.g. for African Oystercatcher and Caspian Tern.

Breeding has been also recorded at sites such as the Walvis Bay Sewage Ponds, Bird Island Guano Platforms and Mile 4 Saltworks area for Cape Cormorant, Crowned Cormorant, Maccoa Duck, Lesser Flamingo, Hartlaub's Gull, Great White Pelican and Chestnut-banded Plover; and for Damara Tern in the area proposed for a desalination plant at Mike 4 Saltworks (Scott & Scott 2015).

4.2.6 Feeding and diet

As the brine effluent from the desalination process has the potential to impact on food organisms and the feeding of bird species, the diet of the Red Data species and near-endemic species has been classed according to whether the bird species feed primarily on fish (five species); on a combination of fish and invertebrates (eight species); or primarily on marine invertebrates (nine species) (based on Simmons et al. 2015; Chittenden et al. 2016).

4.2.7 Potential flight paths

Given the high proportion of species showing some form of migratory and/or nomadic behaviour, bird movements up and down the coast, and among the various wetland habitats in the area, are common. Both short term and longer terms movements are possible.

Examples of local movements of two individual Greater Flamingo tracked by means of GPS PTTs on the coast (Scott et al. 2016) are shown below (Figure 20 a and b). These include recorded movements of up to 100 km between Mile 4 Saltworks to Cape Cross, and of 45 km from Mile 4 to Walvis Bay. No major migratory movements inland (for breeding) were recorded due to the dry conditions at the time.

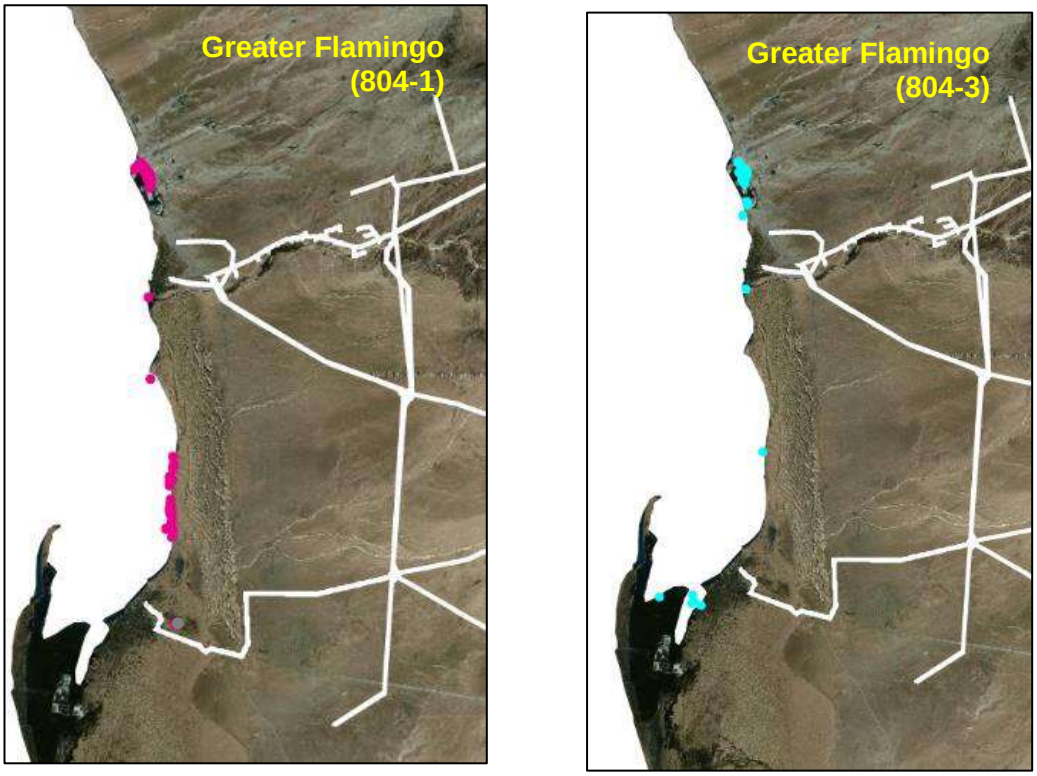


Figure 20 a and b. Examples of local movements of individual Greater Flamingo (pink and blue dots) tracked by means of GPS PTTs on the coast (Scott et al. 2016) (white lines indicate power lines).

4.3 Threats and bird species at risk

4.3.1 Natural and anthropogenic threats to the Walvis Bay wetland habitats and avifauna

Natural and anthropogenic threats to the Walvis Bay wetland complex and its biodiversity, as identified by Wearne and Underhill (2005); Simmons et al. (1998); and Simmons (2017), are outlined below.

The proximity of the wetlands complex to a major port and its associated activities gives rise to a suite of potential threats.

Disturbance is an ongoing, cumulative threat, whether from construction, or from daily operational activities at the port and city including noise, shipping activity, traffic and light aircraft. The resultant pollution from such activities is a further threat. Artificial lighting may impact on night-flying or migrant birds, especially in terms of causing disorientation and/or collisions on structures.

Impacts on natural marine habitats and processes, including pollution in any form, or disturbance of the substrate, may affect the normal functioning of associated organisms, including feeding, movements, and breeding.

In terms of the lagoon system, the transport of wind-driven sand from the Kuiseb Delta into the lagoon and the large silt load present in the ocean in and around the mouth of the lagoon reduce the tidal sweep and may lead to the eventual siltation of part of the system. Of all anthropogenic impacts, the reduction of natural intertidal habitat poses the major ongoing threat to the waterbirds; this has happened in three main ways: by the construction of the saltpans over habitats that were previously intertidal; the construction of roads; and the reclamation of land for the port and suburbs of Walvis Bay. The construction of the saltworks at the southern end of the lagoon is

also considered to play a part in reducing the tidal sweep and possibly add to increased siltation. Avian food sources in the wetland habitat are at risk from impacts such as sedimentation, decreased water flow that results in a reduction of tidal flushing, and any form of pollution.

The cumulative impacts of the threats above are also likely to be influenced by the effects of climate change on the natural coastal systems (e.g. Roux 2003; Simmons et al. 2015).

4.3.2 Bird species at risk

The present scoping and assessment are directed towards priority species (see 4.2 above).

Of the 159 bird species on the checklist (Appendix 1), 24 species have been shortlisted as priority species (Table 8). However, the potential for impacts also extends to any of the other species listed in Appendix 1, in particular to around 60 species with some form of migrant status.

Of these priority species:

- 25 are threatened in Namibia, namely two that are Critically Endangered, four Endangered, six Vulnerable and thirteen Near Threatened (Brown et al. 2017).
- Eighteen of the above species are also Globally Threatened (IUCN 2020).
- Three species are near-endemic to Namibia (Brown et al. 2017).
- Thirteen Red Data species have some form of migrant status (including four Palearctic and seven intra-African migrants) (Chittenden et al. 2016).
- Five species feed primarily on marine fish, eight species feed on a combination of fish and invertebrates and nine species feed primarily on invertebrates (based on Simmons et al. 2015; Chittenden et al. 2016). The dietary items and feeding of these bird species may be impacted by any changes in the marine environment, including increased salinity.

Three species provisionally on the priority checklist are not expected to occur within the study area but rather in more inland, terrestrial habitats (although within the same Quarter Degree Square), and are therefore not discussed further:

- Ludwig's Bustard
- Kori Bustard
- Rüppell's Korhaan

The remaining 24 priority species are considered potentially at risk to any impacts of the proposed development, to varying degrees.

Table 8. Priority bird species identified in the study area for the Walvis Bay desalination and solar plant* (see also Appendix 1)

*This list includes the following priority groups: Red Data species, Namibian endemics, (Red Data) migrant species, and species recorded breeding in the area; see Appendix 1 for scientific names

Key:

Priority status:

- **Group:** W = waterbird; T = terrestrial species; R = raptor
- **RDB status:** Red Data Book/conservation status (Brown *et al*. 2017) - CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened (remaining species LC = Least Concern); G = global status
- **End:** endemism (Brown *et al*. 2017) - NEnd = near-endemic (with ≥90% of population in a country), Nam = Namibia
- **Residency / migrant status** (after Chittenden et al. 2016): Pal mig = Palearctic migrant; Intra-Afr mig = intra-African migrant; Res = resident; Non-br = non-breeding
- **Breeding:** Br = breeding recorded in Walvis Bay wetlands complex and in greater area

Reporting rates

- S1 - SABAP1: species recorded in QDS 2214Dc, 1987-1992. Source: Bird Atlas of Namibia, being a subset of the Southern African Bird Atlas Project (SABAP1) data, that was published as Harrison et al. (1997); accessed at the Namibia Biodiversity Database web site (http://www.biodiversity.org.na)

- SABAP2: all records for pentads 2245_1430, 2250_1430 and 2255_1430 (accessed at http://sabap2.adu.org.za)) (red crosses = reporting rates >60%)

Bird species names are according to the Roberts Bird Guide (Chittenden et al. 2016)

Diet

Diet/feeding according to Simmons et al. (2015); Chittenden et al. (2016); Dietary items: F = fish; I = invertebrates (including bacteria, algae/diatoms); T = terrestrial species

Species name	Group	RDB status/ endemism	Residency / migrant status / nomadism	Br	S1	SABAP2			Diet	Details of diet / feeding methods and habitat, and other sensitivities
						N	C	S		
Bird species with an aquatic diet: primarily fish										
Gannet, Cape	W	CR, G EN			X	X	X	X	F	Feed by means of shallow plunge-diving off the continental shelf up to about 100 km offshore; historically fed predominantly on sardine *Sardinops sagax* before collapse of stocks, now dominated by horse mackerel *Trachurus t. capensis*, saury *Scomberesox saurus* and juvenile snoek *Thyrsites atun*. Sardine and anchovy *Engraulis capensis* taken when available; energy-poor hake *Merluccius* spp. discards scavenged from behind trawlers

Species name	Group	RDB status/ endemism	Residency / migrant status / nomadism	Br	S1	SABAP2			Diet	Details of diet / feeding methods and habitat, and other sensitivities
						N	C	S		
Penguin, African	W	EN, G EN			X				F	Previously fed mainly on sardine *Sardinops sagax*, before the collapse of stocks; now on nutritionally inferior bearded goby *Sufflogobius bibaratus*
Tern, Caspian	W	VU	Res, sed, nom, intra-Afr mig	br	X		X	X	F	Feed almost entirely on fish (usually 10-20 g) in shallow waters, including mullet (*Liza* sp.), kob, riverbream and spotted grunter
Pelican, Great White	W	VU	Intra-Afr mig, sed, nom	br	X	X	X	X	F (I)	Feed mainly on large fish (up to 600 g) by surface swimming, often in groups that funnel the fish until they can be caught by the enclosing circle of pelicans; shrimps; discarded fish parts; cormorant chicks; eggs
Tern, Damara	W	NT, G VU Nam NEnd	Br intra-Afr mig	br	X	X	X	X	F	Forage mainly over shallow water, often in bays, over reefs or in salt works; catch fish by plunge-diving (capture success did not differ between periods of high turbidity [through sediment discharge from diamond mining activities] and periods without discharge); courting birds may catch larger fish; diet in S Namibia (50 identifiable prey items) dominated by Cape silverside (*Atherina breviceps*, 18%), blennies (Blennidae, 14%), southern mullet (*Liza richardsonii*, 13%) and anchovy (*Engraulis encrasicolus*, 11%)
Bird species with an aquatic diet: mixed fish and invertebrates										
Grebe, Great Crested	W	CR	Res, nomad; rare		X				F, I	Small fish, aquatic insects and larvae, crustaceans and molluscs; mainly freshwater habitats, occasionally salt pans
Cormorant, Bank	W	EN, G EN			X				F (I)	Feed inshore, often among kelp beds; feed demersally (underwater) by diving; bearded goby *Sufflogobius bibarbatus* dominates the diet in Namibia, but Cape rock lobster (*Jasus lalandii*), sole and klipvis are also taken
Cormorant, Cape	W	EN, G EN		br	X	X	X	X	F (I)	Forage by pursuit-diving within 60 km of the coast, but also offshore; dive benthically or in the water column; sardine *Sardinops sagax* was the preferred food item in Namibia, before the collapse of the stocks; in S Namibia feed mainly on bearded goby *Sufflogobius bibaratus*, but can feed on a variety of mostly pelagic fish species, including sardine *Sardinops sagax* and anchovy *Engraulis encrasicolus* if available, as well as on squid and crustaceans

Species name	Group	RDB status/ endemism	Residency / migrant status / nomadism	Br	S1	SABAP2			Diet	Details of diet / feeding methods and habitat, and other sensitivities
						N	C	S		
Petrel, White-chinned	W	VU, G VU	Mig visitor		X	X			I, F	Crustaceans, cephalopods and fish, often in association with cetaceans; feed by diving and by floating on the surface and dipping head into the water; feed behind longline trawlers that discard offal
Gull, Hartlaub's	W	VU	Sed, local movements	br	X	X	X	X	I, F	Feed generally in kelp habitats, on the abundant invertebrates; also feed on a range of invertebrates and small fish in the intertidal zone and in protected bays, and scavenge fish scraps
Cormorant, Crowned	W	NT, G NT		br	X	X	X		F, I	Forage in shallow water, close to rocky shores, in tidal pools, in protected bays and among kelp beds; feed on benthic fish, as well as crustaceans, molluscs and polychaete worms
Shearwater, Sooty	W	NT, G NT			X				F, I	Feed mostly by surface-seizing and shallow-diving, but also actively pursue prey; diet includes small fish, squids, euphausiids, mantis shrimps and other crustaceans; fishery discards; may feed in flocks on schooling fish
Grebe, Black-necked	W	NT	Res, nomadic (intra-Afr mig)		X		X	X	F, I	Feed almost entirely on small fish, but also on water insects, crustaceans and tadpoles
Bird species with an aquatic diet: primarily invertebrates										
Flamingo, Lesser	W	VU, G NT	Intra-Afr mig, nomadic	br	X	X	X	X	I	Feed by wading in shallow water; filter cyanobacteria from the water surface, and small diatoms (unicellular algae) from the bottom layer
Flamingo, Greater	W	VU	Intra-Afr mig, nomadic	br	X	X	X	X	I	Feed by wading in shallow water; feed on aquatic invertebrates: saline lake crustaceans such as fairy shrimps, e.g. *Artemia* spp. and *Branchinella* spp., brine flies *Ephydra* spp. and marine benthic organisms such as molluscs and diatoms
Duck, Maccoa	W	NT, G VU	Res, nomadic	br	X			X	I	Feed mainly on benthic invertebrates, including chironomid fly larvae and pupae, crustaceans and molluscs, as well as on seeds and roots of water plants and on algae
Curlew, Eurasian	W	NT, G NT	Non-br Pal mig		X	X		X	I	Forage mainly on worms, crabs, molluscs and larval insects, and occasionally on vegetable matter, small vertebrates and eggs
Godwit, Bar-tailed	W	NT, G NT	Non-br Pal mig		X				I	Polychaete worms, molluscs, crustaceans, fish fry
Knot, Red	W	NT, G NT	Non-br Arctic mig		X		X		I	Molluscs (especially bivalves), crustaceans and other intertidal invertebrates

Species name	Group	RDB status/ endemism	Residency / migrant status / nomadism	Br	S1	SABAP2			Diet	Details of diet / feeding methods and habitat, and other sensitivities
						N	C	S		
Oystercatcher, African (Black)	W	NT, G NT	Res (nursery area: juvs disperse)		X	X	X		I	Molluscs (mussels, limpets, whelks) and bivalves *Donax* spp.; invasive Mediterranean mussel *Mytilus galloprovincialis*, which is also part of diet of sub-adult birds at Walvis Bay lagoon
Plover, Chestnut-banded	W	NT, G NT	Intra-Afr mig, res, nom	br ?	X			X	I	Highly specialised and adapted to highly saline habitat (pans, coastal flats); insects and crustaceans; diet and feeding ecology poorly known
Sandpiper, Curlew	W	NT, G NT	Non-br Pal mig		X		X	X	I	Polychaete worms, molluscs, crustaceans, fly larvae and *Salicornia* seeds
Bird species with a terrestrial diet										
Bustard, Ludwig's	T	EN, G EN	Partial mig		X				T	Not likely to occur on coast
Bustard, Kori	T	NT, G NT	Local movements		X				T	Not likely to occur on coast
Falcon, Peregrine	T, R	NT	Res (+ Pal mig)			X		X	T	May occur on coast; terrestrial predator, feeds exclusively on birds (medium-sized, such as pigeons and doves, and smaller species)
Korhaan, Rüppell's	T	Nam NEnd	Sed		X				T	Not likely to occur on coast
Lark, Gray's	T	Nam NEnd	Nomadic			X	X		T	Not likely to occur on coast, but occurrence needs to be verified

5 Impact assessment

5.1 Description of potential impacts

Potential impacts that could result from the proposed development are described below.

5.1.1 Disturbance of birds due to noise, traffic and other forms of disturbance during construction or operation

During the construction of the desalination plant and solar PV installation, increased noise, traffic, human presence and other forms of disturbance including heavy machinery are unavoidable.

These forms of disturbance have a direct impact, and could cause birds to move from areas of choice to less disturbed but less productive areas, or even to withdraw from the area (i.e. resulting in displacement); road mortalities (and poaching) could also occur. However, these impacts are likely to be temporary in nature. The development area also lies in a semi-industrial location and is already disturbed to some extent.

During the operational phase disturbance is also likely, but expected to be at a lower level.

The construction of new structures could impact on avifauna movement corridors and patterns, including at night, also resulting in displacement (also see Impact No. 2 below).

The potential impact of disturbance is regarded as low, but mitigation of these impacts is fairly unlikely.

Significance of impact: pre-mitigation – low (2); post-mitigation: low (2)

5.1.2 Collisions of birds on solar PV and associated structures

A collision occurs when a bird in mid-flight does not see an overhead structure until it is too late to take evasive action. In the present development, bird collisions are possible on solar PV panels and associated structures such as fencing, as well as on other power supply structures.

Birds may be injured or killed by collisions, which is thus a direct and permanent impact.

Collisions on solar PV panels and associated structures

It is thought that collision trauma with solar PV panels may be associated with polarised light pollution and/or with waterbirds mistaking large arrays of PV panels as wetlands – the so-called "lake effect" (Horvath et al. 2009; Lovich and Ennen 2011; H.T. Harvey and Associates 2014; Kagan et al. 2014; Walston et al. 2016; in Jenkins et al. 2017). This impact may possibly be likely to take place at night, and would be exacerbated by the presence of numerous aquatic habitats in the greater area (to which the birds are already habituated), and the large numbers of birds, including migrant species, many of which fly at night. Reflections of moonlight, fog and the cumulative impacts of other sources of light (see below) may also play a role. Indirect impacts resulting from such collisions, and/or entrapment in surrounding fences, could include predation if the bird is unable to fly or take off. However, the likelihood and nature of the above lake effect as an impact is still unproven (S Ralston-Paton pers. comm. 2020); the precautionary principle should thus apply, and post-construction monitoring would therefore be essential (see below). Should collisions on solar PV panels take place on a regular basis, the impacts would be permanent and would need to be mitigated.

Collisions on other power supply structures
The risk of collisions on other power supply structures has been obviated by the proposed use of underground supply cables to connect the development to the grid. Step-down structures/ transformers will also be enclosed.

Effects of artificial lighting on collisions

Artificial lighting may impact on night-flying birds, including many migrant species in the area, and cause disorientation and/or collisions on structures (also see above). Flamingos usually fly at night, and fall into this group. New forms of lighting in areas that were previously unlit (e.g. in the project area) may exacerbate the problem of collisions, and also change movement patterns and corridors (see above). The lighting of the desalination plant itself would however be within the building structures.

The cumulative impacts of other sources of light in the city and port, including the Pelican Point Lighthouse and the oil and gas pipeline jetty, as well as any existing unshielded lighting in the area, would contribute to this impact. The occurrence of fog may also contribute to disorientation.

At this stage the potential impact of bird collisions is regarded as low, and could be mitigated to some extent; however, monitoring is essential.

Significance of impact: pre-mitigation – low (2); post-mitigation: low (1)

5.1.3 Impacts on bird habitat, including increased salinity from brine discharge, and pollution caused by spillages

Brine effluents

Effluents resulting from the desalination process, including brine, have the potential to impact on bird habitat, especially on feeding habitats within the ocean and possibly in the intertidal zone.

Brine salinity will range from 51.9 – 58.6 ppt (parts per thousand), compared to that of sea water (for which 34.5 ppt is considered representative). At this stage, salinity is the only constituent in the brine effluent that is considered as critical. The potential impact of the brine effluent temperature (12 - 21°C) and the effluent TSS (total suspended solids) are assumed negligible.

The area in the ocean that will be potentially impacted by the effluents is estimated to be within 20 m of the diffuser.

The salinity of the brine effluent has the potential to impact on the diet and feeding habitat of at least 22 priority bird species identified in the present study. These include five species that feed primarily on marine fish; eight species that feed on mixed fish and invertebrates; and nine species that feed primarily on marine invertebrates. However, it is beyond the scope of the present study to determine the detailed impacts of the increased salinity on the above dietary organisms. A precautionary approach is therefore indicated.

Other pollutants, e.g. from spillages

Pollution of any form during construction and operational activities, e.g. spillage of oil, cement or other building materials or chemical products, could potentially impact on bird habitats and health.

Any disturbance of the substrate (e.g. trenching for marine pipeline diffuser option) could also impact on the organisms that form the food for birds.

The cleaning of the solar PV panels will use minimal water, and take place over several days, nullifying the risk of the volume of water accumulating and becoming a pond.

