Prepared for
Project Applicant: **Coega Development Corporation (Pty) Ltd**

Project:

Coega Land-Based Aquaculture Development Zone (ADZ)

Location: Coega Industrial Development Zone (IDZ), Nelson Mandela Bay Municipality, Sarah Baartman District Municipality, Eastern Cape

Report Type: **Final Environmental Impact Report (FEIR)**

Report Short Name: Coega ADZ EIR (Final)

Coega ADZ EIR Volume: **Volume 1: Main Report**

(with Appendix A, Appendix B and Appendix C)

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Project Information Sheet

PROJECT

Coega Land-Based Aquaculture Development Zone (ADZ), located in the Coega Industrial Development Zone (IDZ), Nelson Mandela Bay Municipality, Sarah Baartman District Municipality, Eastern Cape.
DEA REF NO: 14/12/16/3/3/3/214

REPORT DETAILS

Report Name: Environmental Impact Report for the Coega Aquaculture Development Zone
Report Number: X0118/CDC ADZ EIA/01/DEIR/00
Report Status: FINAL
Revision No: 01
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PROJECT APPLICANT

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Department of Environmental Affairs (National)
Department of Environmental Affairs
Legal, Authorisations, Compliance and Enforcement
Integrated Environmental Authorisations: Integrated Permitting System & S24G
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DEA REF NO: 14/12/16/3/3/3/214

Structure of the Environmental Impact Report

Volume 1: Main Report

Volume 2: Public Participation Documentation

Volume 3: Specialist Report and Study Team Information

G7 Waste Management Options in the Aquaculture Sector, compiled by Ethical Exchange

Appendix H: Study Team Details

Volume 4: Scoping Report

As previously issued. Available electronically on request.

Volume 5: Application Forms

Integrated Application for Environmental Authorisation in terms of NEMA and NEMWA.

As previously issued. Available electronically on request.

Volume 6: Supplementary Information

Reading List. Available electronically on request.

Coega Development Corporation (Pty) Ltd

Coega Land-Based Aquaculture Development Zone (ADZ) Environmental Impact Assessment (EIA) Process

Coega Industrial Development Zone (IDZ), Nelson Mandela Bay Municipality,
Sarah Baartman District Municipality, Eastern Cape

Final Environmental Impact Report

Revision 01

Report No: X0118/CDC ADZ EIA/01/FEIR/01

March 2017

Executive Summary and Environmental Impact Statement

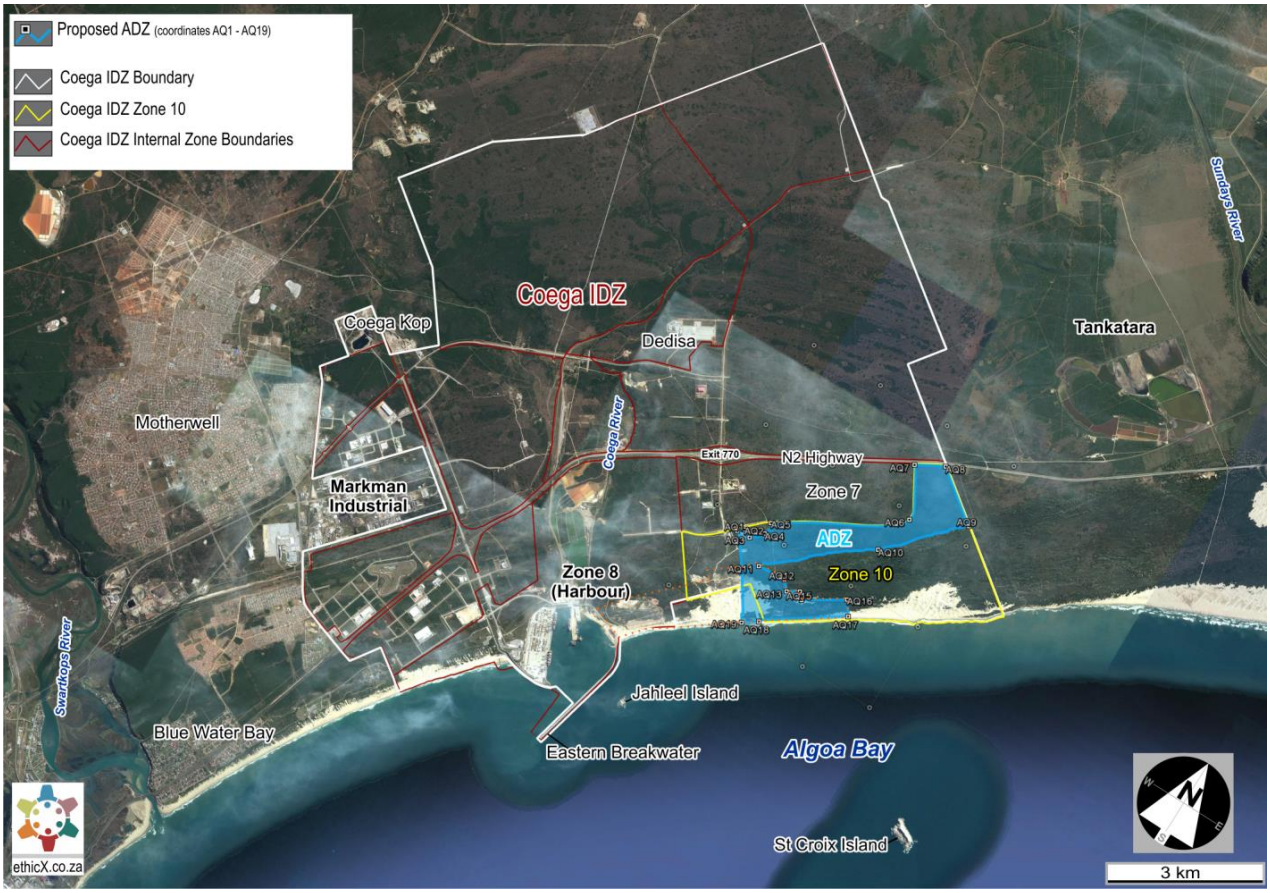
INTRODUCTION AND BACKGROUND

The Coega Development Corporation (CDC) is proposing the development of a land-based aquaculture development zone (ADZ) in Zone 10 of the Coega Industrial Development Zone (IDZ). The overall purpose of the project is to establish an 'investment ready' platform for planned commercial aquaculture operations to establish within the Coega IDZ. The Coega IDZ is located on the northern outskirts of Port Elizabeth, Nelson Mandela Bay Metropolitan Area (NMB Metro) north-east of the residential areas of Motherwell, Wells Estate, St Georges Strand and Bluewater Bay, in the Sarah Baartman District, Eastern Cape.

Aquaculture is a type of agriculture and can be defined as the farming of aquatic animal and plant organisms such as finfish and shellfish and plants, such as macroalgae such as seaweeds, microalgae and other microorganisms. Land-based aquaculture uses constructed systems with tanks, ponds or raceways (Diagram 2 and 3).

LOCATION

The ADZ is proposed for ~440 hectares of land in Zone 10 of the Coega IDZ, located along the coastline to the north-east of the Port of Ngqura (Map 1).



Map 1: Location of the ADZ in Zone 10 of the Coega IDZ

IDZ in white line, Zone 10 in yellow line, ADZ in blue, Coastal Cluster for Development in orange dotted Line

NEED FOR AND DESIRABILITY OF THE DEVELOPMENT

There could be around 9 billion people on earth by 2050 and traditional farming is unlikely to be able to produce enough food for them. Aquaculture serves many purposes but the most important one is to supply food for humans. Wild harvesting of fishery resources, so called capture fisheries, has become increasingly unsustainable due to over exploitation. 85% of the world's marine stocks are either fully exploited or overfished, driving accelerated growth in the aquaculture sector. Globally the total capture fishery production in 2014 was 93.4 Mtn and aquaculture production 101.1 Mtn. According to the WWF (wwf.panda.org):

> 'Aquaculture is a promising solution; producing enough food for a growing population without having to rely exclusively on wild fish stocks' (WWF).

> 'When produced responsibly, aquaculture can thrive alongside healthy wild fish populations and without harming the marine environment, for the benefit of both businesses and local people (WWF).

The South African aquaculture sector is performing below its potential and remains a minor contributor to national fishery products and the country's GDP. Production was ~6000 tn/yr in 2014 and is valued at R 400 million. The CDC's proposal for the development of an ADZ in the Coega IDZ is in line with worldwide trends and national government policies and programmes. The ADZ has the potential to kick-start and facilitate the growth of a responsible local aquaculture industry that could contribute to the economy in terms of GDP contributions, increased trade flow and delivery of goods and services, employment creation and labour income, without detrimental environmental impacts. As a result, food production in the NMB Metro will be diversified and be better adapted to meet the challenges of climate change.

SITE SELECTION AND DEFINITION OF THE DEVELOPMENT FOOTPRINT

The CDC's plans for the development of an aquaculture development zone in Zone 10 of the Coega IDZ follow years of planning and assessment. Various strategic, regional, IDZ-wide and project specific environmental and planning processes have been undertaken to provide context for the ADZ and the selection of the site within the coastal cluster of development in Zone 10 of the IDZ.

In essence, these and the other assessment and planning processes, served to evaluate alternative land uses in Zone 10 of the IDZ, including potential conflicts and synergies with other industries throughout the IDZ, and served as the site selection and delineation of a development footprint for the ADZ. As such, this environmental impact assessment (EIA) does not attempt to repeat an evaluation of site alternatives for the ADZ or of alterative land uses for Zone 10 of the IDZ.

INVESTIGATING THE FEASIBILITY OF AQUACULTURE IN THE COEGA IDZ

An independent concept design and feasibility study was undertaken in 2014 concluded that Zone 10 of the Coega IDZ is favourable for aquaculture development.

The CDC has conducted market research, visited various aquaculture operations and interacted extensively with the aquaculture specialists, operators and potential investors, and there are a number of investors that are keen to establish in the ADZ to produce fresh water species and marine finfish and shellfish species, including abalone. Based on the feedback received and technological development to reduce water exchange and consumptive water use, the CDC is also including intensive fresh water and brackish water aquaculture in the ADZ, in addition to the seawater aquaculture.

CONCEPTUAL LAYOUT AND MAIN COMPONENTS

The CDC has developed a conceptual layout plan for the ADZ, with marine species that require high volumes of seawater, such as abalone and seaweed, as well as the desalination plant, in the lower lying coastal section and intensive recirculating aquaculture on the higher lying inland areas (Map 2).

SCOPE OF THIS EIA

This EIA covers all land-based activities and facilities associated with the ADZ, as schematically illustrated on Diagram 1 and described in the Section 4, Project Description and Design Options, of the environmental impact report (EIR).

