Gas to Power Project:

Coastal, Estuarine and Marine Impact Assessment Report

Port of Richards Bay

A project for Triplo4 Sustainable Solutions

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GroundTruth
Water, Wetlands and Environmental Engineering

ANCHOR environmental

COASTWISE CONSULTING

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Specialist Report Requirements as per EIA Regulations 2014 (as amended)

Table 1 outlines the requirements of the Specialist Reports as per the NEMA EIA Regulations, 2014 (as amended). According to Appendix 6 (1) "A specialist report prepared in terms of these Regulations must contain …" the information outlined in the table below and these are subsequently included in this report at the indicated sections.

Table 1. Prescribed contents of the Specialist Reports (Appendix 6 of the EIA Regulations, 2014)

Relevant section in GNR. 982	Requirement description	Relevant section in this report
(a) details of—	(i) the specialist who prepared the report; and	Report details & Section 13.3
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 13.4.1
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 13.4.2
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 2
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 3.1 & 6
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6.10 & 0
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 3.3, 6 & 7
(g)	an identification of any areas to be avoided, including buffers;	Section 0
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 4.5, 5.3.4 and 7.2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	In Disclaimer, Assumptions and Limitations section
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6, 7 & 0
(k)	any mitigation measures for inclusion in the EMPr;	Section 0, (per identified impact)
(l)	any conditions for inclusion in the environmental authorisation;	Section 0
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 11
(n) a reasoned opinion—	(i) whether the proposed activity, activities or portions thereof should be authorised;	Section 10
	(iA) regarding the acceptability of the proposed activity or activities; and	Section 9 & 10

	(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 10
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Detailed in the consolidated stakeholder engagement report
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Detailed in the consolidated stakeholder engagement report
(q)	any other information requested by the competent authority.	Report updated with required amendments
(2)	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3,6,7,0,9, 10 & 11

Executive Summary

This specialist coastal, estuarine and marine impact assessment report was prepared by Coastwise Consulting, GroundTruth Water Wetlands and Environmental Engineering (GroundTruth), Lwandle Technologies (Pty) Ltd and Anchor Environmental Consultants (Pty) Ltd as part of an Environmental Impact Assessment (EIA), undertaken behalf of Karpowership SA (Pty) Ltd (KSA) by Triplo4 Sustainable Solutions (Pty) Ltd (Triplo4) for the deployment of a floating power plant facility at the Port of Richards Bay. This report adopts a polycentric or holistic approach to the assessment of impacts and should therefore be read in conjunction with various other specialist reports.

The scope of this assessment included undertaking a site investigation, updating the previous desktop assessment, conducting an assessment of potential impacts, including cumulative impacts, and making recommendations and proposing measures to mitigate negative impacts and optimise positive impacts.

Key informants considered included: relevant international treaty's, the National Environmental Management Act (Act No. 107 of 1998, as amended); the Integrated Coastal Management Act of 2008 (Act No. 24 of 2008, as amended) including the various coastal management programmes and the updated 2020 National Estuarine Management Protocol; The National Water Act (Act No. 36 of 1998), the various marine pollution acts and finally the Special Economic Zones Act (Act No. 16 of 2014). Cooling water dispersion modelling, underwater noise as well as and abundant quantitative information on the marine environment within the Port of Richards Bay was considered.

A summary of the affected environment is detailed considering the broader Richards Bay/ uMhlathuze estuarine complex, one of only three <u>extremely rare</u> estuarine bays in the country, with complex marine/riverine interaction and extensive wetlands and mangrove swamps. The history of the Richards Bay and uMhlathuze estuaries and the subsequent port development is detailed taking consideration of numerous historical and recent publications, environmental studies, and environmental management and planning documents. Despite this transformation, Richards Bay still functions as a national priority important estuarine system albeit heavily modified, as well as been rated as a wetland freshwater ecosystem priority area. Ecosystem goods and services are detailed and specific attention paid to the various fisheries and mariculture sectors.

The current threats to the Richards Bay Estuary are a product of the long history of human interference, habitat modification and destruction through port development, flow modification, poor water quality, resource exploitation (fish and vegetation), urban and industrial development, and catchment related impacts, all coupled with ongoing modern-day impacts associated with port activities. These impacts contribute to physical habitat alteration/destruction, suspended solids, siltation, alteration of salinity regime, and toxic chemical pollution.

The impact assessment was undertaken using an adapted scoring to that provided by Triplo4, which was not deemed to provide a true reflection of the project situation or the findings of this assessment, specifically in relation to impact duration. Eight impacts were identified and assessed in the construction phase and an additional ten in the operational phase. It is reiterated that integrated coastal and estuarine management is a cross-cutting speciality and many of the key issues and their potential impacts have been collectively identified and addressed in the other specialist assessments. For example, matters relating to 'sense of place' and potential obstruction of views are considered in the landscape and visual specialist input.

Scoring of impacts, after mitigation measures are applied, is summarised below:

	Impact (after mitigation)	Impact Description	Significance
	CONSTRUCTION PHASE		
1	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology as a result of water-based construction activities	**Low**
2	Alternate layout 1&2	Changes in water quality as a result of water-based construction activities	**Medium-low**
3	Alternate layout 1&2	Disturbance to surrounding estuarine ecology due to increased noise levels from construction	**Medium-Low**
4	Alternate layout 1&2	Effect on ecosystem services (fisheries and mariculture) due to increased noise levels from construction	**Medium-Low**
5	**Effect on terrestrial fauna (including avifauna) as a result of construction activities**		
	Disturbance of avifauna due to increased human presence and possible use of machinery and/or vehicles.	Summary of potential impacts on avifauna associated with the construction phase of the Karpowership project – ships	**Medium-Low**
	Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)		**Medium-Low**
	Habitat Loss (Destroy, fragment and degrade CBA, ESA and ONA habitat, ultimately displacing avifauna)	Summary of potential impacts on avifauna associated with the construction phase of the Karpowership project – transmission lines and ancillary infrastructure	**Very-Low**
	Disturbance of avifauna due to increased human presence and possible use of machinery and/or vehicles.		**Medium-Low**
	Loss of fauna Species of Conservation Concern	Summary of potential impact of loss of fauna Species of Conservation Concern during construction	**Low**
6	**Effect on macrophyte habitats as a result of construction within the estuarine functional zone**		
	Loss of modified habitat	Summary of impacts associated with the construction of the Karpowership transmission line, and ancillary infrastructure on the terrestrial ecology of Richards Bay estuary	**Low**
	Loss of reed beds		**Low**
	Loss of bushveld		**Low**
	Loss of flora SCC		**Low**
	Loss of biodiversity in general		**Low**
	Fragmentation		**Low**
	Invasion of alien species		**Low**
	Establishment of a construction site camps and erection of ablution facilities within a previously disturbed area.	Summary of potential impacts of the proposed development on the surrounding watercourses/ wetlands within the Richards Bay estuary	**Negligible**
	Establishment of a construction site camps for the material laydown area, site office and concrete coating area and stringing yard.		**Low**
	Demarcation of buffer zones and no-go areas and the allocation/ preparation of spoil sites (topsoil separate from subsoil), waste dump sites and construction vehicle routes		**Negligible**
	Construction vehicle movement throughout the lifespan of the proposed development.		**Low**
	Direct destruction of vegetation and topsoil layer within the footprint of the Overhead Powerlines and temporary material laydown area, site office and concrete coating area and stringing yard		**Low**
	Construction of the 132kV Overhead Lattice Steel Structure and Switching Station		**Low / Moderate**
	Construction and installation of the gas pipeline		**Negligible**
	De-establishment of the site camp, spoil sites, waste dumps and the rehabilitation of the temporary access/haulage roads		**Negligible**

	Utilisation of the Overhead Powerlines and Switching Station		**Low/ Moderate**
7	General Construction	Effect of solid waste pollution generated during the construction period	**Low**
8	General Construction	Effect on chemical pollution arising from construction related spills of hazardous substance	**Medium-low**
	OPERATIONAL PHASE		
9	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology due to seawater intake for cooling purposes	**Medium-low**
10	Alternate layout 1&2	Effect of powership cooling water discharge on estuarine/marine ecology	**Medium**
11	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology due to increased underwater noise and vibrations	**Medium**
12	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology due to light pollution	**Medium-low**
13	Alternate layout 1&2	Effect of the combined operational impacts on ecosystem services (fisheries and mariculture)	**Medium**
14	Loss of modified habitat	Effect on macrophyte habitats and terrestrial fauna	**Low**
	Loss of reed beds		**Low**
	Loss of bushveld		**Low**
	Loss of flora SCC		**Low**
	Loss of fauna SCC		**Low**
	Loss of biodiversity in general		**Low**
	Fragmentation		**Low**
	Invasion of alien species		**Low**
	Loss of fauna Species of Conservation Concern	Summary of potential impact of loss of fauna Species of Conservation Concern during operation	**Low**
15	Habitat loss (Destroy, fragment and degrade CBA, ultimately displacing avifauna)	Effect on coastal and estuarine avifauna associated with <u>overhead transmission lines and ancillary infrastructure</u>	**Very-Low**
	Collisions with transmission lines and associated infrastructure		**Medium-Low**
	Electrocution by infrastructure and connections to transmission lines		**Medium-Low**
16	Light pollution	Effect on coastal and estuarine avifauna due to <u>operation of powerships</u> (disturbance, noise and light)	**Low**
	Noise and vibration impacts		**Medium**
	Human disturbance		**Very-Low**
17	General operation	Effect of chemical pollution arising from spills and leaks to hazardous substances, and day-to-day shipping practices	**Medium-Low**
18	Alternate layout 1&2	Effects of catastrophic accidents on estuarine/marine ecology, avifauna and ecosystem services	**Low**

While the ICM Act specifically states that coastal public property excludes port infrastructure, natural areas within the Port of Richards Bay are still considered to be part of the coastal protection zone. AS such the principles and directives contained in the Act still apply. An example is the Acts directive not to view development activities in isolation from their local and regional contexts, but rather to consider direct and indirect impacts as well as potential cumulative and synergistic impacts of proposed activities in the coastal zone. Assessing cumulative impacts involves examining the impacts of a proposed activity at a coarser scale, and in relation to adjacent and regional activities. These projects are detailed and it is concluded that the project will positively impact on the port function and the economic activities related thereto as well as compliment other technologies proposed.

Given the major modifications of the natural environment due to port development, the estuarine space in Richards Bay is already limited. The addition to the proposed powership development further reduces the space available for estuarine and marine organisms that use the environment of Richards Bay, which may cause significant spatial changes to their distribution *i.e.*, vacation of the Bay entirely. The comprehensive, quantitative assessment of cumulative impacts requires extensive input from government departments, regulating authorities and other stakeholders. Overall, cumulative impacts of the KSA Gas to Power project and the significantly larger Nseleni Independent Floating Power Plant, if operating simultaneously, are expected to be highly negative from an ecological perspective. The cumulative impacts of these two projects (if both are simultaneously approved) are anticipated to reduce the current state of the estuarine environment making the approval of both projects unworkable.

Based on the findings of this report, and specialist reports included herein, the proposed KSA Gas to Power project has the potential to impact various abiotic and biotic attributes of the Richards Bay estuary, that contribute to its overall high biodiversity, structure and function, but which are already in a highly- to critically modified condition. Notwithstanding the above, no impacts were identified as highly negative or resulting in fatal flaws that would prevent the project from proceeding (except for transmission line alternative route 2, which is not supported). Considering the overall rarity, biodiversity importance and conservation significance of the Richards Bay estuarine system, any potential negative impacts must be counter-balanced by a very strong motivation of socio-economic need and desirability for the project that would concede some level of degradation of this critical ecosystem.

Preface

This report was originally prepared by Coastwise Consulting and GroundTruth Water Wetlands and Environmental Engineering (GroundTruth), to be read in conjunction with the original Marine Ecology Specialist Report prepared by Lwandle Technologies (Pty) Ltd as part of an Environmental Impact Assessment (EIA), undertaken behalf of Karpowership SA (Pty) Ltd (KSA) by Triplo4 Sustainable Solutions (Triplo4) for the deployment of a floating power plant facility at the Port of Richards Bay on the east coast of South Africa (DEFF REF NO: 14/12/16/3/3/2/2007).

The Competent Authority for the project, Department of Forestry Fisheries and the Environment (DFFE) issued a Record of Refusal refusing Environmental Authorisation for the project on 23 June 2021. Reasons for refusing Environmental Authorisation are outlined in the Record of Refusal issued by the DFFE dated 23 June 2021 (DFFE Reference: 14/12/16/3/3/2/2007), and include the fact that the applicant did not meet the minimum requirements relating to public consultation and information gathering set out in the National environmental Management Act (NEMA 1998) and the Environmental Impact Assessment Regulations of 2014, that certain specialist studies (specifically a noise modelling study) recommended by specialists on the project had not been completed, and that all potential and actual impacts on the environment had not been fully evaluated.

Karpowership SA (Pty) Ltd appealed this decision, but the appeal was also rejected by the Minister DFFE on 5 August 2022. Reasons for the rejection are set out in a letter issued by the minister on 1 August 2022 (Ref: LSA207022). In refusing the Appeal, the Minister noted that there were gaps in information and procedural defects in relation to the process followed for the EIA that could not be corrected during the appeal process and made the decision, and in accordance with her powers under NEMA, elected to remit the KSA Environmental Authorisation to the Competent Authority in the DFFE, to enable the applicant to address the perceived gaps and procedural defects, and to resubmit the application to the Department.

Following the advice of the Minister, KSA have elected to revise and resubmit an application for Environmental Authorisation to the Competent Authority for consideration. This report now represents the combined Coastal, Estuarine and Marine Ecology (inclusive of Fisheries) Specialist Report for the EIA. The original Coastal and Estuarine Specialist Assessment prepared by Coastwise Consulting and the Marine Ecology Specialist Assessment prepared by Lwandle Technologies (Pty) Ltd have been reviewed, updated and expanded by Coastwise Consulting/GroundTruth and experts from Anchor Environmental Consultants (Pty) Ltd, respectively, and combined into a single report given the system overlap of these aspects. This revised report has taken into account changes in the project description, comments posted on the previous EIA, perceived gaps as well as integrate new information and collaborate with other relevant Specialist Studies, where there is an overlap or dependency. The constituent assessments were undertaken, and the combined report specifically designed to meet all of the requirements of NEMA (1998) and the Environmental Impact Assessment Regulations (2014).

Disclaimer, Assumptions and Limitations

This report has been prepared collectively by Coastwise Consulting/GroundTruth/Anchor Environmental, with all reasonable skill, care and diligence within the terms of the contract with Triplo4 (the 'Client'). The findings in this report are based on the author/s' professional knowledge, data and resources available at the time and relevant information provided by the Client. The nature of the study, and detail of assessment undertaken are dependent on the human and time resources committed to the study in agreement with the Client prior to the assessment.

Project assumptions and limitations include:

- Having been provided with all the relevant information required;
- Only readily available data and information were used;
- The assessments are reliant on the existing scientific literature and the reliability of the modelled outputs (plume, thermal and noise);
- Physical, chemical or biological sampling was not deemed necessary due to adequate available baseline information provided in the Long-Term Ecological Monitoring Programme for the Port of Richards Bay and other available research and studies;
- The assessment was undertaken within the timeframes prescribed by the EIA Regulations; and
- It is assumed that any significant changes made to the project mentioned above design will be conveyed to assessors in order to reassess the related impact on the receiving environment, should this be necessary.

Coastwise Consulting/GroundTruth/Anchor Environmental accepts no liability or consequential liability for the use of the outcomes or in respect of any matters outside the scope of the above contract, and the client, by acceptance of this document, indemnifies Coastwise Consulting/GroundTruth/Anchor Environmental against any liability of whatsoever nature, to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

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List of Acronyms

List of acronyms and abbreviations used in the Scoping and Impact Assessment Report:

BEEMS	British Energy Estuarine and Marine Studies	LNG	Liquefied Natural Gas
CBA	Critical Biodiversity Area	LPG	Liquid Propane Gas
CER	Centre for Environmental Rights	MARPOL	International Convention for the Prevention of Pollution from Ships
CSIR	Council for Scientific and Industrial Research	NBA	National Biodiversity Assessment
CWAC	Co-ordinated Waterbird Counts	NEMA	National Environmental Management Act (No. 107 of 1998)
DAERD	Former KZN Department of Agriculture, Environment and Rural Development	NGOs	Non-governmental Organisations
DEA	Former Department of Environmental Affairs	NIFPP	Nseleni Floating Independent Power Plant
DEFF/ DFFE	Department of Environment, Forestry and Fisheries	NWA	National Water Act (No. 36 of 1998)
DO	Dissolved Oxygen	ONA	Other Natural Areas
DWAF	Former Department of Water Affairs and Forestry	PES	Present Ecological State
EAPASA	Environmental Assessment Practitioners Association of South Africa	[the] Protocol	National Estuarine Management Protocol
EBSA	Ecological or Biologically Significant Marine Area	PTS	Permanent Threshold Shift
EDC	Estuarine Dependence Category	RBIDZ	Richards Bay Industrial Development Zone
EDTEA	KZN Department of Economic Development, Tourism and Environmental Affairs	REC	Recommended Ecological State
EFZ	Estuarine Functional Zone	RMS	Root-Mean-Square pressure
EHI	Estuarine Health Index	RQOs	Resource Quality Objective(s)
EIA	Environmental Impact Assessment	SANBI	South African National Biodiversity Institute
EMP	Estuarine Management Plan	SAR	Situation Assessment Report
ESA	Ecological Support Area	SCC	Species of Conservation Concern
FEPA	Freshwater Ecosystem Priority Area	SEL_{cum}	Cumulative Weighted Sound Exposure Criteria
FSRU	Floating Storage Regasification Unit	SPL	Sound Pressure Level
GNR	Government Notice Regulation	SPL_{peak}	Unweighted Peak Criteria
IAIAsa	International Association for Impact Assessment South Africa	SPL_{RMS}	Root Mean Square
IBA	Important Bird and Biodiversity Area	SEZ	Special Economic Zone
ICM Act	Integrated Coastal Management Act (No. 24 of 2008)	TNPA	Transnet National Ports Authority
IDZ	Industrial Development Zone	TSS	Total Suspended Solids
KSA	Karpowership SA (Pty)Ltd	TTS	Temporary Threshold Shift
KZN	KwaZulu-Natal	WESSA	Wildlife and Environment Society South Africa

1. INTRODUCTION

Triplo4 Sustainable Solutions (Pty) Ltd. (Triplo4) was appointed by KSA to undertake the Environmental Impact Assessment (EIA) process for the proposed Gas to Power project within the Port of Richards Bay.

The proposed activity is located within the Port[1] which is an estuarine bay, as per the National Estuaries Layer (CSIR, 2018a) as well as parts of the marine and terrestrial coastal zone as per the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008) (ICM Act). Coastwise Consulting, supported by GroundTruth Water, Wetlands and Environmental Engineering (GroundTruth) were subsequently appointed to undertake the respective Coastal and Estuarine Scoping and Impact Assessments.

This document serves as the Coastal, Estuarine and Marine Specialist Impact Assessment Report to the Gas to Power EIA process for the Port of Richards Bay. The aim of the report is to describe the current environmental characteristics and sensitivities of the study area, *i.e.,* the Richards Bay Estuary[2] and surrounding coastal environment, and identify and assess the impacts of the proposed project on the coastal and estuarine environment. Impacts on the adjacent Mhlathuze Estuary are also considered. This impact report includes the coastal component previously included in the coastal and climate change scoping assessment (Moore and Breetzke, 2020).

A further issue required to be highlighted was that of integration and the adoption of a polycentric or holistic approach to the assessment of impacts as per Section 2(4)(b) of NEMA. This requires that all impacts and mitigation measures proposed are weighed up against each other; risks and consequences reviewed and negative impacts minimised and benefits maximised. A specialist integrative workshop and weekly meetings were held during the EIA process where specialists raised matters to be considered by the specialist team and also verified technical information to prevent any discrepancies and where relevant, to co-ordinate approaches. This approach ensured that there are no gaps contained between the various specialist reports and provides a holistic picture of the project and allows a polycentric assessment of environmental and socio-economic impacts and the identification of appropriate mitigations and recommendations for potential negative impacts and the maximisation of positive impacts and the value of the project to society.

As a result, this Coastal, Estuarine and Marine Specialist Report should therefore be read in conjunction with the following reports and it should be noted that such reports considered this specialist report in their findings:

- the updated Marine Ecology Assessment (incorporated into this report);
- the updated Avifauna Assessment (Anchor Environmental and TBC, 2022);
- the updated Terrestrial Noise Assessment (Safetech, 2022);
- the updated Terrestrial Ecology Assessment (de Wet, 2022);
- the updated Wetland Assessment (Triplo4, 2022a);
- the Underwater Noise Assessment (Subacoustech Environmental, 2022)
- the updated Climate Change Assessment (Promethium Carbon, 2022);
- the Richards Bay Landscape and Visual assessment input (Environmental Planning & Design, 2022); and
- the Socio-Economic Impact Assessment and small-scale fisheries appendix (Social Risk Research, 2022; Steenkamp and Rezaei, 2022).

This report was peer reviewed by Dr Barry Clark (Pri.Sci.Nat. 400021/05), a SACNASP professional with both valid and extensive experience.

[1] It is noted that Port infrastructure is excluded from coastal public property in the ICM Act

[2] The Richards Bay Estuary is one component of the uMhlathuze/Richards Bay estuarine complex, and is the focus of this assessment. See Section 0 for more detail.

2. TERMS OF REFERENCE

The specialist assessment considered the proposed mooring, deployment and operation of the Karpowerships and their associated facilities and infrastructure, including natural gas supply, storage and distribution and overhead lines for the transmission of the generated electricity to the transmission connection point.

It is noted that while the application was initially refused by the competent authority, and the subsequent Appeal process was refused, the Minister made a decision in accordance with her powers under NEMA to remit the Karpowership South Africa (KSA) Environmental Authorisation to the Competent Authority, with a view to addressing perceived gaps, and procedural defects in order to reconsider and re-adjudicate the application. Therefore, the coastal, estuarine and marine specialist impact assessment has been reviewed and updated to address perceived gaps as well as integrate and collaborate with other relevant Specialist Studies, where there is an overlap or dependency.

The scope of the Impact Assessment entailed:

- updating the scoping assessment, where necessary;
- undertaking the requisite site visit and ground-truthing exercise (*i.e.*, limited to visual observations/sightings) to:
    - confirm (or dispute) the current land use and environmental sensitivity as identified by the DFFE web-based screening tool, in accordance with the "*Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity*" (DFFE, 2020; GN 320)[3]; and
    - confirm the potential impacts of the proposed development in respect of the coastal, estuary, and marine environments and identified sensitive receptors;
- provide a description of the existing baseline conditions of the receiving estuarine, coastal and marine environment in the vicinity of the project area;
- conducting an assessment of the potential impacts of the construction and operation of the project on the sensitive receptors, including cumulative impacts, and recommendations to prevent or mitigate negative impacts; and
- making recommendations for inclusion in the Environmental Impact Report (EIR) and Environmental Management Programme.

3. METHODOLOGY

3.1. Desktop Assessment

Prior to the site investigation, the following available desktop resources were interrogated to inform the site sensitivity verification and serve as baseline information for the specialist report:

- 2021 CoastKZN Estuaries theme map;
- 2020 Long-Term Ecological Monitoring Programme for the Port of Richards Bay;
- 2018 Final Draft uMhlathuze and Richards Bay Estuarine Management Plan and accompanying Situation Assessment;
- 2018 National Biodiversity Assessment and supporting spreadsheets;
- 2018 National Vegetation Map;
- 2014 KwaZulu-Natal (KZN) Biodiversity Sector Plan;
- Google Earth imagery;
- Historical satellite imagery;

[3] Promulgated under the Environmental Impact Assessment Regulations, in terms of Section 23 (5) of the National Environmental Management Act (Act No 107 of 1998) (NEMA).

- Method Statements for the Proposed Karpowership for the Proposed Karpowership for Gas to Power Project. PRDW Report No. S2117-DEFF-MS-001-R1 and as per the Project Description provided via email on 14th of October 2022 (Triplo4, 2022);
- Final Scoping Report and Plan of Study for EIA for the Proposed Gas to Power via Powership Project at Port of Richards Bay, uMhlathuze Local Municipality, KZN. Triplo4. DEFF REF NO: 14/12/16/3/3/2/2007;
- SA Powership Mooring Study. Richards-Bay – Cooling Water Dispersion Modelling for 100% Load Case. REV.2. PRDW Report No S2117-07-RP-CE-003-R0 (PRDW 2022);
- As of 10th October 2022, an email giving the preferred alternative location for the Powership and document S2117-07-SK-GA-211-S1 B; and
- Associated pipeline information included in the following reports and items: S2117-07-DR-GA-202-S1 A, S2117-07-SK-GA-212-S1 A Contr Facilities, Port Richards Bay 27092022, Karpowership 20221010 rev1.

In addition, the proposed project will be located in an established port where numerous studies have been completed (for example, Grindley and Wooldridge 1974, Harris and Cyrus 1996, Cyrus and Forbes 1996, Weerts 2002, Atkins *et al.* 2004, Jerling 2008, Beckley *et al.* 2008, Johnson 2012, MER 2013, Vivier and Cyrus 2014, Transnet 2014, van Ballegooyen *et al.* 2015, CSIR 2018, Izegaegbe *et al.* 2020). Consequently, abundant quantitative information on the environment within the Port of Richards Bay already exists, and dedicated field surveys to add to these data for the envisaged EIA were considered unnecessary. Therefore, the environmental baseline description provided below has been compiled as a desktop study that draws on the information available.

The impact assessment methodology used is described in Section 8.2.

3.2.Site Investigation

The initial site investigation was undertaken in a single day on the 4th of February 2021, during the peak summer (wet) rainfall period. While physical or biological sampling was not undertaken, there was increased opportunity of observing fish activity in the shallow intertidal areas since the primary recruitment period is between winter and early summer. Ground truthing of the shoreline coincided with low tide on the day (but outside of the spring low tide period), during which time a greater proportion of the shoreline and sandspit would have been exposed allowing better access to the site and better observation of intertidal habitat conditions and features.

The purpose of the site investigation was to verify the sensitivity of the site as indicated in the DFFE screening tool by means of identifying:

- estuarine habitats and plant species/vegetation types of concern;
- estuarine associated fauna (*e.g.*, wading birds, invertebrates, etc.); and
- areas of important estuarine functions/processes (*e.g.* nursery areas, roosting areas).

The following activities were undertaken during the site investigation:

- A site walk-over of the development footprint and surrounding areas including the:
    - assembly basin;
    - powership mooring location within the 600 Berth basin;
    - Kabeljous Flats and sandspit – these areas were not accessible on foot and thus only observed at a distance using binoculars;
    - transmission line corridor;
    - switching station;
    - site office and concrete coating yard (4 October 2022); and
    - *Zostera* intertidal habitat – gaining access to this area was extremely difficult due to dense vegetation and steepness of the terrain;
- Collection of photographs illustrating the above.

A second site investigation was undertaken on the 4th of October 2022 to inspect the area of the proposed site office and concrete coating yard, and materials lay-down area, which were not included in the original project plan.

Additional site investigations were undertaken by Dr Barry Clark from Anchor Environmental, a short inspection of the mooring locations on the 11th of September 2022 and a second longer visit on 29th of September 2022, entailing a waterbird count (CWAC) for the whole port area.

The level of assessment and the timing at which the site investigations were undertaken was considered adequate to verify the sensitivity of the site.

3.3.Study Area and Scale

Disturbance to the seabed during pipeline installation and burial, the discharge of heated cooling water and the generation of underwater noise are considered to be the most important sources of disturbance to the marine environment. Modelling of the dispersion of cooling water suggests that the effect of this disturbance will be contained around the location of the Powerships within the Port of Richards Bay (PRDW 2022). Disturbance to the seabed will occur on the port's western side, extending between the Powerships and the FSRU. Terrestrial noise impacts will likely extend up to 650m away and underwater noise will be discernible in the 700 Berth Basin and on the Kabeljous Flats. The transmission lines, and their associated impacts extend above the water line across terrestrial portion of the Richards Bay Estuary, and beyond the boundaries of the estuary (See Section 4.5).

As a result, the baseline description and subsequent impact assessment focusses on receptors in the water column and in and on the seabed, and the local avifauna, the estuarine habitat, assessed at the local scale within the local scale within the limits of the Richards Bay estuarine functional zone (See Section 6.2). References to the uMhlathuze Estuary are made where applicable.

4. PROJECT DESCRIPTION AND LOCATION

The South African government is investigating and planning to implement alternative power production methods in order to supplement its unstable electricity supply. One such option, currently used in several locations around the globe, is the generation of power from natural gas through the use of floating mobile powerships (Triplo4, 2022b). The advantage of powerships for power generation is that they can travel easily to where there is a demand, moor in the relevant port, connect into the national grid and start generating power immediately. In addition, the capacity can be modularly up-scaled on-site with a very short lead time to meet additional requirements, should there be a need (Triplo4, 2022b). Their presence is temporary; their purpose is to supplement the current supply as an interim measure to fill the lag time of power infrastructure development in the country (Triplo4, 2022b).

The information presented below was obtained from the project method statement (document number S2117-DEFF-MS-001-R1) and the relevant draft scoping report and study plan for the EIA process in the Port of Richards Bay and, as per emails sent on the 10th October 2022, regarding the revised location for the Powership and associated infrastructure within Richards Bay (document number, S2117-05-SK-GA-211-S1 B).

In the current context, the proposed Gas to Power project will entail the mooring, deployment and operation of two gas engine powerships (one Shark and one Khan Class vessel) and a floating storage regasification unit (FSRU) within the Port of Richards Bay (Figure 1), uMhlathuze Municipality, for a contracted 20-year lifespan. The project location is immediately adjacent and linked to the Richards Bay Industrial Development Zone (IDZ), which is a designated Special Economic Zone (SEZ).

As provided in the project overview (Triplo4, 2022b), the components and processes of the power-generating arrangement include:

- mooring facilities for the Liquefied Natural Gas (LNG) carrier;
- LNG supply, storage and regasification on-board a Floating Storage Regasification Unit (FSRU);

- distribution of the natural gas to the powership via subsea gas pipeline infrastructure;
- the berthed powerships – a ship and barge, which have been reconfigured to incorporate elements for the generation of electricity using natural gas. The natural gas is supplied to the engines. The 27 reciprocating engines in operation drive the generator shaft to generate electricity, and the heat generated by the engines in operation is captured and used by additional steam turbines for increased efficiency;
- an on-board High Voltage substation for the conversion of the generated power; and
- overhead lines for the evacuation or transmission of the generated electricity to transmission connection points onshore and onward to the substation that is connected to the national grid.

4.1.Location of moored vessels

The Port of Richards Bay is South Africa's most northern port, located 160 km northeast of Durban on the east coast of South Africa. It hosts the Transnet operated Dry Bulk Terminal and Multipurpose Terminal and the privately operated Richards Bay Coal Terminal. Several other terminals are in operation, including wood chip export terminals and a bulk liquid terminal.

Within the Port of Richards Bay, the proposed Gas to Power project will be located in the far western portion of the bay, on the northern side of the sandspit that is adjacent to the area known as the Kabeljous Flats (Figure 1 and Figure 2). Both these features are considered ecologically-sensitive.

Two layout options or mooring locations are proposed (Figure 1 and Figure 2) based on vacant space, existing and planned port operations, depth considerations, and adequate space for mooring, navigation and operations (Triplo4, 2022b). The sand spit area has been identified as sensitive – The FSRU will moored within a minimum distance of 230 m from the low water mark and 170 m from the base of the sandspit to the moored FSRU will be maintained (Triplo4, 2022b); while the closest mooring legs will be approximately 120 m of the base of the sandspit.

In Alternative Layout 1 (preferred option) (Figure 1), the proposed Khan Class and Shark Class powerships (450 MW combined contracted output) are positioned within the dead-end 600 Berth basin adjacent to the break bulk quay /multipurpose terminal. The Khan powership will be approximately 81 m and 175 m off the main land promontory along its starboard side and from the stern, respectively, and the Shark powership approximately 192 m off the water line of the sandspit along its starboard side. The powerships are positioned "in-line" and connected to the FRSU by approximately 1 500 m of subsea gas pipeline (Triplo4, 2022b).

In Alternative Layout 2, the powerships are positioned roughly 900 m further seaward (closer to the FSRU) and side-by-side, and connected to the LNG/ FRSU mooring facility by approximately 500 m of subsea gas pipeline (Figure 2) (Triplo4, 2022b). In Alternative Layout 2, the marine infrastructure (ships, mooring, and gas pipeline, etc.) is in closer proximity to the sensitive sandspit and without the "buffer" afforded by the promontory, and is thus the least preferred alternative from an ecological perspective, but also engineering perspective. Although this alternative presents a shorter gas pipeline, the position of the powerships in relation to the shore is not supported from an engineering design perspective, and consequently the position of the associated gas pipeline is also not supported (Triplo4, 2022b).

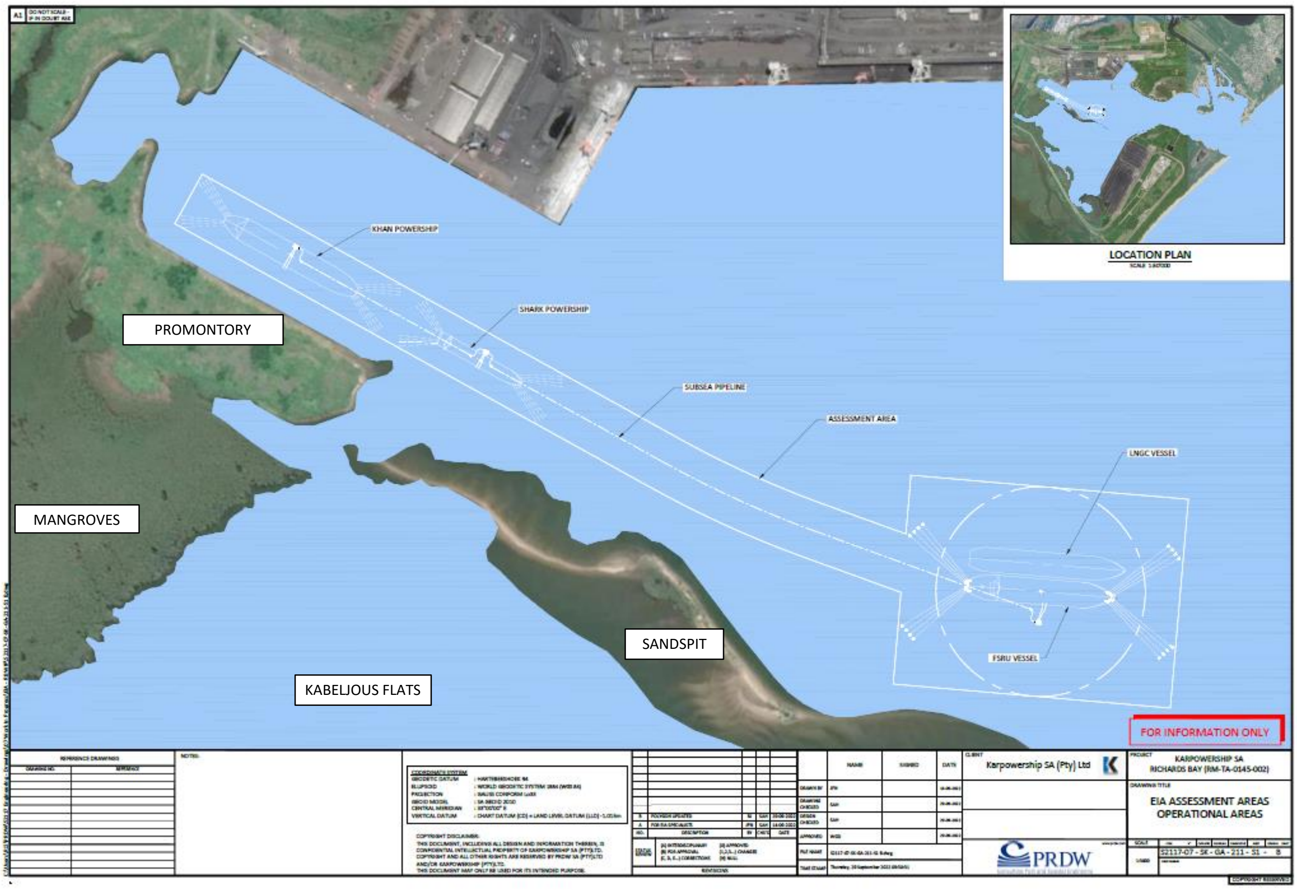

Figure 1. Alternative Layout 1 (Preferred option) of the proposed Gas to Power components within the Port of Richards Bay

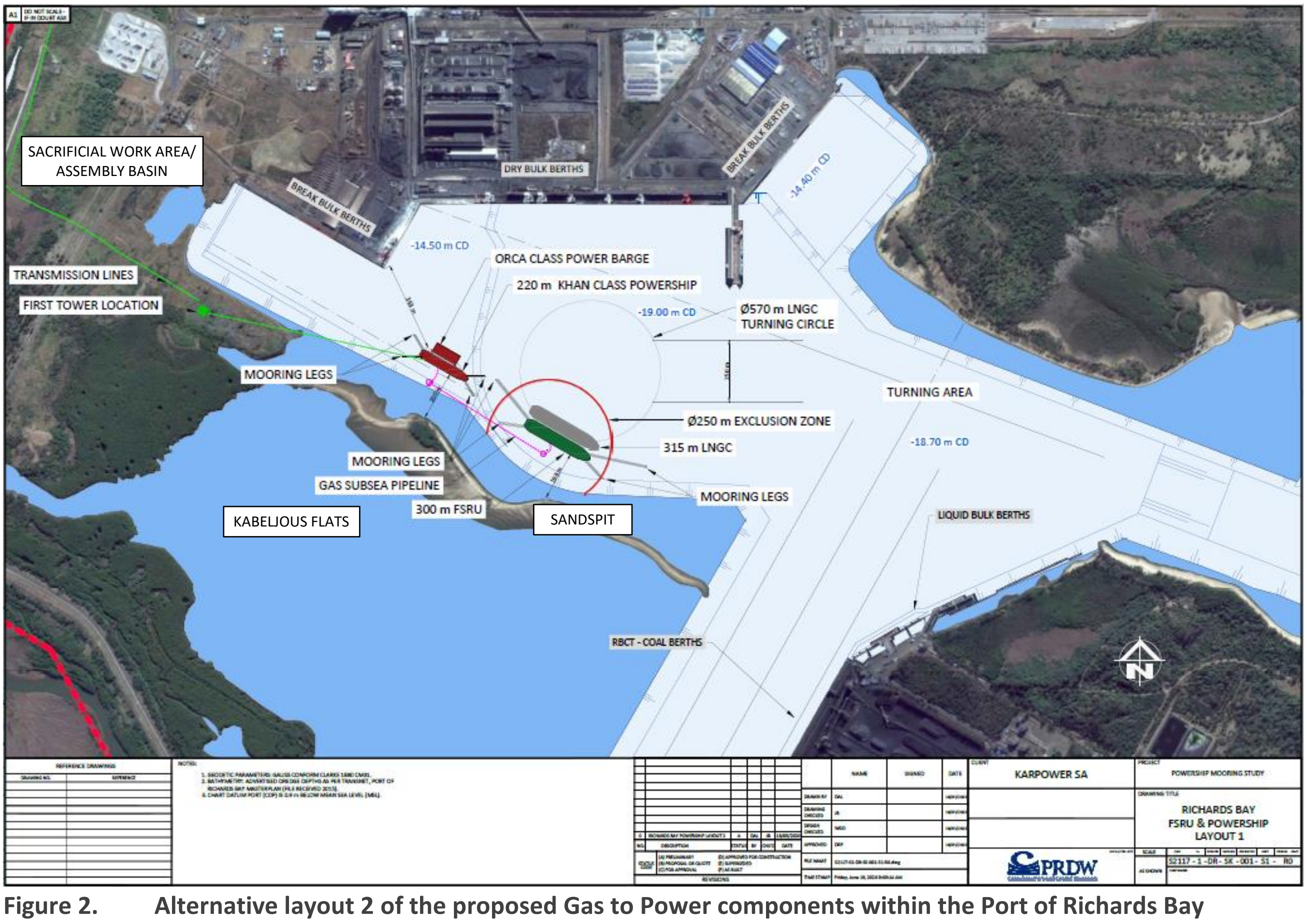

Figure 2. Alternative layout 2 of the proposed Gas to Power components within the Port of Richards Bay

4.2.Mooring

The powerships and the FSRU are assembled off-site and delivered fully equipped and operational to the Port of Richards Bay. Berthing and mooring of the powerships and the FSRU will be conducted as per the Ports approved maintenance plans, procedures and requirements. The powerships and FSRU will be moored in position (approximately 14m deep) using a spread mooring arrangement, comprising 16 mooring legs (four from each corner of the vessel) each consisting of a catenary mooring chain connected to an anchor pile with a padeye connector (Triplo4, 2022b). The anchor piles will be installed using vibro piling to drive the casing to refusal and then the Reverse Circulation Drilling method (RCD) to drill the pile to depth. No impact hammer driving will be used as part of this methodology. The FSRU will be anchored using 16 mooring legs each consisting of a catenary mooring chain connected to a Vertical Load Anchor (VLA) which is dragged by an anchor handling tug down to its embedment depth. No marine structures are planned, and the mooring system for the vessels will be a heavy chain lying on the seabed attached to anchor piles or vertical load anchors.). The vertical load anchors are by design buried during the installation, whilst the anchor piles will be installed such that they are flush or below the surrounding seabed (Triplo4, 2022).

4.3.Gas Lines

Gas will be transferred between the FSRU and the powerships in sequence via flexible risers attached to a pipeline end manifold (PLEM) (containing necessary valves, connections, etc.), one for each vessel installed on the seabed next to the respective vessel, and onward via the subsea steel pipeline with concrete weight coating installed on the seabed between vessels The subsea pipeline will be installed according to international best practice, along the existing dredged slopes between the powerships and FSRU and will have a servitude of approximately 50m either side of the pipeline (Triplo4, 2022b).

The pipeline will have a diameter of approximately 600 mm and will be weight coated for stability and welded together at a pipe stringing yard in close proximity to the water’s edge. Incremental assembly and installation will take place using a winch-mounted barge. The pipeline will be placed on the seabed with minimal disturbance to the seabed and weighted with concrete elements to ensure the on-bottom stability of the pipeline during operation. It is important to note that dredging will not be required for the instalment of the Gas to Power components, although levelling of high spots or infilling of depressions in the seabed may be necessary for the subsea pipeline, and likely to be undertaken by divers during installation (Triplo4, 2022b).

4.4.Contractor Facilities

The contractor facilities include a site office and concrete coating yard, a material laydown area, the stringing yard and the load out berth (**Figure** 3), and there are no alternative locations for these facilities. These areas were carefully selected from areas within the port that have been previously disturbed and with sufficient space to accommodate the construction and pipe assembly activities (Triplo4, 2022b).

The site office and concrete coating yard (11 000m^2) will be located on historically disturbed open space/scrubland westward of the harbour arterial road, approximately 100 m from the port access control gate. The material laydown area (8 000m^2) will be located on disturbed open space/scrubland north of the 600 Berth quayside, adjacent to the break bulk (ferro manganese) storage facilities. The stringing yard (10 000m^2) is located at the landward extent of the adjacent promontory, perpendicular to the Harbour Arterial Road. A launch way will be constructed with rollers to transfer the pipeline from the stringing yard to the sea. The load out berth is located in the far southern portion of the port, within the 300 Berth Coal Terminal area (**Figure** 3) (Triplo4, 2022b).

Once the pipeline installation is complete, the stringing yard and laydown site will be rehabilitated to the topographical and environmental condition prior to the disturbance during the construction phase of this project (Triplo4, 2022b).

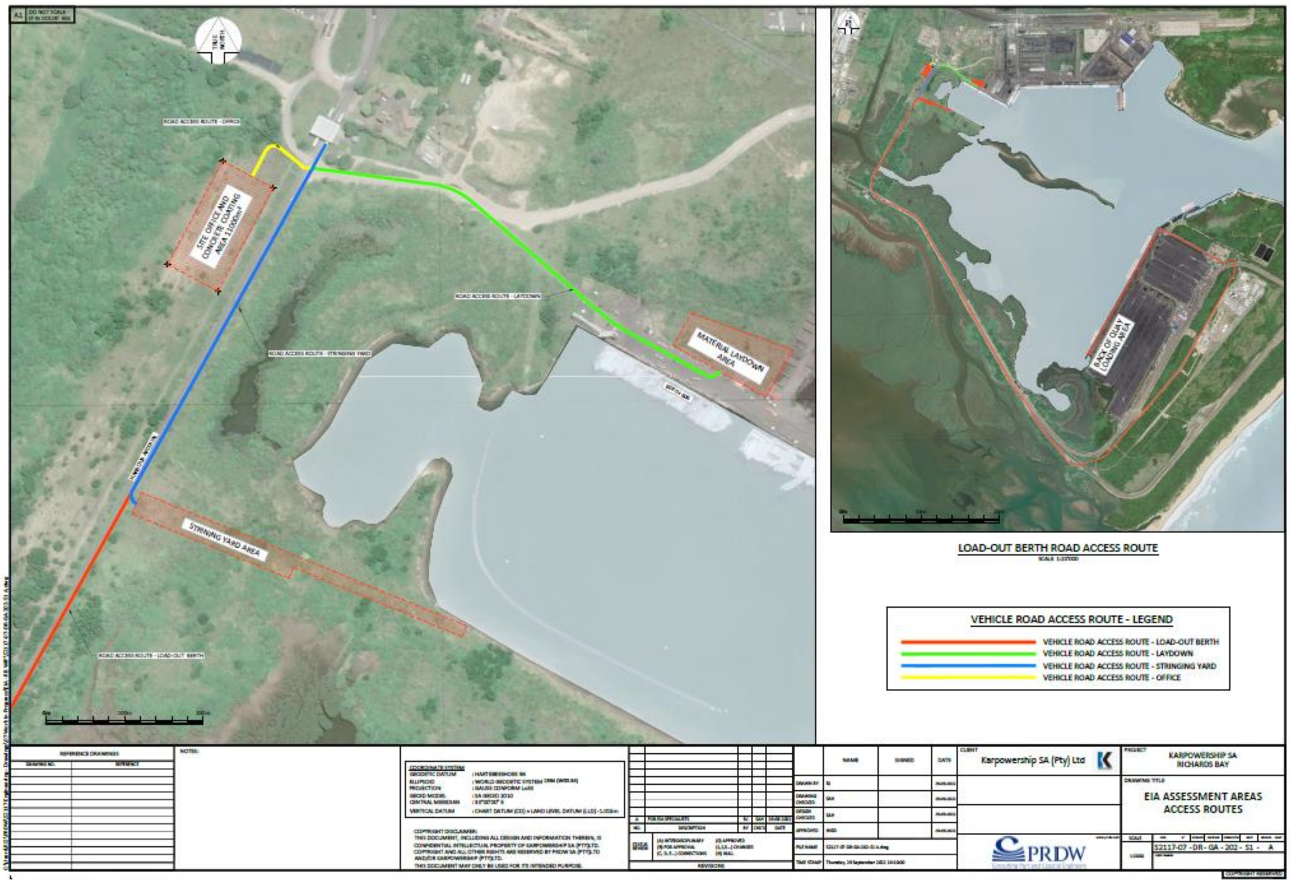

Figure 3. **Location of the proposed Gas to Power components within the Port of Richards Bay, showing site office and concrete coating area, materials laydown area, stringing yard area, load out berth, and associated access routes (2022)**

4.5.Transmission Lines

The proposed transmission line will comprise piled monopoles. The span lengths between towers will vary. Average spans lengths will be approximately 200 m, however, based on the ground profile shorter spans of less than 100 m or larger spans of greater than 300 m can be constructed (Triplo4, 2022b).

There are two options for the proposed overhead transmission lines. In both route options, the transmission lines will link to the first land-based connection, that is the terminal tower (monopole design), positioned atop the promontory adjacent to the large mangrove stand (Figure 4) and ultimately link into the Eskom National grid via a new switching station (17 542 m²) in the north western corner of the former Bayside Aluminium Smelter site (Figure 4) (Triplo4, 2022b).

Alternative 1 route (preferred route) runs westwards, joins into the existing power servitude through open grassland/scrubland and unchanneled valley bottom wetland, thereafter running north along the existing power servitude along the Manzamnyama Canal, before heading around the northern property boundary of the smelter site to the endpoint at the switching station. The route is the preferred overhead transmission line from the powerships to the proposed switching station, as it offers a shorter route to the end point, covering approximately 3.6 km with estimated 16 towers (31 m working servitude, 111 600 m^2) (Triplo4, 2022b). In addition, the majority of the Alternative 1 route is located in areas of low to moderate ecological sensitivity, and will not be traversing highly sensitive wetland and swamp forest. The location of the route is in transformed areas or in highly degraded areas adjacent to transformed areas, and a large portion of this alternative follows the route of the existing powerline servitude. The existing servitude will be used to access the majority of this route, and an additional access / working servitude will be required for the construction of tower(s) in the area between the port and the Manzamynama Canal as well as from the start point to the Harbour Arterial Road (the first four towers) (Triplo4, 2022b).

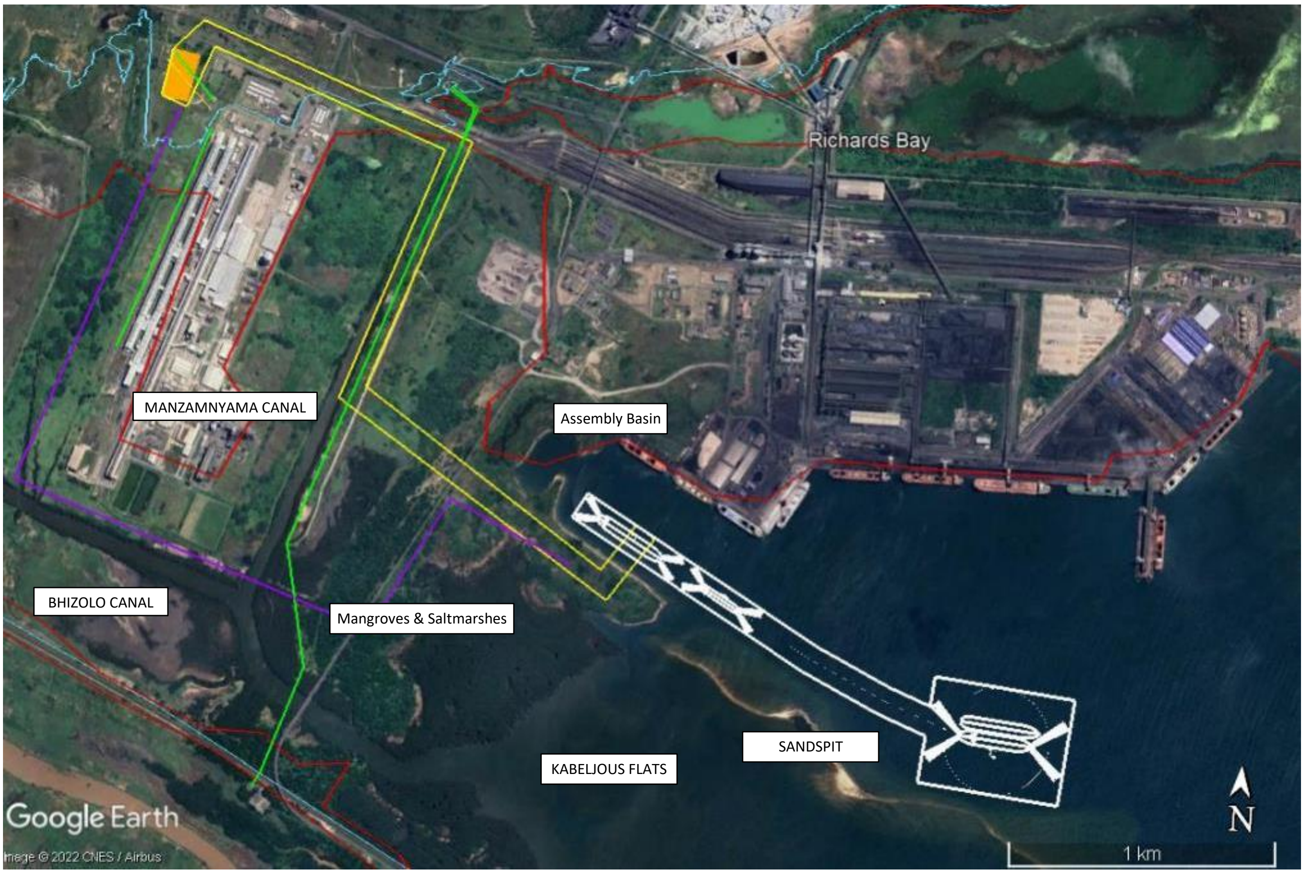

Figure 4. **Location of the proposed Gas to Power components within the Port of Richards Bay, indicating the corridor of the alternative 1 transmission line route (yellow), the alternative 2 route (purple), switching station (orange polygon) existing Municipal transmission line (green), relative to the 5 m (red) and 10 m estuarine functional zone (blue) boundaries (Image source: Google Earth, 2022)**

From the same starting point as Alternative 1, the Alternative 2 route (Figure 4) joins the harbour arterial road servitude, and before the lower Bhizolo Canal, it cuts west passing through the mangroves and across the lower Manzamnyama Canal, traversing the smelter site, before heading north through mixed mangrove and wetland habitat on the western boundary of this site. The route is approximately 4km long, requiring 19 towers (31m working servitude, 124 000m^2) (Triplo4, 2022). This alternative route traverses areas that have been historically transformed, however these areas are still considered highly sensitive due to the unique flora and fauna that resides within these environments. Furthermore, a substantial length of this proposed transmission line route is located within wetlands, and it traverses two Critically Endangered vegetation types, namely Mangrove Forest and Swamp Forest. These have extremely high sensitivity and as such, can be considered as a fatal flaw and therefore this alternative route is not supported (Triplo4, 2022).

Both options traverse properties owned by the TNPA. Each tower will cover a maximum footprint of 2.75 m x 2.75 m for monopoles, which will necessitate the clearing of vegetation to allow for these structures to be erected (Triplo4, 2022b).

4.6. Power Generation

An LNG carrier will periodically supply LNG to the FSRU (approximately once every 20 to 30 days) and will temporarily stay (1-2 days) in the location in a ship-to-ship configuration to offload the LNG cargo. The LNG remains on the FSRU and is regasified to natural gas. It has been confirmed that the system is closed and requires no uptake or discharge of water). The natural gas will be transferred to the powerships through a connecting pipeline as indicated above.

The two powerships will have a combined total electrical output capacity of 540 MW. The powerships use reciprocating engines (GEN-SET) that run on gas. These can run in a simple cycle configuration or a combined cycle with steam turbine generators (STG) that utilise exhaust heat from the engine. The on-board high voltage substation then converts the power generated from this. The electricity is evacuated via the 132 kV overhead transmission line that runs to the switching station. The powerships also have freshwater generators (FW GEN) to produce freshwater for operational purposes.

The operation of the powerships involves the abstraction of seawater for cooling of the power generators and the subsequent discharge of heated water back into the receiving environment. Total intake/outlet flow rates range from 2.4 to 11.4 m^3/s, and the increase in temperature (ΔT) ranges from 4 to 15°C (PRDW, 2020). For example, based on the modelled scenario detailed in PRDW (2022), in which the reciprocating engines, steam turbine generators and freshwater generators are in use with 100% loads (*i.e.* the worst-case scenario), the estimated total intake/outlet flow rate for both vessels (all generators combined) is 8.49 m^3/s. The increase in temperature is between 10 and 15°C (Table 2). The total flows will be discharged at depth (8 m) through multiple outlets on the vessel hulls. Discharges will operate continuously, and no other constituents, such as biocides or brine[4], will be added to the cooling water discharge.

Table 2. Discharge characterisation for the powerships moored in the Port of Richards Bay, based on the modelled scenario for the 100% load case (PRDW, 2022)

	Total flow (m^3/s)			Discharge temperature increases (ΔT)		
POWERSHIP	**GEN-SET**	**STG**	**FW GEN**	**GEN-SET**	**STG**	**FW GEN**
Shark	1.25	0.50	0.13	14.0	10.0	15.0
Khan	4.38	2.00	0.23	13.0	12.0	14.0

[4] Total brine discharge is less than 1% of total sea water outlet hence brine outlet is neglected and assumed zero.

5. KEY INFORMANTS

5.1.International informants

Relevant international informants in this instance relate specifically to birds and are detailed in Table 3 below.

Table 3: Summary of relevant key International Informants (extracted from Anchor Environmental and TBC, 2022)

International Informant	Overview	Relevance
The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)	South Africa is a signatory of the United Nations Bonn Convention, whose purpose is the global conservation and sustainable use of migratory animals and their habitats (CMS 2020).	The Richards Bay sandspit and Kabeljous flats are considered to be important habitats for both feeding and roosting grounds. If these are lost then there are global conservation implications for such species.
The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AWEWA)	AWEWA, a Bonn Convention Treaty, coordinates conservation over the African-Eurasian Migratory Waterbirds.	As above, significant quality and quality of habitat is required which applies to the Richards Bay sandspit and Kabeljous flats.

5.2.National Environmental Management Act

According to the National Environmental Management Act (Act 107 0f 1998) (as amended) (NEMA), environmental authorisation must be obtained from the relevant competent authority, in this case the Department of, Forestry, Fisheries and Environment (DFFE), for the proposed development and associated listed activities in the case of this project relative to the coast and sensitive ecosystems, such as estuaries through an Environmental Impact Assessment (EIA) process. The purpose of an EIA is to determine whether there are any fundamental negative impacts which may result from the proposed development activity, and which cannot be effectively mitigated. The report is then submitted to the authority to inform their decision to grant/not grant approval for the project, as well as specific conditions to mitigate negative impacts, should authorisation be granted.

5.3.Integrated Coastal Management Act

The Integrated Coastal Management Act of 2008 (Act No. 24 of 2008, as amended) (ICM Act)[5] emanates from the White Paper for Sustainable Coastal Development in South Africa (2000) and establishes a system of integrated coastal and estuarine management. This is promoted through directives in terms of the conservation and maintenance of the natural attributes of the coastal environment concomitant with development that is sustainable as well as socially and economically justifiable. It defines the rights and responsibilities of all coastal stakeholders, including those of organs of State, and gives effect to South Africa's international responsibilities in respect of coastal pollution. The ICM Act aims to facilitate the implementation of the principles and guidelines presented by the White Paper and has a number of objectives including:

- The provision of a legal and administrative framework to promote cooperative, coordinated and integrated coastal management;
- The protection of the natural coastal environment as a national heritage;
- The management of coastal resources in the interests of the whole community;
- The promotion of equitable access to the resources and benefits provided by the coast; and
- The fulfilment of South Africa's obligations under international law.

[5] It is noted that Port infrastructure/development is specifically excluded from coastal public property and not the intent of the Act as a whole.

The ICM Act requires that activities that are potentially harmful to the coastal zone are considered as part of the NEMA EIA processes. The competent authority needs to consider, amongst others:

- If coastal public property, coastal access land or the coastal protection zone will be affected by the proposed action;
- Estuarine management plans, Coastal Management Programmes, coastal management lines and coastal management objectives;
- The socio-economic impact if that activity or action is authorised or not authorised;
- The likely effect of dynamic coastal processes (such as wave, current and wind action, erosion, accretion, sea-level rise, storm surges and flooding) on the activity; and
- Whether the development of activity is likely to cause irreversible or long-lasting adverse effects on the coastal environment that cannot be properly mitigated; will prejudice the achievement of any coastal management objective; or will not be in the interests of the community as a whole.

5.3.1. National Coastal Management Programme

The National Coastal Management Programme (CMP) recognises the benefit and value provided by port and harbour development and the economic activities associated thereof, and the key opportunities they provide in respect of sustainable coastal development and balancing benefiting from the economic opportunities provided while maintaining our coastal zones' environmental integrity (DEA, 2014a). It acknowledges that port management is the responsibility of the Transnet National Ports Authorities (Transnet NPA) under the National Ports Act.

The National CMP further recognises that oil and gas are likely to be key drivers of the world economy for the foreseeable future and this need will continue to drive demand. While not directly relevant in this instance, the importance of conducting any activity related to gas and shipping in general, should be environmentally sound and take consideration of the risks associated with marine pollution and oil spills, ensure that conflicting use is reduced and that the best interest of the public is considered (DEA, 2014a).

In respect of responses to climate change in coastal management, the CMP notes that an adaptive management approach is required, supported by monitoring and frequent review. In this instance anticipated sea level rise and increased storminess must be taken into consideration and included in any contingency plans.

National priorities identified in the CMP and considered relevant to this project include effective planning for coastal vulnerability to global change (including climate change); integrating management in estuaries; and managing pollution in the coastal zone.

5.3.2. KwaZulu-Natal Coastal Management Programme

The KZN Coastal Management Programme was developed to bring provincial coastal management in KZN in line with the Integrated Coastal Management Act. The Provincial Coastal Management Programme (PCMP) sets out the objectives and requirements to fully realise integrated coastal management in KZN. It was developed within existing policy and legal frameworks. Similar to the Western Cape PCMP, it identifies nine priority areas that are critical for achieving the overall mission of the PCMP:

Through cooperative governance and best practice, the intrinsic value of the coast is protected, restored and enhanced, while ensuring climate change resilience and promoting equitable access and sustainable use of coastal resources for all stakeholders.

In addition to the nine priority areas, the KZN PCMP stresses the importance of cross-sectoral collaboration for achieving effective integrated coastal management. This is identified to be of particular importance in KZN because of the complex nature of the coastline and the importance of sustainable management that protects environmental infrastructure and ecosystems while simultaneously contributing to economic development and the realisation of the economic potential of the provincial coastal zone. The nine priority areas identified for KZN are associated with various goals, objective and actions that need to be undertaken in order to achieve the PCMP mission. The goals for each of the priority areas, as well as how they relate to the project is described below in Table 4.

Table 4. Summary of the KZN PCMP and relevance to the proposed project activities

Priority Area	Goal Summary/Objective	Project relevance/implications
1. Coastal Access	Promote equitable and sustainable access to the coast by enabling physical public access to the sea and along the seashore, on a managed basis.	Coastal access land is not designated within ports without declaration by the Minister and land within ports is excluded from considerations regarding coastal public property. Where proposed activities extend beyond the designated port boundary (for example, the transmission lines), the preferred alternatives from a coastal access perspective are to follow existing servitudes to minimise disruption to coastal access during the operation phase. During construction, the need for coastal access should specifically be taken into consideration in the development of site-specific environmental management programmes (EMPrs).
2. Coastal and Marine Planning	Promote balance between economic development and conservation of natural resources.	The project is not likely to adversely affect development planning at a local or provincial level. The increased electricity generation capacity, when considered as part of the national Integrated Resources Plan (IRP), from the project will contribute to an enabling environment for economic growth. Additionally, the location of the proposed infrastructure within existing ports renders a significant impact on ecosystem goods and services unlikely. Mitigation measures to offset the impacts of proposed activities in the linear infrastructure aspects of the project (*i.e.* the transmission lines), should be considered as part of the terrestrial ecological assessments, which may include wetlands, indigenous vegetation, and other aspects of biodiversity that contribute ecosystem goods and services in the local context.
3. Coastal information and research	Promote relevant research and access to information	Not directly relevant to the project and proposed activities.
4. Coastal vulnerability, adaptation and resilience	Promote resilience to the effects of dynamic coastal processes, environmental hazards and natural disasters	The location of the proposed infrastructure within an existing port is unlikely to disrupt existing dynamic coastal processes, with the possible exception of the subsea cable installations. The impacts of the abovementioned activity should be considered as part of the marine specialist scoping report or assessed during subsequent project phases based on site-specific data. Should subsequent project phases identify the need for biodiversity offsets or coastal protection (*i.e.* where transmissions lines may be situated outside of the protected environment of the port), approaches such as ecosystem-based adaptation (EbA) or nature-based solutions should be prioritised.
5. Cooperative governance	Establish and strengthen institutional partnerships and mechanisms for ICM to facilitate better management	The proposed project is unlikely to negatively influence or impact cooperative governance locally or provincially. Opportunities for increased collaboration with port authorities and other operators (*e.g.* Eskom and Transnet) should be considered within governance structures such as the Provincial Coastal Committee

		(PCC) and any relevant municipal coastal committees (MCCs) to promote knowledge sharing and continued alignment with coastal management objectives.
6. Education, awareness and training	Develop capacity and promote public awareness and education for integrated coastal management	Not directly relevant to the project and proposed activities.
7. Estuarine management	Undertake estuarine management which optimises the value of these systems on a sustainable basis	The location of the proposed infrastructure within an existing port as well as being within the Richards Bay Estuary and adjacent to the uMhlathuze estuary means this specialist impact assessment is critically important in respect of the ultimate decision-making process.
8. Minimising land and marine based sources of pollution	Minimise the impacts of pollution and waste on the health of coastal communities and coastal ecosystems	The location of the proposed infrastructure within an existing port/estuary as well as being adjacent to a protected estuary means that the potential and negative impact of coastal pollution must be mitigated.
9. Monitoring, compliance, and enforcement	Monitor the State of the Coast (SoC) and promote compliance with coastal and other regulations	While the proposed project does not have direct implications for monitoring, compliance and enforcement at the provincial level concerning the ICM Act, other monitoring, compliance and enforcement requirements may arise from the suite of related specialist assessment reports and should take this Provincial priority area into account to ensure alignment.

5.3.3. King Cetshwayo District Coastal Management Programme

The King Cetshwayo District, formerly the uThungulu District Municipal CMP, was updated in 2015 and substantially simplified including only a summary of the situation assessment, coastal management precincts, a municipal vision and concluding with priorities and strategies (KCDM, 2014). Priorities identified include:

- Integrating the management of estuaries;
- Management of pollution in the coastal zone;
- Ensuring equitable public access in the coastal zones;
- Effective planning for coastal vulnerability to global climate change (coastal erosion); and
- Strengthening awareness, education and training to build capacity.

5.3.4. 2020 National Estuarine Management Protocol

The updated Protocol was promulgated in 2020 (DEA, 2013) and sets out, the strategic vision and objectives for achieving effective integrated management of estuaries in South Africa; the standards for the management of estuaries (specifically human activities or actions that impinge on estuarine health and function); the procedures regarding how estuaries must be managed and how the management responsibilities are to be exercised by different organs of state and other parties; the minimum requirements for estuarine management plans (EMPs); detail on who must prepare EMPs and the process to be followed in doing so; and the process for reviewing EMPs to ensure that they comply with the requirements of the ICM Act. Specific strategic objectives outlined and management standards prescribed are detailed in

Table 5. An EMP has been developed for the uMhlathuze/ Richards Bay estuarine system and is unpacked in Section 5.2.5.

Table 5. 2020 National Estuarine Management Protocol strategic objectives and management standards (DFFE, 2020)

Strategic Objectives	Management Standards
• To conserve, manage and enhance sustainable economic and social use without compromising the ecological integrity and functioning of estuarine ecosystems; • To maintain and/or restore the ecological integrity of South African estuaries by ensuring that the ecological interactions between adjacent estuaries, between estuaries and their catchments, and between estuaries and other ecosystems, are maintained; • To manage estuaries co-operatively through relevant organs of state across all spheres of government; and to engage the private sector and civil society in estuarine management; • To protect a representative sample of estuaries (such protection could range from partial protection to full protection) in order to achieve overall estuarine conservation targets as determined by the National Biodiversity Assessment of 2011 and the subsequent updates; • To generate awareness, education and training that relate to the importance and value of South African estuaries; and • To minimise the potential detrimental impacts of predicted climate changes through a precautionary approach to development in and around estuaries and with regard to the utilisation of estuarine habitat and resources.	• An estuary must be managed according to the allocated management class and the set of both resource quality and quantity attributes as prescribed in terms of the National Water Act (1998). In the absence of the allocated class, an estuary must be managed in its current state and/ or improved state in order to achieve national biodiversity targets as outlined in National Biodiversity Assessment of 2011 and the subsequence updates. The assessment includes a list of national priority estuaries, their current health; recommended extent of protection and degree of undeveloped margins; • An estuary must be managed to avoid, minimize or mitigate significant negative impacts that include but are not limited to reduced water flows and loss of habitat or species. This will require the participation of Departments responsible for utilization of estuarine resources; • Promoting the integration of land use planning and natural resource management outcomes with estuarine management outcomes; • Management actions should be based on sound scientific evidence and, where lacking, the precautionary approach should prevail; and • The adoption of risk management approaches to address issues, such climate change and associated impacts, must be promoted.