Breeding habitat

The terrestrial coastal habitats in the greater project area may be used for breeding by species such as Damara Tern and White-fronted Plover. As far as could be ascertained, no recent records of the breeding of any priority species have been found for the local project area and this is considered unlikely, given the degree of existing disturbance in the area. The breeding activity on Bird Island is regarded as being far enough away to be impacted by the present development.

The above impacts have the potential to cause the loss or destruction of bird habitats, and are likely to be cumulative.

The impact on bird habitat are regarded as moderate, and could be mitigated to some extent.

Significance of impact: pre-mitigation – moderate (6); post-mitigation: minor (4)

5.1.4 Attraction of birds to new, artificial habitats, including infrastructure, for perching/ roosting/nesting

Birds may be attracted to new, artificially created habitats for perching, roosting and/or nesting. Their guano could result in pollution of the roosting surfaces. Habitats that would potentially be favourable for such purposes include solar PV panel arrays, roofing and fencing.

Larger species such as Great White Pelican and cormorants, as well as Kelp Gull and Hartlaub's Gull, have been observed using roofing for perching and roosting in the greater area, including on sheds at fish production facilities in the urban area.

Species that do not normally occur in an area may be attracted by the artificial provision of large areas of shade beneath the solar panels, or opportunities to perch on the solar panels or other structures.

Scavengers such as gulls and crows may be attracted to food waste that is not disposed of effectively.

This impact is regarded as low.

Although no mitigation is proposed at this point, some form of mitigation is possible should monitoring indicate that this activity is becoming a problem.

Significance of impact: pre-mitigation – low (1)

5.1.5 Electrocution of birds on power supply structures

An electrocution occurs when a bird is perched or attempts to perch on an electrical structure (e.g. pole, transformer) and causes an electrical short circuit by physically bridging the air gap between live components and/or between live and earthed components. Bird nesting activity on low voltage power line structures also has the potential to cause flash-overs between live components.

The risk of electrocutions on power supply structures has been obviated by the proposed use of underground supply cables to connect the development to the grid. Step-down structures/ transformers will also be enclosed.

The impact of electrocution are therefore not discussed further, unless a need is indicated by results of monitoring.

5.1.6 Cumulative impacts

Together with existing threats both in the area and at other migrant bird destinations, including the growing threats of climate change on bird habitats and food (Roux 2003; Simmons et al. 2015), the above impacts have the potential to act cumulatively, e.g. on avian food sources, feeding and roosting, and survival. Sensitive species that are already under threat, including Red Data and endemic species, as well as migrants/nomadic species are at particular risk to such cumulative effects.

5.2 Impact assessment

Four main potential impacts have been identified for the project. These impacts are outlined above (Section 5.1) and assessed in Table 9, according to the methodology described in Section 2.2 above.

Table 9. Assessment of impacts on avifauna of the proposed desalination solar plant development at Walvis Bay.

Impact	Sensitivity & value	Nature of impact	Magnitude of change	Level of certainty	Significance rating	
					Pre-mitigation	Post-mitigation
A. Impacts on biodiversity						
1. Disturbance of birds due to noise, traffic and other forms of disturbance during construction or operation	Low	Negative Direct Local Short-term Temporary/ Reversible Certain	Minor	Medium	**Low 2**	**Low 2**
2. Collisions of birds on solar PV and associated structures	Low	Negative Direct Onsite/local Short-term Permanent/ Irreversible (if bird dies) Likely	Minor	Medium	**Low 2**	**Low 1**
3. Impacts on bird habitat, including increased salinity from brine discharge, and pollution caused by spillages	Medium	Negative Indirect/direct Local Medium/long-term Temporary/ Reversible Likely	Moderate	Low - Medium	**Moderate 6**	**Minor 4**
TOTAL					**10**	**7**
B. Impacts on the development						
4. Attraction of birds to new, artificial habitats, including infrastructure, for perching/roosting	Low	Negative Indirect/(direct) On-site Short-term Temporary/ Reversible Likely	Negligible	Low	**Low 1**	-
TOTAL					**1**	**-**

Summary of main impacts and impact assessment

1. Disturbance of birds due to noise, traffic and other forms of disturbance during construction or operation

Significance of impact: pre-mitigation – low (2); post-mitigation: low (2)

2. Collisions of birds on solar PV and associated structures

Significance of impact: pre-mitigation – low (2); post-mitigation: low (1)

3. Impacts on bird habitat, including increased salinity from brine discharge, and pollution caused by spillages

Significance of impact: pre-mitigation – moderate (6); post-mitigation: minor (4)

4. Attraction of birds to new, artificial habitats, including infrastructure, for perching/roosting

Significance of impact: pre-mitigation – low (1)

6 Recommendations for mitigation and monitoring

6.1 Mitigation

Mitigation measures are aimed at avoiding, minimising or rehabilitating negative impacts, or enhancing potential benefits. The significance of potential impacts without and with mitigation is provided above (see Table 9).

Recommended mitigation/management options are provided below.

6.1.1 Disturbance of birds due to noise, traffic and other forms of disturbance during construction or operation

- Before construction starts, the proposed site should be inspected for any signs of bird nesting activity. Disturbance of nesting birds or sites should be avoided (also see 6.1.3 below).
- Where possible, the unnecessary destruction of habitat or degradation of the environment, including any breeding habitats, should be avoided.
- Ongoing awareness should be promoted about the value of biodiversity and the negative impacts of disturbance, especially to breeding birds, and of road mortalities and poaching.
- The need for reporting any injury or mortality incidents should be stressed, and reporting procedures clarified.

6.1.2 Collisions of birds on solar PV and associated structures

- All lighting should be shielded downwards, and should avoid direct illumination on the panels and in the surrounding areas.
- Should bird collisions on the solar panels become a problem, the overall surface area could be subdivided by marking the panels with a white grid pattern, to avoid the creation of a large, continuous reflective surface. This would help reduce the chances of the panel array being perceived as a waterbody or one continuous mass.
- If monitoring shows repeat collisions of nocturnal fliers, e.g. flamingos, some form of nocturnally visible marking can be investigated. The possibility of using a design that enables the tilting of the panels when not in use at night could also be investigated.

6.1.3 Impacts on bird habitat, including increased salinity from brine discharge, and pollution caused by spillages

- Broadly speaking, any potential effects that the brine discharge could have on food sources for birds, including marine invertebrates and fish of all sizes, in the area would appear to be being addressed by the fact that the impacted area is expected to be within 20 m of the diffusers (i.e. a relatively small area) and, provided that the expected dilution is achieved, the final salinity of the effluent should lie within the range of 32 - 36 ppt, which would be in line with the water quality guidelines mentioned in the dispersion modelling report (Anon. 2020b). This mitigation is therefore of critical importance. However, the input of a marine ecology specialist would be invaluable in this respect.
- Pollution and spillages of any form should be avoided during construction and operational activities, and dealt with according to standard procedures. Diffuser options that avoid trenching would be preferable.
- Disturbance of nesting birds or sites, in particular Damara Tern (during the summer months), should be avoided.

6.1.4 Attraction of birds to new, artificial habitats, including infrastructure, for perching/ roosting

- Food wastes should be disposed of effectively, to avoid attracting scavengers such as gulls and crows.
- No mitigation is recommended at this stage. However, should the results of monitoring indicate a need, mitigation measures should be applied subsequently.

6.2 Monitoring

The impacts of solar PV developments and of desalination plants are little known. Ongoing monitoring can provide valuable insights into the future prediction and management of impacts. Pre- and post-construction monitoring is essential, for at least the solar PV aspects.

The following monitoring initiatives should be initiated by the proponent.

- As the size of the solar PV development is small, but the avifaunal sensitivity of the greater study area is considered high, a Regime 2 approach to this aspect of the assessment (Jenkins et al. 2017) is indicated. These requirements for any further baseline data collection take into account the comprehensive long term bird count data already available for the greater Walvis Bay wetlands complex. It is therefore recommended that a minimum of two one-day detailed monitoring periods are carried out over six months pre-construction, followed by a similar post-construction monitoring programme (or as indicated by the pre-construction monitoring).
- After construction, monitor the entire site in an acceptable way for any signs of bird mortalities or injuries resulting from the construction and operation of the facility, including the solar panels and fencing; ideally, regular dedicated monitoring patrols should be carried out once a week or more frequently for at least the first year after construction, and thereafter at least once per month.
- Monitor bird nesting and perching activities on structures and, should this become a problem, investigate appropriate mitigation measures.
- Set up a reporting channel, and clarify monitoring and reporting procedures to all staff. Record all bird mortalities on a standardised form, with details of the structure and bird species concerned, and photographs of the carcass (especially the head of the bird, for identification).
- Monitor the effectiveness of mitigation measures; should repeat incidents, including collisions, occur, consider the retro-fitting of further mitigation; reassess and replace mitigation devices as and when necessary.

7 Conclusion

The study area falls within the Namib Desert biome, with a hyper arid desert environment. The major avifauna habitat component is a group of aquatic habitats that comprise the Walvis Bay Important Bird Area, including the Walvis Bay Lagoon and wetland complex, the municipal sewage ponds, Bird Rock (an artificial guano platform) and the coast. The avifauna habitats in the greater study area may be considered as being of high sensitivity in terms of the high conservation status of two officially Protected Areas, two Ramsar sites, and five Important Bird Areas. This sensitivity is due largely to the varied, extensive and favourable aquatic habitats in the arid coastal desert environment. In view of the above criteria, the greater area would also qualify as a site of high sensitivity as a solar PV development site. Within the local study site, three main marine habitat types are represented, namely sandy intertidal habitats, rocky intertidal habitats and the Atlantic Ocean itself. An extensive dune system and gravel plain habitats lie on the coast and east of the site. Although the local area of the study site itself is likely to be of relatively lower sensitivity, its proximity to the above sensitive habitats in the greater area and the mobility of the bird species are an important consideration, and a precautionary approach is therefore indicated.

The bird checklist for the relevant quarter degree square and three pentads (SABAP1 and SABAP2 data) comprises 159 species, or 24% of the 676 species currently recorded in Namibia; this diversity is regarded as relatively high for the desert environment.

The present scoping and assessment are directed towards 24 shortlisted priority species, namely those that have a high biological significance, i.e. primarily Red Data species and/or species endemic or near-endemic to Namibia, as well as species with migrant status. Further factors taken into consideration include recorded breeding activity in the area, feeding and diet, and general and local abundance as represented by available atlassing data.

Of these priority species:

- 23 are threatened in Namibia, namely
  - two that are Critically Endangered (Cape Gannet, Great Crested Grebe)
  - three are Endangered (African Penguin, Cape Cormorant, Bank Cormorant)
  - six are Vulnerable (White-chinned Petrel, Lesser Flamingo, Greater Flamingo, Great White Pelican, Caspian Tern, Hartlaub's Gull)
  - thirteen are Near Threatened (Damara Tern, Maccoa Duck, Crowned Cormorant, Sooty Shearwater, Eurasian Curlew, Red Knot, Chestnut-banded Plover, Curlew Sandpiper, Bar-tailed Godwit, African Oystercatcher, Black-necked Grebe, Peregrine Falcon)
- Sixteen of the above species are also Globally Threatened.
- Two species are near-endemic to Namibia (Damara Tern [Near Threatened, see above], Gray's Lark).
- Twelve Red Data species have some form of migrant status (including four Palearctic and seven intra-African migrants). At least 57 species (36%) of the total of 159 species have some form of migrant status.
- Five of the priority species feed primarily on marine fish, eight species feed on a combination of fish and invertebrates and nine species feed primarily on invertebrates. The dietary items and feeding of these bird species may potentially be impacted by any changes in the marine environment, including increased salinity.

Within the greater study area, Red Data bird species that have been recorded as breeding within the Walvis Bay wetland complex include Greater Flamingo, Caspian Tern and Damara Tern. The lagoon area is also important as a nursery area, e.g. for African Oystercatcher and Caspian Tern. Breeding

has been also recorded at sites such as the Walvis Bay Sewage Ponds, Bird Island Guano Platforms and Mile 4 Saltworks area for Cape Cormorant, Crowned Cormorant, Maccoa Duck, Lesser Flamingo, Hartlaub's Gull, Great White Pelican, Chestnut-banded Plover and Damara Tern.

The proximity of the wetlands complex to a major port and its associated activities gives rise to a suite of potential threats, chiefly in the form of increasing disturbance (including noise and light) from human activities, particularly the port; and of habitat alteration. The cumulative impacts of the above threats are also likely to be influenced by the effects of climate change on these coastal systems.

Four main potential impacts have been identified for the proposed project. These are:

- Disturbance of birds due to noise, traffic and other forms of disturbance during construction or operation (significance of impact: pre-mitigation – low [2]; post-mitigation: low [2]);
- Collisions of birds on solar PV panels and associated infrastructure (significance of impact: pre-mitigation – low [2]; post-mitigation: low [1]);
- Impacts on bird habitat, including increased salinity from brine discharge, and pollution caused by spillages (significance of impact: pre-mitigation – moderate [6]; post-mitigation: minor [4]); and
- Attraction of birds to new, artificial habitats, including infrastructure, for perching/roosting (significance of impact: pre-mitigation – low [1]).

Recommendations are provided for the mitigation and management of potential impacts. Apart from the standard requirements, the effective management of the brine discharge is considered to be of critical importance.

Ongoing monitoring for any impacts on avifauna is also considered essential. This includes pre- and post-construction monitoring for the solar PV facility.

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APPENDIX 1

Checklist of bird species in the Walvis Bay desalination plant project area, Erongo Region

Total: 159 species

Key:

Group: W = waterbird; T = terrestrial species; R = raptor

Priority status:

- **Group:** W = waterbird; T = terrestrial species; R = raptor
- **RDB status:** Red Data Book/conservation status (Brown *et al*. 2017) - CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened (remaining species LC = Least Concern); G = global status
- **End:** endemism (Brown *et al*. 2017) - NEnd = near-endemic (with ≥90% of population in a country), Nam = Namibia
- **Residency / migrant status** (after Chittenden et al. 2016): Pal mig = Palearctic migrant; Intra-Afr mig = intra-African migrant; Res = resident; Non-br = non-breeding
- **Breeding:** Br = breeding recorded in Walvis Bay wetlands complex and in greater area

Reporting rates

- S1 - SABAP1: species recorded in QDS 2214Dc, 1987-1992. Source: Bird Atlas of Namibia, being a subset of the Southern African Bird Atlas Project (SABAP1) data, that was published as Harrison et al. (1997); accessed at the Namibia Biodiversity Database web site (http://www.biodiversity.org.na)

- SABAP2: all records for pentads 2245_1430 (N), 2250_1430 (M) and 2255_1430 (S) (accessed at http://sabap2.adu.org.za) (red crosses = reporting rates >60%)

Bird species names are according to the Roberts Bird Guide (Chittenden et al. 2016)

Species name	Scientific names	Group	RDB status/ endemism	Residency / migrant status / nomadism	br	S1	SABAP2		
							N	M	S
Avocet, Pied	*Recurvirostra avosetta*	W		Intra-Afr mig		X			X
Bishop, Southern Red	*Euplectes orix*	T / W		Res		X			X
Bulbul, African Red-eyed	*Pycnonotus nigricans*	T		Res, local movements		X	X	X	X
Bunting, Lark-like	*Emberiza impetuani*	T		Highly nomadic			X		
Bustard, Ludwig's	*Neotis ludwigii*	T	EN, G EN	Partial mig		X			
Bustard, Kori	*Ardeotis kori*	T	NT, G NT	Local movements		X			
Buttonquail, Common (Kurrichane)	*Turnix sylvaticus*	T		Nomadic		X			
Canary, White-throated	*Crithagra albogularis*	T		Nomadic non-br			X		
Chat, Familiar	*Emarginata familiaris*	T		Resident		X			X
Chat, Tractrac	*Emarginata tractrac*	T		Resident		X			X
Cisticola, Zitting	*Cisticola juncidis*	T		Resident					X
Coot, Red-knobbed	*Fulica cristata*	W		Sed, nomadic		X			X
Cormorant, Bank	*Phalacrocorax neglectus*	W	EN, G EN			X			
Cormorant, Cape	*Phalacrocorax capensis*	W	EN, G EN		br	X	X	X	X
Cormorant, Crowned	*Microcarbo coronatus*	W	NT, G NT		br?	X	X	X	
Cormorant, Reed	*Microcarbo africanus*	W		Res, nom/partial mig		X			X

Species name	Scientific names	Group	RDB status/ endemism	Residency / migrant status / nomadism	br	S1	SABAP2		
							N	M	S
Cormorant, White-breasted	*Phalacrocorax lucidus*	W		Sed, nomadic			X	X	X
Crake, Black	*Amaurornis flavirostra*	W		Br intra-Afr mig		X			
Crow, Cape	*Corvus capensis*	T		Res		X			
Crow, House	*Corvus splendens*	T	(Alien)	Res					X
Crow, Pied	*Corvus albus*	T		Res, local movements		X			X
Curlew, Eurasian	*Numenius arquata*	W	NT, G NT	Non-br Pal mig		X	X		X
Dove, Laughing	*Spilopelia senegalensis*	T		Res		X	X	X	X
Dove, Namaqua	*Oena capensis*	T		Res, nomad		X			
Dove (Turtle-dove), Ring-necked (Cape)	*Streptopelia capicola*	T		Res, nom		X	X		
Dove, Rock (Pigeon, Feral)	*Columba livia*	T	(Alien)	Res		X	X	X	X
Drongo, Fork-tailed	*Dicrurus adsimilis*	T		Sed				X	
Duck, Maccoa	*Oxyura maccoa*	W	NT, G VU	Res, nomadic	br	X			X
Duck, Yellow-billed	*Anas undulata*	W		Res, nomadic		X			
Eagle-Owl, Spotted	*Bubo africanus*	R		Res		X			
Egret, Little	*Egretta garzetta*	W		Res, nomadic		X	X	X	X
Egret, Western Cattle	*Bubulcus ibis*	W / T		Res, nomadic		X			X
Egret, Yellow-billed (Intermediate)	*Egretta intermedia*	W		Res, nomadic		X			X
Falcon, Peregrine	*Falco peregrinus*	R, T	NT	Res (+ Pal mig)			X		X
Fiscal, Southern (Common)	*Lanius collaris*	T		Res, sed		X	X		
Flamingo, Greater	*Phoenicopterus roseus*	W	VU	Intra-Afr mig, nomadic	br	X	X	X	X
Flamingo, Lesser	*Phoeniconaias minor*	W	VU, G NT	Intra-Afr mig, nomadic	br	X	X	X	X
Gannet, Cape	*Morus capensis*	W	CE, G EN			X	X	X	X
Go-away-bird, Grey	*Corythaixoides concolor*	T		Res, local nomad		X			
Godwit, Bar-tailed	*Limosa lapponica*	W	NT, G NT	Non-br Pal mig		X			
Godwit, Black-tailed	*Limosa limosa*	W		Rare non-br Pal mig		X			
Goose, Egyptian	*Alopochen aegyptiaca*	W		Res		X			X
Goshawk, Southern Pale Chanting	*Melierax canorus*	R, T		Sed, local movements		X			X
Grebe, Black-necked	*Podiceps nigricollis*	W	NT	Res, nomadic (intra-Afr mig)		X		X	X
Grebe, Great Crested	*Podiceps cristatus*	W	CR	Res, nomad		X			
Grebe, Little (Dabchick)	*Tachybaptus ruficollis*	W		Res, local movements		X			X
Greenshank, Common	*Tringa nebularia*	W		Non-br Pal mig		X	X	X	X
Guineafowl, Helmeted	*Numida meleagris*	T		Res			X		

Species name	Scientific names	Group	RDB status/ endemism	Residency / migrant status / nomadism	br	S1	SABAP2		
							N	M	S
Gull, Black-headed	*Chroicocephaus ridibundus*	W		Pal vagrant		X			
Gull, Grey-headed	*Chroicocephalus cirrocephalus*	W		Res, partial mig		X		X	X
Gull, Hartlaub's	*Chroicocephalus hartlaubii*	W	VU	Sed, local movements	br	X	X	X	X
Gull, Kelp	*Larus dominicanus*	W		Res, dispersing widely	br	X	X	X	X
Hamerkop	*Scopus umbretta*	W		Res, sed		X			
Heron, Black	*Egretta ardesiaca*	W		Res, nomadic					X
Heron, Black-headed	*Ardea melanocephala*	W / T		Res		X	X		X
Heron, Grey	*Ardea cinerea*	W		Res		X	X	X	X
Heron, Purple	*Ardea purpurea*	W		Res, nomad		X			
Heron, Squacco	*Ardeola ralloides*	W		Res, sed		X			
Hornbill, African Grey	*Lophoceros nasutus*	T		Res, locally mig			X		X
Ibis, Glossy	*Plegadis falcinellus*	W		Sed, nomadic					X
Jacana, African	*Actophilornis africanus*	W		Res, nomadic		X			
Jaeger, Long-tailed	*Stercorarius longicaudus*	W		Mig visitor		X			
Jaeger, Parasitic	*Stercorarius parasiticus*	W		Mig visitor		X			
Kestrel, Greater	*Falco rupicoloides*	R, T		Sed, local movements		X			X
Kestrel, Rock	*Falco ruppicolis*	R, T		Res			X	X	X
Kite, Black-winged	*Elanus caeruleus*	R, T		Nomadic		X			
Knot, Red	*Calidris canutus*	W	NT, G NT	Non-br Pal mig		X		X	
Korhaan, Rüppell's	*Eupodotis rueppellii*	T	Nam NEnd	Sed		X			
Lapwing, Blacksmith	*Vanellus armatus*	W		Res, sed, nomadic		X			X
Lark, Gray's	*Ammomanopsis grayi*	T	Nam NEnd	Nomadic			X	X	
Lark, Red-capped	*Calandrella cinerea*	T		Res, sed, nom, partial migrant			X	X	X
Lovebird, Rosy-Faced	*Agapornis roseicollis*	T		Nomadic		X			
Martin, Banded	*Riparia cincta*	W / T		Br intra-Afr mig		X			
Martin, Brown-throated	*Riparia paludicola*	W		Res, (mig)		X			
Martin, Common House	*Delichon urbicum*	T		Non-br Pal mig					X
Martin, Rock	*Ptyonoprogne fuligula*	T		Res (some movements)		X	X		X
Martin, Sand	*Riparia riparia*	W / T		Non-br Pal mig		X			
Moorhen, Common	*Gallinula chloropus*	W		Sed, local movements		X			X
Mousebird, Red-faced	*Urocolius indicus*	T		Res, nomadic		X			X
Mousebird, White-backed	*Colius colius*	T		Sed		X			
Ostrich, Common	*Struthio camelus*	T		Nomadic		X			
Owl, (Western) Barn	*Tyto alba*	R		Res		X			