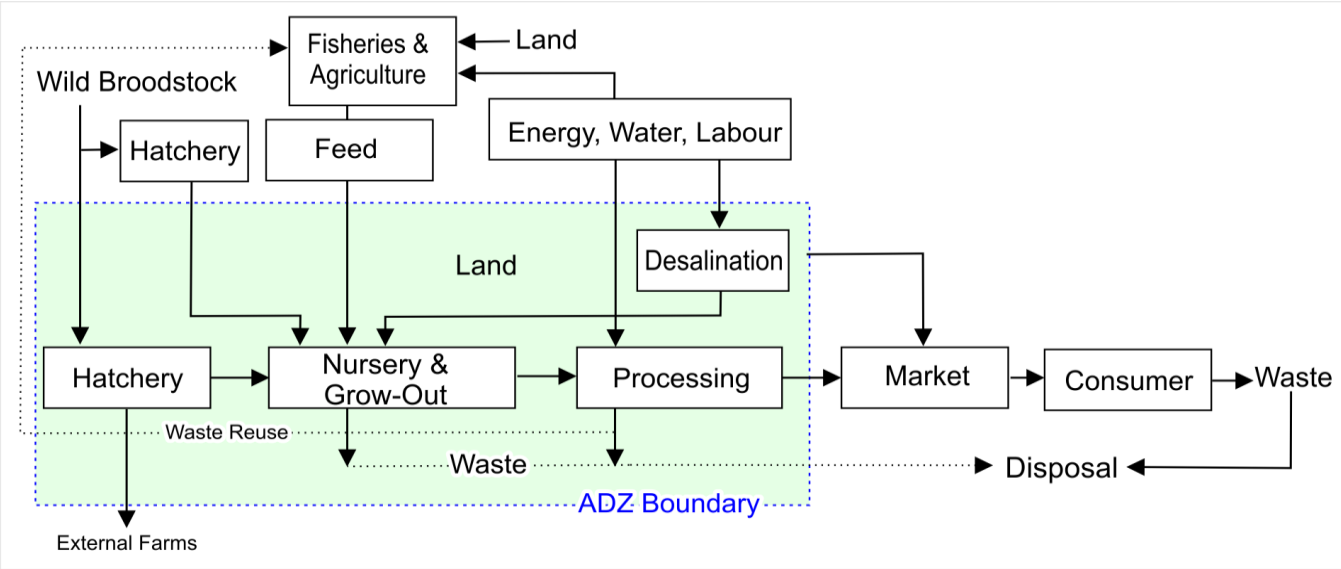
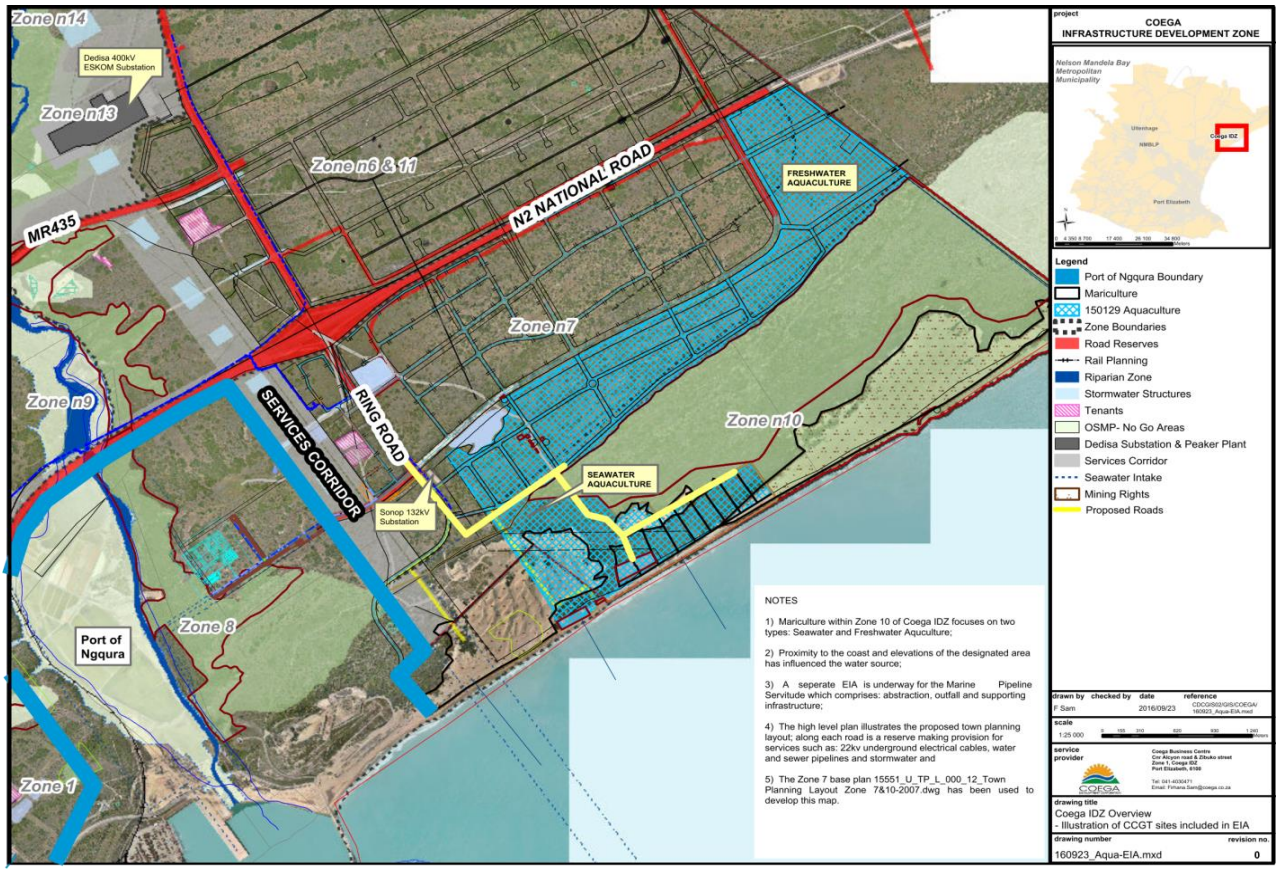


Diagram 1: Schematic of ADZ Main Components and Key Inputs and Outputs



Map 1: Conceptual Layout of the ADZ

MARINE PIPELINE SERVITUDE PLANNING AND ASSESSMENT

Land-based aquaculture for marine species such as abalone, seaweed and marine finfish and a desalination plant require proximity and linkage to the sea as a source of water and for release of treated production water and brine effluent. The same applies to various other industries in the Coega IDZ. The CDC plans to establish an integrated marine pipeline servitude in which current and future investors in the Coega IDZ can establish infrastructure to abstract seawater and discharge treated effluent as required by various industrial processes.

A specialist marine impact assessment and dispersion modelling is being undertaken to inform the preferred positioning of the servitude(s). A separate EIA is underway to investigate the impacts associated with the pipeline(s) as it spans over land and coastal environments, as well as the impacts on the marine environment associated with the abstraction of water from the sea and, in particular, the impacts associated with the discharge of effluent into the sea. It will therefore include an assessment of the impacts of the ADZ effluent as well as effluent from other industries and proposed waste water treatment plant in the Coega IDZ, as well as the physical impacts of the sea water intake and discharge pipelines to and from the boundary of the ADZ.

PROJECT DESCRIPTION AND DESIGN OPTIONS

Species Selection

Potential investors in the ADZ have expressed interest in cultivating a number of different species in the ADZ, including the introduction of agricultural crops through aquaponic systems to diversify production, utilise nutrients in the fish production, improve water use efficiencies and have a more robust business financially. The CDC has developed a preliminary list of potential species in response to investor interest, what has been produced in the Eastern Cape, advice from researchers and specialists in the aquaculture sector, and previous lists produced by the Department of Agriculture, Forestry and Fisheries (DAFF) for the Eastern Cape.

Aquaculture production

Depending on the species farmed, flow-through systems with a continuous supply of 'new' water could be used, or recirculating systems could be used involving the continuous treatment, reconditioning, aeration, and recirculation of water. Examples of flow-through and recirculating systems are illustrated in Diagram 2 and 3. Both flow-through and recirculating systems use a variety of culture tanks, raceways and constructed ponds.

Seafood Processing

The aquatic organisms harvested will be processed at a processing facility in the ADZ. Primary processing includes gutting, washing, grading, sorting and packing. Secondary processing includes de-heading, skinning, filleting, trimming and portion cutting. Primary and secondary processed products can be packed fresh, frozen, or can be vacuum-packed. Tertiary processing includes some form of heating, such as smoking, re-cooking, poaching in vacuum packed bags, or drying, canning, pickling, crumbing (i.e. fish fingers) and then packaging.

Desalination

The CDC is proposing to establish a desalination plant that removes dissolved salts from seawater to produce fresh water. The most widely used technology today is reserve osmosis (RO) and involves four basic steps: seawater intake, pre-treatment (screening and filtration), RO membrane filtration, and post-treatment.