5.3.5. Richards Bay/ uMhlathuze Estuarine Management Plan

The development of an EMP is a two-phase process that entails firstly, the Scoping Phase or Situation Assessment Report (SAR), which serves as the main information gathering stage and assessment of the *status quo* to inform the EMP. This is followed by the Objective Setting Phase (the EMP), where critical stakeholder engagement takes place to develop a local vision for the estuary and associated management objectives, and propose specific actions to address the issues identified in the SAR (DEA, 2015). A third phase (post adoption) encompasses the implementation of the EMP through numerous proposed project plans internal to the various departments/institutions, as well as monitoring and evaluation of the implementation by means of performance indicators.

The development of an EMP for the uMhlathuze/ Richards Bay estuaries was initiated in early 2017 and, following the gazetting of the final draft EMP (DEA, 2017a) in November 2019 (GN 1395), was approved in July 2020.

Vision and Strategic Objectives

The vision for the Richards Bay/ uMhlathuze estuaries is (DEA, 2017a):

"The uniqueness and socio-economic values of our beautiful estuaries are sustainably protected for future generations through responsible, holistic and inclusive management approaches"

As part of the EMP development process, strategic objectives (or goals) are derived from the vision and typically reflect the overarching issues identified in the SAR. They inform the development of detailed management strategies, which in turn are carried forward as plans of action within the EMP. The relevant strategic objectives of the Richards Bay/ uMhlathuze EMP are provided below (Table 6).

Table 6. Strategic objectives for the uMhlathuze/Richards Bay EMP ((DEA, 2017a) **relevant to the proposed Gas to Power Project**

	Objective	Performance Indicator(s)
Ecological	Estuarine ecological health meets the desired ecological state (*e.g.* agreed upon during Classification process), including successful rehabilitation of unacceptably impacted areas in EFZ	• Resource Quality Objectives (RQOs) for a C Category are achieved
Economic	Large-scale industrial development contributes to economic growth in an environmentally - and socially sound manner (*i.e.* balancing ecological-social-economic benefits)	• Number of projects or development with approved Environmental Authorisation • Extent of compliance
Governance	Private sector participates in cooperative management, sharing their skills and resources to ensure protection of biodiversity and socio-economic value	• Established advisory forum • Private sector membership • No. of public-private sector partnerships
	Environmental integrity is ensured through effective compliance informed by continuous, science-based monitoring programmes	• No. and extent of monitoring programmes • No. of illegal activities vs successful prosecution/ mitigations

Management Objectives

Management objectives aim to address the range of issues, impacts and threats identified during stakeholder consultation meetings, in order to achieve the vision and strategic objectives. Of particular relevance are the management objectives relating to Conservation, Land-use and Infrastructure Planning and Development, Water Quality and Quantity, and Cooperative Governance. Applicable actions are listed below in Table 7 to Table 10.

Table 7. Management objectives, and associated actions, related to Conservation (DEA, 2018a)

Objective 2:	**In accordance with Resource Protection Measures under National Water Act, formally set Management Classes, Reserves and Resource Quality Objectives for uMhlathuze/Richards Bay estuaries at a Category C**
Action 2:2:	Conduct a comprehensive Classification study (National Water Act) for the uMhlathuze and Richards Bay catchments that addresses both surface and sub-surface (ground water) resources for rivers, wetlands, lakes and estuaries.
Applicability: ***Once the outcomes of the Classification study are gazetted, these will prescribe various thresholds to uphold the desired state (and ecological health) of the uMhlathuze/Richards Bay estuaries. Resource Quality Objectives (RQOs) for water quality within the Bay will have reference and will need to be compliant. RQOs provide the environmental targets against which to assess ecological health.***	

Table 8. Management objectives, and associated actions, related to Land-use and Infrastructure Planning Development (DEA, 2018a)

Objective 6:	**Ensure that planning, construction, maintenance of infrastructure in uMhlathuze/ Richards Bay EFZs (*e.g.* in Port of Richards Bay, Richards Bay IDZ and Waterfront Development) are undertaken in an environmentally sustainable manner to protect biodiversity and socio-economic values benefiting other users.**
Action 6.1:	Conduct strategic planning for future port development, Richards Bay IDZ and Waterfront development taking into consideration biodiversity requirements and socio-economic values benefiting other users in uMhlathuze/Richards Bay estuaries

Action 6.2:	Conduct appropriate EIA studies for infrastructure developments in port (*e.g.* boat repair and dry dock facilities), IDZ and waterfront, and for future marine aquaculture developments in Richards Bay EFZ, as per requirements under the NEMA EIA regulations Notice 3.
Action 6.3:	Maintain infrastructure in the study area so as to not detrimentally impact on biodiversity and socio-economic values benefiting other users in uMhlathuze/Richards Bay estuaries.
Applicability: ***It is evident that land-use and infrastructure planning development must take the biodiversity of the Bay into account. This includes the current proposed Gas to Power project, and its potential impact on the highly sensitive Kabeljous mudflats and mangrove habitats.***	

Table 9. Management objectives, and associated actions, related to Water Quantity and Quality (DEA, 2018a)

Objective 7:	**Ensure appropriate pollution prevention/mitigation measures are implemented in uMhlathuze/Richards Bay estuaries**
Action 7.1:	Prepare standard operational procedures (SOPs) for pollution management and control in uMhlathuze/Richards Bay system, explicitly stating relevant legislation applying to atmospheric emissions, wastewater discharges (both point and diffuse stormwater runoff) and solid waste disposal, specifying approval and permitting processes, operational requirements, as well as responsible authorities in terms of approval, compliance and enforcement.
Action 7.2:	Prepare an inventory of sources of atmospheric emissions originating within uMhlathuze/ Richards Bay EFZs and stipulate mitigation actions where required in accordance with SOPs.
Action 7.3:	Prepare an inventory of sources and location of wastewater discharges into uMhlathuze/ Richards Bay estuaries (surface and sub-surface runoff) and stipulate mitigation actions, where required, in accordance with SOPs.
Action 7.4:	Prepare an inventory of sources and location of solid waste disposal within uMhlathuze/ Richards Bay EFZs and stipulate mitigation actions, where required, in accordance with SOPs
Action 7.5:	Prepare/revise oil spill contingency plan for uMhlathuze/Richards Bay estuaries, including disaster management planning, and handling and disposal of waste originating from clean-up
Action 7.6:	Instate a ballast water auditing programme for vessels entering Port of Richards Bay.
Applicability: ***While the discharge of cooling water is not addressed directly (potentially as wastewater or ballast water), it could be considered a source of pollution that will alter estuarine/marine water quality. These together with emissions from the powership, should be included in the SOPs and inventory of pollution sources, and should be subject to compliance with specified water quality and air quality standards/thresholds. The project infrastructure also represents potential sources of solid waste and oil (and other hazardous materials) pollution.***	

Table 10. Management objectives, and associated actions, related to Climate Change (DEA, 2017a)

Objective 11:	**Address coastal vulnerability to climate change in uMhlathuze/Richards Bay estuaries**
Action 11.1:	Establish appropriate management lines in terms of the ICM Act to reduce hazard risks (*e.g.* flooding) and to ensure environmentally suitable development in uMhlathuze/Richards EFZs to assist with preventing "coastal squeeze" under future sea level rise conditions.
Applicability**:** ***While the Gas to Power project is to be considered a temporary intervention and predominantly water-based, permanent supporting land-based infrastructure is required (transmission lines, towers, etc.). The routing and siting of these components must consider the impacts of climate change on the EFZ. It should also be noted that the proposed coastal management line delineation process will not be applicable within the Port boundary.***	

Spatial Zonation

Spatial zonation is a management tool that is used in EMPs to identify specific attributes of an estuary as a means to separate/reduce user conflict as well as conflicting management goals (*e.g.* conservation vs recreational activity vs port operations).

The spatial zonation of the uMhlathuze/Richards Bay estuarine system is presented using several maps. In the zonation, sensitive and important estuarine habitats were identified; these include *inter alia*, the productive and highly sensitive Kabeljous mudflats (See Section 6.1) and the surrounding mangroves stands (DEA, 2017a) (Figure 5)

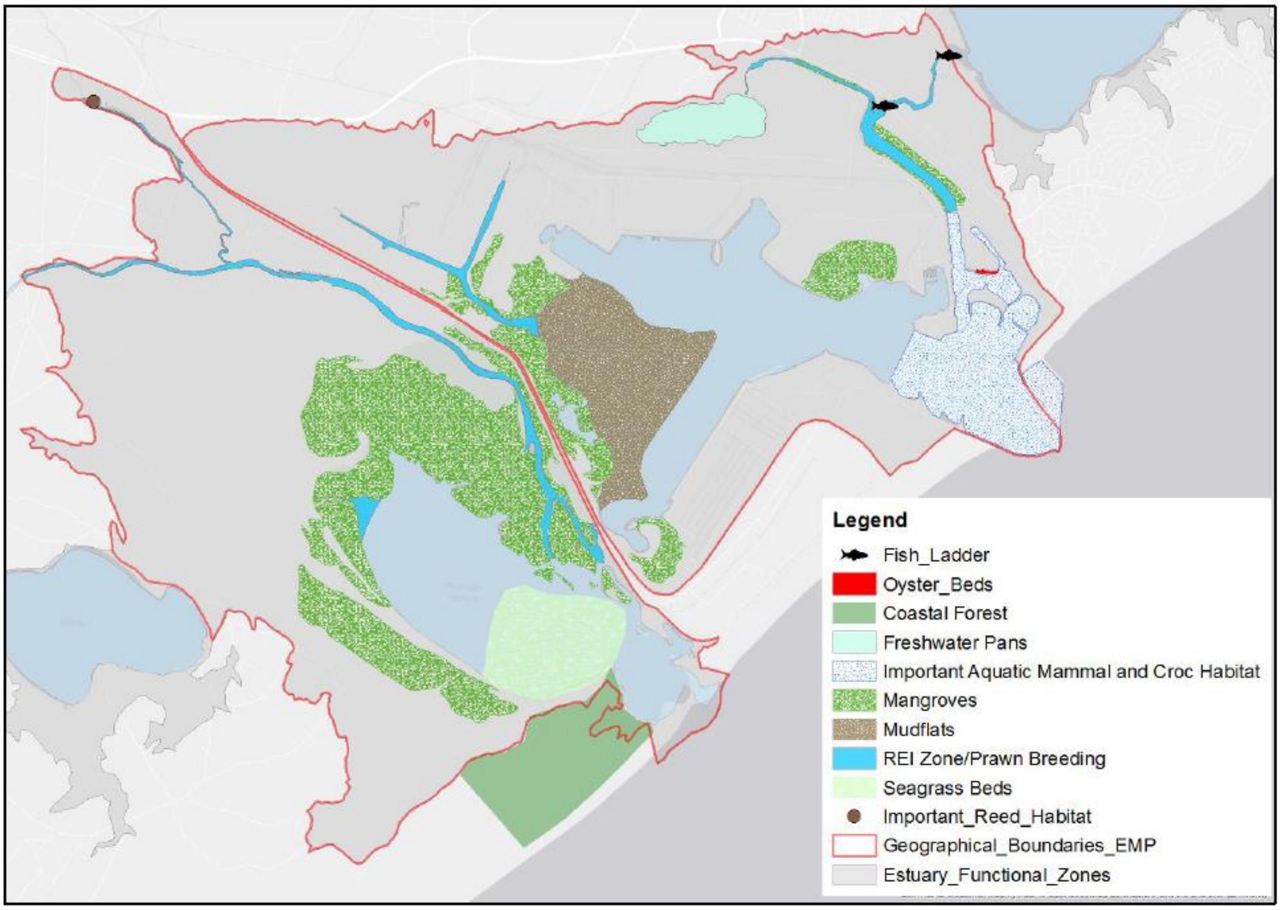

Figure 5. Zonation of sensitive and important estuarine habitats within geographical boundaries of the uMhlathuze/Richards Bay EMP ((DEA, 2017a)

Also indicated in the spatial zonation are the marine aquaculture activities, the initial proposed LNG terminal and the proposed port expansion relative to the existing port limits. In respect of nearby mariculture activities, an area of 7 ha in the Port of Richards Bay on the northern edge of the sand spit was leased out for pilot testing of commercial marine sea finfish farm, using Dusky Kob (*Argyrosomus japonicas*). This was a collaborative undertaking between the various institutions as part of Operation Phakisa (DEA, 2018a). An Aquaculture Development Zone (ADZ) study has commenced within the port (DFFE 2020).

Within the spatial zonation, the initial proposed LNG terminal was intended to be located adjacent to the eChwebeni Natural Heritage Site (see Figure 6 in Section 6.1). It is acknowledged that the proposed long term port expansion / expansion plan (Year 2046) would directly impact critical estuarine habitat (mangroves, mudflats/sandflats, Bhizolo/Manzamnyama Canal system, etc.) as well as the location of Gas to Power project should the project be approved in the near future (DEA, 2018a).

Integrated Monitoring Plans

A Reserve Determination Study is required to be undertaken for the Richards Bay Estuary as per the actions of the EMP, during which time an ecological monitoring programme and RQOs will be confirmed. A Reserve Determination Study was completed for the uMhlathuze Estuary in 2003 (DEA, 2018a) but excluded the Richards Bay Estuary. Until such study is undertaken for the Richards Bay Estuary, the EMP recommends that the uMhlathuze ecological resource plan be used for the Bay. The plan includes monitoring of the following abiotic and biotic attributes:

- Birds;
- Fish;
- Invertebrates;

- Macrophytes;
- Microalgae;
- Water quality;
- Hydrodynamic; and
- Sediment.

A compliance monitoring plan is also provided in the EMP. This is to test for compliance against relevant laws, regulations, policies, standards, guidelines, and/or permits and license agreements. Key activities or uses needing compliance monitoring plans, relevant to the current proposed project, include atmospheric emissions, and port facilities (Table 11).

Table 11. Management objectives, and associated actions, related to Water Quantity and Quality (DEA, 2017a)

USE/ACTIVITY	INDICATOR	TEMPORAL SCALE	TARGET/ LIMIT	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
Atmospheric emissions	Constituents in emission	As per permit requirements		NEM: Air Quality Act / Municipal Bylaws	DEA/City of uMhlathuze
Port Facilities	Depends on facility, as specified by TNPA	As per requirements specified by TNPA		National Ports Act TNPA	National Ports Act TNPA

5.4. Marine Pollution Act and other Acts related to pollution

The potential for pollution (including solid waste [garbage], discharge of effluent, discharge of brine, discharge of heated water, and ballast water) as a result of the proposed gas to power process is considered to be high and specific controls will need to be incorporated into the environmental authorisation, if approved. It should be noted that such pollution is deemed to not be land-based, it will therefore not be controlled by the ICM Act but rather in terms of International Convention for Prevention of Pollution from Ships Act (Act No. 2 of 1986) (MARPOL Act), the South Africa Maritime Safety Authority Act (Act No. 5 of 1998) (SAMSA Act), the Marine Pollution Act (Act No. 6 of 1981) (Control and Liability Act) as well as the Merchant Shipping Act (Act No. 57 of 1951). It is also primarily the responsibility of the National Department of Transport and the South African Maritime Safety Authority (SAMSA) as regulator of this predominantly marine based activity. While discharges would need to be compliant with the South African Water Quality Guidelines for Coastal and Marine Waters (DEA, 2018; DWAF, 1995), it has been confirmed that the system will now be closed and will require no seawater input or discharge. It should also be noted that while SAMSA is developing a risk assessment for purposes of mitigation and oversight, such assessment, as well as those conducted through the Major Hazard Installation legal requirements, would need to address any other possible unforeseen disasters and mitigation measures proposed.

The responsibility, in the case of oil pollution from ships and once oil has been released to sea, includes the national Department responsible for the environment, DFFE, specifically through their Kuswag Programme, which undertakes regular oil spill surveillance and monitors for potential illegal oil discharges. This includes shoreline protection and clean-up, and at-sea response using dedicated oil response vessels and aircraft and dispersant spraying operations (DEA and Royal HaskoningDHV, 2017).

Potential impacts on the various Marine Protected Areas (MPAs) must be taken into consideration and should not be compromised by the proposed gas to power operation, including any accidental spillages.

5.5. National Water Act

The National Water Act (Act No. 36 of 1998) (NWA) provides for the protection of South Africa's water resources and aquatic ecosystems, including estuaries, as estuaries are included in the definition of a water resource under the Act. The Act makes provision for a water "Reserve" which provides the quantity and quality of freshwater flow required in aquatic ecosystems in order to meet basic human needs and to protect the natural functioning of a water resource. Establishing the Ecological Reserve entails the determination of the Present Ecological State (PES) of an estuary and the Recommended Ecological Category (REC), which is the target for protection and management of the resource from an ecological perspective. Included in the protection of water resources is the setting of Resource Quality Objectives to achieve the desired state, that is, specific aspects related to freshwater flows and for the quality of the resource, in terms of water quality, functioning requirements, habitat integrity, and composition of biological communities. A reserve determination was undertaken for the Mhlathuze Estuary but not for Richards Bay. However, the estuarine component of the National Biodiversity Assessment (NBA) (van Niekerk et al., 2019a) does document the provisional PES and REC as Category D (largely modified).

5.6. Special Economic Zones Act

Also of relevance to this proposed activity is the Special Economic Zones Act (Act No. 16 of 2014), given that the Richards Bay Industrial Development Zone – a designated SEZ, is linked to the Port of Richards Bay. The Act details the country's effort to reposition itself in the world economy, attract Foreign Direct Investment and export of value-added commodities within established the Industrial Development Zones (IDZ) Programme (DTIC, 2021). The new SEZ Policy and SEZ Programme were developed also in response to the National Industrial Policy Framework, and the New Growth Path, as well as developments in the global economic environment such as the formation of BRICS[6].

Both initiatives promote national economic growth and industrial development by offering various incentives, investment opportunities, import and export duty exemptions, fast tracked construction and customised space for heavy, medium, and light industry and custom secure areas amongst others.

[6] BRICS is the acronym coined for an association of five major emerging national economies: Brazil, Russia, India, China, and South Africa. The BRICS members are known for their significant influence on regional affairs.

6. SUMMARY OF THE AFFECTED ENVIRONMENT

6.1.Richards Bay Estuary

The Richards Bay (28°48'40.63"S, 32° 5'17.32"E) Estuary forms part of the broader Richards Bay/uMhlathuze estuarine complex. It is one of only three estuarine bays in the country, along with the Knysna Estuary and Durban Bay, and is thus considered an extremely rare estuarine type among South Africa's 300 or so estuaries. It goes without saying that the system is of local, regional, and national significance.

Estuarine bays are characterised by their large size and a permanent connection to the sea, which imparts strong marine influences in terms of tidal activity, salinity, and water temperature (Van Niekerk et al., 2020; Whitfield, 1992). The estuarine environment is generated by marine and riverine interactions, and extensive wetlands, and oftentimes mangrove swamps, are noteworthy features in the Richards Bay/uMhlathuze system and Durban Bay (Whitfield, 1992).

The history of the Richards Bay and uMhlathuze estuaries is well documented in numerous historical and recent publications, environmental studies, and environmental management and planning documents (Begg, 1978; Branch et al., 1981; DAERD, 2011; DEA, 2017b; MER, 2013; Minnaar, n.d.). In brief, the uMhlathuze/Richards Bay estuarine complex once existed as a single, large shallow bay (Begg, 1984). Between 1972 and 1975, the system was divided by a 4 km long berm wall and the northern two thirds of the original system was developed into the deep-water (>15 m) industrial Port of Richards Bay. The berm wall was fitted with tidal gates to assist with flood control in the southern section and to enable tidal connectivity (Begg, 1984), however these were proven dysfunctional (Jerling, 2008). To the south, a new mouth was excavated for the remaining uMhlathuze portion, creating the uMhlathuze Estuary, also known as the Sanctuary (Figure 6). The ecological importance of the original system was duly acknowledged, and the berm wall intended to primarily preserve and protect the remaining natural environment from the impacts of the port (Campbell, 1976; Zwamborn and Cawood, 1974). The Mhlathuze River was subsequently canalised and directed into the remaining uMhlathuze portion of the estuary, effectively bypassing and negating the flood dissipating and sediment trapping functions of the extensive papyrus swamp that once existed (Begg, 1984; Weerts and MacKay, 2019).

Drastic transformation of the Richards Bay Estuary and its habitats continued through port development activities, including the widening and stabilisation of the mouth for the entry channel, the protection of the mouth with constructed breakwaters, dredging, wharf construction, infilling and the construction of supporting infrastructure and industry (Begg, 1984; Campbell, 1976; MER, 2013; Zwamborn and Cawood, 1974). At the western extent of the harbour, the Bhizolo and Manzamnyama Canals where excavated (by *ca.* 1976) as a means to drain the local wetlands and swamps to facilitate industrial development around the Port, *e.g.,* the then Alusaf (Bayside) Aluminium smelter (Begg, 1984). The Bhizolo/Manzamnyama river confluence discharges into the western corner of the Bay into an ecologically sensitive area known as the Kabeljous Flats (MER, 2013) (Figure 6). Despite the historical separation, Richards Bay still functions as an estuarine system due to the underdeveloped areas being shallow in nature (Vivier and Cyrus, 2014a).

The port is biogeographically in the subtropical Natal Ecoregion and within the KwaZulu Natal Bight Subregion (Sink et al., 2019). A relatively wider continental shelf characterises this subregion, and the coastline has several critical estuarine systems. Offshore and south of Richards Bay lies the Tugela bank area, which constitutes the only mud belt on the South African east coast continental shelf and provides a unique home for biotic assemblages.

In terms of neighbouring protected areas, or areas of conservation importance, the uMhlathuze Estuary is a formal protected area, *i.e.*, Richards Bay Game Reserve (1290 ha), and a nationally important bird area (SA No: SA079) managed by Ezemvelo KZN Wildlife (EKZNW) (Birdlife, 2016; CoastKZN, 2019; DEA, 2017b). It is formally recognised as a nature reserve (Category IV, Site Code 13307) by the International Union for Conservation of Nature (IUCN). The rivers draining into the estuary create a shallow tidal lagoon fringed by mangroves and reed beds. Together with the Richards Bay Estuary, these two systems support more than 50 % of South Africa's mangrove habitat (Weerts and MacKay, 2019). The estuary and surrounding marginal vegetation provide important estuarine habitat for a complex community of water and water-associated birds and mud and sandflat areas in reserve also support nursery areas for several crustacean and fish species (Sink et al., 2004). Further, the eChwebeni Natural Heritage Site is a Transnet designated site of conservation significance within the Port of Richards Bay, which preserves part of an original mangrove site that existed prior to the development of the Port (DEA, 2017b; Tholet, 2012). It is located approximately 4.4 km south-east of the site adjacent to the liquid bulk terminal (Figure 6).

Figure 6. Landscape features of the Richards Bay Estuary (after CRUZ 2009, in MER 2013)

6.2.Delineation

In South Africa, estuaries are currently defined by the 5 m topographical contour (referenced from the indicative mean sea level), which incorporates the estuarine functional zone (EFZ) (Figure 7). The EFZ encompasses the natural features of the system, including the waterbody, the floodplain, estuarine habitats (such as sand and mudflats, and vegetation), as well as the dynamic processes, such as tidal fluctuations and backflooding, which characterise the estuarine environment (Van Niekerk and Turpie, 2012). The EFZ is included in the legal definition of an estuary in terms of the National Environmental Management Act, 2014 EIA Regulations (as amended in 2017) (GNR 324), and as such, any activities within this sensitive environment require Environmental Authorisation before they may commence.

Further to the 5 m contour, recent studies indicate that the EFZ in some estuarine systems may extend beyond the current 5 m contour and that the 10 m contour may, in the near future, be considered the new boundary of an estuary. In the most recent NBA (CSIR, 2018a; van Niekerk et al., 2019a), the boundaries of the EFZ have been modified to include additional areas of important estuarine habitat and/or expanded to the 10 m contour. Furthermore, the 2018 NBA includes the adjacent surf zone within the boundaries of the EFZ to reflect a continuum in estuarine-marine connectivity (van Niekerk et al., 2019a). However, the 5 m contour remains the default estuarine boundary in respect to EIAs until the 10 m contour is formally approved. In the interim, in KZN, the provincial Department of Economic Development, Tourism and Environmental Affairs (EDTEA) views the 10 m contour as the preferred development buffer in respect to new developments proposed in and/or around estuaries.

In the case of the uMhlathuze/Richards Bay estuaries, the default EFZ includes the two lake systems, namely Lake Cubhu (to the south) and Lake Mzingazi (to the north), largely based on their historical connectivity in the lower uMhlathuze catchment (DEA, 2017b). However, the two lake systems are classified as freshwater lakes/pans and are therefore excluded from the management area, in terms of the uMhlathuze/Richards Bay EMP (DEA, 2017b).

The current assessment is focussed on the Richards Bay estuarine environment. References to the uMhlathuze Estuary are made where applicable.

Figure 7. Estuarine functional zone of the uMhlathuze/Richards Bay estuarine system, as delineated by the 5 m contour in red, and 10 m contour in blue (Image source: Google Earth; National Estuaries layer CSIR 2018a)

6.3.Local Oceanography and Hydrodynamics

The tides in Richards Bay are semi-diurnal (with a period of 12 hours 23 min) and have a mean spring and neap tidal range of 1.84 m and 0.51 m, respectively (Table 12).

Table 12. Tide characteristics for the Port of Richards Bay (van Ballegooyen *et al.* 2015)

Tide	Height (m) above Chart Datum
Highest astronomical tide	2.47
Mean high water spring	2.11
Mean high water neap	1.48
Mean level	1.20
Mean low water neap	0.97
Mean low water spring	0.27
Lowest astronomical tide	0.00

Tidal flows are strongest near the port entrance in the deep navigation channel and are considered to range from approximately 0.03 m/s during neap tides to about 0.17 m/s during spring tides (Figure 8) Tidal flows are the dominant driver of currents in the main port channel and the proposed development vicinity (CSIR, 2020; van Ballegooyen et al., 2015) (Figure 8). Wind-driven circulation appears to be of secondary importance, mainly occurring in the region of the mudflats, and waves only play an important role in certain wave climates at the shoreline (outside of the port) (van Ballegooyen et al., 2015) (Figure 8). The resulting hydrodynamics are important in distributing deposited or disturbed sediments in the system and are especially important when planning dredging works.

Outside of the port, waves exert significant 'event scale' effects on nearshore currents and sediment distributions both nearshore and in deeper water (van Ballegooyen et al., 2015). The currents in the surf-zone and the shallow nearshore areas and within the port entrance channel's mouth are determined by prevailing wave conditions and their angle of incidence. The more oblique the wave angle at the shoreline, the stronger the flows (van Ballegooyen et al., 2015). The highest waves are observed during the winter and spring. South-south-easterly waves reach the shoreline at an oblique angle. They will tend to drive a northward-flowing surf zone current, while east-south-easterly waves, also arriving at an oblique angle, generate a southward flowing current in the surf zone.

Figure 8. Schematic of major hydrodynamic processes within the Port of Richards Bay and adjacent coastline (modified from van Ballegooyen *et al.* 2015). The red rectangle demarcates the proposed Project development area.

Various wave climates and wind conditions result in different wave conditions within the port. Model simulations conducted by Van Ballegooyen *et al.* (2015) indicate that wave intrusions into the port from the open sea are markedly dampened at the entrance. However, under strong south westerly winds, waves impinge on the port's windward northern areas whilst strong north-easterly winds generate the reverse effect. Within the port, it is apparent that the sand spit plays a shielding role for the existing berths and the shallow mudflats; the degree of protection depending mainly on the wind direction (van Ballegooyen et al., 2015).

6.4.Hydrology

The uMhlathuze/Richards Bay estuarine complex falls within the Usutu-Mhlathuze Water Management Area. The uMhlathuze River drains a catchment area of 4 209 km^2 with a Mean Annual Runoff (MAR) to the uMhlathuze estuarine system estimated at 560 to 645 x 10^6 m^3 (DEA, 2017b; van Niekerk et al., 2019a). The catchment area of the Richards Bay Estuary is far smaller, covering an area of 183 km^2. The MAR from the Richards Bay Estuary catchment is yet to be determined (DEA, 2017b). Freshwater inflow to the estuary is via the Bhizolo/Manzamnyama canal complex and the Mzingazi canal, which flows into a small craft harbour near the harbour entrance. In the dry season (austral autumn to early spring), the rivers almost cease flowing, and in wetter times (austral late spring and summer), they can carry considerable volumes of freshwater into the bay (van Ballegooyen et al., 2015).

6.5.Estuarine type and functioning

Prior to the 2018 NBA, the estuaries of South Africa were classified into five general types based on various attributes, and the Richards Bay/ uMhlathuze estuarine system was classified as a conjoined estuarine bay (Whitfield, 1992). More recently, the estuarine typologies were revised and South Africa's estuaries have now been reclassified into 12 estuarine types (Van Niekerk et al., 2020; van Niekerk et al., 2019a). Richards Bay remains an estuarine bay, whereas the uMhlathuze Estuary is reclassified as a predominantly open estuary, both within the subtropical biogeographical region. The characteristics of estuarine bays are provided in Table 13 below.

Table 13. Characteristics of estuarine bays (Van Niekerk *et al.*, 2019)

Attribute	Description
Estuarine area (ha)	> 1000
% time open to the sea	100
Geomorphology	Circular with unrestricted inlet
Maximum water level determined by	Tides
Average tidal range (m)	1.5 – 2.0
Typical salinity range	30 – 35 (Av. 35)
Mixing process	Tidal
Sediment stability	Stable
Mean Annual Runoff (x10^6 m^3)	40 - 80

The size of the Richards Bay EFZ is approximately 5 509 ha, comprising 3 543 ha (or 64 %) developed and/or transformed area and 1 966 ha (or 36 %) natural habitat, of which approximately 869 ha is open water habitat (van Niekerk et al., 2019a). Tidal currents and circulation have been significantly modified by the historical change in configuration from the natural, joined, shallow-water embayment to the current divided system (DEA, 2017b).

Mixing processes within the system are dominated by tidal action, with tidal amplitude and water levels close to those of the sea due to the unrestricted permanently open mouth (van Niekerk et al., 2019a). Under high wind conditions, strong wind-driven flows occur, especially in the shallow peripheral areas (DEA, 2017b).

The influence of freshwater on circulation is low, due to low freshwater inflow volumes compared with tidal volume exchanges (DEA, 2017b). Freshwater inputs into the system are via the Mzingazi River/Canal (draining from Lake Mzingazi), Manzamnyama and Bhizolo canals (DEA, 2017b), thus freshwater mixing processes are mostly confined to these restricted upper areas.

6.6.Abiotic Attributes

The Council for Scientific and Industrial Research (CSIR) conducted ecological monitoring campaigns during July (winter) 2019 and February (summer) 2020 at stations surrounding and within the Port of Richards Bay, including water and sediment quality. This reports on the measurements recorded during those two surveys, supplemented by other literature.

6.6.1. Water Quality

Salinity

Estuaries are the transitional point between saline marine water and land-derived freshwater. The deep, permanently open mouth of the Richards Bay enables continuous and voluminous tidal exchange with the inshore marine environment. The water column is generally well mixed (weakly stratified) with regards to temperature, salinity, and oxygen concentrations, meaning that there is little difference between top and bottom measurements. This is attributed to the strong marine influence and tidal flushing (CSIR, 2020; Cyrus and Vivier, 2014a).

Water quality results of the 2019/2020 (winter/summer) survey of the long-term ecological monitoring of Richards Bay (CSIR, 2020) confirm that salinities throughout the port, approximate sea water (35) due to the open connection to the sea and limited freshwater input (CSIR, 2020). Salinity is generally uniform throughout the water column at all sites except those within the Bhizolo Canal and the Msingazi Canal, which provide freshwater to the Bay, and periodically exhibit vertical salinity stratification (DEA, 2017; CSIR, 2020). Water quality monitoring sites, which are applicable to the Gas to Power project (Figure 9), are site 3 at the dead-end of the 600 Berth Basin, site 7 within the inner port basin approximately 500 m north of the sandspit, and site Y1, a shallow water site (approx. 2 m depth) located central to the Kabeljous Flats. Water quality results for these sites are display (Table 14).

Figure 9. Aerial view of the Port of Richards Bay, showing the positions where water quality was monitored during a long-term environmental monitoring campaign in Winter 2019 and Summer 2020 (CSIR, 2020). The proposed project will be established at station 3 and in close proximity to site 7.

Table 14. Physical, chemical, and biological indicator values/concentrations measured *in situ* for surface and bottom waters in the Port of Richards Bay during Winter 2019 and Summer 2020 (CSIR, 2020)

Site	Winter 2019	Salinity	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	pH	Turbidity (NTU)	Total Suspended Solids (mg/L)¥	Chl-a (µg/L)
3	Top	35.30	20.52	7.51	102.72	8.13	2.37	7	7.53
	Bottom	35.30	20.50	7.20*	98.15	8.11	6.00*	NS	5.52
7	Top	35.29	20.48	7.58	103.55	8.13	1.82	2	6.65
	Bottom	35.30	20.33	7.20*	98.29	8.12	2.00*	NS	2.49
Y1	Top	35.30	19.89	7.17	96.98	8.09	2.77	NS	2.97
	Bottom	35.31	19.90	7.16*	96.68	8.09	2.77*	NS	2.86
	Summer 2020								
3	Top	34.96	25.57	5.95	88.64	8.12	2.48	8	3.29
	Bottom	35.04	25.41	5.60	83.22	8.13	5.50	NS	1.37
7	Top	35.00	25.59	6.57	97.80	8.17	1.71	5	2.69
	Bottom	35.05	25.25	4.99	73.98	8.10	7.37	NS	1.24
Y1	Top	34.98	24.88	6.51	95.83	8.14	4.10	NS	3.09
	Bottom	34.99	24.89	6.47	95.27	8.15	4.23	NS	3.06

* Approximate values due to perceived error in data table in CSIR 2020

¥ Determined from surface water samples collected at selected sites only through laboratory analyses

NS = not sampled

Temperature

Water temperature, as a key physiological stimulus for aquatic organisms, affects general growth, reproduction and reproduction behaviour, feeding habits, respiration patterns, as well as movement/migration (DWAF, 1995). Water temperature also affects dissolved oxygen concentrations and marked differences in water masses, known as thermal stratification, can cause entrapment of low oxygen water at depth, creating a physiologically stressful environment for bottom fauna.

Within Richards Bay, vertical thermal stratification can occur and is more common in the summer months since winter storms usually ensure a well-mixed water column (CSIR, 2020; DEA, 2017b). The 2019/2020 survey indicated water temperatures were markedly higher during summer. The warmer, more stratified conditions during the summer months can probably be attributed to increased solar radiation heating the surface waters during calmer conditions (van Ballegooyen, 2015; CSIR, 2020). There was little variation in temperature between surface and bottom waters at sites 3 and 7 during both summer and winter, indicating that the water column was well-mixed. At these sites, winter temperatures ranged between 20.33°C and 20.52°C, and summer temperatures between 25.25°C and 25.59°C (CSIR, 2020) (Table 14). It is interesting to note that water temperatures on the Kabeljous Flats (site Y1) were cooler than most sites during winter (ave 19.90°C) and summer (ave 24.89°C) (Table 14), and this was attributed to greater heat loss from this shallow water site (CSIR, 2020)

Dissolved Oxygen

The amount of dissolved oxygen (commonly measured as percentage saturation) is affected by water temperature, depth, turbulence, atmospheric pressure, salinity, and biological processes such as photosynthesis and decomposition. The maintenance of adequate dissolved oxygen (DO) concentrations is critical for the survival and functioning of aquatic biota as it is required for respiration in all aerobic organisms. Eighty percent saturation is considered healthy for aquatic ecosystems, while DO concentrations ≥5 mg/L are generally considered to be adequate for aquatic life (USEPA, 2003).

Vertical stratification develops at times in Richards Bay near freshwater inflows, where lower DO concentrations occur in the bottom waters, reflecting lack of ventilation (DEA, 2017b). During both winter and summer, the water column is generally well-mixed and no stratification was evident, *i.e.*, surface and bottom waters DO levels were uniform at the three sites of interest. Concentration and saturations were generally high and ranged from 7.16-7.58 mg/L and 96.68-103.55% in winter and from 4.99-6.57 mg/L and 73.98-97.80% in summer Dissolved oxygen were slightly higher during winter when water temperatures were lowest and during summer, DO concentrations dropped below the adopted limits at site 7 within the bottom waters (73.98%, 4.99 mg/L) (CSIR, 2020) (Table 14).

pH

The pH value is a measure of acidity or alkalinity and, for natural waters this is determined by geological and atmospheric factors, as well as biological activities and processes. A dramatic change in pH alters the availability of chemical components, including toxic substances, which may have detrimental physiological effects on aquatic biota. Marine waters are well buffered against variations in pH and typical pH values range between 7.9 and 8.2 (DWAF, 1995).

pH values measured in the uMhlathuze/Richards Bay estuarine system were relatively stable and confirmed the marine dominated nature of the systems (DEA, 2017b). In 2019/2020, there was little variation in pH values between surface and bottom waters at all three sites of interest during summer and winter (pH range 8.09 – 8.15), although slightly lower pH values were generally measured in winter, and in the bottom waters (CSIR, 2020) (Table 14).

Turbidity and Suspended Solids

Turbidity in the water column arises from fine particulate matter in suspension and influences light penetration to deeper waters. Turbid waters are typically encountered at the points of discharge of the different rivers where sediment plumes are often visible, and at stormwater outlets or culverts. Elevated turbidities occur during dredging activities and as a result of vessel movement (propeller wash) (CSIR, 2020).

Richards Bay is considered a clear-water system, with the lowest turbidity generally found near the sandy habitats in the system, whereas the most turbid areas occur over the mudflats, possibly related to wind-induced turbulence in this shallow area, and in close proximity to the Bhizolo and Mzingazi Canals which introduce turbid freshwater to the system (Cyrus and Vivier, 2014a; DEA, 2017b). Turbidity is naturally somewhat lower in the 600 Berth Basin (*i.e.,* around the multipurpose/ break bulk terminal) compared to other areas, such as the mudflats and lower Bhizolo Canal (Cyrus and Vivier, 2014a).

The 2019/2020 long-term monitoring water quality results indicate that turbidity levels and Total Suspended Solids (TSS) concentrations in Richards Bay are generally low (< 10 NTU; ≤ 10 mg/L) (CSIR, 2020). Water quality measurements taken at sites 3, 7 and Y1 indicate that surface and bottom water turbidities ranged from 1.82 to 6.00 NTU during winter, and 1.71 to 7.37 NTU during summer (CSIR, 2020) (Table 14). At sites 3 and 7, TSS concentrations in surface waters ranged from 2 to 8 mg/L and were slightly higher during the summer survey. However, strong wind and wave action, vessel propeller wash and dredging will lead to elevated levels of suspend particulate matter as well as turbidity (CSIR, 2020).

Nutrients

High levels of nutrients (namely phosphorus and nitrogen), emanating mainly from urban stormwater runoff, discharges from wastewater treatment plants and agriculture practices negatively affect water quality, estuarine biota and ecological processes in aquatic ecosystems. Nutrient loading is generally an indication of environmental degradation.

Inorganic nutrients (dissolved inorganic nitrogen and dissolved inorganic phosphate) enter the Richards Bay Estuary via the Bhizolo/Manzamnyama Canal complex as a result of activities in the catchments, groundwater seepage, as well as the spillage of industrial products (DEA, 2017b).

The long-term ecological monitoring indicates that inflowing rivers are the primary source of nutrients into the harbour (CSIR, 2020). During the 2019 winter survey, water samples were not collected for laboratory analyses and thus nutrient concentrations were not determined. The 2020 summer results revealed that nutrient concentrations at most sites were low, except for orthophosphate, which was elevated at all sites (a trend also observed in previous surveys), indicating contamination from various possible sources including contaminated groundwater and spillages of phosphate rock during vessel offloading in the port (CSIR, 2020).

Chlorophyll-a

Microalgae suspended in the water column (phytoplankton) and in or on the sediment surface (microphytobenthos) provide an important food source for estuarine food webs. The latter also plays a role in stabilising muddy sediments (McLusky and Elliot, 2004). Algae growth is influenced by nutrient availability and turbidity. Microalgae are living organisms and the abstraction of chlorophyll-*a* from phytoplankton is used as an indicator of water quality based on the quantity of algae (biomass) in the water column (Forbes and Demetriades, 2010), and is thus reported here.

Data from the long-term ecological monitoring programme of 16 sites within the bay showed that, during the winter, chlorophyll-*a* concentrations were moderate to high at various sites and varying depths. Sites 3 and 7 exhibited concentrations above 5 µg/L in surface water, with a maximum of 7.52 µg/L recorded at site 3 (CSIR, 2020) (Table 14). These elevated concentrations were evidence of an algal bloom in the inner area of the port at the time of sampling. The surface water quality was thus classified as fair for sites 3 and 7, whilst the low concentrations in the bottom waters rendered the water quality good (CSIR, 2020). During summer, surface and bottom water concentrations across most sites were below 5 µg/L and overall water quality was rated as good (CSIR, 2020).

Trace Metals

Metals, such as iron, copper and zinc are required in trace amounts for physiological well-being of living organisms. However, these metals can be acutely or chronically toxic at elevated concentrations, while others like mercury can be toxic at low concentrations and some even exhibit carcinogenic effects. Furthermore, some metals have the potential to bio-magnify through the food web. It is thus necessary to monitor metal concentrations to determine the potential risk of exposure by aquatic biota to metal contamination and toxicity (CSIR, 2020).

During 2019/2020 most metal concentrations in surface water were either below the detection limit or low to moderate at all sites (CSIR, 2020). Several metals were detected at sites 3 and 7, although concentrations were within acceptable limits. Notwithstanding, the concentrations of copper, and manganese and nickel at site 3 where the highest recorded during the winter and summer surveys, respectively. In general, the water quality at sites 3 and 7 was classified as good in both summer and winter (CSIR, 2020).

Summary

Taking all water quality parameters into account, the overall water quality for sites 3 and 7 was rated as good and excellent, respectively, according to the integrated water quality index (CSIR, 2020) (Figure 10), with the only concerns being high chlorophyll-*a* concentrations in winter, and high orthophosphate concentrations in summer (CSIR, 2020).

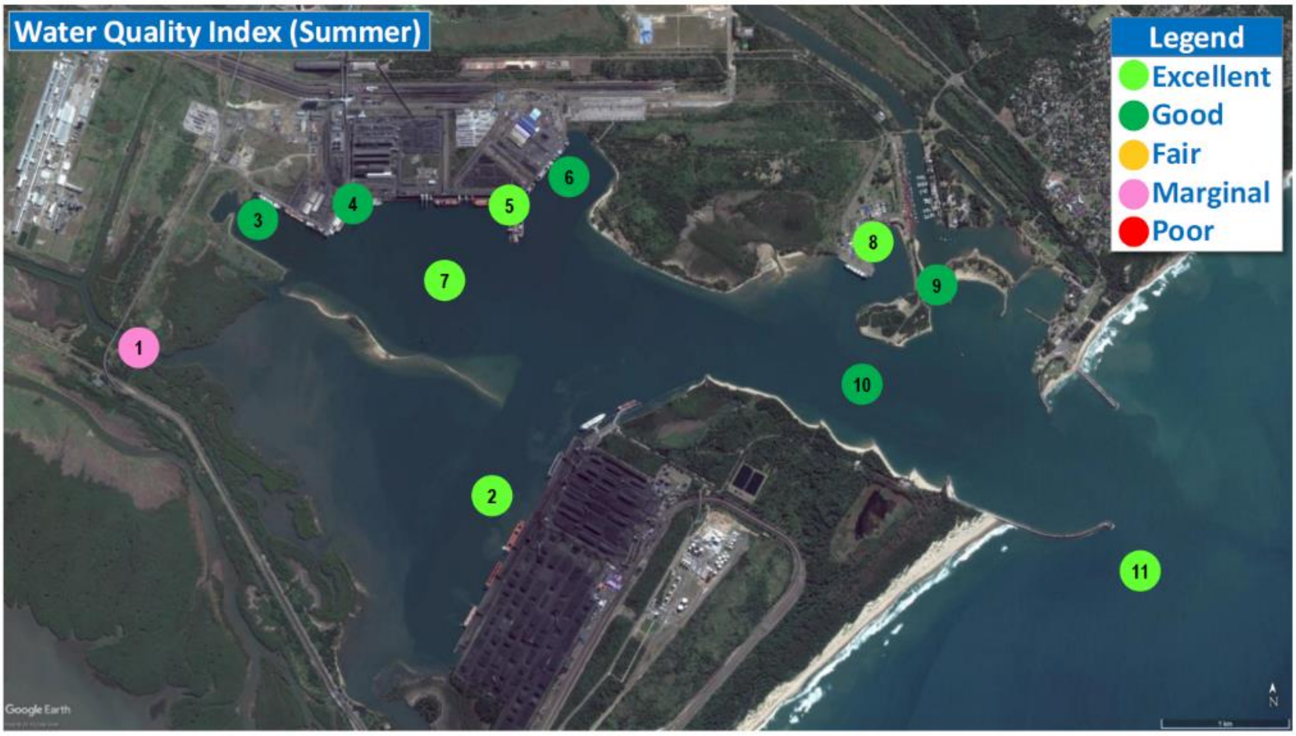

Figure 10. Water quality index categories for surface water monitoring sites for the summer 2020 survey (CSIR, 2020)

6.6.2. Sediment Composition and Quality

Understanding sediment composition and sediment quality is vitally important in ecological assessments. Benthic macrofauna (invertebrates), or organisms living in or on the sediment surface, exhibit particular habitat preferences for different sediment types. Moreover, sediment characteristics determine the fate of toxic substances that settle in the estuarine environment. The higher the percentage of small grain sizes (very fine sand and mud) and organic content, the greater the capacity to sequester contaminants. The accumulation and subsequent bacterial breakdown of organic matter in sediment can lead to hypoxia or anoxia, resulting in toxicity for living organisms, severely altering the structure and composition of bottom-dwelling communities.

Grain size composition and organic content

The long-term monitoring programme illustrated that the sediments in the Bay are dominated by mud (CSIR, 2020). Sediment analyses in winter revealed that the substrate within the project area (sediment sites 5 and 7, see Figure 11) comprised between 86.8 to 97.1% mud fraction (<0.0063 mm). Accordingly, and due to its sheltered nature, the port can be defined as a depositional environment (as most ports are). Sources of mud sized sediment to the Port are likely freshwater discharges from the nearby Bhizolo and Mzingazi canals and their flocculation and sedimentation due to influx of seawater in the tidal cycle (CSIR, 2020).

The sediment organic content was within an acceptable range (2.15 – 3.05% total organic carbon) and showed no evidence of enrichment. Sediment quality was rated as good, although organic content at site 7 was highest of all the sites sampled during winter survey period and was border-line fair in terms of sediment quality (CSIR, 2020).

Sediment quality: metals and other contaminants

Disturbances in the estuarine and marine environment, either anthropogenic or natural, can increase metal concentrations in seafloor sediments. These contaminants, if bioavailable, can have negative impacts on benthic communities, particularly filter feeders.

There is significant sediment contamination by metals and hydrocarbons in some parts of the Richards Bay estuary, with cadmium, copper, chromium, and zinc being the most important metal contaminants (DEA, 2017b). The presence of sediment contaminants, specifically heavy metals, is a common occurrence and expected within ports given the nature of the activities and materials handled. Other significant contaminants sampled as part of the long-term monitoring programme are hydrocarbons, which include a range of compounds originally derived from crude oil, for example, polycyclic aromatic hydrocarbons (PAH), a subset of total petroleum hydrocarbons. These contaminants are of particular concern because of their toxicity, and/or their potential carcinogenicity and mutagenicity (CSIR, 2020).

The long-term monitoring programme (2019 winter survey) indicated that metal concentrations within the sediment at most of the sites where within the expected range (CSIR, 2020). The sediment sample sites relevant to the proposed project are site 5 in the dead-end of the 600 Berth and site 7 in the inner port basin (See Figure 11). Both sites showed degrees of metal enrichment, but more so for site 5 where the highest number of metals at an enriched concentration (five) was sampled, and two metals at site 7, along with several other sites within the 600 and 700 Berth basins (CSIR, 2020). At site 5, the Enrichment Factors for cadmium, copper and chromium were particularly high relative to other sites in the port and were among the highest recorded throughout several ports sampled in the 2019 survey period of the long-term ecological monitoring programme (CSIR, 2020). The Enrichment Factor was rated as poor for two (copper and chromium), and fair for three (cadmium, nickel, and zinc). At site 7, the chromium and copper Enrichment Factor was rated as poor and fair, respectively. Overall, sites 6, 5 and 7 possessed the most severely metal contaminated sediment within Richards Bay (CSIR, 2020).

Figure 11. Sediment quality index categories for sediment monitoring sites for the winter 2019 survey (CSIR, 2020)

The sediment concentration of Total PAHs was rated as fair and good at sites 5 and 7, respectively. The overall sediment quality was rated as fair and good, respectively (Figure 11). However, the high individual concentrations of cadmium, copper, and chromium were sufficiently high to result in poor sediment quality (CSIR, 2020). It is also important to note, that site 6 in close proximity to the proposed project site had the highest level of sediment contamination, including metals, PAHs and organochlorine pesticides (*e.g.*, DDT and DDX) (CSIR, 2020).

6.7. Biotic Attributes

6.7.1. Overview of Estuarine Habitats

By virtue of port development, as well as urban and agricultural development, the uMhlathuze/Richards Bay estuarine complex has experienced devastating, mostly irreversible, habitat loss, transformation, and degradation (Begg, 1984; MER, 2013). Very little natural habitat remains in the Port of Richard Bay today, whilst that which is present in the uMhlathuze Estuary, is largely transformed through changes in tidal variation, river inflow and sediment deposition directly because of port development.

Notwithstanding the above, the importance of the transformed Richards Bay (and uMhlathuze Estuary) in supporting critical ecosystem services, such as habitat provision and feeding grounds for fish and crustaceans, has long been recognised (Begg, 1984; Cyrus and Forbes, 1996; Forbes et al., 1996; Weerts, 2002). It still supports habitats of conservation significance, including intertidal salt marsh, reeds and sedges, mangroves, swamp forest, intertidal and shallow subtidal sand banks and mudflats, the subtidal benthic zone, Zostera beds and the water body itself (AECOM, 2014; Begg, 1984; Cyrus and Vivier, 2014b; MER, 2013; van Niekerk and Turpie, 2012; Weerts, 2002).

Of particular note is the Kabeljous Flats, which is a 440 ha shallow embayment area in the western corner of the port at the outlet of the lower Bhizolo Canal, that comprises a variety of habitats including intertidal and subtidal sand- and mudflats, and mangrove habitat, which in turn support different biotic communities and serve different biological functions (MER, 2013). This area, together with the lower reaches of the Bhizolo and Manzamnyama Canals, performs an important nursery function for a range of marine and estuarine fauna utilising the estuary. The total area covered by mudflats in the western portion of the harbour is approximately 125 ha, which support a high diversity and abundance of macrobenthos (AECOM, 2014).

Sandflats occur primarily on the south-western side of the Port near and on the sand spit, which forms a physical boundary between the intertidal habitats (mud- and sandflats) and the main berthing area of the Port (and the proposed powership and FSRU location). Sandflats are also prevalent on shoreline edges in undeveloped areas of the port. They cover a large area of approximately 400 ha (AECOM, 2014). As with the mudflats, sandflats are considered an important nursery ground for juvenile fish and serve as a habitat for birds.

The sandflats, mudflats and mangroves that make up the Kabeljous Flats were ranked in the top three most important habitats of the 12 habitat types found in the port (Table 15) and were consequently categorised as of high conservation significance (CSIR, 2005 cited in CRUZ, 2009). In comparison, the harbour (marine embayment) and deep-water sediments, and intertidal beaches were rated the three least important habitats of 12 habitat types within the harbour boundaries (CRUZ, 2009). An overview of the sensitive habitats of Richards Bay is provided in Figure 12. A photographic record of the site observations is provided in Section 7.

Table 15. The Ecological significance scores of the different habitat types within the Richards Bay port boundary *Habitat types associated with the Kabeljous Flats (based on CSIR 2005)

Habitat type	Score (Max. 30)
Sandflats*	27
Mudflats*	26
Papyrus swamp	26
Hygrophilous trees (swamp forest) *	25
Mangrove swamps	25
Freshwater pans/channels	24
Tidal artificial channel (Bhizolo/Manzamnyama Canal)	23
Reed swamp	23
Rivers	21
Harbour (marine embayment)	20
Intertidal beaches	17
Deepwater sediments	13

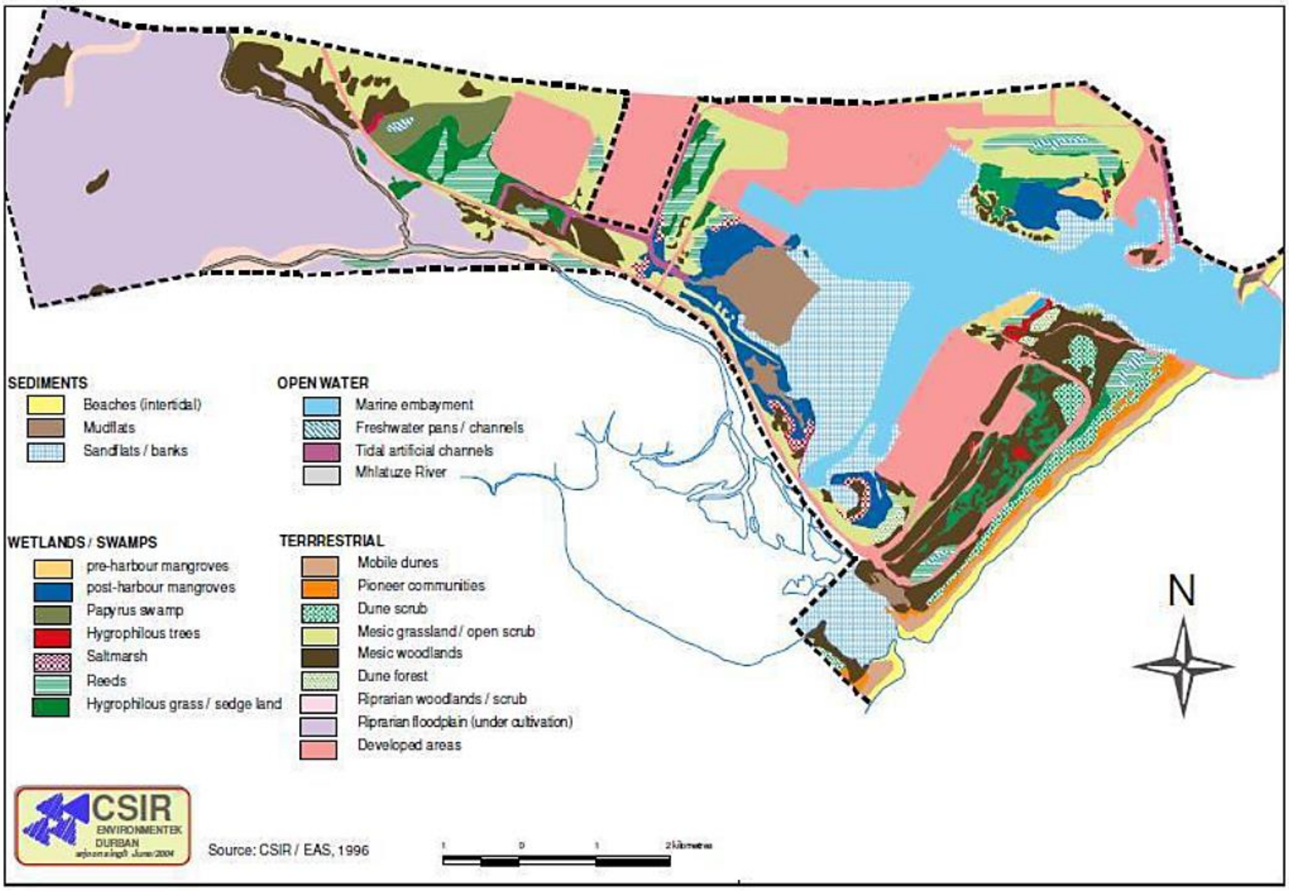

Figure 12. Sensitive habitats in the Port of Richards Bay (CSIR, 1996 in AECOM, 2014)

During the Terrestrial Ecology Assessment, De Wet (de Wet, 2022) produced a site-specific habitat map which details estuarine habitats in respect to the proposed Gast to Power project, which is provided here (Figure 13 overleaf) to supplement the above sensitive map (CSIR, 1996).

6.7.1. Flora

The Port of Richards Bay is known to have the oldest area of mangroves in the country (van Niekerk and Turpie, 2012), which are preserved in the eChwebeni Natural Heritage Site (NHS) covering an area of about 54 ha (DEA, 2017b). This site is also important because it contains all three species of mangroves found in the Bay. Together, the Richards Bay and uMhlathuze estuaries support almost half (47 %, 652.1 ha) of South Africa's mangrove habitat (van Niekerk and Turpie, 2012). Richards Bay also possesses the highest density of White Mangrove, *Avicennia marina* and Red Mangrove, *Rhizophora mucronata* (van Niekerk and Turpie, 2012) (although this is not necessarily a defining feature of a mature mangrove forest). The estimated total area of mangrove habitat in the Bay ranges between 267 – 305 ha (van Niekerk and Turpie, 2012), of which 85 % comprises *A. marina*. The largest stand of mangroves is located in the western portion of the Bay, at the outlet of the Bhizolo Canal, and extends up the Bhizolo and Manzamnyama Canals.

The mangroves of the port are characterised by high productivity, supporting large numbers of invertebrate and fish species. Several studies on the fauna of the uMhlathuze/Richards Bay estuarine complex have indicated that the mangrove habitats have an important influence on structuring invertebrate and fish communities (Cyrus and Forbes, 1996; Weerts, 2002; Weerts et al., 2003; Weerts and Cyrus, 2002) and thus their value as a purely botanical attribute should not be underestimated. At a national and provincial level, mangrove forests are classified as a Critically Endangered vegetation type, with a 100% conservation target (Anchor Environmental and TBC, 2022; EKZNW, 2011).

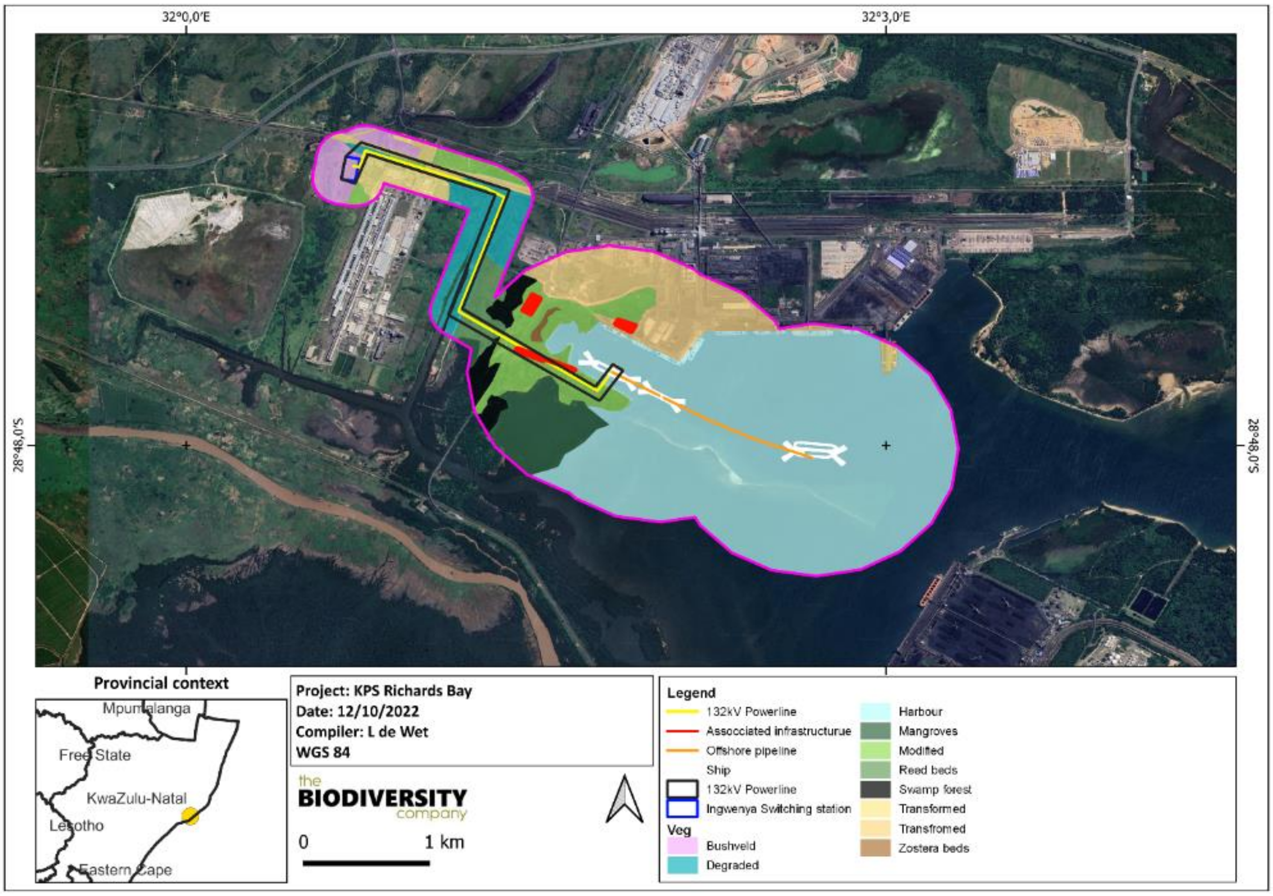

Figure 13. Site-specific vegetation map (de Wet, 2022b)

Reeds and sedges cover approximately 309 ha and occur mainly to the west of the port, with some habitat noted on the seaward margin of the Manzamnyama Canal (Turpie et al., 2012). Saltmarsh communities have been nearly eliminated from Richards Bay, with only 52 ha still remaining, predominantly in the western part of the port. Nonetheless these saltmarshes add to the region's ecological integrity (AECOM, 2014). The dominant plants there included *Sarcocornia natalensis*, *Juncus kraussii*, *Sporobolus virginicus* and *Paspalum vaginatum,* and herbs, such as *Apium graveolens¸* as well as *Salicornia pachystachya* (Adams *et al.*, cited in DEA, 2017).

Swamp forests, dominated by *Barringtonia racemosa*, *H. tiliaceus* and *Ficus trichopoda,* occur in small dense stands along rivers, drainage channels, and the upper portions of the bay (SiVEST, 2018). Remaining swamp forest covers approximately 18 ha (Turpie et al., 2012). A fairly large and well-developed swamp forest occurs seaward of the Manzamnyama Canal and railway line, comprising *Ficus trichopoda–Syzygium cordatum* swamp forest, and *Phragmites australis–Cyperus papyrus* freshwater wetland (Cyrus, 2014). More details on these vegetation types can be found in the Terrestrial (de Wet, 2022) and Wetland Specialist (Triplo4, 2022a) assessments. As with mangrove forests, swamp forests are also classified as a Critically Endangered vegetation type at both a national and provincial level, with a 100% conservation target (Anchor Environmental and TBC, 2022; EKZNW, 2011).

Zostera capensis (Marine seagrass or eelgrass) was recently 'rediscovered' in the port in 2014 within the enclosed shallow intertidal area at the head of the dead end-basin during specialist studies for the Berth 600 Series Extension Port Expansion Project (Cyrus and Vivier, 2014b). This area is linked to the 'assembly basin' through a large pipe (Plate A), which allows for tidal exchange (*i.e.,* the enclosed area experiences tidal rise and fall). This habitat is fringed by *Avicennia-Bruguiera* mangrove stands and *H. tiliaceus* visible from the Harbour Arterial Road to the west (Plate 1B-D). This occurrence is noteworthy as *Z. capensis* has not been recorded in the system for some 30 years, the species is listed as Vulnerable on the IUCN Red List of Threatened Species, and because it is only found in few estuaries on the South African east coast (Adams, 2016; Cyrus and

Vivier, 2014b). Attempts were made to confirm the presence of the *Z. capensis* in this area. However at the time of the site investigation, the tide was up, and the area inundated and water clarity poor, obscuring any view of *Z. capensis*. The presence of Z. capensis was not confirmed but it is still assumed that the beds are present. It is worthwhile to note that *Zostera* was not observed in the immediate vicinity of the project area within the dead-end basin nor along the outer edge of the sandspit during the April 2021 site investigation (de Wet, 2022).

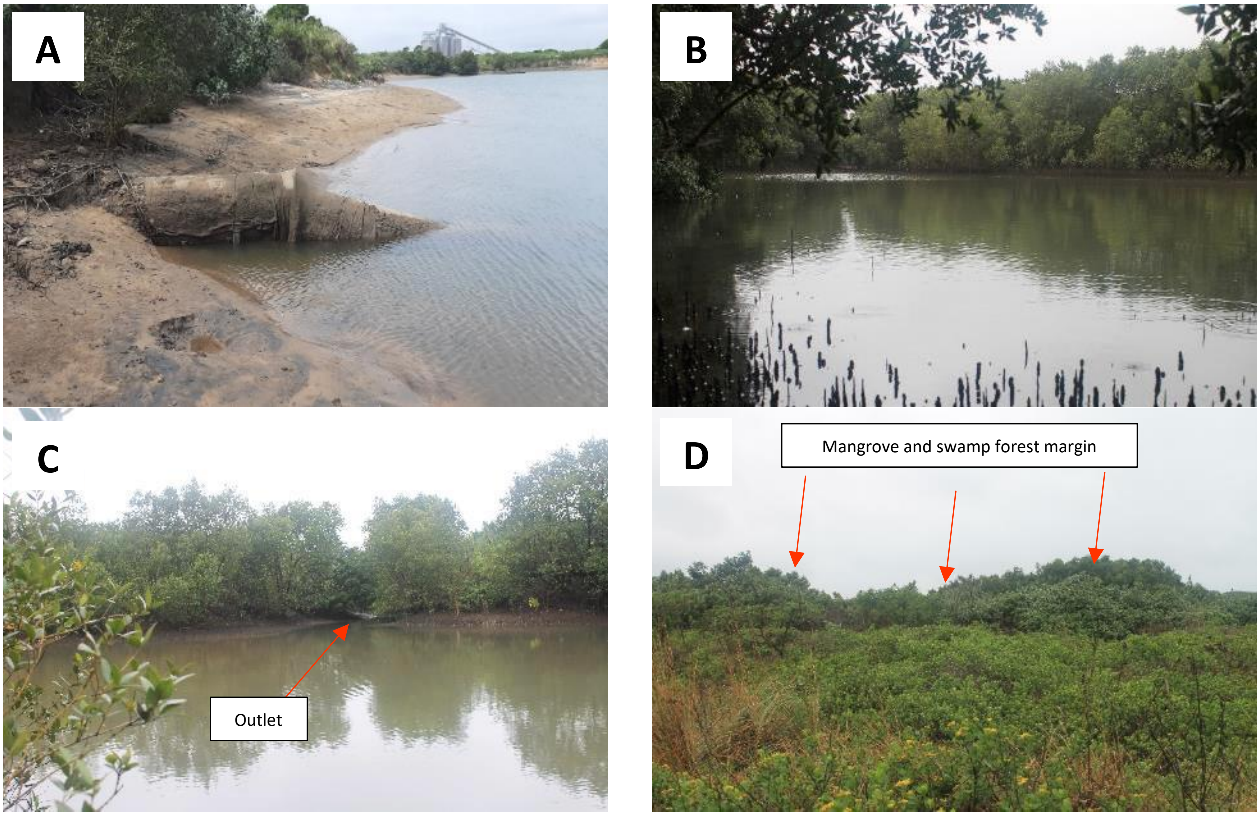

Plate 1. Pipeline linking the enclosed shallow intertidal area where *Zostera* habitat has been found to the assembly basin (A), habitat conditions (B-C), view toward pipeline outlet (C), and view of enclosed area from Harbour Arterial Road (D).