Species name	Scientific names	Group	RDB status/ endemism	Residency / migrant status / nomadism	br	S1	SABAP2		
							N	M	S
Oystercatcher, African (Black)	*Haematopus moquini*	W	NT, G NT	Res (nursery area: juvs disperse)		X	X	X	
Pelican, Great White	*Pelecanus onocrotalus*	W	VU	Intra-Afr mig, sed, nom	br	X	X	X	X
Pelican, Pink-backed	*Pelecanus rufescens*	W		Sed, nom		X			
Penguin, African	*Spheniscus demersus*	W	EN, G EN			X			
Petrel, White-chinned	*Procellaria aequinoctialis*	W	VU, G VU	Mig visitor		X	X		
Phalarope, Red-necked	*Phalaropus lobatus*	W		Mig		X			
Pigeon, Speckled (Rock)	*Columba guinea*	T		Res		X	X	X	X
Plover, Caspian	*Charadrius asiaticus*	W		Pal mig		X			
Plover, Chestnut-banded	*Charadrius pallidus*	W	NT, G NT	Intra-Afr mig, res, nom	br?	X			X
Plover, Common Ringed	*Charadrius hiaticula*	W		Pal mig		X		X	
Plover, Grey	*Pluvialis squatarola*	W		Non-br Pal mig		X	X	X	X
Plover, Kittlitz's	*Charadrius pecuarius*	W / T		Res, nom, mig		X			X
Plover, Three-banded	*Charadrius tricollaris*	W		Res, nomadic		X			X
Plover, White-fronted	*Charadrius marginatus*	W		Res		X	X	X	X
Pochard, Southern	*Netta erythrophthalma*	W		Res, nomad		X			X
Prinia, Black-chested	*Prinia flavicans*	T				X			X
Quelea, Red-billed	*Quelea quelea*	T		Nom		X			
Ruff	*Philomachus pugnax*	W		Non-br Pal mig		X			X
Sanderling	*Calidris alba*	W		Non-br Pal mig		X	X	X	X
Sandpiper, Common	*Actitis hypoleucos*	W		Non-br Pal mig		X	X		X
Sandpiper, Curlew	*Calidris ferruginea*	W	NT, G NT	Non-br Pal mig		X		X	X
Sandpiper, Marsh	*Tringa stagnatilis*	W		Non-br Pal mig		X			X
Sandpiper, Terek	*Xenus cinereus*	W		Non-br Pal mig		X			
Sandpiper, Wood	*Tringa glareola*	W		Non-br Pal mig		X			X
Shearwater, Sooty	*Ardenna griseus*	W	NT, G NT			X			
Shelduck, South African	*Tadorna cana*	W		Widespread movements		X			X
Shoveler, Cape	*Anas smithii*	W				X			X
Shrike, Lesser Grey	*Lanius minor*	T		Non-br Pal mig		X			
Skua, Pomarine	*Stercorarius pomarinus*	W		Summer visitor		X			
Skua, Subantarctic (Brown)	*Stercorarius antarcticus*	W		Winter visitor		X	X		
Sparrow, Cape	*Passer melanurus*	T		Sed		X	X	X	X
Sparrow, Great	*Passer motitensis*	T		Sed, nom		X			
Sparrow, House	*Passer domesticus*	T	(Alien)	Res, sed		X	X	X	X
Sparrow-Lark, Grey-backed	*Eremopterix verticalis*	T		Nom, partial mig		X			
Sparrow-weaver, White-browed	*Plocepasser mahali*	T		Res		X			

Species name	Scientific names	Group	RDB status/ endemism	Residency / migrant status / nomadism	br	S1	SABAP2		
							N	M	S
Spoonbill, African	*Platalea alba*	W		Res, nom		X			
Starling, Cape (Glossy)	*Lamprotornis nitens*	T		Res		X			
Starling, Pale-winged	*Onychognathus nabouroup*	T		Res, local movements		X			
Starling, Wattled	*Creatophora cinerea*	T		Nom		X			
Stilt, Black-winged	*Himantopus himantopus*	W		Res, nom, partial intra-Afr mig		X		X	X
Stint, Little	*Calidris minuta*	W		Non-br Pal mig		X		X	X
Stork, White	*Ciconia ciconia*	T (W)		Non-br Pal mig		X			
Sunbird, Dusky	*Cinnyris fuscus*	T		Nomadic			X	X	X
Swallow, Barn	*Hirundo rustica*	T		Non-br Pal mig		X	X	X	X
Swallow, Greater Striped	*Cecropis cucullata*	T		Br intra-Afr mig			X		
Swallow, Pearl-breasted	*Hirundo dimidiata*	T		Br mig		X			
Swallow, White-throated	*Hirundo albigularis*	T		Br intra-Afr mig		X			
Swamphen, African (Purple)	*Porphyrio madagascariensis*	W		Res, nomad					X
Swift, African Palm	*Cypsiurus parvus*	T		Res			X		X
Swift, Bradfield's	*Apus bradfieldi*	T		Sed, wide-ranging			X		
Swift, Little	*Apus affinis*	T		Res (partial mig)		X	X		X
Swift, White-rumped	*Apus caffer*	T		Br intra-Afr mig		X			X
Teal, Cape	*Anas capensis*	W		Nom, partial mig		X			X
Teal, Hottentot	*Anas hottentota*	W		Res, nom		X			X
Teal, Red-billed	*Anas erythrorhyncha*	W		Res, nom		X			X
Tern, Arctic	*Sterna paradisaea*	W		Non-br Holarctic mig		X		X	X
Tern, Black	*Chlidonias niger*	W		Non-br Pal mig		X			
Tern, Caspian	*Hydroprogne caspia*	W	VU	Res, sed, nom, intra-Afr mig	br	X		X	X
Tern, Common	*Sterna hirundo*	W		Non-br Pal mig		X	X	X	X
Tern, Damara	*Sternula balaenarum*	W	NT, G VU ; Nam NEnd	Br intra-Afr mig	br	X	X	X	X
Tern, Gull-billed	*Gelochelidon nilotica*	W		Pal vagrant		X			
Tern, Sandwich	*Thalasseus sandvicensis*	W		Non-br Pal mig		X	X	X	X
Tern, Swift	*Thalasseus bergii*	W		Intra-Afr mig		X	X	X	X
Tern, Whiskered	*Chlidonias hybrida*	W		Res, nom		X			
Tern, White-winged	*Chlidonias leucopterus*	W		Non-br Pal mig		X			X
Thick-knee, Spotted	*Burhinus capensis*	T		Res, local movements		X			
Turnstone, Ruddy	*Arenaria interpres*	W		Non-br Pal mig		X	X	X	X
Wagtail, Cape	*Motacilla capensis*	W / T		Res		X	X	X	X

Species name	Scientific names	Group	RDB status/ endemism	Residency / migrant status / nomadism	br	S1	SABAP2		
							N	M	S
Warbler, African Reed	*Acrocephalus baeticatus*	W / T		Res, (br intra-Afr mig)		X			X
Warbler (Titbabbler), Chestnut-vented	*Sylvia subcaerulea*	T		Sed		X			
Warbler, Lesser Swamp	*Acrocephalus gracilirostris*	W		Res, sed		X			X
Warbler, Willow	*Phylloscopus trochilus*	W		Non-br Pal mig		X			X
Waxbill, Common	*Estrilda astrild*	W / T		Res		X	X	X	X
Weaver, Southern Masked	*Ploceus velatus*	T		Res, partial nomad		X			X
Whimbrel	*Numenius phaeopus*	W		Non-br Pal mig		X	X	X	X
White-eye, Orange River	*Zosterops pallidus*	W / T		Sed		X			X
Whydah, Shaft-tailed	*Vidua regia*	T		Res		X			

DISPERSION MODELLING
WALVIS BAY
TECHNICAL ASSESSMENT

PREPARED BY

WAMTECHNOLOGY CC

Project nr. ECC001

Report No: ECC_08072020

JULY 2020

PREPARED FOR

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ENVIRONMENTAL
COMPLIANCE CONSULTANCY

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PROJECT

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Approved by: W.A.M. Botes	Location: Stellenbosch

REVISION HISTORY

Rev No.	Date	Nature of Revision
1	18 May 2020	Draft Document
2	30 May 2020	Comments from ECC/WML
3	30 May 2020	WAMTechnology comments on Rev.No.2
4	17 June 2020	Final Document
5	24 June 2020	Revised Final Document. Alternative pipeline route.
6	8 July 2020	Revised Final Document. Alternative pipeline routes.

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1 INTRODUCTION

1.1 BACKGROUND

The Joint Venture (JV) between InnoSun Energy Holding (PTY) LTD and Turnkey Water Solutions (PTY) LTD requires a full scope Environmental Impact Assessment (EIA) to be conducted for a pilot project focusing on the possible commercial use of renewable energy powered desalination technology in Walvis Bay, Namibia.

It is required by the JV to be fully advised on all environmental concerns, including all required permits and to achieve full bankability from a legal and permitting point of view.

- *The purpose of this feasibility project is to test the competitive of alternative water solutions and renewable energy implementation, from a technical level, and through to implementation for generating usable commercial data. This scope necessitates the injection desalinated water into the local municipal potable water network. This water injection will only account for a fraction of the Water needs of Erongo Region and Walvis Bay Town Council.*
- *A full Scoping & Impact Assessment for a small desalination plant in Northern Walvis Bay is required. Including all required specialist studies, permits and mention of potential additional studies required by MET.*
- *Walvis Bay Municipality intends to allow and consume only 4000kl/day from this small feasibility desalination plant.*
- *Abstraction is most likely to be via a series of beach wells whilst discharge is going to be via a direct jetty mounted pipeline. This will be to the side of the existing Oil and Gas terminal jetty. This is essential to ensure the viability of such a small desalination project.*
- *During June 2020 the route of the main pipeline for the brine effluent pipeline and discharge location was reviewed and three alternative options were considered, with the discharge locations on the -5 m contour. For all three options gravity head was preferred for discharging the brine effluent (removing brine discharge pumps); lowering the RO Plant's energy consumption and subsequently reducing the CAPEX, OPEX, Maintenance, and likely the Solar Plant size. The indicative layouts and profiles of Option 1 and Options 2 and 3 can be seen in figures 1 and 2 below.*
- *The facility will take up approximately 40 000 m^2 on Erf 4688 (Walvis Bay). Final positions for the treatment plant and solar facilities to be confirmed.*

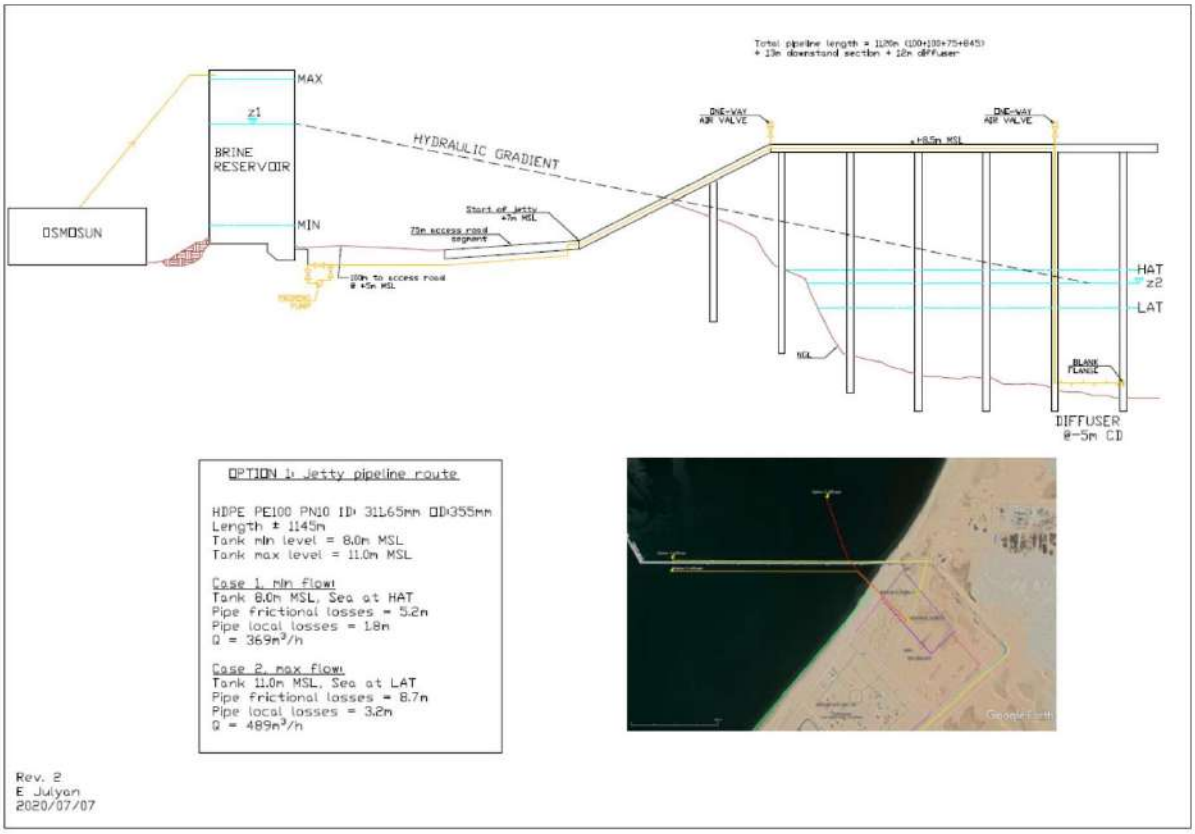

Figure 1: Sea outfall Option 1: (WMLCoast, July 2020)

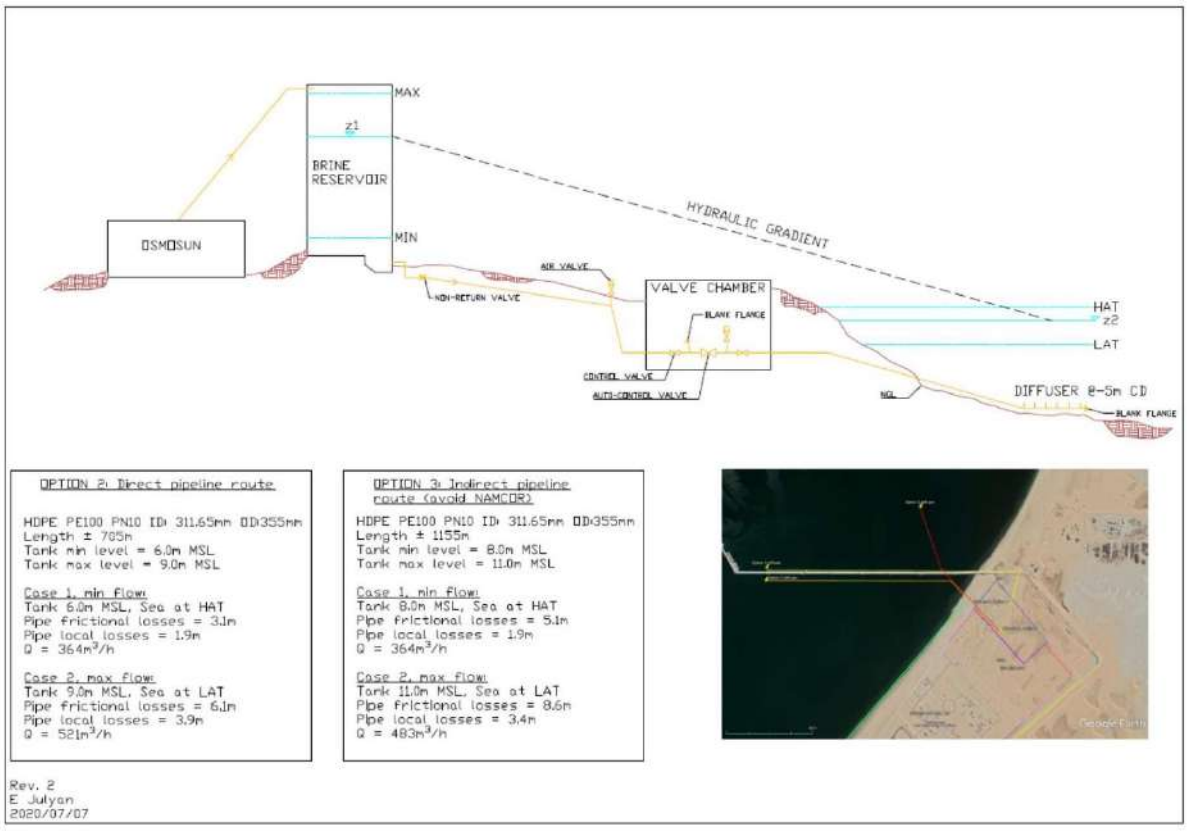

Figure 2: Sea outfall Options 2 and 3: (WMLCoast, July 2020)

- *Assessment and compliance with respect to Namibian Environmental Regulations (2014, 2017 & EMA 2007). These include but are not limited to:*
    - *An Environmental Clearance Certificate (ECC):*
    - *Construction of activities within a catchment area (TBC);*
    - *Release of brine into the ocean associated with desalination operations;*
    - *Construction of infrastructure below the high-water mark of the sea.*
- *Verification around the Water Resources Management Act (WRMA, 2013) the abstraction and use of a water resource (including the sea) may only be undertaken in terms of a Water Use License.*
- *Verification around licensing of the release of effluent (liquid waste) into the sea.*
- *The possibility of a combined abstraction and discharge license.*
- *The numerical (dispersion) modelling study is required to provide an estimation of 1) dilution rates for effluent and associated key contaminants and 2) the footprint of the plume after effluent discharge into the marine environment.*
- *Advice of whether specialists will be requested to conduct two separate assessments in order to expedite ECC.*
- *Detailed timeline or program (quote approval to ECC). Including an indication of the review and decision-making time of the relevant authority. The intention is for the ECC to be received by September 2020.*
- *List of required specialists, and confirmation of their availability to comply with the above EIA timeline. Do any require specific seasons to conduct their respective study?*
- *Payment terms.*
- *Attend stakeholder meetings and respond to comments. Prepare reaction of proponent to public concerns (how issues/concerns can be avoided / mitigated / accommodated);*
- *Should further assessment be required (to be confirmed by the Environmental Commissioner once the scoping report is submitted, what impact may this have on the timeline?*
- *Confirmation whether both baseline and detailed impact assessment levels will be required.*

1.2 SCOPE OF WORK

This technical/scientific assessment conducted by WAMTechnology CC include the following:

Diffuser design & dispersion study:

1. Review information with regards to the legislative requirements for the discharge of effluents to the marine environment;
2. Review national and local guidelines and standards and where applicable, identify relevant international guidelines for providing applicable baseline standards for the project;
3. Review existing site related ambient sea water quality data and information if available;
4. Confirm effluent discharge rates and composition (i.e. min, max flows, discharge patterns, constituent concentrations, physical characteristics)
5. Define the water quality objectives: the discharge will be assessed using the Receiving Water Quality Objectives (RWQO) approach which requires the definition of site-specific water quality objectives based on the designated beneficial uses of the area, and recommended water quality guidelines;
6. Define the allowable mixing zone
7. Diffuser configuration and hydraulic analysis
8. Determine required dilutions: Determination of the required dilutions with regards to the water quality objectives;
9. Initial dilution/dispersion modelling: the dilution characteristics of the initial mixing zone will be based on near field (initial dilution modelling);
10. Secondary dilution/dispersion modelling: the transport and dispersion of the brine plume in the far field will be assessed by means of secondary (far field) dispersion modelling – using an analytical prediction model;
11. Impact assessment: compile short summary of mixing zone, compliance to marine water quality guidelines
12. Input to monitoring, management and mitigation measures

Note that we are proposing an analytical approach for the secondary dilution / dispersion modelling and do not intend modelling the area.

NOTES:

- No field surveys or data acquisition exercises will be conducted.
- Items 1 and 2: Literature survey of available information (legislation, standards, guidelines, etc.) for the site in Namibia and refer to international guidelines and policies).
- Item 3: Literature survey of relevant available ambient quality data. Client to provide data if available.

- Item 4: Effluent flows and loads. To be provided by the client.
- Item 5: Beneficial use areas to be provided by the client.
- Item 8, 9 and 10: Environmental data (currents/circulation, wind, waves and tides) to be provided by the client.

2 STATUTORY OBLIGATIONS

2.1 Legislation

National legislation which will have to be considered for the design and operation of a brine outfall for a pilot solar desalination project on the northern coast of Walvis Bay are listed below. A brief description of the relevant clauses are summarised in Appendix A.

- Namibian Ports Authority Act, No. 2 of 1994
- Seashore Ordinance, No. 37 of 1958
- Water Act, No. 54 of 1956
- Marine Resources Act, No. 27 of 2000
- Environmental Management Act of Namibia (2007)
- Aquaculture Act (2002)
- Atmospheric Pollution Prevention Ordinance of Namibia (No. 11 of 1976)
- Hazardous Substances Ordinance (No. 14 of 1974)
- Regional Councils Act, Act 22 of 1992
- Water Resource Management Act, 2013 (Act .11 of 2013)
- Draft Pollution Control and Waste Management Bill (1999)

2.2 Conventions & Agreements

International conventions and agreements which Namibia signed or agreed to implement with regards to pollution of the marine environment are listed below. A brief description and background of each convention/agreement is summarized in Appendix B.