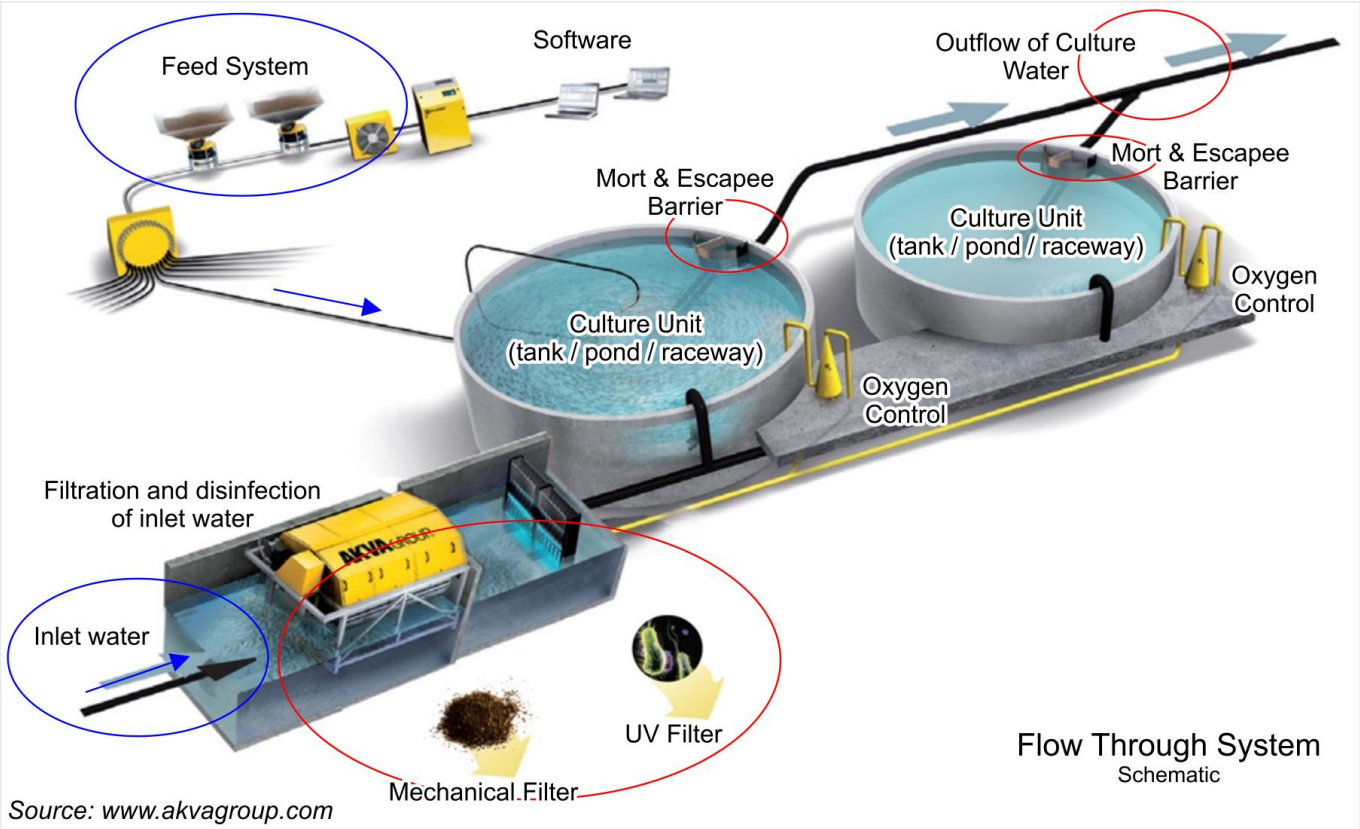


Diagram 2: Schematic Example of a Flow-through Aquaculture System

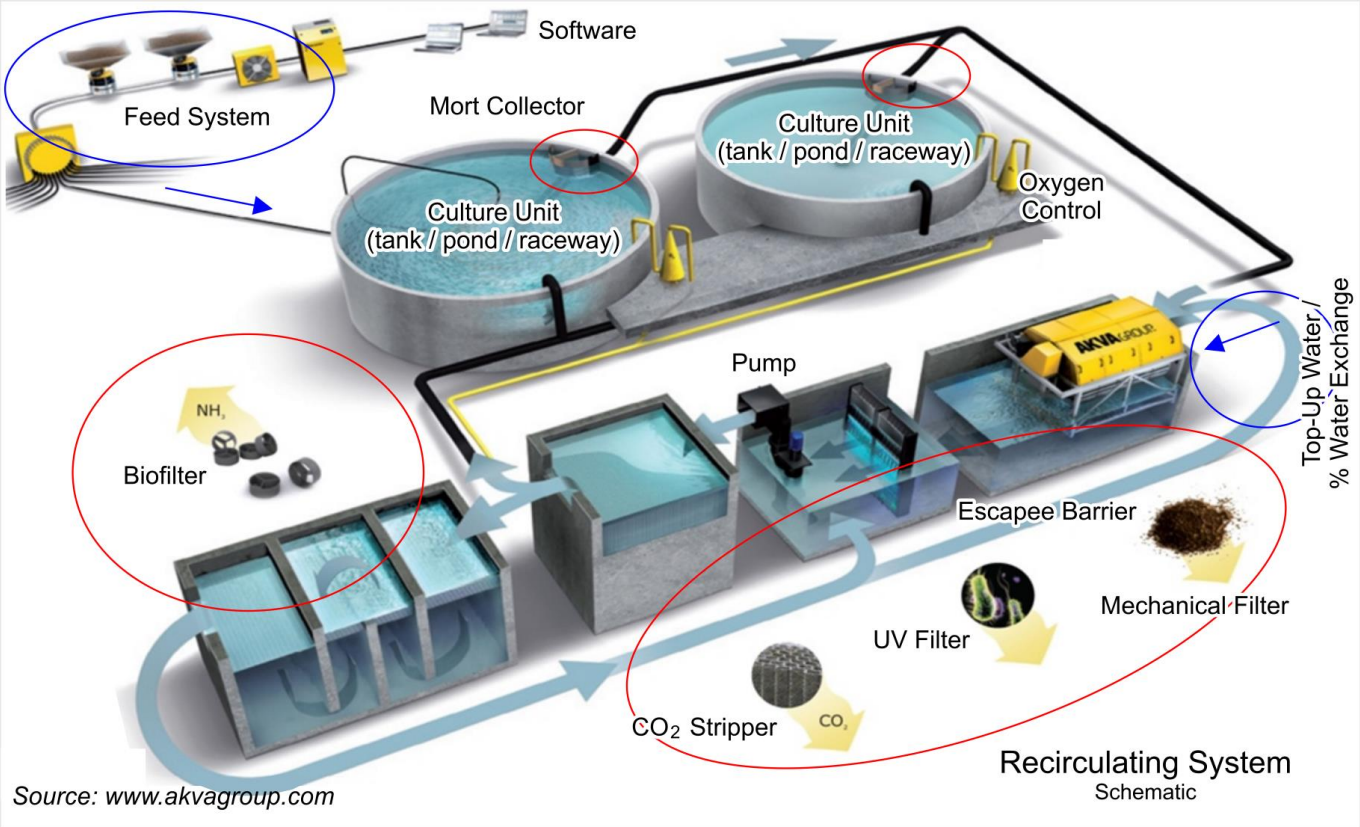


Diagram 3: Schematic Example of a Recirculating Aquaculture System

Water Supply Options

Sea Water Intake Options

The CDC's intention is to establish a marine pipeline servitude for seawater intake in the IDZ. Once this is in place, it will serve the marine aquaculture developments in the ADZ. Flow-through aquaculture systems such as abalone farms are dependent on the development of a large-diameter marine pipeline but intensive and super-intensive recirculating systems require smaller volumes of water to be pumped from the sea as water is recirculated within the aquaculture system and there are a number of alternative water supply options available to them.

The following interim and alternative sea water intake options exist:

- Beach abstraction points, or beach wells.
- Boreholes into the saline aquifer.
- Development of a dedicated intake pipeline, with offshore intake structure at the seaward end of the pipe to supply the smaller and first aquaculture operators before the CDC marine pipeline is in place.

Fresh Water Supply Options

Fresh water aquaculture is completely independent of the establishment of a marine pipeline. The following are options for fresh water supplies to the ADZ:

- Municipal water supply.
- Rainwater harvesting from roofs and greenhouses in the ADZ.
- Boreholes (separate investigation required to assess feasibility of boreholes, and a separate water use license / general authorization required).
- Development of a desalination plant as and when required to supplement water supply in the NMB Metro.
- Utilization of 'clean' fresh water produced as a by-product at other industries in the IDZ. The Cerebos plant is

a current example to be explored.

- Potential future options and linkages between aquaculture and other industries in the IDZ, i.e. utilizing waste water for aquaculture biomass production (health, biosecurity and product quality constraints may preclude this practice for food or feed production), while improving the quality of waste water releases at the same time.
- New developments in the field of waste water treatment, i.e. forward osmosis, could potentially be applied in future to provide an alternative and 'clean' source of water for aquaculture.

It is likely that a combination of these options will be used over the life of the ADZ. Obviously some of the potential sources will require further research and development. However, based on the projected water use in the IDZ and the NMB Municipality's longer term planning to meet projected water use to the IDZ and the broader NMB Metro, the current projected water requirements from the NMB Municipality to the CDC will be sufficient for the initial and targeted aquaculture production in the ADZ.

Waste Streams

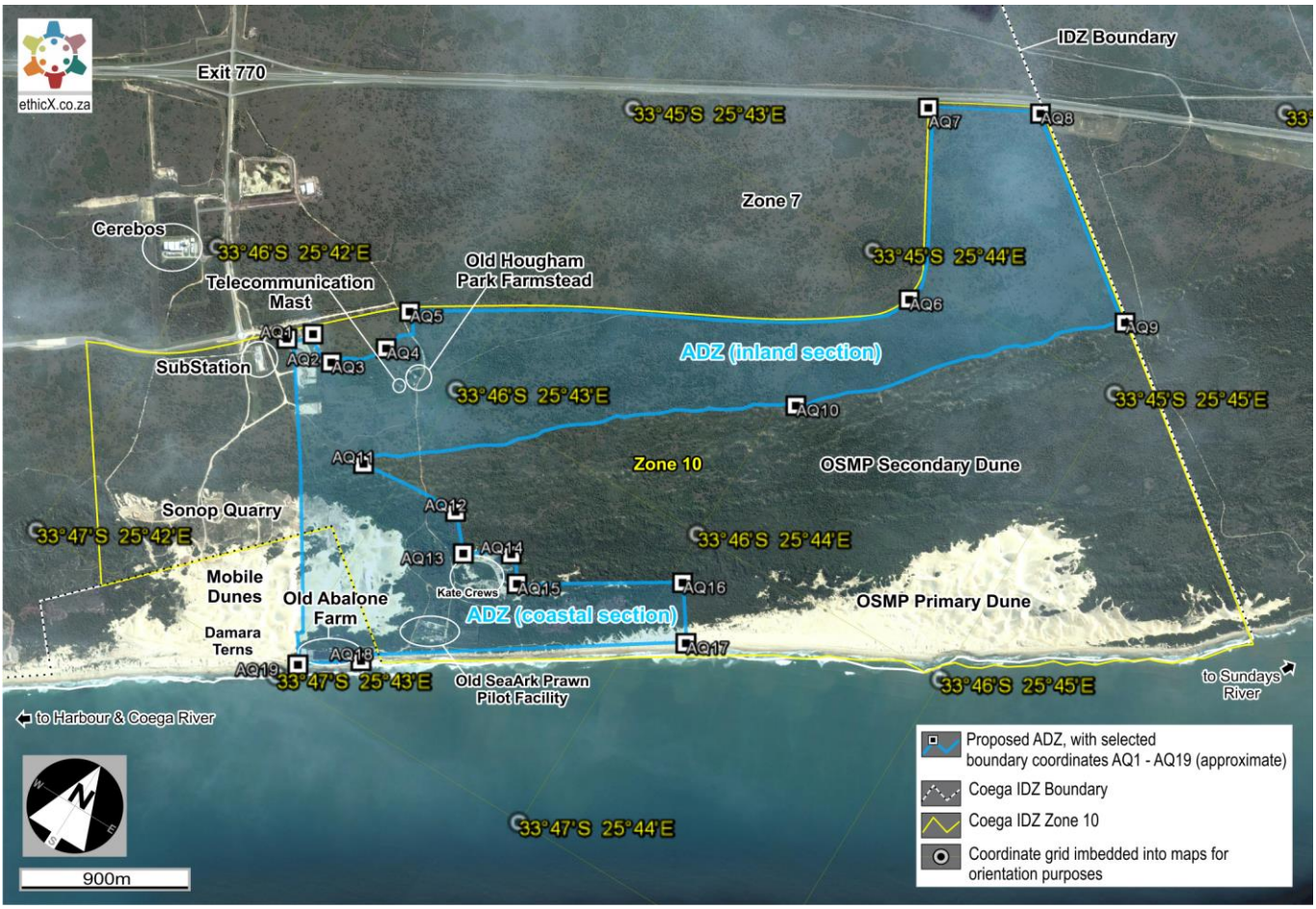
An analysis of all the key waste streams were assessed and conceptually quantified based on industry norms. These are described in detail in Appendix G7 and summarised in the main EIR.

Supporting Infrastructure and Services

The report described all the planned infrastructure and services, including storm water, sewage, water reticulation, telecommunications and electricity. The 'installation of ancillary service infrastructure, including service roads and storm water drainage systems, water supply, sewerage systems, electrical and telecommunication infrastructure associated with the establishment of and IDZ' is authorized in terms of the EA (DEA, 2007) for the 2006 change of land use EIA for the Coega IDZ remaining areas (SRK, 2006).

NATURE OF THE AFFECTED ENVIRONMENT

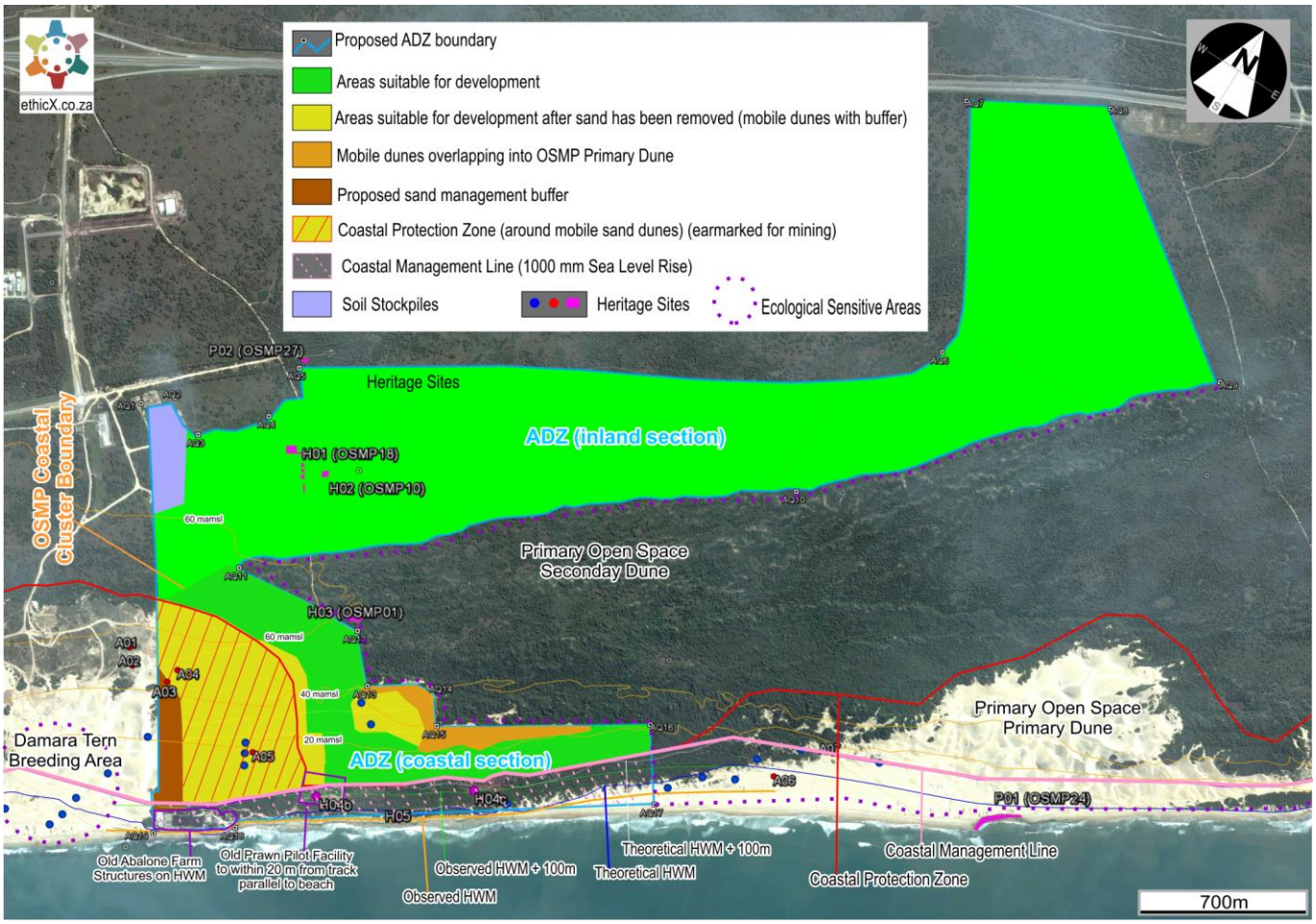
The ADZ can be broadly subdivided into two areas. There are the coastal dunes abutting the land-ocean interface and then a wave-cut plateau characterised by low palaeo-beach ridges extending roughly parallel to the coast. From the coastline the elevation rises relatively gently for the first ~250 m inland. Thereafter the gradient increases rapidly within a relatively short distance. It then flattens out at a height of ~60 mamsl. The majority of the ADZ is located on the relatively flat plateau at ~60 mamsl. Within the Agulhas Bioregion, Algoa Bay is located within the Agulhas Inner Shelf Ecozone with the Agulhas Current playing a major role in the ecology within this area. The ADZ in Zone 10 of the Coega IDZ is situated adjacent to a sandy and mixed rock and sand intertidal coastline. The coastal dune field on both sides of the Port of Ngqura, including Zone 10 is classified as critical biodiversity areas. The dune field is part of a greater sand process corridor stretching from the Sundays to the Swartkops Rivers, and is part of the Alexandria dune field. The coastal section of the ADZ and the strip of land between the ADZ and the harbour form part of the IDZ's coastal cluster for development as defined on the Coega Open Space Management Plan (OSMP). The dunes in the ADZ are highly impacted due to previous attempt to stabilise the dunes, sand built up behind, alien wattle infestations, and sand mining. Little natural vegetation remains within the ADZ.