Early investigations of port prior to construction recorded large beds of *Z. capensis*, particularly near the mouth(Cyrus and Vivier, 2014b). Post port construction, it was said to have disappeared completely, but has since been recorded erratically over the years, and similarly in the Mhlathuze Estuary. Cyrus and Vivier (2014b) provide a historical account of *Z. capensis* occurring in both systems.

During the 2014 assessment (Cyrus and Vivier, 2014b), the stands of *Z. capensis* were described as well-established and extensive, covering close to 40% of the surface area of this habitat. A large number of juvenile fish were present, and the area is evidently of high ecological value as a nursery habitat, therefore contributing to ecosystem functioning within the highly modified environment of the Richards Bay Estuary (Cyrus and Vivier, 2014b). *Zostera* is known to provide habitats for shelter, foraging, and nursery area, and high levels of primary of primary productivity (Adams, 2016; Cyrus and Vivier, 2014b). Consequently, it supports a rich diversity of marine and estuarine fauna, including endemic species such as the migrant estuarine prawn *Palaemon peringueyi* (Adams, 2016; Cyrus and Vivier, 2014b; MER, 2013). Cyrus and Vivier (2014b) regards this discovery as of great ecological significance.

Several important recommendations were made based on these findings, which include *inter alia*, an in-depth investigation of the *Zostera* ecosystem to fully understand its current status and significance to the harbour and establishing whether there are other stands of *Z. capensis* present in the port that are yet undiscovered (Cyrus and Vivier, 2014b). This is important to ascertain as *Z. capensis* is highly dynamic, but it is easily disturbed by *inter alia*, boat disturbance, bait digging, floods, and eutrophication causing prolific growth of smothering macroalgae (Adams, 2016).

6.7.2. Fauna

Department of Environmental Affairs (2017b) list key literature pertaining to invertebrate studies of the Richards Bay and uMhlathuze estuaries. The following is a summary of this information drawn largely from MER (2013) in specific reference to the Richards Bay Estuary. Please refer to the Terrestrial Ecology specialist report for detailed account of terrestrial species (de Wet, 2022).

Zooplankton

Zooplankton is commonly described as organisms floating in the water column and that have limited mobility. This group comprises predominantly small crustaceans, namely calanoid copepods, larvae of benthic fauna, single celled organisms as well as larger organisms, like mysid shrimps and jellyfish. They serve as an important food source for higher trophic levels such as planktivorous feeding fish and birds (*e.g.*, flamingos).

Since construction, there has been a reduction in estuarine zooplankton species density in the port of Richards Bay and adjacent Mhlatuze Estuary (Grindley and Wooldridge 1974; Jerling 2008). A study by Jerling (2008) confirmed that the zooplankton is predominantly of marine origin, with key marine taxa notably the neritic paracalanid copepod *Parvocalanus crassirostris* and the cyclopoid *Oithona* spp. (Jerling, 2008). Densities of the estuarine calanoids *Pseudodiaptomus stuhlmanni* and *Acartia natalensis*, which dominated the single system before port construction, were low and predominantly restricted to upper fresher areas (Jerling, 2008). Higher zooplankton abundances are present in the port compared to the adjacent estuary. This is mainly attributed to the high number of *Oithona* spp. present in the port and the less stable aquatic environment in the shallow estuary. Salinity and temperature were the main environmental factors that governed the distribution of zooplankton abundance. Abundance varied seasonally within the port and was highest during spring and summer. The species, *Acartia spinicauda* is an introduced (alien) species that was probably introduced through ballast water discharged in the harbour (Jerling, 2008). A list of the taxa recorded by Jerling (2008) is provided in

Table 16.

Table 16. Zooplankton taxa present in the Port of Richards Bay (Jerling, 2008)

Taxonomic name	Taxonomic name	Taxonomic name	Taxonomic name
Acartia natalensis	Cypris larvae	Moina spp.	Shrimp and prawn larvae
Acartia spp.	*Eucalanus* spp.	Mollusc larvae	*Synidotea* spp.
Acartia spinicauda	*Euchaeta* spp.	*Oithona* spp.	*Temora stylifera*
Amphipoda	*Evadne* spp.	*Oncaeidae Corycaeidae*	*Temora turbinata*
Apseudes digitalis	Fish eggs	*Peltidium* spp.	Tintinnids
Candacia spp.	Fish larvae	*Podon* spp.	*Tropodiaptomus* spp.
Centropages natalensism	*Gastrosaccus* spp.	*Poecilostomatoida*	*Undinula* spp.
Centropages spp.	*Halicyclops* spp.	*Pseudodiaptomus nudus*	Unidentified copepodites
Cirolana spp.	*Leptanthura laevigata*	*Pseudodiaptomus stuhlmanni*	Unidentified harpacticoids
Copilia spp.	*Lucifer* spp.	*Rhincalanus* spp.	Unidentified insect larvae
Cyphonautes larvae	*Mesopodopsis africana*	*Rhopalophthalmus tropicalis*	Unidentified nauplii

Ichthyoplankton

Along the east coast of South Africa, ichthyoplankton is primarily confined to inshore waters. The Richards Bay Estuary, and specific habitats within it (particularly the undeveloped shallower section of the port), serve as critically important nursery habitat for many fish species (MER, 2013). Several studies have recorded the occurrence of larvae and eggs of both marine and estuarine fish species in the port (Harris and Cyrus, 1997; Jerling, 2008). Harris and Cyrus (1997) reported larvae from 106 taxa, with species from the families Engraulidae and Gobiidae dominating. The most abundant larvae were those of the Thorny anchovy *Stolephorus holodon* and an unidentified goby. Other abundant species included the Orangemouth anchovy

Thryssa vitrirostris, the Bulldog eelgoby *Taenioides esquivel,* the Indian pellona *Pellona ditchela* and the Burrowing goby *Croilia mossambica.*

A total of 28 species that occurred are either partially or wholly dependent on estuaries to complete their life cycle. These species dominated in terms of density within the port (Harris and Cyrus, 1997).

Subtidal Macrobenthos

Macrobenthos, also known as benthic invertebrates, are relatively sedentary, long-lived organisms residing within the sediment or at the sediment-water interface and possess various physiological and/or behavioural adaptations to tolerate extreme fluctuations in the physical and chemical conditions of the estuarine environment (Stow, 2011). They are an important component of estuarine ecosystems reaching high diversity, density and biomass in healthy environments. They are critical food organisms for marine and estuarine fish and coastal bird species, and thus contribute to a complex food web with strong species interdependence (MER, 2013). They are also effective indicators of environmental change and disturbance, and are commonly used to assess the effects of pollution and anthropogenic activities on the health of marine and estuarine ecosystems (Stow, 2011). Generally, sandy habitats, characterised by high flows and low organic detritus deposition, are dominated by suspension feeding benthic species. In muddy areas, characterised by low flow and high organic detritus deposition rates, deposit feeders dominate.

The long-term ecological monitoring programme of the Port of Richards Bay (CSIR, 2020), indicates that, the macrobenthic community within Bay is typical of estuarine embayments on the South African east coast.

During a 2014 survey, Vivier and Cyrus (2014a) recorded an overall mean catch per unit effort of 661 organisms.m^{-2}, in a recent study by Izegaegbe *et al.* (2020), much higher mean densities of 90,551 organisms.m^{-2} were recorded. This discrepancy is likely due to the latter study sampling from within the Bhizolo and Mzingazi canals and where the Mhlatuze estuary joins the port (Izegaegbe et al., 2020), whilst the former study only sampled within boundaries of the Port and adjacent mudflats. The Bhizolo and Mzingazi canals had especially high densities of the tanaid *Halmyrapseudes digitalis* (140 212 individuals.m^{-2} and 23 220 individuals.m^{-2} at each canal site, respectively), and this is mainly as a result of these sites being less impacted by port activities. Within the port itself, both studies recorded highest macrofaunal densities in the mudflats to the south-west of the proposed powership and FSRU site, with the community being dominated by the bivalve *Dosinia hepatica,* the polychaetes *Mediomastus capensis* and *Aphelchaeta marioni* and the tanaid *H. digitalis* (Izegaegbe et al., 2020; Vivier and Cyrus, 2014a)

The macrofaunal density in the proposed powership and FSRU location region is relatively low, especially compared to the mudflat habitat (CSIR, 2020; Izegaegbe et al., 2020; Vivier and Cyrus, 2014a). Polychaete worms primarily dominate the community in the proposed development area, mainly *Mediomastus capensis* and *Aphelochaeta marioni* (Izegaegbe et al., 2020; Vivier and Cyrus, 2014a). (Table 17). These indicate a disturbed region that aligns with the findings of CSIR (CSIR, 2020) where high sediment metals concentrations were found in this region of the port.

Table 17. The percent contribution of macrobenthos taxa collected at sites in the vicinity of the proposed powership and FSRU location (Adapted from Izegaegbe *et al.* 2020 and Vivier and Cyrus, 2014a)

Taxon	Percent contribution to abundance	
	Izegaegbe *et al.* 2020	Vivier and Cyrus, 2014a
Nemertea	0.24	4.6
Oligochaeta	0.01	
Polychaeta		
Acromegalomma sp	0.09	
Aonides oxycephala	0.17	
Aphelochaeta marioni	17.81	5.2
Armandia intermedia	1.08	
Cirratulus spp	0.03	

Taxon	Percent contribution to abundance	
	Izegaegbe *et al.* 2020	Vivier and Cyrus, 2014a
Dipolydora normalis	0.27	
Euchone capensis	0.31	
Fabrica spp	0.09	
Glycera tridactyla	0.11	
Glycera longipinus	0.02	
Glycera natalensis	0.05	
Glycera sp1	0.21	
Glycera sp2	0.09	
Glycera subaena	0.08	
Lumbrinereis cavifrons	0.06	
Lumbrinereis latreilli	0.6	
Mediomastus capensis	18.23	19.8
Micronephtys sphaerocirrata	0.8	8.3
Nereis spp	0.17	
Notomastus aberans	0.06	2.8
Notomastus fauveli	0.03	
Onuphis eremita	0.01	
Owenia fusiformis	2.93	
Paraprionospio pinnata	0.13	
Phyllodoce malmgreni	0.5	
Polydora spp	1.07	
Prionospio sexoculata	9.2	
Sigambra constricta	2.67	
Spionidae spp	0.01	
Terebillinae spp	0.01	
Bivalvia		
Dosinia hepatica		9.6
Eumarcia paupercula	0.23	2.6
Tellina spp	0.97	9.8
Crustacea		
Amphipod sp1	0.11	
Amphipod sp2	0.2	
Halmyrapseudes digitalis	28.3	2.8
Iphinoe truncata	0.02	
Leptocheli barnardi	0.05	
Paratylodiplax blephariskios	5.73	3.9
Urothoe pinnata	0.01	
Sipunculidae		
Sipunculid spp	1.13	

A 2019/2020 surveys of the long-term ecological monitoring programme of the Port of Richards Bay (CSIR, 2020), revealed that the macrobenthic community of the port was dominated by annelid worms, comprising more than 60% of the total abundance at ten stations, followed by small crustaceans, namely tanaids, comprising up to 62% of the total abundance specifically within the Mzingazi Canal (CSIR, 2020). In the vicinity of the project site, the macrobenthic communities were poorly diverse and depauperate at sites 5 (dead-end 600 Berth basin) (3 main taxonomic groups, < 1000 ind.m^{-2}) and 7 (inner port 700 Berth basin) (2 main taxonomic groups ~1000 ind.m^{-2}) (CSIR, 2020) (Figure 14). In terms of community composition, the communities at these sites were dominated by annelid worms (~65 – 68%) followed by 10 - 28% other collective taxa and bivalves (~3-12%) (Figure 14). Importantly, the presence of pollution and disturbance tolerant taxa was found to be relatively minor. At both sites, the assemblage comprised similar proportions of species indifferent to organic enrichment or disturbance, species tolerant of excess organic matter enrichment, second order opportunistic species as well as pollution/disturbance sensitive species. The latter was more prevalent at site 5 (CSIR, 2020). Izegaegbe *et al.*, (2020) documented findings similar to the above. The macrobenthic community at site 4 (dead-end of the 600 Berth basin) was the least diverse and shared the lowest abundance with a site located on a sandflat near to the small craft harbour. Overall, the health of the macrobenthic community at sites 5 and 7 was classified as slightly disturbed (CSIR, 2020).

Conversely, and reported in other studies, the macrobenthic invertebrate community of the Kabeljous Flats is highly diverse, supporting a total of 113 species (MER, 2013). The fauna comprises a mixture of marine and estuarine taxa, including cnidarians, nemerteans, nematodes, sipunculids, predominantly marine polychaete groups, molluscs including gastropods and bivalves, and a wide variety of crustaceans including typical estuarine species (MER, 2013). Izegaegbe *et al.*, (2020) found the Kabeljous flats to be the second most diverse site, and fourth highest in terms of abundance. Unfortunately, the long-term monitoring surveys do not include sites on the Kabeljous Flats or the sandspit.

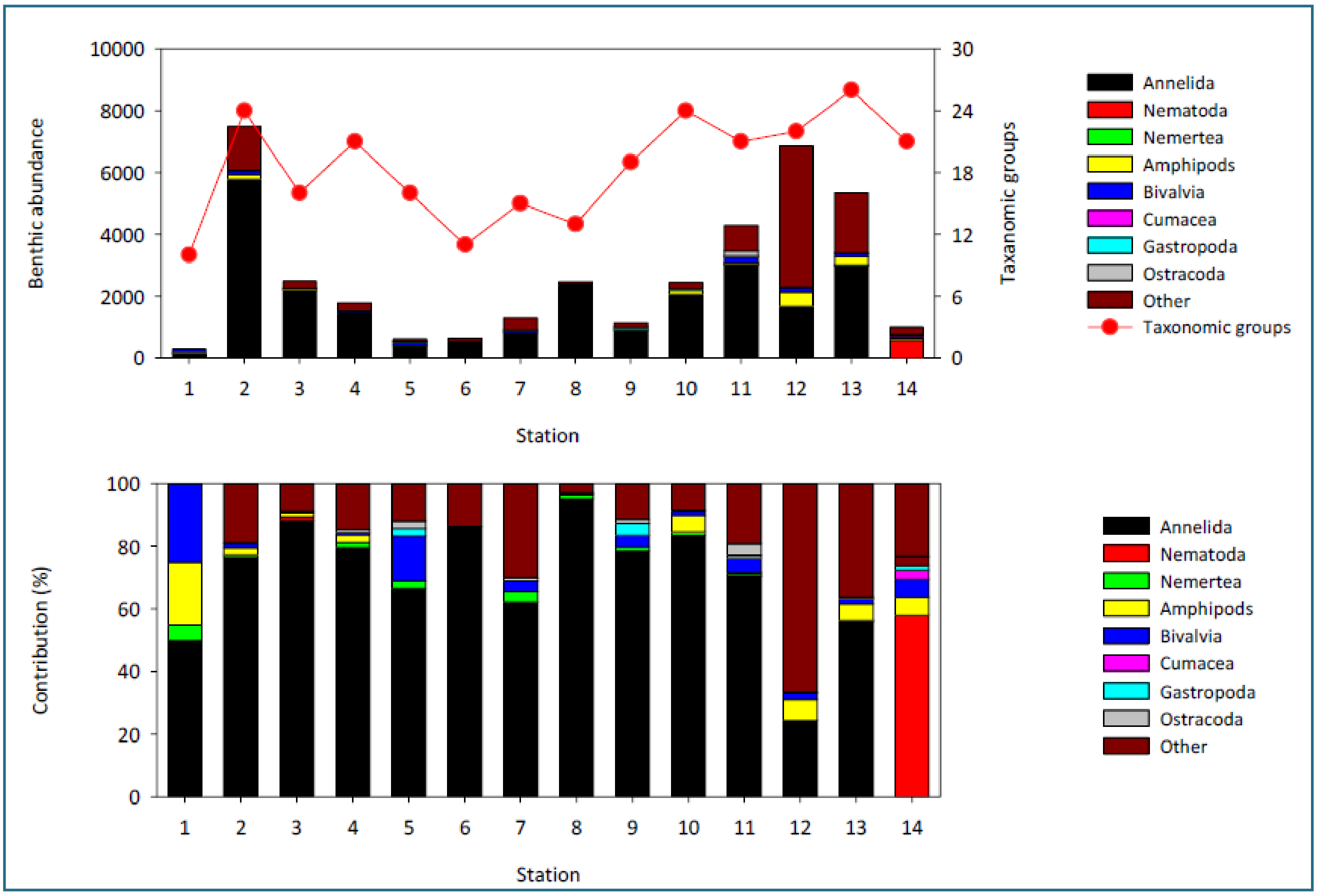

Figure 14. Top: abundance and number of taxonomic groups comprising the microbenthic community at each station sampled in Richards Bay, August, 2019. Bottom: Contribution of various taxonomic groups to microbenthic abundance at each station sampled in the Port of Richards Bay, August, 2019 (CSIR, 2020)

Macrocrustaceans (Prawns)

Regarding macrocrustaceans, Richards Bay as well as the Mhlathuze Estuary are major providers of prawn nursery grounds in the KZN region (Fielding, 1989; MER, 2013). Penaeid prawns in the western Indian Ocean are typically associated with suitable estuarine nursery grounds.

The life cycles of the local penaeid prawn species require estuarine habitat for the juveniles. Adults spawn offshore, before the eggs undergo several planktonic larval transformations at sea, eventually metamorphosing into post-larva (Forbes & Forbes 2013). The post-larvae then enter Richards Bay where they reside as juveniles and grow until they reach a maximum carapace length of 25 mm (Forbes & Forbes 2013). The juveniles emigrate out to sea usually well before a carapace length of 25 mm is reached. The cue for this movement is unknown (Forbes & Forbes 2013). Sub-adults grow larger at sea becoming adults which eventually spawn.

The prawn stocks on the Thukela Bank off the coast of northern KZN, South Africa's former prawn trawling area, are derived largely from KZN nursery grounds, particularly the large estuarine systems of St Lucia, Richards Bay and Mhlatuze (DWAF 2004, Forbes & Forbes 2013). The most abundant species caught in this area are *Penaeus indicus*, *Metapenaeus monocerus* and *P. monodon* (Forbes & Forbes 2013). Juvenile prawn stocks utilising Richards Bay contributed significantly (reportedly more than 50 %) to the breeding population of prawns on the Tugela Banks, (Clark et al., 2002). The Bhizolo/Manzamnyama Canals were once regarded as the 'prime prawn habitat' in the bay and considered crucial to the commercial prawn fishery at the time (Cyrus and Forbes, 1996).

It is important to note, that the Tugela Bank inshore/shallow-water commercial prawn fishery collapsed in around 2004-2005 largely as a result of poor recruitment due to the drought and prolonged closure of the St Lucia Estuary mouth (DAFF, 2014). It is arguable that the function of Richards Bay as a prawn nursery ground became increasingly important during this time.

Studies on the macrocrustaceans utilising the canals and the Kabeljous Flats yielded 34 species, comprising 14 prawns, one sand prawn and 20 crab species (MER, 2013). The most abundant species on the Kabeljous Flats was the small pelagic shrimp, *Acetes erythraeus*, followed by *Metapenaeus monoceros* and *Marsupenaeus japonicus* (CRUZ, 2009). These areas are expected to support significant food resources for the predacious fish populations of the port (MER, 2013). The importance of the harbour as a nursery for estuarine crustacean species of considerable ecological and commercial value must be considered in future development plans (Weerts et al., 2003).

Fish and Elasmobranchs

Being an estuarine system, the undeveloped, shallower sections of the Richards Bay Port function as an important nursery ground for many fish species. Fish surveys conducted in the port since 1996 have emphasised the overall significance of the estuary and particular habitats within the system in the functioning of fish communities in the area (MER, 2013). The Richards Bay Estuary is ranked as the third most important estuary out of 247 South African systems in terms of its importance for fish populations (Turpie et al., 2002).

Numerous fish surveys have repeatedly shown that different habitats support different numbers and species. Variable species counts have been reported, but species richness is generally high with an estimated total of 100 species. Fifty-three species were recorded from the sheltered mangrove areas on the south-western edge of the Kabeljous Flats (Cyrus and Forbes, 1996 cited in MER, 2013). Weerts (2002) reported 64 species, with 41 of these occurring on subtidal mudflats, 32 occurring on subtidal sandflats, 24 occurring in mangroves and 26 occurring in the Bhizolo Canal. Nhleko and Cyrus (2008, cited in MER, 2013) recorded 80 species, Beckley *et al.* (2008) reported 46 species from recreational anglers' catches, and Weerts and Newman (2009) reported 64 species. In a study conducted by CRUZ (Vivier and Cyrus, 2014b), 486 individuals comprising 20 fish species were caught during sampling conducted in the port's intertidal areas. In most studies conducted, most fish sampled were juveniles occurring within the intertidal and shallow subtidal zones, demonstrating the importance of this habitat (MER, 2013). Based on the classification proposed by Whitfield (Whitfield, 2019), (Table 18) most species encountered in the Port are either partially (category II, euryhaline marine species which breed at sea with their juveniles showing varying degrees of dependence on estuaries as part of their life cycle) or wholly (category I, estuarine species which breed in the system) dependent on the estuary. Of the 100 fish found in previous surveys of the Richards Bay Port, 53% of species use the estuary as a nursery area (Categories I, IIa, IIb and IIc), and 14% are important in the commercial line fisheries (Table 19 and Figure 15).

Table 18. Life cycle categories of fish utilising estuaries in southern Africa (Whitfield 2019) and the dependence factor used for valuation of inshore fisheries by Lamberth & Turpie (2003)

Category	Description	Dependence factor (%)
I	Estuarine species which breed in southern African estuaries. This category includes resident species that spawn only in estuaries, as well as species that also have marine or freshwater breeding populations.	100
II	Euryhaline marine species which usually breed at sea, with the juveniles showing varying degrees of association with southern African estuaries:	
	IIa Juveniles dependent on estuaries as nursery areas.	100
	IIb Juveniles occur mainly in estuaries, but are also common at sea	90
	IIc Juveniles sometimes occur in estuaries but are more abundant at sea	30
III	Marine stragglers which occur in estuaries in very small numbers and are not dependent on these systems.	0
IV	Freshwater species, whose penetration into estuaries is determined primarily by salinity tolerance. This category includes a few species which may breed in both freshwater and estuarine systems. It also includes some freshwater stragglers that are seldom recorded in estuaries.	N/A
V	Obligate catadromous species which use estuaries as transit routes between the marine and freshwater environments:	100

Of the species that use the port as a nursery area, Perch *Acanthopagrus vagus* and Elf *Pomatomus saltatrix* are listed as Vulnerable on the IUCN Red List and Dusky kob *Argyrosomus japonicus* is listed as Endangered (Carpenter *et al.* 2015, Fennessy 2020, Mann *et al.* 2014). Also found in the port are Bonefish *Albula vulpes*, Catface rockcod *Epinephelus andersoni,* and the Bronze bream *Pachymetopon grande* which are all listed as Near Threatened in the IUCN Red List (Adams *et al.* 2012, Fennessy 2018, Mann *et al* 2014). Additionally, the Vulnerable Yellowbelly rockcod *Epinephelus marginatus* and Mozambique tilapia *Oreochromis mossambicus* are also found in the port (Bills 2019, Pollard *et al.* 2018).

Most estuary-dependent species enter the estuary as larvae or post larvae (Whitfield & Marais 1999; Harris & Cyrus 1994, 1995, 1996; Harris *et al.* 1999) and once the estuarine dependent phase is complete, they leave the estuary for the marine environment where they become available to marine fisheries, and upon maturity contribute to the spawning stock (Wallace 1975a, b). These estuarine-dependant species are particularly important to the estuary as they dominate both numbers and biomass of the fish fauna in the estuary.

The studies by Weerts (2002) and Weerts and Cyrus (2002) emphasised the ecological importance of the Lower Bhizolo Canal and Kabeljous Flats as nursery habitat, the varying habitat requirements of different fish communities, and the importance of maintaining such varied habitats in the Richards Bay harbour to ensure the system continues to support diverse fish assemblages.

Common species encountered in the Port include mullet *Crenimugil buchanani* , *Chelon dumerili*, and *Planiliza macrolepis*, as well as spotted grunter *Pomadasys commersonnii*, slimy *Leiognathas equula*, target fish *Terapon jarbua*, and the bream *Acanthopagrus berda*, (Beckley et al., 2008; Vivier and Cyrus, 2014b). Other species previously recorded are listed in Table 19. Furthermore, species such as the Mugilids and *Gilchristella aestuaria* are also extremely important fodder fish supporting many of the line fish and are indicated with an asterisk * in Table 19.

Table 19. Fish species previously recorded in the Port of Richards Bay. Data obtained from Cyrus & Forbes (1996), Jairam 2005, Beckley *et al.* (2008) and CRUC (2014e). Estuarine Dependence Category (EDC) (from Whitfield 2019) is also listed where possible. Important line fish and those caught by the illegal gillnet fishery (see Section 6.9.1) in the region are indicated (DFFE 2021, Jariam 2005, Kyle 1999, Mann 1995). Species marked with an asterisk are important fodder species in the system.

Scientific name	Common name	Estuary Dependence Category	Line fish	Gillnet
Abudefduf vaigiensis	Sergeant major			
Acanthopagrus berda	River Bream	IIa		Yes
Acanthopagrus vagus	Perch	IIa		Yes
Acanthurus nigrofuscus	Brown surgeon			
Acanthurus xanthopterus	Yellowfin surgeon			
Albula vulpes	Bonefish			
Alectis spp.	Mirrorfish			
Ambassis ambassis	Commerson's glassy perchlet	I		Yes
Ambassis dussumieri	Malabar glassy	I		
Ambassis gymnocephalus	Bald glassy	I?		
Ambassis natalensis	Slender glassy	I		
Amblyrhynchotes honckenii	Evileye blaasop	III		
Argyrosomus japonicus	Dusky kob	IIa	Yes	Yes
Arothron hispidus	Whitespotted puffer	IIc		
Carangoides ferdau	Blue kingfish			
Caranx heberi	Blacktip kingfish	III		
Caranx ignobilis	Giant kingfish	IIb		
Caranx melampygus	Bluefin kingfish	IIc		
Caranx sexfasciatus	Bigeye kingfish	IIb		
Caranx spp.	Kingfish			Yes
Chaetodon lunula	Halfmoon butterflyfish			
Chanos chanos	Milkfish	IIc		Yes
*Chelon dumerili**	Groovy mullet	IIa		Yes
Crenidens crenidens	White karanteen	III		
Crenimugil buchanani	Bluetail mullet	IIc		
*Crenimugil seheli**	Bluespot mullet	IIc		Yes
Dinoperca petersi	Cavebass or lampfish		Yes	
Diplodus capensis	Blacktail	IIc		
Drepane longimana	Concertina fish	III		
Drepane punctata	Concertina fish			
Elops machnata	Ladyfish	IIa		Yes
Epinephelus andersoni	Catface rockcod	III	Yes	
Epinephelus coioides	Orangespotted rockcod			
Epinephelus marginatus	Yellowbelly rockcod	III	Yes	
Epinephelus sp.	rockcod		Yes	
Epinephelus tukula	Potato bass		Yes	
Galeichthys feliceps	White seacatfish	IIb		
Gerres filamentosus	Threadfin pursemouth	IIb		Yes

Scientific name	Common name	Estuary Dependence Category	Line fish	Gillnet
Gerres longirostris	Smallscale pursemouth	IIb		Yes
Gerres methueni	Evenfin pursemouth	IIb		Yes
Gerres spp.	Pursemouth			
*Gilchristella aestuaria**	Estuarine roundherring	I		
Hilsa kelee	Kelee shad	IIb		
Leiognathus equula	Slimy	IIb		Yes
Lethrinus spp.	Emperor		Yes	
Lichia amia	Garrick	IIa		
Lutjanus argentimaculatus	Mangrove red snapper	IIc		Yes
Lutjanus fulviflamma	Dory snapper	IIc		
Lutjanus russellii	Russell's snapper			
Lutjanus spp.	Snapper			
Monodactylus falciformis	Cape moony	IIa		
*Mugil cephalus**	Flathead mullet	IIa		Yes
Muraenesox bagio	Pike conger			
Neoscorpis lithophilus	Stonebream			
Oreochromis mossambicus	Mozambique Tilapia	IV		Yes
*Osteomugil cunnesius**	Longarm mullet	IIa		Yes
*Osteomugil robustus**	Robust mullet	IIa		Yes
Otolithes ruber	Snapper kob	IIc	Yes	
Pachymetopon grande	Bronze bream		Yes	
Paralichthodes algoensis	Peppered flounder			
Parupeneus spp.	Goatfish		Yes	
*Planiliza alata**	Diamond mullet	IIa		Yes
*Planiliza macrolepis**	Large-scale mullet	IIa		Yes
Planiliza subviridis	Greenback mullet	IIb		
Platycephalus indicus	Bartail flathead	IIc		Yes
Plectorhinchus gibbosus	Brown sweetlips	III		
Plotosus nkunga	Eel-catfish			
Polyamblyodon germanum	German		Yes	
Pomadasys commersonnii	Spotted grunter	IIa		Yes
Pomadasys kaakan	Javelin grunter	IIc	Yes	
Pomadasys maculatus	Saddle grunter			
Pomadasys multimaculatus	Cock grunter	IIc		Yes
Pomadasys olivaceus	Pinky	IIc		
Pomadasys spp.	Grunter		Yes	
Pomatomus saltatrix	Elf	IIc		Yes
Pseudomyxus capensi	Freshwater mullet	IIa		
Pseudorhombus arsius	Largetooth Flounder	III		
Redigobius balteatops				
Rhabdosargus holubi	Cape stumpnose	IIa	Yes	
Rhabdosargus sarba	Natal stumpnose	IIb		Yes

Scientific name	Common name	Estuary Dependence Category	Line fish	Gillnet
Rhabdosargus spp.	Stumpnose			
Sardinella spp.	Sardine			
Sarpa salpa	Strepie	IIc		
Scarus spp.	Parrotfish			
Scomberoides commersonnianus	Talang queenfish	III		
Scomberoides lysan	Double spotted queenfish	IIc		
Scomberoides spp.	Queenfish			
Scomberoides tol	Needle scaled queenfish	IIc		
Sillago sihama	Northern whiting	IIc		
Soleidae spp.	Sole			
Sphyraena jello	Pickhandle barracuda	IIc		Yes
Sphyraena qenie	Blackfin barracuda			
*Strongylura leiura**	Branded needlefish	IIc		
Strophidon sathete	Slender giant moray	IIc		
Terapon jarbua	Target fish	IIa		Yes
*Thryssa vitrirostris**	Orangemouth anchovy	IIb		
Trachinotus botla	Largespotted pompano			
Trachinotus spp.	Pompano			
Trichiurus lepturus	Cutlass fish	III		
Tylosurus crocodilus	Crocodile needlefish	IIc		
Umbrina spp.	Baardman			

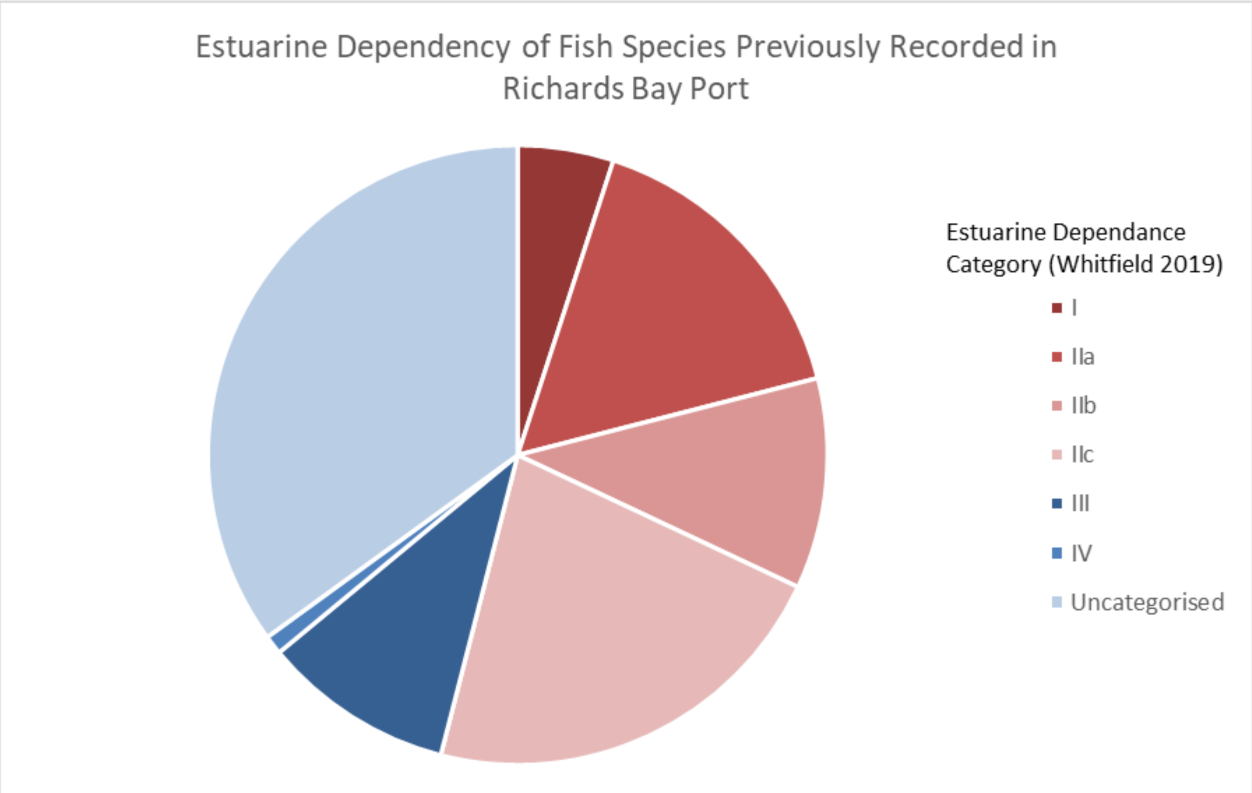

Figure 15. Estuarine dependency of fish species previously recorded in Richards Bay, based on the data presented in Table 19. Estuary-dependant species are represented shades of red while species not estuary dependant or otherwise uncategorised are represented in shades of blue.

Several shark and ray species have been recorded in the port, including Bull shark *Carcharhinus leucas,* Blacktip shark *C. limbatus,* Dusky shark *C. obscurus,* Milkshark *Rhizoprionodon acutus,* Giant guitarfish *Rhynchobatus djeddensis,* Sharpnose stingray *Himantura gerradi* and Honeycomb stingray *H. uarnak* (Beckley et al., 2008). These species are all listed as either Vulnerable (VU), Endangered (EN), or Critically Endangered (CR) on the IUCN Red List (Table 20).

Table 20. IUCN Red List status of the shark and ray species recorded in Richards Bay port. VU = Vulnerable, EN = Endangered, and CR = Critically Endangered.

Species	IUCN Red List Status	Reference
Carcharhinus leucas	VU	Rigby *et al.* 2021b
Carcharhinus limbatus	VU	Rigby *et al.* 2021a
Carcharhinus obscurus	EN	Rigby *et al.* 2019
Rhizoprionodon acutus	VU	Rigby *et al.* 2020
Rhynchobatus djiddensis	CR	Kyne *et al.* 2019
Maculabatis gerrardi	EN	Sherman *et al.* 2020
Himantura uarnak	EN	Sherman *et al.* 2021

Birds

According to MER (2013), the diversity of water-associated bird species present in the Richards Bay Estuary is unmatched in South Africa. The system reportedly supports the highest numbers of individuals in South Africa of 18 species of water birds (MER, 2013). A total of 109 waterbird species have been recorded at Richards Bay (Allan 2009, cited in MER 2013). Of these, 82 are resident or local visitors (75 %), while 27 are long-distance Palaearctic migrants (25 %). A further 29 rare vagrant waterbird species have also been recorded. The great diversity is attributed to the wide diversity of wetland habitats present in the Bay (MER, 2013).

Intertidal sand and mudflats are critical feeding habitats for coastal wading birds, which mainly predate on soft-sediment invertebrates. Of the 135 waterbird species occurring in South African wetlands, 109 have been regularly recorded at Richards Bay (MER 2013). On a single day during spring high-tide, some 1,230 birds representing 24 species were recorded on the sandspit bordering the Kabeljous Flats (Allan 2009, cited in MER 2013) emphasising the ecological importance of this area of the port. About 20 % of the waterbirds that regularly visit Richards Bay were found in this area. Moreover, Richards Bay Estuary is critically important for national and global water bird populations. Many of the recorded species feature in species lists associated with the Ramsar and Bonn[7] Conventions, Important Bird Area (IBA) Programme and Red Data book (AECOM, 2014; MER, 2013). At least 11 Red Data species are known to occur in Richards Bay (Cyrus, 1998 cited in Anchor, 2014). Out of 42 South African estuaries, the Richards Bay Estuary was ranked as the most important system in terms of the species populations it supports, the second most important in terms of species endemism and third for total bird abundance (Turpie, 1995).

Anchor Environmental and TBC (Anchor Environmental and TBC, 2022) indicate that some 91 non-passerine waterbird species have been recorded in seasonal counts of the Richards Bay and uMhlathuze estuaries, collectively, belonging to ten different taxonomic orders (Table 21). Of these, 21 species are palearctic migrants and 70 species are South African residents. The waders, gulls and terns (Order Charadriiformes) account for 42% of the species recorded, with most of these being wader species (Table 21). These species are dependent intertidal areas for foraging, where they feed on a variety of invertebrates, during both day and night, and undisturbed roosting sites at high tide. Two thirds of the 28 wader species are regular Palaearctic

[7] The Bonn Convention also known as the Convention on Migratory Species of Wild Animals is an international agreement that aims to conserve migratory species throughout their ranges, including their habitats and migration routes. South Africa is a signatory to the Bonn Convention, since 1991 (CMS, 2020). As a signatory to the Bonn Convention, South Africa is obligated to take "*individually or in co-operation appropriate and necessary steps to conserve such species and their habitat*" (CMS, 2020) (See Avifauna Specialist Report).

migrants. Apart from these and two migratory tern species, the remaining species are species that breed in southern Africa ((Anchor Environmental and TBC, 2022).

Table 21. Taxonomic composition of the waterbirds recorded in the estuarine habitats of the study area (Anchor Environmental and TBC, 2022)

Common groupings	Order	SA Resident species	Palearctic migrant species	Total
Waterfowl	Podicipediformes (Grebes)	1	-	**1**
	Anseriformes (Ducks, geese)	11	-	**11**
	Gruiformes (Rails, crakes, gallinules, coots)	7	-	**7**
Cormorants, darters, pelicans	Pelecaniformes (Cormorants, darters, pelicans)	6	-	**6**
Wading birds	Ciconiiformes (Herons, egrets, ibises, storks, openbill)	18	-	**18**
	Phoenicopteriformes (Flamingos)	2	-	**2**
Waders, gulls, terns	Charadriiformes: Waders	9	19	**28**
	Charadriiformes: Gulls	2	-	**2**
	Charadriiformes: Terns	6	2	**8**
Kingfishers	Alcediniformes (Kingfishers)	4	-	**4**
Birds of prey	Falconiformes (Birds of prey)	4	-	**4**
	Strigiformes (Owls)	-	-	**-**
Total		**70**	**21**	**91**

There is limited recent bird data available for the Richards Bay as the last co-ordinated waterbirds counts (CWAC) were undertaken in 2012, and more recently in 2020 and 2022 as part of specialist avifauna assessments for different proposed power generation projects within the port (Anchor Environmental and TBC, 2022). During the most recent counts (five counts between 2020 -2022), an average of just 14 species were recorded, with the highest count being 18 species in April 2022. These are similar to the numbers recorded in the last CWAC survey in 2012 (Anchor Environmental and TBC, 2022). It is important to note that relative contribution of each bird group to the bird numbers in the project area differs substantially over the summer and winter months, due to the prevalence of migratory birds arriving in summer (Anchor Environmental and TBC, 2022). During summer, waders account for a third of the birds on the estuary with most being migratory species. During winter, however, there is a far more even representation of taxonomic groups, reflecting a very different community composition in comparison to summer (Anchor Environmental and TBC, 2022).

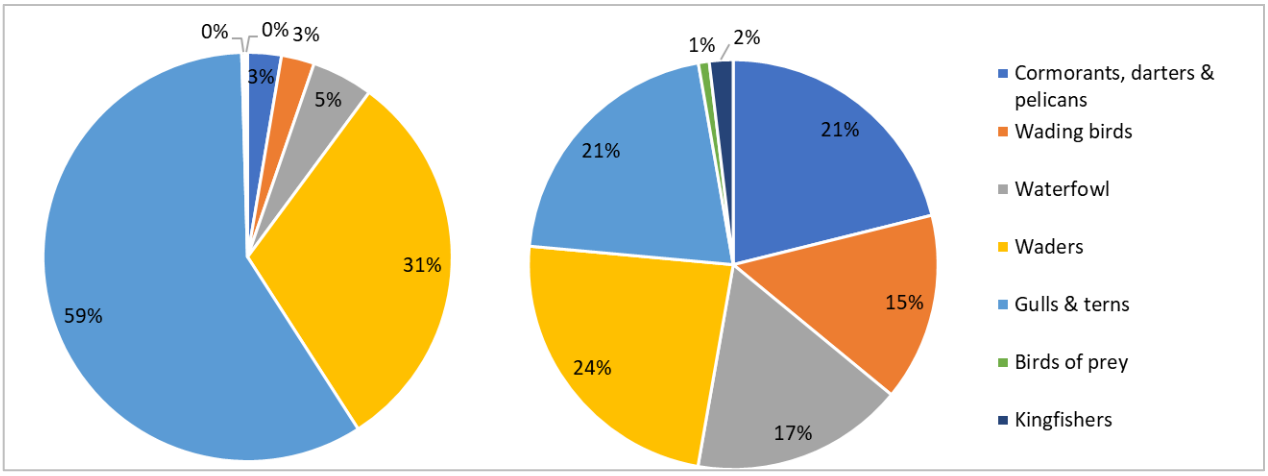

Figure 16. Composition of the birds in the project area of influence during summer and winter (1993-2022) (Anchor Environmental and TBC, 2022)

Anchor Environmental and TBC (2022) report historical counts of 9723 water birds in 1981, an average of 3434 and 689 non-passerine waterbirds recorded in summer and winter CWAC counts between 1993 and 2012, and average of just 215 birds during the recent bird counts (2020-2022). The full species list can be found in the Avifauna Specialist report. These results suggest a significant decline in bird numbers, however this may be attributed to the restricted area for counting in the recent surveys (only Richards Bay Estuary) versus the broader Richards Bay/uMhlathuze estuarine complex for previous counts. Also, recent counts were undertaken outside of the peak season periods (Anchor Environmental and TBC, 2022).

Based on the recent avifaunal surveys on the Richards Bay estuary, bird numbers within the estuary have indeed declined, which is attributed to the development and expansion of the port, with increases in pollution (*e.g.* observed coal dust emissions) and industrial and recreational activity and noise, habitat loss due to agriculture, and urban expansion in the surrounding areas, undocumented, uncontrolled illegal exploitation of fish and possibly birds, and external factors affecting water bird populations at broader scales *(i.e.* global reduction in migratory waders due to habitat degradation and loss) (Anchor Environmental and TBC, 2022).

Thirteen water-associated species of conservation concern were identified for the project area, (Anchor Environmental and TBC, 2022). Eight of these were identified as high-risk species in terms of the proposed Gas to Power project, *i.e.* species that would be sensitive to habitat loss, disturbance and those regarded as collision prone (Anchor Environmental and TBC, 2022). However, almost all of these species, with the exception of the Great White Pelican, are uncommon to the project area. Pelicans were observed nesting in the tall light structures of the port in large numbers (Anchor Environmental and TBC, 2022). Species of Conservation Concern are uncommon or rare, with only the Caspian Tern and Great White Pelican (and Lanner falcon) are the most common Red Data species recorded in the project area in recent counts (Anchor Environmental and TBC, 2022). Outside of the Species of Conservation Concern, there are other species that are likely to be at high risk of collision and/or electrocution, based on their occurrence/abundance within the project area, and their sensitivity to disturbance (light, noise) and their propensity for collisions with the proposed transmission lines. These include species such African Fish Eagle, herons, storks, and terns (Anchor Environmental and TBC, 2022).

In terms of the seabirds, the Grey-headed gull (*Chroicocephalus cirrocephalus*) and the Common tern (*Sterna hirundo*) occur in great numbers (as many as 3 500 individuals) in Richards Bay.

Further detailed discussion on the estuarine and coastal birds occurring within the Port of Richards Bay is not included here as it is included in the Avifauna Specialist Report (Anchor Environmental and TBC, 2022).

Marine Megafauna

Marine megafauna includes large bodied species such as sea turtles, sharks, dolphins, and whales. While there are numerous whale species that utilise the warm waters of the South African east coast for feeding or during migrations, they prefer the offshore marine environment and generally do not venture into KZN ports. Sharks and dolphins are commonly observed within the Port of Richards Bay, and turtles less so.

Five species of sea turtles occur on the east coast of South Africa. The Green turtle (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricate*) and occasionally the Olive Ridley (*Lepidochelys olivacea*) forage on reefs but are restricted almost entirely to the tropics (Hughes, 1973). The Loggerhead turtle (*Caretta caretta*) is more tolerant of temperate waters, but only the Leatherback (*Dermochelys coriacea*) is known to be capable of maintaining its body temperature above that of the ambient sea and has been found in very high latitudes (Hughes, 1973). Table 22 includes information on the IUCN Red List status of these species. Important loggerhead and leatherback nesting sites occur along the sandy beaches north of the Port of Richards Bay, in iSimangaliso Wetland Park during the summer month (Tuček 2014). Satellite tracking of leatherbacks revealed that their home range-extended southwards to Richards Bay (CSIR, 2016) The species may therefore occur in the port on occasion.

Table 22. IUCN Red List status of turtles with occurrence in South Africa with year assessed. GA= Globally Assessed, RA= Regionally Assessed (Sink *et al.*, 2019)

Scientific Name	Common name	IUCN Red List status
Eretmochelys imbricata	Hawksbill Turtle	Critically Endangered (2008) GA
Chelonia mydas	Green Turtle	Endangered (2004) GA
Caretta caretta: Southwest Indian Ocean subpopulation	Loggerhead Turtle	Near Threatened (2015) RA
Dermochelys coriacea: Southwest Indian Ocean subpopulation	Leatherback Turtle	Critically Endangered (2013) RA
Lepidochelys olivacea	Olive Ridley Turtle	Vulnerable (2008) GA

The Humpback dolphin (*Sousa plumbea*) occurs along inshore areas in water not deeper than 25 m off the east coast of Africa. Along the KZN coastline, they are most commonly found in large estuarine systems. The Richards Bay area is the preferred habitat for this species, and the harbour entrance serves as important feeding area (Atkins et al., 2004; Johnson, 2012; Keith et al., 2013). Consequently, the Humpback dolphin regularly occurs within the port. The conservation status of this species has declined from Near-Threatened to Endangered according to the IUCN Red List of Threatened Species due to declining sighting rates and group sizes (Braulik et al., 2017), and it is considered to be South Africa's most endangered marine mammal (IUCN CSG, 2016). Given the sensitivity of this species, Keith *et al.* (2013) suggested that further development of the Richards Bay Port should be carefully considered. Based on species distributions, several other dolphin species may occur in the Port's vicinity as well, *e.g.,* Indo-Pacific Bottlenose Dolphin, *Tursiops aduncus*.

6.8. Health Status and Biodiversity Importance

6.8.1. Health Status

The 2018 NBA (van Niekerk et al., 2019a) provides, *inter alia*, an updated assessment of the health status of estuaries in South Africa. The health condition of each estuary (also known as the Present Ecological State (PES)) was provisionally determined (or confirmed if updated studies were available, *e.g.,* for the uMhlathuze Estuary) at the desktop level using the Estuarine Health Index, in which the current conditions of various abiotic and biotic components are rated as a percentage of the probable pristine condition. The resultant health score was then assigned to one of six categories, ranging from natural (A) to critically modified (F) (van Niekerk et al., 2019a) (Table 23).

In the 2011 NBA (Van Niekerk and Turpie, 2012), and as given in the EMP (DEA, 2017a), the PES of the uMhlathuze and Richards Bay estuaries was C/D (borderline moderately modified/heavily modified) and D (heavily modified), respectively. In the updated 2018 NBA, the PES of both the uMhlathuze and Richards Bay estuaries is D (*i.e.,* heavily modified) (Table 23) (van Niekerk et al., 2019a). MER (2013) suggests that the ecological functioning of Richards Bay is more threatened by degradation and habitat loss than by pollution and poor water quality. Nonetheless, such impacts will become more problematic with future port expansion.

Category D is the minimum standard and thus effective management of activities affecting the estuarine area is required to prevent further degradation of the system (see Section 6.8.4 below).

Table 23. Desktop Present Ecological Status allocated to uMhlathuze and Richards Bay estuaries in the 2018 NBA (Van Niekerk *et al.*, 2019)

COMPONENT	CATEGORY	
	MHLATHUZE	RICHARDS BAY
Hydrology	B	D
Hydrodynamics and mouth condition	D	D
Water quality	E	D
Physical habitat alteration	E	E
Habitat health score	D	D
Microalgae	C	D
Macrophytes	E	F
Invertebrates	D	E
Fish	F	E
Birds	E	D
Biotic health score	D	E
PRESENT ECOLOGICAL STATE (PES)	D	D
2018 CONDITION STATUS	HEAVILY MODIFIED	HEAVILY MODIFIED

6.8.2. Biodiversity Importance

The Estuary Importance Score for an estuary takes size, the rarity of the estuary type within its biographical zone, habitat diversity and biodiversity importance of the estuary into account. Biodiversity importance, in turn, is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. These importance scores are essentially a comparison with the system in its natural condition (Turpie et al., 2002; Turpie and Clark, 2007).

Based on their Estuary Importance Scores, the uMhlathuze Estuary is ranked within the top 10 most important of the 256 estuaries in South Africa and the Richards Bay Estuary is ranked the 26th most important estuarine system (DEA, 2017b). These two estuaries collectively support the largest area of mangroves in the country, and together with the St Lucia complex, provide "*the majority of the suitable nursery habitat for penaeid prawns*" (DEA, 2017b, p. 33). Furthermore, Richards Bay is ranked third on a national level in terms of its importance to waterbird populations (after the St Lucia and Berg River systems) (MER, 2013), while the Mhlathuze Estuary is a rated as a regional IBA (recently downgraded from international status (Anchor Environmental and TBC, 2022). Both estuaries are very important estuarine nursery areas both in terms of protecting biodiversity and also nationally important fisheries, namely Kob (*Argyrosomus japonicas*), and potentially Zambezi sharks (*Carcharhinus leucas*)(DEA, 2017b).

Further to this, and using the same criteria, the habitats that comprise the Kabeljous Flat were ranked in the top three most important habitats of the 12 types within the Port and were consequently categorised as of high conservation significance (CSIR, 2005 cited in CRUZ, 2009).

6.8.3. Conservation Importance

The 2011 NBA developed a biodiversity plan for the estuaries of South Africa by prioritising and establishing which estuaries should be assigned partial or full Estuarine Protected Area status (Turpie et al., 2012). This biodiversity plan followed a systematic approach that took pattern, process and biodiversity persistence into account. The biodiversity plan indicated that, on a national scale of 133 estuaries, 61 required full protection and 72 required partial protection including those already protected, to meet biodiversity targets (Turpie et al., 2012).

As one of only three estuarine bays in the country, the uMhlathuze/Richards Bay estuarine system is an extremely rare estuarine type and was included in the priority estuaries requiring formal protection in order to conserve South Africa's estuarine biodiversity. The 2011 biodiversity plan required that the uMhlathuze/Richards Bay estuaries be partially protected (*e.g.,* possess a designated no-take fishing zone), have 50 % of its estuarine margin left untransformed, and achieve a Recommended Ecological Category (REC) of A (natural) or best attainable state (Turpie et al., 2012).

However, given the highly transformed state of the estuarine complex, and the operation of the Richards Bay Estuary as an industrial port, the restoration of the uMhlathuze/Richards Bay estuaries to their natural/pristine state is both impractical and unattainable.

The plan was subsequently updated as a component of the 2018 NBA (van Niekerk et al., 2019a), which includes a summary of the biodiversity importance for all estuaries in South Africa and indicates their priority status. The uMhlathuze/Richards Bay estuarine system remains a national priority system and is recognised for its importance for birds and as fish nursery habitat (van Niekerk et al., 2019d). It is rated as an Endangered ecosystem (ecosystem threat status) and thus at risk of losing vital aspects of its structure, function and composition, and this type of estuarine ecosystem is poorly protected (van Niekerk et al., 2019c).

In respect of other national and regional assessments, the Richards Bay Estuary is rated as a wetland Freshwater Ecosystem Priority Area (FEPA) by virtue of its linkage with this priority estuarine system and its associated wetland systems (Nel et al., 2011). It is also rated as an Irreplaceable Critical Biodiversity Area (CBA) in the KZN Systematic Biodiversity Conservation Plan (EKZNW, 2014, 2012). "*These areas are considered critical for meeting biodiversity targets and thresholds, and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems*" (EKZNW, 2014, p. 36).

6.8.4. Recommended Ecological Category

The Recommended Ecological Category (REC), or desired state, signifies the level of protection assigned to an estuary (generally from a flow perspective). The REC takes into account the estuary biodiversity importance and its conservation importance (protected area status).

According to the 2018 NBA, the REC for both the uMhlathuze and the Richards Bay estuaries is a category D. Thus, at a minimum, the current state of these systems must be upheld and human activities must be managed to prevent further degradation.

However, confirmation of the PES, REC and Resource Quality Objectives (RQOs) for both systems is required (DEA, 2017b). Within the EMP, the collective REC is category C, *i.e.* management interventions of the EMP are thus aimed at achieving an improved ecological state (DEA, 2017a).

6.9. Ecosystem Goods and Services

Ecosystem services, also known as ecosystem goods and services, are the products that emerge from the natural environment through various biological, chemical, and physical processes and functions, which are typically used by people and contribute to enhanced human wellbeing. Estuaries are among the most productive ecosystems worldwide, and because they are natural features, the ecosystem services they provide are considered free commodities. The greater Richards Bay area provides many ecosystem services to society (DEA, 2017a). Most of these fall under socio-economic topics and are only briefly mentioned here, but some are directly dependent on ecosystem health and functionality.

Provisioning services provided include:

- fisheries, mainly recreational and subsistence, but commercial fishing occurs on the adjacent continental shelf, and
- raw materials for firewood and building from plant resources.

Regulating services provided include:

- carbon sequestration by, for example, phytoplankton and mangroves within the estuary and Port area,
- protection from extreme sea conditions and large swells provided mainly by the mangrove stands, and

- regulation of water flows from, for example, stormwater runoff.

Cultural services provided include:

- ecotourism and recreation provided by the Richards Bay Nature Reserve and the surrounding beaches and water body. The sea and estuary areas are also used for various ceremonies by residents in the area.
- Supporting services provided include:
- nutrient cycling, in which mangroves play an important role and which allows for primary production,
- nursery areas, refuge areas and food sources for numerous marine biota, some of which are commercially important,
- river flow, which supports some species through, inter alia, the transmittal of olfactory cues to the offshore region
- effluent disposal and intake waters used for various industrial applications such as cooling, desalination and processing, and
- commercial transport, which is significant as Richards Bay hosts several large commercial terminals.

The EMP (DEA, 2017b) provides a detailed list of the ecosystem goods and services provided by the uMhlathuze/Richards Bay estuarine complex (Table 24 overleaf). The estimated value of ecosystem services provided by the estuarine system amounts to approximately R22 million per annum (Rands in 2009) (DEA, 2017b).

Recreational and subsistence fishing occur within the confines of the Port (Beckley *et al.* 2008). The mangrove areas in the Port provide raw materials to surrounding communities, and the stands play an important role in carbon sequestration, protection from extreme sea conditions and nutrient cycling. The port water body assists in regulating water flow. The intertidal and shallow subtidal habitats are important nursery areas for numerous invertebrate and fish species, some of which are commercially important. Most obviously, the Port hosts an area where commercial transport is significant, and so conflict with other shipping activities needs to be considered by the Port Authority. The importance of the port and surrounding area for mariculture is described below.

Table 24. Important ecosystem service potential of the uMhlathuze/Richards Bay estuaries (DEA, 2017)

ECOSYSTEM SERVICE		DESCRIPTION/RELEVANCE	ESTIMATED ANNUAL VALUE in 2009)
Provisioning service	Water		
	Food and medicine	Small scale/subsistence fisheries	R 400 K
	Raw materials	Plant resources	R 100 K
Regulating services	Carbon sequestration	Support extensive areas of mangroves and other estuarine vegetation to taking up CO_2 from the atmosphere through photosynthesis, acting as carbon sinks	R 300 K
	Flood regulation	Harbour development, as well as construction on new mouth largely reduced these regulatory services of system which relies on large undeveloped flood plains to enable water and sediment retention	Expected loss in value (not quantified)
	Flow regulation		
	Sediment erosion control/ retention		
	Ecological regulation	-	Not valued
	Water purification	Assimilation of contaminated stormwater runoff from harbours areas	Not valued
Supporting services	Biological refuge/Nursery areas	Important nursery and export function for, sediment and nutrient exports, and prawns	R13.5 million (fish) R1.6 million (sediment/nutrients) R4 million (prawn)
	Exporting function		
	Genetic resources	-	Not valued
Aesthetic/ cultural services	Nature-based tourism	Mostly linked to birding	R 2 million
	Property value	-	Not valued
	Recreational angling	-	Not valued
	Spiritual/cultural value	-	Not valued
	Scientific/educational value	Scientific value (based on research outputs)	R 100 K

6.9.1. Fisheries

Much of the information available on inshore fisheries in the Port of Richards Bay and surrounding areas is a little dated (more than 10 years old) but does provide a good indication on the nature, value and importance of the different fisheries in this area.

Inshore fisheries

Lamberth & Turpie (2003) estimated the value of the contribution made by estuaries to inshore marine fisheries in South Africa (not including prawn fisheries). These include recreational shore-angling, recreational boat-angling, recreational spearfishing, commercial boat-based line fishing, gill netting and beach-seine netting. In KZN, the value of inshore marine catches attributable to estuaries was 18%, slightly lower than the national average of 21%. This was estimated on the basis of the value of catches made up of fish of different degrees of estuary dependence, multiplied by a factor indicating the degree of dependence. Hassan & Crafford (2015) demonstrate an explicit link between the functioning of estuaries and the dynamics of the KZN fisheries.

Lamberth & Turpie (2003) estimated that inshore marine catches in KZN amounted to some 2 747 tonnes per annum. Shore angling, which was estimated to be more valuable in terms of impact on the economy, was estimated to land 642 tonnes of fish from annual effort estimated at about 1.5 million days per annum. Recreational boat anglers in KZN were estimated to land 470 tonnes, recreational spear fishers 108 tonnes, commercial boat anglers 1 335 tonnes and commercial net fishers 192 tonnes. These estimates were largely derived from the national line fish roving creel and access point surveys conducted during the period 1994-1996, and other published surveys (Mann *et al.* 1996, 1997, Brouwer *et al.* 1997, Sauer *et al.* 1997, Beckley & Fennessy 1996).

Lamberth & Turpie (2003) estimated the total contribution of all South African estuaries to coastal and inshore marine fisheries to be R1 225 million (2013 Rands[8]). The 73 estuaries of the KZN coast were estimated to contribute R223 million per year, largely due to the estimated R211 million contribution to shore angling catches. The high value attributed to shore angling was a result of the high levels of participation, and the relatively high proportion (83%) of estuary-dependent species in the catch of this sector.

Updated catch data are not available for the recreational spearfish sector or the commercial net fishery in KZN, and these fisheries were not included in this analysis. The estuarine contribution to the catch value in these two sectors was estimated to be comparatively small (R2.7 million) or just 1.3% of near shore fishery value attributed to KZN estuaries by Lamberth & Turpie (2003). Commercial (legal) gill netting in KZN was phased out with the allocation of medium-term commercial fishing rights in 2003 and the remaining commercial beach seine operation near Durban lands very low volumes of fish, estimated at 7 tonnes by Beckley & Fennessy (1996).

Richards Bay Port is a popular site for multiple fisheries sectors; it is used extensively by local residents for recreational estuarine angling and the Port sees some of the highest numbers of boat launches for recreational boat angling and commercial line fishing in KZN (Mann-Lang *et al.*, 1997 in Jairam 2005).

Shore angling

Over the period 2009-2010 approximately 54 000 people participated in shore angling in KZN, expended a total fishing effort of ~802 000 angler-days per year and landed an estimated 263 tonnes of fish (Table 25, Dunlop & Mann 2012). The participation figure includes an estimated 350-540 true subsistence fishers and between 8 463 and 13 958 shore anglers from other provinces that visit KZN annually (Dunlop & Mann 2012). Estuary-associated species comprised an estimated 88% (numerically) of the shore angling catch in the province in 2009-2010 (Table 26).

Table 25. Estimated participation, annual effort and catch in four KZN near-shore fishing sectors based on surveys conducted during 2009-2010 (Dunlop and Mann 2012, 2014)

Fishery	Participation[1]	Annual effort [2]	Catch (t)
Shore-angling	41 283-68 087	759 682-843 702	263
Recreational boat angling	2 768	30 435	457
Charter boat angling	~100	5 898	245
Commercial line fishing	51	3 331	785
Total			1 750

1: Shore angler participation is number of anglers; Boat fisheries are number of boats

2: Effort is shore angler-days.y^{-1}, and number of boat launches.y^{-1}

Based on 2009 - 2010 survey data, the value of the KZN recreational shore fishery was estimated at R338 million (2013 Rands[7]) of which estuary-associated species contributed 88% but estuary-dependent species R103 million or 30.5% (Table 26, Lamberth & Turpie 2003). The value attributed to the estuary associated species has decreased by half since 1994 (Lamberth & Turpie 2003). Not all of this loss is attributable to the loss of estuary functioning but change in estuary nursery area function (the proportional decrease in value of estuary dependent species in the catch) accounts for at least R19.3 million of this loss. This loss is mostly a result in decreased contribution by catches of estuarine dependent Category IIb and IIc species such as *Rhabdosargus sarba* and *Pomatomus saltatrix*.

[8] Note that this value needs to be escalated by a factor of 1.553 to convert it to 2022 Rands

Table 26. Percentage contribution of estuary-associated fish to the total value (2013 Rands[9]) of the inshore marine fishing sectors in KZN, the total annual values of the fisheries, the amount and percentage of the total contributed by estuary-associated species, and the contribution of estuaries to total fishery values.

Survey	Estuary dependence category				Total	Estuarine Fish Contribution		Value attributable to estuaries[1]	
	IIa	IIb	IIc	III	Value R(million)	Value R(million)	%	Value R(million)	%
Shore Angling	11.4	0.7	61.7	13.9	338	297	88	103	30.5
Recreational Boat-Angling	1.6	0.0	0.3	4.4	114	7.2	6.3	1.94	1.7
Charter Boat Angling	0.1	0.0	0.1	1.6	61	1.09	1.8	0.07	0.11
TOTAL SPEND RECREATIONAL FISHERIES 2009-2010[2]					**513**	**305**	**60**	**105**	**20**
Commercial line fishing[3]	0.8	0.0	0.0	5.3	16.6	1.03	6.2	0.140	0.84
TOTAL COMMERCIAL + RECREATIONAL 2009-2010					**530**	**306**	**58**	**105.5**	**19.9**

1: The latter is calculated on the basis of 100% of the value of Category, IIa, species, 90% of the value of Category IIb species, and 30% of the value of Category IIc species. Category III species are not included in this value.

2: The 2009-2010 values were calculated using the same methods as Lambert & Turpie (2003) and fishery survey data from Dunlop & Mann 2012 & 2013.

3. Commercial line fishing estimate is derived from modelled value based on catch value; other fisheries are total expenditure/turnover.

The Richards Bay Port is a popular estuarine recreational angling site, used extensively by the residents of the Mhlathuze Municipality (which includes the towns of Empangeni and Richards Bay). The total annual fishing effort expended by shore-anglers was estimated at approximately 69 000 angler outings, which is higher than the 54 024 shore-angler outings estimated by Pradervand *et al.* (2003) for Durban Harbour (180 km south of Richards Bay) (Beckley *et al.* 2008). In a survey of shore-based anglers by Beckley *et al.* (2008), spotted grunter *Pomadasys commersonnii* made up 23% of the total catch and was the most commonly targeted and retained species. *P. commersonnii* juveniles are 100% dependent on estuaries as nursery areas (EDC category IIa; Whitfield 2019). Overall, the total retained catch was estimated at 8.5 tonnes per year. Of the total catch, 78% was released, predominantly due to small size, emphasising the role of the Richards Bay Port in serving as a nursery habitat (Beckley *at al*. 2008).

All of the most retained shore-angled species recorded by Beckley *et al.* (2008) are estuarine dependent. As shore angling mainly takes place within the Richards Bay Port, it follows that the predominant species caught have some estuarine association. The ecology and estuarine function of the Richards Bay Port are fundamental to the shore angling fishery within the area.

Recreational boat angling

Based on survey data collected during 2009-2010, an estimated 8 000-10 000 recreational boat anglers fishing on ~2 800 vessels made a total of ~30 500 launches and caught in the region of 457 tonnes of fish per year in KZN (Dunlop & Mann 2013) Estuary-associated species comprised 6.3% of the catch by weight (Table 26 above). The catch rate of the most important estuary-dependent species in recreational boat anglers' catches, *A. japonicus,* is at a low 0.03 fish per outing, which probably reflects the collapsed status of this stock in South Africa more than anything else (Childs & Fennessy 2013).

The Lamberth & Turpie (2003) study estimated a very low overall value of only R1.45 million for the recreational boat fishery in KZN, despite reporting a relatively large catch of 470 tonnes (Table 26 above). Using the 2009-2010 survey data, the KZN recreational boat fishery value was estimated at R114 million. Estuary-associated fish contributed ~6% of this value, whilst the amount attributable to estuaries (estuary-dependent fish) was estimated at only R1.9 million or 1.7% of the total fishery value (Table 26 above). This was largely due to the contribution of *A. japonicus*.

[9] Values need to be escalated by a factor of 1.553 to convert them to 2022 Rands

An access-point study on recreational boat-angling was conducted in Richards Bay by Everett and Fennessy (2007). Approximately 10 977 individual angler-outings were undertaken annually by 1497 anglers. As of 2004, Richards Bay saw the second highest number of recreational launches in KZN (Mann-Lang *et al.* 1997 in Jairam 2005). Recreational line fishers tend to stay within 15 nautical miles of the Richards Bay Harbour (Jairam 2005). Although 91% of fish caught in the Richards Bay Harbour were released due to their small size, emphasising the role of the Harbour as a nursery area, the retained catches were predominantly spotted grunter *Pomatomus saltatrix*, catface rockcod *Epinephelus andersoni* and stumpnose *Rhabdosargus sarba*. Pike conger *Muraenesox bagio*, dusky shark *Carcharhinus obscurus* and *E. andersoni* dominated by mass. The total annual retained catch was estimated at 5 355kg (Everett and Fennessy 2007).

Charter Boat fishing

The charter boat fishery in KZN has grown considerably in recent 15 years, having increased from fewer than 10 boats (mainly based in Durban harbour) to more than 100 boats operating throughout the province in 2010 (Dunlop & Mann 2013). Dunlop & Mann (2013) speculate that the 70% reduction in commercial fishing rights associated with the long-term rights allocation process contributed to the growth of this sector. Charter boats take paying recreational fishers out, so there is a commercial motivation driving the fishing effort, but total catch is still limited by the recreational bag limits. An estimated 10 000 fishers undertake 5 900 trips and landed approximately 245 tonnes of fish in KZN per year (Dunlop & Mann 2013, Table 26). Only 1.8% by mass of the fish landed by charter boat fishers comprises estuary-associated species. Estuary-dependent species are estimated to contribute only R68 000 to the R61 million (1997 Rands) total estimated value (total spend) of the KZN charter boat fishery in 2009/2010.