- BCLME Projects: *Land-Based Marine Pollution in the BCLME Region*
- The Stockholm Declaration on the Human Environment, Stockholm 1972
- United Nations Law of the Sea Convention (1982)
- Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London Convention, 1972)

2.3 Policies

The policies listed below provide general principles, rules and guidelines either formulated or adopted by the Namibian government with regards to pollution, industries, desalination plants and waste/effluent discharge to the marine environment.

Although the policies are not part of legislation, certain procedures or protocols within the policies are referred to within the country's legislation and should be noted.

Refer to Appendix C for a brief description of each policy listed below.

- Namibia's Green Plan (1992)
- Namibia's Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1995)
- Draft Environmental Management Bill
- Draft Pollution and Waste Management Bill
- Walvis Bay Lagoon Integrated Environmental Management Plan (1998)

3 THE PROJECT AREA

The proposed desalination plant is located on the northern shore of Walvis Bay, approximately 6 km NE of the new Container Terminal and approximately 3.5 km south of Bird Island on a portion of Erf. 4688 as shown in Figure 3.

Figure 3: Site location within the Bay

The site is at the root of the new Liquid Bulk Terminal which extends west from the sandy shore to a water depth of -5 m for I km (weak sea bed slope of 1 in 200) and then to NW for about 700 m to a water depth of -7m (slope of 1 in 350). The marine waters are within the limits and under the jurisdiction of NAMPort.

4 COASTAL PROCESSES

4.1 WIND

Refer to Figure 4 and Table 1 below, the prevailing wind directions are from SW to SE (almost 90% of the time). Rarely from the North. Winds at the coast blow predominantly from the south (oblique to the alignment of the coastline) (Namibian Ports Authority, 2010).

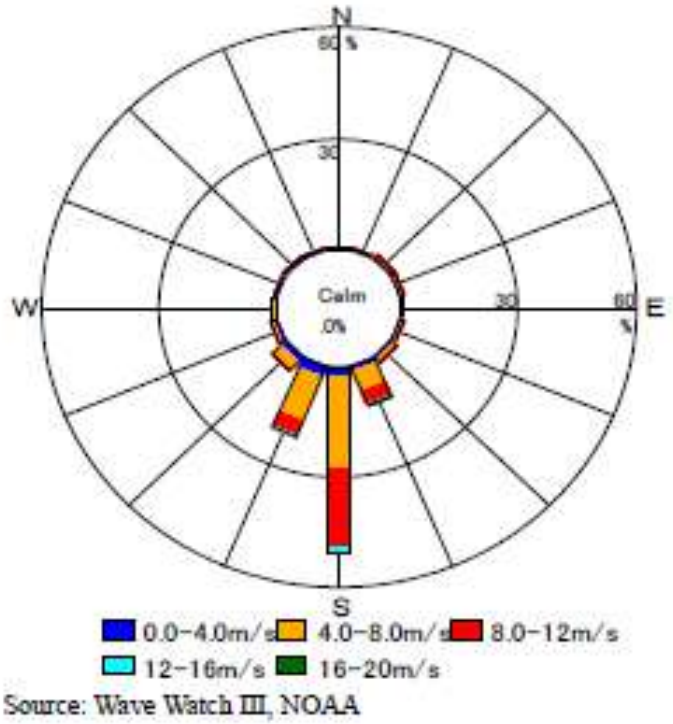

Figure 4: Walvis Bay: Offshore wind speed and directional occurrences (Namibian Ports Authority, 2010)

Table 1: Walvis Bay: Offshore wind speed and directional occurrences (Namibian Ports Authority, 2010).

(m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.4	0.4	0.3	0.2	0.2	0.2	3.8
2-4	0.2	0.2	0.2	0.2	0.2	0.3	0.6	1.2	2.6	2.7	1.7	0.9	0.5	0.4	0.3	0.2	12.4
4-6	0.1	0.2	0.3	0.3	0.3	0.3	0.7	2.7	8.8	6.2	1.9	0.5	0.2	0.1	0.2	0.1	23.0
6-8	0.0	0.1	0.4	0.3	0.2	0.2	0.5	3.5	15.6	6.6	0.8	0.1	0.0	0.0	0.0	0.0	28.6
8-10	0.0	0.0	0.2	0.2	0.1	0.0	0.1	2.6	15.0	3.7	0.2	0.0	0.0	0.0	0.0	0.0	22.1
10-12		0.0	0.0	0.0			0.0	0.9	6.4	0.7	0.0				0.0	0.0	8.2
12-14								0.2	1.4	0.0							1.6
14-16								0.0	0.2	0.0							0.2
16-18								0.0	0.0								0.0
18-20								0.0	0.0								0.0
	0.5	0.6	1.3	1.2	0.9	1.0	2.1	11.5	50.5	20.4	5.0	1.9	1.1	0.8	0.8	0.6	100

For shallow outfalls (typically less than 20m water depth), the diurnal land and sea breezes will result in diurnal changes of the transport (onshore/offshore) of surface waste fields. On site wind measurements are not available at present.

4.2 TIDE

The Table below lists the astronomical tide levels measured at Walvis Bay.

Table 2: SANHO tidal levels for Walvis Bay (2012)

DESCRIPTION		*MEAN SEA LEVEL (m MSL)*	*CHART DATUM (m CD)*
Highest Astronomical Tide	HAT	+1.004	+1.97
Mean High Water of Spring Tide	MHWS	+0.724	+1.69
Mean High Water of Neap Tide	MHWN	+0.324	+1.29
Mean Level	ML	+0.014	+0.98
Mean Sea Level	MSL	0.00	+0.966
Mean Low Water of Neap Tide	MLWN	-0.296	+0.67
Mean Low Water of Spring Tide	MLWS	-0.696	+0.27
Lowest Astronomical Tide	LAT	-0.966	0.00
Chart Datum	CD	-0.966	0.00

The Table above indicates that the maximum tidal variation seldom exceeds 1.8 metres, with the average tidal variation about 1 metres. Water levels may govern the hydraulic design of the outfall and associated tidal currents will influence the dispersion and transport of the effluent plumes.

4.3 WAVES

Refer to Figure 5, current and wave recorders were deployed during 2009 (Namibian Ports Authority, 2010).

- W2: Wave recorder (-13 m waterdepth)
- C2: Current recorder (-11 m waterdepth)

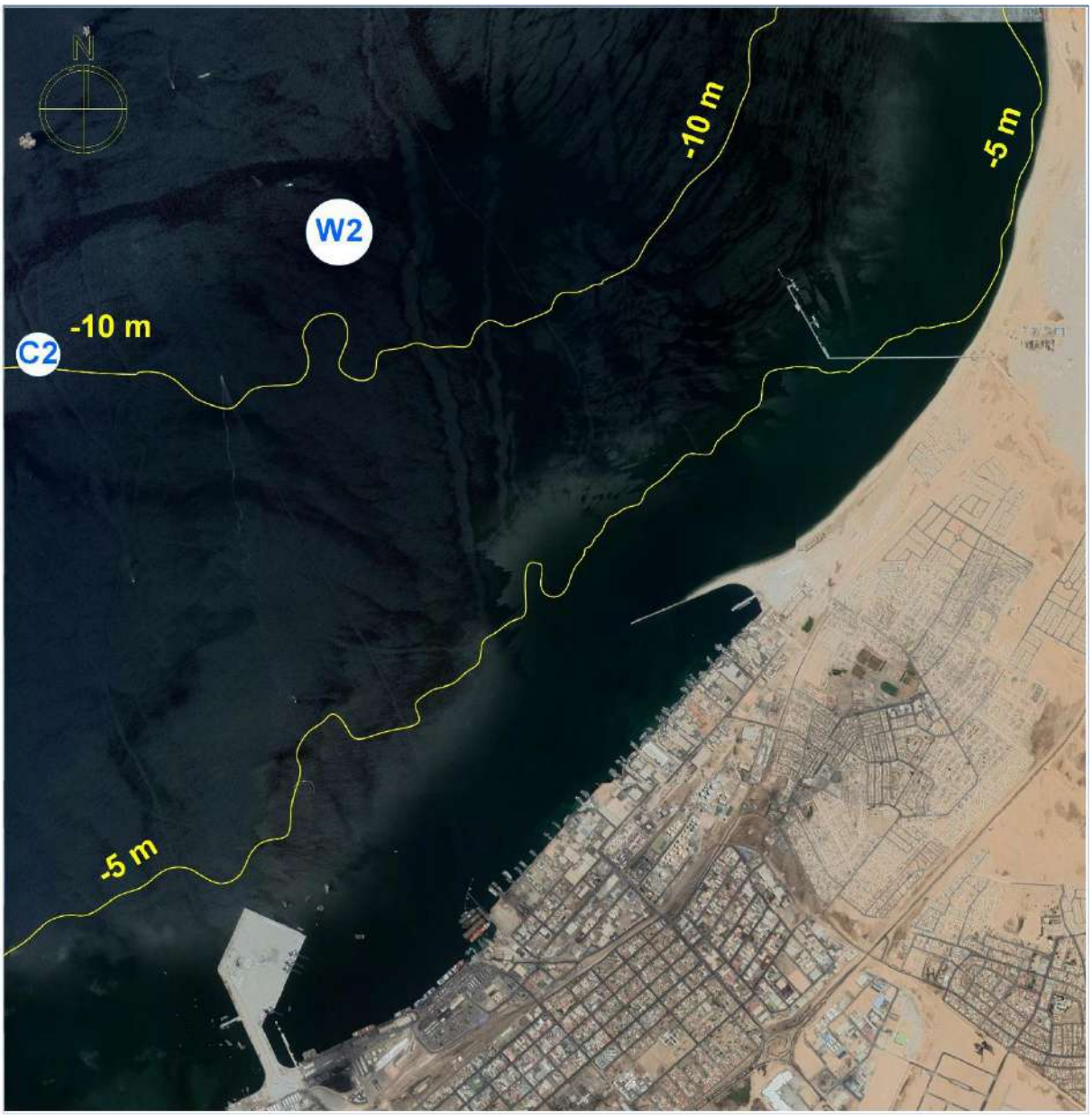

Figure 5: Current and wave recorders (Namibian Ports Authority, 2010)

Maximum wave heights during June/July 2009 at the location (W2) in 13 m waterdepth were only 0.3 m due to sheltered effect of the prevailing SW'erly waves in Walvis Bay.

4.4 CURRENTS

Refer to Figure 5 (Location of current recorders) and Figure 6, currents are weak (maximum about 20 cm/s) with scattered diurnal directions. (Namibian Ports Authority, 2010).

For this assessment of the behavior of the brine effluent, to be discharged to the sea in approximately -5 m waterdepth the current velocities below were used and are considered descriptive of the conditions:

- Weak currents (Velocities): Surface: 0.01 m/s: Bottom: 0.005 m/s
- Average currents (Velocities): Surface: 0.1 m/s: Bottom: 0.01 m/s
- Maximum currents (Velocities): Surface: 0.2 m/s: Bottom: 0.01 m/s

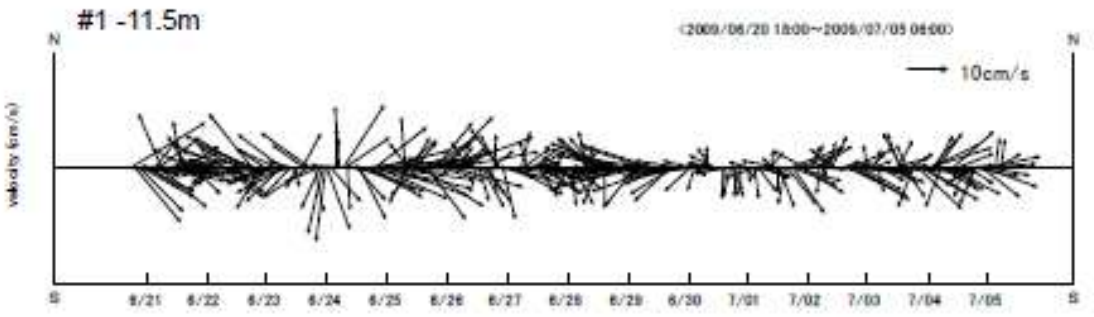

Figure 6: Current vectors at Location C2 (-11 m waterdepth) (Namibian Ports Authority, 2010)

4.5 STRATIFICATION

Stratified conditions (layering in the water column) occur due to a density gradient between the surface and the bottom, subsequently inhibiting an effluent plume to rise with subsequent reduced initial dilutions.

Due to relatively shallow water, stratification is considered as mild for the purpose of this study. However, it will be confirmed during the detail design phase when actual temperature and salinity measurements have been conducted at the site.

In addition, the density of the effluent which will be discharged offshore will be denser than the receiving environment (seawater) and therefore the possible effect of stratification on the initial dilutions are considered insignificant.

5 WATER QUALITY OBJECTIVES

5.1 BENEFICIAL USE AREAS

The South African Water Quality Guidelines for Coastal Marine Waters provides recommended target values for a range of water quality constituents to prevent negative impacts on the marine ecosystem and are applicable to the entire marine environment. Specific water quality guidelines (target values) exists for the following beneficial use areas:

Table 3: Beneficial uses of the coastal marine waters

Full contact recreation	Activities such as swimming, diving (scuba and snorkeling), water skiing, surfing, paddle skiing, wind surfing, kite surfing, parasailing and wet biking
Intermediate contact recreation	Activities such as boating, sailing, canoeing, wading, and angling, where users may come in contact with the water or swallow water
Non-contact recreation	All recreational activities taking place in the vicinity of marine waters, but which do not involve direct contact, such as sightseeing, picnicking, walking, horse riding, hiking etc.
Basic amenities	Aesthetically acceptable environment.
Mariculture	Refers to the farming of marine and/or estuarine organisms in land-based (i.e. 'off-stream' tanks using pumped seawater) or water-based (i.e. 'in-stream') systems.
Industrial uses	Waste water discharges, cooling water, desalination, and aquariums.

The beneficial uses in the vicinity of the project area can be summarized as follows and are delineated in Figure 7.

Figure 7: Beneficial Use Areas

Natural environment:

- The "natural environment" includes the entire area.
  - Note: Brine effluent discharge to comply with Marine Water Quality Guidelines.
  - At this stage only salinity is considered as a critical constituent.
- Protected areas: The Walvis Bay Lagoon (RAMSAR site).
  - Note: Not relevant. Entrance to lagoon > 7 km south west of project area.

Recreational:

Official Beaches:

- Kuisebmond Beach (< 1 km south of discharge Location)
- Entire coastline:
- Water sport and activities:
- Windsurfing:
    - Note: Brine effluent discharge to comply with Marine Water Quality Guidelines. At this stage only salinity is considered as a critical constituent. No domestic waste in effluent.

Collection of sea food:

- Aquaculture:
    - Potential Aquaculture Development (Oelerman).
- Collection of mussels for food:
- Line fishing:
- Diving: Spearfishing
    - Note: Brine effluent discharge to comply with Marine Water Quality Guidelines. At this stage only salinity is considered as a critical constituent. No domestic waste in effluent.

Industrial:

- Walvis Bay harbour (including new container terminal)
    - Note: Harbour > 4 km to the south of the discharge location. Brine effluent discharge to comply with Marine Water Quality Guidelines.
- The Liquid Bulk Terminal
    - Can be considered as a specific harbour facility, primarily for bulk liquid off-loading with typical navigational activities (oil tankers, dredgers, tug boats and service vessels).
        - Activities in harbour that could result in marine pollution are numerous, including:

- Cleaning and maintenance of vessels within harbours (e.g. dust from sand blasting), as well as emptying of toilets into harbour areas
- Dredging operations

- Harbour water is particularly prone to pollution because harbours are sheltered basins often with poor water circulation, which will have adverse effects on the ambient water in and adjacent areas, which will have adverse effect on the required dilutions of an ocean outfall due to the reduced buffer capacity of the receiving waters. The complex and restricted flow in a harbour (confined area) makes the basic assumptions and theories (required dilutions) for the determination of achievable dilution invalid. Currents induced by natural processes (tides, wind, storm surge, swell, long period waves) will be amplified or suppressed according to the geometry of the harbour with varying directions and behaviour depending on the continuously varying tide (water depth), superimposed on each other and effected by unpredicted resistance such as moving and moored vessels and artificially induced currents due to navigational operations. The influence of currents in the receiving water (discharge location) is the influencing parameter related to the behaviour of an effluent plume and the subsequent dilutions which can be achieved.

- Fish factories:
  - Note: Nearest factories > 2 km to the south of the discharge location. Brine effluent discharge to comply with Marine Water Quality Guidelines.

5.2 WATER QUALITY GUIDELINES

Target values for constituents which may have impact on the marine ecosystem or on other beneficial use areas. These target values are listed in Table 3.

Table 4: Target values: South African Water Quality Guidelines for Coastal Marine Waters (DWAF, 1995)

BASIC AMENITIES - all marine & estuarine water	
Constituents	**Guideline (Target Value)**
Aesthetics	Water should not contain floating particulate matter, debris, oil, grease, wax, scum, foam or any similar floating materials and residues from land-based sources in concentrations that may cause nuisance or in amounts sufficient to be unsightly or objectionable. Water should not contain materials from non-natural land-based sources which will settle to form putrescent or objectionable deposits. Water should not contain materials from non-natural land-based sources which will produce color, odors, turbidity or taints or other conditions to such a degree as to be unsightly or objectionable. Water should not contain submerged objects and other sub-surface hazards which arise from non-natural origins and which would be a danger or cause nuisance or interfere with any designated/recognized use.
Color (turbidity)	Turbidity and color acting singly or in combination should not reduce the depth of the euphotic zone by more than 10 per cent of background levels measured at a comparable control site. With specific reference to color, levels should not increase by more than 35 Hazen units above background levels in a particular area. Color can also be measured in units of mg Pt/l, where 1 mg Pt/l is equivalent to 1 Hazen unit.
Suspended Solids	The concentration of suspended solids (SS) should not increase above 10% of the background concentrations.
MAINTENANCE OF THE ECOSYSTEM - all marine waters	
Temperature	Should not exceed the ambient temperature by more than 1^0C.
PH	The pH should lie within the range of 7.3-8.6.
Dissolved Oxygen	Should not fall below 5 mg/l (Dissolved oxygen should not fall below 5 mg/l (99 per cent of the time) and below 6 mg/l (95 per cent of the time))
Salinity	Salinity should lie within the range 32 to 36.

Dissolved Nutrients in mg/l Phosphates: $P0_4$-P Nitrogen ($N0_2$ and NO_3 and NH_3	Should not cause excessive algae growth and the loads should not exceed the levels which are introduced by natural processes such as upwelling.
Ammonia (mg/l)	0.02 mg N /liter as NH_3 0.60 mg N /liter as $NH_3 + NH_4^+$
Toxic Inorganics in mg/l Arsenic (As) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Mercury (Hg) Nickel (Ni) Silver (Ag) Zinc (Zn)	 0.012 0.004 0.008 0.005 0.012 0.0003 0.025 0.005 0.025
ADDITIONAL GUIDELINES FOR DIRECT CONTACT RECREATION - (Specific Areas)	
Faecal coliforms (if limits are exceeded, test for E.coli using same target values)	Maximum acceptable count per 100 ml 100 in 80 percent of the samples 2000 in 95 percent of the samples
ADDITIONAL GUIDELINES FOR FILTER FEEDER COLLECTION - (Specific Areas)	
Faecal coliforms (if limits are exceeded, test for E.coli using same target values)	Maximum acceptable count per 100 ml 20 in 80 percent of the samples 60 in 95 percent of the samples

5.3 BACKGROUND WATER QUALITY

At this stage the assumption is that the only relevant constituent for the proposed brine effluent is salinity. Ambient characteristics of other constituents (parameters) which may be relevant or have to be considered after more detailed investigations or effluent analyses are listed below.

5.3.1 Salinity

A salinity of 34.5 ppt is assumed as representative (CSIR, 2009). Long term data was not available at this stage.

5.3.2 Suspended solids and turbidity

The maximum and the minimum turbidity for the period (August 2006 – Jan 2008 are 34.50 and 1.56, respectively. (Namibia Water Corporation, 2008).