Map 3: Orientation Map

PHYSICAL SUITABILITY OF THE LAND FOR DEVELOPMENT

Based on the specialist assessments and the characteristics and sensitivities of the ADZ footprint described in preceding sections of the report, an assessment of the general physical suitability of the site for development was completed. The results are illustrated on Map 4 and discussion in detail in the EIR.



Map 4: ADZ Site Suitability for Development, with Sensitive Areas Indicated

SUMMARY OF POTENTIAL IMPACTS AND RISKS

Air Quality

Construction Phase

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Dust generation during construction*				
Significance	Negative Medium	Negative Low	Negative Very Low	Negative Low	As Existing

Operational Phase

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Odours from processing of by-products and handling and treatment of aquaculture and fish processing waste*				
Significance	Very Low	Negative High	Negative Very Low	Very Low	As Existing or Unknown
Nature of Impact	*Air emissions generated by aquaculture impacting on local ambient air quality*				
Significance	N/A	N/A	Negative Insignificant	N/A	N/A

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Cumulative industrial development and IDZ air emissions affecting the health of penguin population on off-shore islands*				
Significance	Negative Low	Negative Insignificant		As Existing	As Existing or Unknown
Nature of Impact	*Aquaculture posing constraints to the development of heavy polluting industries*				
Significance	Impact can be viewed as positive and/or negative, but negative impacts are not regarded as significant based on the strategic planning and direction of development in the IDZ over the past decade.				

External Impacts on the Development (Development Restrictions)

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Air emissions from industries affecting aquaculture production*				
Significance	Negative Low	N/A (External Impact on the ADZ)		Negative Low	N/A
Nature of Impact	*Dust from mining operations impacting on aquaculture developments*				
Significance	Negative High if Unmitigated Negative Low if Mitigated	N/A		Negative High if Unmitigated Negative Low if Mitigated	N/A

Terrestrial and Aquatic Ecology

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Loss of Vegetation and Open Space Management Habitats*				
Overall Significance of Impacts	Negative High	Negative High	Negative Moderate	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Loss of Species of Special Concern and their Habitats*				
Overall Significance of Impacts	Negative Moderate	Negative Low	Negative Low	Negative Low	Negative Moderate to Unknown
Nature of the Impact	*Risk of increased alien plant invasion*				
Overall Significance of Impacts	Negative High	Negative High	Negative Low	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Increased animal road mortality*				
Overall Significance of Impacts	Negative Low	Negative Moderate	Negative Low	Negative Low	Negative Low to Unknown
Nature of the Impact	*Changes to migration corridors*				
Overall Significance of Impacts	None	Negative Moderate	Negative Low	Negative Low	None to Unknown

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Loss of Vegetation and Open Space Management Habitats*				
Overall Significance of Impacts	Negative High	Negative Low	Negative Low	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Loss of Species of Special Concern and their Habitats*				
Overall Significance of Impacts	Negative Moderate	Negative Low	Negative Low	Negative Moderate	Negative Moderate to

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
					Unknown
Nature of the Impact	*Risk of increased alien plant invasion*				
Overall Significance of Impacts	Negative High	Negative High	Negative Low	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Increased animal road mortality*				
Overall Significance of Impacts	Negative Low	Negative Moderate	Negative Low	Negative Low	Negative Low
Nature of the Impact	*Changes to migration corridors and resulting impacts on species of special concern*				
Overall Significance of Impacts	None	Negative High	Negative Moderate	Negative Moderate	None to Unknown

Coastal Dunes, Sand Movement and Sediment Dynamics

	Existing and Reasonable Anticipated Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Impact on dunes within in ADZ footprint*				
Significance	Negative High	Negative Low	Negative Very Low	As Existing	As Existing
Nature of Impact	*Impact on regional dune dynamics and sand movement*				
Significance	Negative Medium	Negative Low	Negative Very Low	As Existing	As Existing

Heritage Resources

	Existing Impact	**Project Impact**		**Cumulative Impacts with Project Mitigation**	**No Go Development**
		Unmitigated	**Mitigated**		
Nature of the Impact	*Risk of vandalism due to limited human presence and lack of security.* *Destruction of heritage sites during site clearance, grading, earthworks and excavations.* *Discovery of undocumented heritage sites and opportunities to enhance heritage knowledge base.*				
Frequency	Sporadic	Sporadic	Sporadic	Sporadic	
Overall Significance of Impacts	Negative Medium	Negative Medium	Positive Low	Positive Low	Same as Cumulative

Visual

Construction Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Visual exposure towards the shoreline and tourist boat routes in Algoa Bay.* *Very limited exposure towards a section of the N2.*				
Overall Significance of Impacts	Negative Moderate	Negative Very Low	Negative Very Low	Negative Moderate	Same as Cumulative

Operational Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Visual exposure towards the shoreline and tourist boating routes in Algoa Bay.* *Very limited exposure towards a section of the N2.*				
Overall Significance of Impacts	Negative Moderate	Negative Low	Negative Very Low	Negative Moderate	Same as Cumulative

Noise

Construction Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Localised and short-term noise created by construction equipment.*				
Overall Significance of Impacts	Negative Low	Negative Low	Negative Very Low	Negative Low	Same as Cumulative

Operational Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Localised noise created by high pressure pumps, generators and certain desalination plant equipment.*				
Overall Significance of Impacts	Negative Low	Negative Moderate	Negative Very Low	Negative Low	Same as Cumulative

Traffic

Traffic and access related matters have been assessed for the IDZ as a whole during previous EIA processes and are managed by the CDC on an IDZ-wide basis.

Storm Water Management and Erosion Control

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Construction activities leading to increased erosion and sedimentation*				
Overall Significance of Impacts	N/A	Negative Moderate	Negative Very	Negative Very	None to Unknown

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Operational activities leading to increased erosion and sedimentation*				
Overall Significance of Impacts	N/A	Negative Moderate	Negative Very Low	Negative Very Low	None to Unknown

Surface Water

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Impacts on Surface Water Resources (Excluding Marine Environment)*				
Overall Significance of Impacts	N/A	None	None	None	None to Unknown

Soil and Groundwater

Construction Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Spillage of hydrocarbons and chemicals infiltrating into the soil and groundwater.*				
Significance	N/A	Negative Medium	Negative Very Low	Negative Very Low	As Cumulative

Operational Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Hazardous spills and leaks infiltrating into the soil and groundwater.*				
Significance	N/A	Negative Medium	Negative Low	Negative Very Low	As Cumulative

Marine Environment

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Construction activities leading to increased erosion and sedimentation*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Spillage of hydrocarbons and chemicals during construction*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Construction below the HWM*				
Overall Significance of Impacts	N/A	Negative Medium	Negative Medium	Negative Medium	None to Unknown
Note	assessment confidence: Insufficient information. Measures to address low assessment confidence: Separate EIA for the CDC Marine Pipeline Servitude EIA.				

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Chemical pollutants entering the nearshore*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Storm water runoff*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Ecological impacts due to escapees*				
Overall Significance of Impacts	N/A	Negative Very High	Negative Medium	Negative Medium	None to Unknown
Note	Low assessment confidence: No technologies have been decided on, and could therefore not be assessed in detail. The impacts of the ADZ project on the marine environment will be strongly linked to the culture species selected by various investors which in turn dictates the culture technology to be employed and the mitigation measures required to ensure a biosecure culture environment. Measures to address low assessment confidence: – Each aquaculture project will require individual permits from DAFF and/or DEA which will have certain conditions based on the culture species and farm design. – Development of ADZ and farm level biosecurity management plans and disease and animal health management plans. – Individual aquaculture farms to comply with the Alien and Invasive Species (AIS) Regulations (GNR 598, GG 37885). No species on the invasive species list to be cultured on any farm in the ADZ without the operation conducting a risk assessment specific to the operation and species and receiving approval from the relevant authorities.				
Nature of the Impact	*Transfer of diseases, pathogens and parasites to wild stocks*				
Overall Significance of Impacts	None	Negative Very High	Negative Medium	Negative Medium	None
Note	Low assessment confidence: No technologies have been decided on, and could therefore not be assessed in detail. The impacts of the ADZ project on the marine environment will be strongly linked to the culture species selected by various investors which in turn dictates the culture technology to be employed and the mitigation measures required to ensure a biosecure culture environment. Measures to address low assessment confidence: – Each aquaculture project will require individual permits from DAFF and/or DEA which will have certain conditions based on the culture species and farm design.				

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
	– Development of ADZ and farm level biosecurity management plans and disease and animal health management plans.				
Nature of the Impact	*Interim abstraction and effluent discharge*				
Overall Significance of Impacts	N/A	Negative Medium	Negative Medium	Negative Medium	None to Unknown
Nature of the Impact	*Abstraction of seawater for the ADZ*				
Overall Significance of Impacts	Assessed in Separate EIA for the CDC Marine Pipeline Servitude EIA				
Nature of the Impact	*Discharge of ADZ effluent waters*				
Overall Significance of Impacts	Assessed in Separate EIA for the CDC Marine Pipeline Servitude EIA				

Biosecurity and Biodiversity Risk Assessment

Recirculating Systems (RAS)

Category	Identified Risk	With or Without Mitigation	Impact Status	Significance
DISEASE MANAGEMENT	*Influent water supply as a disease vector*	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Introduction of disease agent through new broodstock or juveniles	Unmitigated	Negative	High
		Mitigated	Negative	Low
	Contaminated feed as a potential disease vector	Unmitigated	Negative	Very low
		Mitigated	Negative	Very low
	Disease transmission between operations within the ADZ	Unmitigated	Negative	Medium
		Mitigated	Negative	Very low
	Wastewater/storm water / system flooding as a potential disease vector	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Undetected spread of disease agents/ deterioration of animal health	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Spread of disease agent within the facility	Unmitigated	Negative	Medium
		Mitigated	Negative	Very low
	Seabirds and other animals as a vector for disease	Unmitigated	Negative	High
		Mitigated	Negative	Very low
BIODIVERSITY AND GENETICS	*Disease and parasite transfer to wild populations via effluent water*	Unmitigated	Negative	Very high
		Mitigated	Negative	Very low
	Transfer of disease and parasites to native species through escaped fish	Unmitigated	Negative	Very high
		Mitigated	None	None
	Genetic pollution of the local stocks through escapees	Unmitigated	Negative	Very high
		Mitigated	None	None
	Introduction of invasive non-native species through escapees	Unmitigated	Negative	Very high
		Mitigated	None	None
FISH HEALTH MANAGEMENT	*Poor husbandry practices leading to disease/parasite outbreak*	Unmitigated	Negative	High
		Mitigated	Negative	Very low
BIO-ACTIVE COMPOUNDS	*Drug and therapeutant treatment risk to the environment*	Unmitigated	Negative	Low
		Mitigated	Negative	Very low

Flow-Through Systems (FTS)

Category	Identified Risk	With or Without Mitigation	Impact Status	Significance
DISEASE MANAGEMENT	*Influent water supply as a disease vector*	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Introduction of disease agent through new broodstock or juveniles	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Contaminated feed as a potential disease vector	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Disease transmission between operations within the ADZ	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Wastewater/storm water / system flooding as a potential disease vector	Unmitigated	Negative	Medium
		Mitigated	Negative	Very low
	Undetected spread of disease agents/ deterioration of animal health	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Spread of disease agent within the facility	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Seabirds and other animals as a vector for disease	Unmitigated	Negative	High
		Mitigated	Negative	Very low
BIODIVERSITY AND GENETICS	*Disease and parasite transfer to wild populations via effluent water*	Unmitigated	Negative	Very high
		Mitigated	Negative	Low
	Transfer of disease and parasites to native species through escaped fish	Unmitigated	Negative	Medium
		Mitigated	Negative	Very low
	Genetic pollution of the local stocks through escapees	Unmitigated	Negative	Very high
		Mitigated	Negative	Very low
	Introduction of invasive non-native species through escapees	Unmitigated	Negative	Medium
		Mitigated	Negative	Very low
FISH HEALTH MANAGEMENT	*Poor husbandry practices leading to disease/parasite outbreak*	Unmitigated	Negative	High
		Mitigated	Negative	Very low
BIO-ACTIVE COMPOUNDS	*Drug and therapeutant treatment risk to the environment*	Unmitigated	Negative	Low
		Mitigated	Negative	Very low