Pradervand & van der Elst (2008) reported 4 charter boats operating out of the Richards Bay Harbour, together making an average of 228 launches per annum and landing approximately 9.9 tonnes of fish.

Commercial Line fishing

The South African commercial line fishery[10] is a boat-based fishery that dates back to the 1500's (Thompson 1913). By the end of the 1990s there were approximately 3 000 fishing boats ranging from 3 m dinghies to 15 m deck boats carrying a total of around 3000 crew (Griffiths 2000, Mann 2000). This fishery lands about 250 different species annually, although only about 20 of these are commercially important (Lamberth & Joubert 1999). Lines are set with no more than 10 baited hooks and boats operate inshore. Employing an estimated 27% of all fishers, the commercial line fishery has the largest fleet, but its catches make up only 6% of the total value of all commercial marine fisheries (DFFE 2020). Commercial fishing vessels range from 6 – 8 m ski-boats capable of surf-launching, to harbour-based freezer vessels (generally longer than 20 m) that can remain at sea for more than 2 weeks at a time (Mann 2013b). Fishers are constrained in terms of what species they can target, as well as by bag and size limits but effort is primarily limited by weather and sea conditions as ski boats go out only when the wind is less than 15 knots. Fishing takes place throughout the year but there is some seasonality in catches. Marine recreational anglers in South Africa tend to use similar gear and target similar species to their commercial counterparts.

Commercial line fishing in South Africa is only permissible by rights holders fishing from vessels (Note that recreational shore and boat anglers are not permitted to sell or barter their catches). Considerable changes have taken place in the management of the South African commercial line fishery between 1994 and the present day. In an effort to rebuild depleted line fish stocks an environmental emergency in the commercial line fishery was declared in December 2000. In terms of the emergency, the Minister determined that a Total Allowable Effort (TAE) of no more than 450 vessels and 3 450 persons may fish commercially for line fish. Revised bag and size limits for commercial and recreational line fishers were implemented in 2005. The commercial line fishery was split into three regional management zones, with restrictions on movement of vessels from one region to the next with the 2006-2013 long-term rights allocation.

After 2003, the number of licensed vessels in the commercial fleet was reduced by a tenth; however, effective effort has not diminished to the same degree due largely to an improvement in boats. The results of DFFE

[10] Referred to as the traditional line fishery by DFFE

stock assessments conducted in 2017 indicated that the drastic reduction of fishing effort from 2003 onwards resulted in the partial recovery of some species, including Slinger, Santer, Hottentot seabream and Carpenter. However, other important stocks such as Silver kob are still being overfished (DFFE 2021).

Within KZN these management measures resulted in a decrease in the number of commercially registered fishing vessels from 173 in 1994-1996 to 51 in 2009-2010 (of which only 38 had activated their rights) (Dunlop & Mann 2013). This 70% reduction in participation resulted in a corresponding decrease in annual effort from over 15 000 to ~3 300 launches per year, but the reduction in annual catch mass (40%) over the same period was less severe with an estimated 785 tonnes landed per year in 2009/2010 (Table 25 above). Estuary-associated species comprised 6.2% of the commercial boat line fish catch in the 2009-2010 survey (Table 26 above). These species depend on these habitats for feeding, refuge or reproduction so the health of these fish stocks is therefore intrinsically linked to the ecological status of the estuaries (DEFF 2020).

The landed catch in the KZN commercial line fishery was valued at R16.6 million per annum using the 2009-2010 survey data of which just 0.84% or R140 000 was attributable to estuaries (Table 26 above).

Utilising the landed value of the commercial line fishing catch attributed to estuaries at R14 000 as calculated above, an associated industry value to the KZN economy developed by applying the KZN Input-Output model multiplier of 1.7 for trade, catering and accommodation sector which includes the economic activities of restaurants, retailers, and wholesalers of line fish of the province. An associated economic value of R 481 222 is ascribed to the commercial line fish contribution of estuaries.

The Richards Bay Port is particularly important in the area between St Lucia and Tugela, as it provides line fishers with access to several productive reefs, especially the deeper reefs (100-200 m) to the north of the Tugela River (Penney *et al.* 1999).

As of 2004, there were 11 licenced commercial ski boats (line fishers) operating regularly out of Richards Bay (Jairam 2005). These fishers made a total of 1 918 launches between July 2002 and June 2004. Richards Bay sees the highest number of commercial skiboat launches in KZN (Mann-Lang *et al.* 1997 in Jairam 2005). The survey by Jairam (2005) reported that most commercial fishing trips took place within 15 nautical miles of Richards Bay Port, although longer trips up to 30 nautical miles were also reported. Between 2016 and 2020, line fishers spent an average total of 25 416.2 boat hours per year, working out to approximately 70 boat hours per day (DFFE).

Spatially referenced catch and effort data for commercial fisheries that operate in the Richards Bay area were obtained from the Department of Agriculture, Forestry and Fisheries (DFFE) and mapped using GIS. The spatial distribution of the average annual catch (tonnes) and effort (boat hours) in the Richards Bay area are represented in Figure 17 and Figure 18 below. The preference for fishing on the offshore reefs closest to Richards Bay is demonstrated by the density of catch and effort in these blocks.

Between 2016 and 2020, the top five species caught in the Richards Bay area were slinger *Chrysoblephus puniceus*, santer *Cheimerius nufar*, rockcods *Epinephelus* sp., geelbek *Atractoscion aequidens*, and kobs *Argyrosomus* spp. (DFFE; Table 27). Of the 100 fish species found in Richards Bay Port, 14 are important in the commercial line fishery (Table 19 above).

Table 27. Average annual catch (kg) of the most commonly caught species in the Richards Bay line fishery between 2016 - 2020 (Source: DFFE).

Species	Common name	Average annual catch between 2016 – 2020 (kg)
Chrysoblephus puniceus	Slinger	101 077.2
Cheimerius nufar	Santer	21 184
Epinephelus spp.	Rockcod	11 473.8
Atractoscion aequidens	Geelbek	9 835
Argyrosomus inodorus and *japonicus*	Kob	8 600.4
Unidentified Teleost redfish	Redfish	5 830.4
Polysteganus coeruleopunctatus	Blueskin	4 408

Cymatoceps nasutus	Poenskop	2 414.8
Argyrosomus thorpei	Squaretail kob	1 937.25
Scomberomorus plurilineatus	Queen mackerel	1 889.5
Lethrinus spp.	Emperor	1 479.2

Of the species in the Richards Bay line fishery, five have juvenile stages which use estuaries to some extent. In particular, the Kobs *Argyrosomus* spp. and Cape stumpnose *Rhabdosargus holubi,* are 100% dependant on estuaries as juveniles, meaning that the well-being of these stocks is reliant on the ecological status of estuaries such as that of Richards Bay. Between 2017 and 2020, estuarine-dependent species (*Argyrosomus japonicus, Argyrosomus spp., Otolithes ruber, Pomadasys kaakan, Pomadasys* spp., *Rhabdosargus holubi*) contributed an average total annual catch of 8.9 tonnes to the Richards Bay line fishery, with the majority made up by the kobs *Argyrosomus* spp.

Dusky kob *A. japonicus* is valuable in the recreational, commercial and subsistence fisheries (Griffiths 1996). Currently, the stock is in a critical state and spawner biomass per recruit (SB/R) has collapsed to 1.1-4.5% of pristine spawning biomass. The preservation of estuaries as obligate nursery grounds for the species is fundamental to its preservation (Sink *et al.* 2019).

Over and above direct employment and revenue, the commercial line fishery provides indirect or secondary opportunities for businesses in Richards Bay (Jairam 2005).

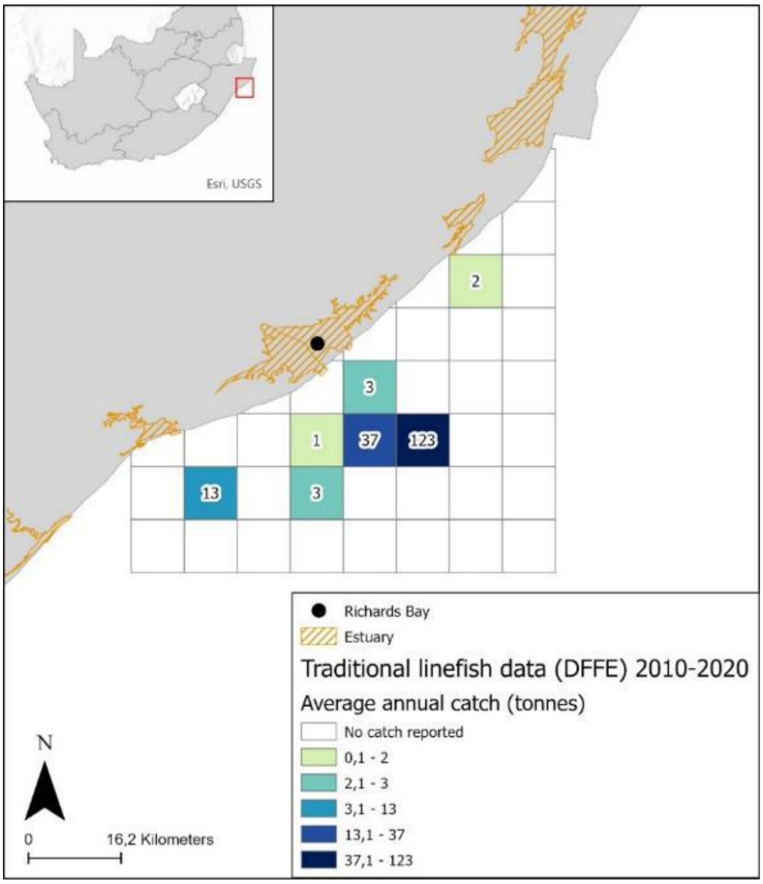

Figure 17. Average annual linefish catch (all species) from 2010 to 2020 in relation to the Richards Bay Port (CSIR 1999). Supporting data were provided by DFFE

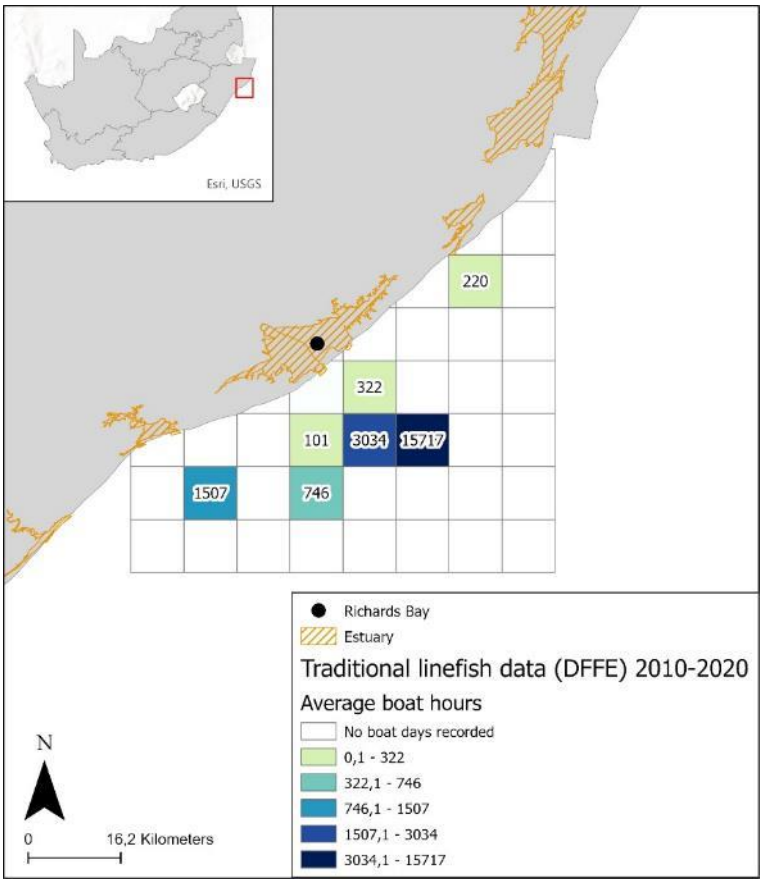

Figure 18. Average annual linefish effort (all species) from 2010 to 2020 in relation to the Richards Bay Port (CSIR 1999). Supporting data were provided by DFFE

Prawn fisheries

Industrial trawling for crustaceans off KZN commenced in the 1960s and continues at a low level today; albeit that the initially targeted deep-water rock lobster was gradually replaced with other targets - prawns, langoustine and crabs. Recruitment failure due to drought conditions and the closure of the St Lucia estuary mouth in the last decade has resulted in collapse of the Thukela Bank prawn (penaeid) fishery, with historic low catches recorded in recent years (DAFF 2012).

The KZN crustacean trawl grounds are well defined due to target species' habitat preferences for sand and mud. The fishery operates year-round and is marginally economically viable, owing to difficult working conditions, an ageing fleet, high operating costs and target species that are at the limit of their distribution (Fennessy 2022). There is a small inshore area trawled to the north of Richards Bay (Figure 19).

Landed catch in the inshore prawn trawl fishery has been highly variable (Figure 20). This is related to variability in rainfall and hence recruitment from estuarine nursery areas. However, the influence of the loss of the St Lucia nursery grounds is notable. Over the period 1992-2002 the average landed catch was ~64 tonnes, after 2002 it declined steadily with an average annual catch of just 20 tonnes over the period 2003-2010. Catches over the period 2008-2012 were less than 10 tonnes per year, after which they dropped to below 3 tonnes per year. The low catches post 2013 are due to the absence of fishing effort in the shallow water areas (DEFF 2020). The current status of the stock needs to be ascertained (DEFF 2020).

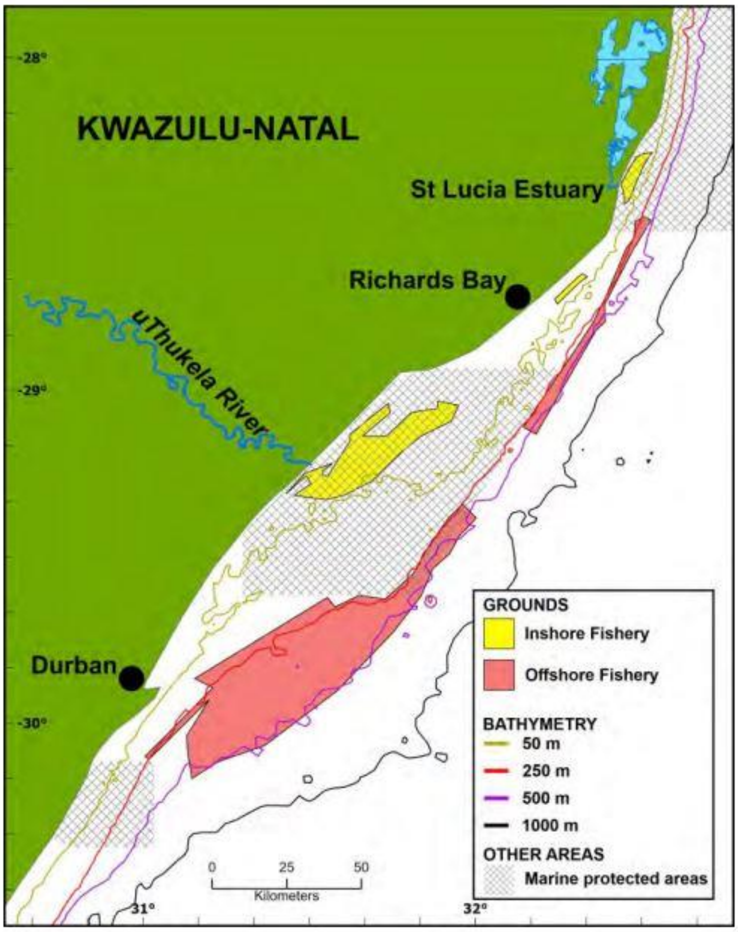

Figure 19. Inshore (yellow) and offshore (red) crustacean trawl areas of the KZN coast. Marine Protected Areas are also shown (B. Everett, ORI)

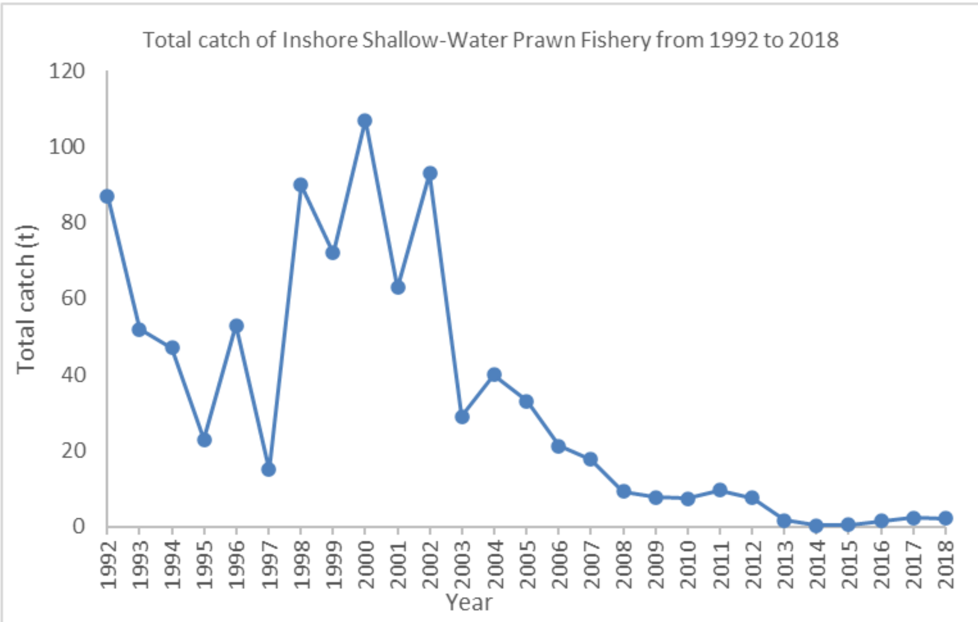

Figure 20. Annual total catch of all species of prawns in the KZN inshore prawn trawl fishery (Source DEFF 2020)

In 2003, the KZN crustacean fishery was estimated to be worth some R40 million (Turpie & Lamberth 2004), equivalent to about R69 million in 2013 Rands[11]. Inshore prawn catches were estimated to contribute about 23% of this value (R15.9 million), and offshore prawn catches contributed 50% (with the remainder attributed to other crustaceans and bycatch). These values represent the total economic contribution of the prawn trawl fishery. In terms of landed catch value (estimated at R75/kg), the decline in average reported catch by two thirds over the period 2003-2010 suggests that as much as R3.2 million per annum has been lost due to the collapse of the inshore prawn trawl fishery. The very low catches reported for 2008-2010 are worth an estimated R600 000 per year suggesting a loss of as much as R 4 million in landed catch value.

Although the Richards Bay estuarine system makes up only approximately 7% of the total estuarine area along the KZN coast, in comparison to St Lucia which makes up about 80% of the total area, the recruitment contribution from Richards Bay to the Thukela Bank prawn stocks is considered to be equal to that of St Lucia (Ayers *et al.* 2013). Therefore, in times where the St Lucia estuary mouth is closed, Richards Bay can be considered to be the sole contributor to the inshore shallow-water prawn stocks.

Small-scale and subsistence fisheries

Small-scale fishing in South Africa has been considered to include various fishing methods targeting more than 30 species (Griffiths and Branch 1997) from a range of habitats (Branch *et al.* 2002, Clark *et al.* 2002). Although small-scale fisheries contribute less than 1% to South Africa's GDP, they play an important role in the provision of protein and employment for an estimated 136 coastal communities distributed along South Africa's 3 000 km coastline (Sink *et al.* 2019). The extent and spread of small-scale fishers covers the four provinces with coastlines, especially the Western Cape, where fishing has been an important source of protein among the coastal communities since the 1700s (Isaacs 2013). Small-scale fishers are found both in urban and rural coastal areas.

The dominant activity on the east coast is the harvesting of intertidal and subtidal invertebrates including mussels, oysters, redbait and limpets, crabs and octopus as well as fishes (Hockey and Bosman 1986, Siegfried 1988, Kyle *et al.* 1997, Clark *et al.* 2002). High value resources such as rock lobsters, oysters and Abalone are also caught by this sector although these resources are usually sold.

The Marine Living Resources Act, (Act No. 18 of 1998, MLRA), excluded small-scale and artisanal fishers who catch and sell fish to sustain livelihoods. In 2005, the government adopted long-term fishing policies that made no provision for small-scale fishers. South Africa's cabinet adopted a Small-Scale Fisheries Policy in June 2012, but implementation has not been fully realised due challenges in the ability to map and assess this pressure separately. The Small-Scale Fisheries Policy seeks to address imbalances of the past and ensure that small-scale fishers are accommodated and properly managed. For the first time, fishing rights will be allocated on a group, rather than an individual basis. The policy further aims to support investment in community entities to take joint responsibility for sustainably managing the fisheries resources and to address the depletion of critical fisheries stocks. In 2016, the former Department of Agriculture, Forestry, and Fisheries (DAFF) verified 8 488 individuals in fishing communities that had expressed interest in the Small-Scale Fishery sector. This was followed by the declaration of 2 802 small-scale fishers. Several complaints regarding the justness and transparency of the process followed, which has inhibited the implementation of the policy to date.

In 2002, the subsistence sector was estimated to include 29 000 participants of which the majority (75%) were found on the east coast in KZN and the former Transkei (Clark *et al.* 2002). Of the estimated 30 000 small-scale fishers active along the South African coastline, 85% harvest line fish (Clark *et al.* 2002). Currently, the small-scale fishing sector will be given priority in the subsequent line fish Rights-allocation process. Furthermore, the number of recreational angling permits may have to be limited in order to accommodate the newly established small-scale fisheries sector so as not to compromise resource sustainability. Various species have been set aside for the small-scale fishing sector. Some have already been allocated to the existing small-scale fishing co-operatives in other coastal provinces as part of the 2021 Fishing Rights Allocation Process. Many species allocated to the small-scale "baskets" are primary targets of the commercial and recreational line fish

[11] Note that this value needs to be escalated by a factor of 1.553 to convert it to 2022 Rands

sectors, and these shared resources must be carefully monitored given the increased fishing pressure expected.

The Small-Scale Fisheries Policy proposes that certain areas on the coast be prioritised and demarcated as small-scale fishing areas (DAFF 2012). In some areas access rights could be reserved exclusively for use by small-scale fishers. A basket of species may be harvested or caught within particular designated zones. The basket allocated to the small-scale community based legal entity will depend on quantity of the marine living resources available in the total allowable catch (TAC), zonal allocations and total allowable effort (TAE). The Port of Richards Bay is currently located in 'Basket Area E – Pondoland MPA to the Mozambican border', which has 127 different resources marked for potential exploitation by small-scale fishers (Figure 21). There are a number of identified small-scale fishing communities in the region of Richards Bay who may access earmarked coastal and marine resources (Clark *et al.* 2002).

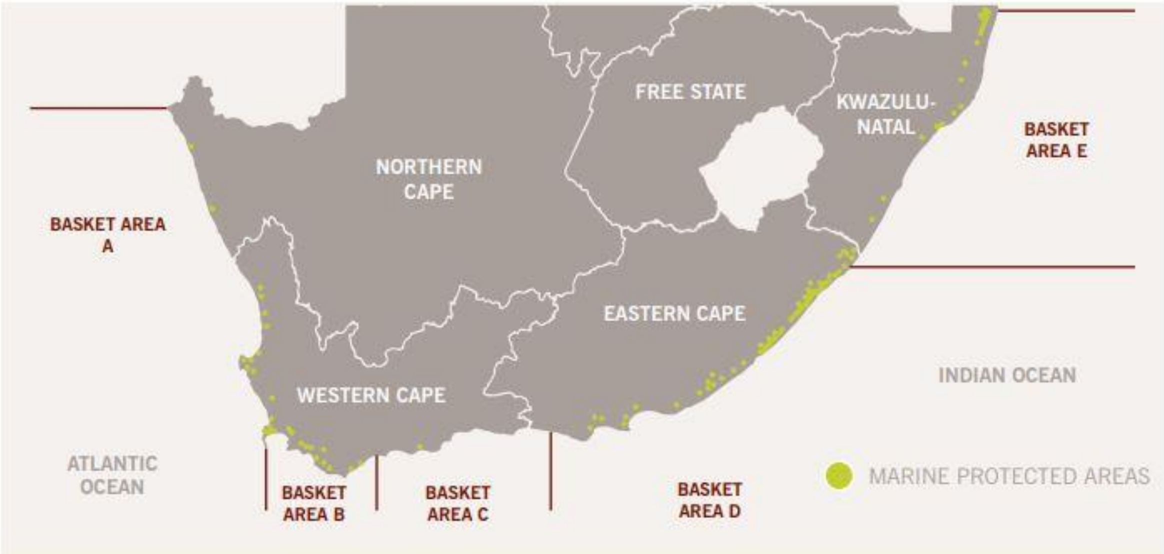

Figure 21. Map of small-scale fishing communities in South Africa (Hara & Isaacs, 2015)

In light of the Small-Scale Fisheries policy (DAFF 2012), it is possible that the fishers operating in the illegal gill net fishery may be granted licenses. As there are limited data on the current illegal gill netting catches, it is difficult to quantify the potential impacts on this fishery. However, any occurring impacts would have negative socio-economic consequences, as there are a great number of gill net fishers in the area. For comparison, in nearby St Lucia there were 37 gillnet permits, with an additional estimated 270 people operating illegally in the system in 2003 (Lambeth & Turpie 2003). It is estimated that illegal fishing will have increased since then.

The species known to be captured in the gill net fishery are indicated in Table 19, based on the species captured in the same fishery in nearby St Lucia and Kosi Bay (Kyle 1999, Mann 1995). All but one (Mozambique tilapia *Oreochromis mossambicus*) of the 27 species predominantly caught in the gill net fishery are estuarine-dependent.

As part of the environmental impact assessment for the KSA Gas to Power project, discussions were undertaken at a meeting on the 7th of October 2022 with small-scale fishers at the Port of Richards Bay, as supplementary engagement to the prerequisite public participation process for the project (Steenkamp and Rezaei, 2022). Any fisher or fishing community, in close proximity to the port, who were willing to engage, were invited to the meeting, whilst authorities were excluded to allow for free and open communication. Attendees indicated that they do not fish in the port or the immediate surrounds. Furthermore, DFFE has confirmed that no small-scale fishing cooperatives are registered to fish in the port. As an active port and industrial zone, TNPA does not allow fishing to take place in the port (Steenkamp and Rezaei, 2022). Thus, even if fishers operating in the illegal gill net fishery were granted licenses, this would not be permitted within the Port of Richards Bay. In addition, the attendees did not highlight any other points of access or uses associated with the port and its immediate surrounds. Key concerns were noted regarding potential negative impacts on the natural environment, particularly the marine ecosystem, and how this may impact on the fish population, and consequently the fisher's subsistence and livelihoods (Steenkamp and Rezaei, 2022).

6.9.2. Mariculture

Richards Bay has been explored as a site suitable for marine aquaculture, specifically finfish cage culture, due to warm water temperatures and sheltered conditions. In 2014, a collaboration between the Department of Science, Technology and Innovation (DSTI), the DAFF and Stellenbosch University (SU) undertook a pilot project to determine the feasibility of farming dusky kob *Argyrosomus japonicus* in sea cages in Richards Bay.

The project involved the grow-out of a single batch of fish to a targeted weight of 2.0 kg. The estimated production target during the pilot project was 50 tons (over a 19-month period) (Viljoen 2019).

The specific objectives of the pilot project were:

- To evaluate dusky kob growth rates, food conversion ratio (FCR) and survival under commercial sea cage culture conditions;
- To demonstrate the suitability of high-density polyethylene (HDPE) sea cages, mooring technology and husbandry procedures for application in Richards Bay in KZN;
- To demonstrate the environmental sustainability of sea cage aquaculture in Richards Bay;
- To provide a platform for the training of personnel in all fish and cage husbandry methods; and
- To catalyze the development of commercial marine finfish sea cage aquaculture in KZN.

As part of this project, four Fusion Marine Aquaflex surface gravity type cages (Fusion Marine Limited, Scotland, UK) were installed on a nearshore site leased by SU from Transnet National Ports Authority in the Port of Richards Bay (Figure 22) (Viljoen 2019). The site was located on the northern slope of the sandspit at the distal end, with the cages anchored to the sandspit (in the approximate location of the proposed FRSU of the proposed KPA Gas to Power project). The cages had a circumference of 50 m, the nets were 5 m deep and had a volume of 1000 m^3. Cages were stocked with fingerlings that were spawned from wild broodstock held in a recirculation aquaculture system operated by Pure Ocean Aquaculture (Pty) Ltd in East London. Fingerlings were fed initially with feed supplied by Avi-Products (Pty) Ltd (Pietermaritzburg) and later feed manufactured by Montego Pet Nutrition (Pty) Ltd (Graaff-Reinet). The stocked fingerlings grew from an initial weight of 9 g to a maximum weight of 1 580 g in 23 months (Viljoen 2019).

Overall, the DST SU KZN Aquaculture Development Project was reported to have achieved its primary objectives as set out at the beginning of the project (Viljoen 2019). Specifically, the project proved the suitability of the HDPE sea cages and the associated mooring technology as installed in Richards Bay especially taking into account that the fingerlings were produced from undomesticated wild broodstock where no prior genetic selection made to increase the performance of the fish. Water quality in the Port of Richards Bay was considered suitable for the production of Dusky kob, and growth rates and food conversion ratios (FCR) were both considered satisfactory. The fish reportedly adapted well to aquaculture conditions with an acceptable survival rate, in spite of a number of isolated events of significant mortalities due to stress (Viljoen 2019).

An Aquaculture Development Zone (ADZ) study has commenced in the Port of Richards Bay (DFFE 2020), but no details are available on this as yet.

In a Strategic Environmental Assessment for Marine and Freshwater Aquaculture Development in South Africa prepared by the CSIR (DEFF 2019), the Port of Richards Bay was identified as a potential site for commercial marine sea cage finfish farming (specifically for Dusky kob), but it was noted that given conflicting uses and the fact that this port is an estuary, this areas are not likely to support any large scale mariculture development.

Figure 22: Four Fusion Marine Aquaflex cages installed in the port of Richards Bay as part of the DST SU KZN Aquaculture Development Project. (Source: Viljoen, 2019).

6.10. Current Threats / Impacts

The current threats to the Richards Bay Estuary are a product of the long history of human interference, habitat modification and destruction through port development, flow modification, poor water quality, resource exploitation (fish and vegetation), urban and industrial development, and catchment related impacts, all coupled with ongoing modern-day impacts associated with port activities (DEA, 2017b). The overall cumulative pressure on the system is considered to be High (van Niekerk et al., 2019b).

In a significantly transformed and industrialised system such as the Richards Bay Estuary, the extent of human impacts is plentiful. These impacts are categorised into three groups related to land-use and infrastructure, water quality and quantity, and living resources (DEA, 2017b).

Among the plethora of impacts associated with port-related activities, the following were noted as key issues from an ecological perspective (DEA, 2017b), with relevance to the proposed Gas to Power project:

- Port construction activities (high extent);
- New port infrastructure development (high extent);
- Vessel (ship movement) (medium extent);
- Brine discharge (desalination) (low extent);
- Oil and cargo spills (low extent); and
- Ballast water discharges (low extent).

These impacts contribute to physical habitat alteration/destruction, suspended solids, siltation, alteration of salinity regime, and toxic chemical pollution. The ecological consequences of these threats include, *inter alia* (DEA, 2017b):

- Loss of overall biodiversity;
- Smothering of benthic communities;
- Chronic effects on biota;
- Mortality (acute effects) on biota;
- Harmful/nuisance algal blooms;
- Human health and safety risks through recreational activities;
- Human health and safety risks through the consumption of contaminated seafood;
- Loss in quality of seafood products;
- Loss of fisheries resources and revenue; and
- Loss of aesthetic value.

7. SITE INVESTIGATION

7.1.Description of Findings

The powership will be moored within the dead-end 600 Berth basin, which is a relatively geometric deep-water area (~14 m depth) bound by the break bulk/multipurpose terminal to the north, and rocky and muddy/sandy shoreline to the south (Plate 2). The artificial rocky shoreline (rock defence) in the north western corner is colonised by typical subtropical rock-shore invertebrate community, *e.g.* Oysters *Saccostrea* and barnacles, *Tetraclita* (Plate 3A-C). The southern shoreline is characterised by a 665m long stretch of mixed muddy boulder/sandy beach (Plate 4), lined with *Hibiscus tiliaceus* and isolated specimens of White Mangrove, *Avicennia marina* toward the head end (Plate 5). Numerous active crab burrows were observed in this area likely belonging to *Ocypode ceratophthalmus* (Horn-eyed ghost crab) (Plate 6A), as well as pseudofaecal pellets (Plate 6B) (possibly from sand-bubbler crab *Dotilla fenestrata*, which is known to occur in the system) within a zone of high primary productivity (high microphytobenthos biomass) evident as green-tinted sediment. For almost the entire stretch, the beach is backed by a steeply cut erosion terrace (~1.2m height) of the adjacent vegetated promontory (Plate 7 and Plate 8). Ammonite fossils were observed along the beach (Plate 9A-B), as well as mounds of dumped solid waste and accumulated flotsam (Plate 10A-B).

Plate 2. View of dead-end of 600 Berth Basin from north western harbour access point

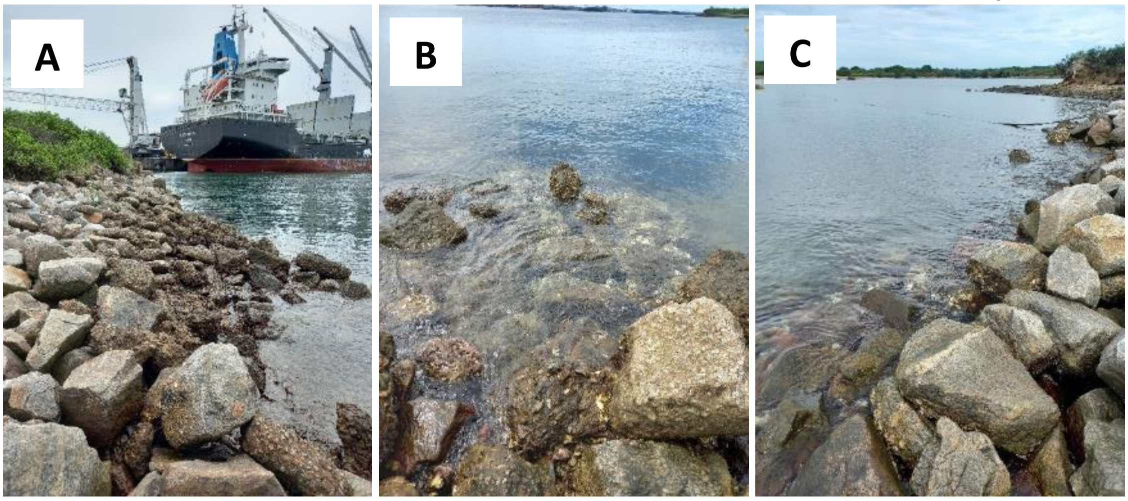

Plate 3A-C. Rock defence and encrusted with barnacles and oysters at north western corner of 600 Berth Basin

Plate 4. Mud/silt covered boulders at low tide charcterising the southern shoreline of 600 Berth Basin

Plate 5. Intertidal sandy shoreline at head of 600 Berth Basin, lined with *Hibiscus tiliaceus*

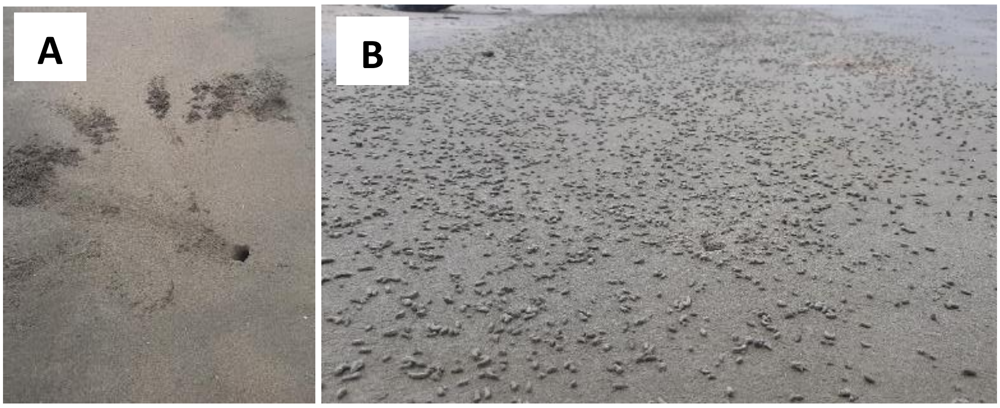

Plate 6. Active crab burrow (A) and pseudofaecal pellets (B) within a zone of high primary productivity


Plate 7. Vertical erosion of promonatory/ high ground adjacent 600 Berth Basin. Insert of Horn-eyed ghost crab observed in the upper beach area


Plate 8. Shoreline characteristics at low tide at headland of 600 Berth Basin

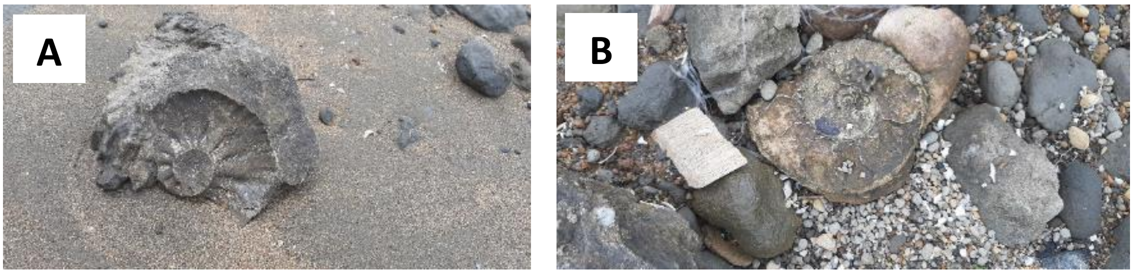

Plate 9A-B. Palaeontological elements on site (Ammonites)

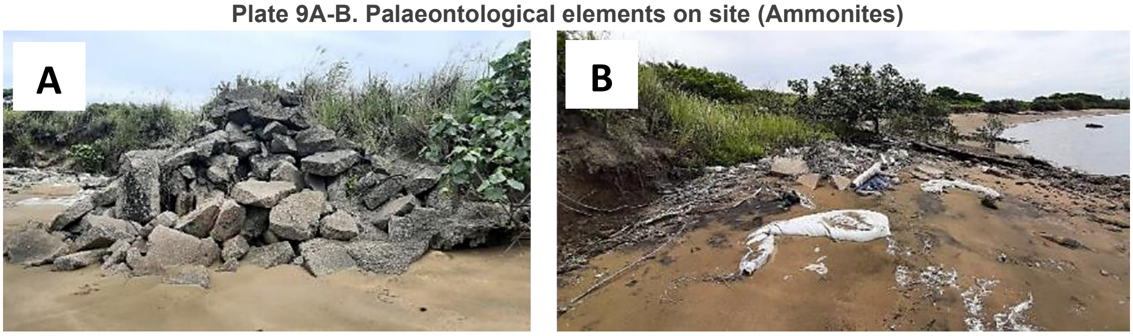

Plate 10A-B. Illegal dumping of construction waste/spoil and stranded solid and plastic waste/flotsam

At the far western end is the ‘assembly basin’, which is a quiet water area sheltered from vessel movement of the active channel used for maritime construction, maintenance and storage purposes as and when required (Plate 11). Although it is artificial, it provides valuable shallow intertidal and subtidal habitat for fish and invertebrates. Numerous sandprawn (*Kraussillichirus kraussi*) burrows were observed (Plate 12) and fish/prawn activity was also noted in the shallows. This area is also sparsely lined with *H. tilicaeus* and *A. marina* (Plate 13), and dune pioneer species (*e.g.* Goat’s foot - *Ipomoea brasiliensis*) colonise the headland between ‘assembly basin’ and 600 Berth Basin (Plate 14).

Plate 11. View into ‘assembly basin’ at dead-end of 600 Berth Basin, showing usage of the area for maritime storage purposes

Plate 12. Burrows of the sandprawn *Kraussillichirus kraussi* observed in the intertidal area of the assembly cove

Plate 13. Overview of shoreline within ‘assembly basin’ at head of 600 Berth Basin

Plate 14. Dune pioneer species colonising the headland between 'assembly basin' and 600 Berth Basin

As indicated in the project description, the LNG carrier and the FSRU mooring facility will be located approximately 230 m off the sandspit which forms the north eastern boundary of the Kabeljous Flats (Plate 15). The sandspit is a 2km-long permanent, sinuous sedimentary feature, with a small stand of mangroves (0.41ha) located approximately 550m from proximal end (Plate 16); remnant stand of mangroves exists closer to the mainland (Plate 17). The narrow channel between the promontory and the sandspit allows for connectivity and circulation between the deeper harbour waters and the shallow Kabeljous Flats (Plate 18 and Plate 19). From the promontory, the Kabeljous Flats (Plate 20 and Plate 21) and the Bhizolo Canal (Figure 22) are bordered by dense mangrove forest.

Plate 15. Aerial view of the sandspit looking east across the proposed mooring location of the FSRU, 700 Berth Basin on the left, Kabeljous Flats on the right
(Credit: Drone Air, 29/09/2022)

Plate 16. View of sandspit showing isolated mangrove stand (left) and middle section (right)

Plate 17. View of sandspit showing remnant dead mangrove stand toward the proximal end

Plate 18. Proximal end of sandspit and end of promontory viewed toward the Kabeljous Flats

Plate 19. Aerial view of Kabeljous Flats showing channel between sandspit and a mangrove lined cove (Credit: Drone Air, 29/09/2022)

Plate 20. View toward mangrove forest bordering Kabeljous Flats showing channel between sandspit and a mangrove lined cove

Plate 21. Dense mangrove forest bordering Kabeljous Flats along north western margin (Credit: B. Clark, 29/09/2022)

Plate 22. Upstream view of the Bhizolo Canal from the Harbour Arterial Road. Note the dense mangrove forest flanking the waterway and the existing powerlines spanning the canal

Following the line of the transmission route from the first land-based connection (terminal tower), the proposed area of construction is located upon the erosion terrace above the intertidal zone of the 600 Berth Basin (Plate 23). The vegetation comprises *Cylindrica imperata* on the flat areas, with *Osteospermum monilifera* thicket on the higher lying areas with infestations of invasive alien species, namely *Schinus terebinthifolius*, *Lantana camara*, and *Chromalaena odorata* (Plate 24).

Plate 23. Overview of vegetation of erosion terrace above the intertidal zone of 600 Berth Basin

Plate 24. Vegetation of erosion terrace dominated by *C. imperata, O. monilifera, Schinus terebinthifolius, L camara,* and *C. odorata*

Moving inland and westward, *C. monilifera* and *S. terebinthifolius* form a nearly impassable dense thicket (Plate 25). Any remnants of natural vegetation are highly disturbed by this invasive infestation along with illegal dumping of solid waste, particularly building rubble and asphalt (Plate 26 and Plate 27). This vegetation type is characteristic of the area where the proposed of the stringing yard will be located, and extends up to the Harbour Arterial Road in the west, interspersed with patchy mesic grassland. It is worth noting that the spoor of hippopatamus (*Hippopotamus amphibius*) was observed along one of the footpaths entering the assembly basin indicating the usage of this harbour environment by this species.

Plate 25. Disturbed dense shrubland thicket dominated by *O. monilifera* and *S. terebinthifolius*

Plate 26. Prevalence of illegal dumping activities across the site (old road surfacing)

Plate 27. Prevalence of illegal dumping activities across the site (building rubble)

Heading west, between the Harbour Arterial Road and the railway line, the disturbed vegetation grades from open grassland-scrubland into a relatively large of *Phragmites* dominated wetland interspersed with woody species (Plate 28). The invasive species, *S. terebinthifolius* is conspicuous across the entire area and is particularly prevalent along the transmission line corridor (Plate 29). Just south of this wetland area lies mangrove habitat, which is an extension of the dense mangrove forest that lines the Manzamnyama and lower Bhizolo Canals. This area includes supratidal saltmarsh, sand and mudflats along the western margin and a mixture of *Phragmites* reeds and hygrophilous grasses adjacent to the railway line (Plate 30).

Plate 28. Extensive *Phragmites* dominated wetland adjacent to mangrove forest, between Harbour Arterial Road and the railway line.

Plate 29. Disturbed grassland shrubland mix within preferred transmission corridor, comprising predominantly *Phragmites* and *S. terebinthifolius*

Plate 30. Back-end of mangrove habitat between the Harbour Arterial Road and the railway line. Note the saltmarsh habitat mid-frame.

The existing monopole powerline servitude lies westward of the railway line and runs parallel with the Manzamnyama Canal (Plate 31). Habitats within this ~60m-wide corridor include a narrow strip of mangroves lining the canal (*A. marina* and *B. gymnorrhiza*), intertidal sand/mudflat, *Phragmites* reeds and hygrophilous grasses, and invasive plant species, such *Ricinus communis* (Plate 32).

Plate 31. Overview of lower portion of existing powerline servitude and preferred transmission route (looking north east), showing Amanzamnyama Canal lined with mangroves (back left), *Avennia marina and Bruguiera gymnorrhiza*, intertidal sandflat (mid-frame), *Phragmites* reed beds (front left) and invasive alien plants, *Ricinus communis* (front centre)

Plate 32. Overview of middle portion of existing powerline servitude showing hygrophilius grasses and shrubland adjacent to mangrove habitat. Insert of monopole powerline structure constructed on an earthern berm.

As one moves northward, woody, dune thicket/coastal forest species become more prevalent (*Strelitzia nicolai*) and the corridor gradually widens as the railway diverts away from the canal (Plate 33). This mixed vegetation type extends northwards along the canal and around the northern boundary of the Bayside Aluminium Smelter property.

Plate 33. Overview of the upper middle portion of the existing powerline servitude (looking north east toward the Bayside Aluminium Smelter site)

The proposed switching station is positioned outside of the EFZ of the Richards Bay Estuary and comprises disturbed secondary grassland and a few woody tree species, *e.g. Syzygium cordatum* and *Vachellia* spp. (Plate 34). To the northwest of this site is a longitudinal wetland system, which drains in a southerly direction alongside the smelter site into the Bhizolo Canal.

Detailed coverage and descriptions of these vegetation types are included in Terrestrial (de Wet, 2022) and Wetland Specialist (Triplo4, 2022a) reports.

Plate 34. Overview of the habitat characteristics of proposed switching station location adajcent to the Bayside Aluminium smelter site

The location of the proposed site office and concrete coating yard is characterised by a large expanse of historically modified mesic grassland – bushveld dominated by *I. cylindrica – O. monolifera – Vachellia sp.*(Plate 35 A-F), disturbed with few invasive alien species, *e.g. L. camara* and *S. terebinthifolia*. *Imperata* cylindrica is conspicuous in the south-western section of the site (Plate D), which transitions into a dense thicket of *O monolifera*, which in turn is backed by an area of dense coastal forest (*Trema orientalis, Strelitzia nicolai*) (Plate 33 F) approximately 50m away, reportedly with swamp forest elements (*e.g. Ficus trichopoda*) (Cyrus, 2014). The soils are visibly marine in origin being sandy with shell fragments, and supporting dune pioneer species, *e.g. Carpobrotus edulis* (Plate C) and are the result of a dumped dredge material and historical modification of the area (de Wet, 2022).

The materials laydown area, located within the break-bulk loading area, is similarly characterised by *I. cylindrica-O. monolifera* grassland/scrubland with invasive *L. camara*, and *Ricinus communis* (Castor oil) (Plate 36 A – B). The area is heavily transformed and severely impacted on an ongoing basis by loading activities of mineral commodities, with the area serving as a dumping ground (*e.g.* tyres, solid waste), vehicle/plant parking area, and storage area. The vegetation over much of the area is covered in black-mineral soot (Plate 36 C-D). Further to this, during the September site investigation and windy conditions, significant air pollution (coal dust emission) was observed emanating from the multipurpose terminal (600 Berths) (Plate 37A-B). The surrounding vegetation including nearby mangroves were also noted as being covered in soot. This airborne-impact is a major concern for the fauna and flora of the Richards Bay Estuary.

The load out berth is located at the southern extent of the coal terminal within the existing port operations area. This site was not visited during the site investigation as the footprint will not be transformed (it is an existing quayside) but it is noted that site is adjacent to a narrow margin of mangrove vegetation.

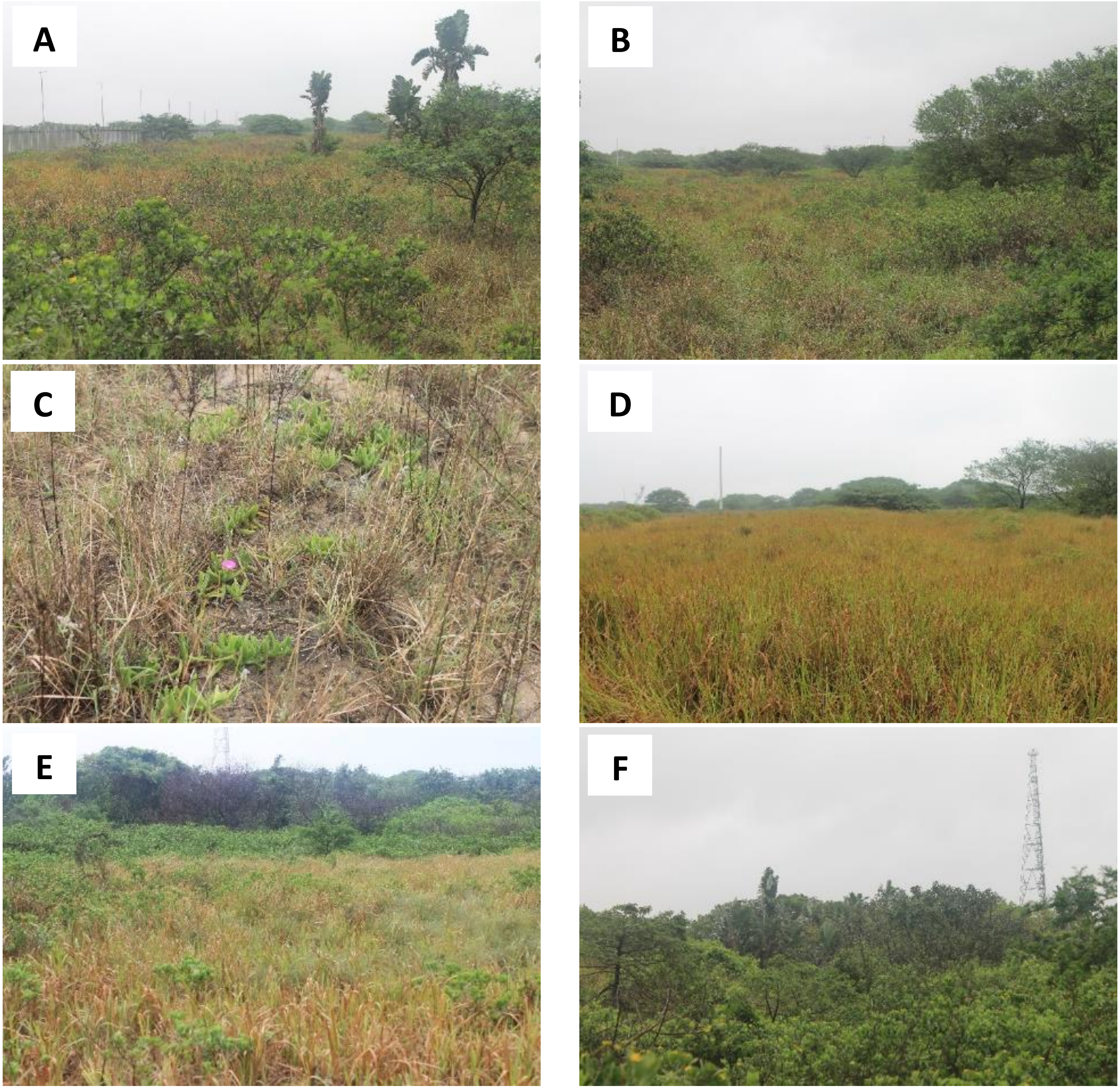

Plate 35. Overview of the habitat characteristics of the site office and concrete coating yard showing conditions on eastern margin of site (A), western margin of site (B), nature of soils with *C. edulis* (C), expansion of I. cylindrica in the western half of the site (D), western margin showing *O. monolifera* thicket grading into coastal forest (E), and close up of *S. nicolai* - coastal forest (F)

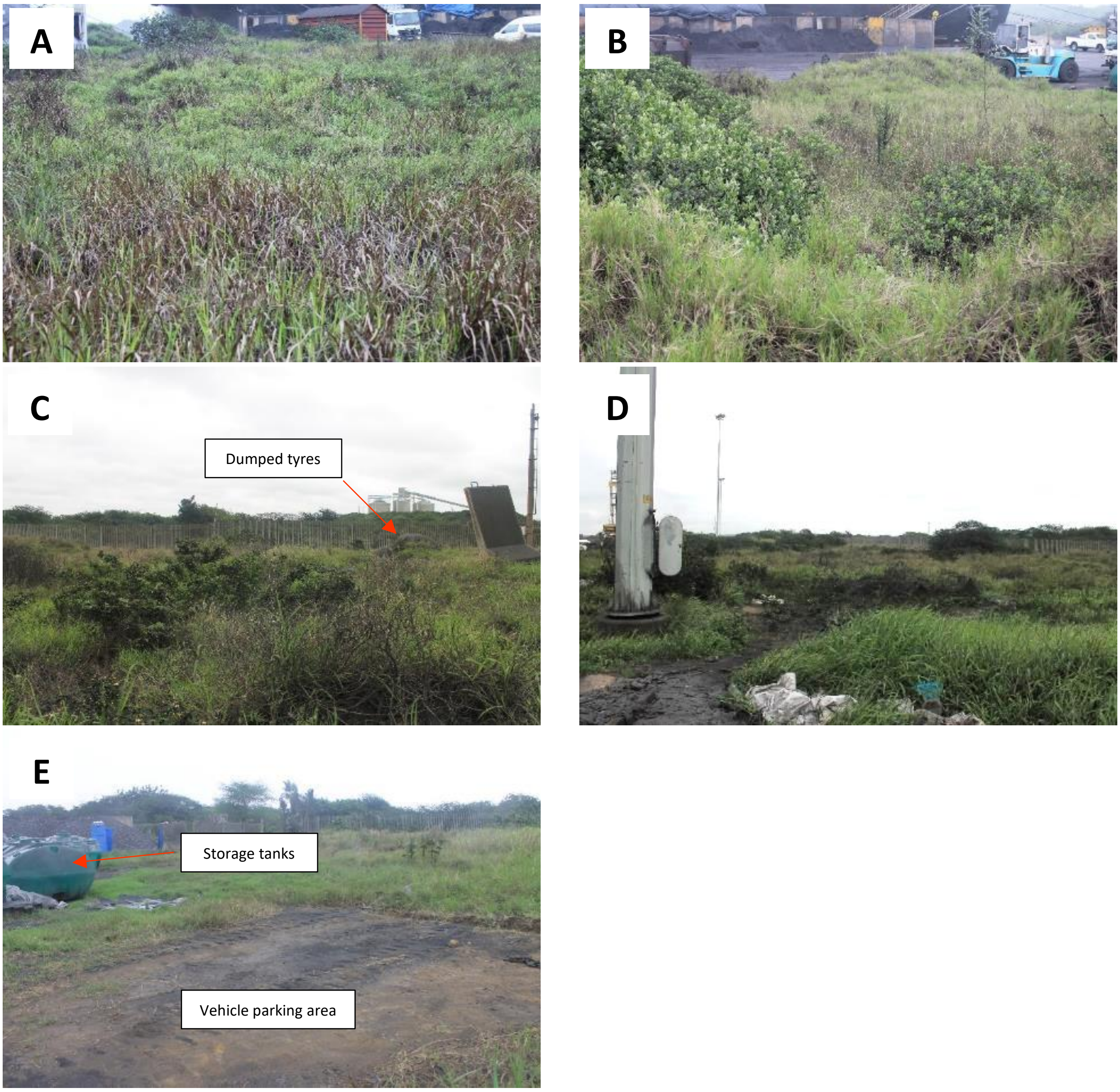

Plate 36. Overview of the habitat characteristics of the materials laydown area behind the 600 Berth Basin: showing *I. cylindrica* (A) and *O. monilifera* (B), and proximity of loading activities, general condtion looking north (C), north-west (D), and other disturbance and use of the north western portion of the site (E). Note the prevalence of black soot/dark coating of most of the area.

Plate 37. Coal dust emissions emanating from the multipurpose terminal (Credit: B. Clark, 29/09/2022)

7.2.Site Sensitivity Verification Conclusion

Based on the desktop assessment, literature review and findings of the site investigation, the specialist confirms that the development site and development footprint falls within the EFZ of the Richard Bay estuary, with areas notably transformed and currently impacted by port development and ongoing activities. It follows that the development site and development footprint contains very high sensitivity aquatic biodiversity features, which are also highly transformed, associated with the Richards Bay estuary.

A specialist report requirement of the EIA Regulations is the provision of a map which superimposes the activity, including the associated structures and infrastructure, in relation to the estuarine and coastal specific environmental sensitivities of the site, which includes the mangroves, Kabeljous flats and the sandspit (Figure 4, Figure 5 and Figure 13). It is however, reiterated, that the development site and development footprint in totality falls within the EFZ of the Richard Bay estuary.

8. IMPACT ASSESSMENT

8.1.Introduction

Although estuarine ecosystems are considered key environmental assets, they are one of the most threatened ecosystems in the country. Within the Port of Richards Bay, the proposed Gas to Power project will be located in the back of the port, adjacent to the highly sensitive habitats of the Kabeljous Flats, namely the intertidal and subtidal sand and mudflats, the sandspit, and mangrove forests, as described earlier in this report.

The preferred and alternate layout options were selected based on optimal positions relative to port operations and engineering intervention to eliminate the requirement for large scale dredging (*i.e.*, areas where depths were appropriate), which in itself will reduce environmental impacts (PRDW, 2020). Only these locations were assessed as per the approved Scoping Report and Plan of Study. Although this section of the port includes a sacrificial working area and is also earmarked for future port expansion (600 Berth Series), it is important that potential environmental impacts be assessed in order to minimise further environmental degradation and to formulate and implement appropriate mitigation measures, as part of environmental best practice, to assist in improving the port environment where possible, until the long-term plans are realised.

8.1.1. Marine Specific

Activities Screened Out of Assessment

Several activities were screened out of this assessment because it is assumed they will be adequately controlled in terms of the Port of Richards Bay's existing harbour rules, port reception facilities, vessel management practices, oil spill contingency plans and other relevant domestic and international law. This is standard industry practice and is legally required. Furthermore, all vessel waste will be removed and disposed of onshore. Activities screened out include:

- ballast water exchange procedures;
- removal of biofouling;
- vessel collisions with marine fauna; and
- anchoring (no release of concrete from anchoring blocks).

Conversely, some impacts were specifically raised during the previous public participation period and have been assessed (*e.g.* vessel lighting).

Furthermore, other constituents' discharge, such as biocides or brine, were not considered in this assessment. None of these will be added to the cooling water, according to the project description.

LNG leakage into the surrounding water body is not anticipated to cause harm the marine life or alter water column characteristics, as LNG vaporizes rapidly in air, becoming buoyant at -110°C and disperses quickly. Similarly, the re-gasified NG, used as fuel in the powerships, is supplied at ambient temperature. As such, should a release occur, natural gas would be much lighter than air and would disperse immediately and not affect marine life. Thus, LNG leakage is not assessed here.

While it is possible to use heavy fuel oil as an alternative fuel, this is not recommended as impacts on the estuarine and marine environments arising from a heavy fuel oil spill would likely be much more significant than those from LNG leakage. In addition, KSA have indicated that heavy fuel oil will not be used.

Marine Assessment

The spatial area for assessment, based on the modelling outputs outlined in section 3.1 above, is shown in Figure 23. The impact assessments are based on modelling results that assumed a worst-case scenario with the Powership running at 100%.

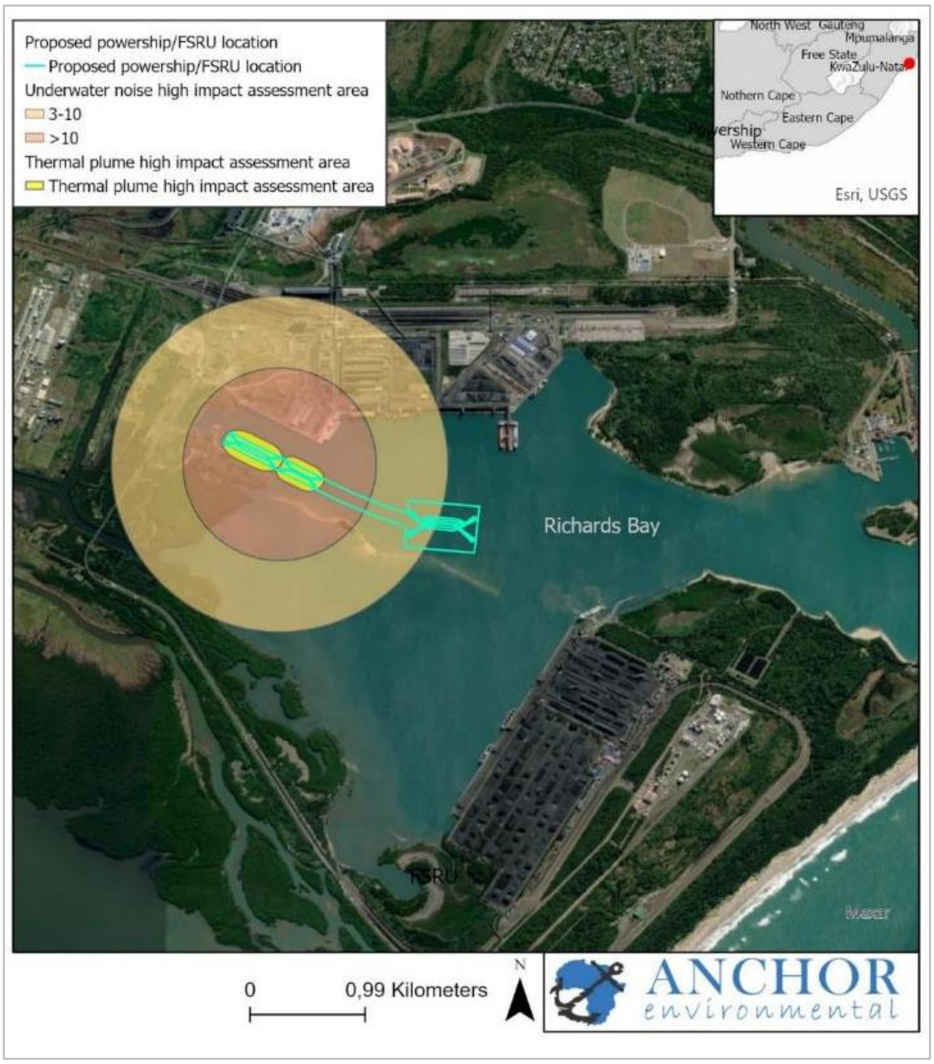

Figure 23. Assessment areas for thermal (yellow) and underwater noise modelling (high impact, >10 dB increase = red; low impact, 3-10 dB increase = orange)

8.1.2. Richards Bay Estuary

In this section, the potential impacts of the proposed project on the Richards Bay Estuary (and adjacent Mhlathuze Estuary where applicable) are assessed. This is necessary to formulate and implement appropriate mitigation measures to minimise environmental degradation of natural elements of the system. The potential impacts of the proposed project on the larger coastal zone are also assessed and mitigation measures to minimise potential negative impacts proposed. It is reiterated that integrated coastal and estuarine management is a cross-cutting speciality and many of the key issues and their potential impacts have been collectively identified and addressed in the other specialist assessments. For example, the impacts on fisheries and thus socio-economic implications are considered in the specialist socio-economic assessment (Social Risk Research, 2022; Steenkamp and Rezaei, 2022).

It must be noted that run-off (MAR) to the estuary and state of the Richards Bay Estuary mouth will not be affected by the project and are therefore not assessed.

Further, for the water-based activities, *i.e.* below the low water mark (*e.g.* vessel layout, gas pipeline routes, noise), the difference between the two alternatives in terms of potential impacts was considered negligible and these were thus assessed collectively.

8.1.3. Coastal Zone

The potential impacts of the proposed project on the larger coastal zone are also assessed and mitigation measures to minimise potential negative impacts are proposed. It is reiterated that integrated coastal and estuarine management is a cross-cutting speciality and many of the key issues and their potential impacts have been collectively identified and addressed in the other specialist assessments. For example, matters relating to 'sense of place' and potential obstruction of views are considered in the landscape and visual assessment input (Environmental Planning & Design, 2022; Social Risk Research, 2022).

A comment noted during the initial assessment process was the lack of consideration of socio-economic impacts related to many aspects. Taking cognisance of the ICM Act requirements, socio-economic aspects are an important part of any coastal specific activity, however, these aspects were best considered in the socio-economic assessment. Holistic issues included (Social Risk Research, 2022; Steenkamp and Rezaei, 2022).

- The cost of continued loss of biodiversity versus the benefit of job creation in the Richards Bay IDZ;
- The implications of the proposed activities on tourism value, related jobs and sense of place;
- The socio-economic impact on livelihoods should this activity not be authorised; and
- Socio-economic impacts due to changes in biodiversity and climate on the economic, and livelihoods of communities
- The loss of opportunities for local fisher folk as well as future mariculture prospects (proposed Aquaculture Development Zone (ADZ).

An additional priority in and requirement of the ICM Act is the provision of equitable (and safe) public access to the coastal zone and its resources. Such coastal access must, however, not conflict with protected areas, protection of the environment or the interests of the community or be located within a harbour, defence or other strategic area without permission of relevant Minister (DEA, 2014b). The Act also requires that any development should allow for safe access and enjoyment of the coastal zone by people. This includes allowing the sustainable utilisation of natural coastal resources by all members of the community, in order to enhance their quality of life (CEN, 2015). However, as the majority of the infrastructure is proposed to be installed within the already access-controlled Port of Richards Bay, no further change in coastal access is expected, as access is already restricted. Neither of the proposed locations of the transmission lines restrict access to the coast nor access routes to the coastline. Coastal access is therefore not highlighted as or rated as an impact.

8.2. Impact Assessment Methodology

This section describes the processes undertaken to identify impacts, to assess and rank the impacts and risks, to describe environmental impacts and risks identified during the EIA process, the assessment of the significance of each impact, risk and an indication of the extent to which the issue and risk can be avoided or addressed by the management actions (as per Appendix 3 of the 2014 NEMA EIA Regulations, as amended), and any deviations from approved Scoping and Plan of Study Report. Assumptions, uncertainties and gaps in knowledge relating to the assessment and mitigation proposed are also discussed. In the EIAR, the significance of the potential impacts is considered before and after identified mitigation is implemented, for direct, indirect, and cumulative impacts, in the short and long term, for all phases of the proposed project. The relevant specialist studies are synthesised and integrated into the overall impact assessment and recommendations for mitigation are included in the EMPr.

The assessment of environmental impacts associated with the project site and related activities was undertaken using the methodology provided by Triplo4. The potential impacts were evaluated according to the nature, spatial scale (extent), duration, severity, frequency and probability of occurrence. The overall environmental significance of an impact is a function of the overall consequence ((severity + duration + extent) / 3) and overall likelihood ((frequency + probability) / 2) of the impact (Table 28). The total number of points scored for each impact indicates the level of significance of the impact. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The significance of the impact is compared before and after the proposed mitigation measures are implemented. Reversibility of the impact and irreplaceability of resources are also considered.