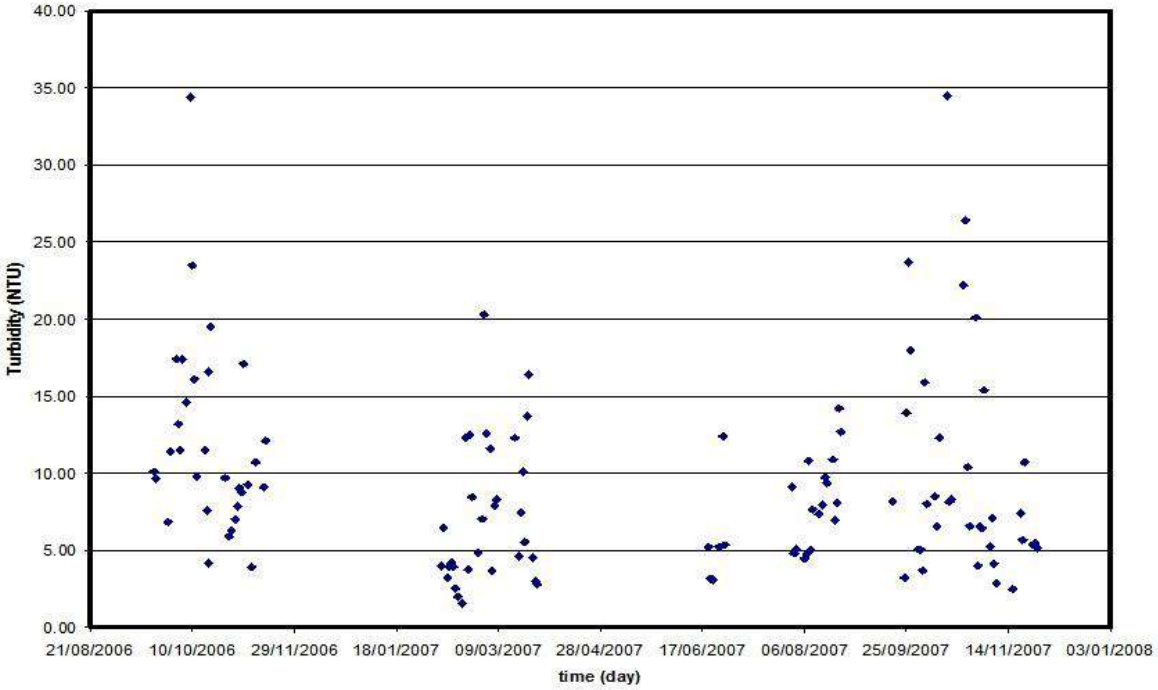

Figure 8: Namibia Seawater Quality: Turbidity (Namibia Water Corporation, 2008)

5.3.3 Temperature

The temperature profile of the Namibian seawater follows a winter-summer pattern as illustrated in the Figure below. The temperature peaks during the early part of the year and then starts dropping until it hits minimum during the winter period (*Namibia Water Corporation, 2008*).

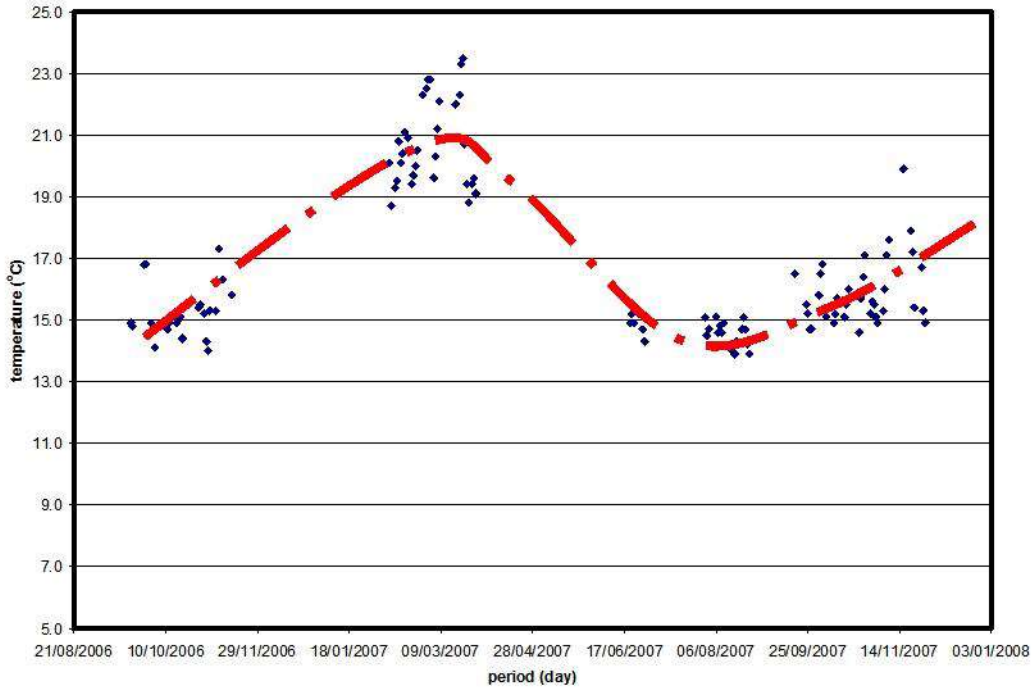

Figure 9: Namibia Seawater Temperature Profile (Namibia Water Corporation, 2008)

The graph in Figure 10 and Table 4 shows the range of monthly Walvis Bay water temperature derived from many years of historical sea surface temperature data (World Sea Temperature 2020).

Table 5: Walvis Bay sea water temperature (World Sea Temperature 2020)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min °C	15.2	17.7	16.5	14.9	13.8	13.2	12.7	12.5	12.7	13.4	13.8	15.3
Max °C	20.3	20.6	20.7	20.3	17	15.1	15.3	14.7	14.7	15.3	16.5	18.1

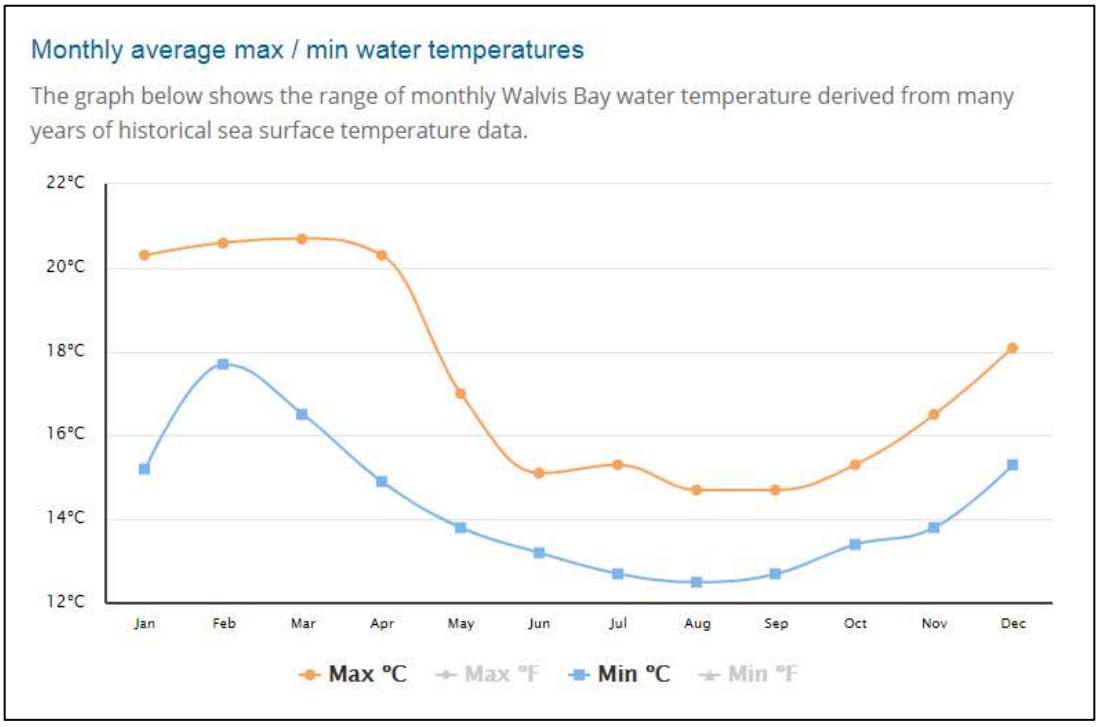

Figure 10: Walvis Bay sea water temperature (World Sea Temperature 2020)

5.3.4 Dissolved oxygen

The saturated dissolved oxygen content of sea water at 20 deg.C and a salinity of 35 ppt is 7.6 mg/l (DWAF, 1995).

5.3.5 Nutrients

According to Chapman and Shannon (1985), the coastal waters of Namibia have nitrate and phosphate concentrations that generally fluctuate between 10 and 30 µM and between 2 and 3 µM respectively. These values are higher than those of the south Atlantic central water (10-18 µM of nitrate and 0.8-1.5 µM of phosphate). (*LLUCH, 2002*).

5.3.6 pH

Results of pH measurements conducted previously are illustrated in the Figure below. Measurements indicated that pH for about 90% of the water sampled were within the range of 7.6 to 7.8 and with a maximum of 8.4 and a minimum of 7.4 (*Namibia Water Corporation, 2008*).

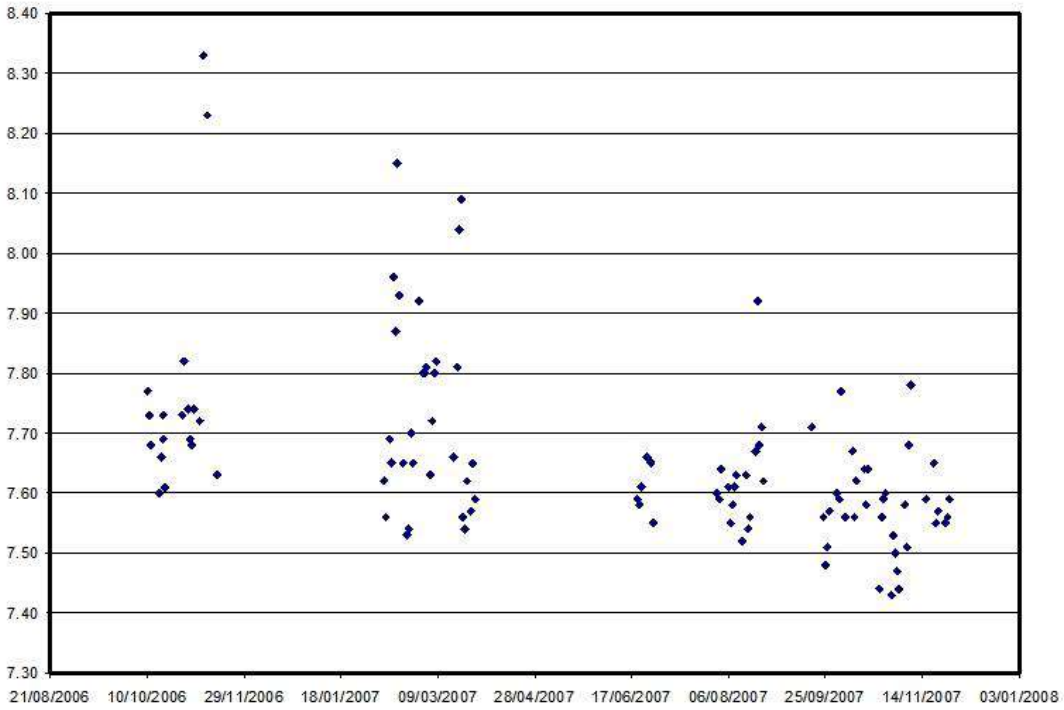

Figure 11: Namibia Seawater pH Profile (Namibia Water Corporation, 2008)

6 EFFLUENT CHARACTERISTICS

6.1 EFFLUENT VOLUMES

At this stage the preferred option for the discharge of the brine effluent is intermittent gravity flow from an elevated brine reservoir. The maximum and minimum flows were determined by WMLCoast (2020) and summarized below in Table 6. These flow rates were used to ensure adhering to the criteria for the proposed diffuser in 8.2.2 as well as for achieving the required dilutions.

A 355 mm OD (311.65 mm ID) main pipe was proposed by WMLCoast (2020).

Table 6: Brine flow rates (gravity discharge) (WMLCoast, 2020)

Reservoir level	Reservoir level (m to MSL)	Discharge rate (m3/hr)
Maximum	8.5	533
Minimum	5.5	362

6.2 EFFLUENT QUALITY

6.2.1 Critical parameters

At this stage the only constituent in the brine effluent which is considered as critical (refer to The South African Water Quality Guidelines for Coastal Marine Waters is salinity, however an analysis of source water (from boreholes) as well possible residues from any additives (anti-scaling, flocculants, coagulants, etc.) will be required to determine if any other physical property or chemical constituent, which may have an effect on the marine water quality has to be included. If sludge from backwash water is not separated and withdrawn before discharging, the loads and critical constituents must be identified and quantified.

Table 7: Summary: Brine effluent properties

Constituent	**Minimum**	**Operational**	**Maximum**
Salinity (ppt)	51.9	55.6	58.6
Density	1039.8	1042.0	1044.0
Temperature (deg.C)	12	14	21
Other to be confirmed or to be considered			
Nutrients			
pH			
Dissolved Oxygen (mg/l)			
TSS (mg/l)			
Residues from additives			
Backwash sludge properties			

NOTE:
The South African Water Quality Guidelines for Coastal Marine Waters which serves as the yard stick to determine the dilutions to be achieved, does not list specific commercial chemical products. For an industrial effluent (or an effluent with constituents (combination of constituents) which are difficult to quantify or clearly define, to be evaluated with regard to the impact on the natural environment, toxicity testing can save time and costs, if more constituents from example additives are considered in the future.

A typical effluent quality scenario can be simulated for toxicity testing to provide the Minimum Acceptable Toxicant Dilution (MATD) values for the effluent quality scenarios.

"It is recognised that point source discharges, such as municipal and industrial wastewater can be complex mixtures that may contain unknown compounds which may act together to increase or ameliorate the toxic effects to the receiving marine environment (RSA DWAF, 2003b).

Rather than attempting to identify all the chemicals in a sample or where the toxic effects of specific chemicals are not known, toxicity tests (bioassays) using living organisms provide a useful means of determining the potential toxicity of wastewater to the marine life. In the case of complex mixtures, toxicity testing of the waste stream (also referred to as the Whole Effluent Toxicity [WET] test) is therefore very important (ANZECC, 2000a; US-EPA, 2002b).

The US-EPA (2002b) recommends that wastewater toxicity tests consist of a control and five or more concentrations of wastewater (i.e. a range of wastewater dilutions). These tests are used to estimate:

- LC50, i.e. the wastewater concentration which is lethal to 50% of the test organisms in the time period prescribed by the test, or
- No-Observed-Adverse-Effect Concentration (NOAEC), i.e. the highest wastewater concentration at which survival is not significantly different from the control, and/or

Minimum Acceptable Toxicant Dilution (MATD), which lies between a dilution with a response which is not significantly different from a control test (NOAEC) and the highest observed effect dilution."

7 REQUIRED DILUTIONS

The term dilution describes the process of reducing the concentration of effluent constituents by mixing the effluent with uncontaminated ambient seawater and therefore achieving acceptable concentration levels for maintaining ecosystems functioning and recreational human activities (e.g. swimming).

To assess the assimilative capacity of the receiving waters, a straight forward first estimate is based on the required dilutions for a specific constituent in the effluent. The required dilution is a function of the effluent concentration and the 'buffer capacity', which is the difference between a guideline value (target value) and the ambient concentration of the specific constant and can be expressed as follows:

$$\mathbf{S = (C_E - C_A) / (C_T - C_A)}$$

Where:

S = Required dilution
$\mathbf{C_E}$ = Effluent concentration
$\mathbf{C_A}$ = Ambient (background) concentration
$\mathbf{C_T}$ = Target or guideline concentration (Which should not be exceeded)
$\mathbf{(C_T - C_A)}$ = "Buffer capacity"

It is clear that if $\mathbf{C_A}$ approaches $\mathbf{C_T}$, then $\mathbf{(C_T - C_A)}$ will approach **0** and subsequently **S** (Dilution) **>>>>** (infinite - not achievable).

Table 8: Required Dilutions.

Constituent	Background	Guideline	Effluent conc. (mg/l)	Required dilutions
Salinity)	34.5 ppt	36 ppt	51.9 ppt (minimum)	12
			55.6 ppt (average)	14
			58.6 ppt (maximum)	16

8 OUTFALL

8.1 LOCATION OF THE OUTFALL

The approximate route of main pipeline for Options 1, 2 and 3 and the diffuser is illustrated in the Figure 12.

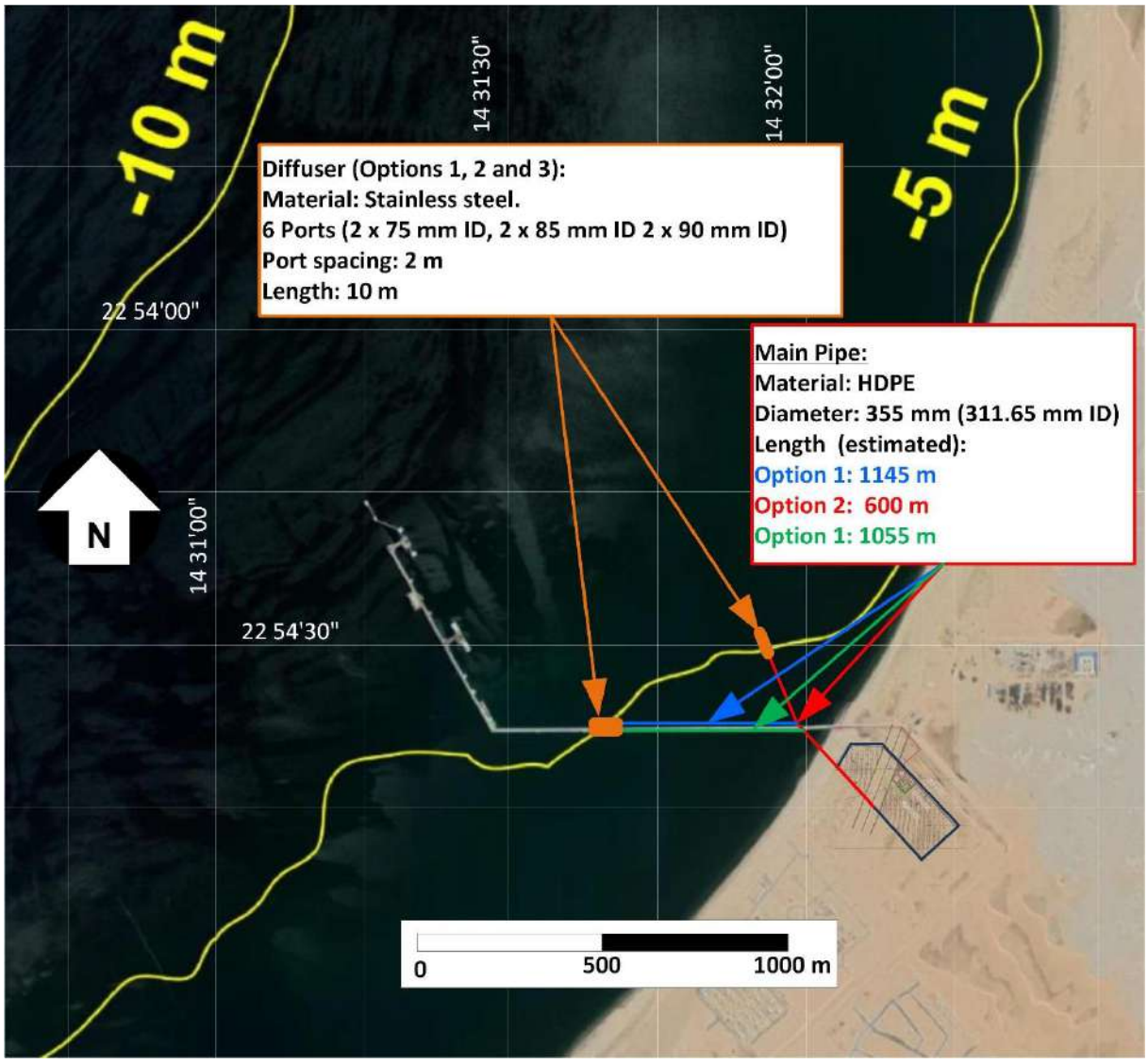

Figure 12: Location of the outfall (Options 1, 2 and 3)

8.2 CONFIGURATION

8.2.1 Main pipeline

The main pipe diameter depends on:

- Flow scenarios (present flow as well as the envisaged future flow conditions)
- Available gravity head to discharge the effluent.

The design criteria for a first assessment are:

- Maintain a main pipe velocity of greater or equal to 0,7 m/s to prevent deposition of solids.
- Discharge maximum flows with available gravity head, taking into account the increase in roughness during the lifetime of the outfall as well as all losses at fittings (entrances, exits, bends, contractions, expansions, valves) in the main pipe and the diffuser.

Preliminary details as provided by WMLCoast (2020) of the main pipeline for Options 1, 2 and 3 (Refer to Figures 1, 2 and 12) are:

- Material: HDPE
- Diameter: 355 mm OD; 311.65 mm ID
- Length (estimated):
    - Option 1: 1145 m
    - Option 2: 600 m
    - Option 3: 1055 m

For the gravity flows (maximum 533 m^3/hr and minimum of 362 m^3/hr) the estimated total headlosses (friction and local losses) are:

Flow rate	Option 1	Option 2	Option 3
	Headloss (m)		
0.148 cumec (maximum)	11.9	10.0	12.0
0.1005 cumec (minimum)	7.0	5.0	7.0

8.2.2 Diffuser

For the optimisation of the diffuser, the following criteria must be met:

- Design flows must be discharged satisfactorily through the ports. A rule of thumb for the continuity of flow is that the total cross-sectional areas of the ports should not be less than 0.7 times the cross-sectional area of the main pipe at any point in the diffuser. A port diameter of less than 75 mm is not recommended because it will be more susceptible to blockage.

- Maintain sufficient flow in each port to prevent the intrusion of seawater. This can be achieved by the gradual increasing of the sizes of the ports towards the end of the pipe. To prevent the intrusion of seawater, the port exit velocities must be such that the densimetric Froude Number for each port is greater than unity.

- Ensure an even distribution of flows, through all the diffuser ports, because the flow is directly related to the achievable initial dilution, and the worst performing port (highest flow and lowest dilution) will be considered as representative of the performance of the diffuser. Even distribution can be achieved by the gradual increase of the port sizes.

- Maintain scouring flows within the diffuser section: this can be achieved by introducing tapers in the diffuser section together with increasing port sizes towards the seaward end of the diffuser.

- The distance between any two ports must be such that the plumes do not merge before terminal height is reached.

The above criteria can be met by discharging always at design flow rates. Gravity release – 533 m^3/hr (max) to 362 m^3/hr (min).