Pond Culture (PC)

Category	Identified Risk	With or Without Mitigation	Impact Status	Significance
DISEASE MANAGEMENT	*Influent water supply as a disease vector*	Unmitigated	N/A	N/A
		Mitigated	N/A	N/A
	Introduction of disease agent through new broodstock or juveniles	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Contaminated feed as a potential disease vector	Unmitigated	Negative	Medium
		Mitigated	Negative	Very low
	Disease transmission between operations within the ADZ	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Wastewater/storm water / system flooding as a potential disease vector	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Undetected spread of disease agents/ deterioration of animal health	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Spread of disease agent within the facility	Unmitigated	Negative	High
		Mitigated	Negative	Very low
	Seabirds and other animals as a vector for disease	Unmitigated	Negative	Very high
		Mitigated	Negative	Very low
BIODIVERSITY AND GENETIC	*Disease and parasite transfer to wild populations via effluent water*	Unmitigated	Negative	Very high
		Mitigated	Negative	Very low
	Transfer of disease and parasites to native species through escaped fish	Unmitigated	Negative	High
		Mitigated	None	None
	Genetic pollution of the local stocks through escapees	Unmitigated	Negative	Very high
		Mitigated	Negative	Very low
	Introduction of invasive non-native species through escapees	Unmitigated	Negative	Very high
		Mitigated	Negative	Very low
FISH HEALTH MANAGEMENT	*Poor husbandry practices leading to disease/parasite outbreak*	Unmitigated	Negative	High
		Mitigated	Negative	Very low
BIO-ACTIVE COMPOUNDS	*Drug and therapeutant treatment risk to the environment*	Unmitigated	Negative	Low
		Mitigated	Negative	Very low

Socio-Economics

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Employment creation*				
Overall Significance of Impacts	Negative High	Positive Medium	Positive Medium	N/A	As Existing
Nature of the Impact	*Provision of goods and services by local service providers*				
Overall Significance of Impacts	Negative High	Positive Medium	Positive Low	N/A	As Existing
Nature of the Impact	*Contribution to the GGP of the NMB Metro*				
Overall Significance of Impacts	Negative Medium	Positive Low	Positive Low	N/A	As Existing
Nature of the Impact	*Skills development and transfer*				
Overall Significance of Impacts	Negative High	Positive Medium	Positive Medium	N/A	As Existing

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Induced migration and conflict between local unemployed people and employment seekers from elsewhere*				
Overall Significance of Impacts	Negative Medium	Negative Low	Negative Very Low	As Existing	As Existing
Nature of the Impact	*Induced migration and the spread of HIV/AIDS*				
Overall Significance of Impacts	Negative High	Negative Low	Negative Very Low	As Existing	As Existing
Nature of the Impact	*Induced migration and increased demand for housing and municipal infrastructure and services*				
Overall Significance of Impacts	Negative High	Negative Medium	Negative Very Low	As Existing	As Existing
Nature of the Impact	*Induced migration and increased criminal activity*				
Overall Significance of Impacts	Negative High	Negative Medium	Negative Low	As Existing	As Existing
Nature of the Impact	*Public health and safety impacts due to increased construction related vehicular traffic*				
Overall Significance of Impacts	Negative Very Low	Negative Low	Negative Very Low	As Existing	As Existing

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Employment creation*				
Overall Significance of Impacts	Negative High	Positive High	Positive High	N/A	As Existing to Unknown
Nature of the Impact	*Provision of goods and services by local service providers*				
Overall Significance of Impacts	Negative High	Positive High	Positive High	N/A	As Existing to Unknown
Nature of the Impact	*Skills development and transfer*				
Overall Significance of Impacts	Negative High	Positive High	Positive High	N/A	As Existing to Unknown
Nature of the Impact	*Induced migration and conflict between local unemployed people and employment seekers from elsewhere*				
Overall Significance of Impacts	Negative Medium	Negative Medium	Negative Very Low	As Existing	As Existing to Unknown
Nature of the Impact	*Induced migration and the spread of HIV/AIDS*				
Overall Significance of Impacts	Negative High	Negative High	Negative Very Low	As Existing	As Existing to Unknown
Nature of the Impact	*Induced migration and increased demand for housing and municipal infrastructure and services*				
Overall Significance of Impacts	Negative High	Negative High	Negative Very Low	As Existing	As Existing to Unknown
Nature of the Impact	*Induced migration and increased criminal activity*				
Overall Significance of Impacts	Negative High	Negative High	Negative Medium	As Existing	As Existing to Unknown
Nature of the Impact	*Public health and safety impacts due to increased construction related vehicular traffic*				
Overall Significance of Impacts	Negative Very Low	Negative Low	Negative Very Low	As Existing	As Existing to Unknown

Resource Consumption and Greenhouse Gas Emissions

The EIR includes a high-level assessment of the resource consumption and greenhouse gas emissions of aquaculture as proposed for the ADZ, including feed inputs, water use, land take, energy use, transportation and greenhouse gas emissions over the life cycle of aquaculture products. Over the life cycle of an aquacultural product, the two main variables in terms of energy use and GHG emissions up to the farm gate, are feed production and on farm energy use for pumping of water. Aquaculture compares very favourably with terrestrial agricultural animal protein products including chicken.

The EIR discusses the status of the South African small pelagic forage fish species (caught wild) used in the production of fish feed ingredients; and the management of these species by DAFF on a national level, including their efforts to manage impacts on seabird populations, including the penguins in Algoa Bay. Since South Africa is a nett exporter of fish, it can be argued that it would be more beneficial to the country to apply the small pelagic forage fishery resources to the local aquaculture sector to support food production and thereby beneficiate these fishery resources into high value products for the export.

In terms of fresh water resource use, fresh water intensive aquaculture production systems are very similar to terrestrial animal farming systems. However, technological development over the past decade has resulted in more and more intensive systems and so called zero water exchange systems.

All seawater aquaculture operations are virtually independent of fresh water supplies. From a 'fresh water input' perspective, marine aquaculture is the most efficient form of animal protein food production.

Climate Change Adaptation

Developments situated too close to the sea are threatened by erosion and wave attack and over time to sea level rise induced by climate change. Realistic coastal management lines have the potential to maintain both the economic and ecological functioning of the littoral active zone and to mitigate the impacts of climate change.

By nature, certain infrastructure need to be close to the seashore, below the HWM, close to or within a source of sea water supply, at a low elevation to reduce water pumping costs, or at an elevation lower than other developments in the area to facilitate water/waste water to be gravity fed – particularly those aquaculture systems that require large volumes of seawater but would not be economically viable if pumping costs are excessive.

The NMB coastal management line study recognised that there is an inherent need to determine the economic requirements of the coast and that those economic demands may require a trade off with environmental aspects at a particular site. It included a decision matrix for risk selection to sea level rise to deal with the possible conflicts between the desire for environmental protection and the need for economic activities. This decision matrix for risk selection, international principles of the managed retreat approach to sea level rise, and the results of the environmental assessment in the EIR, inform the development of criteria for development decision-making in areas potentially affected by sea level rise within the ADZ.

DEVELOPMENT ALTERNATIVES

Site Alternative and Development Footprint Definition for Aquaculture

As discussed in detail in the EIR, the CDC's plans for the development of an ADZ in Zone 10 of the Coega IDZ follow years of planning and assessment. Various strategic, regional, IDZ-wide and project specific environmental and planning processes have been undertaken to provide context for the ADZ and the selection of the site within the coastal cluster of development in Zone 10 of the IDZ. In essence, these and the other assessment and planning processes, served to evaluate alternative land uses in Zone 10 of the IDZ, including potential conflicts and synergies with other industries throughout the IDZ, and served as the site selection and delineation of a development footprint for the ADZ. As such, this EIA does not attempt to repeat an evaluation of site alternatives

for the ADZ or of alterative land uses for Zone 10 of the IDZ. The fact that the EIA will not be investigating site alternatives was explained in the Scoping Report and the plan of study for EIA.

Site Alternatives for Seafood Processing

The CDC initially proposed to have the processing facilities located in Zone 3 of the IDZ. However, based on feedback received from prospective aquaculture investors, CDC has eliminated Zone 3 as a development option because investors specifically requested to have processing integrated on the same site as their aquaculture operations.

Technology Alternatives

Various options and technologies are listed and discussed in Section 4 of the EIR, but most of these are options that are open for consideration and not a discussion to select a preferred development alternative. Design criteria are provided where relevant to deal with decision-making regarding these options post the EIA phase.

The No-Go Development

The no-go development option is discussed in the impact assessment section of the report (Section 7) and all impact ratings include a rating of impacts for the no-go development. As illustrated through the detailed assessment of impacts in Section 7 of the EIR, the assessment did not identify reason to enforce the no-go development option.

ENVIRONMENTAL MANAGEMENT PLAN (EMPr)

The EMPr is attached to the EIR as Appendix B. It contains all mitigation measures and design criteria developed by the based on the input from the various specialists, comments from IAPs, assessment of impacts and specific site conditions.

This EMPr provides a framework for managing environmental risks specific to the ADZ. Each aquaculture farmer (investor) in the ADZ will be required to develop their own operational EMPr to give effect to the requirements of this framework as it pertains to their specific operations. Previous EIA processes have dealt with general environmental management matters in the IDZ and these have been written into the CDC's environmental specifications and procedures, and are not repeated in this EMPr.

CONCLUSION AND RECOMMENDATIONS

Based on the outcome of the various specialist studies and a detailed assessment of all potential significant impacts (Section 7 of the EIR), the EAP concluded that there is no reason why the development of the proposed ADZ should not be authorized. The EAP carefully evaluated all impacts as well as all the issues raised during the public participation process and included mitigation measures and design criteria to address all of these. The recommendations made by the various specialists were carefully considered and were integrated into the mitigation measures and design criteria as presented in the EIR.

It is recommended that the proposed ADZ be authorised on condition that the mitigation measures and design criteria contained in the EIA and EMPr be implemented.

DECLARATION BY THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

Mari Wolmarans, the undersigned, declares that this EIR represents an objective and complete assessment of the environmental impacts associated with the proposed Coega ADZ in Zone 10 of the Coega IDZ. Details of her qualifications, certification as environmental assessment practitioner and professional experience are listed in Section 11.1 of the report.

A full CV and a declaration signed under oath are included in Appendix H.

Mari Wolmarans
BL Arch, MSAIE&ES, EAPSA Certified
DIRECTOR
Ethical Exchange Sustainability Services (Pty) Ltd

Coega Development Corporation (Pty) Ltd

Coega Land-Based Aquaculture Development Zone (ADZ) Environmental Impact Assessment (EIA) Process

Coega Industrial Development Zone (IDZ), Nelson Mandela Bay Municipality,
Sarah Baartman District Municipality, Eastern Cape

Final Environmental Impact Report

Revision 01

Report No: X0118/CDC ADZ EIA/01/DEIR/00

January 2017

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A2 Activities triggered by GNR 921, in terms of the NEM:WA (Waste Management Licence)
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(Version 1 in DSR, Version 2 in FSR, Version 3 in DEIR, Version 4 in FEIR)

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(Written submissions and comments, questions asked and issued raised have been summarised in Appendix C: Comments and Response Report)

Appendix E: Competent Authority (DEA) Requirements

Appendix F: Minutes of Meetings and Presentations

F1 ELC Meeting 1 (19 February 2015)

F2 Pre-Application Meeting (16 April 2015)

F3 Public Meeting (16 November 2015)

F4 ELC Meeting 2 (19 November 2015) (relevant section of meeting minutes available on request)

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Appendix G: Specialist Reports

G1 Social Impact Assessment for the Coega ADZ, by Dr Anton de Wit (De Wit, 2016b)

G2 Dune Geomorphology Specialist Assessment for the Coega IDZ, Dr Werner Kurt Illenberger (Illenberger, 2016)

G3 Ecological (Terrestrial and Aquatic) Specialist Assessment, by Sherman Colloty & Associates (SC&A, 2016)

G4 Marine Specialist Assessment for the Coega ADZ, by Dr Russell Chalmers (Chalmers, 2016)

G5 Biosecurity and Biodiversity Risk Assessment for the Coega ADZ, by Timothy Guy Paulet (Paulet, 2016)

G6 Air Quality Assessment for the Coega ADZ, by Chris Albertyn, LAQS

G7 Waste Management Options in the Aquaculture Sector, compiled by Ethical Exchange