The construction or assembly of the respective infrastructure components is estimated to last more than two years (but less than five years[12]), whilst contractual period of operation is 20 years (*i.e.* more than 10 years), During operation, the duration of the impact is thus life span of the project (*i.e.,* more than 10 years), but may not necessarily be **permanent**, and therefore be **reversible**. Should an impact not be reversible, then this is explicitly stated.

The **irreplaceable loss of resources** has been assessed, but not explicitly stated as such. For example, a less severe impact will be insignificant or non-harmful and the resultant loss of resources can be replaced. In contrast, the loss of resources from disastrous or extremely harmful impacts cannot be satisfactorily replaced.

****Caveat – It is the opinion of the specialists of this report that the scoring methodology provided is not a true reflection of the project situation and the findings of this assessment (*e.g.* impact duration). The scoring has thus been adapted and/or added to, to provide the best assessment possible as indicated in the table below. ****

Table 28 indicates the scoring of the impacts and how the overall significance is determined.

Table 28. Criteria used to assess the potential impacts of proposed activities within the Port of Richards Bay, adapted for the estuarine, marine and coastal environment (adapted from Triplo4, 2022)

SCORING OF IMPACTS	Triplo4 scoring	Adapted scoring
Consequence		
Severity the degree to which the project affects or changes the environment	1 – Insignificant / Non-harmful 2 – Small / Potentially harmful 3 – Significant / Slightly harmful 4 – Great / Harmful 5 – Disastrous / Extremely harmful	1 - Site-specific and wider natural functions and processes are not altered 2 - Site-specific and wider natural processes and functions are slightly altered 3 - Site-specific and wider natural processes and/or functions continue albeit in a modified way (general integrity maintained) 4 – Site-specific and wider natural processes and/or functions are altered to a large degree/temporarily cease 5 - Site-specific and wider natural functions and/or processes are completely altered/cease
Duration a measure of the lifetime that the impact will be present	1 – up to 1 month 2 – 1 to 3 months 3 – 3 months to 1 year 4 – 1 to 10 years 5 – Beyond 10 years/Permanent	1 – up to 1 year 2 – 1 to 2 years 3 – 2 to 20 years 4 – Beyond 20 years 5 - Permanent
Spatial Scale the extent or size of the area that will be affected	1 – Immediate, fully contained area / within the site 2 – Surrounding area (<2km) 3 – Within farm / town / city 4 – Within municipal area 5 – Regional, National, International	1 – Project footprint 2 – Within the broader EFZ 3 – Beyond the EFZ, 4 – Beyond uMhlathuze Municipality 5 – Affecting KZN, SA, or Global
Overall Consequence = (Severity + Duration + Extent) / 3		
Likelihood		
Frequency of the Impact how often the impact will occur	1 – Once a year or once or more during operation 2 – Once or more in 6 months 3 – Once or more a month 4 – Once or more a week	1 – Once a year or once or more during operation, or once-off 2 – Once or more in 6 months 3 – Once or more a month 4 – Once or more a week

[12] The powerships are assembled off-site and arrive in the port ready for commissioning.

	5 – Daily or hourly	5 – Daily or hourly
Probability of the Incident / Impact the likelihood or the chances that the impact will occur	1 – Almost never / almost impossible 2 – Very seldom / highly unlikely 3 – Infrequent / unlikely / seldom 4 – Often / regularly / likely / possible 5 – Daily / highly likely / definitely	1 – < 5% chance of occurring (improbable) 2 – >5 - 25% chance of occurring (possible) 3 – >25 - 50% chance of occurring (probable) 4 – 50 - 75% (highly probable) 5 – >75% chance of occurring (definite)
Overall Likelihood = (Frequency + Probability) / 2		
Overall Environmental Significance = Overall Consequence X Overall Likelihood		
Overall Environmental Significance:		
0–- 2.9	Very Low	
3–- 4.9	Low	
5–- 6.9	Medium–- Low	
7–- 8.9	Medium	
9–- 10.9	Medium–- High	
11 and above	High	

Reversibility	
Reversibility degree to which the impact t can be reversed	Reversible – the impact is reversible Irreversible – the impact is not reversible
Irreplaceable Loss of Resources	
Irreplaceable Loss of Resources degree to which the loss of resources can be replaced	Yes – the impact causes a loss of resources that cannot be replaced No – the impact causes a loss of resources that can be replaced
Fatal Flaw	
Fatal Flaw degree to which the impact is a fatal flaw	Yes – the impact results in a fatal flaw No – the impact does not result in a fatal flaw
Confidence (from Anchor Environmental methodology)	
Status of impact	+ve (beneficial) or – ve (cost)
Confidence of assessment	Low, Medium or High

8.3.Construction Phase

The activities involved in the construction of the proposed Gas to Power project components will result in interactions with receptors in the estuarine / marine environment. Disturbances that have the potential to result in significant impacts are assessed and detailed below.

8.3.1. Impact 1: Effect on surrounding estuarine / marine ecology as a result of water-based construction activities

The proposed project site is located within a completely transformed section of the Richards Bay EFZ. The area has undergone drastic historical modifications including infilling, canalisation of rivers, quay wall construction, capital dredging, and industrial, commercial and transport infrastructure development. Extrapolating from the macrobenthic data from the long-term ecological monitoring of the port, the project footprint on the seabed is likely to support a disturbed macrobenthic community.

Installation of mooring facilities (*i.e.,* heavy chain, vertical anchor system) and laying of the subsea pipeline will result in localised disturbance of the intertidal and subtidal soft-sediment environment through vibro-piling, drilling and rock clearance. These activities will result in temporary resuspension of sediment in the water column as well as shifting/displacement of sediment into adjacent areas with likely knock-on effects for benthic and pelagic organisms, which may result in smothering and/or injury of estuarine/marine organisms. Turbidity generated by these construction activities may be advected into surrounding areas but, as each turbidity-generating event will be spatially constrained, areas affected are likely to be small. This will cumulatively contribute a small amount to suspended sediment from port maintenance dredging activities. Accordingly, combined with natural episodic high turbidity events, periodic dredging (Laird and Clark, 2014), as well as propellor wash, the local biological communities should be acclimatised to elevated turbidity levels.

The installations will disturb approximately 15 000 m^2 (1 500 m pipeline multiplied by approx. 10 m servitude + the mooring blocks) of benthic habitat within the site-specific area of about 78.5 ha[13] .This will result in the modification of approximately 1.9% of the benthic community structure on site. Following installation, sessile organisms should colonise hard surfaces causing a minor increase in benthos biodiversity in the project area and resulting in restored ecological function (except if colonised by invasive species). Furthermore, the development will occur within an already compromised area of the port. The subtidal benthic macrofauna in the Port of Richards Bay is detailed in the baseline (Section 6.7.2). Trace metal concentrations (Section 6.6.2) measured in sediment in the Berth 600 Basin, where the proposed project will be located, showed that the area is highly contaminated compared to other port areas (CSIR, 2020). This indicates that this area has already been disturbed by port activities. As a result, the macrofaunal density in the region of the proposed powership and FSRU location is relatively low, especially compared to the those in the mudflats and other areas less impacted by port activities such as the Bhizolo and Mzingazi canals (Vivier and Cyrus, 2014; CSIR, 2018; Izegaegbe *et al.* 2020). The benthic community in the proposed project development area is primarily dominated by polychaete worms. Many of these species can proliferate in disturbed environments. Their presence in the development area likely indicates that the site is already disturbed (see Giangrande *et al.* 2005) and that following further disturbance, recolonisation should be rapid, on the scale of months, particularly if colonising source material is easily available (as is the case due to unimpeded connectivity to the marine environment) (Stow, 2011). Pelagic fish and bottom dwelling fish species such as gobies (*e.g.*, *Glossogobius callidus*), sole (*Solea bleekeri*) and rays etc., may be disturbed but are likely to evade the area of disturbance.

Physical disturbance of the intertidal zone is expected during the assembly of the gas pipeline and undertaking of other construction related activities for the Gas to Power project. This may involve heavy machinery and construction personnel accessing and moving along the shoreline in the vicinity of the stringing yard to the mooring location. In general, the intertidal zone is inherently dynamic, being exposed to constant daily changes and in the active port areas, exposed to disturbance by propeller wash, ship movement, wind and

[13] Approximate surface water area of the port, from the confluence of the Bhizolo and Manzamnyama canals in the west, up to the steel bridge crossing the Mzingazi canal in the north, to the eastern extremities of the port enclosed by the breakwaters (2012 NBA, Van Niekerk and Turpie, 2012).

wave action. Therefore, recovery of the intertidal fauna due to the disturbance by construction activities will be fairly rapid as the fauna are likely to be adapted to such environmental conditions. In addition, the shoreline adjacent to the mooring location is already disturbed by ship movement in this area (See Section 7) and the immediate shoreline around the dead-end basin provides limited habitat value for large numbers of waterbird species in terms of nesting, feeding, and roosting, and thus disturbance in this regard is expected to be relatively low. It is worthwhile to note that *Zostera* was not observed in the immediate vicinity of the project area within the dead-end basin nor along the outer edge of the sandspit during the recent avifaunal site investigations (de Wet, 2022).

Disturbance to benthic and littoral habitats and fauna is an unavoidable consequence of the proposed development. However, disturbance to potentially sensitive habitats should be minimised, *e.g.* sandspit and assembly basin, which must be considered no-go areas. If minimised, the probability of estuarine/marine biota being impacted is reduced.

Table 29. Impact ratings for disturbance or loss of estuarine and marine fauna as a result of water-based construction activities

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 &2	1	2	2	**1.7**	4	4	**4.0**	**6.8 Medium-low**
Mitigation measures: • Disturbance must be kept to a minimum by confining the pipeline laying activity, working barge and/ or excavation/levelling equipment to within the project area and designated access routes/paths. • The assembly basin area and the sandspit must not be disturbed or utilised during construction or during mooring activities. These are no-go areas. • Mooring of the FSRU must maintain a minimum distance of 230 m from the sandspit. • Construction activities must be restricted to daylight hours. • No animals (birds, fish, reptiles, mammals) are to be disturbed unnecessarily and no animals are allowed to be shot, trapped or caught for any reason. • A comprehensive environmental awareness programme must be conducted amongst contracted construction personnel about sensitive estuarine and coastal habitats and fauna. • Management of all site activities and site camp/laydown area must be undertaken in accordance with a site specific EMPr and audited by an ECO. • In the unlikely event that *Zostera* is discovered within project area (*i.e.,* 600 Berth Basin), an offset is proposed replacing like-with-like should it be affected by the powerships and associated infrastructure.								
Alternative layout 1 &2	1	1	1	**1.0**	3	4	**3.5**	**3.5 Low**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

8.3.2. Impact 2: Changes in water quality as a result of water-based construction activities

Laying of the mooring facilities (heavy chain, anchor system) and the subsea pipeline will result in localised disturbance of the intertidal and subtidal soft-sediment environment, which in turn will affect the water quality in the immediate vicinity, specifically in respect to total suspended solids/ turbidity, dissolve oxygen concentrations, and sediment contaminants. This will have knock on effects for benthic and pelagic organisms.

Turbidity levels and TSS concentrations in Richards Bay are generally relatively low (< 10 NTU; ≤ 10 mg/L). (CSIR, 2020). Water quality measurements taken in the 600 and 700 Berth Basin (sites 3 and 7) indicate that surface and bottom water turbidities range from 1.82 to 7.37 NTU, and TSS of surface waters from 2 to 8 mg/L (CSIR, 2020). However, strong wind and wave action, and vessel propeller wash and dredging in ports, lead to elevated levels TSS and turbidity.

Agitation of the sediment during the laying of the gas pipeline and anchorage legs on the seabed, as well as necessary levelling, will lead to a temporary increase in TSS and turbidity of the water column. This may have negative implications in the case of light penetration and the primary productivity of microalgae (phytoplankton and microphytobenthos), and for invertebrates and fish. The response of larval fish to turbidity of the water column is generally species-specific (Harris and Cyrus, 1999) and estuarine fauna are generally well adapted to high levels of turbidity. However, fine particulate matter may result in the clogging of the feeding and breathing apparatus of certain organisms (*e.g.* filter feeding invertebrates and the gills of sensitive fish species). Notwithstanding, impaired visibility in the water column due to increased turbidity will also affect the detection of prey by predatory fish species, however these species are generally marine and will migrate away or out of the harbour when conditions become unfavourable (Harris and Cyrus, 1999; Laird and Clark, 2014). Overall, the area of disturbance is small and the quantity of sediment disturbance that will take place for this Gas to Power project is minimal in comparison to periodic capital dredging operations required to maintain the depth of the shipping channels and berths. Further to this, the sandspit provides a form of natural barrier to the Kabeljous Flats, mostly during low tide levels.

In respect of dissolved oxygen concentrations of the water column, it is possible that disturbance of the seabed during laying of the pipeline and mooring anchors will release potentially anoxic sediments into the water column resulting in oxygen deficient conditions, with negative knock-on effects for aquatic organisms. This could be exacerbated by muddy sediments with high organic content for decomposition by bacteria in the sediment and limited re-ventilation of the water column by currents in the dead-end basin (CSIR, 2020). However, sediment analyses revealed that, despite the predominance of muddy substrate within the project area, the organic content was within the expected range and sediment quality was rated as good, in this regard (CSIR, 2020). In light of this and given that a relatively small area of the seabed will be disturbed during these activities, exposure to extended periods of oxygen poor conditions is expected to be low.

The presence of sediment contaminants, specifically heavy metals, is a common occurrence and expected within ports given the nature of port activities and materials handled. Both sites 5 and 7 within the 600 Berth Basin showed degrees of metal enrichment, but more so for site 5 where the highest number of metals at an enriched concentration (five) was sampled, and two metals at site 7, along with several other sites within the 600 and 700 Berth basins (CSIR, 2020). At site 5, the Enrichment Factors for cadmium, copper and chromium were particularly high relative to other sites in the port (CSIR, 2020). The Enrichment Factor was rated as poor for two (copper and chromium). Sites 5 and 7 were among the top three most severely metal contaminated sediment within Richards Bay (CSIR, 2020). Evidently, there is a slightly greater risk of exposure of benthic and pelagic organisms at site 5 due to sediment contaminants released during construction activities.

Table 30. Impact ratings for changes in water quality as a result of water-based construction activity

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 &2	2	2	2	**2.0**	4	4	**4.0**	**8.0 Medium**
Mitigation measures: • Disturbance must be kept to a minimum by confining the pipeline laying activity, working barge and/ or excavation/levelling equipment to within the project area. • Duration of pipe laying and anchorage operations must be minimised as much as possible to reduce suspended sediment loads. • Pipe laying and anchorage operations should not take place during inclement weather conditions where risk of disturbance to adjacent areas would be greater. • The sandspit must not be disturbed or utilised during mooring activities. This is a no-go area. • Mooring of the FSRU must maintain a minimum distance of 230 m from the sandspit. • Laying of the pipeline and the anchor legs must be undertaken with as little disturbance of the seabed as possible. • Monitoring of turbidity levels must be undertaken daily during the pipe laying and anchorage operations. TSS levels may not exceed 20 mg/l. • Management of all construction activities and site camp/laydown area must be undertaken in accordance with a site specific EMPr.								
Alternative layout 1 &2	2	2	1	**1.7**	3	4	**3.5**	**6.0 Medium-low**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

8.3.3. Impact 3: Effect on surrounding estuarine/marine ecology due to increased noise levels from construction

Anthropogenic noise in and around underwater habitats can impact the marine species inhabiting them. The extent and likelihood of underwater noise causing adverse impacts on marine life is dependent on the qualities of the sound such as the sound level, source frequency, duration of exposure, and/or repetition rate of an impulsive sound (Hastings and Popper 2005, in Subacoustech Environmental 2022). Most research into the effects of underwater sound on marine life focuses on high level underwater noise such as blasting, seismic surveys, or impact piling, as these noises are more likely to have greater, more immediate and observable environmental effects. However, research into long-term, relatively low-level noise exposure is increasing.

The proposed Gas to Power project in the Port of Richards Bay is surrounded by important habitats such as the mangroves, seagrass beds, intertidal and shallow subtidal mud and sand flats, the subtidal benthic zone and the water body itself. Depending on their distance from the proposed Gas to Power project location, the biota in the nearby area could be impacted by underwater noise from the construction activities. Exposure to noise for a long period of time, can cause chronic effects, including developmental deficiencies and physiological stress (Popper and Hawkins 2016). These may affect life functions, including individual health and fitness, foraging efficiency, avoidance of predation, swimming energetics and reproductive behaviour (Popper and Hawkins 2016). However, as stated above, these responses to sound are dependent on the sound qualities and the sensitivity of different organisms to sound waves.

The most noise-sensitive groups in Richards Bay are expected to be mammals and fish. Richards Bay acts as an essential nursery habitat for many fish species due to its sheltered and food-rich waters. Aggregations of juveniles are present in the area during key recruitment periods (August to November) (Whitfield 1994, Wallace 1975). Juveniles are considered more susceptible to noise disturbances as they are less mobile, while adult fish (and marine mammals) can move out of affected areas. It is often assumed that animals will avoid disturbing noise. However, territoriality or a response of immobility may mean that the animal does not move away from the noise source (de Soto 2016). Other important marine receptors in the area are the various seabird and waterbird species. Marine invertebrates may also be impacted by underwater noise; however, evidence is limited (de Soto 2016).

Southall *et al.* (2019) provides groupings of marine mammals of similar species by their hearing range (Table 31) and approximates the hearing sensitivities of each group by applying filters to unweighted noise.

Table 31. Marine mammal hearing groups (from Southall *et al.* 2019) with some South African species examples

Hearing group	Generalised hearing range	Example species
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	Baleen whales *e.g.*, southern right whale (*Eubalaena australis*), humpback whale (*Megaptera novaeangliae*), Bryde's whale (*Balaenoptera edeni*)
High-frequency cetaceans (HF)	150 Hz to 160 kHz	Dolphins, toothed whales, beaked whales, bottlenose whales *e.g.*, common dolphin (*Delphinus delphis*), Heaviside's dolphin (*Cephalorhynchus heavisidii*), dusky dolphin (*Lagenorhynchus obscurus*), killer whale (*Orcinus orca*), Atlantic bottlenose dolphin (*Tursiops truncatus*), short-finned pilot whale (*Globicephala macrorhynchus*)
Very high-frequency cetaceans (VHF)	275 Hz to 160 kHz	True porpoises (None in South Africa)
Phocid carnivores in water (PCW)	50 Hz to 86 kHz	True seals *e.g.*, southern elephant seal (*Mirounga leonina*), leopard seal (*Hydrurga leptonyx*)
Otariid and other carnivores in water (OCW)	60 Hz to 39 kHz	Cape fur seals (*Arctocephalus pusillus*), Cape clawless otter (*Aonyx capensis*)

Southall *et al.* (2019) also provides individual criteria based on whether the noise source is considered impulsive or non-impulsive. Examples of non-impulsive noise include sonar, vibro-piling, drilling, shipping, and other relatively low-level continuous noise. The noise produced by the construction activities is considered non-impulsive, and Southall *et al.* (2019) presents cumulative weighted sound exposure criteria (SEL_{cum}) for both implusive and non-impulsive noise (Southall *et al.* 2019). SEL_{cum} are provided for both the onset of permanent threshold shift (PTS), where unrecoverable (but incremental) hearing damage may occur, and onset of temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors. Unweighted peak criteria (SPL_{peak}) are only used for impulsive noise and are thus not appropriate for this assessment.

The effect of weighting using a frequency spectrum for a Powership output of 420 MW at 200 m from the hull (in a harbour) on the sound perception of the various species groups, as calculated by Subacoustech Environmental (2022), is presented in Appendix 13.3.

A moving animal model is typically used for SEL_{cum} exposure thresholds for marine mammals, which assumes that the receptor will swim away from the source of high noise levels. Continuous noise sources will not necessarily cause this kind of reaction, although it is unlikely that a species would remain still for the duration of the noise exposure. However, the assumption of a static mammal is used as a worst-case scenario.

Authoritative guidelines for fish exposure to sound are provided in Popper *et al.* (2014), using categories for fish that are representative of general fish species, according to their anatomy. Based on the guidelines in Popper *et al.* (2014), no weighting is applied to calculate the impact thresholds for fish. The most sensitive species of fish (those with a swim bladder involved in hearing) must be exposed to 158 dB SPL_{RMS} from continuous noise sources, such as shipping, for 12 hours to experience the onset of TTS (Table 32). Sciaenidae are examples of such fish, of which Dusky kob *Argyrosomus japonicus* is present in Richards Bay.

In cases of insufficient data availability to determine a robust numerical threshold, Popper *et al.* (2014) also provide qualitative criteria summarising the effect of noise on an individual as having either a high, moderate or low effect in either the near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres) (Table 32).

As defined in Popper *et al.* (2014), masking is the "*impairment of hearing sensitivity by greater than 6 dB, including all components of the auditory scene, in the presence of noise*." This is not a direct physiological effect on hearing but describes the effect of making a sound harder to hear due to the increase background noise. Behavioural effects are defined as "*substantial change in behaviour for the animals exposed to a sound".* This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements (Popper *et al.* 2014).

Table 32. Summary of the qualitative effects on fish from continuous noise from Popper *et al.* (2014) (N = Near-field; I = Intermediate-field; F = Far-field). Distances are considered as follows: near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres).

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	170 dB SPL_{RMS} for 48 hrs	158 dB SPL_{RMS} for 12 hrs	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Construction noise sources

The noise producing activities expected to be present during the construction of the infrastructure required for the Powerships and supporting vessels includes vibro-piling, drilling, and rock clearance. Vibro-piling will be required to install the first stage of the piled anchors for the Powerships and FSRU. Drilling will be needed to install the piles for the remained of the required depth into bedrock, and rock clearance is potentially required for the installation of the pipelines. High intensity impulsive piling will not be used.

Subacoustech Environmental (2022) predicted the subsea noise levels produced by construction activities based on data from measurements of similar equipment, scaled to relevant parameters for the site and to the specific noise sources used. Underwater noise transmission loss for non-impulsive sources was calculated based on an empirical analysis of the noise measurements taken along transects around these noise sources (Subacoustech Environmental 2022).

For more details on the predicted noise levels in Richards Bay as a result of the proposed Gas to Power project construction, refer to Subacoustech Environmental Report No. P292R1001 (Subacoustech Environmental 2022).

- Drilling and vibro-piling

The coupling of the piles to the piling hammer generates vibro-piling noise in the piles. Subacoustech Environmental (2022) based their noise calculations on measurements from a similar, but slightly more powerful vibro hammer to the one to be used in Richards Bay. Therefore, the noise levels predicted are potentially slightly worse than will actually be produced. The source level for vibro-piling (*i.e.*, theoretical noise level at 1 m from the noise source, used for calculations) was calculated to be 184.0 dB SPL_{RMS}.

The source levels for drilling were based on measurements from underwater drilling on shallower rock than the bedrock in Richards Bay and as a result, represent a precautionary prediction. The source levels for drilling were calculated to be 168.8 dB SPL_{RMS} (Subacoustech Environmental 2022).

The ranges at which marine mammals may experience the onset of TTS due to cumulative exposure to vibro-piling and drilling operations, based on the guidelines in Southall *et al.* (2019) are presented in Table 33. The ranges for vibro-piling are based on 2 hours of operation in any 24-hour period and were calculated for both a stationary and moving animal. The ranges for drilling were calculated assuming that drilling would be undertaken for up to 12 hours within a 24-hour period and that the animal would be stationary.

Table 33. TTS ranges to Southall *et al.* (2019) SELcum criteria for vibro-piling and drilling operations

Threshold	Criteria SEL_{cum} (weighted)	Vibro-piling (2 hours)		Drilling, stationary (12 hours)
		Stationary animal	Moving animal (1.5 m/s)	
LF Cetaceans TTS	179 dB re 1 $\mu Pa^2 s$	200 m	<50 m	110 m
HF Cetaceans TTS	178 dB re 1 $\mu Pa^2 s$	<50 m	<50 m	<50 m
VHF Cetaceans TTS	153 dB re 1 $\mu Pa^2 s$	520 m	<50 m	130 m
PCW Pinnipeds TTS	181 dB re 1 $\mu Pa^2 s$	120 m	<50 m	<50 m
OCW Mammals TTS	199 dB re 1 $\mu Pa^2 s$	<50 m	<50 m	<50 m

The impact ranges for vibro-piling show that an individual of the most sensitive group of marine mammals, VHF cetaceans, would need to remain stationary at 520 m from the noise source for 2 hours in order to experience the onset of TTS. VHF cetaceans are not expected to be found in Richards Bay and all other groups of marine mammals would need to be 200 m or nearer to meet the TTS threshold. The Indo-Pacific humpback dolphins that occur in the Port are HF cetaceans and would therefore need to be within 50 m of the vibro-piling or drilling for the duration of the activity to experience the onset of TTS. The likelihood of this occurring is considered to be low.

The PTS impact ranges for all marine mammal species and noise types was calculated to be less than 50 m.

For fish, all impact ranges will be less than 50 m, based on the 158 dB SPL_{RMS} threshold for TTS in fish from continuous noise sources (Table 32). This also requires 12 hours of continuous exposure for an individual. Based on the qualitative criteria provided by Popper *et al.* (2014), fish and fish larvae and eggs will experience moderate to high levels of masking and behavioural impacts within hundreds of metres of the construction noise source (Table 33). The extent to which this will impact their ecological functioning is uncertain.

TTS and PTS thresholds are not available for invertebrates or diving seabirds. However, threshold levels for marine mammals are generally considered appropriate for seabirds as well.

There is limited information on the effects of anthropogenic underwater noise on invertebrates such as crustaceans (de Soto 2016). However, there is evidence that anthropogenic noise can cause marine invertebrates to experience masking of important biological sound cues, as well as sublethal physiological stress in response to high levels of sound such as that from vessel traffic or construction noise (Hudson *et al.* 2022, Jézéquel *et al.* 2021, Solan *et al.* 2016). Exposure to underwater broadband sound fields at 135–140 dB re 1 µPa can reduce sediment-dwelling invertebrates' (in this case, the decapod *Nephrops norvegicus*, and clam *Ruditapes philippinarum*) ability to undertake ecologically-important benthic nutrient cycling processes (Solan *et al.* 2016). These sound levels will be experienced by invertebrates within hundreds of metres of the construction activities. Crustaceans have been shown to experience short- to medium-term stress or tissue repair effects in response to exposure to ship noise but may become adapted to such noise (Hudson *et al.* 2022, Wale, Simpson & Radford 2013). European lobsters (*Homarus gammarus*) were found to significantly increase their call rates in the presence of shipping noise of around 118.4 ± 7.7 SPL_{RMS} dB re 1 µPa, suggesting the need to vocally compensate for the reduction in intraspecific communication ability due to noise (Jézéquel *et al.* 2021). This is within the range of noise already experienced in Richards Bay (Table 31) but suggests that crustaceans near to the construction activities may experience noise interference with ecologically important sounds.

- Rock breaking

It is possible that some of the hard rock substrate under the route of the pipeline at the Powerships will be cleared, to avoid the risk associated with the pipeline "riding" on a rock outcrop. There have been no specifications of equipment that will be used for clearing rock, but a mechanical breaker would be expected. The site where rock may be broken is in shallow water north of the Powerships and north of the FSRU.

The shallowness of the water in which the rock breaking will occur is beneficial in reducing underwater noise levels, as noise attenuates more readily in shallow water. The predictions of noise produced by rock breaking were based on noise measured from rock breaking using 4.2 tonne, 10.4 kJ hydraulic hammer, which had a calculated source noise level of 175.1 dB SPL_{RMS} at 1 m.

The duration for which a rock breaking hammer will be used in a day is unknown but is not anticipated to be prolonged as there is a relatively small area of rock to be cleared, and the equipment is intermittent by nature. However, 6 hours a day was applied to the noise predictions as a precaution.

The ranges at which marine mammals would experience the onset of TTS due to continuous exposure of 6 hours to rock breaking noise are set out in Table 34. The most sensitive group of marine mammals, VHF cetaceans, would need to be stationary within 950 m of the noise source for the entire 6 hours in order to experience the onset of TTS. This group of species is not found in South Africa, and all other species would need to be much closer in order to experience the onset of TTS.

Table 34. TTS ranges to Southall *et al.* (2019) SELcum criteria for rock breaking operations

Threshold	Criteria SEL_{cum} (weighted)	Rock breaking (6 hours)	
		Stationary animal	Moving animal (1.5 m/s)
LF Cetaceans TTS	179 dB re 1 µPa²s	360 m	<50 m
HF Cetaceans TTS	178 dB re 1 µPa²s	80 m	<50 m
VHF Cetaceans TTS	153 dB re 1 µPa²s	950 m	<50 m
PCW Pinnipeds TTS	181 dB re 1 µPa²s	220 m	<50 m
OCW Mammals TTS	199 dB re 1 µPa²s	<50 m	<50 m

Fish would need to remain within less than 50 m of rock breaking for an extended period in order to experience the onset of TTS (Table 32).

Based on the qualitative criteria provided by Popper *et al.* (2014), fish and fish larvae and eggs will experience moderate to high levels of masking and behavioural impacts within hundreds of metres of the rock breaking Table 32. The extent to which this will impact their ecological functioning is uncertain.

TTS thresholds are not available for estuarine/marine invertebrates or diving seabirds. However, as discussed above, invertebrates such as crustaceans within hundreds of metres of the construction may have reactions to the noise that include changes in their ecological functioning, increased stress levels and the need to acoustically compensate for the masking of intraspecific communication. Impacts on diving seabirds are likely to be similar as for marine mammals.

Impact Assessment

The noise produced by construction of the Gas to Power project is not anticipated to contribute meaningfully to the existing noise levels in the Richards Bay estuary. Furthermore, the construction noise is not anticipated to produce noise to the extent that it will cause direct harm to marine organisms, based on current understanding and available research. Marine mammals and fish would need to be very close, in the order of tens of metres, for the duration of the construction activities within a day, in order to experience the onset of a temporary reduction in hearing ability (TTS), and this is considered to be unlikely to occur.

However, it is possible that estuarine/marine organisms within hundreds of metres of the construction site will experience noise levels that interfere with ecologically relevant sounds, or which cause behavioural changes, which could have negative impacts over time. There is limited research available on the sensitivity of invertebrates to construction noise. Considering these factors, the severity of the noise produced by the construction activities is considered to be "Site-specific and wider natural processes and functions are slightly altered". Noise produced by the construction will increase the ambient underwater noise levels within hundreds of metres of the source, so it will impact a greater area than the immediate site. It is unclear as to how frequently the noise-producing construction activities will take place, but over the course of the duration it is assumed that they will occur once or more in a week. The likelihood of the marine ecology experiencing an impact from the construction noise is considered as being possible. Accordingly, the assigned overall environmental significance rating is "Medium-Low" without mitigation and with mitigation remains at "Medium-Low". As there is limited research into the impacts of continuous low-level noise on marine organisms, the confidence of this assessment is Medium.

Table 35. Impact ratings for disturbance to surrounding estuarine ecology due to increased noise levels from construction

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 &2	1	2	2	**1.7**	2	4	**3.0**	**5.1 Medium-low**
Mitigation measures: • See below.								
Alternative layout 1 &2	1	2	2	**1.7**	2	4	**3.0**	**5.1 Medium-low**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

Mitigation measures:

In order to ensure that the noise levels produced by construction are not higher than predicted in this report, the equipment used should be similar or less powerful than the equipment used as a model by Subacoustech Environmental (2022). No unnecessary production of noise should take place, to minimise the exposure of the estuarine/marine biota to noise and help to avoid disturbances and potential harm to estuarine/marine organisms. If a marine mammal is observed in the near vicinity of the construction activity, construction should be halted until the marine mammal is outside the range of hundreds of metres from the noise source, as a precaution. These measures will reduce the probability of the estuarine/marine biota being impacted by construction noise but does not reduce it enough to change the score.

A noise impacts monitoring programme should be implemented to validate the predictions made of the impacts of the noise produced by the construction operations on the marine ecology. Monitoring of the ecology in the immediate vicinity of the project should be undertaken following a before-after-control-impact (BACI) approach. This should include monitoring of the local macrofauna, and video surveys and fish sampling to understand the fish community in the area of the port where the powerships will be moored, as well as use of the project area by marine mammals. Monitoring of the distribution and behaviour of diving seabirds in the vicinity of the powerships should also be undertaken.

These surveys should be ongoing and following a sampling methodology that is robust when assessing the impacts of the noise produced by construction on the distributions of benthic macrofauna, fish, seabirds, and marine mammals. The results of such monitoring will be valuable in informing other developments and contributing to the international understanding of the effects of noise from construction activities on marine biota.

8.3.4. Impact 4: Effect on ecosystem services (fisheries and mariculture) due to increased noise levels from construction

The mooring of the Powerships and FSRU will involve the construction of infrastructure and will include noise-producing activities such as vibro-piling, drilling, and rock clearance. The noise levels produced by these activities are outlined in Section 8.3.3. Fish would need to stay within 50 m of these noise sources for 12 hours, continuously, to experience the onset of TTS, in which a temporary reduction in hearing sensitivity can be expected. Therefore, it is unlikely that any fish will experience harm from the noise from the construction activities, so impacts on fisheries from this source are considered to be unlikely.

However, fish and fish eggs and larvae will experience moderate to high levels of masking and behavioural effects within hundreds of metres of the construction noise sources, which could have negative consequences. Within the context of the entire Port of Richards Bay though, these impacts will be relatively localised and are considered unlikely to have fisheries-level effects.

Although we do not have TTS thresholds for invertebrates such as crustaceans, there is evidence that they are also sensitive to noise (Hudson *et al.* 2022, Jézéquel *et al.* 2021, Solan *et al.* 2016). However, they are considered to have a higher threshold than the one held for fish with a swim bladder involved in hearing, referred to above, and so are considered unlikely to experience direct harm from the noise from the construction activities. There is a relatively low density of benthic macrofauna in the region of the proposed powerships and FSRU, and the community is mainly dominated by polychaete worms. Considering these factors, it is unlikely that the inshore prawn fishery will be negatively impacted by the noise from construction.

Currently, there is no active aquaculture in Richards Bay, but an Aquaculture Development Zone (ADZ) has been proposed and is being investigated (DFFE 2020). As a result, the location of the proposed ADZ is unknown. Considering the spatial extent of the impacts of construction noise, the ADZ would need to be within hundreds of metres of the Powerships for there to be any potential impact. As there is limited space around the proposed Gas to Power project location, the likelihood of this occurring is considered to be low.

Impact Assessment

Due to the lack of research into the effects of construction noise on fish, and the uncertainty around the extent to which fisheries will be affected by the construction of the Gas to Power project, the severity of the impacts is considered "Site-specific and wider natural processes and functions are slightly altered". The duration of these impacts will be as long as the planned construction of these components of the project, which is up to 1 year. The noise produced by construction will raise the ambient underwater noise levels within hundreds of metres of the vessel. It is unclear as to how frequently the noise-producing construction activities will take place, but over the course of the duration it is assumed that they will occur once or more in a week. The likelihood of this noise having an impact on ecosystem services is considered to be possible. The scoring results in a “Medium - Low” Overall Environmental Significance, which will remain Medium-Low even with mitigation. The research gaps in the understanding of the effects of noise on the local fisheries means that the assessment is given a Medium confidence.

Table 36. Impact ratings for Disturbance to ecosystem services (fisheries and mariculture) due to increased noise levels from construction

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 &2	1	2	2	**1.7**	2	4	**3.0**	**5.1 Medium-low**
Mitigation measures: • See mitigation measures for the effects of construction are provided in 8.3.1 and 8.3.3. These are mitigation measures for the estuarine/marine ecology that underpin the ecosystem services.								
Alternative layout 1 &2	1	2	2	**1.7**	2	4	**3.0**	**5.1 Medium-low**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

8.3.5. Impact 5: Effect on terrestrial fauna (including avifauna) as a result of construction activities

While the proposed project is located within an industrial and commercial port where noise pollution is already prevalent, additional noise and vibrations will be generated through the presence of heavy machinery, vehicles and generators both on the shoreline and in the more terrestrial habitats in respect of the transmission routes.

Despite the degraded state of the landscape and frequent disturbances associated with the port, such as shipping and vehicular traffic, and harbour operations, the area between the port and the Manzamnyama Canal is still provides some (albeit modified) habitat value. The project footprint is relatively small, involving the loss of a small amount of open water habitat, as well as clearing of terrestrial bush to construct the powerlines and access roads. This will have a negligible impact on the availability of habitat for estuarine waterbirds. Furthermore, some of the species inhabiting the port habitats are not likely to be significantly impacted by noise, light, dust, vehicular traffic as they would be somewhat tolerant of such disturbances or are expected to temporarily evade the unfavourable conditions.

Several bird species recorded are dependent on mud and sandflats for foraging, such as Whimbrel, Grey plover, Common sandpiper), as well as for roosting, such as Swift tern and Caspian tern. The sandspit and adjacent Kabeljous Flats are collectively an important roosting and feeding habitat for such waterbirds recorded in the Bay (Anchor Environmental and TBC, 2022). These area borders on the active shipping channel entering the 600 Berth Basin, and some of the birds recorded are likely to be tolerant of harbour disturbances, and some have been observed utilising port infrastructure (*e.g.* roosting on buoys, nesting on high light structures) (Anchor Environmental and TBC, 2022). However, the temporarily increased local noise levels, lights, vibrations, increased vessel activity on the water, and anthropogenic presence in general, during the construction phase will likely disturb and temporarily displace feeding or roosting birds utilising the sandspit and intertidal flats and other port surrounds, including Species of Conservation Concern (e.g. Caspian tern) (Anchor Environmental and TBC, 2022). Impacts would potentially be higher during summer when migratory species typically visit the system. The abandonment of nests (e.g. African Fish Eagle nest, pers. obs.) within or adjacent to the project footprint due to disturbance is of particular concern, as any chicks will consequently be lost.

With regards to the Alternative route 2 for the transmission lines, this route cuts through highly sensitive mangrove habitat, and will cause significant local disturbance and mortality of fauna utilising this critical and unique habitat, extending from intertidal and supratidal aquatic communities to roosting or nesting birds, reptiles (*e.g.*, snakes), and mammals (*e.g.,* monkeys etc.). This option is not supported and therefore the impacts thereof are not rated.

Integrating the findings of the Terrestrial Ecology Specialist Report (de Wet, 2022), fauna Species of Conservation Concern may potentially be lost, however the majority of wildlife are expected to evade the disturbance and/or area of construction. A qualified ecological expert must be present during construction to relocate any slow-moving (such as chameleons or tortoises) or burrowing (moles, lizards and snakes) species should they occur (de Wet, 2022) .In respect to the avifauna, nesting sites and possibly SCC themselves may be lost (Anchor Environmental and TBC, 2022).

Overall, the significance of impacts related to the construction of the ship components on avifauna are rated as being medium-low post-mitigation, and for the transmission lines, medium-low to very low significance (Anchor Environmental and TBC, 2022). For terrestrial fauna, the impact significance rating post-mitigation is low (de Wet, 2022).

Impacts on the terrestrial fauna and avifauna are assessed in greater detail in the Terrestrial Ecology (de Wet, 2022) and Avifaunal Specialist Reports (Anchor Environmental and TBC, 2022), respectively. All mitigations measures in these reports must be adopted. The impact tables (Table 37, Table 38 and Table 39) are included here for ease of reference.

Table 37. Summary of potential impacts on avifauna associated with the construction phase of the Karpowership project – ships (adapted from Anchor Environmental and TBC, 2022)

Impact		Pre mitigation	Post mitigation
		Significance	**Significance**
Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)		**Medium-Low**	**Medium-Low**
Powership: human disturbance		**Medium**	**Medium-Low**
Reversibility	The impact is reversible		
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that nests of avifauna SCC are avoided.		
Fatal flaw	No, this impact does not result in a fatal flaw		

Table 38. Summary of potential impacts on avifauna associated with the construction phase of the Karpowership project – transmission lines and ancillary infrastructure (adapted from Anchor Environmental and TBC, 2022)

Impact		Pre mitigation	Post mitigation
		Significance	**Significance**
Habitat Loss (Destroy, fragment and degrade CBA, ESA and ONA habitat, ultimately displacing avifauna)		**Medium-Low**	**Very Low**
Infrastructure: human disturbance		**Medium**	**Medium-Low**
Reversibility	The impact is reversible		
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that nests of avifauna SCC are avoided.		
Fatal flaw	No, this impact does not result in a fatal flaw		

* ESA = ecological support areas; ONA = other natural areas

Table 39. Summary of potential impact of loss of fauna Species of Conservation Concern during construction (taken from De Wet, 2022)

Impact		Without Mitigation	With mitigation
Construction phase			
Issue 2: Loss of Species of Special Concern and Biodiversity			
5: Loss of fauna SCC		**Medium**	**Low**
Reversibility	The impact is reversible		
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that faunal SCC are relocated to alternative habitat that is actively conserved (*e.g.* Richards Bay Nature Reserve), and that nests of avifauna SCC are avoided.		
Fatal flaw	No, this impact does not result in a fatal flaw		

Measures (adapted):

- Select alternative transmission route 1.
- Do not place transmission lines or access routes for their construction in functional natural habitat, Intact indigenous vegetation must be avoided.
- Do not clear natural vegetation in the process of construction of project infrastructure. No linear 3m footprints should be cleared of vegetation in these areas but individual drilled foundations used.
- Construction measures must consist of the least impactful individual erection of monopole structures.
- No use of the surrounding vegetation will be allowed. This includes use as a toilet facility, for hunting, harvesting of indigenous plants, making fires etc.
- No animals (birds, reptiles, and mammals) are to be disturbed unnecessarily and no animals are allowed to be shot, trapped or caught/hunted for any reason.
- A qualified specialist should be on site during construction to safely remove all slow-moving (chameleons and tortoises) and burrowing (moles, lizards and snakes) species from the path of the excavator and relocated to a conservation area.
- Construction activities, specifically excavation and moving/transporting of large components, must be restricted to daylight hours to prevent potential disturbance to roosting bird populations
- Restrict vehicles to clearly demarcated access routes, construction areas and contractor areas only.
- Keep vehicle access to the shoreline to a minimum. Only allocated access points to the beach be used.
- The surrounding area must be surveyed prior to construction/laydown area establishment to determine the presence of nesting birds and sensitive fauna, and these must be cordoned off.
- Regarding the African Fish Eagle nest on site, construction activities should be initiated during winter, when the nest is not in use, and after which the breeding pair will hopefully relocate their next nest to a safer area.
- Beyond the headland of the 600 Berth Basin, movement of supporting vessels must be restricted to the main channels only.
- The sandspit and Kabeljous Flat must be designated no-go areas, *i.e.* these areas may not be utilised in any way to support or facilitate construction/mooring activities, storing of materials, etc.
- Laying of the gas pipeline and mooring legs of the FSRU must be undertaken during the winter months to reduce disturbance of birds utilising the sandspit.
- Construction vehicles, plant and machinery must be well maintained and fitted with silencers.
- Regular maintenance on vehicle and equipment must be undertaken.

8.3.6. Impact 6: Effect on macrophyte habitats as a result of construction within the estuarine functional zone

The primary components of the project will be positioned along the active port channel and dead-end basin of the 600 Berth Basin. The immediate surrounding landscape has been radically transformed, and some areas irreversibly, as a result of historical port development and associated activities, accumulation of floating harbour waste, dumping of dredge spoil, dumping of building materials etc., and which is also evident in the disturbed wetland (reedbed) / mixed grassland/shrubland communities and composition of the soils (de Wet, 2022).

The stringing yard for assembly of the gas pipeline and the first land-based connection, that is the terminal tower, will be located in, and traverse, the disturbed / modified wetland (reedbeds)/mixed grassland/shrubland, which is characteristic of much the vegetation along the harbour arterial road (except for the distinct mangrove and saltmarsh areas). The location of the terminal tower for the alternative layout 1 and alternative layout 2 options for the powerships is presumably the same, *i.e.* within the disturbed vegetated area of the mainland promontory. The vegetation of the laydown area adjacent to the 600 Berth basin is highly disturbed, on a continuous basis, with limited species diversity.

The site office complex and stringing yard are in relatively close proximity to the shallow intertidal area at the head of the dead end-basin, where *Zostera* beds were reported to occur but this area as well as the assembly basin will not be infringed upon. Access to the laydown area/stringing yard will be via the arterial road, however, an access route will be required for the construction of the towers between the port and the Manzamnyama Canal. Given the degraded state of the vegetation and landscape modification, the loss of functional estuarine habitat is likely to be insignificant. It is important to note however, that swamp forest species, namely *Hibiscus tiliaceus* and few individual mangroves (*A. marina*) line the assembly basin and the eastern/southern shoreline of the dead-end basin. As protected species and threatened ecosystem type, these must be avoided. Permits will be required for removal/destruction of individual trees.

In comparison however, the alternate route will traverse historical, well-established dense mangrove habitat. While the footprint of each tower/pylon may be relatively small, construction within the mangroves will result in destruction and disturbance of critical estuarine habitat and protected mangrove forest species in terms of the National Forest Act (Act No. 84 of 1998) (*e.g.,* Black Mangrove, *Bruguiera gymnorrhiza*), in an area far greater than development footprint in order to gain access to the construction points. For the stringing yard area and preferred transmission line route, the potential impact is likely to be reversible for the most part provided areas beneath the overhead lines are rehabilitated with indigenous vegetation, and no irreplaceable resources are expected to be lost. In contrast, individuals of protected mangrove species will definitely be lost along the alternate transmission line route (Anchor Environmental and TBC, 2022; de Wet, 2022)

Integrating the findings of the Terrestrial Ecology Specialist Report (de Wet, 2022) (Table 40) areas of modified estuarine habitat as well as reed beds will be lost. This vegetation is invaded with *S. terebinthifolius* and other invasive alien plants but still serves as wetland habitat, with corresponding ecosystem services and habitat provisions. However, rehabilitation with indigenous vegetation will facilitate the restoration of biodiversity and ecosystem services to an improved post-construction (de Wet, 2022). Furthermore, the potential loss of protected plant species as a result of construction of the transmission line, laydown area and the switching station was identified. However, no species of conservation concern will be lost (along the preferred transmission line route) as none were recorded from the site (de Wet, 2022). De Wet also considers impacts on overall terrestrial biodiversity, and ecosystems function and services in terms of habitat fragmentation and invasive alien plant infestations. There will be inevitable disturbance and/or loss of the biodiversity within the areas of construction, namely, the transmission line route, the site office complex, stringing yard, laydown area and switching station. However, given the largely modified state of the existing natural environment, the magnitude of loss is likely to be small (de Wet, 2022). The terrestrial habitats within the boundaries of the port are prone to fragmentation, and this is detrimental given that the broader area is designated a critical biodiversity area. Habitat fragmentation reduces migration and dispersal between habitats and results in a reduction of biodiversity. This is somewhat ameliorated by the dense growth of invasive alien vegetation and ruderal indigenous vegetation within the site (de Wet, 2022). Invasive alien plants are present within the site, and construction activities will result in habitat disturbance and dispersal of the existing seed banks, resulting in further proliferation and concomitant risk to indigenous plant species. As this is a persistent impact, effective ongoing management will be required during both the construction and operational phases of the project (de Wet, 2022). All of the impacts identified in the Terrestrial Ecology Specialist Report can be mitigated to low overall environmental significance (Table 40).

Table 40. Summary of impacts associated with the construction of the Karpowership transmission line, and ancillary infrastructure on the terrestrial ecology of Richards Bay estuary (taken from De Wet, 2022)

Impact		Without Mitigation	With mitigation
Construction phase			
Issue 1: Loss of vegetation communities			
1: Loss of modified habitat		Medium-Low	Low
2: Loss of reed beds		Medium	Low
3: Loss of bushveld		Medium-Low	Low
Issue 2: Loss of Species of Special Concern and Biodiversity*			
4: Loss of flora SCC		Medium	Low
6: Loss of biodiversity in general		Medium-Low	Low
Issue 3: Ecosystem function and process			
7: Fragmentation		Medium-Low	Low
8: Invasion of alien species		High	Low
Reversibility	The impact is reversible		
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that floral and faunal SCC are relocated to alternative habitat that is actively conserved (*e.g.* Richards Bay Nature Reserve), and that nests of avifauna SCC are avoided.		
Fatal flaw	No, this impact does not result in a fatal flaw		

*Impact 5 is rated in Section 8.3.5

A specialist Wetland Delineation and Functional Assessment was undertaken for the proposed transmission line routes (Triplo4, 2022a). A total of twenty-six (26) watercourses were identified within the 500m assessment radius, covering eight different categories, including an artificial dam, the estuary/port waters, channelled valley bottom wetlands, depression wetlands, floodplain wetlands, unchannelled valley bottom wetlands, hillslope seepage wetlands and river riparian systems. Only seven of the identified 26 watercourses would be impacted by the proposed development. These systems have undergone moderate to moderately high disturbance from historic and current land use practices. Four of these were in C health category (*i.e.* moderately modified), and three in D health category (*i.e.* largely modified). In terms of ecosystem services, these systems were considered of high importance in terms of assimilation of toxicant and nitrate removal, phosphate and sediment trapping, erosion control and flood attenuation. All but two of these systems were considered to have high ecological importance and sensitivity because they fall with a CBA Irreplaceable and Fresh Water Priority Area (by virtue of the Richards Bay estuary being a national priority system (Triplo4, 2022a). Understandably, the majority of the impacts would manifest during the construction phase as these systems would be affected or modified by construction activities, however, the majority of the impacts (all phases) can be reduced to overall low environmental significance, some requiring additional, stringent mitigation measures (Table 41).

Table 41. Summary of potential impacts (post-mitigation) of the proposed development on the surrounding watercourses/wetlands within the Richards Bay estuary. Pre-C = Pre-construction Phase, C = Construction Phase, O = Operational Phase, R = Rehabilitation Phase). Adapted from the Wetlands Specialist Report DWS Risk Assessment Matrix (Triplo4, 2022b).

Nr.	Activity	Phases	Aspect	Risk Rating	Borderline LOW MODERATE Rating Classes
1	**Establishment of a construction site camps and erection of ablution facilities within a previously disturbed area.**	Pre-C	Increase in surface-area of hardened surfaces	Low	Negligible
		Pre-C	Clearing and grubbing	Low	Negligible
		Pre-C & C	Potential application of herbicide to clear land	Low	Negligible
2	**Establishment of a construction site camps for the material laydown area, site office and concrete coating area and stringing yard.**	Pre-C	Increase in surface-area of hardened surfaces	Moderate	Low
		Pre-C	Clearing and grubbing	Moderate	Low
		Pre-C	Access roads and stringing yards	Moderate	Low
3	**Demarcation of buffer zones and no-go areas and the allocation/preparation of spoil sites (topsoil separate from subsoil), waste dump sites and construction vehicle routes**	Pre-C & C	Erection of silt fencing around all waste dumps and downslope of watercourses (including coverage sails).	Low	Negligible
		Pre-C & C	The dumping of waste and spoil at the designated sites using haulage routes	Low	Negligible
		Pre-C & C	Input of dropper, or wooden poles to extend danger tape on, or paint poles	Low	Negligible
4	**Construction vehicle movement throughout the lifespan of the proposed development.**	Pre-C & C	Movement of construction vehicles over loose soil particles.	Low	Negligible
		Pre-C & C	Different soil structures baring excess weight of the large construction vehicles.	Low	Negligible
		Pre-C & C	Accidental spills (*e.g.* hydrocarbons, chemicals, oil).	Low	Negligible
		Pre-C & C	Movement of vehicles and large construction vehicles on watercourses	Moderate	Low
5	**Direct destruction of vegetation and topsoil layer within the footprint**	Pre-C & C	Loss of biodiversity within the site and disruption and/or destruction of faunal habitats.	Moderate	Low

	of the Overhead Powerlines and temporary material laydown area, site office and concrete coating area and stringing yard.	Pre-C & C	Reduction of groundcover and increased surface-area of exposed bare-ground and impermeable-surfaces.	Moderate	Low
		Pre-C & C	Reducing the soil cohesion created by the plant roots.	Moderate	Low
6	**Construction of the 132kV Overhead Lattice Steel Structure and Switching Station**	Pre C & C	Setup a concrete batch plant onsite (if contractor does not utilise a commercial ready mix concrete supplier)	Low	Negligible
		C	Piling and creation of footings (depending on soil baring capacity) (Preferred Route)	Moderate	Low
		C	Piling and creation of footings (depending on soil baring capacity) (Alternative Route)	Moderate	Moderate
		C	Excavation and trenching for concrete bases (Preferred Alternative)	Moderate	Low
		C	Excavation and trenching for concrete bases (Alterative Route)	Moderate	Moderate
		C	Construction of steel sections and plates (Preferred Route)	Moderate	Low
		C	Construction of steel sections and plates (Alternative Route)	Moderate	Moderate
		C	Construction of circuits required for overhead powerlines (Preferred Route)	Moderate	Low
		C	Construction of circuits required for overhead powerlines (Alternative Route)	Moderate	Moderate
		C	Hardened surfaces in the catchment for switching station and associated infrastructure	Moderate	Low
7	**Construction and installation of the gas pipeline**	C	Pipeline assembly and welding in stringing yard	Moderate	Low
		C	Pipeline installation	Moderate	Low
8	**De-establishment of the site camp, spoil sites, waste dumps and the rehabilitation of the temporary access/haulage roads.**	R	Tillage of areas of bare-soil and revegetation using a mixture of indigenous species typical of the area	Low	Negligible
		R	Reshape local topography to natural slope if necessary.	Low	Negligible
9	**Utilisation of the Overhead Powerlines and Switching Station**	O	Increased risk of pollution and change in watercourse characteristics (Preferred Route)	Moderate	Low
		O	Increased risk of pollution and change in watercourse characteristics (Alternative Route)	Moderate	Moderate
		O	Increased risk of vehicles creating unauthorised tracks during repairs (Preferred Route)	Moderate	Low
		O	Increased risk of vehicles creating unauthorised tracks during repairs (Alternative Route)	Moderate	Moderate

8.3.7. Impact 7: Effect of solid waste pollution generated during construction period

Solid waste will be generated by construction activities and may include concrete rubble and bricks, metal materials, material off-cuts and surplus, plastic waste and general litter. If not properly managed and contained, these materials may find their way into the port, sensitive littoral habitats or ultimately into the open marine environment. Floating or submerged solid waste (especially plastics) in the marine environment can be transported over vast distances through the ocean currents and therefore the area of impact could potentially be extensive. Debris in the port and ocean may have a lethal/sublethal impact on marine fauna, with potentially severe consequences for rare and endangered species (*e.g.* turtles and dolphins). Poor management of the laydown area, the stringing yard and its operations (*e.g.,* waste management facilities), and construction areas (*e.g.* towers) may also lead to contamination of the immediate surrounding environment.

Waste management, in terms of the handling, storage and disposal of general, construction and hazardous waste, must continue for the duration of the construction phase. The possibility of impacts occurring is high if waste is not properly managed, and the intensity of these impacts may be severe and expensive or time consuming to mitigate.

Table 42. Impact ratings for solid waste pollution generated during construction period

<table>
<tr><th></th><th>Duration</th><th>Extent</th><th>Severity</th><th>Consequence</th><th>Probability</th><th>Frequency</th><th>Likelihood</th><th>Significance</th></tr>
<tr><td>General construction</td><td>2</td><td>3</td><td>2</td><td>2.3</td><td>3</td><td>3</td><td>3.0</td><td>6.9
Medium-low</td></tr>
<tr><td colspan="9"><u>Mitigation measures:</u>
• Management of all site activities and site camp/laydown area must be undertaken in accordance with a site specific EMPr.
• Strict adherence to TNPA pollution, emergency, and health and safety protocols, MARPOL and other applicable maritime legislation and policies
• Construction workers and operational staff to adopt best practice waste minimisation procedures.
• Implement the correct handling and disposal procedures for general and hazardous waste.
• Reduce the amount of waste generated from the construction phase by means of efficient operations and recycling of general waste.
• Good housekeeping to be done daily of the intertidal area and surrounding port waters.
• No mixing of concrete in the intertidal zone.
• No dumping of construction materials or excess concrete in the intertidal and subtidal zones.
• Wind screening (e.g., fine mesh shade cloth fencing, or solid fencing) must be installed to prevent excessive wind-blown sand and light-weight solid waste (e.g., litter) entering the estuary; and
• Conduct a comprehensive environmental awareness programme amongst contracted construction personnel about sensitive estuarine/marine habitats and good house-keeping.</td></tr>
<tr><td>General construction</td><td>2</td><td>2</td><td>1</td><td>1.7</td><td>2</td><td>2</td><td>2.0</td><td>3.4
Low</td></tr>
<tr><td colspan="3">Reversibility</td><td colspan="6">The impact is reversible</td></tr>
<tr><td colspan="3">Irreplaceability of Resources</td><td colspan="6">No, the impact does not cause a loss of resources that cannot be replaced provided that correct and appropriate pollution responses are implemented, and rehabilitation is undertaken where necessary.</td></tr>
<tr><td colspan="3">Fatal flaw</td><td colspan="6">No, this impact does not result in a fatal flaw</td></tr>
</table>

8.3.8. Impact 8: Effect of chemical pollution arising from construction related spills of hazardous substances

During the construction period, there is the potential for accidental spills of hydrocarbons, oils from construction vehicles, plant, other equipment and the working barge, and other harmful substances and chemicals used (*e.g.,* concrete). This may enter the water column directly during construction activities or be transported as contaminated runoff into the port from land-based activities as a result of incorrect handling and improper spill management. Once in the harbour channel, contaminants may be transported into other sensitive areas of the harbour or out to sea during strong winds coinciding with spring high tides. This will affect sediment and water quality with toxic and potentially lethal/sun-lethal effects on the flora and fauna of Richards Bay in the immediate vicinity of the activity, namely, the adjacent sandspit and Kabeljous Flats, and other areas depending on weather conditions and dilution. Accidental spills, regardless of volume or concentration, could lead to significant environmental damage.

Table 43. Impact ratings for chemical pollution arising from construction related spills of hazardous substances

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
General construction	2	3	4	**3.0**	3	3	**3.0**	**9.0 Medium-high**

<u>Mitigation measures:</u>

- The establishment and operation of the site office complex, laydown area and stringing yard must follow a stringent Environmental Management Programme, monitored by an ECO.
- Sufficient ablution facilities must be provided for construction personnel and sited away from high-risk areas. These must be frequently cleared (preferably every two weeks depending on the number of staff).
- The laydown area must be adequately protected against adverse weather conditions, particularly the chemical storage areas, to prevent erosion and run-off of contaminants into the port.
- Strict adherence to TNPA pollution, emergency, and health and safety protocols, MARPOL and other applicable maritime legislation and policies.
- A Spill Prevention and Management Plan must be compiled and implemented. In the event of any significant spill the TNPA must be notified.
- A method statement in respect to the use, handling, storage and disposal of all chemicals as well as anticipated generated waste, must be compiled and submitted as part of any Environmental Management Programme.
- Correct handling, storage and disposal procedures must be followed (*e.g.,* bunded storage areas to contain 110% of volume).
- Maintain vehicles and equipment - no leaking vehicles or equipment to be permitted on site. All vehicles and machinery must be parked or stored on an impervious surface.
- A comprehensive environmental awareness programme must be conducted amongst contracted construction personnel about sensitive estuarine and marine habitats and the need for careful handling and management of chemical substances.
- In the event of a spill, a penalty must be issued and the 'Polluter Pays' principle must be applied for clean-up operations and rehabilitation, if necessary.

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
General construction	2	3	4	**3.0**	2	2	**2.0**	**6.0 Medium -low**

Reversibility	The impact is reversible
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that correct and appropriate pollution responses are implemented, and rehabilitation is undertaken where necessary.
Fatal flaw	No, this impact does not result in a fatal flaw

8.4. Operational Phase

8.4.1. Impact 9: Effect on surrounding estuarine/marine ecology due to seawater intake for cooling purposes

Seawater abstracted by the powerships will entrain some small to medium bodied planktonic/pelagic organisms (*e.g.*, phytoplankton, larval stages of invertebrates and fish, juveniles and adults), including reproductive material (eggs) from the surrounding water body into the condenser cooling systems. These fauna constitute food resources for higher trophic levels and also "stocking material" for the disturbed areas of the port. Also, areas subject to propeller wash from passing vessels may experience agitation of the bottom sediments and in these instances, soft sediment invertebrates, including juveniles and adults, may be placed into suspension and may also be abstracted. This will be coupled with the impingement or trapping of larger organisms against the screens used to prevent debris from being drawn into the cooling water intake. As entrained organisms pass through the pumps, they are exposed to collective hydrostatic pressure, shear forces, accelerative forces from changes in velocity and direction, and mechanical buffeting and collision against the pump mechanisms' hard surfaces. These can cause physical damage to estuarine/marine organisms, especially larger and more fragile species, resulting in death or incapacitation, the latter reducing their ability to escape predators post-discharge. Furthermore, the abstracted seawater receives excess heat and increases in temperature through the cooling process, inducing thermal stress on entrained organisms. Temperatures of the cooling water can be expected to increase by a maximum of 15°C (ΔT) whilst in the system. Rapid temperature increases above ambient conditions can affect marine organisms' survival, growth, metabolism, morphology, reproduction, and behaviour. No chemical stress on organisms is predicted as no biocides, chemicals, or brine will be discharged.

Relatively high phytoplankton biomass (exceeding 20 µg/L) has been measured in the vicinity of the proposed Gas to Power project, indicating the potential for phytoplankton blooms to occur within the port. The density of zooplankton in the port has decreased since its construction (Jerling 2008). Several studies have recorded the occurrence of ichthyoplankton of both marine and estuarine fish species in the port (Harris and Cyrus 1996; Jerling 2008), mainly in undeveloped shallower sections which serve as nursery grounds for many species (MER 2013).

There is a lack of project-specific literature on intake and entrainment, *i.e.*, plankton mortality data. However, phytoplankton biomass recovers quickly due to short generation times (~0.3/day) and populations are also quickly replenished via tidal mixing processes from the wider port water body. Additionally, it is reported by Poornima *et al.* 2005, amongst others, that the mortality rate from thermal and mechanical stress of phyto- and zooplankton entrained is not 100%. Thus, survivors are returned to the receiving environment. Carcasses are also returned where they may be consumed or decomposed so the biological material is not lost to the system. Accordingly, and considering that there is low zooplankton biomass in the 600 Berth Basin and ichthyoplankton mainly occurs in undeveloped areas of the port, *i.e.*, not the 600 Berth Basin, it is anticipated that the volumes of plankton entrained will not affect broader ecosystem functioning of the estuary.

The seawater abstraction process also affects other generally larger marine organisms such as juvenile fish through impingement on the intake pipes' screens. Notable organisms that may be impinged in the port of Richards Bay include juvenile fish and several shark species. Given that important loggerhead and leatherback nesting sites occur along the sandy beaches north of the Port of Richards Bay, individuals may therefore occur in the port on occasion. These groups of organisms are generally highly mobile and will be expected to avoid the overall disturbance. Key habitat areas for macrocrustaceans, specifically prawns, are located on the Kabeljous Flats and within the Bhizolo-Manzamnyama Canal complex. Macrocrustacean populations are thus not likely to be affected by seawater abstraction.

Although the cooling water intake velocities are large (2.4 to 11.4 m^3/s), in comparison to the approximate total volume of water in the berth basin (>10million m^3; site-specific area multiplied average depth), volume intake per time by the powerships is low. Research shows that the ecological value of habitats differs, such that the harbour (marine embayment) and deep-water sediments, and intertidal beaches were rated the three least important of 12 habitat types within the harbour boundaries (CRUZ, 2009). Further, the 600 Berth Basin is characterised by low phytoplankton biomass and slightly disturbed benthic community (CSIR, 2020). Overall, the impact on sensitive habitats, species, or important food resources will be minimal. Larger organisms will likely swim away from intake pipes so that entrainment will have a negligible impact. The significance of the disturbance and/or mortality of estuarine/marine life due to the intake of seawater through abstraction pipelines is assessed below.

Impact Assessment

The spatial scale of this impact will be site-specific with minor intensity as natural functions are hardly altered. The duration of the effect will be up to 20 years as the intake of cooling water and the consequent entrainment and impingement of organisms will last for the project's duration. The ecological effect, however, will be temporary as plankton biomass recovers quickly due to short generation times. However, the likelihood of impact occurring is probable, and this will be taking place on an hourly basis. Accordingly, the assigned overall environmental significance rating is Medium-low.

Table 44. Impact ratings for the intake of cooling water on marine organisms in the surrounding water body

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 & 2	3	1	2	**2.0**	3	5	**4.0**	**8.0 Medium**
Mitigation measures: • See below								
Alternative layout 1 & 2	3	1	1	**1.7**	2	5	**3.5**	**6.0 Medium-low**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that correct and appropriate pollution responses are implemented, and rehabilitation is undertaken where necessary.							
Fatal flaw	No, this impact does not result in a fatal flaw							

Mitigation measures:

The intake of cooling water is an unavoidable impact of the operation of Powerships. However, intake velocities can be reduced through the use of footer values — these increase the area of intake, resulting in a decrease in intake velocity to safe levels. The following mitigation measures are proposed:

- Intake velocities must be kept as close to 0.15 m/s to ensure that fish and other mobile organisms can escape the intake current. Intake velocities can be reduced through the use of footer values;
- Intake structures must not draw in water from the upper meter of the water column; and
- Intake structures must ensure the horizontal intake of water.

8.4.2. Impact 10: Effects of powership cooling water discharge on estuarine/marine ecology

It is proposed that two Powership vessels will be moored on the western side of the port in the Berth 600 Basin, with the FSRU positioned 230 m from the sand spit for both alternative layout options (as detailed in Section 4),. The process of power generation from LNG requires the uptake or abstraction of seawater for the purposes of cooling via flow-through systems, and the subsequent discharge of heated water back into the port environment. The seawater is discharged through multiple outlets on the vessel hull, predominantly on the starboard side of the Khan powership. The outlets have diverting elbows and pipes running down the vessel hull to discharge below the water surface.

The discharge of cooling water to the surrounding water body generates chronic level effects on biota. These include alterations in growth, metabolism, respiration patterns and reproduction, and/or influence ecosystem-level processes such as alterations of the amount of oxygen dissolved in seawater, which can be detrimental to marine life (Robinson 2013, Anchor 2015). The sensitive receptors comprise the 'resident biota', including mangrove communities, seagrass beds, benthos on the sand and mudflats, fish larvae, and juvenile fish in the water column. Mudflats and sandflats support a high biological diversity level and are considered an important nursery ground for juvenile fish. Each year millions of larval and juvenile marine fish migrate into the Port of Richards Bay to use it as a sheltered, food-rich nursery area. The key recruitment period is between late winter and early summer, *i.e.*, August to November (Whitfield 1994, Wallace 1975). After some years of growing into adults, the marine fish swim back out to sea to spawn beyond the inshore region.

Sensitive receptors of concern regarding this impact are seagrass beds, plankton, fish larvae and juveniles (unable to swim away), and benthic crustaceans, since larger organisms, such as fish can swim out of the thermal plume.

The biota within the project area in the port experience water temperatures that are generally warm, ranging between 20.33°C and 20.52°C, in winter temperatures and between 25.25°C and 25.59°C in summer (CSIR, 2020). Conditions are detailed in the baseline Section 6.6.1.

Applicable Guidelines and Thresholds

- Water Quality Guidelines

Effluent discharges to receiving marine water bodies need to comply with South African regulations. These require that, in marine and estuarine settings, water quality deterioration resulting from effluent discharges should not compromise beneficial uses of the water body. Marine and estuarine effluent discharges are guided by water quality guidelines (WQG) set by the Department of Water Affairs (DWAF 1995).

DWAF (1995) states that for thermal discharges, temperature deviation from ambient conditions (due to the discharge of heating or cooling water) may not exceed 1°C in the marine environment, *i.e.*, $\Delta T \leq 1°C$. This guideline should be met at the edge of the initial mixing zone, which is the area that extends a short distance from the discharge point (or pipe end). In this zone, water quality guidelines can be exceeded as long as acutely toxic conditions are prevented. If guidelines are exceeded beyond the mixing zone boundary, the probable effects of such are to be evaluated in terms of predicted levels of tolerance and toxicity for the biological organisms that may be exposed to the offending effluent constituents (in this case, temperature). Therefore, exceedances of WQGs are purely a trigger for a further detailed examination of the toxicity risks to the receiving water body ecology.