The proposed (suggested) diffuser can be summarized as follows (illustrated in Figure 13):

- Material: Stainless steel
- Two tapers: 0.311 m (main pipeline) to 0.24 m; 0.24 m to 0.2 m
- No. of ports: 6
- Port diameters: 2 x 75 mm ID (onshore end), 2 x 85 mm ID; 2 x 90 mm (ID)
- Port length: 0.2 m
- Port inclination: 60 degrees (to horizontal)
- Flange at end of diffuser (for removal if flushing (due to possible blockage) is required).
- Depth: Minimum -4.5 m below LWOST (depth to be confirmed)

- Support: Depending on the physical nature (characteristics) of the sea bottom, to be discussed with contractors. For Option 1 the diffuser will be secured to the structure of the Liquid Bulk Terminal.
- Inclination: Horizontal
- Link to main pipe: Flange.

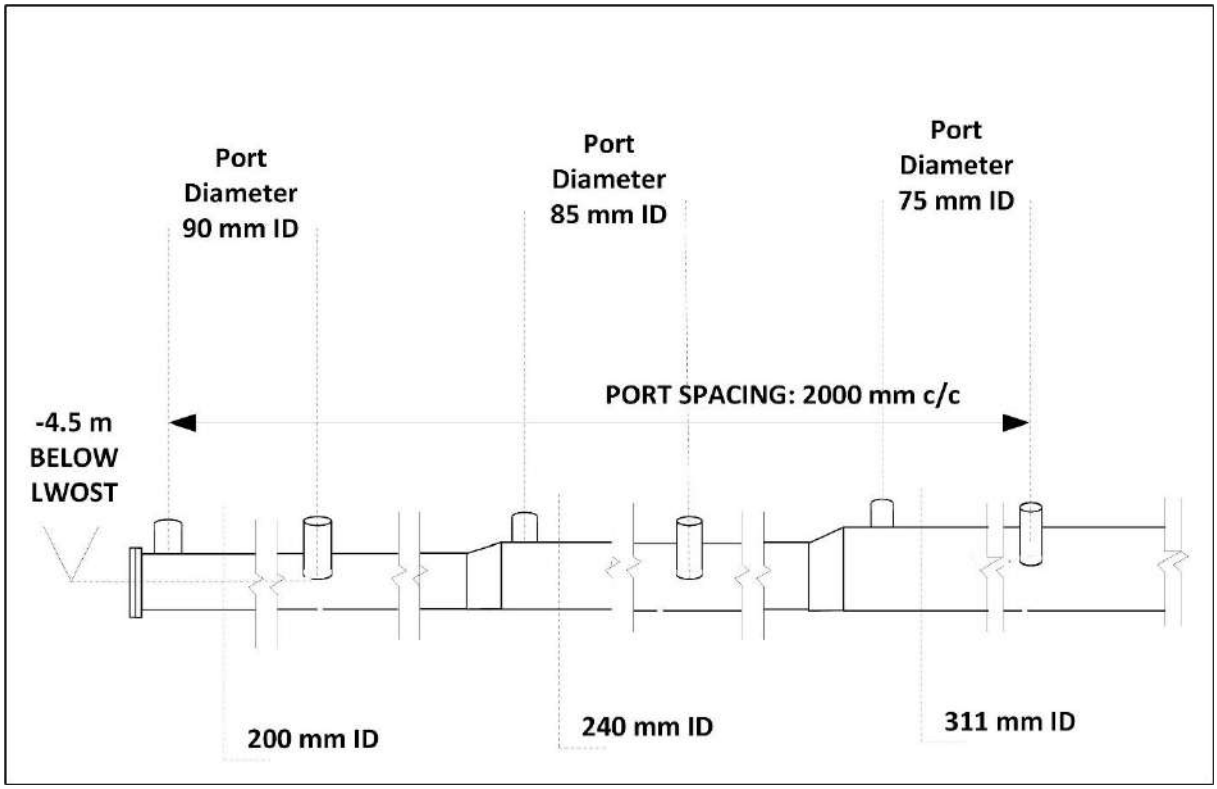

Figure 13: Diffuser configuration

8.3 HYDRAULIC PERFORMANCE

The adherence to the hydraulic requirements of the diffuser for gravity flows with discharging rates between 148 l/s (533 m^3/hr) and 101 l/s (362 m^3/hr) are illustrated in Figures 14 to 17.

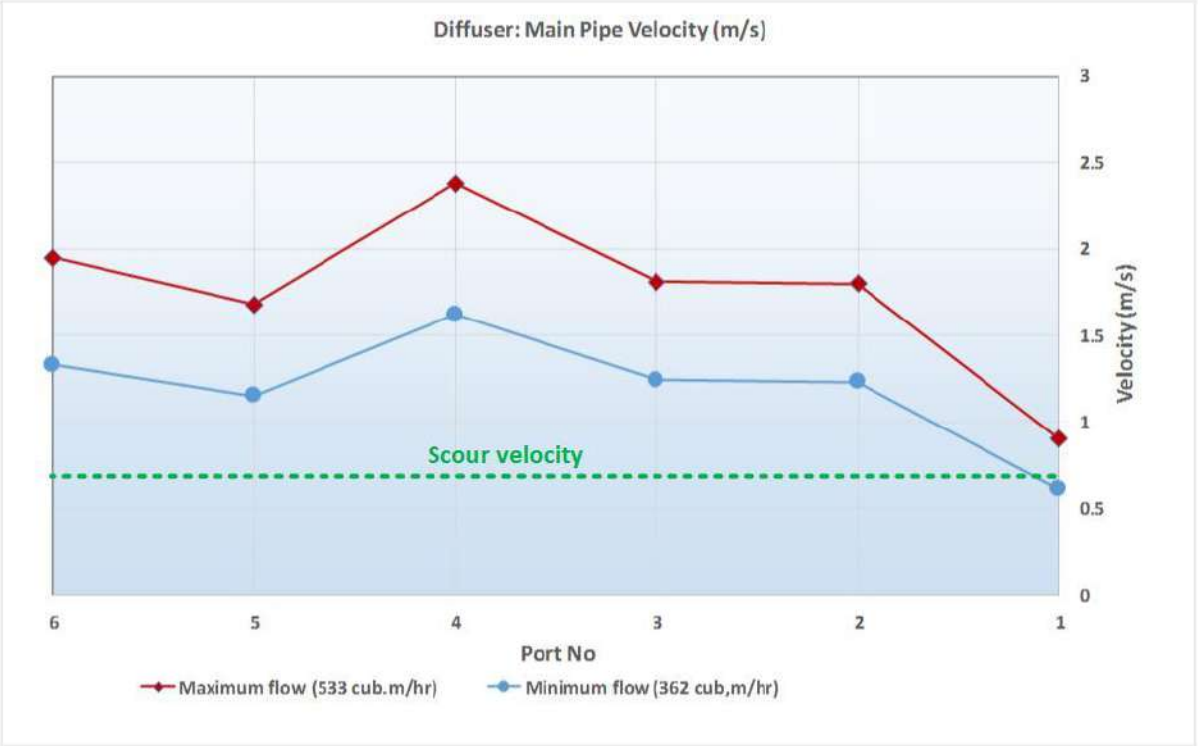

Figure 14: Diffuser Hydraulics: Main Pipe Velocities

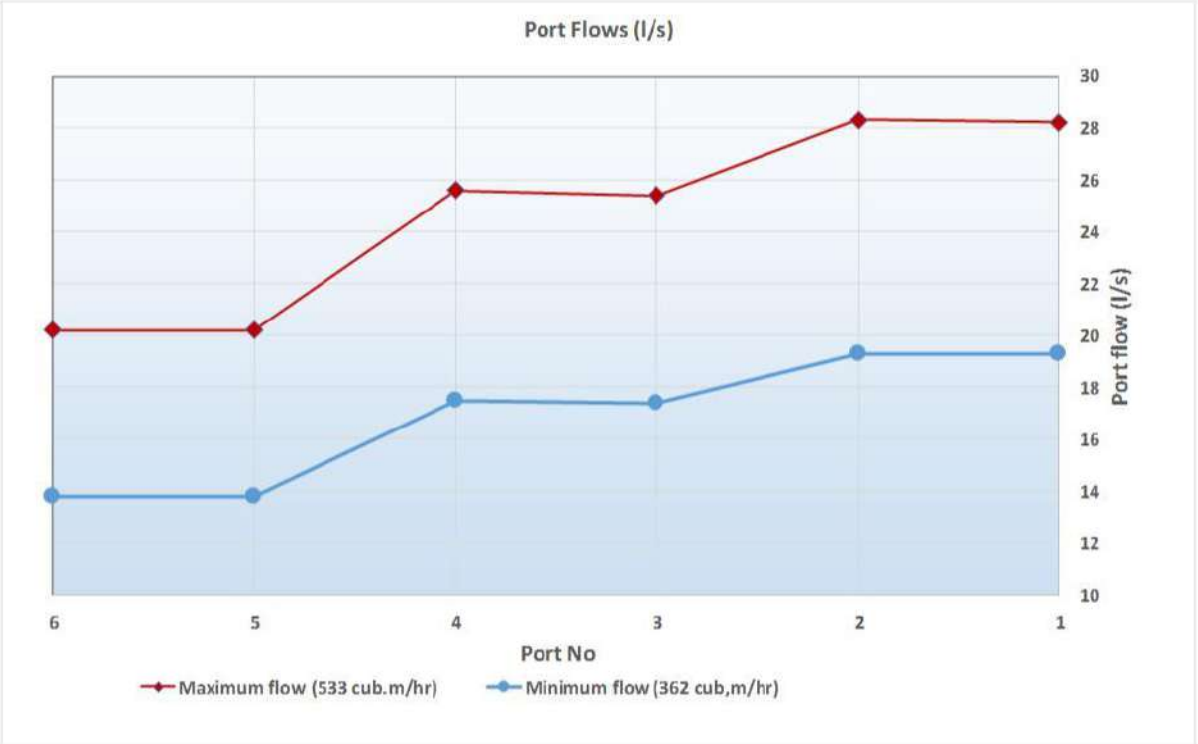

Figure 15: Diffuser Hydraulics: Port Flows

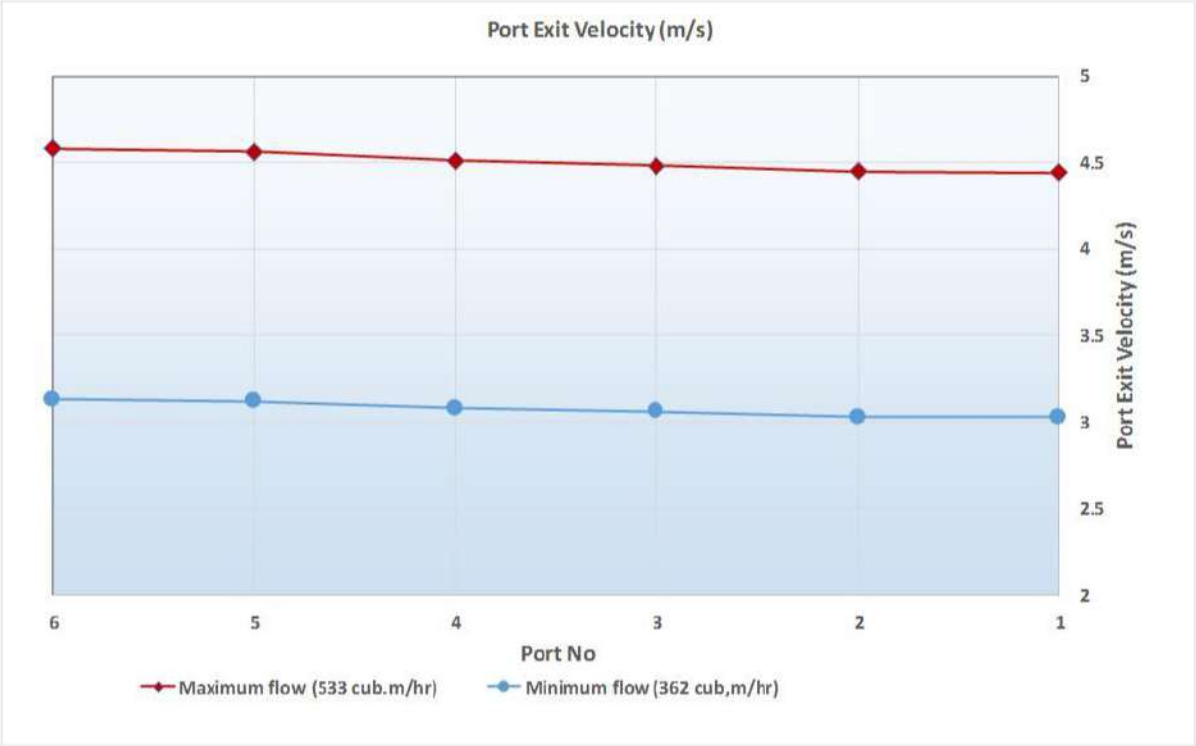

Figure 16: Diffuser Hydraulics: Port Velocities

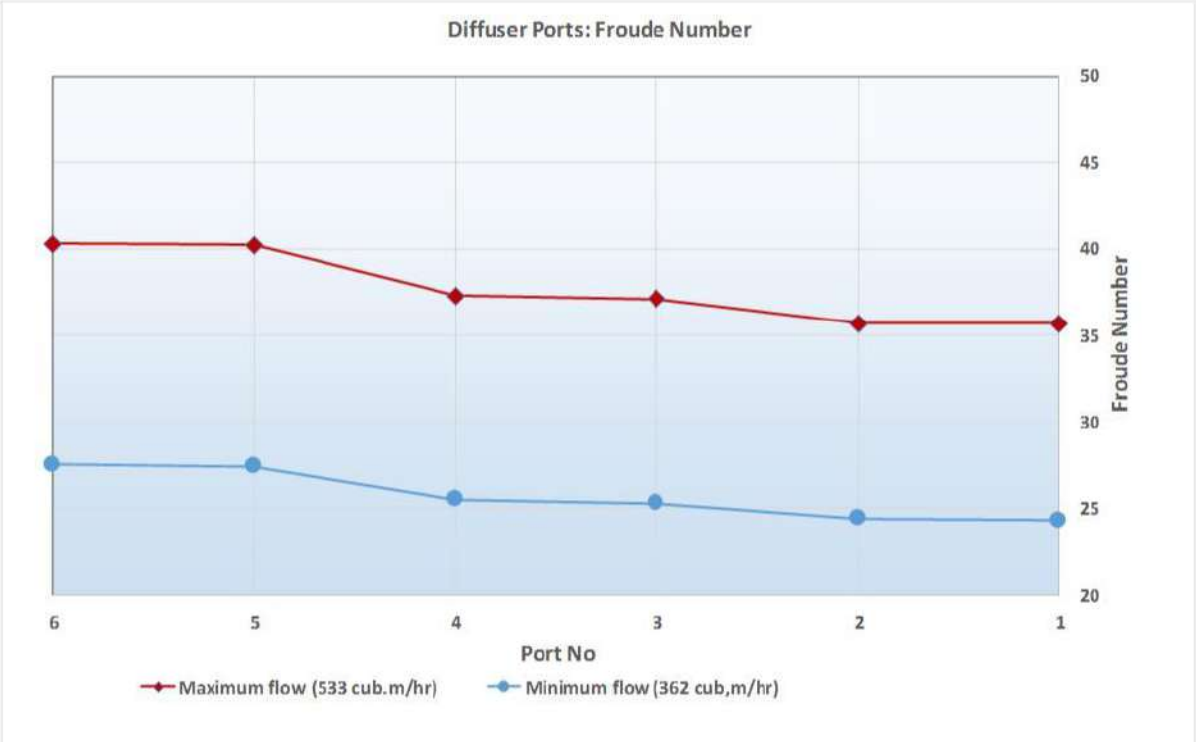

Figure 17: Diffuser Hydraulics: Densimetric Froude Numbers: Effluent salinity: 58.6 ppt

8.4 ACHIEVABLE DILUTIONS

The total dilution of conservative constituents at a distant location can be considered as two distinctive processes that is initial dilution when the effluent stream is injected into the receiving water body and secondary dilution where the waste field is transported to a distant location.

The achievable initial dilutions, rise heights and boil diameters for the three brine scenarios (salinity concentrations) and for weak, average and maximum current velocities with discharging rates of 148 l/s (533 m^3/s) and 101 l/s (362 m^3/s) are summarized in Tables 9 to 10 and the performance of the entire diffuser (all 6 ports) is illustrated in Figures 18 to 23. The geometry of the rising plume is illustrated in Figure 24.

Table 9: Dilutions and Plume Geometry for a maximum discharge rate of 533 m^3/hr.

Currents	Salinity (ppt)	Initial Dilutions (*)	Rise Height (m)	Boil Diameter (m)	Distance to Terminal Height (m)
Weak (1 cm/s)	51.9	27 (16)	4.8	1.6	4.3
	55.6	25 (14)	4.9	1.5	4.0
	58.6	24 (16)	4.9	1.4	3.5
Average (10cm/s)	51.9	36 (12)	4.9	1.6	4.9
	55.6	31 (14)	4.9	1.4	4.5
	58.6	26 (16)	4.9	1.3	4.4
Max (20 cm/s)	51.9	52 (12)	4.9	1.6	5.9
	55.6	40 (14)	4.9	1.4	4.7
	58.6	31 (16)	4.0	1.3	4.1
(*): Required Dilution					

Table 10: Dilutions and Plume Geometry for a minimum discharge rate of 362 m^3/hr.

Currents	Salinity (ppt)	Initial Dilutions (*)	Rise Height (m)	Boil Diameter (m)	Distance to Terminal Height (m)
Weak (1 cm/s)	51.9	18 (16)	4.9	1.1	2.8
	55.6	17 (14)	2.7	1.0	2.6
	58.6	16 (16)	2.5	0.9	2.3
Average (10cm/s)	51.9	21 (12)	2.1	1.0	3.2
	55.6	19 (14)	2.7	0.9	3.0
	58.6	16 (16)	2.5	0.8	2.6
Max (20 cm/s)	51.9	29 (12)	2.7	1.6	3.1
	55.6	22 (14)	2.4	0.9	2.9
	58.6	17 (16)	2.2	0.9	2.6
(*): Required Dilution					

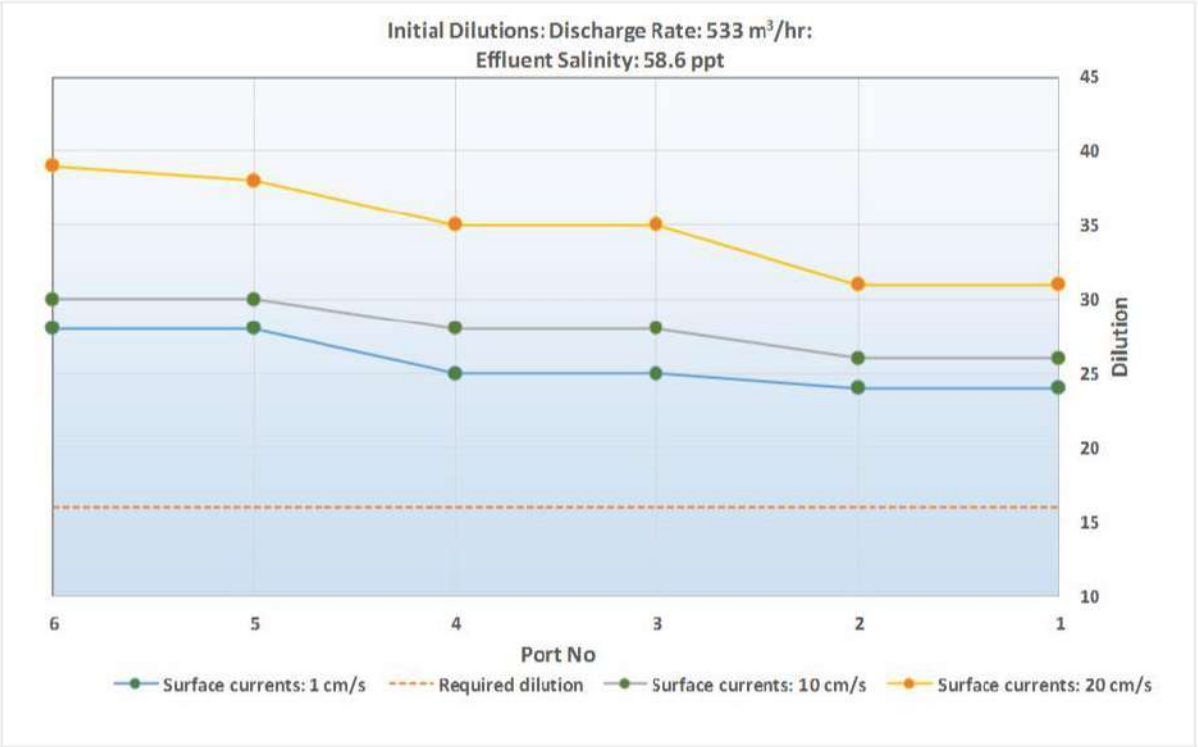

Figure 18: Achievable Initial Dilutions: Maximum flow: 533 m^3/hr. Effluent: Salinity = 58.6 ppt