Appendix H: Study Team Information

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List of Abbreviations

/	per (when used in measurements)
ADZ	Proposed Aquaculture Development Zone
AEL	Air Emission Licence
AIS	Alien of Invasive Species
CBA	Critical Biodiversity Area
CBA-IDZ	CBA in Coega IDZ as defined in the Coega IDZ OSMP
CDC	Coega Development Corporation
Coega IDZ	Coega Industrial Development Zone
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent (measure for GHG emissions)
CRR	Comment and Response Report
d	day
DAFF	Department of Agriculture Forestry and Fisheries
DEA O&C	Department of Environmental Affairs, Oceans and Coast
DEA	Department of Environmental Affairs (National)
DEAT	Department of Environmental Affairs and Tourism (now DEA)
DEDEAT	Department Economic Development Environmental Affairs and Tourism (Eastern Cape)
DEIR	Draft Environmental Impact Report
DFP	Development Framework Plan
DMR	Department of Mineral Resources
DSR	Draft Scoping Report
DWA	Department of Water Affairs (now DWS)
DWAF	National Department of Water Affairs and Forestry (now DWS)
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECBCP	Eastern Cape Biodiversity Conservation Plan
ECO	Environmental Control Officer
ECPHRA	Eastern Cape Provincial Heritage Resource Agency
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
ELC	Environmental Liaison Committee
EMPr	Environmental Management Programme
FAO	Food and Agriculture Organization of the United Nations
FEIR	Final Environmental Impact Report
FSR	Final Scoping Report
GA	General Authorisation
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GNR	Government Notice Regulation
GNR	Government Notice Regulation
H_2S	Hydrogen sulphide (associated with a ‘rotten egg’ smell)

ha	hectares
HACCP	Hazard Analysis and Critical Control Points
hr	hour
I&AP	Interested and/or Affected Party
ICMA	National Environmental Management: Integrated Coastal Management Act (24 of 2008)
IDZ	Industrial Development Zone
L	litre
LUPO	Land Use Planning Ordinance (85 of 1985)
LWM	Low Water Mark
m	metre
m^2	square metres
m^3	cubic metres
mamsl	metres above mean sea level
MBP	Municipal (Metropolitan) Bioregional Plan
ML	Mega (million) litres
MLRA	Marine Living Resource Act (18 of 1998)
mo	month
Mort	Mortality / dead animal or animal carcass
MOSS	Metropolitan Open Space System
MPA	Marine Protected area
MPRDA	Mineral and Petroleum Resources Development Act (28 of 2002)
Mtn	million tonnes
N/A	Not Applicable
NDP	National Development Plan
NEM:BA	National Environmental Management: Biodiversity Act (10 of 2004)
NEM:PAA	National Environmental Management: Protected Areas Act (57 of 2003)
NEM:WA	National Environmental Management: Waste Act (59 of 2008)
NEMA	National Environmental Management Act (107 of 1998)
NHRA	National Heritage Resources Act (25 of 1999)
NMB	Nelson Mandela Bay
NMB Metro	Nelson Mandela Bay Metropolitan Area
NMB Municipality	Nelson Mandela Bay Metropolitan Municipality
NMMU	Nelson Mandela Metropolitan University
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NWA	National Water Act (36 of 1998)
OSMP	Open Space Management Plan
OSMP Revision 1	Open Space Management Plan Revision 1 (July 2014), with map revision 15
OSMP 2006	Open Space Management Plan (2006) with map revision 10
pers. comm	personal communication (interview, meeting, telephone conversation, email)
PM	Particulate matter
PM10	Fine particulate matter smaller than 10 micrometre
PPP	Public Participation Process
s	second
SAHRA	South African Heritage Resource Agency
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SEA	Strategic Environmental Assessment
Sea Shore Act	Sea Shore Act (21 of 1935)
SEMA	Specific Environmental Management Act (i.e. NEM:BA, NEM:AQA, ICMA, NEM:PAA, NEM:WA)
SIP	Strategic Infrastructure Project

SO_2	Sulphur Dioxide
STEP	Subtropical Thicket Ecosystem Programme
TMA	Trimethylamine (associated with a 'fishy small')
TMAO	Trimethylamine oxide
tn	tonne (metric)
TNPA	Transnet National Ports Authority, a division of Transnet Limited
TOPS	Threatened or Protected Species
TPT	Transnet Port Terminals
TSP	Total Suspended Particulates
WHO	World Health Organisation
WML	Waste Management Licence
WUL	Water Use Licence
yr	year
ZLA	Zone Labour Agreement
µg	micrometre (or micron)

List of Definitions

2014 EIA Regulations: Environmental Impact Assessment Regulations published on 4 December 2014 in Government Notice Regulation (GNR) 928, read together with the Listing Notices 1, 2 and 3 published in GNR 983, 984 and 985 respectively.

Alien and Invasive Species (AIS): Any plant or animal species that has been introduced into an area and that thrive in local conditions, suppressing and replacing indigenous biodiversity. Invasive species may cause economic or environmental harm, or even harm to human health.

Anthropogenic: Means of, relating to, or involving the impact of humans on nature.

Aquaculture: Aquaculture is a type of agriculture and can be defined as the controlled cultivation (farming) of aquatic animal and plant organisms such as fish and shellfish (water-dwelling animals other than finfish), which includes molluscs (i.e. clams, oysters, squid, cuttlefish, octopus, mussels, scallops, abalone), crustaceans (i.e. shrimp, crab, krill, lobster), and echinoderms (i.e. sea cucumbers, urchins, stars). It also includes edible plants, such as macroalgae (seaweeds or sea lettuce), microalgae and other microorganisms, for commercial, subsistence, recreational or other public or private purpose. Cultivation implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, disease control, protection from predators, etc.

Aquaponics: A system that combines conventional aquaculture (raising aquatic animals such as fish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment and utilising the waste, or rather the by-products, produced by the farmed aquatic animals as feed for the aquatic plants.

Aquatic organisms: An animal that lives in water for most or all of its life. It may breathe air or extract its oxygen from that dissolved in water through specialised organs called gills, or directly through its skin.

Baseline Environment: Pre-development environmental conditions. The prevailing environmental conditions (or status quo) prior to the start of an activity or project, including current / existing environmental damage / degradation.

Biodiversity: All the different kinds of indigenous plants and animals and micro-organisms in the natural environment, and the natural processes that allow them to survive. Biodiversity is the living component of the natural environment. The word is short for "biological diversity".

Biome: A biome is a broad classification of vegetation according to the kind of plants that occur there, which is influenced by factors such as soil and climate. A biome is not usually found only in one part of the country. Depending on the climate and features of the landscape, a particular biome can be distributed in patches, like forest in the kloofs of mountains all over the country.

Bioregional programme: A plan for a region which brings human communities together to identify their problems and goals, and agree on an approach and projects. It focuses on methods for the effective management of the region's biodiversity, and the long-term survival of that biodiversity.

Brackish Water Aquaculture: Cultivation of plants and animals found in saline waters of creeks, lagoons and estuaries, in water with a lower salt load than seawater.

Cage Culture System: involves the placing of fish cages in lakes, ponds, rivers or oceans to contain and protect the fish until they can be harvested. The two main types of cages are floating cages and pen-cages. Floating cages are floating mobile units which can be moved around in the ocean, dam or river in which they are floating. Pen-cages are stationary netted enclosures on the shore of the ocean, dam or river concerned.

Critical Biodiversity Areas (CBAs): Terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecosystem functioning.

Crustacean: Invertebrate animals with an external skeleton, a segmented body, and jointed appendages, which includes such familiar animals as crabs, lobsters, crayfish, shrimp, krill and barnacles.

Cumulative Impacts: Combined impacts of two or more activities, or the combined impacts of an activity with that of current activities. For this report, cumulative impacts are described as: *Existing Impacts + Incremental Impacts of the Project = Cumulative Impacts.*

Current State for Environment (Existing Impacts): The current level of environmental degradation associated with existing developments, including reasonably anticipated impacts of developments under construction or forthcoming developments for which impacts have been defined. Determination of the current level of degradation associated with existing developments is essential to understand and enable the assessment of cumulative impacts.

Echinoderms: Common name given to any member of the Phylum Echinodermata of marine animals. The adults are recognizable by their (usually five-point) radial symmetry, and include animals as starfish, sea urchins, sand dollars, and sea cucumbers.

Edible Weight: The weight of a seafood item exclusive of bones, offal, etc.

Effluent: Any liquid discharged into the environment, including coastal environments, as waste and includes any substance dissolved or suspended in the liquid, or liquid which is a different temperature from the body of water into which it is being discharged.

Endemic: A plant or animal species that is confined to, or exclusive to, a particular specified geographic area and nowhere else.

Environment: Surroundings in which organisms operate, including air, water, land, natural resources, flora, fauna, humans and their inter- relations (includes bio-physical and socio-economic components). Describes our surroundings, and includes all living plants, animals, bacteria etc. and non-living components (air, water) and systems (e.g. biological, physical, cultural, political, economic and social aspects). The term "natural environment" describes the same surroundings, but excludes humans, their activities and their impacts.

Environmental Authorisation (EIA): Authorisation issued by a competent authority in terms of the current or previous EIA regulations.

Environmental Impact Assessment (EIA): An EIA is an assessment of the positive and negative environmental consequences of the proposed project. The primary objective of the EIA is to aid decision-making by providing factual information on the assessment of these impacts, and determining their significance, as well as making valued judgements in choosing one alternative over another. For this EIA a combination of checklists, overlays and mapping, scoping and professional experience will be used to identify the possible negative and positive impacts on the environmental components. Part of a process required by law when certain "listed activities" are proposed by an applicant (landowner or developer) for a piece of land. These

activities can pose harm to the environment, and therefore require authorisation from an environmental department.

Existing Impacts: See Current State of Environment.

Extensive Production System: Aquaculture production that are maintained largely by natural sources of nourishment that does not rely on much input from humans, like mussel rafts and tilapia ponds.

Fatal flaw: A factor or situation, which prevents the development of an environmentally acceptable project, except at prohibitive cost. These are critical issues with the ability to stop a project's implementation.

Finfish: A bony fish, such as a salmon, or a cartilaginous fish.

Fish Meal: A high-protein animal feed supplement made by cooking, pressing, drying, and grinding fish or shellfish.

Fish Oil: An oil extracted from body (body oil) or liver (liver oil) of fish and marine mammals; mostly a byproduct of fish meal production.

Flow-Through System: Aquaculture system where new water is constantly replacing the water in the system.

Fresh Water: Means water with low salinity levels (not sea water). Not an indication that the water is clean.

Freshwater Aquaculture: cultivation of freshwater plants and animal species such as carp, catfish, koi karp, freshwater crayfish, tilapia and trout.

Fynbos: A biome dominated by medium-height (about 1 to 2 m) bushes, mostly with very small leaves, sometimes with reed-like plants called restios and taller protea bushes. Most types of fynbos are found on sandy soils, mainly on mountains and along the coast. Fynbos is restricted mostly to the southwestern Cape, where most rain falls in the winter, and to the in western coastal and mountain areas of the Eastern Cape.

HACCP (Hazard Analysis and Critical Control Points): A systematic preventive approach to food safety from biological, chemical, and physical hazards in production processes that can cause the finished product to be unsafe, and design measurements to reduce these risks to a safe level.

Incremental Impact: This is the impact of an activity looked at in isolation (impact of an individual activity), thus not considering the combined, cumulative or synergistic impacts of the activity, or the cumulative impacts of the activity with other activities or the current level of degradation.

Intensive Production System / Intensive Farming (or animal rearing / growing): Any concentrated or confined animal growing operation wherein the animals are provided with externally sourced feed.

Interested and Affected Parties (I&APs): These are individuals or groups concerned with or affected by the environmental impacts and performance of a project. Interested groups include those exercising statutory environmental control over the project, local residents/communities (people living and/or working close to the project), the project's employees, customers, consumers, investors and insurers, environmental interest groups, the general public, etc. It covers: Host Communities; Landowners (Traditional and Title Deed owners); Traditional Authority; Land Claimants; Lawful land occupier; The Department of Land Affairs; any other person (including on adjacent and non-adjacent properties) whose socio-economic conditions may be directly affected by the proposed prospecting or mining operation; the Local Municipality; the relevant Government Departments, agencies and institutions responsible for the various aspects of the environment and for infrastructure which may be affected by the proposed project.

Intertidal Zone: The foreshore and seashore and sometimes referred to as the littoral zone, is the area that is above water at low tide and under water at high tide, thus the area between tide marks.

Live Weight (Round Weight): The weight of fish, shellfish, or other aquatic plants and animals as taken from the water; the complete or full weight as harvested / caught.

Mariculture: A short name for 'marine aquaculture', involving the cultivation of seawater species such as abalones, mussels, oyster, dusky kob and seaweed.

Marine Aquaculture: Aquaculture using seawater for cultivation of seawater species.

Mining: In terms of the MPRDA, mining is the making of any excavation for the purpose of winning a mineral, and it includes any other associated activities and processes.