- Initial Mixing Zone Dimensions

Allowed dimensions of initial mixing zones vary across jurisdictions and by sensitivity classification of the receiving water body. For example, the World Bank (1998) indicates 100 m in all directions from the discharge point (with $\Delta T = 3°C$). Local (Anchor 2015) advice is 100 m radius for enclosed water bodies and those classed as sensitive environments and 300 m radius in open coast settings where water depths exceed 10 m and the distance offshore is >500 m.

Sheltered, nearshore and shallow water environments such as estuaries are considered to have a smaller capacity to assimilate effluent than offshore, deep water, and well-flushed environments (Anchor 2015).

Richards Bay is classified as 'sheltered nearshore waters', and therefore a 100 m mixing zone is applicable (Anchor 2015).

- Biological Thresholds

In addition to the guideline values described above, actual biological tolerance limits to temperature change also need to be evaluated to assess impacts.

The degree to which community composition changes with thermal input depends on the initial ambient water temperature. According to DeNicola (1996, in Oliver and Fidler 2001), increases in temperature in environments near 25-30°C usually cause more significant changes in community structure than in environments <25°C; and community structure usually recovers rapidly (<1 year) when temperature stress is discontinued. If temperature changes are beyond the adaptive range of resident communities, sub-lethal effects may occur, such as metabolic inefficiencies, increased susceptibility to disease and toxic effects of pollutants changed behavioural patterns, intra- and inter-specific competition, predator-prey relationships, community composition and parasite-host relationships.

Based on several studies under the British Energy Estuarine and Marine Studies (BEEMS) framework and other literature (Heinle 1969), the upper limit of thermal tolerance for many plankton organisms is between 30 and 35°C. Bamber (1990) lists mean lethal temperatures ranging from 30-34°C for benthic crustacean families and goes on to state temperatures over 30°C (regardless of latitude) and particularly over 33°C represent problems for survival. Temperatures in the 35°C to 40°C range are where most continental shelf and littoral marine biota would die (Bamber 1990 and 1995; BEEMS 2001).

The optimal growth temperature for temperate seagrass species ranges between 11.5 and 26°C (Short *et al.* 2016). *Zostera* species, however, appear to have a wide thermal tolerance. In a study conducted by Rasmusson *et al.* (2020), reductions in photosynthetic performance of *Zostera marina* only occurred at temperatures greater than 35°C. *Zostera capensis* is a temperate and tropical seagrass species that occurs along the east and west coasts of Africa from southern Kenya to Angola. It is abundant in the southern part of its range from southern Mozambique to the west coast of South Africa (Bandeira 2014). Extensive *Z. capensis* beds occur in Maputo Bay, covering around 4 016 Ha (Bandeira 2002, 2014) where water temperatures can regularly exceed 30°C during summer (Hoguane 1999). Evidence thus suggests that *Z. capensis* occurring in subtropical areas such as the Port of Richards Bay is conditioned to withstand high water temperatures greater than 30°C, and likely will only show reduction in photosynthesis and growth at temperatures exceeding 35°C.

Modelling results

A three-dimensional (3D) hydrodynamic modelling study was undertaken by PRDW (2022) to predict the extent of the thermal plume generated by the Powerships at the Port of Richards Bay. This included environmental conditions such as currents and ambient water temperature for winter and summer.

The modelling study assumed some worst-case scenarios:

- It was assumed that the Powerships would be running with all engines and generators at 100% load, with the freshwater generators also in use. This uses an estimated total intake/outlet flow rate for both vessels (all generators combined) of 8.49 m3/s;
- The modelled ΔT values for the engines in the Khan class Powership were 13.0°C, which corresponded to the maximum of the measured range; and
- It was assumed that the Powerships would be operating for 24 hours a day, whereas they are planned to operate for only 16.5 hours a day. As a result, the actual thermal plume will be smaller than the modelled plume.

The study uses 'ecological thresholds' for thermal discharges defined by DWAF (1995) and the World Bank (1998). These are described below:

- ΔT = 3°C at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors, and assimilative capacity (World Bank, 1998); and
- ΔT = 1°C at sensitive receptors or the edge of the mixing zone, which for discharges beyond the surf zone can be assumed 300 m from the discharge point (DWAF, 1995).

Based on previous marine ecology assessments, a site-specific threshold of ΔT = 1°C at 100 m from the discharge point was recommended and was used to present the model results. The results at a distance of 300 m from the Powerships was also presented but is not applicable in Richards Bay.

The modelling results show that a smaller footprint of ΔT is achieved when discharging at a depth of 8 m below the water surface. Thus, this is the recommended discharge depth. Discharging at this greater depth allows the thermal plume to entrain colder sub-surface ambient water as it rises to the surface, reducing the plume's temperature. The increase in seawater temperature predicted by the model is compared to ecological thresholds discussed below.

The discharge simulations predict that, at the worst location along the 100 m boundary, the 99th percentile temperature (*i.e.*, worst case, for 1% of the time) in winter will be 22.0°C and in summer will be 28.2°C, which are increases above the baseline of 1.3°C and 0.2°C respectively. At the worst location along the 300 m boundary, the 99th percentile temperature in winter was predicted to be 21.8°C in winter and 28.3°C in summer, representing increases above the baseline of 1.1°C and 0.2°C respectively. Near the sandspit, predicted 95th percentile temperatures (*i.e.*, worst case, for 5% of the time) were between around 19°C in winter and 24°C summer, representing increases above the baseline of approximately 0.50°C.

The largest ΔT's are generally found at or near the surface, while the bottom is much less affected by the temperature change due to the buoyancy of the discharge. Minimal effects on benthos are thus expected. The 95th percentile ΔT near the surface (depth with largest ΔT) is presented in Figure 24. A cross-section through the water column, as indicated by the red dashed line Figure 24, is shown in Figure 25.

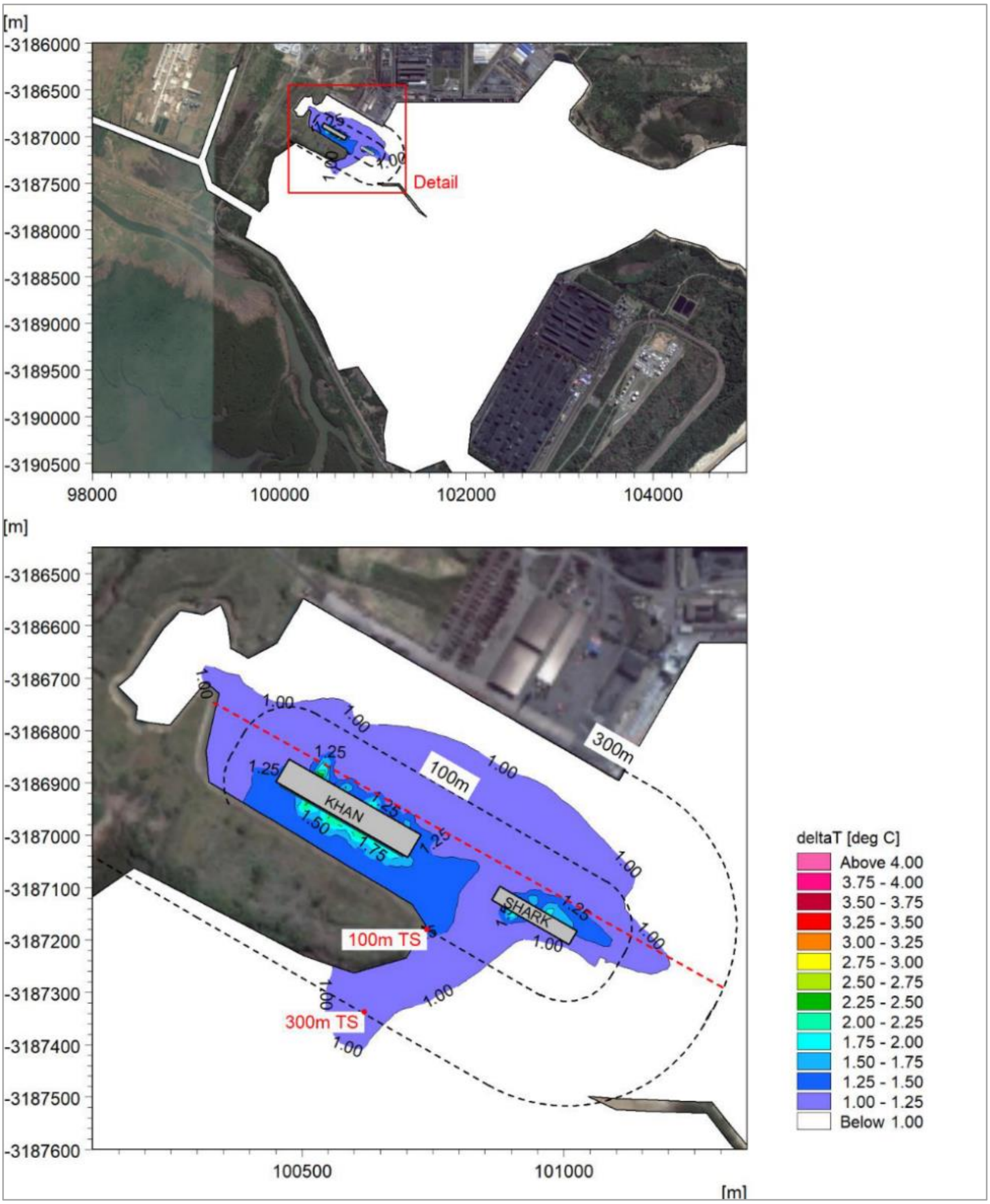

Figure 24. 95th percentile ΔT at the worst depth in the water column, near the surface (where the largest ΔT occurs) (PRDW, 2022)

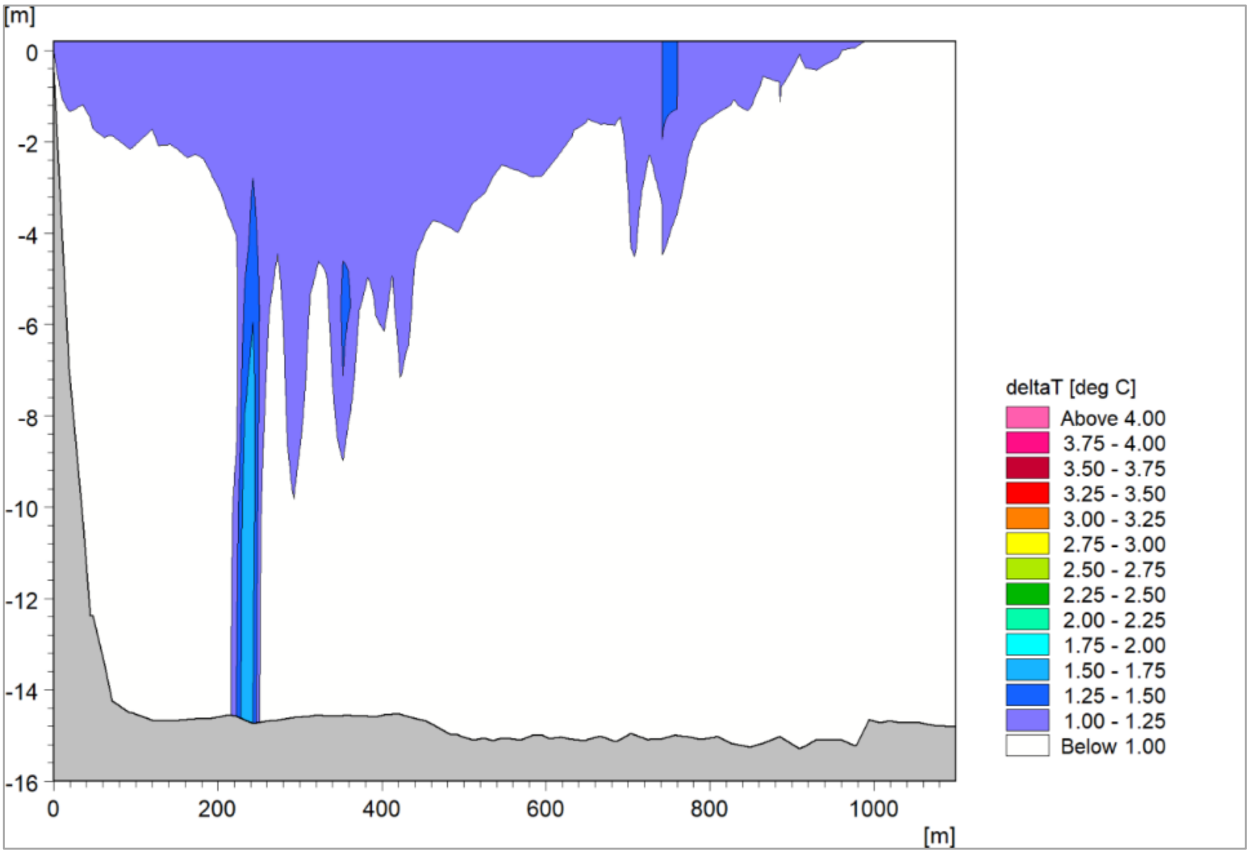

Figure 25. Cross section of the 95th percentile ΔT (red dashed line in Figure 24) (PRDW, 2022)

The 95th percentile ΔT over winter and summer combined, near the surface at the worst location along the 100 m and 300 m mixing zone boundaries (points shown in Figure 24), is tabulated in Table 45. Within the assembly cove, to the west of the basin, temperature changes are expected to align with those within the 100 to 300 m boundary (*i.e.,* 1.3°C) (PRDW *pers comm*.). This estimated temperature change within the cove reflects a conservative approach as it does not account for the increased mixing of water from within the cove.

Table 45: 95th percentile ΔT over winter and summer combined, near the surface at the worst location along the mixing zone boundaries (PRDW 2022)

Mixing Zone Radius (m)	Ecological threshold ΔT (°C)	Achieved ΔT (°C)	Reference
100	1.0	1.3	Anchor (2015)
300	Not applicable	1.1	Not applicable

The model results show that when the discharge depth of cooling water is 8 m, the thermal plume exceeds the recommended guidelines by 0.3°C. Nevertheless, the absolute temperature of the plume did not exceed any of the biological thresholds detailed in 'Applicable Guidelines and Thresholds . Deleterious effects within the Zone of Initial Dilution (ZID) are expected, but these should be limited to non-acute levels. Where exceedance of the guideline was observed (between the 100 and 300 m boundaries), seagrass habitat is present within the intertidal habitat in the assembly cove. If we assume that the water temperature within the cove during discharge increases to between 28 and 29°C (worst case scenario as modelled), the thermal threshold for *Zostera capensis* is not exceeded (as per the above guidelines and thresholds). Given that the seagrass beds in the intertidal area are able to withstand periods of exposure and high air temperatures (Cyrus and Vivier 2014b), it is likely that they will be resilient to these temperature changes. It is however recommended that measurement of the water temperature within the intertidal area of the assembly cove is undertaken before commencing the operational phase of the project to confirm the absolute temperatures in this area.

Of potential concern is the adjacent shallow area, namely the Kabeljous Flats, which is greatly significant ecologically in terms of the maintenance of Richards Bay as a functioning estuarine-type ecosystem (Figure 26, Cruz Environmental 2014). The modelling results show that the 95th percentile ΔT near the surface results in increases of 1.00-1.25°C extending into the narrow, shallow channel between the promontory and the sandspit connecting the Kabeljous Flats to the basin, and partially into the mangrove-lined cove. Additionally, the central area of the Kabeljous Flats was predicted to experience temperature increased of up to approximately 0.75°C during winter, and 0.50°C during summer, with warmer waters covering a larger proportion of the Kabeljous Flats relative to the baseline condition. The sensitive biota on the Kabeljous Flats are anticipated to experience some thermal effect, but considering the biological thresholds, these are not considered to be significant to cause harm.

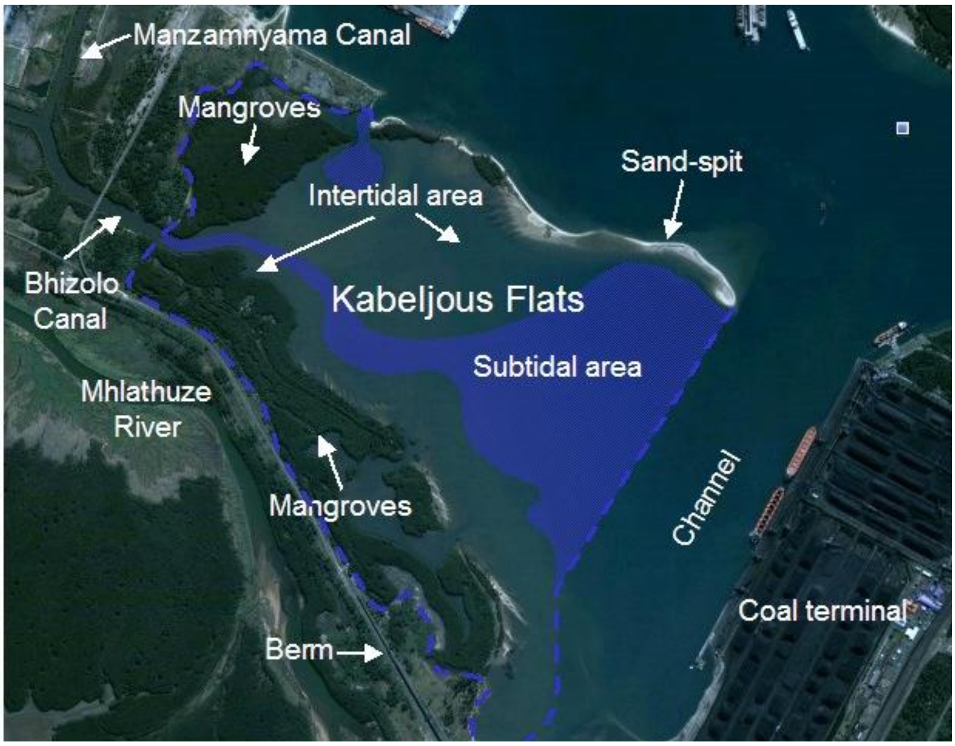

Figure 26. Position of the Kabeljous Flats, associated structures and habitat types in the Port of Richards Bay. Blue dashed line indicates the boundary of the flats (from Cruz Environmental 2014).

The penaeid prawns which recruit from Richards Bay to the inshore trawl fishery mainly occupy turbid, muddy areas within mangrove swamps (Weerts *et al.* 2003) and are therefore anticipated to experience temperature increases of approximately 0.25°C to 0.75°C. However, these increases are still within the temperatures these species are known to inhabit, so no impacts are anticipated (Hoang *et al.* 2020, Ndunguru *et al.* 2022, Raman *et al.* 2019).

As the largest temperature increases occur near the surface, benthic organisms are unlikely to be affected by the thermal plume, except for those residing in a narrow area immediately beneath the discharge points. Furthermore, the macrofaunal density in the region of the proposed location of the Powerships is relatively low and has species reflecting its status as a disturbed habitat that is not particularly sensitive. In addition, larger and highly mobile species (fish, sharks, dolphins) will likely avoid unfavourable habitat conditions. Thus, any potential impacts to the marine biota in the immediate vicinity of the discharge are of relatively low concern.

The probability of damage to marine ecology if temperature guidelines are met is expected to be extremely low outside of the ZID. This does, however, need to be confirmed by temperature measurements within the intertidal area of the assembly cove. Within the ZID, a low level of damage could occur. Community structure may be changed, but ecological function should continue.

Although not modelled, it is postulated in the alternate layout 2 option, that temperature effects on the Kabeljous Flat may occur to a greater degree, specifically during spring high tide when a large portion of the sandspit will be inundated enabling direct connectivity to the Flats. This alternative is not supported.

Impact Assessment

The spatial scale of this impact will be slightly beyond on the project footprint with low severity as natural functions should slightly altered beyond the zone of initial dilution. No irreplaceable loss of marine fauna or flora is expected, although this needs to be confirmed by temperature measurements within the intertidal area in the assembly cove. The duration of the effect will be up to 20 years as the discharge of heated cooling water and the consequent effect on organisms in the receiving water body will last for the project's duration. The ecological effect, however, will be more temporary. This is due to rapid rates of plankton regeneration (Sommer 2009), large sessile organisms, including mussels, being replaced over >6 months and large macrobenthos taking about 1 year to re-establish. Furthermore, the impact will be reversed once the project infrastructure is removed. The frequency of the impact is continuous (daily/hourly), and the probability is rated as probable. Accordingly, the assigned overall environmental significance rating is Medium-High.

Table 46. Impact rating of the of powership cooling water discharge on the estuarine/marine ecology

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 & 2	3	2	2	**2.3**	3	5	**4.0**	**9.2 Medium-high**
Mitigation measures: • See below								
Alternative layout 1 & 2	3	2	2	**2.3**	2	5	**3.5**	**8.1 Medium**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

Mitigation measures:

The results show that a smaller footprint of temperature increase (ΔT) is achieved when discharging at a deeper depth below the water surface. Discharging at a deeper depth allows the thermal plume to entrain colder sub-surface ambient water as it rises to the surface, reducing the temperature of the plume. The following mitigation measured are suggested:

- Cooling water is discharged into the sea at a depth of 8 m, as recommended in the modelling report (PRDW 2022); and
- To reduce the risk of recirculation of the discharge back to the intakes, it is recommended that the discharge pipeline running down the vessel hull has a second elbow to discharge horizontally away from the vessel, and that the discharge pipes be positioned as far from the intakes as possible.

A water quality monitoring programme should be implemented to validate the predictions of the hydrodynamic modelling study and monitor constituents of the effluent. Adaptive management, informed by monitoring results must be implemented to ensure compliance with water quality guidelines.

8.4.3. Impact 11: Effect on surrounding estuarine/marine ecology due to underwater noise and vibrations

The noise generated by the Gas to Power project operations is expected to be semi-continuous, up to 16.5 hours a day. In order to identify any significant risks from underwater noise that could arise due to this project, a study was undertaken to model the underwater noise from the proposed Gas to Power project operations in Richards Bay. A baseline noise survey was conducted in Richards Bay, identifying the noise levels to which the receiving environment is already exposed (Subacoustech Environmental Report No. P292R0501, 2022). Additionally, a survey was carried out in Ghana at the location of a large Khan class Powership that has similar specifications (a sister ship) to that of the Khan class Powership planned for Richards Bay, in order to sample the noise levels produced by such a ship at various power outputs and distances. The data from the Ghanaian survey was applied to the baseline data via standard methodology to predictively model the noise levels that would be present in Richards Bay if all the proposed ships were installed and operating at maximum capacity.

For more details on the predicted noise levels in Richards Bay as a result of the proposed Gas to Power project, refer to Subacoustech Environmental Report No. P292R1001 (Subacoustech Environmental 2022).

Underwater noise measured in Port of Richards Bay, South Africa

To determine the baseline underwater noise levels prior to the proposed installation of the Powerships and auxiliary vessels, noise levels in Richards Bay were measured in November 2021. The baseline noise levels in the Bay are represented in orange text in Figure 27 as dB SPL_{RMS} re 1 µPa, based on attended monitoring sampled on a survey vessel around Richards Bay.

Noise in Richards Bay harbour was dominated by machinery onboard the ships docked at the terminals, when in their vicinity. Outside of the harbour *i.e.*, in the harbour entrance channel and in the area south of the sandbar, the ambient noise levels were predominantly of natural origin and mainly due to snapping noises from marine biota such as fish, shrimp, or other crustaceans, unless a ship was passing in or out of the port. Unless there was a ship in motion nearby, no ship-related noise was apparent beyond much more than one kilometre of the nearest dock, indicating that at this distance the noise had reduced to below the level of background noise.

The highest underwater noise levels in Richards Bay were measured near to the Coal Terminal when a bulk carrier vessel was passing when the measurements were collected. These noise levels measured up to 134.4 dB SPL_{RMS} (129.7 dB SPL_{RMS} on average during measurements). The vicinity of the bulk cargo quay was also busy with vessels and had high noise levels.

Ships were not audible outside of the harbour as noise from berthed vessels were attenuated at that distance. Outside the harbour the noise levels varied between 112 dB and 123 dB SPL_{RMS}.

To contextualise the noise produced by the proposed Powerships, the noise produced by large ships that typically transit the harbour was also measured at various distances. A bulk carrier typical of the type in the harbour produced noise levels of 141-143 dB SPL_{RMS} re 1 µPa at 100 m from its side as it passed, while another reached over 147 dB SPL_{RMS} re 1 µPa at the same distance.

Underwater noise measured in Sekondi, Ghana

At Sekondi Naval Base in Ghana, a survey was made of the underwater noise produced by an operating Powership. The surveyed Powership is a 470 MW capacity Khan Class Powership that is larger in design specification, engine complement and electricity output to the Khan Class Powership that will be used in the Port of Richards Bay, and considerably larger than the Shark Class Powership. Underwater noise was measured using both static monitoring and attended monitoring, in which underwater noise samples were taken at multiple distances, positions and Powership power outputs in line with and moving away from the ship's hull.

Both the Ghanain Powership and the proposed Richards Bay Powerships have noise attenuation devices built in, to limit the escape of both underwater and airborne noise from the ships. Engines and alternators are fitted with anti-vibration mountings, and rotating machinery such as air compressors and pumps have resilient isolation mountings. These mechanisms restrict structure-borne noise from moving from the machinery to and out of the hull, which is the primary source of noise transmission to the surrounding water. Furthermore, the exhaust gas flues are fitted with silencers for the reduction of noise transmission.

The results of the attended monitoring are shown in Figure 27, in which the differences in noise levels at various distances from the Powership at three different power output levels are presented. The measured noise increased with increased power output from the ship and attenuated with increasing distance from the ship. The noise level measured off the end of the ship at the harbour entrance was significantly lower than that of the same distance to the side. The harbour wall was found to effective in reducing noise transmission. Noise levels were found to be negligibly above background noise (*i.e.,* <1 dB) within one kilometre of the measured Powership at 420 MW.

Figure 27: Average of underwater noise measurements sampled along lines at the Osman Khan Powership in Ghana under various operating conditions. All measurements are logarithmic averaged decibel SPLRMS re 1 µPa. This shows the underwater noise levels averaged over each line, recorded when the ship was producing power with one engine (approximately 18 MW), 14 engines (250 MW) and 23 engines (420 MW) (Subacoustech Environmental Report No. P292R1001, 2022).

Although the location at the harbour and water conditions do differ between Ghana and Richards Bay, the differences in water temperature and salinity were found to have a negligible impact on sound (considerably less than 1 dB variance) at the distances being considered (less than a kilometre). The Powership in Ghana was moored in waters of 8-10 m depth, while the depth around the proposed location of the vessels in Richards Bay is approximately 14-20 m deep. These locations are shallow in terms of underwater sound propagation and, over the short distances being considered, the differences in depth are considered to have negligible impact on noise attenuation due to the wavelengths of the sound and the dimensions of the Powership's hull relative to the depth of the water.

The hard sea walls of the harbour have the potential to lead to the reverberation of noise by causing sound from a noise source to reflect off the hard surface and interact with the sound field in the space, which can increase noise levels. While it is expected that the hard surfaces surrounding the vessels will lead to some sound reflection, the space is large enough that any reverberant effect will be small. Furthermore, as the harbour in Ghana is smaller and has more hard surfaces than Richards Bay, the noise levels in Ghana would be slightly higher and can therefore be considered as precautionary *i.e.*, worse than would be measured in Richards Bay.

Powership noise impact in and around the Port of Richards Bay

Three vessels are proposed for installation in Richards Bay Port, on the east side of the harbour, with another vessel intermittently visiting. The vessels are as follows:

- Two Powerships:
    - one 21 engine Khan class Powership (installed capacity 415.6 MW); and
    - one 6 engine Shark class Powership (installed capacity 125.4 MW);

- Two auxiliary vessels:
    - One floating storage regasification unit (FSRU); and
    - one Liquefied Natural Gas Carrier (LNGC) ship that will dock next to the FSRU and will be present intermittently.

The Powerships are predicted to have an average load of 327 MW, which cannot exceed 450 MW at any point. The two auxiliary vessels are mainly storage vessels and have very little machinery active when they are in port, especially in comparison to a Powership. When the FSRU is engaged in the periodic regasification operations, its total load will be lower than 4 MW.

For the purposes of predicting the impact of the proposed Powerships in Richards Bay on underwater noise, the noise levels measured in Ghana were combined with the noise levels from the smaller Shark class Powership and then overlaid with the baseline noise measured in Richards Bay.

The method included a number of worst-case assumptions:

- It was assumed that both Powerships would be simultaneously operating at full rated power. As the maximum contracted capacity is 450 MW, this will not be the case;
- Most of the surrounding areas of water face the ends of the ships, whereas the highest noise levels were measured at the sides of the ships;
- The larger Powership will be located in a partially enclosed space, which will restrict the sound it produces;
- It was assumed that the small, shallow opening at the west side of the sand bar, near the proposed Powerships location will allow free passage of sound, whereas in reality sound from the Powerships will be significantly attenuated;
- It has been assumed that the Powerships will operate at maximum capacity for 24 hours a day; however, it is understood that Powership operation in Richards Bay is limited to 16.5 hours a day;
- It was assumed that both auxiliary storage ships (FRSU and LNGC) will be present and operating with the equivalent of one engine running (based on the Powership measurements). However, the engines running to power the FRSU and LNGC are significantly smaller in power rating than the Powerships (maximum 4 MW compared with 18.3 MW for one engine on a Powership). Additionally, the LNGC is expected to be present in port for approximately 2 days every 4-6 weeks (depending on power dispatch demanded from the Powerships). As a result, this could be considered an unrealistic worst-case; and
- It was assumed that the transit of the LNGC in and out of the port would generate the same noise level as any typical large container or bulk carrier vessel of the type that frequently transits the port.

The larger Powership proposed for Richards Bay is Khan class, capable of operating at up to 416 MW with 21 engines, while the smaller Shark class Powership is capable of operating at up to 125 MW with 6 engines. For the larger ship, the noise level produced by the Ghanaian Powership while operating at 420 MW was used. This was combined with the noise level produced by the Ghanaian Powership while operating at 250 MW, divided by two, which is equivalent to a reduction in noise of approximately 3 dB, *i.e.* 10*log (2).

The calculated noise levels were based on the distance of each noise source to the relevant receiver position. Noise attenuation was based on the Ghanaian measurements directly, where available, or used the best fit from the measurements at 420 MW (approximately 14.log(R) geometric attenuation).

Calculated noise levels with the Powerships and auxiliary vessels are shown in Figure 28. The red-shaded noise levels indicate an increase in the baseline noise of over 10 dB, which could occur nearby to the ships, while noise levels shaded in yellow denote an increase in the baseline of 3-10 dB. All decibel noise sources are combined with simple logarithmic addition as standard for acoustic calculation, *e.g.,* 121.0 dB + 110.9 dB = 121.4 dB.

The results of the underwater noise assessment of the Richards Bay Port show that after the installation of two Powerships and an FSRU, with the Powerships operating at a maximum output in excess of that proposed for the port, an increase in background noise of approximately 12.9 dB in close proximity to the Powerships would be observed. This is equivalent to a noise level of 137.9 dB SPLRMS re 1 µPa (see the red shaded values in Figure 28).

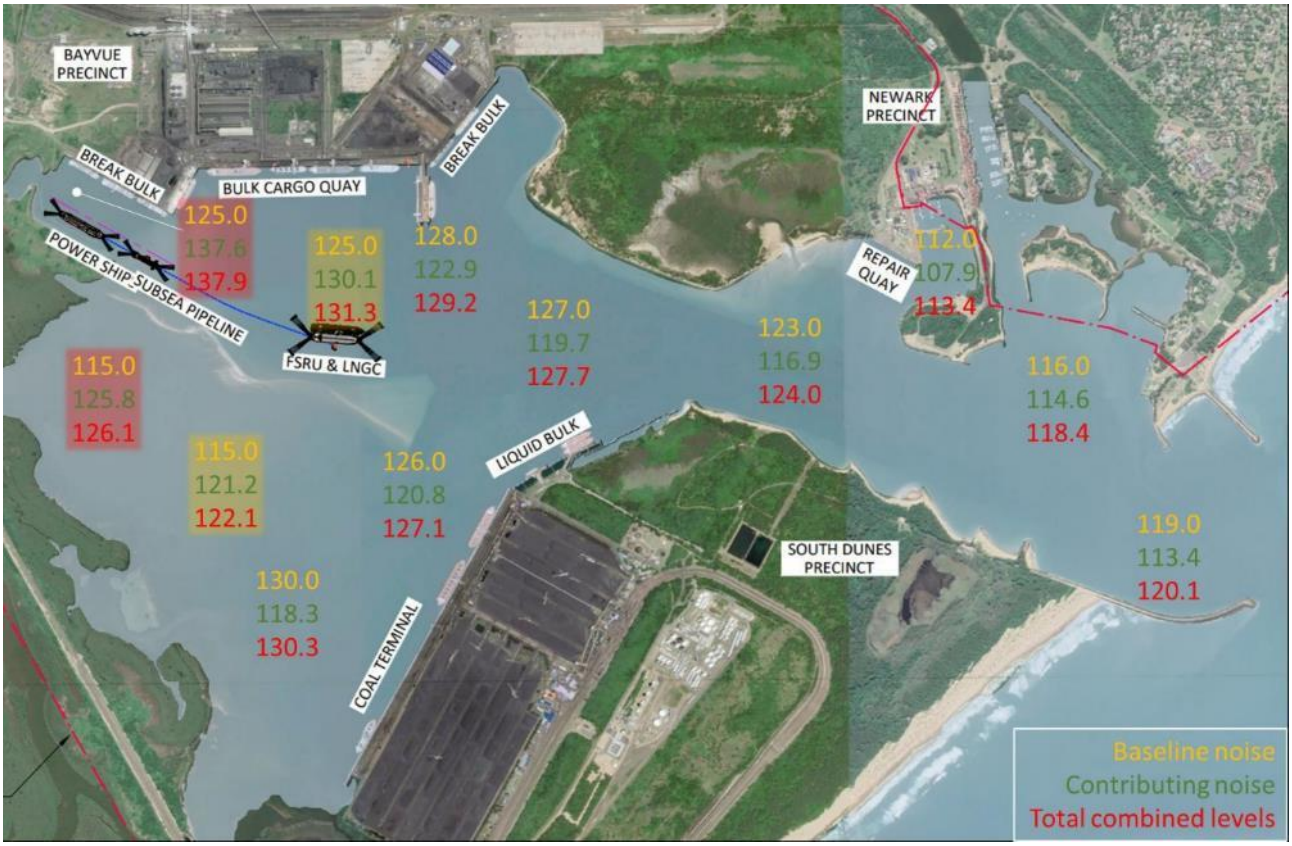

Figure 28: Calculated noise levels in Richards Bay based on the introduction of a Powership and auxiliary vessels operating at full power. "Contributing noise" is the noise at each location exclusively from the Powership and auxiliary vessels in isolation. "Total combined levels" is the total noise level on site as a result of addition of the Powerships and auxiliary vessels to the existing baseline noise level. Noise levels shaded in red in denote an increase in the baseline of over 10 dB, which could occur nearby to the ships. Noise levels shaded in yellow denote an increase in the baseline of 3 - 10 dB. Noise levels remain unshaded for increases of less than 3 dB. Units are logarithmic averaged SPL_{RMS} dB re 1 µPa.

The baseline noise survey of Richards Bay also measured the noise produced by other ships in the vicinity. Large cargo vessels were transiting Port at the time and the noise produced by them can provide context for the noise levels produced by the Powerships. For example, a bulk carrier typical of the type accessed in the harbour produced noise levels of 141-143 dB SPL_{RMS} re 1 µPa at 100 m from its side as it passed, while another reached over 147 dB SPL_{RMS} re 1 µPa at the same distance.

Based on the measurements of the noise produced by other large vessels in Richards Bay, it is evident that the noise levels resulting from the introduction of the Powerships will be exceeded by a transiting container or bulk carrier vessel moving into or out of the port, since noise levels from those existing operations were measured to be higher at equivalent distances.

Due to the worst-case assumptions listed above, the increase of more than 10 dB on the south side of the sand bar is anticipated to be a significant overestimate. As there will be no "line of sight" to the larger Powership and the shallow water at the west end of the sand bar will restrict the passage of sound, the realistic contribution is anticipated to be of the order of 6 dB lower than the predictions. However, this worst-case calculation is used as a precaution.

In cases where the Powership is operating at a low power, which was found to be typical during the survey of the operational Powership in Ghana, the effect on baseline noise levels will be negligible.

Assessment of environmental effects

Anthropogenic noise in and around underwater habitats can impact the marine species inhabiting them. The extent and likelihood of underwater noise causing adverse impacts on marine life is dependent on the qualities of the sound such as the sound level, source frequency, duration of exposure, and/or repetition rate of an impulsive sound (Hastings and Popper 2005, in Subacoustech Environmental 2022). Most research into the effects of underwater sound on marine life focuses on high level underwater noise such as blasting, seismic surveys, or impact piling, as these noises are more likely to have greater, more immediate and observable environmental effects. However, research into long-term, relatively low-level noise exposure is increasing.

The proposed Gas to Power project in the Port of Richards Bay is surrounded by important habitats such as the mangroves, seagrass beds, intertidal and shallow subtidal mud and sand flats, the subtidal benthic zone and the water body itself. Depending on their distance from the Powerships, the biota in these areas could be impacted the underwater noise from the vessel operations. Exposure to noise for a long period of time, such as is expected of the Powership operations, may cause chronic effects, including developmental deficiencies and physiological stress (Popper and Hawkins 2016). These may affect life functions, including individual health and fitness, foraging efficiency, avoidance of predation, swimming energetics and reproductive behaviour (Popper and Hawkins 2016). However, as stated above, these responses to sound are dependent on the sound qualities.

The most noise-sensitive groups in Richards Bay are expected to be mammals and fish. Richards Bay acts as an essential nursery habitat for many fish species due to its sheltered and food-rich waters. Aggregations of juveniles are present in the area during key recruitment periods (August to November) (Whitfield 1994, Wallace 1975). Juveniles are considered more susceptible to noise disturbances as they are less mobile, while adult fish (and marine mammals) can move out of affected areas. It is often assumed that animals will avoid disturbing noise. However, territoriality or a response of immobility may mean that the animal does not move away from the noise source (de Soto 2016). Other important marine receptors in the area are the various seabird species. Marine invertebrates may also be impacted by underwater noise; however, evidence is limited (de Soto 2016).

Southall *et al.* (2019) provides groupings of marine mammals of similar species by their hearing range (Table 47) and approximates the hearing sensitivities of each group by applying filters to unweighted noise.

Table 47: Marine mammal hearing groups (from Southall *et al.* 2019) with some South African species examples

Hearing group	Generalised hearing range	Example species
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	Baleen whales *e.g.*, southern right whale (*Eubalaena australis*), humpback whale (*Megaptera novaeangliae*), Bryde's whale (*Balaenoptera edeni*)
High-frequency cetaceans (HF)	150 Hz to 160 kHz	Dolphins, toothed whales, beaked whales, bottlenose whales *e.g.*, common dolphin (*Delphinus delphis*), Heaviside's dolphin (*Cephalorhynchus heavisidii*), dusky dolphin (*Lagenorhynchus obscurus*), killer whale (*Orcinus orca*), Atlantic bottlenose dolphin (*Tursiops truncatus*), short-finned pilot whale (*Globicephala macrorhynchus*)
Very high-frequency cetaceans (VHF)	275 Hz to 160 kHz	True porpoises (None in South Africa)
Phocid carnivores in water (PCW)	50 Hz to 86 kHz	True seals *e.g.*, southern elephant seal (*Mirounga leonina*), leopard seal (*Hydrurga leptonyx*)
Otariid and other carnivores in water (OCW)	60 Hz to 39 kHz	Cape fur seals (*Arctocephalus pusillus*), Cape clawless otter (*Aonyx capensis*)

Southall *et al.* (2019) also provides individual criteria based on whether the noise source is considered impulsive or non-impulsive. Examples of non-impulsive noise include sonar, vibro-piling, drilling, shipping, and other relatively low-level continuous noise. This noise produced by the Powerships and auxiliary vessels is considered non-impulsive, and Southall *et al.* (2019) presents cumulative weighted sound exposure criteria (SEL_{cum}) (Table 38Table 47; Southall *et al.* 2019). SEL_{cum} are provided for both the onset of permanent threshold shift (PTS), where unrecoverable (but incremental) hearing damage may occur, and onset of temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors. Unweighted peak criteria (SPL_{peak}) are used for impulsive noise and are thus not appropriate for this assessment.

The effect of weighting using a frequency spectrum for a Powership output of 420 MW at 200 m from the hull (in a harbour) on the sound perception of the various species groups, as calculated by Subacoustech Environmental (2022), is presented in Appendix C (Section 13.3).

Table 48: TTS- and PTS-onset thresholds for marine mammals exposed to the Powerships continuously for 24 hr/day (non-impulsive noise), based on thresholds defined in Southall *et al.* (2019). SEL_{cum} (weighted) thresholds in dB re 1 µPa^2s

Hearing group	TTS threshold	Range to meet TTS onset	PTS threshold
Low-frequency cetaceans (LF)	179 dB SEL_{cum}	350 m	199 dB SEL_{cum}
High-frequency cetaceans (HF)	178 dB SEL_{cum}	<50 m	198 dB SEL_{cum}
Very high-frequency cetaceans (VHF)	153 dB SEL_{cum}	850 m	173 dB SEL_{cum}
Phocid carnivores in water (PCW)	181 dB SEL_{cum}	70 m	201 dB SEL_{cum}
Other carnivores in water (OCW)	199 dB SEL_{cum}	<50 m	219 dB SEL_{cum}

A moving animal model is typically used for SEL_{cum} exposure thresholds for marine mammals, which assumes that the receptor will swim away from the source of high noise levels. Continuous noise sources will not necessarily cause this kind of reaction, although it is unlikely that a species would remain still for the duration of the noise exposure. However, the assumption of a static mammal is used as a worst-case scenario.

Low-frequency cetaceans (baleen whales) and very high-frequency cetaceans (porpoises) are the only groups that have calculated impact ranges further than 350 m (Table 38). However, porpoises are not known to inhabit South African waters, so this group is not of concern (Best 2008). In the case of baleen whales, an individual would need to remain within 350 m of the Powerships for a full 24-hour period to be exposed to noise sufficient to cause the onset of TTS. However, this assumes the worst-case scenario that the Powerships would be operating at maximum capacity for 24 hours a day, whereas it is understood that the Richards Bay Powership operation is to be limited to 16.5 hours a day and that it will not be operating at maximum capacity.

In order to meet the criteria for the onset of PTS, an individual of the most sensitive species (VHF cetaceans) would have to stay within approximately 50 m of the Powerships for an entire day while the Powerships were at maximum capacity, and this distance would be much closer for the other species. It is not reasonable to expect that this would occur, not least because these species do not occur in South African waters. There is also little risk of any large baleen specie (LF cetaceans) occurring in the restricted space this close to the Powerships. As a result, no species are expected to be exposed to noise sufficient to cause the onset of PTS.

Based on the above, particularly in consideration of the long durations of exposure and full power operation in excess of the expected maximum load, there is no expected impact from the noise produced by the proposed Richards Bay Powerships on marine mammals. As the noise produced by the Powerships is similar to the noise produced by other large vessels in the port, the Powerships are not anticipated to produce any significant additional disturbance to marine mammals unless a marine mammal is directly adjacent to the ships.

Authoritative guidelines for fish exposure to sound are provided in Popper *et al.* (2014), using categories for fish that are representative of general fish species, according to their anatomy. Based on the guidelines in Popper *et al.* (2014), no weighting is applied to calculate the impact thresholds for fish. The most sensitive species of fish (those with a swim bladder involved in hearing) must be exposed to 158 dB SPL_{RMS} from continuous noise sources, such as shipping, for 12 hours to experience the onset of TTS (Table 48) Sciaenidae are examples of such fish, of which Dusky kob *Argyrosomus japonicus* is present, and is fished, in Richards Bay.

The noise measured at any distance from the Ghanaian Powership was always at least 10 dB below this value (Figure 26) and the calculated noise levels in Richards Bay (Table 48) did not meet this threshold. Thus, no TTS risk to fish is anticipated as the result of the proposed Powerships in Richards Bay.

In cases of insufficient data availability to determine a robust numerical threshold, Popper *et al.* (2014) also provide qualitative criteria summarising the effect of noise on an individual as having either a high, moderate or low effect in either the near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres) (Table 49).

As defined in Popper *et al.* (2014), masking is the "*impairment of hearing sensitivity by greater than 6 dB, including all components of the auditory scene, in the presence of noise*." This is not a direct physiological effect on hearing but describes the effect of making a sound harder to hear due to the increase background noise. Behavioural effects are defined as "*substantial change in behaviour for the animals exposed to a sound*". This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements (Popper *et al.* 2014).

Table 49: Summary of the qualitative effects on fish from continuous noise from Popper *et al.* (2014) (N = Near-field; I = Intermediate-field; F = Far-field). Distances are considered as follows: near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres).

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	170 dB SPL_{RMS} for 48 hrs	158 dB SPL_{RMS} for 12 hrs	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Based on these qualitative criteria, it is assumed that most fish species will experience a high effect of masking and at least moderate levels of behavioural change within hundreds of metres of the Powerships (based on Figure 27. The qualitative criteria above do not take into account the noise level associated with the source, so due to the relatively low noise level of the source under consideration compared to the background noise, these are likely to over-estimate the risk.

As the density of fish within the intermediate field of the proposed Powership location is unknown, the extent to which fish will be affected in this vicinity is unclear. If the location of the Powerships and FSRU is regularly inhabited by fish important to the local fisheries, especially sound-sensitive species such as Sciaenid Dusky kob (*A. japonicus*), it is possible that the fisheries may experience shifts in the physical distribution of populations of their target species. However, overall catches will not necessarily be affected as any displacement would only occur over a relatively short range, expected to be of the order of hundreds of metres. It should be noted that the noise from the Powerships is of a similar level to that of existing ships using the port, and the FSRU much lower, so will not change the existing soundscape of the bay.

This assessment has focused on noise in the water, although seabed vibration can have an impact on benthic species. The ship's hull will vibrate, which transmits noise into the surrounding water. This noise will reach the seabed, affecting species here. Benthic (non-marine mammal) species have a relatively low sensitivity to noise as they do not have a swim bladder, the presence of which leads to a higher sensitivity, as stated by Popper *et al.* 2014. However, there is very little research available on the effects of vibration on benthic species (Roberts & Howard 2022). There is a Moderate risk of TTS close to the ship (see Table 49), and a Low risk of any greater impacts. The evidence of measurements from the operational Powership shows that the noise emitted from the Powerships, and therefore by extension the vibration in surrounding surfaces, will be of the same order of magnitude as other vessels characteristic of those already accessing and mooring at the port.

There is limited information on the effects of anthropogenic underwater noise on invertebrates such as crustaceans (de Soto 2016). However, there is evidence that anthropogenic noise can cause marine invertebrates to experience masking of important biological sound cues, as well as sublethal physiological stress in response to high levels of sound such as that from vessel traffic or construction noise (Hudson *et al.* 2022, Jézéquel *et al.* 2021, Solan *et al.* 2016). Exposure to underwater broadband sound fields at 135–140 dB re 1 µPa can reduce sediment-dwelling invertebrates' (in this case, the decapod *Nephrops norvegicus*, and clam *Ruditapes philippinarum*) ability to undertake ecologically-important benthic nutrient cycling processes (Solan *et al.* 2016). These sound levels are produced within 100 m of the Powerships when operating at full power. Crustaceans have been shown to experience short- to medium-term stress or tissue repair effects in response to exposure to ship noise but may become adapted to such noise (Hudson *et al.* 2022, Wale, Simpson & Radford 2013). European lobsters (*Homarus gammarus*) were found to significantly increase their call rates in the presence of shipping noise of around 118.4 ± 7.7 SPL_{RMS} dB re 1 µPa, suggesting the need to vocally compensate for the reduction in intraspecific communication ability due to noise (Jézéquel *et al.* 2021). This is within the range of noise already experienced in Richards Bay (Figure 27) but suggests that crustaceans near to the Powerships may experience noise interference with ecologically important sounds.

Other important receptors in the area could be the various seabird species. Most information on the noise sensitivity of seabirds focuses on impulsive noise sources such as seismic surveys, and there is little research on their sensitivity to continuous low-level noise underwater. Diving birds, such as penguins and cormorants, use underwater noise in foraging and associated communication (Hansen *et al.* 2017, McInnes *et al.* 2020). In particular, white-breasted cormorants *Phalacrocorax carbo* were found to have an underwater hearing threshold comparable with hearing experts such as odontocetes, with a threshold of 71 dB re 1 µPa RMS at 2 kHz (Hansen *et al.* 2017). Research on the impacts of impulsive noise sources found that gentoo penguins *Pygoscelis papua* showed strong avoidance responses to bursts of broadband noise of between 115 and 120 dB re 1 µPa RMS while another diving bird, the common murre *Uria aalge*, showed avoidance responses to similar noise at levels as low as 110 re 1 µPa RMS (Anderson Hansen *et al.* 2020, Sørensen *et al.* 2020), although this was relative to even lower levels of background noise in the experiment, much lower than that present in the Port of Richards Bay. Although a broadband noise burst has different qualities to that of ship noise, this does suggest that diving birds may also react to ship noise (Anderson Hansen *et al.* 2020). Additionally, Pichegru *et al.* (2017) showed that African penguins *Spheniscus demersus* were displaced by seismic surveys. A relationship between an increase in shipping noise in Algoa Bay, South Africa with an 85% decline in the numbers of a nearby African penguin colony has been found (Pichegru *et al.* 2022). More research into the sensitivity of diving seabirds to underwater noise is needed, but these results do suggest that diving seabirds may have potential responses to the noise from a Powership on par with high-frequency cetaceans. If this is assumed to be true, and if this principle can be transferred to their susceptibility to TTS (this is speculative) then diving seabirds would need to be within approximately 50 m of the Powerships for 24 hours to experience the onset of TTS. Given that the birds do not spend this much time underwater, and that the Powerships will not run for 24 hours a day, the likelihood of this occurring is assumed to be low.

Given the low underwater hearing threshold and importance of hearing in foraging for some diving seabirds, it is possible that some species will experience masking in the near vicinity of the Powerships, which could interfere with their ability to forage. However, resident seabirds recorded in Richards Bay, which could be impacted by the Powerships, are infrequent and limit to the grey-headed gull (*Chroicocephalus cirrocephalus*) and the common tern (*Sterna hirundo*). Given that the Powerships will not contribute meaningfully to the overall soundscape of the Port, this effect will be localised and should not affect these birds' general feeding abilities.

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The noise produced by the Gas to Power project operations is not anticipated to contribute meaningfully to the existing noise levels in Richards Bay. Furthermore, when considering an "above worst-case" scenario, the Powerships do not produce noise to the extent that will cause direct harm to marine organisms, based on current understanding and available research. Marine organisms within hundreds of metres of the ship will experience noise levels higher than the general background noise of the Port, and these will be similar to those noise levels experienced within similar distances to the typical large vessels that transit the Port, however, noise associated with the Powerships will be continuous (16.5 hours a day). It is possible that marine organisms within hundreds of metres of the Powerships will experience noise levels that interfere with ecologically relevant sounds, which could have negative impacts over time. Sound-sensitive marine organisms would need to stay within a few hundred metres of the Powerships for 24 hours in order to experience the onset of TTS (where a temporary reduction in hearing sensitivity may occur).

Considering these factors, the severity of the noise produced by the Gas to Power project is considered to be "Site-specific and wider natural processes and/or functions continue albeit in a modified way (general integrity maintained)". The duration of the effect will be from 2 to 20 years as noise will be produced by the vessel for the duration of its operation. Noise produced by the Gas to Power project will increase the ambient underwater noise levels within hundreds of metres of the source, so it will impact a greater area than the immediate site. The Powerships are expected to run hourly, for up to 16.5 hours a day, making the frequency of the impact hourly. The likelihood of there being an impact of project-induced noise on the estuarine/marine ecology is considered "Possible". No irreplaceable loss of marine fauna or flora is expected. The impact of noise will stop when the project is finished. Accordingly, the assigned overall environmental significance rating is Medium-High without mitigation and with mitigation is reduced to Medium. As there is limited research into the impacts of continuous low-level noise on marine organisms, the confidence of this assessment is Medium.

Table 50. Impact ratings for effects on surrounding estuarine/marine ecology due to increased underwater noise and vibrations

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 & 2	3	2	3	**2.7**	2	5	**3.5**	**9.5 Medium-high**
Mitigation measures: • See below								
Alternative layout 1 & 2	3	2	2	**2.3**	2	5	**3.5**	**8.1 Medium**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

Mitigation measures:

Mitigation measures must ensure that the worst-case scenario assumptions made in this assessment are not met, so that noise levels created by the Gas to Power project are lower than what is predicted. This will help to avoid disturbances and potential harm to marine organisms, and may include the following:

- The Powerships must not be operational for 24 hours a day, to reduce chronic exposure of noise to marine organisms. It is expected that the Powerships will operate for 16.5 hours a day;
- Maximum power output from the Powerships must be avoided – contracted capacity of 450MW must be complied with). Noise levels produced by the Powerships are proportional to the amount of power output, so lower noise levels will be achieved with lower power capacity;
- In the case that a marine mammal, especially a baleen whale, is in the near vicinity *i.e.*, within hundreds of metres of the Gas to Power project, the Powerships should not operate at maximum power output, to reduce the noise level produced and thus the chances of disturbing the animal; and

- When moving in and out of the port, the LNGC must not move at maximum speed, so as to reduce the amount of noise produced by its engines.

A noise impacts monitoring programme should be implemented to validate the predictions made of the impacts of the noise produced by the Gas to Power project on the marine ecology. Monitoring of the ecology in the immediate vicinity of the Gas to Power project should be undertaken following a before-after-control-impact (BACI) approach. This should include monitoring of the local macrofauna, and video surveys and fish sampling to understand the fish community in the region associated with the Powerships, as well as use of the project area by marine mammals.. Monitoring of the distribution and behaviour of diving seabirds in the vicinity of the Powerships should also be undertaken.

These surveys should be ongoing and following a sampling methodology that is robust when assessing the impacts of the noise produced by the Powerships on the distributions of benthic macrofauna, fish, seabirds, and marine mammals. If an effect if observed, adaptive management informed by monitoring results must be implemented. The results of such monitoring will be valuable in informing other developments and contributing to the international understanding of the effects of noise from large vessels on marine biota.

8.4.4. Impact 12: Effect on surrounding estuarine/marine ecology due to light pollution

The powerships and the FSRU will be moored within an active area of the port, namely the 600 Berth Basin, and on the margin of the 700 Berth Basin respectively. In line with various maritime health and safety policies and regulations, operational areas within the port must have adequate lighting to ensure safe working conditions. Thus, dependent on the nature of the work, artificial lighting on the quaysides, at night or during poor visibility or weather conditions, can range from non-directional low intensity lighting, to high intensity, directional lighting (*e.g.* spotlights) at areas of high risk or particularly hazardous activities (*e.g.* loading), whatever is deemed necessary to meet the minimal light levels required.

Vessels moving within the port, or those that are berthed, must comply with applicable maritime laws and regulations, pertaining to standard navigational lighting and lighting in respect to general health and safety requirements and emergencies.

- Safe vessel passage throughout the port environment is ensured by the appropriate navigational aids (*e.g.* buoys, beacons etc. (SAMSA MN 8 of 2016 - Standards for Aids to Navigation in South African waters and Inland Waterways).
- According to SOLAS[14], Chapter II-1 (Part D) Regulation 41.2.1, "*A main electric lighting system which shall provide illumination throughout those parts of the ship normally accessible to and used by passengers or crew...*".
- Chapter 2, Regulation 23 of the Maritime Occupational Safety Regulations (GG 16068, GNR. 1904, 11 November 1994) under the South African Merchant Shipping Act, as amended (Act No. 57 of 1951) states that "*Every employer shall ensure that those areas of a vessel being used for the loading or unloading of cargo or for any other work or transit are adequately and appropriately illuminated.*" Similarly, "*The employer shall ensure that… access equipment (i.e. gangway, ladder, etc. used to gain access to the vessel) and immediate approaches thereto are adequately illuminated*" (Regulation 15).
- The Port Rules (GG 31986, GN. 255, 6 March 2009) under the National Ports Act (Act No. 12 of 2005), Part D, Regulation 32, stipulate that "*when alongside a quay or jetty or moving within a port, a vessel must display the signals, flags and lights required by the Harbour Master*." Such instructions by the Harbour Master may be "*in the interest of security, good order, protection of the environment and the effective and efficient working of the port*." The Terminal Operating Guidelines for the Richards Bay Bulk Terminal do not specify vessel lighting requirements (TPT, 2014).

[14] International Convention for the Safety of Life at Sea (1974) as amended.

It is evident from the above, that the mooring location of the proposed Gas to Power project within the Port of Richards Bay is already impacted by artificial lighting related to the port operations. This includes the nearby undeveloped and ecologically sensitive areas of the port, mangroves, the Kabeljous Flats and the sandspit.

Light emissions from the Karpowerships are compliant with the United *States Safety and Health Regulations for Construction: 1926.56* (Karpowership, 2020). According to the illumination level measurement report (Karpowership, 2020), light levels onboard the powerships will be around 53.8 Lux. Stairs and access points, workshops, accommodation areas and corridors will emit 107.6 Lux, whilst offices and first aid areas will emit 322.8 Lux (brighter than a high-quality hunting or game-spotting spotlight). Outside working areas and transit areas will emit 107.6 Lux. Given the nature of the project, flood lighting of the surrounding port waters will not be required, and lighting will be directed towards the areas of work and movement paths. However light spill from onboard lighting is anticipated. In addition, additional lighting will be necessary for access points to the vessel (embarking/disembarking), and during routine checks of the various components and repair/ maintenance activities on the outside of the vessel. The powerships and the FSRU (as well as the LNGC), will thus contribute additional artificial light that will potentially impact on aquatic communities immediately surrounding the vessels as well as those associated with the adjacent sensitive natural habitats.

Artificial light at night (ALAN) is a significant source of light pollution that interferes with the natural cycles of light and darkness and modifies the intensity, spectra, frequency and duration of light reaching and penetrating the natural water bodies, including the ocean's surfaces, and natural landscapes (CWA, 2020; Nelson et al., 2021; Thompson, 2013; Zapata et al., 2019). Coastlines, estuaries and major rivers are particularly at risk because they are favoured for human settlement and major economic activities, such as ports (Zapata et al., 2019).

The impact of ALAN on natural ecosystems and wildlife populations is receiving increasing research attention, and there is a wealth of information that illustrates that ALAN influences animal orientation, circadian rhythm (nocturnal and diel activity), spatial distribution, habitat use, migration/dispersal, forging efficiency and predatory behaviour, schooling behaviour in fish, stress hormones, and reproduction and life history traits (Bassi et al., 2022; Brüning et al., 2018; Nelson et al., 2021; Thompson, 2013). Zapata *et al.*, (2019) indicates that ALAN can influence the different levels of ecosystem organisation from individual organism physiology and behaviour through to ecosystem function and provision of ecosystem services.

Sensitivity to light and requirements for optimal living conditions and ecological functioning varies between groups of organisms (*e.g.* invertebrates, fish, birds, reptiles, humans) and even within species (CWA, 2020). Most organisms utilise light or visual cues to locate and capture food. For aquatic species, it is well known that different taxa (such as phytoplankton, zooplankton, fish, squid and prawns) respond to artificial light, which is manipulated in a laboratory setting and in-field to increase mariculture productivity (*e.g.* Dusky kob exhibit aggression under red light conditions, and lowest aggression under partial shade, Timmer and Magellan, 2011), and to increase capture rates of wild caught, commercially-important species (*e.g.* using light to attract target species such as squid) (Bassi et al., 2022; Grubisic, 2018; Thompson, 2013). Therefore biological responses will vary with the magnitude, duration, frequency, and predictability of exposure to ALAN (Zapata et al., 2019).

In the context of the Richards Bay estuary, which serves as a critical nursery area for fish, the impact of ALAN on predator-prey relationships as a result of the Gas to Power project is of particular concern. This scenario, *i.e.* ALAN originating from a moored vessel, was modelled by Becker *et al.* (2013) using a floating restaurant in the Bushmans Estuary, Eastern Cape that illuminated the water immediately adjacent. There were clear differences in the abundance of fish between light-on and light-off conditions. Large predatory fish (> 500 mm total length) increased in abundance when the lights were on, their behaviour changed to maintain their position within the illuminated area and the abundance of small shoaling fish also increased with the lights on (Becker et al., 2013). While shoaling is a common anti-predatory response, the concentration of small fish was also likely attributed to the concentration of phytoplankton responding to artificial light (Becker et al., 2013). The study found that ALAN created conditions that benefited larger, piscivorous fish through both the concentration of prey and an enhanced foraging environment for visual predators. In a similar study on predatory-prey interactions for sessile reef-type communities, Bolton *et al.*, (2017) demonstrated that during dark (night time) conditions, fish used the wharf infrastructure for shelter, but under ALAN conditions, there was much greater predation on the seafloor dwelling communities. Overall, these ALAN has the potential to create unnatural top–down regulation of fish and benthic invertebrate populations within urban estuarine and coastal waters, with implications for ecosystem structure and functioning (Becker et al., 2013; Bolton et al., 2017).

As described above, lighting on the powerships will contribute to ALAN and it is reasonable to assume from available literature, that there will be an impact on the estuarine/marine ecology, particularly in the form of altered species assemblages, congregations, and foraging and predatory behaviour, and thus survival of species within the sheltered port environment. These responses will be highly variable amount species. The amount of light spill that will reach sensitive habitats and receptors in the areas surrounding the vessels is unknown, but will be influenced to a large degree by climate/atmospheric conditions. Fish have exhibited changes in circadian rhythm at illuminances (1 lux) that occur in indirectly illuminated environments (Brüning et al., 2015), which may already be expected for those areas closest to the multipurpose quayside where there is active loading operations. Values well below 1 lux are commonly found for moonlight and skyglow (Jägerbrand and Bouroussis, 2021).

Nonetheless, mitigation measures can be put in place to reduce light pollution reaching the natural environment and its ecological impacts. In seeking a benchmark for acceptable level of illuminance, Jägerbrand and Bouroussis (2021) suggest an average of 1-3 lux on the ground (adopted for water surface) and less than 3 lux at eye level as generally acceptable to keep illuminance values as low as possible in sensitive environmental areas. Baseline light level measurements must be undertaken prior to construction and operation of the powerships in the vicinity of the powerships and at the sensitive habitat receptors

Table 51. Impact ratings for effects on surrounding estuarine/marine ecology due to increased light pollution

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 &2	3	2	3	**2.7**	3	5	**4.0**	**10.8 Medium-high**

<u>Mitigation measures (taken from CWA, 2020):</u>

- Only add light for specific purposes. Remove excess/unnecessary lights, and turn off lights in areas not in use.
- Restrict uplighting and water illumination.
- Use adaptive light controls to manage light timing, intensity and colour.
- Light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill.
- Use the lowest intensity lighting appropriate for the task.
- Use non-reflective, dark-coloured surfaces.
- Use lights with reduced or filtered blue, violet and ultra-violet wavelengths. Avoid high intensity light of any colour.
- Implement actions when birds are likely to be present. This includes peak migration periods (flyway locations).
- No light source should be directly visible from foraging or nocturnal roost habitats, or from migratory pathways.
- Install screening/shielding with appropriate materials along the starboard side of the vessels.
- Do not install fixed light sources in nocturnal foraging or roost areas.
- Use curfews to manage lighting near nocturnal foraging and roosting areas in coastal habitats. For example, manage artificial lights using motion sensors and timers from 7pm until dawn.
- Use flashing/intermittent lights instead of fixed beam.
- Use motion sensors to turn lights on only when needed.
- Reduce deck lighting to minimum required for human safety on vessels moored near nocturnal foraging and roost areas.
- Prevent indoor lighting reaching migratory shorebird habitat, by using blinds, curtains, or shutters.
- In facilities requiring intermittent night inspections, turn lights on only during the time operators are moving around the facility.
- Use appropriate wavelength, explosion proof LEDs with smart lighting controls and/or motions sensors. LEDs have no warmup or cool down limitations so can remain off until needed and provide instant light when required for routine nightly inspections or in the event of an emergency.
- Industrial site/plant operators to use personal head torches.

• Undertake a night light audit on a moonless night and 24-hour noise audits in accordance with SANS 10103:2008 on the sandspit and Kabeljous Flats before operations commence to determine the baseline, once operations start and annually thereafter.								
Alternative layout 1&2	3	1	2	**2.0**	2	4	**3.0**	**6.0 Medium-low**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

8.4.5. Impact 13: Effects of the combined operational impacts on ecosystem services (fisheries and mariculture)

The operational-phase impacts assessed here are the effects of the intake of cooling water, the discharge of cooling water, and increased noise produced as a result of the Gas to Power project on fisheries and mariculture.

The impacts of increased noise levels due to the Gas to Power project are not certain due to the sparse literature on the effect of continuous low-level noise on marine organisms. However, there is evidence that noise of this type has the potential to be harmful or interfere with the ecological functioning of marine biota (Hudson *et al.* 2022, Jézéquel *et al.* 2021, Popper *et al.* 2014, Solan *et al.* 2016, Southall *et al.* 2019). As Richards Bay Port already has relatively high levels of background noise due to the operation of the Port and the transit of large vessels, the contribution of the Gas to Power project to the noise levels is predicted to be minor and only of any potential consequence in within hundreds of metres of the Powerships.

The fisheries that take place directly in Richards Bay are the recreational shore angling fishery, the recreational boat angling fishery, and the (currently illegal) gill net fishery. The shore anglers mainly use locations outside of the commercial port, on the eastern side of the harbour (Beckley *et al.* 2008). They are far enough from the Gas to Power project location that any additional noise will have attenuated to the level that it is negligible above the background noise, on the level of 1 dB. Also, this is far outside of the range of influence of the discharged cooling water. Therefore, it is unlikely that the Gas to Power project operations will impact shore angling. The recreational boat anglers utilise the entire harbour but most fishing effort also occurs in regions where the additional noise from the Gas to Power project would not affect the background noise and are far from the area influenced by the discharged water (Everett and Fennessy 2007). The locations that the gill net fishers use is unknown, but it is unlikely that gill net fishing will take place within the sphere of influence of the Gas to Power project operations, which is in the order of hundreds of metres from the Gas to Power project location and within a busy commercial port.

Richards Bay acts as an essential nursery habitat for many fish species due to its sheltered and food-rich waters. Aggregations of juveniles are present in the area during key recruitment periods (August to November) (Whitfield 1994, Wallace 1975). Any impact on juvenile fish will influence the fisheries they recruit to. As juvenile fish have less physical capacity to move out of the way of impacts such noise, discharged warm water, or a water intake pipe, they may be more prone to by impacted by the Gas to Power project. There remains a concern regarding displacement of fish populations occur as a result of impacts arising from Powership operations. A reduction in the available suitable habitat for juvenile and adult fish may lead to the concentration of fish within the more heavily fished areas of Richards Bay, increasing the risk of over-exploitation by commercial and recreational fisheries.

If the Gas to Power project operations result in any reduction of the estuarine function of Richards Bay, fisheries of species with estuarine-dependent life stages will be affected. In the commercial line fishery, five of the species caught are known to have juvenile stages which use estuaries to some extent. In particular, the kobs *Argyrosomus* spp. and cape stumpnose *Rhabdosargus holubi,* are 100% dependant on estuaries as juveniles, meaning that the well-being of these stocks is reliant on the ecological status of estuaries such as that of Richards Bay. Between 2017 and 2020, estuarine-dependent species contributed an average total annual catch of 8.9 tonnes to the Richards Bay line fishery, with the majority made up by the kobs *Argyrosomus japonicus* and *A. inodorus* (DFFE 2022).

Dusky kob *A. japonicus* is valuable in the recreational, commercial and subsistence fisheries (Griffiths 1996). Currently, the stock is in a critical state and spawner biomass per recruit (SB/R) has collapsed to 1.1-4.5% of pristine spawning biomass. The preservation of estuaries as obligate nursery grounds for the species is fundamental to its preservation (Sink *et al.* 2019).