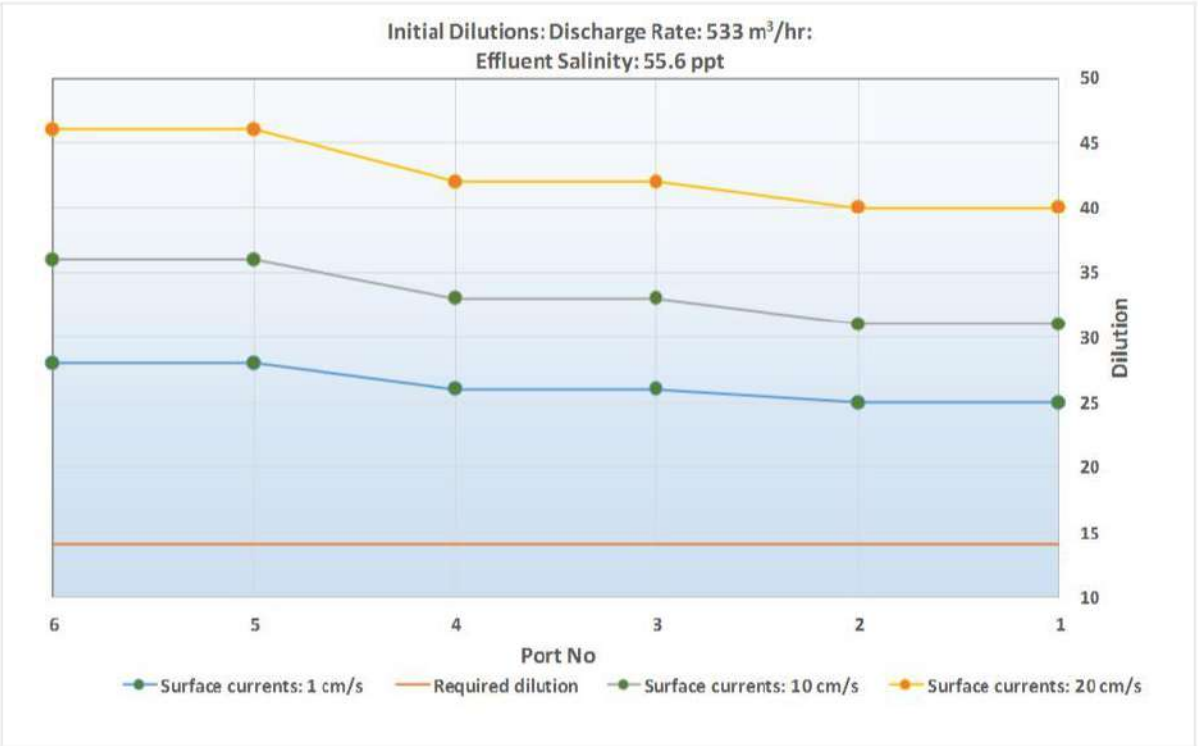

Figure 19: Achievable Initial Dilutions: Maximum flow: 533 m^3/hr. Effluent: Salinity = 55.6 ppt

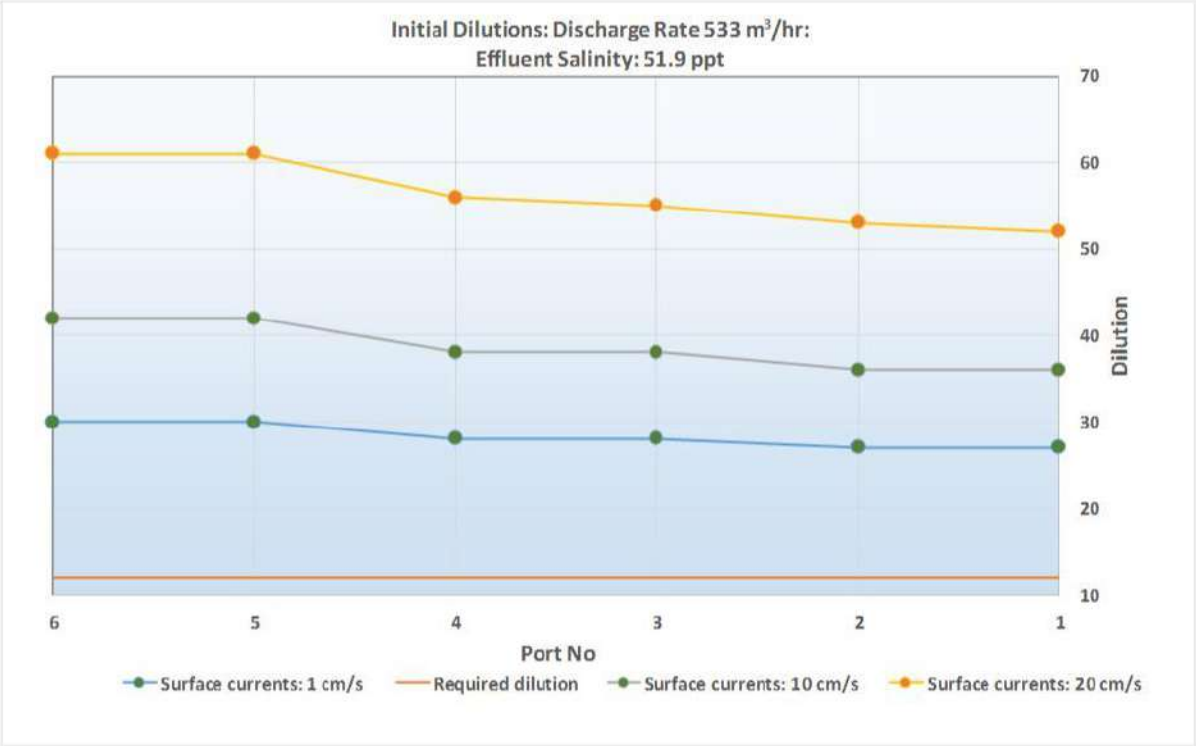

Figure 20: Achievable Initial Dilutions: Maximum flow: 533 m^3/hr. Effluent: Salinity = 51.9 ppt

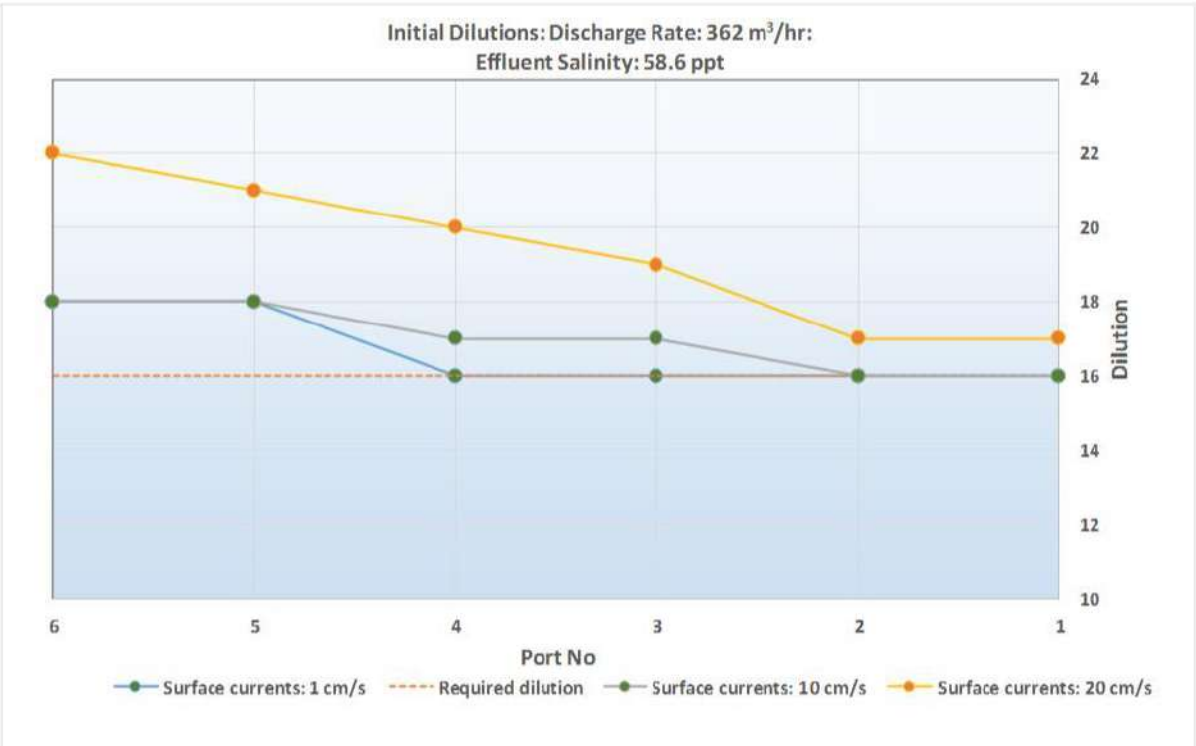

Figure 21: Achievable Initial Dilutions: Minimum flow: 362 m^3/hr. Effluent: Salinity = 58.6 ppt

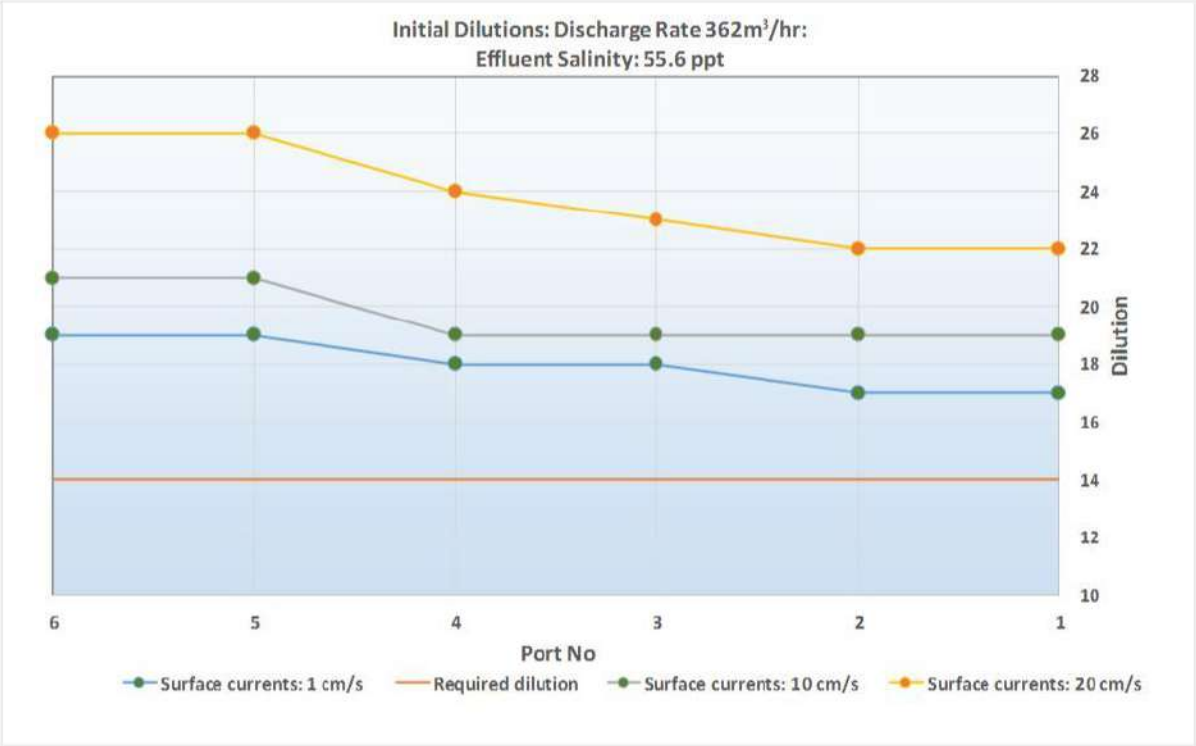

Figure 22: Achievable Initial Dilutions: Minimum flow: 362 m^3/hr. Effluent: Salinity = 55.6 ppt

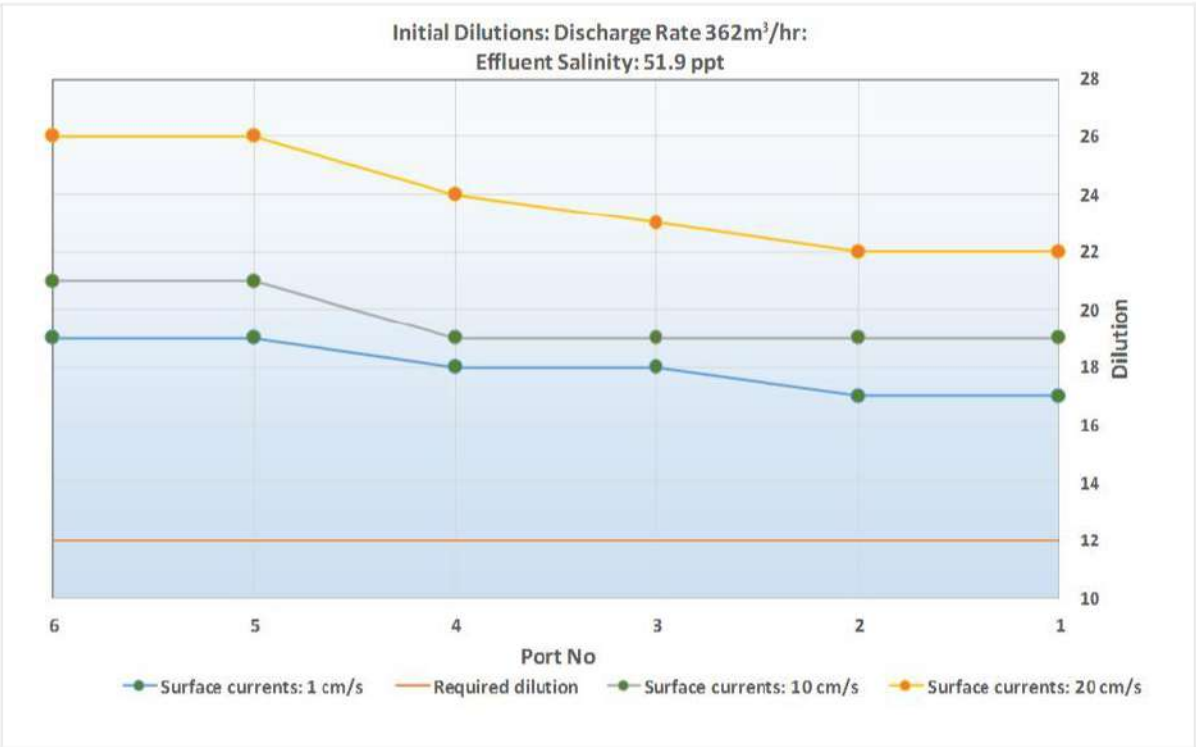

Figure 23: Achievable Initial Dilutions: Minimum flow: 362 m^3/hr. Effluent: Salinity = 51.9 ppt

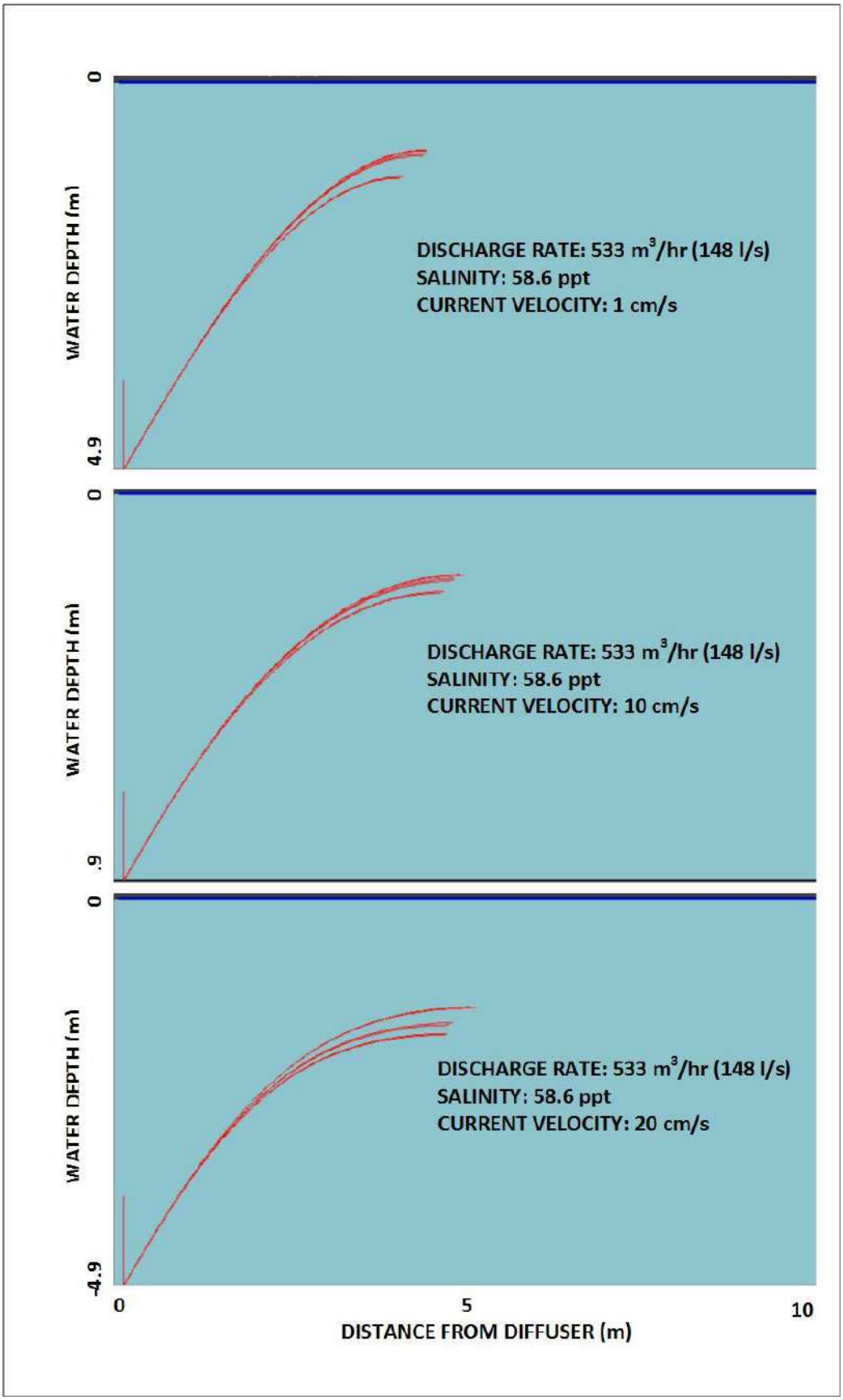

Figure 24: Plume Geometry: Centre line of the brine plume

9 COMPLIANCE TO WATER QUALITY OBJECTIVES

At this stage the only critical parameter for the brine outfall is salinity. Compliance to the water quality guidelines will be within 10 m from the diffuser (discharge location) for Option 1, 2 and 3. For maximum and minimum discharge rates (gravity release) and only salinity (minimum, operational and maximum) which is of relevance to marine water quality guidelines, the required dilutions are achieved during the initial dilution process for a conceptual outfall design, and the "mixing zone" is limited to an area of 200 square meter.

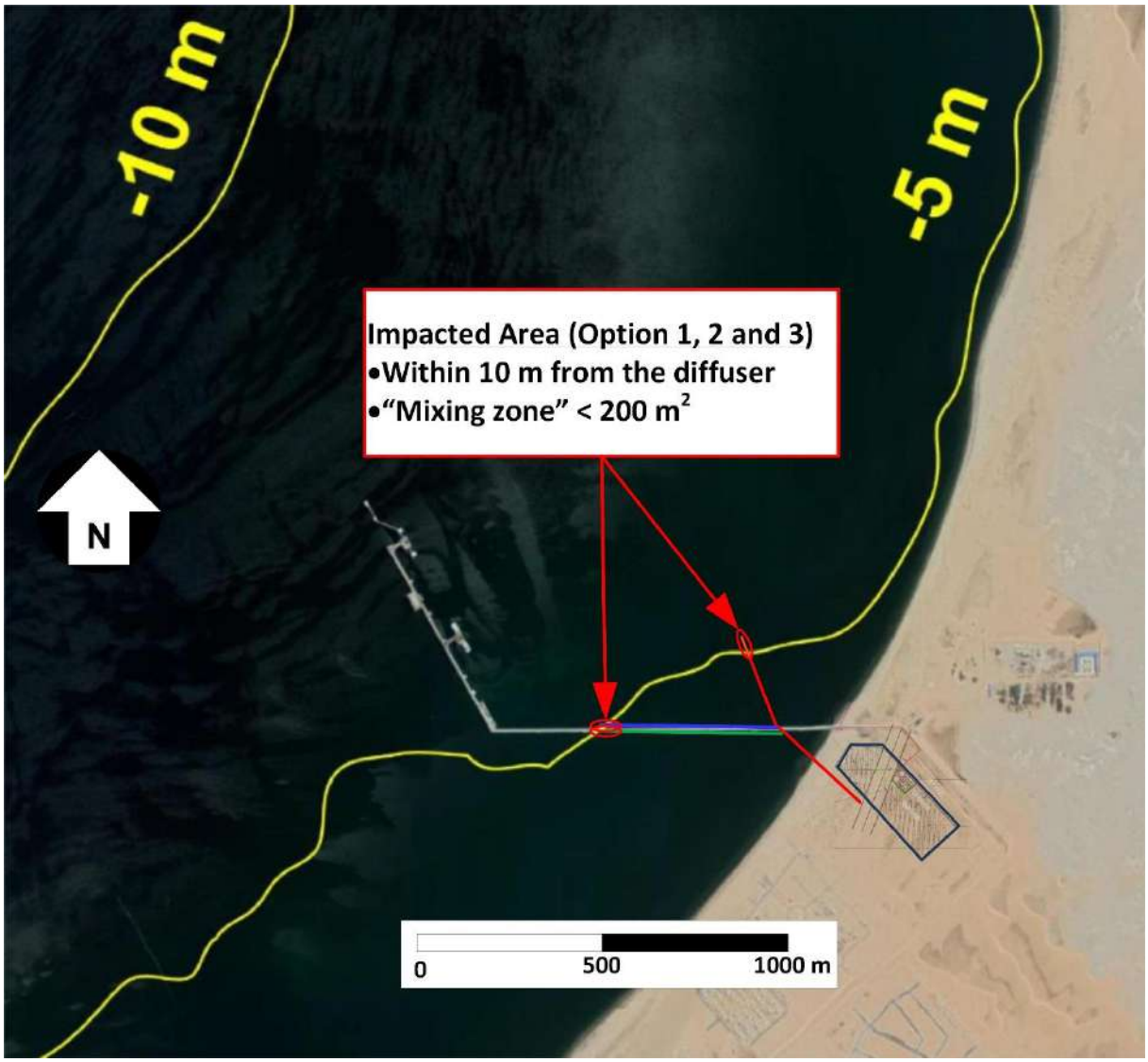

Figure 25: Mixing zone (impacted area) for Option 1, 2 and 3

10 CONTINGENCY PLANS AND DECOMMISSIONING

10.1 CONTINGENCY PLANS

Contingency planning is required to prevent or minimise potentially negative impacts on the receiving environment both during the construction and the operational phases (DWAF, 2004).