Molluscs: Invertebrate animals, many of which have shells, including snails, clams, scallops, oysters, octopus, squid and chitons.

Pond Culture Units: The use of ponds and irrigation ditches to farm fish. It consists primarily of ponds containing fish which are fed and protected against natural predators until they are large enough to harvest. It is usually a closed or semi closed system so every pond will have an inlet and an outlet for water to be exchanged from time to time. In many instances aquatic plants are also kept in the ponds because they help to oxygenate the pond water.

Pontoon: See Raft.

Raceway: A man-made channel used in aquaculture supplied with a continuous flow of water, either flow-through or continuously pumped back and recirculated.

Raft (Pontoon): Generally refers to floating growing system used in lagoons or sheltered bays, primarily used to farm marine invertebrates like mussels or oysters but could also be used in dams and constructed wetlands.

Ranching and Stock Enhancement: Ranching involves the release of hatchery raised aquatic organisms (mainly Abalone in South Africa) into the wild. Eggs are hatched and grown in a hatchery and when ready, the identifiable young specimens are moved into the natural environment where they will grow to maturity and be harvested. Stock enhancement involves the release of stock for the public good.

Receptor: A receptor is the target or object on which the impact, stressor or hazard is expected to have an effect.

Recirculating System / Recirculating Aquaculture System (RAS): Aquaculture system where water is recirculated with limited water exchange.

Record of decision (ROD): A term commonly used for the letter of authorisation issued by a competent authority pre 2006. For the sake of simplicity, the term Environmental Authorisation (EA), as is commonly used today, is used to refer all authorisations issued by a competent authority in terms of current and previous EIA regulations.

Seafood: For simplicity sake the term seafood is used as in the USA for any form of aquatic life consumed as food by humans. Scientifically, 'seafood' would be any form of sea life regarded as food by humans. It includes fish and shellfish. Shellfish (water-dwelling animals other than finfish) include various species of molluscs (i.e. clams, oysters, squid, cuttlefish, octopus, mussels, scallops, abalone), crustaceans (i.e. shrimp, crab, krill, lobster), and echinoderms (i.e. sea cucumbers, urchins, stars). It also includes edible sea plants, such as macroalgae (seaweeds or sea lettuce), microalgae and other microorganisms. In this report, for the sake of simplicity, the term seafood is extended to fresh water organisms eaten by humans, so all edible aquatic life are be referred to as seafood. The harvesting of wild seafood is usually known as 'fishing' and the cultivation and farming of seafood is known as aquaculture, or fish farming in the case of fish. The report uses the terms 'fresh water' and 'marine' species / fishing / aquaculture where distinction is required.

Semi-closed Production System: Aquaculture system where water is added or replaced from time to time.

Semi-intensive Production System: Aquaculture that relies on natural feed and fertilizer sources with added enhancers like cereals, meal and commercial feeds.

Shellfish: Water-dwelling animal other than finfish. A culinary and fisheries term for aquatic invertebrate animals with an external skeleton used as food, including various species of molluscs, crustaceans, and echinoderms.

Significant Impact: An impact can be deemed significant if scientific environmental studies, consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provide reasonable grounds for mitigating measures to be included in the environmental management report and environmental management programme. The onus will be on the proponent to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.

Species: All plants and animals are classified and identified by scientists according to a scientific name (species name). Each species has at least one local name, plus a scientific name which is the same everywhere in the world. Different species are organisms that are distinctly different to each other. For example, the black rhino (scientific name *Diceros bicornis*) and the white rhino (scientific name *Ceratotherium simum*) are both rhinos, but they are different species. As another example, an indigenous forest consists of many different indigenous species of plants and animals, while a plantation of pine trees consists of just one plant species.

Watercourse: as defined in the National Water Act, it means (a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Wet weight: Biological mass of live and dead cultured species before dehydration.

Coega Development Corporation (Pty) Ltd

Coega Land-Based Aquaculture Development Zone (ADZ) Environmental Impact Assessment (EIA) Process

Coega Industrial Development Zone (IDZ), Nelson Mandela Bay Municipality,
Sarah Baartman District Municipality, Eastern Cape

Final Environmental Impact Report

Revision 01

Report No: X0118/CDC ADZ EIA/01/FEIR/01

March 2017

1 Introduction and Background

1.1 Overview of the Development

The Coega Development Corporation (CDC) is proposing the development of a land-based aquaculture development zone (ADZ) in Zone 10 of the Coega Industrial Development Zone (IDZ). The proposal is in line with the CDC's mandate in terms of the Industrial Policy Action Plan of the Department of Trade and Industry (DTI) and the Aquaculture Development and Enhancement Programme as approved by the Department of Agriculture, Forestry and Fisheries (DAFF).

The overall purpose of the project is to establish an 'investment ready' platform for planned commercial aquaculture operations to establish within the Coega IDZ.

The Coega IDZ is located on the northern outskirts of Port Elizabeth, Nelson Mandela Bay Metropolitan Area (NMB Metro) north-east of the residential areas of Motherwell, Wells Estate, St Georges Strand and Bluewater Bay, in the Sarah Baartman District, Eastern Cape. The Coega IDZ consists of approximately (~) 11 500 ha of land, including the Coega River and Port of Ngqura, and has been divided into 14 zones (or clusters) for different heavy, medium and light industries. The location of the Coega IDZ and the different zones within the IDZ are shown on Figure 1-2. The ADZ is proposed for Zone 10, located adjacent to the coastline of the Algoa Bay, and north of the Port of Ngqura (Plate 1-1).

Aquaculture is a type of agriculture and can be defined as the controlled cultivation (farming) of aquatic animal and plant organisms such as fish and shellfish (water-dwelling animals other than finfish), which includes molluscs (i.e. clams, oysters, squid, cuttlefish, octopus, mussels, scallops, abalone), crustaceans (i.e. shrimp, crab, krill, lobster), and echinoderms (i.e. sea cucumbers, urchins, stars). It also includes edible plants, such as macroalgae (seaweeds or sea lettuce), microalgae and other microorganisms, for commercial, subsistence, recreational or other public or private purpose. Cultivation implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, disease control, protection from predators, etc.

Aquatic organisms can be cultivated on land – 'land-based aquaculture' such as proposed for the Coega ADZ, using constructed systems such as tanks, aquaria, ponds or flow-through raceways. Alternatively, they can by cultivated using pens or cages in open water in the ocean, a coastal bay, dam, lake or estuary – open water cultivation in Algoa Bay is not considered as part of the Coega ADZ, which only includes aquaculture on land. Cultivation of seawater species is sometimes referred to as 'mariculture', a short name for 'marine aquaculture'.

Aquaculture is sometimes practiced as a polyculture, where a variety of species occupying different ecological niches are cultivated together and is often combined with other agricultural practices such duck-fish ponds or aquaponics. Aquaponics refer to a system that combines conventional aquaculture (raising aquatic animals such as fish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment. The principle is to use the excrement and 'waste', or more correctly termed the 'by-products' produced by one organism as feed for another organism. The development of an ADZ lends itself to the establishment of different aquaculture operations in the zone with such symbiotic partnerships, as well as potential future symbiotic partnerships with other industries and developments in the Coega IDZ.

1.2 Overview of the Coega Industrial Development Zone (IDZ)

The Coega IDZ was established in 1999 to promote socio-economic growth in the Eastern Cape, in line with the South African Government's focus on infrastructure development as a catalyst to economic growth and investment, Cape and South Africa.

The CDC is a state owned company that has been mandated with the development and operation of the Coega IDZ, including the NMB Logistics Park in Uitenhage. Integrated with the Coega IDZ, is the Port of Ngqura, which is located in Zone 8. It is South Africa's latest commercial port development, situated at the mouth of the Coega River. The multi user port has purpose-built container, bulk and break-bulk terminals. Transnet National Ports Authority (TNPA), a division of Transnet Limited, controls and manages the harbour while Transnet Port Terminals (TPT) is responsible for the terminal operations. The Port of Ngqura has been in operation since 2009 and was officially opened in 2012. The Port of Port Elizabeth is located ~18 km to the south of the Coega IDZ.

The priority sectors for the Coega IDZ are: metallurgical, automotive, services, chemicals, agro-processing, logistics and energy. Aquaculture, food processing and food packaging are sub-sectors of the agro-processing sector, which is widely regarded as crucial for economic development and sustainable employment. The CDC's roadmap for the agro-processing sector is illustrated on Figure 1-3.