Dusky kob are also an example of the most noise-sensitive group of fish (those with a swim bladder involved in hearing) according to Popper *et al.* (2014). This group of fish must be exposed to 158 dB SPL_{RMS} from a continuous noise source, such as shipping, for 12 hours to experience the onset of a temporary threshold shift (TTS) in which an individual experiences a temporary reduction in hearing sensitivity (Southall *et al.* 2019, Table 49). The noise measured at any distance from the Ghanaian Powership was consistently 10 dB below this value, of greater (Figure 27), and the calculated noise levels in the Port of Richards Bay (Figure 28) did not meet this threshold. Therefore, no TTS risk to fish is anticipated as the result of the proposed Powerships in Richards Bay. However, as this genus is particularly sensitive to sound, and uses sound in its breeding behaviour (Lagardère & Mariani 2006, Parsons & McCauley 2017, Pereira *et al.* 2020), it is possible that dusky kob may avoid the higher noise levels within hundreds of metres of the Gas to Power project. If this location is currently inhabited by dusky kob, it is possible that the fisheries may experience shifts in the physical distribution of their targets. However, overall catches will not necessarily be affected as any displacement would only occur over a relatively short range, expected to be of the order of hundreds of metres. Given the importance and Endangered status of dusky kob, the any potential interference with the breeding behaviour of this species should be avoided though. As this type of fish experiences masking even at the far-field from a continuous noise source (Table 49), the noise from the Powerships may mask the calls these fish make when aggregating to breed, which could affect their breeding success. The spatial use of the Port by dusky kob should be determined so that the likelihood of this occurring can be better understood. It should be noted that the noise from the Powerships is of a similar level to that of existing ships using the port, and the FSRU much lower, so will not significantly change the existing soundscape of the bay. As a result, it is currently understood that the impacts on dusky kob will be low.

Marine invertebrates may also be impacted by underwater noise (de Soto 2016, Hudson *et al.* 2022, Jézéquel *et al.* 2021, Solan *et al.* 2016), or the intake and/or discharge of cooling water. If the invertebrate prey of fish are impacted, this could have knock-on effects to the fisheries. However, the impacts of noise and the cooling water system are expected to be relatively localised, it is unlikely that any impacts on invertebrates will have consequences felt at the fisheries-level.

There is relatively low density of benthic macrofauna in the region of the proposed Powerships and FSRU, and the community is mainly dominated by polychaete worms. The areas which are favoured by the commercially important prawn species are outside of the area of influence from the discharge of cooling water and noise produced by the operations (Weerts *et al.* 2003). The mangrove swamps that the prawns prefer are predicted to experience temperature increases of up to approximately 0.75°C (in a worst-case scenario), but these higher temperatures are still within the range of temperatures these species inhabit (Hoang *et al.* 2020, Ndunguru *et al.* 2022, Raman *et al.* 2019). Considering these factors, it is unlikely that the inshore prawn fishery will be negatively impacted by Gas to Power project operation.

Currently, there is no active aquaculture in Richards Bay, but an Aquaculture Development Zone (ADZ) has been proposed and is being investigated (DFFE 2020). As a result, the location of the proposed ADZ is unknown. Considering the spatial extent of the impacts from cooling water intake and discharge and operational noise, the ADZ would need to be within hundreds of metres of the Powerships for there to be any potential impact. As there is limited space around the proposed Gas to Power project location, the likelihood of this occurring is considered to be low.

Impact Assessment

Due to the lack of research into the effects of the type of noise produced by the Gas to Power project on fish, and the uncertainty around the extent to which fisheries will be affected by the operation of the Gas to Power project, the severity of the impacts is considered as "Site-specific and wider natural processes and functions are slightly altered". The duration of these impacts will be as long as the planned operation of the project, which is 20 years. The noise produced by the Gas to Power project will raise the ambient underwater noise levels within hundreds of metres of the vessel. The operational impacts will take place semi-continuously, on a daily basis. The scoring results in a "Medium" Overall Environmental Significance, which will remain "Medium" even with mitigation. The research gaps in the understanding of the effects of noise on the local fisheries means that the assessment is given a Medium confidence.

Table 52. Impact ratings for effects of the combined operational impacts on ecosystem services (fisheries and mariculture)

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layout 1 & 2	3	2	2	**2.3**	2	5	**3.5**	**8.1 Medium**
Mitigation measures: • See below								
Alternative layout 1 & 2	3	2	2	**2.7**	2	5	**3.5**	**8.1 Medium**
Reversibility	The impact is reversible							
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced							
Fatal flaw	No, this impact does not result in a fatal flaw							

Mitigation measures:

The mitigation measures for the intake and discharge of cooling water are provided in Sections 8.4.1 and 8.4.2 respectively, while the mitigation measures for the additional noise produced by the Gas to Power project are provided in Section 8.3.3. These are mitigation measures for the estuarine/marine ecology that underpin the ecosystem services.

8.4.6. Impact 14: Effect on macrophyte habitats and terrestrial fauna

As per the issues described under Section 8.3.6 relating to the construction phase, similar impacts would be prevalent during the operational phase, identified by De Wet (2022). This attributed to ongoing maintenance and potential repairs to the transmission line infrastructure.

Table 53. Summary of potential impacts associated with the operation of the Karpowership on the terrestrial ecology of Richards Bay estuary, as taken from De Wet (2022)

Impact	Without Mitigation	With mitigation
Operational phase		
Issue 1: Loss of vegetation communities		
1: Loss of modified habitat	Medium-Low	Low
2: Loss of reed beds	Medium-Low	Low
3: Loss of bushveld	Medium-Low	Low
Issue 2: Loss of Species of Special Concern and Biodiversity		
4: Loss of flora SCC	Medium-Low	Low
5: Loss of fauna SCC	Medium-Low	Low
6: Loss of biodiversity in general	Medium-Low	Low
Issue 3: Ecosystem function and process		
7: Fragmentation	Medium-Low	Low
8: Invasion of alien species	High	Low
Reversibility	The impact is reversible	
Irreplaceability of Resources	No, the impact does not cause a loss of resources that cannot be replaced provided that flora and fauna SCC are relocated to alternative habitat that is actively conserved (*e.g.* Richards Bay Nature Reserve), and that nests of avifauna SCC are avoided.	
Fatal flaw	No, this impact does not result in a fatal flaw	

8.4.7. Impact 15: Effects on coastal and estuarine avifauna associated with overhead transmission lines

Power generated by the powerships will be transferred to the national powergrid by means of overhead transmissions lines. Two routes are proposed. Alternative route 1 (preferred) joins the existing power servitude along the Manzamnyama Canal, before heading north and around the northern property boundary of the smelter site. Alternative route 2 joins the Harbour Arterial Road servitude, and before the lower Bhizolo Canal, it cuts west passing through the mangroves and across the lower Manzamnyama Canal, traversing the smelter site, before heading north through mixed mangrove and wetland habitat on the western boundary of this site.

In general, powerlines pose a significant threat to birds, primarily through collisions and electrocutions. The former is relevant to species that are highly aerial, those that flock, species that are migratory, and particularly large bodied species such as pelicans (*Pelecanus* sp.), flamingos (*Phoenicopterus* sp.), herons (*Ardea* sp.), and spoonbills (*Platalea alba*). Individuals moving between areas and en route to the surrounding water bodies, such as the neighbouring Mhlathuze Estuary and river floodplains, Lake Msingazi, Lake Nsezi and Lake Cubhu and the Thulazihleka Pan, are at particularly risk. The populations of Threatened and Near-Threatened species are of concern, yet many of these species are rare or uncommon in the project area (Anchor Environmental and TBC, 2022). The risk of bird collisions is likely to be greater at night (*e.g.,* for flamingos, which typically move during the night) (Martin, 2022), and in poor weather conditions when visibility is poor, and where the lines traverse open spaces, such as the southern and western margins of the smelter site close to the Bhizolo Canal and adjacent wetlands. The construction of new infrastructure spanning open spaces, such as the canals, as proposed in the alternative 2 transmission line route, is likely to have a greater impact on flying birds than aligning new infrastructure with existing infrastructure (as in Alternative 1 transmission line route) (Anchor Environmental and TBC, 2022), as the former presents a new obstruction to flight paths, and is therefore not supported *(considered fatally flawed)* and consequently not rated.

The impact of the transmission lines on coastal and estuarine birds is specifically addressed in the Avifaunal Specialist Report (Anchor Environmental and TBC, 2022) and all mitigation measures and conditions provided must be adopted. The summary impact table (Table 54) is provided for ease of reference.

Table 54. Summary of potential impacts on avifauna associated with the operational phase of the Karpowership project – transmission lines and ancillary infrastructure, adapted from Anchor Environmental and TBC (2022)

Impact		Pre mitigation	Post mitigation
		Significance	Significance
Habitat loss: Infrastructure		Medium-Low	Very-Low
Project infrastructure: collisions		Medium-High	Medium-Low
Project infrastructure: electrocution		Medium-Low	Medium-Low
Reversibility	The impact is reversible		
Irreplaceability of Resources	The impact may result in irreplaceable loss of resources (*e.g.* disturbance/harm/displacement of threatened/migratory bird species), however mitigation measure may prevent complete loss or provide a suitable substitute (*e.g.* flight deterrents, utilising existing servitudes- alternative 2 not supported).		
Fatal flaw	No, this impact does not result in a fatal flaw		

<u>Mitigation measures (Anchor Environmental and TBC, 2022):</u>

- Approach and general access to the ships should be from the north side.
- No activities (post construction) must occur between the ships and the sandspit, other than activities in direct contact with the vessels, such as ship maintenance.
- Align transmission lines with existing transmission lines
- Mark the lines for visibility.
- Remove any nests built on powerline structures when not in use, to discourage their re-use.

8.4.8. Impact 16: Effect on coastal and estuarine avifauna due to operation of the powerships (disturbance, noise and light)

The proposed Gas to Power project will be located within an industrial and commercial port where disturbance, noise and light pollution is already prevalent. Anchor Environmental and TBC (2022) indicates that visual disturbance (movement) related to the manning of the powerships and associated infrastructure is an important consideration in establishing the impacts of the project. Various waterbird species exhibit visual disturbance at varying distances. A disturbance threshold of 200 m from the sandspit and Kabeljous Flats is suggested for the Gas to Power project within the Richards Bay estuary (Anchor Environmental and TBC, 2022). While a static powership is likely to cause low levels of disturbance, visual impacts on avifauna making use of the sandpit for roosting or feeding are expected (Anchor Environmental and TBC, 2022), given that parts of the vessels fall within the suggested buffer. Visual disturbance may result in some species taking flight, whilst most species will likely exhibit behaviour changes, such as reduction in feeding and feeding efficiency. Disturbance would be higher during construction, with some species becoming habituated during the operational period (Anchor Environmental and TBC, 2022).

In respect to noise, ambient noise levels within the port are 45 dB(A) with a variety of noises being noted emanating from vessel engines, loading of coal, port terminal operations, etc. as reported in the terrestrial noise generation study (Safetech, 2022). These were all audible from the sandspit and thus current noise impacts for this area are moderate to high (Anchor Environmental and TBC, 2022). Once in operation, the powerships will operate throughout the day and part of the night (16.5 hours), with noise emanating from power generation and supporting activities. The dead-end basin and part of the adjacent shoreline and promontory will be subject to industrial noise at 60-70 dB(A), all areas within an approximately 650 m radius including a portion of the mangrove stand and shallow Kabeljous Flats, the landward third of the sandspit, mangrove-swamp forest of the intertidal cove, and grassland and scrubland will experience 50-60 dB(A) (levels similar to busy urban areas) (Safetech, 2022). The greater Kabeljous Flats and sandspit, broader mangrove and grassland/shrubland and wetlands, Manzamnyama and Lower Bhizolo Canal, as well as small portion of the Mhlathuze Sanctuary /Richards Bay Nature Reserve, will experience 40-50 dB(A) (levels similar to rural and quiet suburban areas) (Safetech, 2022). Beyond these areas, noise levels will decrease from 40 dB(A) to 30 dB(A) (Safetech, 2022). Avifauna foraging on the water line of the sandspit at low tide will be subject to greater noise disturbance as they may be in closer proximity to the vessels, while at high tide when the water line is a further 500m away, noise disturbance reaching the exposed sandflats will be less (Anchor Environmental and TBC, 2022). As there are no legislated noise limits for environmentally sensitive areas or protected areas (Martin, 2022; Safetech, 2022), a conservative approach should be adopted.

Based on an available toolkit for UK waterbird disturbance mitigation, regular noise from 50 to 70 db are rated as moderate to low impact to estuarine avifauna, and noise below 50 db is rated as low impact (Anchor Environmental and TBC, 2022). There is no feasible mitigation other than to move the ships further from the sensitive bird areas.

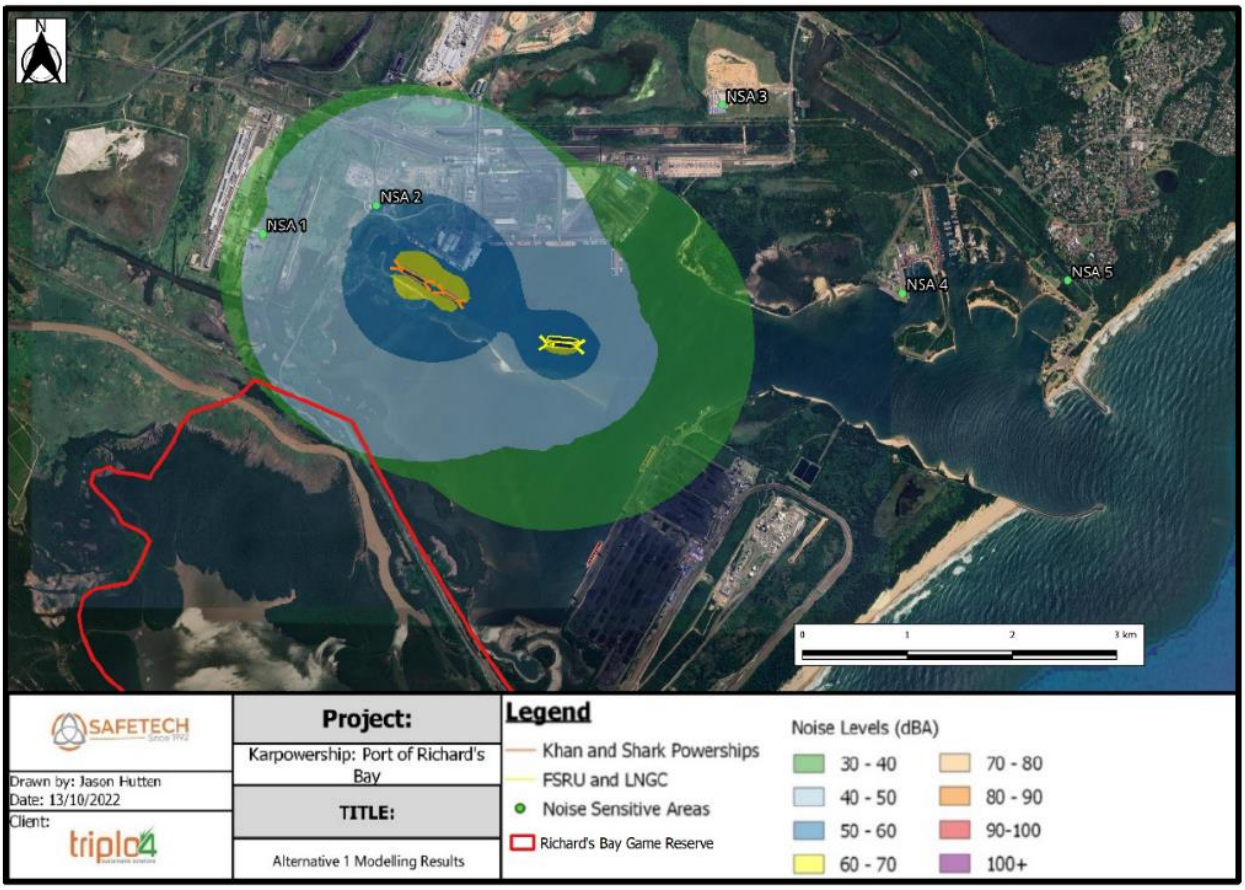

Figure 29. Predicted terrestrial noise levels during operation (Safetech, October 2022)

Light pollution, noise and vibrations emanating from the operation of the powerships will add to the existing effects on avifauna caused by vessel berthed and operating at the break bulk/multipurpose terminal and related port activities, and vessels in transit. As reported by Anchor Environmental and TBC (2022), the port has seen a measurable decrease in the number of waterbirds and this is attributed to the presence of the IDZ, the port infrastructure and associated activities.

Any sensitive bird species utilising the Kabeljous Flats and sandspit for feeding, roosting and those seeking refuge within the mangroves (and linked habitats) may be disturbed by this additional noise and artificial light (specifically during the night) (Adams et al., 2019) due to the close proximity of the powership and FSRU to these important estuarine habitats (*i.e.,* the sandspit). Studies have also shown that artificial lighting can cause behavioural and breeding modifications (Davies et al., 2014). It can also disorientate birds during flight and thus poses a threat to migrating species (Adams et al., 2019).

The Alternative layout 2, which entails mooring of all vessels adjacent to the sensitive sandspit, will result increased impacts to the avifauna utilising this area and is therefore not supported, and is consequently not rated.

The impact of the Gas to Power project on coastal and estuarine avifauna is specifically addressed in the Avifaunal Specialist Report and all mitigation measures and conditions provided must be adopted. A summary impact table (Table 55) is provided for ease of reference.

Table 55. Summary of potential impacts on avifauna associated with the operational phase of the Karpowership project – ships, as taken from Anchor Environmental and TBC (2022)

Impact		Pre mitigation	Post mitigation
		Significance	Significance
Powership: light pollution		Low	Low
Powership: noise and vibration impacts		Medium	Medium
Powership: human disturbance		Medium-Low	Very-Low
Reversibility	The impact is reversible		
Irreplaceability of Resources	The impact may result in irreplaceable loss of resources (*e.g.* disturbance/harm/displacement of threatened/migratory bird species), however mitigation measure may prevent complete loss or provide a suitable substitute (*e.g.* screening, reducing personnel movements).		
Fatal flaw	No, this impact does not result in a fatal flaw		

Mitigation measures (Anchor Environmental and TBC, 2022:

- In respect to noise impacts, layout option 1 must be selected to reduce noise and vibration impacts to surrounding avifauna
- Essential lighting is on at night
- Lumens are kept to a minimum
- Lights are installed as low as possible
- Lit up windows are shuttered at night

8.4.9. Impact 17: Effect of chemical pollution arising from spills and leaks of hazardous substances, and day-to-day shipping practices

During the operational period, there is the potential for leaks of LNG and/or natural gas, accidental spills of oils and grease from the vessels and other supporting equipment /plant, and other harmful substances and chemicals used during operations and overall maintenance. This may enter the water of the port directly as a result of incorrect handling and improper spill management. Any spills and leaks of hazardous substances will have a negative effect on the immediate estuarine/marine water quality, and potentially the most ecologically significant habitats of the bay, and potentially the open ocean under severe circumstances. Accidental spills, regardless of volume or concentration, could lead to significant environmental damage.

The LNG and/or natural gas could leak into the Bay due to incorrect coupling during refuelling, or via breakages in, or damages to, the fuelling line or subsea pipeline. However, LNG is non-toxic and spills on seawater vapourise rapidly, leaving no residue or film (Mokhatab et al., 2014). Due to the shallow depth (<100 m), any subsea leaks will rise rapidly and dissipate into the atmosphere and are thus not likely to result in dissolved oxygen depletion of the surrounding water column (Di et al., 2019). Thus, leakage of LNG into the surrounding water body is not anticipated to cause harm to estuarine marine life or alter water column characteristics. Similarly, the re-gasified NG, used as fuel in the powerships, is supplied at ambient temperature. As such, should a release occur, natural gas would be much lighter than air and would disperse immediately and not affect estuarine/marine life.

The potential for pollution from shipping (including spent oil and lubricants, paint, solvents and waste detergents, waste from ship maintenance activities, sewage, galley waste, sweepings from hatches and engine rooms, slops from holds and tanks, ballast water, general domestic waste, medicinal/medical waste, spent batteries, discharge of heated water, etc.) as a result of the proposed gas to power project is considered to be high. However, as the proposed operation of the gas to power process takes place within a port environment, the necessary TNPA environmental management programme and systems, specifically policies and processes relating to waste, dockside maintenance and repairs and comprehensive emergency response plans dealing with all foreseeable environmental emergencies, must be applied. Furthermore, the ‘Polluter Pays’ principle whereby those responsible for the spill are held liable for the clean-up and rehabilitation costs, will apply in any pollution incident.

It should be noted that such pollution is deemed to not be land-based, it will therefore not be controlled by the ICM Act but rather in terms of International Convention for Prevention of Pollution from Ships Act (Act No. 2 of 1986) (MARPOL Act), the South Africa Maritime Safety Authority Act (Act No. 5 of 1998) (SAMSA Act), the Marine Pollution Act (Act No. 6 of 1981) (Control and Liability Act) as well as the Merchant Shipping Act (Act No. 57 of 1951). It is also primarily the responsibility of the National Department of Transport and the South African Maritime Safety Authority (SAMSA) to manage. Discharges must also be compliant with the South African Water Quality Guidelines for Coastal and Marine Waters (DEA, 2018; DWAF, 1995). The responsibility, in the case of oil pollution from ships and oil released to sea, lies with DFFE, specifically through their Kuswag Programme, which undertakes regular oil spill surveillance and monitors for potential illegal oil discharges. This includes shoreline protection and clean-up, and at-sea response using dedicated oil response vessels and aircraft and dispersant spraying operations (DEA & RHDHV, 2017).

The potential impact is likely to be reversible and no irreplaceable resources are expected to be lost, provided the correct and appropriate pollution responses are implemented timeously and rehabilitation is undertaken where necessary.

All mitigation measures provided in the Risk Assessment for Major Hazard Installations (MHR, 2022) must be adopted.

Table 56. Impact ratings for chemical pollution arising from construction related spills of hazardous substances and shipping activities

<table>
<tr><th></th><th>Duration</th><th>Extent</th><th>Severity</th><th>Consequence</th><th>Probability</th><th>Frequency</th><th>Likelihood</th><th>Significance</th></tr>
<tr><td>General Operation</td><td>3</td><td>5</td><td>4</td><td>4.0</td><td>3</td><td>3</td><td>3.0</td><td>12.0 High</td></tr>
<tr><td colspan="9"><u>Mitigation measures:</u>

Only specialist personnel who are well trained on the standard protocols for preparation, coupling and decoupling of the gas pipeline between vessels, may undertake these operations.
Strict adherence to TNPA pollution, emergency, and health and safety protocols, MARPOL and other applicable maritime legislation and policies for the storage and handling of LNG, and power generation processes.
A Spill Prevention and Emergency Response Plan must be compiled and implemented. In the event of any significant spill the TNPA must be notified.
A method statement in respect to the use, handling, storage and disposal of all chemicals as well as anticipated generated waste, must be compiled and submitted as part of any Environmental Management Programme;
Correct handling, storage and disposal procedures must be followed.
Conduct a comprehensive environmental awareness programme amongst contracted construction personnel about sensitive estuarine and marine habitats and the need for careful handling and management of chemical substances.
In response to possible pollution as a result of Shipping activities:

Provide an inventory of waste produced and the nature of waste being produced and cooperate with the TNPA in every way;
A requirement to report environmental accidents and emergencies immediately they occur, to the port captain;
A Formal Failure Analysis (FFA) must be conducted to conclude each incident investigation in order to inform preventative measures to be taken in future;
Training of emergency response teams to deal with environmental implications of an emergency in addition to the safety implications; and

In the event of a spill, a penalty must be issued and the 'Polluter Pays' principle must be applied for clean-up operations and rehabilitation, if necessary.
</td></tr>
<tr><td>General Operation</td><td>3</td><td>3</td><td>4</td><td>3.3</td><td>2</td><td>2</td><td>2.0</td><td>6.6 Medium-low</td></tr>
<tr><td colspan="3">Reversibility</td><td colspan="6">The impact is reversible</td></tr>
<tr><td colspan="3">Irreplaceability of Resources</td><td colspan="6">No, the impact does not cause a loss of resources that cannot be replaced provided that correct and appropriate pollution responses are implemented, and rehabilitation is undertaken where necessary.</td></tr>
<tr><td colspan="3">Fatal flaw</td><td colspan="6">No, this impact does not result in a fatal flaw</td></tr>
</table>

8.4.10. Impact 18: Impacts of catastrophic accidents on estuarine/marine ecology and ecosystem service

The introduction of the Powerships and FSRU vessels increase the risk of the likelihood of catastrophic accidents occurring. The following are considered to be a catastrophic accident:

- Large hydrocarbon spills above Tier 3 as outlined in the "Coastal Oil Spill Contingency Plan No. 24: Richards Bay Zone" (DEA 2012);
- Explosion/flash fires;
- Major vessel collision/sinking;
- Unintentional removal of vessel from moorings; and/or
- Introduction of toxins, biocides or alien species considered extremely harmful to marine ecology.

According to MHR (2022), the greatest risk during the operation of the powerships is the possible rupture of one of the transfer hoses between the LNGC and FSRU. In terms of the types of risks, both a vapour cloud explosion and flash fire would have the greatest predicated area of impact, followed by a jet fire caused by rupture of a transfer hose (MHR, 2022). The impact area of both the explosion and flash fire was modelled to extend in a north-easterly direction toward the finger-jetty and mangrove/sandflat habitat adjacent to the Balloon Rail area. The largest jet fire emanating from the FSRU/LNGC ships extends in the same direction. However, the greatest extent of predicted thermal radiation (255m) will not reach the sandspit or the Kabeljous Flats; similarly, the closest zone of risk (yellow zone, where pain and second-degree burns) does not intercept the sandspit. With respect to the powership, a jet fire emanating from a transfer hose rupture, with a flame length of 83m, is directed toward the 600 Berth quayside and will not reach the adjacent shoreline. No mortalities of fauna utilising the estuary or shoreline are anticipated, unless flying directly over or within the impact area when the incident occurs, which is highly unlikely but not impossible.

Overall, the level of risk on sensitive areas is low, with 1: 10 000 risk area confined to the two ships and 160m around the hose connections, the 1: 1 million risk area stretching for a maximum distance of 295 m from the FSRU/LNGC ships and approximately 36 m around the powership hose connection, 1: 30 million risk area stretching for a maximum distance of 310 m from the FSRU/LNGC ships and approximately 40 m around the powership hose connection (MHR, 2022).

Although highly unlikely yet also unpredictable, the risks will reach the distal third of the sandspit which would result in significant habitat disturbance and disturbance or harm to marine /estuarine fauna, specifically birds on the sandspit. There is no difference in risk between the two layout options because the primary risk revolves around the FSRU/LNGC ships, which remain in the same location for either layout option.

All these catastrophic events have protocols in place to avoid incidents, therefore the probability and overall significance score for catastrophic accidents in Low. These catastrophic accidents have been assessed together with the consideration of impacts on marine ecology and the provision of ecosystem services.

Figure 30. Top Left: Area of impact from a vapour cloud explosion from transfer hose shear (blue), showing overpressure contour (yellow) where severe damage and 1% fatality would occur (red). Top Right: Jet fire from a gas transfer hose shear between the FSRU/LNGC showing zones of thermal radiation and risk. Bottom Left: Jet fire from the gas transfer powership manifold hose shear showing zones of thermal radiation and risk (purple is the flame, red= worst (fatality), yellow=least (pain and second-degree burns)) (MHR, 2022).

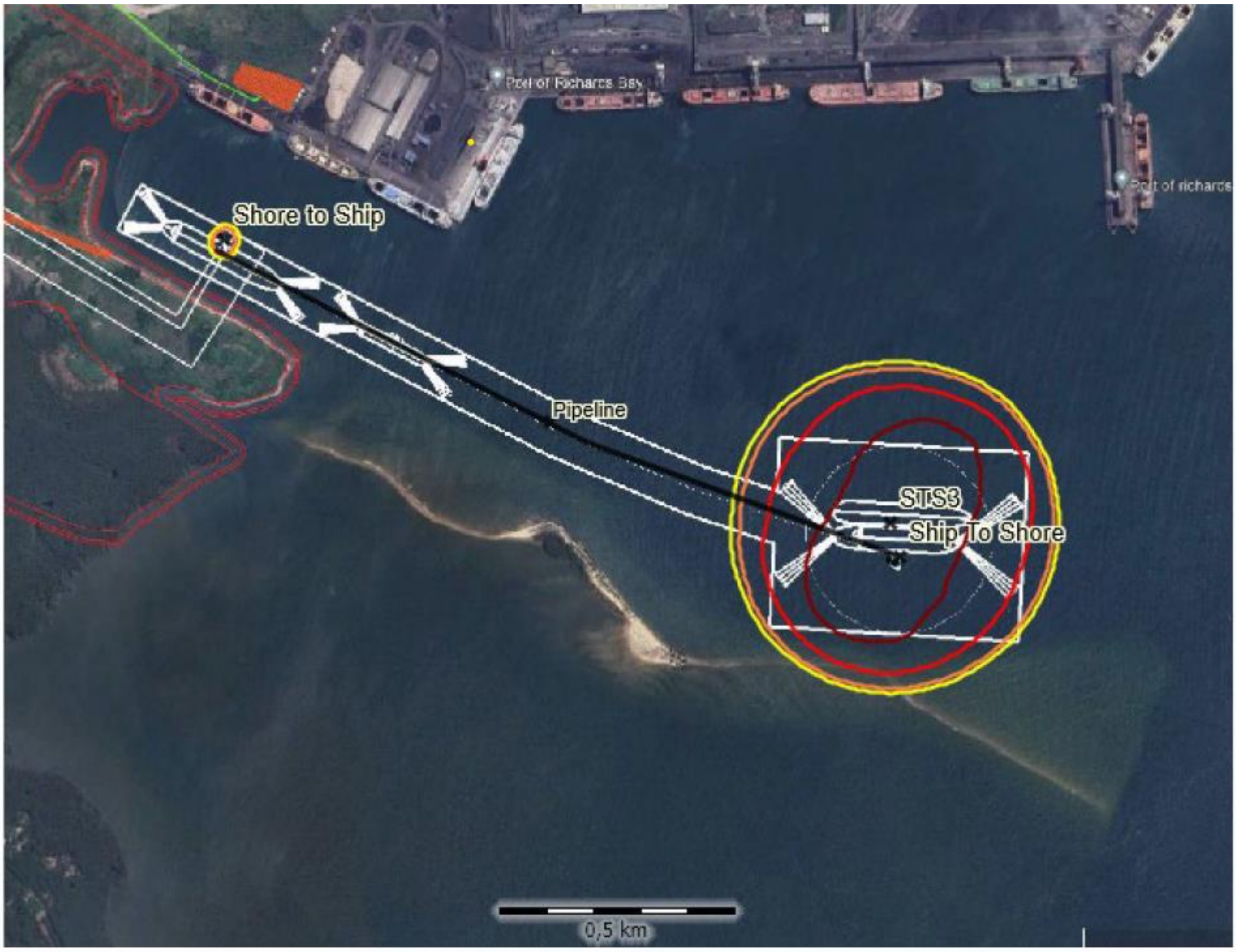

Figure 31. Individual risk horizons calculated for the Gas to Power project: 1:10 000 (red), 1:100 000 (orange), 1:1000 000 (yellow) and 1: 30 000 000 (green)

Table 57. Impact ratings for effects of catastrophic accidents on estuarine/marine ecology, avifauna and ecosystem services

	Duration	Extent	Severity	Consequence	Probability	Frequency	Likelihood	Significance
Alternative layouts 1&2	4	4	5	**4.7**	1	1	**1.0**	**4.7 Low**
Mitigation measures: • All mitigation measures provided in the Risk Assessment for Major Hazard Installations (MHR, 2022) must be adopted. • Only specialist personnel who are well trained on the standard protocols for preparation, coupling and decoupling of the gas pipeline between vessels, may undertake these operations. All applicable certificates of conformance must be on site. • An emergency plan that is compliant with the Major Hazardous Installation Regulations must be compiled and implemented. • Strict adherence to TNPA pollution, emergency, and health and safety protocols, MARPOL and other applicable maritime legislation and policies for the storage and handling of LNG, and power generation processes. • Comprehensive safety checks frequently undertaken of all project components and processes. • Frequent risk assessments and adaptive management where required. • Good housekeeping to be done daily.								
Alternative layouts 1&2	4	4	5	**4.7**	1	1	**1.0**	**4.7 Low**

Reversibility	The impact is NOT reversible
Irreplaceability of Resources	Yes, the impact causes a loss of resources that cannot be replaced.
Fatal flaw	No, this impact does not result in a fatal flaw

8.4.11. Impact 19: Effect on the Mhlathuze Estuary/ Sanctuary

The natural Richards Bay was divided into two separate water bodies during the construction of the Port of Richards Bay in the early 1970's. Richards Bay and the uMhlathuze Estuary have remained hydrologically disconnected for nearly 50 years due to the early failure of the tidal gates. Thus, the project will not directly affect the functioning of the uMhlathuze Estuary by virtue of this permanent separation.

According to the noise generation study (Safetech, 2022), average ambient noise levels in the port were 45 dB(A) and reached a maximum of 52.9 dB(A) during the course of the noise study. While the noise generation study does not provide an indication of current noise levels within the uMhlathuze Estuary, when the powership is in operation, a very small portion of the uMhlathuze system (2%), comprising predominantly mangrove habitat on the margin of the Richards Bay Nature Reserve, will be subject to noise disturbance between 30 - 50 dB(A) (Safetech, 2022) (Figure 29). This is within the range for rural districts and quiet suburban areas. However, this area is located immediately adjacent the harbour railway line and Harbour Arterial Road, and thus experiences noise disturbance from trains and traffic, including heavy vehicles, en route to the coal terminal and South Dunes Precinct. Given that the source of the noise is not within the nature reserve and that the noise received at the margin will be ≤50 db(A), overall, noise disturbance within the uMhlathuze Estuary is predicted to be minimal. The presence of the mainland promontory adjacent to the preferred location will likely contribute to noise attenuation.

As reported by Safetech (2022) on SANS 10103, noise levels produced "*by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries, should not exceed a maximum sound pressure level of 50 dB(A) at a distance of 15 m from each individual source*". As per the recommendations of the Avifauna specialist (Anchor Environmental and TBC, 2022), monitoring of noise levels at the sandspit and the Kabeljous Flats is recommended at least monthly during operation so these can be compared to the changes in bird populations, if any. In any instance of detectable change, additional means of reducing airborne noise from the powerships must be implemented to prevent lasting impacts on the birdlife.

8.5.Impact Rating Summary

Several potentially significant impacts of the proposed Gas to Power project on the ecology of the Port of Richards Bay were identified and assessed. A summary of the impact scoring is presented below (Table 58).

Table 58. A summary of impacts associated with the construction and operation of the proposed Gas to Power project that were identified and assessed

Impact (after mitigation)		Impact Description	Likelihood			Significance		
			Duration	Spatial scale	Severity	Frequency	Probability	
	CONSTRUCTION PHASE							
1	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology as a result of water-based construction activities	Up to 1 year	Project footprint	Site-specific and wider natural processes and functions are not altered	Once or more a week	Probable	**Low**
2	Alternate layout 1&2	Changes in water quality as a result of water-based construction activities	1 – 2 years	Within the broader EFZ	Site-specific and wider natural functions and processes are slightly altered	Once or more a week	Probable	**Medium-low**
3	Alternate layout 1&2	Disturbance to surrounding estuarine ecology due to increased noise levels from construction	1 – 2 years	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Once or more a week	Possible	**Medium-Low**
4	Alternate layout 1&2	Effect on ecosystem services (fisheries and mariculture) due to increased noise levels from construction	Up to 1 year	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Once or more a week	Possible	**Medium-Low**
5	**Effect on terrestrial fauna (including avifauna) as a result of construction activities**							
	Disturbance of avifauna due to increased human presence and possible use of machinery and/or vehicles.	Summary of potential impacts on avifauna associated with the construction phase of the Karpowership project – ships	Up to 1 year	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Daily	Possible	**Medium-Low**
	Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)		2 - 20 years	Project footprint	Site-specific and wider natural processes and functions are not altered	Once a year or once during operation	Definite	**Medium-Low**
	Habitat Loss (Destroy, fragment and degrade CBA, ESA and ONA	Summary of potential impacts on avifauna associated with the construction phase of the	2 - 20 years	Project footprint	Site-specific and wider natural processes and functions are not altered	Once a year or once during operation	Improbable	**Very-Low**

	Impact (after mitigation)	Impact Description	Likelihood			Significance		
			Duration	Spatial scale	Severity	Frequency	Probability	
	habitat, ultimately displacing avifauna)	Karpowership project – transmission lines and ancillary infrastructure						
	Disturbance of avifauna due to increased human presence and possible use of machinery and/or vehicles		Up to 1 year	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Daily	Possible	**Medium-Low**
	Loss of fauna Species of Conservation Concern	Summary of potential impact of loss of fauna Species of Conservation Concern during construction	Brief	Immediate	Small	Once a year	Likely	**Low**
	Effect on macrophyte habitats as a result of construction within the estuarine functional zone							
	Loss of modified habitat	Summary of impacts associated with the construction of the Karpowership transmission line, and ancillary infrastructure on the terrestrial ecology of Richards Bay estuary	Brief	Immediate	Small	Once a year	Definitely	**Low**
	Loss of reed beds		Brief	Immediate	Significant	Once a year	Possible	**Low**
	Loss of bushveld		Brief	Immediate	small	Once a year	Definitely	**Low**
	Loss of flora SCC		1 to 3 months	Immediate	Insignificant	Once a year	Definitely	**Low**
	Loss of biodiversity in general		Brief	Immediate	Small	Once a year	Likely	**Low**
	Fragmentation		Brief	Immediate	Small	Once a year	Likely	**Low**
	Invasion of alien species		Brief	Immediate	Insignificant	Once a year	Definitely	**Low**
	Establishment of a construction site camps and erection of ablution facilities within a previously disturbed area.	Summary of potential impacts of the proposed development on the surrounding watercourses/ wetlands within the Richards Bay estuary	Ratings are as per detailed DWS Risk Assessment Matrix					**Negligible**
6	Establishment of a construction site camps for the material laydown area, site office and concrete coating area and stringing yard.		Ratings are as per detailed DWS Risk Assessment Matrix					**Low**
	Demarcation of buffer zones and no-go areas and the allocation/ preparation of spoil sites (topsoil separate from subsoil), waste dump sites and construction vehicle routes		Ratings are as per detailed DWS Risk Assessment Matrix					**Negligible**
	Construction vehicle movement throughout the lifespan of the proposed development.		Ratings are as per detailed DWS Risk Assessment Matrix					**Low**
	Direct destruction of vegetation and topsoil layer within the footprint of the Overhead Powerlines and temporary material laydown area, site office and concrete coating area and stringing yard		Ratings are as per detailed DWS Risk Assessment Matrix					**Low**
	Construction of the 132kV Overhead Lattice Steel Structure and Switching Station		Ratings are as per detailed DWS Risk Assessment Matrix					**Low / Moderate**
	Construction and installation of the gas pipeline		Ratings are as per detailed DWS Risk Assessment Matrix					**Negligible**

Impact (after mitigation)		Impact Description	Likelihood			Significance		
			Duration	Spatial scale	Severity	Frequency	Probability	
	De-establishment of the site camp, spoil sites, waste dumps and the rehabilitation of the temporary access/haulage roads				Ratings are as per detailed DWS Risk Assessment Matrix			**Negligible**
	Utilisation of the Overhead Powerlines and Switching Station				Ratings are as per detailed DWS Risk Assessment Matrix			**Low/ Moderate**
7	General Construction	Effect of solid waste pollution generated during the construction period	1 – 2 years	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Once or more in 6 months	Possible	**Low**
8	General Construction	Effect on chemical pollution arising from construction related spills of hazardous substance	1 – 2 years	Beyond the EFZ	Site-specific and wider natural processes and functions are altered to a large degree/temporarily cease	Once or more in 6 months	Possible	**Medium-low**
	OPERATIONAL PHASE							
9	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology due to seawater intake for cooling purposes	2 - 20 years	Project footprint	Site-specific and wider natural processes and functions are not altered	Daily or hourly	Possible	**Medium-low**
10	Alternate layout 1&2	Effect of powership cooling water discharge on estuarine/marine ecology	2 - 20 years	Within the broader EFZ	Site-specific and wider natural processes and/or functions are slightly altered	Daily or hourly	Possible	**Medium**
11	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology due to increased underwater noise and vibrations	2 - 20 years	Within the broader EFZ	Site-specific and wider natural processes and/or functions are slightly altered	Daily or hourly	Possible	**Medium**
12	Alternate layout 1&2	Effect on surrounding estuarine/marine ecology due to light pollution	2 - 20 years	Project footprint	Site-specific and wider natural processes and functions are slightly altered	Once or more a week	Possible	**Medium-low**
13	Alternate layout 1&2	Effect of the combined operational impacts on ecosystem services (fisheries and mariculture)	2 - 20 years	Within the broader EFZ	Site-specific and wider natural processes and/or functions are slightly altered	Daily or hourly	Possible	**Medium**
14	Loss of modified habitat	Effect on macrophyte habitats and terrestrial fauna	Long term	Immediate	Small	Once a year	Unlikely	**Low**
	Loss of reed beds		Medium term	Immediate	Significant	Once a year	Highly likely	**Low**
	Loss of bushveld		Long term	Immediate	Insignificant	Once a year	Highly unlikely	**Low**

Impact (after mitigation)		Impact Description	Likelihood			Significance		
			Duration	Spatial scale	Severity	Frequency	Probability	
	Loss of flora SCC		Long term	Immediate	Insignificant	Once a year	Highly unlikely	**Low**
	Loss of fauna SCC		Long term	Immediate	Insignificant	Once a year	Highly unlikely	**Low**
	Loss of biodiversity in general		Long term	Immediate	Insignificant	Once a year	Highly unlikely	**Low**
	Fragmentation		Long term	Immediate	Small	Once a year	Highly unlikely	**Low**
	Invasion of alien species		Brief	Immediate	Insignificant	Once a year	Definitely	**Low**
	Loss of fauna Species of Conservation Concern	Summary of potential impact of loss of fauna Species of Conservation Concern during operation	Long term	Immediate	Insignificant	Once a year	Highly unlikely	**Low**
15	Habitat loss (Destroy, fragment and degrade CBA, ultimately displacing avifauna)	Effect on coastal and estuarine avifauna associated with overhead transmission lines and ancillary infrastructure	2 - 20 years	Project footprint	Site-specific and wider natural processes and functions are not altered	Once a year or once during operation	Improbable	**Very-Low**
	Collisions with transmission lines and associated infrastructure		2 - 20 years	Beyond the EFZ	Site-specific and wider natural processes and functions are slightly altered	Once or more in 6 months	Probable	**Medium-Low**
	Electrocution by infrastructure and connections to transmission lines		2 – 20 years	Beyond the EFZ	Site-specific and wider natural processes and functions are not altered	**Once a year or once during operation**	Possible	**Medium-Low**
16	Light pollution	Effect on coastal and estuarine avifauna due to operation of powerships	2 – 20 years	Within the broader EFZ	Site-specific and wider natural processes and functions are not altered	Once a year or once during operation	Possible	**Low**
	Noise and vibration impacts		2 – 20 years	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Daily	Possible	**Medium**
	Human disturbance		2 – 20 years	Within the broader EFZ	Site-specific and wider natural processes and functions are slightly altered	Once a year or once during operation	Improbable	**Very-Low**

Impact (after mitigation)		Impact Description	Likelihood			Significance		
			Duration	Spatial scale	Severity	Frequency	Probability	
17	General operation	Effect of chemical pollution arising from spills and leaks to hazardous substances, and day-to-day shipping practices	2 - 20 years	Beyond the EFZ	Site-specific and wider natural processes and functions are altered to a large degree/temporarily cease	Once or more in 6 months	Possible	**Medium-Low**
18	Alternate layout 1&2	Effects of catastrophic accidents on estuarine/marine ecology, avifauna and ecosystem services	Beyond 20 years	Affecting KZN, SA or global,	Site-specific and wider natural functions and/or processes are completely altered/cease	Once a year or once or more during operation or once off	Improbable	**Low**

8.6.Cumulative Impacts

Anthropogenic activities can result in numerous and complex effects on the natural environment. While many of these are direct and immediate, the environmental effects of individual activities or projects can interact with each other in time and space to cause incremental or aggregate effects. Impacts from unrelated activities may accumulate or interact to cause additional effects that may not be apparent when assessing the activities individually. The ICM Act is clear in its directive to not view development activities in isolation from their local and regional contexts, but rather to consider direct and indirect impacts, as well as potential cumulative and synergistic impacts of proposed activities in the coastal zone. Cumulative effects are defined as the total impact that a series of developments, either present, past or future, will have on the environment within a specific region over a particular period of time (DEAT IEM Guideline 7, Cumulative effects assessment 2004). Assessing cumulative impacts involves examining the impacts of a proposed activity at a coarser scale, and collectively in relation to adjacent and regional projects, developments or activities. Need and desirability, and potential oversupply of power, of the various options should be considered in the overarching environmental impact assessment.

8.6.1. Consideration of other projects and developments

As the project site is located within the existing and operational Port of Richards Bay, existing and operational facilities in proximity include various substations (Impala, Hillside, Athene, Polaris, Newside), various 132kV overhead power lines (Impala/Nseleni 1, Alusaf Bayside/Impala 1, Alusaf Bayside/Impala 2, Athene/Hillside 1, Athene/Hillside 2 and Athene/Hillside 3), Phinda gas-to-power facilities, the Richards Bay Coal Terminal, Fermentech Fertilizer Supplier facility, South32 / Bayside Aluminium facility (in the process of being decommissioned) and the Mondi Richards Bay facility. In addition, developments that have received authorisation which potentially pertain to cumulative impacts in terms of emissions include Eskom CCPP, Elegant Afro Chemicals Chlor-Alkali Plant, Hulamin (previously Isizinda) expansions, and the Mondi Upgrade.

There are several gas-to-power projects proposed within the Port of Richards Bay and in the Richards Bay Industrial Development Zone.

- The proposed **Richards Bay Gas to Power Plant at IDZ 1F**. The proposed 400MW gas to power project at the Richards Bay IDZ (proposed amendments to the existing Environmental Authorisation and EMPr), **located outside of the Richards Bay EFZ.** The scope includes 6 gas turbines for mid-merit/peaking plant power provision, with 2 steam turbines utilizing the heat from the engines in a separate steam cycle, as well as 3 fuel tanks of 2000 m³ each for on-site fuel storage. This also includes the grid connection infrastructure for the 400MW RBGP2 gas-to-power plant. Based on the final Scoping Report, this project includes the development of an 8.5 km long 132kV overhead powerline and switching station to connect the authorised RBGP2 400MW gas-to-power facility to the national grid at a feasible grid connection point to the south of the power station site. An environmental authorisation was issued in 2016, however, an amendment was applied for in 2020 and in May 2022 the Centre for Environmental Rights (CER) approached the Pretoria High Court to challenge the reissued authorization.

- The proposed **Eskom 3000 MV Combined Cycle Power Plant (CCPP)** and associated infrastructures is proposed to be construction on Portion 2 and Portion 4 of Erf 11376 within the RBIDZ Zone 1D, **located outside of the Richards Bay EFZ**. The facility will operate with natural gas as the main fuel source and diesel as a back-up source. This project is planned to go-ahead; however, objections have been submitted. The main infrastructure associated with the facility includes the following:
  - Gas turbines for the generation of electricity through the use of natural gas or diesel;
  - Heat recovery steam generators (HRSG) to produce steam;
  - Steam turbines for the generation of additional electricity through the use of steam generated by the HRSG;
  - Condensers for the conversion of steam back to water;
  - Bypass stacks associated with each gas turbine;
  - Exhaust stacks;

- A water treatment plant for the treatment of potable water and the production of demineralised water;
- A water pipeline and water tank;
- Dry-cooled system or Once-Through-Cooling system technology;
- Closed Fin-fan coolers to cool lubrication oil for the gas and steam turbines;
- A gas pipeline and a gas pipeline supply conditioning process facility;
- Diesel off-loading facility and storage tanks;
- Ancillary infrastructure including access roads, warehouse and buildings, storage facilities, generators and 132 kV and 400 kV switch yards; and
- A power line (separate EIA process) to connect the Richards Bay CCPP to the national grid for the evacuation of the generated electricity.

- The proposed **Nseleni Independent Floating Power Plant (IFPP)** is proposed to be located **within the EFZ of Richards Bay,** at the seaward end of the sandspit, with supporting infrastructure traversing the sandspit, the Kabeljous Flats and adjacent mangrove habitat. It will initially comprise four Floating Power Barges generating a nominal 700 MW per barge resulting in 2 800 MW generation capacity. Thereafter, additional barges would be shipped in to take the combined power generation potential to as much as 8 400 MW. The power plants themselves would be Combined Cycle Gas Turbines providing high generation efficiencies. The gas turbines have low NOx burners and selective catalytic reduction (SCR) to control NOx emissions and three stage filtration to remove respirable Particulate Matter (PM). At the same time LNG is a clean burning fuel with relatively low PM loads Power would be evacuated to a newly constructed land-based substation and switching yard at the old Bayside complex and from there into the national grid. While this application was refused it could still proceed and thus needs to be taken into consideration.

- The proposed **Phinda Power Producers (Pty) Ltd Emergency Risk Mitigation Power Plant** and associated infrastructure near Richards Bay. The Project site is to be located in Alton, near the Richards Bay Industrial Development Zone (IDZ) **but outside of the Richards Bay EFZ**. The facility will have an installed generating capacity of 320MW, to operate with liquified petroleum gas (LPG) or naphtha as an initial source and will convert to utilising natural gas once this is available in Richards Bay. While Environmental Authorisation has been granted, the decision is being challenged.

The Richards Bay Gas to Power project and the Eskom CCPP projects both have proposed onshore infrastructure and do not require seawater for cooling. These projects, thus, presumably will have no estuarine ecological impacts and are not considered further. However, based on the information provided, the only project to be considered for cumulative assessment because of its location within the Richards Bay EFZ, and close proximity to the KSA Gas to Power project is the Nseleni IFPP.

8.6.2. Assessment of cumulative impacts

By definition, cumulative marine environmental impacts emanating from the proposed Gas to Power project are related to the overlap with various other sources of anthropogenic disturbance in the vicinity of the powership and FRSU. This "zone of impact" where cumulative impacts may be of concern has been defined by the operational thermal and noise modelling results. Under the worst-case scenario, the thermal zone of impact extends 100 m from the powership location, and the underwater noise zone of impact extends hundreds of metres each of the powership and FSRU (Figure 23). Cumulative thermal and underwater noise impacts are only of concern within this area, however, additional cumulative impacts that could occur outside of this area are detailed below. The high impact areas for both thermal and underwater noise operational impacts do not currently overlap with other developments with expected similar impacts (*i.e.*, discharge of cooling water, underwater noise generation).

The project site is located within an existing and operational port. Any development or maintenance activity in the Port of Richards Bay (in close proximity to the proposed project) involving the disturbance of sediments, the intake of large volumes of water, the increase in vessel traffic, the occupation of space, along with the proposed Gas to Power project, may have cumulative impacts on the surrounding marine ecology through increased underwater noise, vessel collision risk, hydrocarbon spill, invasive alien species transfer (via ballast water release), increased pollution of Richards Bay through maintenance and repair activities, and storm water runoff.

The Nseleni development, in combination with the proposed KSA Gas to Power project, may result in cumulative impacts on the surrounding estuarine ecology which will need to be considered. The following cumulative impacts provided through a high-level, qualitative assessment may arise, but are not limited to:

- A positive impact on the port function and the economic activities related thereto by providing for short-term provision of power to the Richards Bay IDZ and SEZ when the country is experiencing power shortages. The increased electricity generation capacity, when considered as part of the national Integrated Resources Plan (IRP), from the project will contribute to an enabling environment for economic growth even at times of power shortfalls and during load shedding;
- Contribution to the potential polluting activities in the Richards Bay, especially when combined with other shipping and heavy industrial activities, with resultant negative impacts on the Richards Bay Estuary, the avifauna and the system's critically important nursery function. Mariculture facilities and operations could also be negatively impacted. Such events must be controlled collectively by the TNPA and SAMSA. While issues relating to pollution are not considered to be of greater threat or significance than current port activities, the risk of cumulative impacts to the sensitive estuarine environments increases as activities within the port increases;
- Greater negative impacts are anticipated for the sensitive receptors of Richards Bay (specifically the biological communities of the Kabeljous sand and mudflats, the sandspit and the adjacent mangrove habitat) if the significantly larger Nseleni project is implemented simultaneously with the KSA Gas to Power project. It is possible that sensitive bird populations will be displaced as a result of significantly greater noise and light disturbance, and underwater noise impacts could affect both the nursery function and the productivity of the intertidal and subtidal areas. Overall, the critical ecosystem functions, and biodiversity value of Richards Bay, could be diminished. Cumulative impacts without mitigation are expected to be high;
- Increased risk to all vessels (possible collision etc.) and port operations as a result of dynamic coastal processes related to climate change (increased storminess, tidal surge etc.). Again, this would be part of normal shipping practices controlled by the TNPA; and
- The transient nature of the KSA Gas to Power proposal (as well as the Nseleni project), in comparison to permanent infrastructural development, landscape transformation and longer-term environmental impacts associated with the proposed land-based operations within the RBIDZ 1D and 1F zones.

Given the major modifications of the natural environment due to port development, the estuarine space in Richards Bay is already limited. The addition to the proposed powership development further reduces the space available to estuarine and marine organisms that use the environment of Richards Bay. Considering this it is reasonable to assume that a threshold will exist where an exceedance of which (in terms of disturbance space) will have substantial negative effects on the estuarine environment as a whole. Estuarine and marine organisms will be displaced to elsewhere in the Bay until a lack of available habitat causes significant spatial changes to their distribution *i.e.*, vacation of the Bay entirely. The Richards Bay open water area is 13 km^2 and the proposed powerships will further reduce available space within the Bay by 0.42 km^2, equivalent to 3.2%.

The comprehensive, quantitative assessment of cumulative impacts requires extensive input from government departments, regulating authorities and other stakeholders. The impact studies for the Nseleni NIFPP project were recently completed (2021) and revealed ecological impacts in terms of wetland and terrestrial vegetation communities, noise, dredging of the Kabeljous Flats, routing of power evacuation pipeline and cabling bridge piles across the Kabeljous Flats (with unknown consequences for hydrodynamics and sediment deposition), moderate impacts to estuarine fauna (including fish), whereas the impact on avifauna was considered a fatal flaw (SE Solutions, 2021). The environmental authorisation was refused. The cumulative impacts of these two Gas to Power projects (KSA Gas to Power and NIFPP) if operating simultaneously, are expected to be highly negative, from an ecological perspective.

Of critical importance to this application and all the other power generating applications either already approved or proposed, relates specifically to the key informants discussed in Section 4. These informants direct that the responsible authority is unable to approve an application for environmental authorisation if the said activity is not aligned with the key objectives of the uMhlathuze/Richards Bay EMP (DEA, 2017a). The cumulative impacts of the KSA Gas to Power project, in conjunction with the significantly larger Nseleni Gas to Power project (if both are simultaneous approved) are anticipated to reduce the current state of the estuarine environment making the approval of both projects unworkable.

8.7.Specialist Integration

In line with the polycentric or holistic approach the following specialist reports should take consideration or have been taken into consideration (*i.e.* findings and recommendations of this report must be considered):

- the updated Avifauna assessment (Anchor Environmental and TBC, 2022):
    - Avifaunal communities are a key feature of the Richards Bay estuary, with sensitive species of conservation concern found utilising various habitats of the estuarine environment, including the built port environment.
- the updated Terrestrial Noise assessment (Safetech, 2022):
    - noise generated by the operation of the powerships will impact surrounding estuarine faunal communities and sensitive habitats, including the Kabeljous Flats, sandspit and mangroves which are important bird habitats in the system.
- the updated Terrestrial Ecology Assessment (de Wet, 2022):
    - the estuarine functional zone encompasses aquatic (estuarine water body) as well as terrestrial habitats and related biodiversity that will be affected.
- the updated Wetland Ecology Assessment (Triplo4, 2022a):
    - the estuarine functional zone encompasses aquatic (estuarine water body) as well as wetland habitats and related biodiversity that will be affected.
- the Underwater Noise Assessment (Subacoustech Environmental, 2022):
    - underwater noise generated by the operation of the powerships has the potential to impact on the surrounding estuarine/marine ecology of the Richard Bay estuary
- the updated Climate Change Assessment (Promethium Carbon, 2022):
    - as a result of the requirement by the ICMA to consider the likely effect of dynamic coastal processes (such as wave, current and wind action, erosion, accretion, sea-level rise, storm surges and flooding) on the activity.
- the Richards Bay Landscape and Visual assessment input (Environmental Planning & Design, 2022):
    - this is considered as a result of ICMA requirements to consider sense of place, it is however noted that the anticipated visual influence of the proposed activity is reported to be largely limited to active areas within the Port and adjacent industrial areas, and therefore not a specific negative impact.
- the Socio-Economic Impact Assessment and small-scale fisheries appendix (Social Risk Research, 2022; Steenkamp and Rezaei, 2022).
    - as a result of the requirement by the ICMA to consider the socio-economic impact if that activity or action is authorised or not authorised

9. CONCLUDING REMARKS

A Gas to Power project is proposed to be deployed within the Port of Richards Bay, The immediate areas surrounding the port, *i.e.* the Richards Bay IDZ constitute a Strategic Economic Zone, and much of the vacant areas around the port have been earmarked for port and industrial/economic development. The nature of the landscape is highly modified as a result of the historical development, more recent port developments and expansions, and active development projects currently taking place within the IDZ, with limited natural and/or undeveloped areas remaining. Furthermore, the provisional long-term development plans for the port entail the excavation and extension of the 600 Berth Basin to the west (inland) to increase berth capacity.

Notwithstanding the above, the Port of Richards Bay also supports highly productive, biologically diverse and ecologically sensitive habitats, which require special consideration for future development proposals. The ecological importance of the Richards Bay Estuary cannot be overemphasised:

- Richards Bay is one of only three estuarine bays in the country and is consequently considered a rare estuarine type. It is a national priority estuary that requires protection in order to preserve South Africa's estuarine biodiversity.
- Despite its modified state, it supports a diversity of habitats, and therefore a rich diversity of estuarine and marine fauna and flora, including threatened or protected species.
- The endangered humpbacked dolphin regularly occurs within the port, and consideration must be given to the protection of this species, as well as its preferred habitat.
- It also provides important ecosystem services of high monetary and societal value.
- The Kabeljous Flats and the sandspit are a unique habitats that support a higher diversity of organisms relative to other areas of the port, and contributes significantly to the overall biodiversity and conservation importance of the estuary.
- Richards Bay is ranked third on a national level in terms of its importance to waterbird populations (previously supporting large numbers of birds, high numbers of migrant species, as well as species of conservation concern) and is also rated as a very important estuarine nursery area both in terms of protecting biodiversity and also sheltering commercially important fish and prawn species.
- It is an Endangered estuarine ecosystem type, meaning that it is at risk of losing vital aspects of its structure, function and composition. With a low level of ecosystem protection, *i.e.* limited to no area under formal protected area status, there little means to prevent such loss from occurring.
- It is designated an irreplaceable CBA and is also classified as a FEPA, inferring that any loss of natural features or living resources would mean an irreplaceable loss of critical biodiversity assets with national implications.

In considering the proposed Gas to Power project, the potential impacts associated with the project vary from being localised, that is, *in situ* of the project components to beyond the EFZ to a regional extent, as local bird populations as well as commercially important fish species found using the estuary, may be affected by certain impacts. The close proximity of the project to the undeveloped sensitive habitats renders these areas and their associated biological communities vulnerable to potential disturbance and/or displacement.

During the construction phase, the most significant of the identified impacts range from medium-high to high negative prior to mitigation; the highest ranking being the proliferation of invasive alien plants (high), followed by potential chemical spills (medium-high). With mitigation, these impacts were rated to be of low moderately-low negative significance, respectively. The transmission line alternate route 2 is not supported and was not rated as it is felt that this route was fatally flawed due to deliberate destruction of protected tree species and threatened mangrove habitat.

During the operational phase, the most significant impacts prior to mitigation were again proliferation of invasive alien plants (high) and chemical pollution (high), followed by the discharge of cooling water, underwater noise, and light pollution and bird collisions with the transmission line. The latter four impacts are rated as medium-high negative significance. All of these concerning operational impacts can be mitigated to be of low, med-low and medium significance, respectively, through the implementation of the applicable measures. Several of the operational impacts remained of medium negative significance even after mitigation (discharge of cooling water, underwater noise, operation on ecosystem services, noise impacts to birds) largely due to the ongoing/continuous daily effects on the surrounding environment.

When considering the potential implications for critical ecosystem services provided by the Richards Bay estuary, namely nursery grounds and waterbird habitat, the regional finfish fisheries, as well as the inshore prawn fishery, are unlikely to be significantly negatively impacted (low to moderate) by the Powership operations; and avifauna are likely to be impacted to a moderate degree by noise disturbance due to the close proximity of the ships to valuable bird habitat.

Given the sensitivity of the sandspit, the Kabeljous Flats and adjacent mangroves, it goes without saying, that any impacts on these habitats and sensitive species therein can be reduced if a more environmentally-sensitive location away from these areas is pursued. However, only the prescribed locations were assessed as per the approved Scoping Report and Plan of Study, and the identification of alternative, less sensitive sites was outside the project scope.

Cumulative negative impacts arising in conjunction with other proposed energy projects within the EFZ (specifically the NFIPP proposed to be located off the Kabeljous Flats), include contribution to polluting activities within the port, greater disturbance to habitats and biological communities, increased risk to vessels and port operations as a result of climate change impacts and at a high level of assessment, highly negative if both projects are approved and operate simultaneously.

Specific reference is made to section 63(1) of the ICM Act, which requires the relevant competent authority to consider additional criteria when evaluating an application for an activity which will take place in the coastal zone. The competent authority must ensure that the terms and conditions of any environmental authorisation are consistent with the objectives of any CMPs, EMPs in the area, and specifically any coastal management objectives (DEA and Royal HaskoningDHV, 2017). In this case, the uMhlathuze/ Richards Bay EMP (DEA, 2017a) is the most relevant programme, and the most applicable objectives included therein are that:

- estuarine ecological health meets the desired ecological state (that which is agreed upon during the Classification process, *i.e.,* C Category), including successful rehabilitation of unacceptably impacted areas in the EFZ; and
- large-scale industrial development contributes to economic growth in an environmentally - and socially-sound manner (*i.e.,* balancing ecological-social-economic benefits).

All activities within the port should therefore work toward improving the state of the estuary to achieve the desired ecological state and obtaining the resource quality objectives (once determined). Consequently, the proposed project, which is a large-scale industrial development, must ensure that the long-term ecological health of the Richards Bay estuary does not deteriorate due to its implementation.

Based on the findings of this report, and specialist reports included herein, the proposed Gas to Power project has the potential to impact various abiotic and biotic attributes of the Richards Bay estuary, that contribute to its overall high biodiversity, structure and function, but which are already in a highly- to critically modified condition (See Table 23, pg. 49). Notwithstanding the above, no impacts were identified as highly negative or resulting in fatal flaws that would prevent the project from proceeding (except for transmission line alternative route 2, which is not supported). Considering the overall rarity, biodiversity importance and conservation significance of the Richards Bay estuarine system, any potential negative impacts must be counter-balanced by a very solid motivation of socio-economic need and desirability for the project that would concede some level of degradation of this critical ecosystem.

10. REASONED OPINION

Based on the impacts considered in this report as potentially affecting the Richards Bay Estuary, which integrates assessments from various specialist fields (*i.e.* estuarine/marine ecology, avifauna, terrestrial ecology including wetlands), there are no highly negative impacts or fatal flaws that would prevent the proposed Gas to Power project from proceeding, on condition that:

- the preferred powership layout and transmission line route are adopted;
- all conditions, mitigation measures and recommendations provided, and those provided in the supporting specialist reports are strictly implemented;
- the construction and operational phases of the project are undertaken accordance in with a stringent EMPr, which contains all the mitigation measures put forward by the various specialists and which monitored by a suitably qualified ECO(s);
- the project must comply with the relevant environmental standards and thresholds throughout its lifespan, *i.e.,* water temperature thresholds, noise emissions standards, air emissions standards, etc.;
- the project must comply with TNPA pollution, emergency, and health and safety protocols, MARPOL and other applicable maritime legislation, regulations and policies for the storage and handling of LNG, and power generation processes,
- the Wetland Rehabilitation Plan developed for the project is implemented; and
- a conservation plan/ open space management plan be developed by the TNPA for the conservation of sensitive species and habitats, such as the sandspit and Kabeljous Flats. If no such document exists, KPS in partnership with TNPA, SANPARKS and Ezemvelo should have input into its development.

11. MANAGEMENT AND MONITORING RECOMMENDATIONS

Long term monitoring of the receiving water body and estuarine ecology must be implemented during construction and operation of the proposed Gas to Power project. Monitoring must follow a BACI (before/after control/impact) approach.

The following monitoring programmes are recommended:

- Monitoring of turbidity levels must be undertaken daily during the pipe laying and anchorage operations. Total suspended solid levels may not exceed 20 mg/l.
- Undertake a night light audit on a moonless night and 24-hour noise audits in accordance with SANS 10103:2008 on the sandspit and Kabeljous Flats before operations commence to determine the baseline, once operations start and annually thereafter.
- A water quality monitoring programme must be implemented to validate the predictions of the hydrodynamic modelling study and monitor constituents of the effluent.
- At a minimum the temperature of the receiving water body in the vicinity of the discharge must be monitored to validate the modelling results and to ensure compliance with the stipulated water quality guidelines.
- A noise impacts monitoring programme must be implemented to validate the predictions made of the impacts of the noise produced by the proposed project on the estuarine ecology. Benthic macrofauna, fish, birds and megafauna communities surrounding the proposed powerships, FSRU and pipeline locations must be monitored (e.g. using grab survey techniques for benthic macrofauna, video monitoring and fish sampling, visual observation) to provide pre-, during, and post- operation scenarios. This must also include areas on the Kabeljous Flats, sandspit and adjacent mangroves.
- Monitoring of the distribution and behaviour of diving seabirds in the context of the powerships should also be undertaken.
- The long-term monitoring of underwater noise in Richards Bay must be conducted.
- Avifauna monitoring is to take place monthly for one (1) year pre-construction and then monthly for one (1) year post construction so that mitigation measures can be adapted to ensure the development

does not have a long-term impact on the avifauna Species of Conservation Concern and migratory waders in the area.

- A follow-up assessment on avian biodiversity and species abundance within the assessment area and surrounding areas must be conducted within one year after the facility has been in operation and should be repeated every 3-5 years.
- A monitoring plan has been developed for the site and monitoring is currently ongoing. Information obtained from the monitoring must be provided to BirdLife Renewable Energy Programme on energy@birdlife.org.za. The data must be presented as described in Jenkins *et al.,* 2017.
- A comprehensive monitoring programme must be implemented to ensure that operation, as well as maintenance, of the Gas to Power project and its various components comply with relevant standards and all environmental, health and safety regulations. All records of discharge volumes and quality are to be kept for auditing purposes.

These surveys should be ongoing and following a sampling methodology that is robust when assessing the impacts produced by the powerships on the distributions of estuarine biotic communities. Importantly, adaptive management, informed by monitoring results must be implemented to reduce negative impacts and also to ensure compliance with applicable guidelines (*e.g.* water quality guidelines). Participation in and contribution of data to external, long-term monitoring programmes currently being undertaken in Richards Bay is encouraged.

During construction, general environmental compliance monitoring must be undertaken by a suitably qualified environmental control officer (ECO) on a weekly basis as a minimum to ensure that basic environmental best practices are followed and that conditions of the environmental authorisation are observed. The presence of an on-site environmental officer is essential to monitor daily activities.