Construction phase: For Option 2 and 3 outfall the pipe will be buried below the lowest possible seabed profile in the surf zone area (between HAT (Highest Astronomical Tide) and LAT (Lowest Astronomical Tide). During construction, potentially significant negative impacts (onshore and offshore) typically relate to the method of construction (trenching at the shore-crossing and offshore pipe laying). Contingency plans and mitigation measures must be specified and incorporated in clauses in the construction contract documents. These clauses must include alternatives for ensuring minimum impact, monitoring programmes for the duration of the construction phase, mitigation measures, and specifications for reinstatement and rehabilitation (especially for the shore-crossing of the pipeline).

For Option 1 the outfall will be linked to the existing structures of the Liquid Bulk Terminal, thus activities to the marine environment will be limited (onshore as well as offshore) and impacts during this phase will be insignificant.

Operational phase: Plans and mitigation measures during the operation phase of a marine outfall relate mainly to accidental damage or failure of the system to perform to expected standards.

- Deviations from specifications and procedures:
    - Increased flows which will have adverse effects on the achievable dilutions. However, the discharge relates to the capacity of the RO plant, with specific capacities and the pump capacities will be related to the design discharge rate. Storage volumes should be re-considered as this is a practical and cost effective approach if plant is still to be constructed.
    - Deviation from design effluent quality (salinity or other constituents) which will have an effect on the required dilutions and adverse impact on the mixing zone and impacted area.
        - A datalogger will provide data continuously (also with visual readings) at a predetermined sample frequency, and deviations should be easily to detect.

- Equipment/plant or outfall breakdown
    - Electrical and mechanical breakdowns: Electrical power failures (local network or national power supply)
        - Gravity head will be sufficient for the discharge of the brine effluent (no pumps except for the primer pump for Option 1).
        - A full preventative maintenance plan and schedule will be in place.

- Damage to main pipeline or diffuser:
  - The main pipeline is in < 5 m waterdepth and marine traffic of larger vessels is limited. Traffic will also be limited because the pipeline is adjacent to the jetty of the Bulk Liquid Terminal.
  - For Option 2 and 3 the diffuser (stainless steel) will be anchored (concrete weights). For Option 1 the diffuser will be secured to the structure of the Liquid Bulk Terminal.

10.2 DECOMMISSIONING

For Option 2 and 3 the exposed main pipeline on the seabed and diffuser should be removed without any impact to the marine environment. The area must be reinstated to the condition prior to construction of the outfall.

For Option 1 the entire pipeline should be removed from the structures of the Liquid Bulk Terminal, except if it can be used for other purposes.

11 MONITORING

11.1 Compliance Monitoring

For licensing purposes (permits) the following will have to be monitored, logged and reported:

- *Flow (discharge rates):* The sampling frequency need to be sufficient to resolve the actual *variability* in the wastewater volume.

- *Critical constituents in the effluent:* The list of constituents to be monitored will depend on the composition of the wastewater, while the frequency of monitoring needs to reflect the actual *variability* in wastewater composition.

At this stage only salinity is identified. Flow as well as constituent monitoring can be done automatically by using flow and CST (Conductivity, Salinity, Temperature) dataloggers.

11.2 System (Performance and Physical Monitoring)

Because the water depth at the diffuser is only -5 m to MSL and the sheltered environment, the physical condition of the diffuser and the performance with regard to port discharges can easily be inspected by divers. The performance with regard to port discharges can be conducted by the injection of a visual tracer (such as Rhodamine B). Blocked or partly blocked ports will be easily identified.

11.3 Environmental Monitoring

For the present effluent quality, environmental monitoring is not considered essential, except if required by a license or permit. If other monitoring programs are in place, results (reports) can be assessed in order obtain a holistic overview of the environmental health of the area when considering the waste load contribution from this outfall.

12 SUMMARY AND CONCLUSIONS

Effluent flows and quality

- The discharge of the brine effluent will be intermittent gravity flow from an elevated brine reservoir with discharge rates varying between 533 m^3/hr and 362 m^3/hr.

- At this stage the quality of the effluent relates to salinity only (51.9 ppt, 55.6 ppt and 58.6 ppt).

Required dilutions

- The three effluent scenarios (salinity concentrations of 51.9 ppt, 55.6 ppt and 58.6 ppt) require dilutions of 12, 14 and 16 respectively.

Outfall system

- Main pipeline:
    - Material: HDPE: 355 mm OD (311.65 mm ID).
    - Length and route:
        - Option 1: Approximate 1145 m, secured to the Bulk Liquid Terminal.
        - Option 2: Approximate 600 m, buried between HAT and LAT.
        - Option 3: Approximate 1055 m, buried between HAT and LAT.

- Diffuser:
    - Depth: -5 m below MSL.
    - Stainless steel with two tapers and 6 ports (2 x 0.075 mm ID, 2 x 0.085 mm ID and 2 x 0.09 mm ID) at 2000 mm intervals.

Compliance to water quality criteria

- Required dilutions for Option 1, 2 and 3 were achieved during the initial dilution process within 10 m from the diffuser.
- "Mixing zone" (sacrificial area) is < 200 m^2.

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14 APPENDICES

14.1 APPENDIX A: STATUTORY OBLIGATIONS

Namibian Ports Authority Act, No. 2 of 1994

In terms of this Act **Namport is responsible for "protecting the environment" within its demarcated area** of control.

Although open-ended, the Act does afford Namport the power to monitor and regulate activities within the ports and adjacent bays. However, there **may be uncertainty as to who is responsible for enforcing this as the Ministry of Fisheries and Marine Resources has overall responsibility for all living marine resources and the Ministry of Agriculture, Water and Rural Development responsibility for water quality and marine pollution from land-based sources**. (*Tarr et al, 2004*).

Seashore Ordinance, No. 37 of 1958

The Sea Shore Ordinance is very similar to the Sea-shore Act, discussed above. It makes provision for the **definition of the seashore, high water and low water marks**, and empowered the former Administrator of Namibia (during the South African occupation) to make regulations concerning the use of the seashore, including regulations **regulating the deposit or discharge of rubbish and the like on the seashore or in the sea within 3 nautical miles offshore. This Ordinance does not appear to have been implemented nor have regulations been made under it.** (*Tarr et al, 2004*).

Water Act, No. 54 of 1956

This is the **principal law dealing with water pollution in Namibia**. The Act is administered by the Department of Water Affairs (DWA) within the Ministry of Agriculture, Water and Rural Development (MAWRD). It is a criminal offence in terms of the Act (section 22) to – "**Pollute freshwater or the sea in a way that makes the water less fit for any purpose** for which it is or could be used by people, **including use for the propagation of fish or other aquatic life, or use for recreational or other legitimate purpose**."

The Act requires that **water used for industrial purposes be purified before it is returned to a public stream or the sea**, so as to conform with requirements established by the Minister of Agriculture, Water and Rural Development, **but may be exempted from doing so, subject to certain conditions**. The Minister in this instance may issue a **permit to allow the discharge of waste water, effluent or**

waste in a un-purified or semi-purified state into a public stream, subject to such conditions that it does not cause pollution of "public or other water, including sea water" or provided that the discharge point is sufficiently close to the sea that no person will be prejudicially, and no aquatic or marine life detrimentally, affected by such discharge.

The **definition of pollution is missing from this Act**, which is a significant omission. Whilst the existing **Act covers only marine pollution from land based sources**, and is therefore of little consequence for the activities under this study, the new draft *Water Resources Management Bill* does not appear to cover the water quality of the marine environment either. (*Tarr et al, 2004*).

Marine Resources Act, No. 27 of 2000

This Act is designed to **provide for the conservation of the marine environment** in Namibia, for the responsible utilisation, protection and promotion of marine resources, and for control over marine resources. This **act replaces the Sea Fisheries Act, 1992** and the Sea Birds and Seals Protection Act, 1973. It provides for the appointment of fishery inspectors and observers, for the establishment of a Fishery Observer Agency, a Marine Resources Advisory Council, and a Marine Resources Fund. It lists requirements for commercial harvesting of resources and measures for the management and control of fisheries.

The Act allows in Article 51 for the establishment of Marine Reserves, while Article 52 imposed penalties on dredging or extraction of sand and gravel in Marine Reserves, **discharges or deposits waste or any other polluting matter and discharges in Namibian waters of anything which may be injurious to marine resources or which may disturb the ecological balance**. (Tarr et al, 2004).

Government Notice No. 5111(No. 316 of 2012) - Regulations relating to Namibian islands' marine protected area: Under section 61 of the Marine Resources Act, 2000 (Act No. 27 of 2000) read with section 51 of that Act, the Minister has made the regulations set out in the Schedule. Zonations – 4

1) The Namibian Islands' Marine Protected Area consists of an all-encompassing buffer zone, further subzoned into four degrees of increasing protection. The approved conditions enforceable in each zone are contained in the management zonations for the Namibian Islands' Marine Protected Area.
2) Zone 1 represents the buffer zone with generalized and fewest restrictions, applicable to all islands, islets, rocks and areas specifically mentioned, as stipulated in Part 6.
3) Enforceable conditions for Zone 2 apply to near-shore and on-shore mining areas up to a water depth of 30m.
4) Zone 3 restrictions are enforceable to a perimeter of 120 m (or less in specified cases in the approved management zonations) around each island, islet or rock.
5) Zone 4 represents areas of priority conservation and highest protection status and is in force on the islands, islets, rocks, rock lobster sanctuaries and line fish sanctuaries.

Prohibition on trawling in the MPA: 'Trawling activities may not be undertaken in the Namibian Islands'
Marine Protected Area.' Regulations related to mining are stipulated for specific areas and only 1% of the EPL's registered area may be mined annually (See the regulations for details).
(*SOLBAKKEN, 2014*).

Environmental Management Act of Namibia (2007)

In terms of section 58 of this Act, the Environmental Management Act came into force on the 6th of February 2012, as determined by the Minister of Environment and Tourism (Government Notice No. 28 of 2012). Under section 56 of the Environmental Management Act, 2007 (Act No.7 of 2007), the Minister has made the regulations for Environmental Impact Assessment as set out in the Schedule of Government Notice No. 30 (2012). These regulations require that all projects, plans, programs and policies that have a detrimental effect on the environment must be accompanied by an EIA. Under section 27 of the Environmental Management Act, 2007 (Act No. 7 of 2007), and after following the consultative process referred to in section 44 of that Act, the Minister lists in the Annexure to the above mentioned Schedule, activities that may not be undertaken without an environmental clearance certificate (Government Notice No. 29 of 2012). The Act and Regulations need to be given due consideration, particularly to achieve proper waste management and pollution control:

Cradle to Grave Responsibility
This principle provides that those who manufacture potentially harmful products must be liable for their safe production, use and disposal and that those who initiate potentially polluting activities must be liable for their commissioning, operation and decommissioning.

Precautionary Principle
There are numerous versions of the precautionary principle. At its simplest it provides that if there is any doubt about the effects of a potentially polluting activity, a cautious approach must be adopted.

The Polluter Pays Principle
A person who generates waste or causes pollution must, in theory, pay the full costs of its treatment or of the harm, which it causes to the environment.

Public Participation and Access to Information
In the context of environmental management, citizens must have access to information and the right to participate in decision making.

(*SOLBAKKEN, 2014*).

Aquaculture Act (2002)

The Act states in Section 26 with regards to water quality monitoring that:

"(1) The Minister must, for the purpose, of aquaculture, cause a water quality monitoring system to be established and maintained to provide timely information to licensees of the occurrence or imminent occurrence of any pollution or natural phenomenon which may have a harmful or detrimental effect on the aquatic environment or any aquaculture product.
(2) Where any area of Namibian waters in which aquaculture is conducted is affected by any pollution or natural phenomenon, the Minister must immediately order the testing of the water of the affected area and of the aquaculture products farmed in or with such water to determine:-
(a) whether aquaculture activities can be undertaken and continued; and
(b) in consultation with the Minister responsible for public health, whether the aquaculture products farmed therein are fit for human consumption;
(c) in consultation with the Minister responsible for trade prevent the sale or marketing of aquaculture products that are unfit for human consumption.
(3) If the results of the tests ordered by the Minister under subsection (2) show that: -
(a) the water quality of the affected area is unsuitable for the continuation of aquaculture; or
(b) the aquaculture products farmed therein are not fit for human consumption, the Minister must immediately, by notice in at least two newspapers circulating in the country, order the closure of the aquaculture facility and may prohibit the sale or marketing of aquaculture products farmed therein."

(*SOLBAKKEN, 2014*).

Atmospheric Pollution Prevention Ordinance of Namibia (No. 11 of 1976)

Part 2 of the Ordinance governs the control of noxious or offensive gases. The Ordinance prohibits anyone from carrying on a scheduled process without a registration certificate in a controlled area. The registration certificate must be issued if it can be demonstrated that the best practical means are being adopted for preventing or reducing the escape into the atmosphere of noxious or offensive gases produced by the scheduled process (*SOLBAKKEN, 2014*).

Hazardous Substances Ordinance (No. 14 of 1974)

The Ordinance applies to the manufacture, sale, use, disposal and dumping of hazardous substances, as well as their import and export and is administered by the Minister of Health and Social Welfare. Its primary purpose is to prevent hazardous substances from causing injury, ill-health or the death of human beings (*SOLBAKKEN, 2014*).

Regional Councils Act, Act 22 of 1992

This sets out the powers, duties, functions, rights and obligations of Regional Councils (section 28). Of

relevance to the coastal area are the powers to undertake, with due regard to the powers and functions of the National Planning Commission (NPC), and any other law relating to planning: "the planning of the development of the region for which it has been established with a view to – the physical, social and economic character of such region; the distribution, increase and movement and the urbanization of the population in such region; the natural and other resources and the economic development potential of such region; the existing and planned infrastructure, such as water, electricity…in such region; the general land utilization pattern; the sensitivity of the natural environment". This provides the legal basis for the drawing up of Regional Development Plans (RDPs) for the Regions. Although initiated and guided by the NPC the Regional Councils play a central role in developing RDPs (*SOLBAKKEN, 2014*).

Water Resource Management Act, 2013 (Act .11 of 2013)

This Act provides a framework for managing water resources based on the principles of integrated water resource management. It provides for the management, development, protection, conservation, and use of water resources. This Act has not been approved by parliament, however it is best practice to comply with this Act. (ECC, 2018)

Draft Pollution Control and Waste Management Bill (1999)

The Bill amalgamates a variety of legislative frameworks in Namibia, regulating pollution in different sectors of the economy. The Bill promotes sustainable development; to provide for the prevention and regulation of the discharges of pollution. (ECC, 2018)

14.2 APPENDIX B: STATUTORY OBLIGATIONS: CONVENTIONS AND AGREEMENTS

BCLME Projects: Land-Based Marine Pollution in the BCLME Region

Baseline Assessment of Sources and Management of Land-Based Marine Pollution in the BCLME Region. CSIR (2006).

The primary purpose of this project was to standardize on the approach and methodology with which land-based pollution sources in the BCLME region are managed. This was achieved through the preparation of a generic (draft) management framework for the management of such sources, including protocols for the design of baseline measurements and long-term monitoring programmes.

The proposed framework for the management of land-based marine pollution sources in the BCLME region is largely based on a framework that was developed for the Department of Water Affairs and Forestry (South Africa) as part of their *Operational Policy for the Disposal of Land-derived Wastewater to the Marine Environment of South Africa* (RSA DWAF, 2004a&b). However, the proposed framework still needs to be **officially approved and adopted** by responsible government authorities in Namibia and Angola. It may well be that individual countries require further refinement or adjustment of the management framework to meet requirements specific to their own countries.

The management framework developed as part of this project is **closely link to the recommended water and sediment quality guidelines** for the coastal areas of the BCLME region (developed as part of another BCLME project – BEHP/LBMP/03/04). In particular, the guidelines will assist in the initial establishment of environmental quality objectives.

The Stockholm Declaration on the Human Environment, Stockholm 1972

Namibia adopted the Stockholm Declaration on the Human Environment on 28 August 1996. It 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".
Among the proclamations are, in short:

- Natural resources must be protected
- Wildlife must be protected
- Pollution must not exceed the environment's capacity to clean itself
- Oceanic pollution that is damaging must be prevented
- Rational Planning must prevent or resolve conflicts between environment and planning

(*SOLBAKKEN, 2014*).

United Nations Law of the Sea Convention (1982)

Namibia ratified the convention in 1994 and is thus obliged to protect and preserve the marine environment. This includes the prevention, reduction and control of pollution of the marine environment (*SOLBAKKEN, 2014*).

Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London Convention, 1972)

The Convention also aims at control and prevention of marine pollution. It contains special guidelines for dredged material known as the Dredged Material Assessment Framework. It provides guidelines for dredging and disposal operations to minimize environmental damage. Namibia must still ratify the convention (*SOLBAKKEN, 2014*).

14.3 APPENDIX C: STATUTORY OBLIGATIONS: POLICIES

Namibia's Green Plan (1992)

With respect to pollution, the Green Plan notes the need for new comprehensive legislation to address effluent treatment and disposal methods and standards, and also states that - *"more effective legislation is needed to control pollution. An awareness of polluter responsibility should be promoted and fines increased in line with current market values".* The Green Plan also calls for, *inter alia*, the establishment of a national body to be responsible for waste management as well as the preparation and adoption of a national waste reduction plan, backed up by legislation. In respect of hazardous waste, the Green Plan notes that the most important shortcoming is the lack of effective legislation to control the disposal and processing of hazardous waste produced in Namibia. (*Tarr et al, 2004*).

Namibia's Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1995)

The Ministry of Environment and Tourism published the Policy which was approved by Cabinet in 1995. This policy requires that all policies, programmes and projects, as listed in the Policy, whether they are initiated by the government or private sector, should be subject to an Environmental Assessment (EA). The list of policies, programmes and projects requiring an EA is comprehensive and **includes any policy, programme or project on the use of natural resources as well as structure plans, land acquisition for parks and reserves (including marine),** mining and mineral exploration, ports and harbours, reclamation of land from the sea, salt works, mariculture, tourism and recreation facilities, **effluent and desalination plants**, to name but a few. The format and requirements for an environmental assessment are laid out in the policy. The purpose of the policy is seen as informing

decision makers and promoting accountability, ensuring that alternatives and environmental costs and benefits are considered, promoting the user pays principle, and promoting sustainable development. *(Tarr et al, 2004*).

Draft Environmental Management Bill

The purpose of the Bill is to – "give effect to Article 95(l) of the Namibian Constitution by establishing general principles for the management of the environment and natural resources; to promote the coordinated and integrated management of the environment; to give statutory effect to Namibia's Environmental Assessment Policy; to enable the Minister of Environment and Tourism to give effect to Namibia's obligations under international conventions."

The Bill sets out various environmental rights and duties: it ensures that proponents and decision makers can be held accountable to the public, and sets out the following list of principles for environmental management:

With reference to waste discharges to the **marine environment**":

- The **precautionary principle** and the principle of preventative action shall be applied
- Namibia's moveable and immoveable cultural and natural heritage, including its **biodiversity**, shall be protected and respected for the benefit of current and future generations
- Generators of waste and polluting substances shall **adopt the best practicable environmental option** to reduce such generation at source
- The **'polluter pays' principle** shall be applied
- **Reduction, re-use and recycling** shall be promoted

The Bill defines pollution as "The **direct or indirect introduction**, as a result of human activity, **of substances**, vibrations, heat, radiation or noise into the air, water or land which may be harmful to human health or well-being or the quality of the environment, result in damage to material property, or **impair or interfere with amenities and other legitimate uses of the environment**."

(Tarr et al, 2004)

Draft Pollution and Waste Management Bill

The purpose of this Bill is to **regulate and prevent discharge of pollutants** to the air, **water** and land in Namibia, and to enable the country to fulfil its international obligations in this regard. With respect

to water pollution, the draft Bill **forbids any person from discharging or disposing of pollutants into any water or water course** aside from the discharge of domestic waste from a private dwelling or the discharge of pollutants or waste to a sewer or sewage treatment works, without a water pollution license.

Such license must:

- Specify the **amount of pollutants** that may be discharged over a specified period;
- The **locations of pipes or structures** from which discharges may take place
- Any **treatment or pre-treatment** to which pollutants must be subject to prior to discharge;
- The **design, construction, operation and maintenance** of any structures required to achieve this;
- Requirements for **monitoring and reporting** of the amount and rate of discharges;
- Provision for **seasonal and other variations that may occur** in the amount of pollutants which may be discharged.

The Bill requires that the application for a water pollution license must be accompanied by details of the activity to which the application relates, including the **nature and location of the activity and its actual and potential effects on the environment**. Members of the public must be given the opportunity to comment on all license applications.

(Tarr et al, 2004)

Walvis Bay Lagoon Integrated Environmental Management Plan (1998)

The Management Plan sets out measures to be implemented to manage the Lagoon and avoid environmental impacts, preserve the ecological integrity as well as promote and encourage sustainable use of the Lagoon. (ECC, 2018)