It is recommended that these monitoring requirements are included in any subsequent EMPr. These monitoring activities will make an important contribution to environmental monitoring of the Richards Bay Estuary as whole, especially if undertaken in alignment with uMhlathuze/ Richards Bay EMP. The resultant report must be submitted to TNPA for integrated and adaptive environmental management of the port overall

The Wetland specialist report (Triplo4, 2022a) indicated that several impacts could not be mitigated lower the moderate risk rating and therefore a Water Use License Application would be required.

In support of De Wet (2022) and Anchor Environmental and TBC (2022), it is recommended that a joint venture including TNPA and all port users (including current and future users, including Karpowership) should ideally be actioned as soon as possible to allow for the following (critical management systems) to take place:

- Management and control of alien and invasive plants;
- Definition and maintenance of a Conservation and/or Open Space Management Plan; and
- Development and implementation of a rehabilitation plan.

Each of these aspects cannot be taken on by one individual user, as overall management is critical to such an important ecosystem and management in isolation will be ineffective.

This is to ensure that sensitive, ecologically important habitats, which support threatened species and species of conservation concern, *e.g.* the Kabeljous Flats, mangroves, sandspit etc., are duly acknowledged by all current and prospective operators/stakeholders within the port. This will help to instate collective stewardship of these areas such that they are preserved and rehabilitated and/or enhanced to mitigate the impacts of industrial development and port activities in general.

If a conservation management plan does not already exist, KPS in partnership with TNPA, SANPARKS and Ezemvelo should have input into its development.

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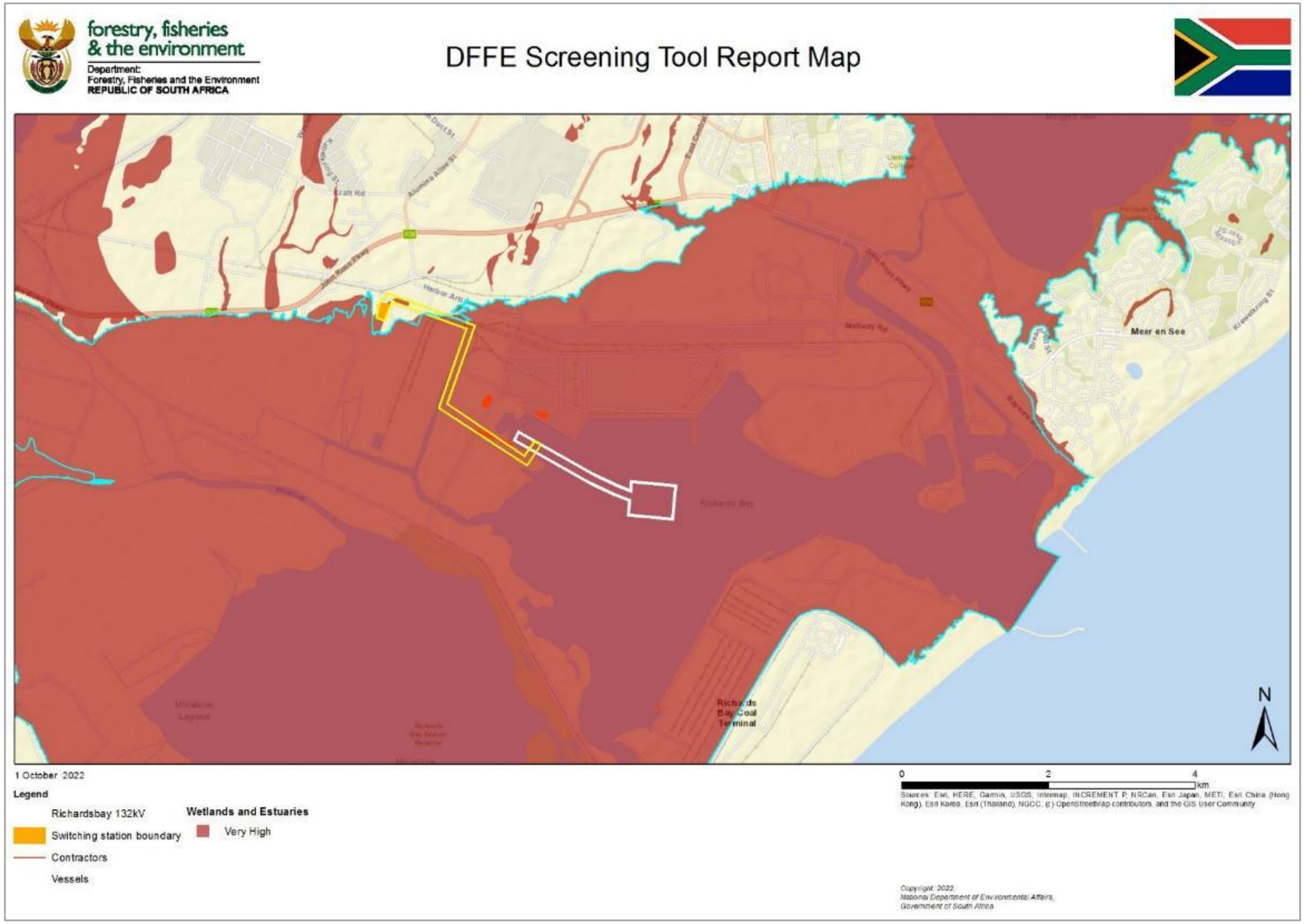
13. APPENDICES

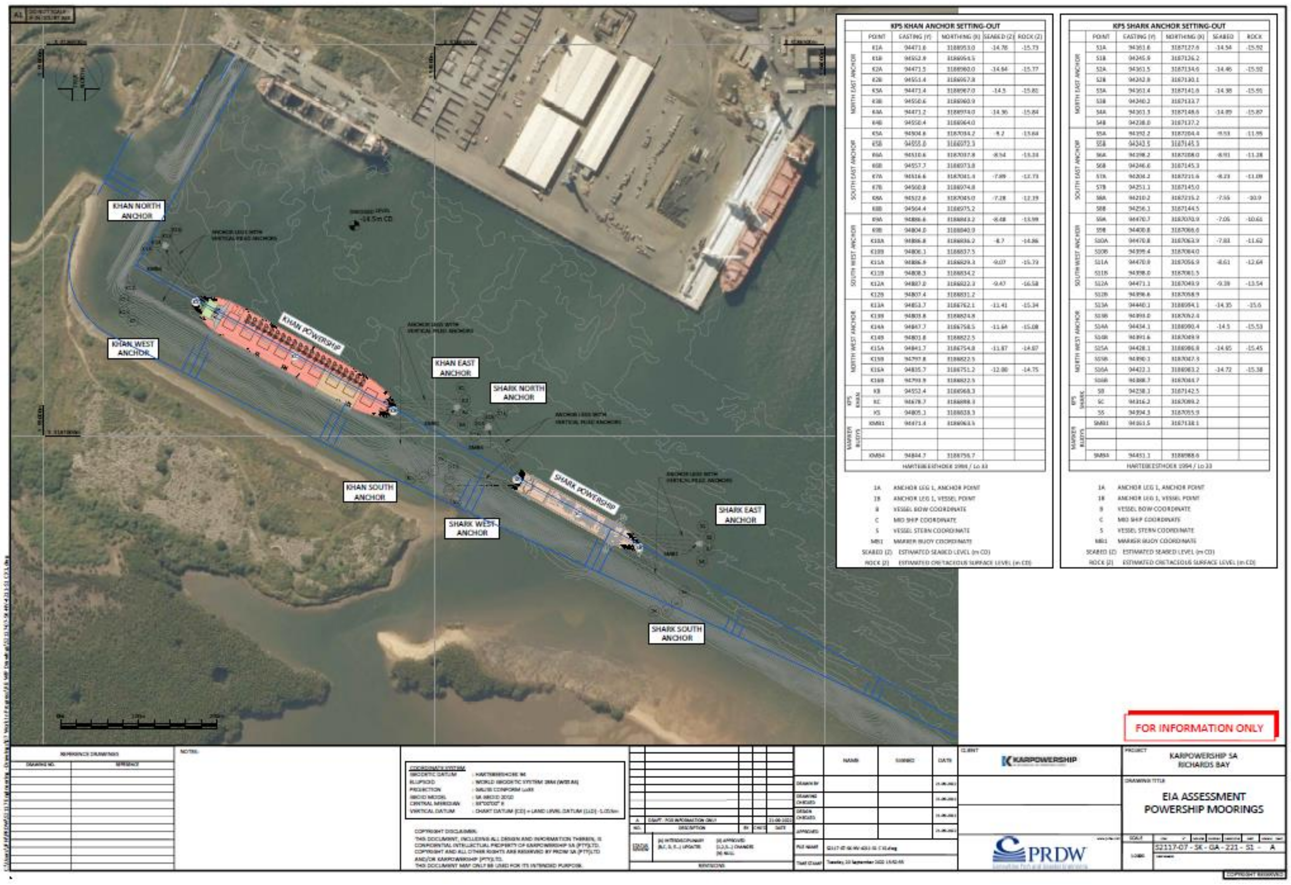
13.1. Appendix A: Site Sensitivity



Appendix 1. DFFE Screening Tool Site Sensitivity Map (2022) showing the Gas to Power project components relative to the sensitive estuarine-wetland features of the Richards Bay-Mhlathuze estuarine complex

13.2. Appendix B: Component Coordinates

Vessels and gas pipelines



Appendix 2. Coordinates for vessels and pipelines (Alternative 1 layout, preferred)

Contractor Areas

Appendix 3. Central coordinates for contractor areas

Description	Central Coordinates	
	Longitude	Latitude
Stringing Yard	32°01' 32.28" E	28°47' 37.81" S
Material laydown	32°01' 52.99" E	28°47' 29.11" S
Site Office and concrete coating	32°01' 28.88" E	28°47' 23.73" S

Transmission Line Routes

Appendix 4. Coordinates for transmission line routes: Alternative 1 route (preferred)

Point	Coordinates	
	Longitude	Latitude
From powership (Khan Class) to First Tower Alternative 1 – Start point	32°01'50.35"E	28°47'39.67"S
From powership (Khan Class) to First Tower Alternative 1 – End point	32°01'45.68"E	28°47'45.92"S
From powership (Shark Class) to First Tower Alternative 1– Start point	32°01'50.35"E	28°47'39.67"S
From powership (Shark Class) to First Tower Alternative 1 – End point	32°01'45.68"E	28°47'45.92"S
Transmission Line Route – Alternatives 1– Start point	32°01'50.35"E	28°47'39.67"S
Transmission Line Route – Alternatives 1– End point	32°00'44.55"E	28°46'48.48"S

Transmission Line Route Alternative 1 – mid-way point	32°01'14.68"E	28°47'12.86"S
Transmission Line Route Alternative 1 (bend 1)	32°01'45.68"E	28°47'45.92"S
Transmission Line Route Alternative 1 (bend 2)	32°01'10.48"E	28°47'25.89"S
Transmission Line Route Alternative 1 (bend 3)	32°01'21.27"E	28°46'55.16"S
Transmission Line Route Alternative 1 (bend 4)	32°00'45.97"E	28°46'44.11"S

Alternative 2 route (not supported)

Appendix 5. Coordinates for transmission line routes: Alternative 2 route

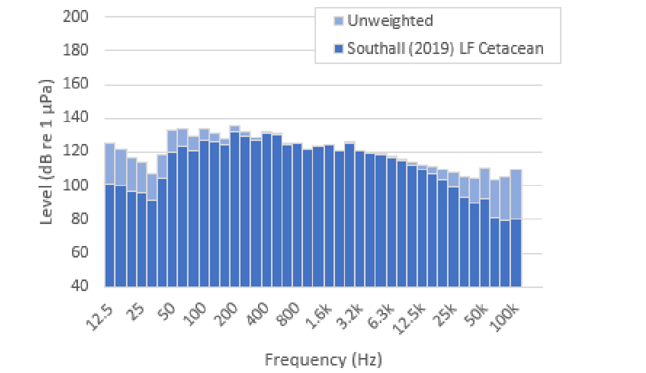
Point	Coordinates	
	Longitude	Latitude
From powerships to First Tower Alternative 2 – Start point	32° 2'17.26"E	28°47'59.62"S
From powerships to First Tower Alternative 2 – End point	32° 1'41.17"E	28°47'44.90"S
Transmission Line Route Alternative 2 – mid-way point	32° 0'38.92"E	28°47'44.07"S
Transmission Line Route Alternative 2 (bend 1)	32° 1'23.59"E	28°47'37.78"S
Transmission Line Route Alternative 2 (bend 2)	32° 1'13.48"E	28°47'54.36"S
Transmission Line Route Alternative 2 (bend 3)	32° 0'23.24"E	28°47'39.11"S
Transmission Line Route Alternative 2 (bend 4)	32° 0'42.61"E	28°46'52.51"S

Switching Station

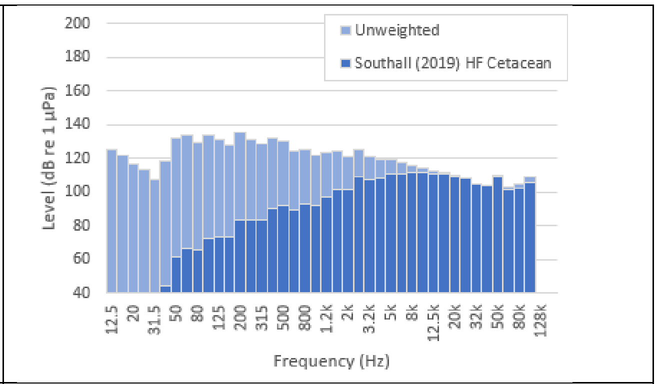
Appendix 6. Coordinates for switching station

Corner	Coordinates	
	Longitude	Latitude
1	28° 46' 45.32"	32° 00' 41.00"
2	28° 46' 51.48"	32° 00' 39.84"
3	28° 46' 52.01"	32° 00' 43.41"
4	28° 46' 46.24"	32° 00' 44.72"
Midpoint	28° 46' 48.83"	32° 00' 42.16"

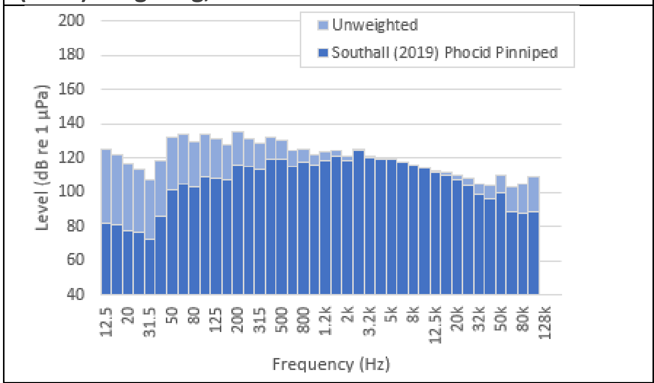
13.3. Appendix C: Weighted Sound Exposure for Marine Mammals



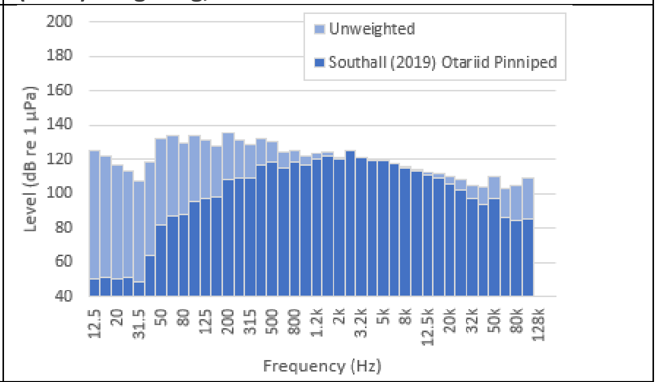
A) Powership frequency with effect of Southall *et al.* (2019) weighting, LF cetacean



B) Powership frequency with effect of Southall *et al.* (2019) weighting, HF cetacean



C) Powership frequency with effect of Southall *et al.* (2019) weighting, phocid pinniped



D) Powership frequency with effect of Southall *et al.* (2019) weighting, otariid pinniped and other marine carnivores

Appendix 7. Powership frequency with effect of Southall *et al.* (2019) weighting for various marine mammal species groups, from Subacoustech Environmental (2022)

13.4. Appendix D: Specialist Information

13.4.1. Project Team

<table>
<tr><th>Staff name</th><th>Job title</th></tr>
<tr><td></td><td>Name: Tandi Breetzke
Position: Director
Company: Coastwise Consulting
Years' Experience: +30 yrs
Location: Durban
Project Role: Project manager, coastal/estuarine management, team liaison, institutional knowledge, strategic input</td></tr>
<tr><td colspan="2">Tandi Breetzke is a coastal management specialist with extensive coastal management / environmental experience in both the public as well as private sectors. She has a BA honours degree in Geography and served on the IAIAsa National Executive Committee; is a member of both the KZN provincial Coastal Committee as well as the eTkekwini Coastal Committee, is a member of the WESSA affiliated coastal NGO, CoastWatch, as well as being a long-standing jury member and now Chairman of the South African National Blue Flag Jury.
Tandi was responsible for the management and development of the Royal HaskoningDHV Coastal Management Unit where she undertook coastal and estuarine specific consultancy work and was recognised by the company as a Leading Professional. Prior to that, Tandi championed the development of the Integrated Coastal Management specialisation in South Africa and KZN, from its early policy beginnings as a Green Paper and White Paper to its eventual enactment into law and implementation. She initially developed governmental policies, practices and procedures as a provincial government official and thereafter, as an environmental consultant, implemented these hard-won principles of ICM that were developed. Tandi has also mentored and guided numerous young professionals and students within the field of integrated coastal and environmental management, thereby promoting the sustainability and longevity of the profession and ICM specialisation.
Tandi is now the owner and director of her own consultancy, Coastwise Consulting, specialising in coastal specific work and is associated with various companies including Royal HaskoningDHV, FutureWorks, Phelamanga Projects, Groundtruth and others.</td></tr>
<tr><td></td><td>Name: Catherine Meyer
Position: Environmental Consultant (Estuarine Ecologist)
Years' Experience: 10 yrs
Company: GroundTruth
Location: Durban/Hilton
Project Role: Estuarine ecologist, data and information collation and interpretation, coastal/estuarine management, strategic input</td></tr>
<tr><td colspan="2">Catherine Meyer is a passionate and energetic young coastal environmental scientist. She has a Bachelor of Science Degree, majoring in Environmental Biology and Geology, from the University of KwaZulu-Natal.
For four years, Catherine conducted biological studies in numerous estuarine systems in KZN, leading to the achievement of a master's degree in Estuarine Ecology. She has more than five years' experience in biological data collection, laboratory processing, microscopy and identification of benthic macroinvertebrates. Catherine is also an accredited SASS5 biomonitoring practitioner, focussing on invertebrate communities and riverine health.
During her time as an Environmental Consultant at Royal HaskoningDHV, Catherine provided specialist support regarding estuarine and coastal ecology to the Royal HaskoningDHV Coastal Service Line in South Africa. In so doing, Catherine has undertaken several estuarine impact assessments and aquatic biomonitoring studies, and contributed to the development of estuarine management plans, estuarine mouth management plans, coastal management programmes, environmental management frameworks, development concept planning, and state of the environment reporting.
For 3 years, Catherine was an Associate at Coastwise Consulting, which specialises in coastal-specific work and is associated with various companies including Royal HaskoningDHV, FutureWorks, Phelamanga Projects, Groundtruth and others. She is now based at GroundTruth, where she undertakes aquatic biomonitoring and related surveys, but is still integrated with Coastwise Consulting in the field of estuarine and coastal assessments and management.</td></tr>
</table>

Name: Dr Barry Clark
Position: Director

Years' Experience: 30 years

Company: Anchor Environmental

Location: Cape Town

Project Role: Review and update of previous marine assessment, fisheries assessment, SACNASP review and signoff

Dr Barry Clark is founder and Director of Anchor Environmental Consultants. He has thirty years' experience in marine biological research and consulting on coastal zone and marine issues. He has worked as a scientific researcher, lecturer and consultant and has experience in tropical, subtropical and temperate ecosystems. He is presently Director of an Environmental Consultancy firm (Anchor Environmental Consultants) and Research Associate at the University of Cape Town. As a consultant has been concerned primarily with conservation planning, monitoring and assessment of human impacts on estuarine, rocky shore, sandy beach, mangrove, and coral reef ecosystems as well as coastal and littoral zone processes, aquaculture and fisheries. Dr Clark is the author of 27 scientific publications in class A scientific journals as well as numerous scientific reports and popular articles in the free press. Geographically, his main area of expertise is southern Africa (South Africa, Lesotho, Namibia, Mozambique, Tanzania, Seychelles, Mauritius and Angola), but he also has working experience from elsewhere in Africa (Republic of Congo, Sierra Leone, Liberia, Cote d'Ivoire, Ghana, Nigeria), the Middle East (UAE) and Europe (Azerbaijan, Greenland).

Curriculum Vitae –Tandi Breetzke

PERSONAL
Name: Tandi Breetzke
Nationality: South African
ID number: 6710080006081
Industry: Integrated Coastal Management specialist / environmental consultant
Experience: 30 years

CONTACT DETAILS
Tel: 031 764 4947
Cell Phone: 082 8737 400
Email: tandi@coastwise.co.za
Address: 9 Edward Drive, Gillitts, 3610

QUALIFICATIONS
1992 - 1988 BA (Hons) Geography, Natal University Pietermaritzburg, South Africa BA Geography, Pretoria University, South Africa

MEMBERSHIPS
- International Association for Impact Assessment South Africa (IAIAsa) Member as well as former National Executive Committee member
- KZN Coastal Committee: former Member
- eThekwini Coastal Committee: former Member
- Coast Watch (Coastal NGO), Member
- Blue Flag National Jury, Chair

LANGUAGES
English - Native proficiency and Afrikaans - Bilingual proficiency

PROFILE
Tandi Breetzke is a coastal management specialist with extensive coastal management / environmental experience in both the public as well as private sectors. She has a BA honours degree in Geography and is an IAIASA member; she was formally a member of both the KZN provincial Coastal Committee as well as the eThekwini Coastal Committee, is a member of the WESSA affiliated coastal NGO, CoastWatch, as well as being a long-standing jury member and now Chairman of the South African National Blue Flag Jury. Tandi spearheads her own consultancy, Coastwise Consulting, specialising in integrated coastal and estuarine management specific work and is associated with various companies including GroundTruth, FutureWorks, Phelamanga Projects, and others. Prior to 2017 Tandi managed the Royal HaskoningDHV Coastal Unit where she also undertook coastal and estuarine specific consultancy work and was recognised as a Leading Professional. Prior to that, Tandi championed the development of the Integrated Coastal Management specialisation in South Africa and KZN, from its early policy beginnings as a Green Paper and White Paper to its eventual enactment into law and implementation. She initially developed governmental policies, practices and procedures as a provincial government official and thereafter, as an environmental consultant, implemented these hard-won principles of ICM that were developed. Tandi has also mentored and guided numerous young professionals and students within the field of integrated coastal and environmental management, thereby promoting the sustainability and longevity of the profession and ICM specialisation.

EMPLOYMENT HISTORY

January 2017 to present	Coastwise Consulting	Sole proprietor/Director
January 2013 to December 2016	Royal HaskoningDHV	Principal Specialist / Leading Professional
July 2011 to December 2012	SSI Engineers and Environmental Consultants	Principal Specialist / Leading Professional
January 2009 to June 2011	SSI Engineers and Environmental Consultants	Unit Manager: Coastal Management & Associate

July 2008 to December 2008	SSI Engineers and Environmental Consultants	Unit Manager: Coastal Management
August 2001 to June 2008	KZN Department of Agriculture and Environmental Affairs	Chief Planner then Deputy Manager
June 1993 till July 2001	KZN Department of Traditional and Local Government Affairs (Integrated Development Planning)	Planner
December 1991 till May 1993	KZN Department of Traditional and Local Government Affairs (Integrated Development Planning)	Town and Regional Planning Technician
June 1991 till November 1991	KZN Department of Traditional and Local Government Affairs (Physical Development)	Town and Regional Planning Technician
March 1990 till May 1991	KZN Department of Traditional and Local Government Affairs (Land Affairs)	Assistant Administrative Officer
May 1989 till February 1990	National Department of Public Works & Land Affairs	Assistant Property Administrative Officer

CORE COMPETENCIES

- considerable integrated coastal management skills and experience;
- extensive existing networks both in the public and private sectors;
- in-depth knowledge of current and proposed legislation, legislated coastal management requirements, government systems and processes;
- in-depth knowledge of local government needs;
- proven ability to innovate;
- excellent report writing and communication skills;
- strategic thinking and project management skills; and
- International and national best practice.

AWARDS/ATCHIEVEMENTS

- 2009 SSI Innovation Award - When joining SSI in 2008, and after having been promoted to Associate within a few months of being employed, she competed in and won the Gold award for the SSI Implementation of Innovation Ideas project.
- The user friendly Guide to the ICM Act - The development of this guide was the result of a private-public partnership.
- IAIA 2010 Premium Award - an annual award presented to recognise excellence in environmental management through the application of the principles of Integrated Environmental Management (IEM).
- Nomination as a finalist in the professional category of the KZN Business Woman's Association Regional Business Achievers Award 2011
- Promotions to Principal Specialist in July 2011 - Principal Specialists are nationally recognised experts in their fields within SSI and Royal HaskoningDHV
- Appointment as Leading Professional in 2013 - Appointment is in recognition of the role played in Integrated Coastal Management within South Africa and the contribution made to the company's profitability and reputation.

ABRIDGED PROJECT EXPERIENCE (SINCE 2008)

Integrated Coastal Management	
Projects	• Technical support to the KZN Coastal Management Line delineation process • Stakeholder engagement process for the listing of KwaZulu-Natal boat launch sites • Coastal Management Plan for the Ballito Hills development • Coastal Management and development setback Line determination and coastal access audit for the Eden District • Mossel Bay Sediment Study • Tongaat Hulett Developments Professional Support

	• Refinement of the Coastal Management Lines for the Overberg District • Updating the Western Cape Coastal Management Programme • Overberg Coastal Management Programme • Northern Cape Coastal Management Programme • Coastal Set-back Lines for the West Coast District • Alfred Nzo District Municipality Coastal Management Programme • Mandeni Coastal Management Programme • Eastern Cape Coastal Management Programme • Coastal setback lines demarcation for the Overberg District • City of Cape Town Coastal Management Institutional Assessment • KwaDukuza Coastal Management Programme
Project roles	Project management, specialist coastal management and professional support, client liaison, overall project quality control, input and guidance in respect to the determination of coastal management lines, presentation at public meetings and project review and finalisation, drafting of coastal management programmes; project review and finalisation, stakeholder engagement, and assessment of the roles and responsibilities for effective coastal governance
Clients	Provincial Departments, Metropolitan Municipalities, District Municipalities, Local Municipalities, Conservation Authorities and Environmental Consultancies
Estuarine Management	
Projects	• Support to the development of the Kowie Estuarine Management Plan • The development of the iZinkwazi Estuarine Management Plan • The development of the iKongweni Estuarine Management Plan • Support to the development of Umdoni Estuarine Management Plans • Ambrose Fuel Depot Estuarine and Coastal Impact Assessment • The development of seven estuarine management plans for the Ray Nkonyeni Municipality • Estuarine Management Framework and Implementation Strategy for the Western Cape Province including the updating of 17 estuarine management plans and development of 17 new estuarine management plans • Mpenjati Estuarine Management Plan • Kleinbrak Estuarine Management Plan • Isipingo Estuarine Management Plan • Various estuarine impact assessments
Project roles	• Overall project quality control, attendance of project steering and other meetings, input and guidance in respect to the updating of Estuarine Management Plans (EMPs), compilation of new EMPs; the development of an Estuary Management Framework and Implementation Strategy for the Western Cape Province as well as presentation at public meetings and project review. • Project overview and financial control. Review of situation analysis and development of Estuarine Management Plans. • Review of the impact of proposed development on specific estuaries
Clients	Provincial Departments, Metropolitan Municipalities, District Municipalities, Local Municipalities, Conservation Authorities and Environmental Consultancies
Strategic Planning	
Projects	• Western Cape Coastal Infrastructure Development Project • Umlalazi Coastal Development Plan • Development of a Wetland off-set Management Plan for the Richards Bay IDZ • Environmental Management Framework for the iLembe District Municipality • South Africa Environmental Outlook 2012 Chapter Writers • Upgrading of Mossel Bay Point Area, Phase 1 • Hibiscus Coast Local Municipality Spatial Development Framework (SDF) • Margate Urban Renewal Project • Scottburgh Urban Renewal Project • Short Course in Strategic Planning for the Namibian Coast Conservation and Management Project (NACOMA)

Project roles	• Overall project quality control, client liaison, attendance of project steering and other meetings, input and guidance in respect to offset plan; presentation at public meetings and project review and finalisation. • Undertake the coastal specific status quo assessment as well as desired state report. • Lead author of Oceans and Coasts chapter, co-ordination of coastal team. • Prepare specialist coastal opportunities and constraints report, review master plan and precinct plan and provide support in environmental impact process • Input into project inception, engagement with stakeholders and client, strategic coastal review, contribution to concept precinct development framework, and intervention strategies and design interventions, detailed coastal study and final consolidated report review • Overall project co-ordination and management, client liaison, review of objectives proposed and burning issues, contribute to training material, co-ordinate case studies, preparation for training in respect to materials etc.; review training material and undertake training
Clients	National Government, Provincial Departments, Metropolitan Municipalities, District Municipalities, Local Municipalities, Conservation Authorities, Industrial Development Zones and NACOMA
Environmental Screening, feasibility assessments and permits	
Projects	• Support to Metamorphosis Environmental Consultants in respect to the coordination of the environmental response to the UPL Cornubia arson incident and subsequent pollution event • Support to Royal HaskoningDHV in respect to IFC eThekwini WWTW processes • Coastal investigation in response to compliance notices issues: Ugu District Municipality • Stakeholder engagement process for the listing of KwaZulu-Natal boat launch sites • Coastal and estuarine high level screening report for the proposed uMhlathuze Waterfront Bridge • Coastal Waters Discharge Permit application for UMhlatuze marine effluent Disposal Pipeline, • Coastal Waters Discharge Permit application for eThekwini Southern Waste Water Treatment Works • Mpophomeni / Howick Sanitation Project • Coastal Development Feasibility Assessment Farm Blythedale • Tongaat Hullet Developments North Coast Landholdings Coastal Assessment • Mossel Bay Coastal Protection • Risk Assessment for the setting up of a Coal Transit Station at Mer Rouge, Mauritius • Coastal Opportunity Assessment and Launch Site, Tongaat River Public Node • Professional Coastal Management Support to the KZN provincial coastal lead agent • Coastal Specialist and Risk Assessment for the Nkongweni Estuary, Margate • Coastal Specialist Report for the Proposed Nonoti Beach Development
Project roles	• Overall Project Management, client liaison and presentation at meetings; quality control, project review and finalisation; • Provide support in respect to and facilitate environmental impact assessment process as well as undertake high level environmental screening • Coastal Assessment including regional, legal and management context, spatial assessment, integration of specialist studies, review of coastal access and scenario planning. Report of opportunities and constraints, contribution to concept and block plan development. • Environmental design and preparation of environmental management programme • Review physical effects of coal in the coastal environment, undertake an institutional review and project context identify existing and proposed facilities and propose coastal and marine considerations of existing and proposed operations undertake an environmental risk assessment and formulate detailed recommendations. • Review the coastal development opportunities, undertake environmental screening and application to license new and existing boat launch sites • Undertake stakeholder engagement process for the listing of KZN boat launch sites including facilitating workshops • Undertake assessment of impacts from waste water discharge into the marine environment
Clients	Provincial Departments, Metropolitan Municipalities, District Municipalities, Local Municipalities, Conservation Authorities, Environmental Consultancies, Water Authorities, private land owners and the Mauritius Central Electricity Board

Environmental Impact Assessments and Monitoring	
Projects	• Coastal and estuarine specialist impact assessment for the proposed gas to power project (Richards Bay, Coega and Saldanha) • KwaDukuza Municipality beach rehabilitation plan • Jumpstart Investments Mbango estuarine and coastal impact assessment • Port Shepstone, The Block Environmental Management Programme • 128 North Beach Road, Westbrook, Coastal Impact Assessment • Tinley North Resort Coastal Impact Assessment • Portion 3 and 5 of Erf 187, Shaka's Rock, Coastal Impact Assessment • Coastal and estuarine Impact Assessment for the Hitachi desalination plant • Environmental Impact Assessment for the Tinley Manor Southbanks Development • Environmental Impact Assessment for the Tinley Manor Beach Enhancement • Rorqual Estate Coastal Assessment • Beachfront Upgrade Phase 1: Extended in-fill Environmental Monitoring • Mnini Housing Development - An Assessment of Coastal Sensitivity • EB Steam EIA • eThekwini Promenade Upgrade • eThekwini Promenade Phase 2
Project roles	• Project management, background and information gathering, drafting of final report; update as well as compilation of Environmental Management Programmes (EMPr), amend the authorisation and review Environmental Control Officer (ECO) work on site • Assessment of Coastal Sensitivity, provide strategic input regarding coastal and water related issues, client and authority liaison • Undertake coastal specific EIAs as well as Basic Assessments including monitoring and environmental support
Clients	Metropolitan Municipalities, Local Municipalities, Environmental Consultancies, private land owners, developers and the business community

ABRIDGED PROJECT EXPERIENCE (PRIOR TO 2008)

Prior to July 2008, Tandi Breetzke gained over 20 diverse years of working in the civil service – from managing the former Town and Regional Planning Commission's Research portfolio; having involvement in hands-on development planning; low-income housing development; to land development matters. From 1998 onwards, she specialised in integrated coastal management (ICM) within the KZN provincial government. As head of the KZN Provincial Coastal Unit, she provided leadership for the implementation of the National Sustainable Coastal Livelihoods Programme, the development, coordination and management of various institutional and governance structures as well as the development of policies, plans and programmes. She established, facilitated and chaired the KZN Provincial Coastal Committee, the longest running coastal co-operative governance structure in South Africa, which formed the basis for the establishment of similar groups in other coastal provinces as well as the basis for the statutory structure incorporated in the Integrated Coastal Management Act. She also managed the long running research partnership with the Oceanographic Research Institute (ORI) which resulted in the establishment of KZN Coastal Sensitivity Analysis as a decision support tool. She conceptualised, established and chaired the co-operative governance advisory structure, the KZN Boat Launch Site Advisory Group, which evaluated impact assessments to license boat launch sites in KZN and this process achieved international recognition as best-practice (including such components as an operation manual, guideline documents, application adjudication, and compliance monitoring frameworks).

PUBLICATIONS AND PAPERS

1. The Department of Environmental Affairs and Royal HaskoningDHV. 2017. An updated Guide to South Africa's Integrated Coastal Management Act, revised edition. Cape Town
2. Breetzke, T. and Moore, L. 2015. The hidden cost of streamlined EIA Regulations: who will pay the price when the ocean bites back? Presentation to IAIAsa Conference 2015.
3. Breetzke, T., van Weele, G., Moore, L. and Mather, A.A. 2015. Integrated Coastal Management Implementation in South Africa – in practice not just concept. Paper to Conference: Marine & Coastal Management 2015 - Developing Sustainable Blue Economies. Cape Town, South Africa.
4. Moore, L. 2013. Oceans & Coasts Chapter. State of Environment Outlook Report for the Western Cape Province 2013. Western Cape Department of Environmental Affairs and Development Planning. 1st ed: Cape Town. 35pp.

5. Celliers, L C; Colenbrander, D R; Breetzke, T; Oelofse, G (2013), Towards Increased Degrees of Integrated Coastal Management in the City of Cape Town, South Africa. Ocean & Coastal Management
6. Breetzke, T., Moore, L. and Celliers, L (2012), Oceans and Coasts Chapter. South Africa Environment Outlook 2011/12. Department of Environmental Affairs.

7. Breetzke T, Moore L & van Weele G (2011), Drawing lines in the sand: Responding to climate change in the Coastal Zone., IAIAsa Conference 2011.
8. Breetzke T, Moore L & Jacobs H (2010), An arranged marriage made in heaven? Linking policy and development planning, IAIAsa Conference 2010.
9. Celliers, L., Breetzke, T., & Moore, L. R. (2010). A Toolkit for implementing the Integrated Coastal Management Act. Guideline Document, SSI Engineers and Environmental Consultants, Durban.
10. Celliers, L., Breetzke, T., Moore, L., & Malan, D. (2009). A User-friendly Guide to South Africa's Integrated Coastal Management Act. The Department of Environmental Affairs and SSI Engineers and Environmental Consultants.
11. Breetzke, T., Celliers, L. and Moore, L. 2009. From White Paper to National Coastal Management Programme and Beyond. Presentation to IAIAsa Conference 2009.
12. Breetzke, T., Celliers, L. and Moore, L. 2009. Implications of the New Integrated Coastal Management Act for Conservation Management Agencies. Presentation to the KwaZulu-Natal Marine and Coastal Management Research Group Symposium.
13. Celliers L, Colenbrander DR, Winson T-L, Breetzke T (2008) National Environmental Management: Integrated Coastal Management Bill 2007: A users Guide. Unpublished Report (publication pending, Enactment of ICMB 2007). pp26.
14. Breetzke T, Parak O, Celliers L, Mather A, Colenbrander DR (eds.) (2008) Living with coastal erosion in KwaZulu-Natal: a short-term, best practice guide. KwaZulu-Natal Department of Agriculture and Environmental Affairs, Cedara, Pietermaritzburg: 13pp.
15. Breetzke T., Parak O, Celliers LC, Mather AA and Colenbrander D: (2008) 'Living with Coastal Erosion': – Steps That Might Be Taken, Based on the Kwazulu-Natal Best Practice Response Strategy: International Environmental Law-making and Diplomacy Review 2008, University of Joensuu, Finland, UNEP Course Series 8.
16. Celliers L, Bulman R, Breetzke T, Parak O (2007) Institutional mapping of integrated coastal zone management in KwaZulu-Natal, South Africa. Ocean Yearbook. 21:365-404.
17. Breetzke T, Bulman R, and Celliers L (2004) Sustainable decision-making? A Best Practice South African Case Study in Green et al. (ed) Delivering Sustainable Coasts: Connecting Science and Policy, Littoral 2004, 20-22 September 2004, Aberdeen Scotland. Conference Proceedings.
18. Celliers L, James NC, [Breetzke] Moffett T, Mann BQ (2004) A strategic assessment of off-road vehicle recreational use areas in the coastal zone of KwaZulu-Natal, South Africa. Ocean and Coastal Management. 47:123-140.
19. Celliers L, Pradervand P, [Breetzke] Moffett T (2004) Boat launch sites and the impact on coastal and marine resources along the coast of KwaZulu-Natal, South Africa. In Green et al. (ed) Delivering Sustainable Coasts: Connecting Science and Policy, Littoral 2004, 20-22 September 2004, Aberdeen Scotland. Conference Proceedings 1:371-376.
20. [Breetzke] Moffett T (2004), Department of Agriculture and Environmental Affairs. A South African Best Practice Case Study, IAIAsa Conference 2004.
21. [Breetzke] Moffett T, Celliers L (2003) Implementation of NEMA's Control of Vehicles in the Coastal Zone Regulations in KwaZulu-Natal, IAIAsa Conference 2003.
22. Breetzke] Moffett T (2003) The KZN Lead Agent Experience: The Role of the Public Sector in Optimizing Sustainable Coastal Development, IAIAsa Conference 2001

Curriculum Vitae – Catherine Meyer

PERSONAL DETAILS:

Name Catherine Anne Meyer
Profession: Aquatic Ecologist (estuarine and freshwater)
Date of Birth: 4 January 1985
Marital Status: Married
Identity Number: 850104 0021 080

KEY EXPERIENCE

Eleven years' consultancy experience providing specialist input and guidance in respect to estuarine and coastal ecology and management thereof. Undertaken several estuarine impact assessments and aquatic biomonitoring studies; contributed to the development of numerous estuarine management plans, estuarine mouth management plans, coastal management programmes, environmental management frameworks; provided specialist input into status quo assessments of coastal assets, urban renewal projects, sensitivities and opportunities for specified land holdings, development concept planning, and proposed mitigation and rehabilitation interventions; Environmental Control Officer responsibilities for coastal development projects; acquisition of critical information and data and compilation of specific environmental chapters in State of the Environment Reports; and facilitation of stakeholder engagement.

EDUCATION AND TRAINING

- 2012 MSc Biology (Estuarine Ecology) – University of KwaZulu Natal
- 2007 BSc Hons Marine Biology (cum laude) – University of Natal KwaZulu-Natal
- 2006 BSc Environmental Biology and Geology – University of Natal KwaZulu-Natal

PROFESSIONAL MEMBERSHIPS and ASSOCIATIONS

- Department of Water and Sanitation Accredited SASS5 practitioner (SASS5, DWS) (due for renewal)

EXPERIENCE RECORD

Feb 2020 to date Aquatic Ecologist (Estuarine and Freshwater) – GroundTruth
2017 – Feb 2020 Freelance Environmental Consultant – Coastwise Consulting
2011 – 2017 Environmental Consultant – Royal HaskoningDHV (formerly SSI Engineers)
2007 – 2011 Research Assistant – South African Association for Marine Biological Research

LIST OF SELECTED ESTUARINE/COASTAL RELATED PROJECTS

- Development of an Estuarine Management Plan for the Mpenjati Estuary
- Development of an Estuarine Management Plan for the Isipingo Estuary
- Development of an Estuarine Management Plan for the iKongeni Estuary
- Development of an Estuarine Management Plan for the iZinkwazi Estuary
- Seven Estuarine Management Plans for the Ray Nkonyeni Municipality, Ugu District
- Estuary Management Framework and Implementation Strategy for the Western Cape Province
- Karpowership Port of Richards Bay Estuarine Impact Assessment
- Karpowership Port of Ngqura Estuarine Impact Assessment
- Karpowership Saldanha Bay Estuarine Impact Assessment
- Tinley Manor Public Boat Launch Site relocation (in progress)
- Tinley Manor Southbanks Coastal Development: uMhlali Estuarine Impact Assessment and Water Use License Application
- Tinley Manor Beach Enhancement: uMhlali Estuarine Impact Assessment
- Hitachi Remix Water Project: Hitachi Desalination Plant: Durban Bay Estuarine Impact Assessment
- Tinley Manor North Resort: Bob's Stream Estuarine Impact Assessment
- eThekwini IRPTN: uMgeni Estuarine Impact Assessment
- Northern Aqueduct Bulk Water Pipeline Project: uMgeni Estuarine Impact Assessment
- Jumpstart Investments: Mbango Estuarine Impact Assessment
- Bayside Aluminium Smelter Assimilation Assessment toward obtaining a Coastal Waters Discharge Permit
- Northern Cape Coastal Management Programme
- Eastern Cape Coastal Management Programme
- Alfred Nzo District Municipality Coastal Management Programme
- Development of a Wetland Off-set Management Plan for the Richards Bay IDZ
- Dube TradePort State of the Environment Report 2014 (Water Resources Chapter)
- Environmental Management Framework (EMF) for the Ilembe District Municipality

• Tongaat Hulett Developments Open Space Master Plan
• Coastal Waters Discharge Permit application for eThekwini Southern Waste Water Treatment Works Sea Outfall
• Coastal Waste Impact Assessment: Umdoni Bitumen Spill
• High level environmental screening for the uMhlathuze Waterfront Bridge
• Tinley Manor North Resort: Bob’s Stream Water Use License Application (specialist input)
• Kwadukuza Municipality Coastal Maintenance Management Plan: Dune Rehabilitation Plan
• Winkelspruit Dune Rehabilitation Environmental Control Officer (ECO)
• Virginia Airport Stormwater Network ECO
• Margate South Beach Tidal Pool Rehabilitation ECO
• Beachfront Upgrade Phase 1: Extended in-fill ECO
• eThekwini Promenade Phase 2 ECO
• Mkuze River Bridge on Road D2442 Makhwela Road ECO
• Aquatic Biomonitoring (SASS5) for SAPPI
• Aquatic Biomonitoring (SASS5) for ACSA KSIA (c/o GCS Consulting)
• Aquatic Biomonitoring (SASS5) for Buffalo Coal (c/o GCS Consulting)

ABRIDGE RESEARCH EXPERIENCE (PRIOR TO 2011)
• Spatial and temporal variations in macrozoobenthic communities in KwaZulu-Natal temporarily open/closed estuaries
• Ecological changes to Lake Nhlabane related to artificial level fluctuation and Indirect effects of heavy mineral dune mining on the estuarine ecology of Nhlabane Estuary
• St Lucia drought monitoring: monitoring changes in invertebrate communities
• Ecological effects of dredging and dredge disposal on the coastal environment
• Macrobenthos of the Kosi Bay Estuarine Lake System

CONFERENCE PRESENTATIONS
• Spatial and temporal variation of macrozoobenthic communities in KwaZulu-Natal temporarily open/closed estuaries– South African Marine Science Symposium/ Estuarine and Coastal Sciences Association International Conference, Grahamstown (2011). Best Oral Presentation

CURRICULUM VITAE - BARRY MALCOLM CLARK

Born: 25 August 1968; Livingstone, Zambia
Nationality: South African, British
Languages: English (excellent)/Afrikaans (good)
Present occupation: Director: Anchor Environmental Consultants PTY Ltd.

ACADEMIC QUALIFICATIONS:
Ph.D. Marine Biology, 1997, University of Cape Town
BSc (Hons) Marine Biology, 1991, University of Cape Town
BSc Zoology and Ocean & Atmosphere Science, 1990, University of Cape Town
COUNTRY EXPERIENCE:
South Africa, Namibia, Lesotho, Mozambique, Tanzania, Kenya, Mauritius, Seychelles, Angola, Ghana, Cote d'Ivoire, Nigeria, Liberia, Sierra Leone, Somaliland, Republic of Congo, Egypt, United Arab Emirates, Azerbaijan

RELEVANT WORK AND PROJECT EXPERIENCE
· 1991-1993 – Scientific Officer, University of Cape Town
· 2000-2002 – Marine Coordinator, Cape Peninsula National Park
· 1996-Present - Director, Anchor Environmental Consultants PTY Ltd.
· 2002-Present – Research Associate, University of Cape Town

MEMBERSHIP OF PROFESSIONAL BODIES/ORGANISATIONS
· Professional Natural Scientist, registered with the South African Council for Natural Scientific Professions (2004-)
· Professional member of the South African Institute of Ecologists and Environmental Scientists (2000-)
· South African representative to the SURVAS Network (Synthesis and Upscaling of Sea-level Rise Vulnerability Assessment Studies) (2000-)
· Member of the International Association of Impact Assessors (IAIA) (2000-)
· Member of the Subsistence Fisheries Task Group (1999-2000)
· Member of the Subsistence Fisheries Advisory Group (2000-2002)
· Member of the South African Network for Coastal and Oceanic Research (SANCOR) Economics Task Team
SUMMARY PROFILE
Dr Barry Clark has thirty years' experience in marine biological research and consulting on coastal zone and marine issues. He has worked as a scientific researcher, lecturer and consultant and has experience in tropical, subtropical and temperate ecosystems. He is presently Director of an Environmental Consultancy firm (Anchor Environmental Consultants) and Research Associate at the University of Cape Town. As a consultant has been concerned primarily with conservation planning, monitoring and assessment of human impacts on estuarine, rocky shore, sandy beach, mangrove, and coral reef ecosystems as well as coastal and littoral zone processes, aquaculture and fisheries. Dr Clark is the author of 27 scientific publications in class A scientific journals as well as numerous scientific reports and popular articles in the free press. Geographically, his main area of expertise is southern Africa (South Africa, Lesotho, Namibia, Mozambique, Tanzania, Seychelles, Mauritius and Angola), but he also has working experience from elsewhere in Africa (Republic of Congo, Sierra Leone, Liberia, Cote d'Ivoire, Ghana, Nigeria), the Middle East (UAE) and Europe (Azerbaijan, Greenland).

SCIENTIFIC PUBLICATIONS
· Clark, B.M. 1997. Dynamics and utilization of surf zone habitats by fish in the south-western Cape, South Africa. PhD Thesis, University of Cape Town, 216 pp.
· SHELTON, J.M., CLARK, B.M., SEPHAKA, T. & TURPIE, J.K. 2016. Population crash in Lesotho's endemic Maloti minnow Pseudobarbus quathlambae following invasion by translocated smallmouth yellowfish Lebeobarbus aeneus. Aquatic Conservation: Marine and Freshwater Ecosystems. DOI: 10.1002/aqc.2633.
· Clark, B.M. 2009. Introduction – The Berg River Baseline Monitoring Programme. Transactions of the Royal Society of South Africa 64(2): 95,
· Clark, B.M. & S. Taljaard. 2009. Historic changes in inorganic nutrient loading and its effects on water quality biota of the Berg estuary, South Africa. Transactions of the Royal Society of South Africa 64(1) In press
· Clark, B.M., Hutchings, K. & Lamberth, S.J. 2009. Long-term variations in composition and abundance of fish in the Berg estuary, South Africa. Transactions of the Royal Society of South Africa 64(2): 238–258.

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· Clark, B.M., Hauck, M., Harris, J., Salo, K. and E. Russell. 2002. Identification of subsistence fishers, fishing areas, resource use and activities. S. Afr. J. mar. Sci. 24: 425-438.
· Clark, B.M. 1996. Variation in surf zone fish community structure across a wave exposure gradient. Est. cstl. Shelf Sci. 44: 659-674.
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· Clark, B.M. & B.A. Bennett 1993. Are juvenile fish an issue in the trek net controversy? Fish, fishers and fisheries, Proc. 2nd Mar. Recreational Angling Symp., Durban, October 1992. Beckley, L.E. & R.P. van der Elst (eds.) Spec. Publ. oceanogr. Res. Inst. S. Afr. 2: 157-159.
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· Clark, B.M., B.A. Bennett & S.J. Lamberth 1994. Assessment of the impact of commercial beach-seine netting on juvenile teleosts in the surf-zone of False bay, South Africa. S. Afr. J. mar. Sci. 14: 255-262.
· Clark, B.M., B.A. Bennett & S.J. Lamberth 1996. Factors affecting spatial variability in seine net catches of fish in the surf-zone of False Bay, South Africa. Mar. Ecol. Prog. Ser. 131: 17-34.
· Clark, B.M., B.A. Bennett & S.J. Lamberth 1996. Temporal variations in surf-zone fish assemblages from False Bay, South Africa. Mar. Ecol. Prog. Ser. 131: 35-47.
· Branch, G.M. and Clark, B.M. 2006. Fish stocks and their management: The changing face of fisheries in South Africa. Marine Policy 30 (1): 3-17.
· Hutchings, K., Clark, B.M., Atkinson, L.J. & C. G. Attwood. 2008. Evidence of recovery of the linefishery in the Berg River Estuary, Western Cape, South Africa, subsequent to closure of commercial gillnetting. African Journal of Marine Science 2008, 30 (3): 507–517.
· Napier V.R., J.K. Turpie & B.M. Clark. 2009. Value and management of the subsistence fishery at Knysna estuary, South Africa. African Journal of Marine Science In press
· Branch, G.M., May, J., Roberts, B., Russell, E., Clark, B.M. 2002. Case studies on the socio-economic characteristics and lifestyles of subsistence and informal fishers in South Africa. S. Afr. J. mar. Sci. 24: 439-462.
· Cockroft, A.C., Sauer, W., Branch G.M., Clark, B.M., Dye, A. H. and E. Russell. 2002 - Assessment of resource availability and sustainability for subsistence fishers in South Africa with a review of resource management procedures. S. Afr. J. mar. Sci. 489-502.
· Griffiths, C. L., L. van Sittert, P. B. Best, A. C. Brown, B.M. Clark, P. A. Cook, R. J. M. Crawford, J. H. M. David, B. R. Davies, M. H. Griffiths, K. Hutchings, A. Jerardino, N. Kruger, S. Lamberth, R. Leslie, R. Melville-Smith, R. Tarr & C. D. van der Lingen, 2004. Impacts of human activities on marine animal life in the Benguela – An historical overview. Oceanogr. Mar. Biol. Ann. Rev. 42, 303-392.
· Harris, J.M., Branch, G.M., Clark, B.M.., Coetzee, C., Dye, A.H., Hauck, M., Johnson, A., Kati-Kati, L., SiqWano-Ndulo, N., and M. Sowman. 2002. Recommendations for the management of subsistence fishers in South Africa. S. Afr. J. mar. Sci. 24: 503-523.
· Harris, J.M., Sowman, M., Branch, G.M., Clark, B.M., Cockroft, A.C., Coetzee, C., Dye, A.H., Hauck, M., Johnston, A., Kati-Kati, L., Maseko, Z., Salo, K., Sauer, W.H.H., Siqwana-Ndulo, N. and J. Beaumont. 2002. The process of developing a management system for subsistence fisheries in South Africa: recognizing and formalizing a marginalized fishing sector in South Africa. S. Afr. J. mar. Sci. 24: 405-424.
· Hauck, M., Sowman, M., Russel, E., Clark, B.M., Harris, J.M., Venter, A., Beaumont, J. and Z. Maseko. 2002. Perceptions of subsistence and informal fishers in South Africa. S. Afr. J. mar. Sci. 24: 464-474
· Lamberth, S.J., B.A. Bennett & B.M. Clark 1994. The catch composition of commercial beach-seine fishermen in False Bay, South Africa. S. Afr. J. mar. Sci. 14: 69-78.
· Lamberth, S.J., B.A. Bennett & B.M. Clark 1995. The vulnerability of fish to capture by commercial beach-seine nets in False Bay, South Africa. S. Afr. J. mar. Sci. 15: 25-31.
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· Lamberth, S.J., W.H.H. Sauer, B.Q. Mann, S.L. Brouwer, B.M. Clark & C. Erasmus. 1997. The current status of the South African beach-seine and gill-net fisheries. S. Afr. J. mar. Sci. 18: 195-202
· Napier, V.R., Turpie, J.K. & B.M. Clark. 2009. Value and management of the subsistence fishery at Knysna Estuary,South Africa. African Journal of Marine Science 31(3): 297–310.
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ceps) fishery of Saldanha Bay, South Africa. African Journal of Marine Science 2017, 39(2): 153–166.
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· Harris, J.M., Branch, G.M., Clark, B.M. & S.C. Sibiya. 2007. Redressing Access Inequities and Implementing Formal Management Systems for Marine and Estuarine Subsistence Fisheries in South Africa. In: T.R. McClanahan and J.C. Castilla (eds.) Fisheries Management: Progress towards Sustainability. Blackwell Press, pp. 112-138.
· Niang, I., Nyong, A., Clark, B.M., Desanker, P., Din, N., Githeko, A., Jalludin, M., Osman, B. (2007) Vulnerability, Impacts and Adaptation to Climate Change. In: Otter, L., Olago, D.O. and Niang, I. (eds) Global Change Processes and Impacts in Africa: A Synthesis. START/East African Educational Publishers, Nairobi, pp. 226-249.

SELECTED PROJECT EXPERIENCE
Period Country Client Project, Tasks
2020-
2021 Sierra Leone Iluka/Sierra Rutile/Digby Wells Environmental, Safety and Health Impact Assessment (ESHIA) for mining of the Sembehun group of deposits in the Southern Province of Sierra Leone
2020 South Africa Department of Forestry, Fisheries and the Environment Environmental assessment and monitoring for a sea-based Aquaculture Development Zone (ADZ) in Saldanha Bay
2020 Kenya Ministry of Water, Sanitation and Irrigation of Kenya / Aurecon Kenya Water Security and Climate Resilience Project - Development and piloting of a resource directed measures (RDM) Framework for Kenya
2020 South Africa Diamond Coastal Aquaculture Design and implementation of an environmental monitoring programme for an abalone ranching operation at Kleinzee, Northern Cape.
2020 South Africa Department Forestry Fisheries & Environment Implementation of an environmental monitoring programme for the Saldanha Bay Aquaculture Development Zone
2018 Somaliland WSP/DP World Marine specialist study for an Environmental and Social Impact assessment (ESIA) for the upgrade of Berbera Port, Somaliland
2017-
2018 Sierra Leone Iluka/Sierra Rutile (Ltd) Marine and estuarine specialists studies for an Environmental, Social and Health Impact Assessment (ESHIA) for proposed expansions to Sierra Rutile Limited’s mining operations in Sierra Leone
2017 South Africa Viking Fishing (Pty) Ltd Socio-economic assessment of a 60% reduction in Viking fishing group’s allocation in the inshore demersal trawl fishery
2016-
2017 South Africa Department of Agriculture, Forestry, Fisheries Assessment of catch and effort in the West Coast Rock Lobster recreational fishery
2014-
2015 South Africa South African Pelagic Fishing Industry Association Assessment of the socio-economic impacts of a reduction in the sardine minimum Total Allowable Catch (TAC)

2014 Seychelles USAID Implementation of the “reef gardening” approach for restoration of coral reefs on Praslin Island, Seychelles, lost as a result of El Nino and global warming induced bleaching events.
2014 South Africa WWF-SA Design and development of a Fisheries Improvement Project for Small Scale Fisheries in the Kogelberg
2014 Tanzania Aurecon Development of a Spatial Development Framework for the coastal environment in the Mtwara/Mikandani Municipal area, Tanzania
Period Country Client Project, Tasks
2009-
2011 South Africa WWF-SA, Lotto Programme Recreational fisheries monitoring programme coordinating a team of 20 fisheries monitors at 6 sites on the South and East coasts of South Africa.
2009-
2010 Azerbaijan United National Development Programme, Azerbaijan International consultant appointed to prepare Project Identification Form (PIF) and Project Preparation Grant (PPG) for a GEF medium-size project on the expansion of the marine and coastal protected area network in Azerbaijan.
2009 Global UNDP Researcher on an assessment of the impact of climate change on the Global Fisheries sector and opportunities and incentives required for adaptation
2008-
2009 Tanzania, Kenya Programme for the Sustainable Management of the Coastal Zone of the Countries of the Indian Ocean Design and implementation of training courses and workshops on Information for Fisheries Co-Management in Dar es Salaam, Tanzania and Mombassa, Kenya.
2007-
2011 South Africa Department of Environmental Affairs & Tourism Shore based fisheries monitoring programme designed to assess levels of fishing mortality, stock abundance indices and to evaluate the effectiveness of management measures for the commercial and recreational linefishery, tuna pole and hake handline fishing in South African waters.
2007-
2011 South Africa Department of Environmental Affairs & Tourism Offshore, boat-based fisheries monitoring programme designed to supply and deploy aboard fishing vessels, competent, suitably trained and equipped scientific observers for the inshore trawl, hake longline and west coast rock lobster fisheries.
2006-
2011 Tanzania International Conservation Union (IUCN)/Pangani Water Basin Office, Tanzania International mentor of the Estuary Team for a project entitled “Flows for People and the Environment: Supporting Sustainable Land Management in the Pangani Basin (Tanzania)”.
2005-
2007 Angola, Namibia, South Africa BCLME Programme/ United Nation Development Programme (UNDP)/ UNOPS/Global Environment Facility (GEF) Assessment of human capacity, training and infrastructure available within the three countries bordering the BCLME – Angola, Namibia and South Africa.
2005 South Africa Department of Environmental Affairs & Tourism Supervisor on a project to assess the socio-economic value and ecological impacts of the subsistence fishery for sand and mud prawns, and fish in the Knysna estuary, South Africa
2004-
2008 South Africa WWF-SA/South African National Parks Development and implementation of a coastal monitoring programme for the Table Mountain National Park Marine Protected Area.
2004 DRC, Angola, Namibia, South Africa, Mozamb., Tanz., Mauritius, Seychelles EU-SADC MCS Fisheries Programme Production of instructional material and the holding of a seminar on the effects of pollutants, illegal fishing methods and the requirements of relevant conventions signed by the SADC states.
2004 Mozambique Southern African Development Community/ Government of Mozambique Production of a policy document and strategy for fisheries Monitoring Control Surveillance in Mozambique.
2004 South Africa EKZN Wildlife Service/ Department of Environmental Affairs and Tourism (DEAT) Review and assessment of the management of subsistence fisheries in KwaZulu-Natal, South Africa.
2002-
2003 South Africa Department of Environmental Affairs & Tourism Assessment of the quantity of abalone caught by recreational fishers during the 2002/2003 fishing season.
Period Country Client Project, Tasks
2002 Africa GEF/UNDP UNESCO/IOC/ACOPS Regional Technical Coordinator for the Working Group on Sustainable Use of Living Resources as part of Phase 2 of the GEF MSP Sub-Saharan Africa Project (GF/6010-0016): Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa.

2002 South Africa Department of Environmental Affairs & Tourism Acoustic tracking study of the West Coast rock lobster (Jasus lalandii) in the Hermanus Whale Sanctuary, on the south-west coast of South Africa.
2002 South Africa Department of Environmental Affairs & Tourism Assessment of sardine migration habitats off the East coast of South Africa.
2002 South Africa Department of Environmental Affairs & Tourism Fisheries monitoring programme for an experimental hoop-net fishery for west coast rock lobster off Cape Hangklip, South Africa.
2002 South Africa University of Rhode Island/ History of Marine Animal Populations Desktop assessment of the likely impacts of climate change on the ecosystem functioning and fisheries of the Benguela ecosystem, South Africa.
2001- 2002, 2009-
2010 South Africa Department of Environmental Affairs & Tourism Assessment of the quantity of west coast rock lobster caught by recreational fishers during the 2001/2002 and 2009/2010 fishing seasons.
2001-
2003 South Africa Department of Environmental Affairs & Tourism/ Rhodes University Economic Sectoral Study of the South African Fishing Industry.
2000-
2002 South Africa South African National Parks Marine Coordinator Cape Peninsula National Park, responsible for the design and development of a marine component for the newly established Cape Peninsula National Park.
1999-
2000 South Africa Foundation for Research Development Assessment of impacts of exploitation of wonderworm Marphysa sanginea on bouldershore habitats on the Cape Peninsula, South Africa.
1999-
2000 South Africa Department of Environmental Affairs & Tourism, South Africa National Co-ordinator of the Subsistence Fisheries Programme designed to identify subsistence fishing communities in South Africa, to assess socio-economic profiles and resource harvesting techniques and to provide recommendations for the implementation of appropriate management systems for these fishers.

13.4.2. Statement of Independence

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/14/12/16/3/3/2007
Date Received:	02 November 2020

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

The Proposed Gas to Power Powership Project at the Port of Richards Bay, Umhlathuze Local Municipality, King Cetshwayo District, Kwazulu-Natal.

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Coastwise Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	
Specialist name:	Tandi Breetzke			
Specialist Qualifications:	BA (Hons) Geography			
Professional affiliation/registration:	IAIAsa			
Physical address:	9 Edward Drive, Gillitts			
Postal address:	9 Edward Drive, Gillitts			
Postal code:	3610	Cell:	082 8737 400	
Telephone:	031 7644947	Fax:	-	
E-mail:	tandi@coastwise.co.za			

2. DECLARATION BY THE SPECIALIST

I, __Tandi Breetzke______________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

TBreetzke

Signature of the Specialist

Coastwise Consulting

Name of Company:

31/10/22

Date

Details of Specialist, Declaration and Undertaking Under Oath

Page 2 of 3

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ___Tandi Breetzke______________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

TBreetzke

Signature of the Specialist

Coastwise Consulting

Name of Company

31.10.22

Date

Signature of the Commissioner of Oaths

2022-10-31

Date

SOUTH AFRICAN POLICE SERVICE
CSC
31 OCT 2022
HILLCREST
KWAZULU - NATAL
SOUTH AFRICAN POLICE SERVICE

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
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0001

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Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	GroundTruth Water Wetlands and Environmental Engineering			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	
Specialist name:	Catherine Meyer			
Specialist Qualifications:	MSc Estuarine Ecology			
Professional affiliation/registration:	Nil			
Physical address:	9 Quarry Road, Leonard, Hilton, 3245			
Postal address:	PO Box 916, Hilton, 3245			
Postal code:	3245	Cell:	082 7366 357	
Telephone:	033 343 2229	Fax:	086 599 2300	
E-mail:	catherine@groundtruth.co.za			

2. DECLARATION BY THE SPECIALIST

I, ___Catherine Meyer_______________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

GroundTruth Water Wetlands and Environmental Engineering

Name of Company:

31 /10/ 2022

Date

Details of Specialist, Declaration and Undertaking Under Oath

3. **UNDERTAKING UNDER OATH/ AFFIRMATION**

I, ___Catherine Meyer_______________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

GroundTruth Water Wetlands and Environmental Engineering

Name of Company

31/10/2022

Date

COMMISSIONER OF OATHS EX OFFICIO
CHIEF LEGAL ADVISOR
SOUTH AFRICAN POST OFFICE LIMITED

S.A. POST OFFICE LTD
KLOOF 3640

Signature of the Commissioner of Oaths

3 VILLAGE ROAD, KLOOF, 3610

KLOOF 2022-10-31 5

Date

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Anchor Environmental Consultants (Pty) Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	Non-compliant	Percentage Procurement recognition	
Specialist name:	Barry Clark			
Specialist Qualifications:	Ph D Marine Ecology			
Professional affiliation/registration:	SACNASP 400021/05			
Physical address:	8 Steenberg House, Silverwood Close, Tokai			
Postal address:	8 Steenberg House, Silverwood Close, Tokai			
Postal code:	7945	Cell:	0823730521	
Telephone:	021 7013420	Fax:		
E-mail:	Barry @anchorenvironmental.co.za			

2. DECLARATION BY THE SPECIALIST

I, Barry Clark; declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

Anchor Environmental Consultants (Pty) Ltd

Name of Company:

2 November 2022

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Barry Clark, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Anchor Environmental Consultants (Pty) Ltd

Name of Company

2 November 2022

Date

Signature of the Commissioner of Oaths

4·10·2022

Date

Janine van Graan
Commissioner of Oaths
Professional Accountant (SA)
SAIPA Membership No. 7380
Minter House, 1 Otto Close
Westlake, 7945

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/14/12/16/3/3/2/2007
Date Received:	02 November 2020

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

The Proposed Gas to Power Powership Project at the Port of Richards Bay, Umhlathuze Local Municipality, King Cetshwayo District, Kwazulu-Natal.

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

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1. SPECIALIST INFORMATION

Specialist Company Name:	GroundTruth Water Wetlands and Environmental Engineering			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	
Specialist name:	Catherine Meyer			
Specialist Qualifications:	MSc Estuarine Ecology			
Professional affiliation/registration:	Nil			
Physical address:	9 Quarry Road, Leonard, Hilton, 3245			
Postal address:	PO Box 916, Hilton, 3245			
Postal code:	3245	Cell:	082 7366 357	
Telephone:	033 343 2229	Fax:	086 599 2300	
E-mail:	catherine@groundtruth.co.za			

2. DECLARATION BY THE SPECIALIST

I, ___Catherine Meyer______________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

GroundTruth Water Wetlands and Environmental Engineering

Name of Company:

31/10/2022

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ___Catherine Meyer______________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

GroundTruth Water Wetlands and Environmental Engineering

Name of Company

31/10/2022

Date

COMMISSIONER OF OATHS EX OFFICIO
CHIEF LEGAL ADVISOR
SOUTH AFRICAN POST OFFICE LIMITED
33 VILLAGE ROAD, KLOOF, 3610

S.A. POST OFFICE LTD
KLOOF 3640

Signature of the Commissioner of Oaths

KLOOF
2022-10-31
5

Date

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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File Reference Number:	
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Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Coastwise Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	
Specialist name:	Tandi Breetzke			
Specialist Qualifications:	BA (Hons) Geography			
Professional affiliation/registration:	IAIAsa			
Physical address:	9 Edward Drive, Gillitts			
Postal address:	9 Edward Drive, Gillitts			
Postal code:	3610	Cell:	082 8737 400	
Telephone:	031 7644947	Fax:	-	
E-mail:	tandi@coastwise.co.za			

2. DECLARATION BY THE SPECIALIST

I, ___Tandi Breetzke_______________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

TBreetzke

Signature of the Specialist

Coastwise Consulting

Name of Company:

31/10/22

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ___Tandi Breetzke_______________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

TBreetzke

Signature of the Specialist

Coastwise Consulting

Name of Company

31.10.22

Date

Signature of the Commissioner of Oaths

2022-10-31

Date

SOUTH AFRICAN POLICE SERVICE
CSC
31 OCT 2022
HILLCREST
KWAZULU - NATAL
SOUTH AFRICAN POLICE SERVICE