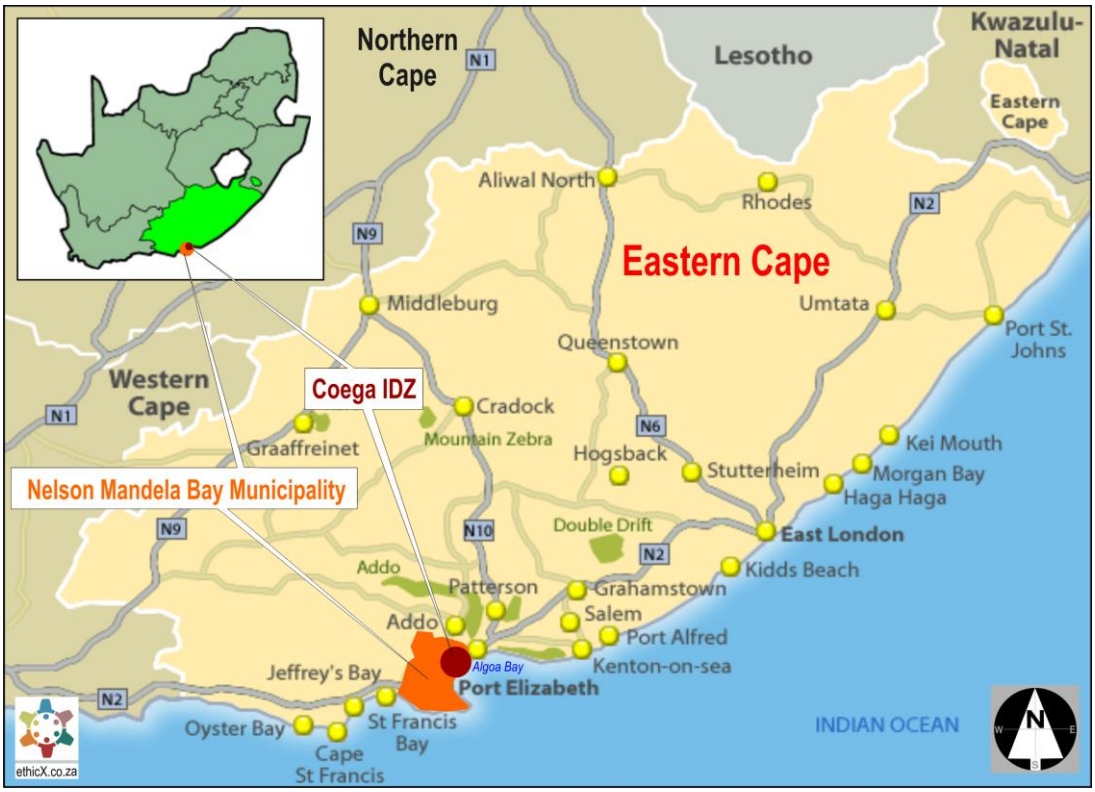


Figure 1-1: Location of the Coega IDZ

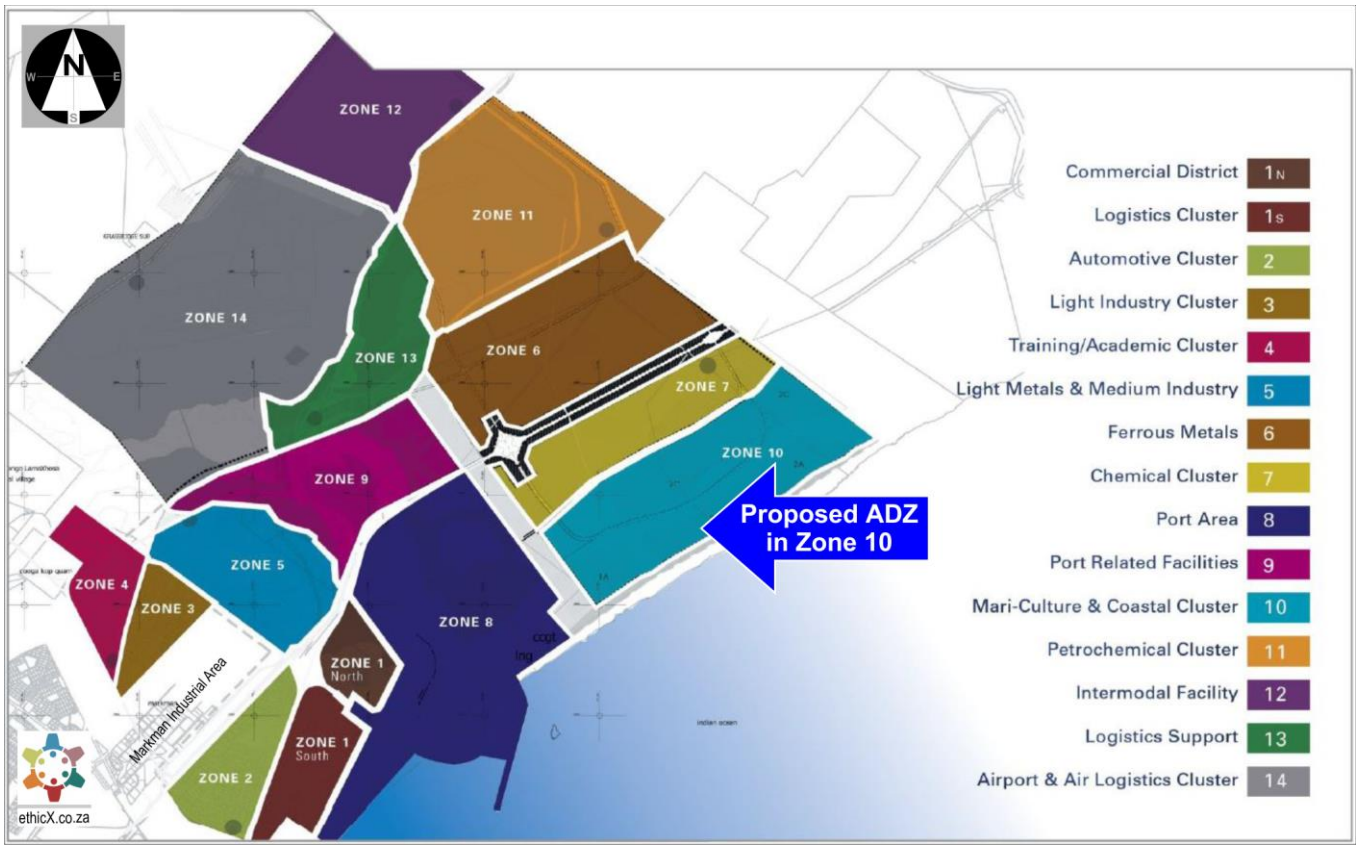


Figure 1-2: Overview of the Coega IDZ Zones

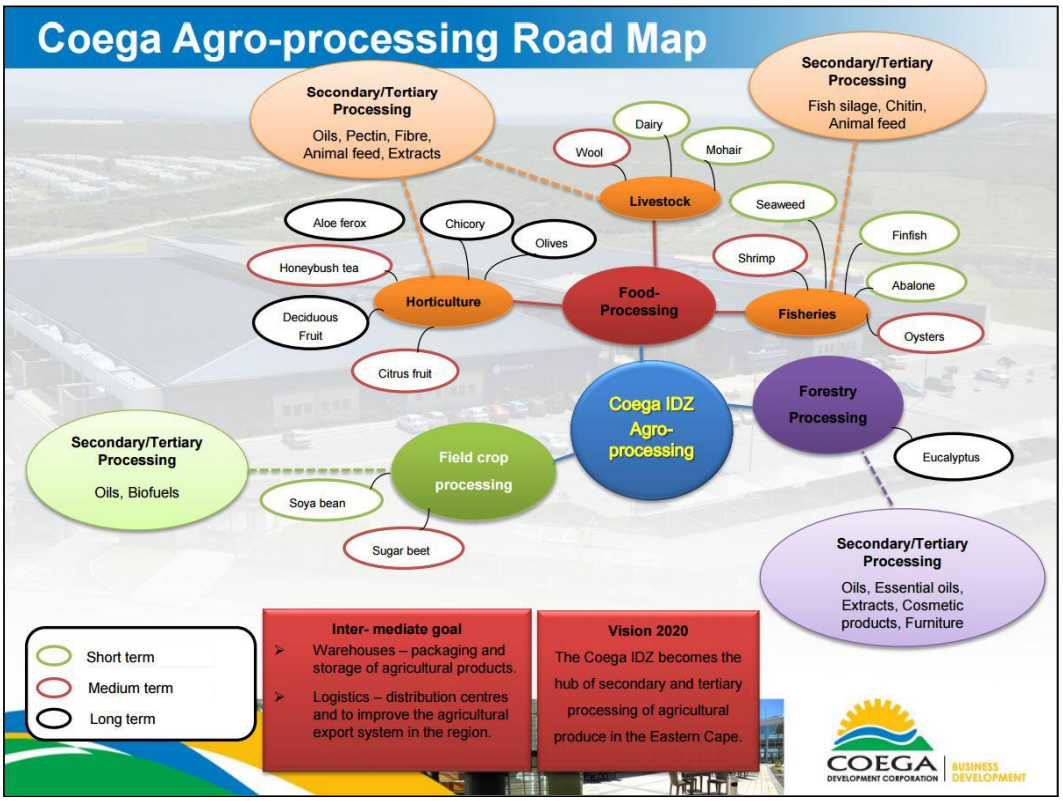


Figure 1-3: CDC Roadmap for the Agro-Processing Sector Development in the Coega IDZ

1.3 Location of the ADZ

The ADZ is proposed to occupy a development footprint area of ~440 hectares within Zone 10 of the Coega IDZ. Zone 10 is ~1200 ha in size and located along a ~5.8 km stretch of the Algoa Bay coastline to the north-east of the Port of Ngqura. The ADZ footprint can be roughly divided into a coastal and inland section. The ADZ coastal section fronts onto a ~2100 m long shoreline, is ~140 ha in size and falls entirely in the Coega IDZ's coastal cluster for development where the old Marine Growers abalone farm and SeaArk prawn pilot facility used to operate from. The rest of the coastal strip in Zone 10 has been zoned as primary open space.

The ADZ inland section is located behind the primary and secondary dunes and links to the ADZ coastal section directly inland from the old abalone farm. The inland section ~300 ha sized narrow strip of land, ~4.5 km long between the coastal dunes and IDZ Zone 7, except for the northern corner where it widens and stretches inland up to the N2 highway.

Access to the site is via exit 770 along the N2 highway, about 2 km north-east of the Coega River and salt works, then a tar road from the exit southwards for ~1.5 km, past the Cerebos plant, to a traffic circle, and gravel tracks from there to Hougham Park and further south along a gravel road to the coastal section of the ADZ.

Plate 1-1: Approximate location of the ADZ (red circle) and the IDZ's Coastal Cluster for Development (orange outline) in relation to the Port of Ngqura and Algoa Bay Coastline

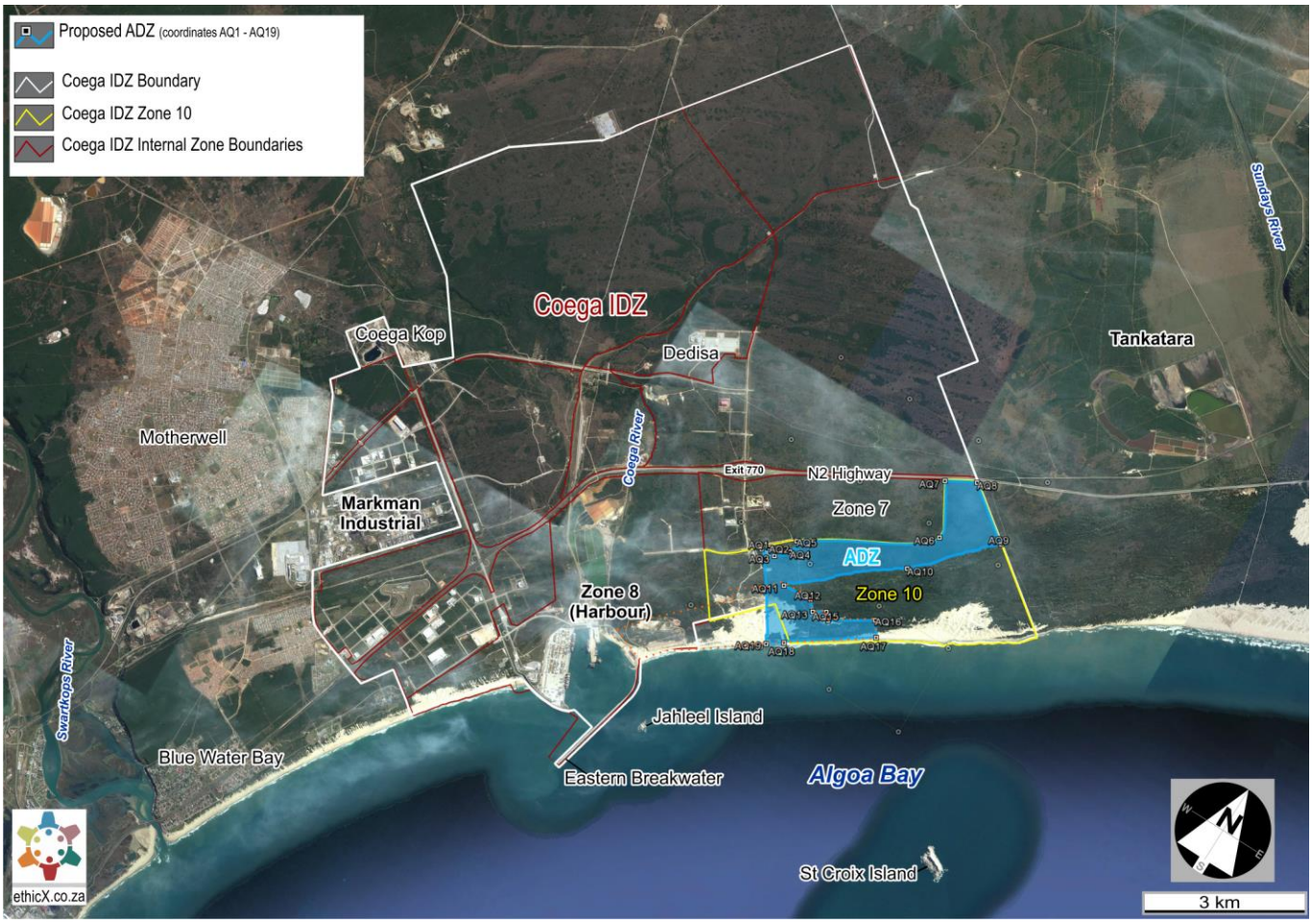


Figure 1-4: Location of the ADZ in Zone 10 of the Coega IDZ

(IDZ in white line, Zone 10 in yellow line, ADZ in blue line, Coastal Cluster for Development in orange dotted Line)

1.4 Need for and Desirability of the Development

There could be around 9 billion people on earth by 2050 and traditional farming is unlikely to be able to produce enough food for them (Forster, 2011; FAO, 2016). DAFF reports that more than 14 million citizens in South Africa have insufficient access to food, are vulnerable to hunger and are food insecure (DAFF, 2016).

Aquaculture serves many purposes but the most important one is to supply food for humans. It also supports the food chain at a lower level by producing algae and other plant organisms for animal feed. Although often associated with high-priced species such as abalone, prawns and mussels, some of the world's poorest populations depend heavily on aquaculture, too (Winkler, undated).

A milestone in the evolution of the human diet was reached in 2011 when for the first time in modern history, world farmed fish production topped beef production and the gap is widening (Larsen, 2013). Another milestone was reached in 2014 when the aquaculture sector's contribution to the supply of seafood for human consumption overtook that of wild-caught fish for the first time. These trends illustrate the latest stage in a historic shift in food production—a shift that at its core is a story of natural limits. Wild harvesting of fishery resources, so called 'capture fisheries', has become increasingly unsustainable due to over exploitation. 85% of the world's marine stocks are either fully exploited or overfished, driving accelerated growth in the farmed seafood industry (FAO).

Many millennia after terrestrial food production shifted from hunter-gatherer activities to agriculture, aquatic food production has transitioned from being primarily based on capture of wild fish to the culture of increasing numbers of farmed species. Global total capture fishery production[1] in 2014 was 93.4 Mtn, of which 81.5 Mtn

[1] *Production figures quoted in live weight harvested or caught (also called 'round weight').*

from marine waters and 11.9 Mtn from inland waters. Total aquaculture production (animals and plants) were 101.1 Mtn. Production of aquatic animals from aquaculture in 2014 amounted to 73.8 Mtn, with an estimated first-sale value of US$ 160.2 billion. In addition, 27.3 million tonnes of aquatic plants valued as US$ 5.6 billion were cultured. Aquatic plant farming, overwhelmingly seaweeds, has been growing rapidly as a human food source and is now practised in about 50 countries (FAO, 2016).

Aquaculture has the potential to have a major socio-economic impact. Worldwide 18 million people are engaged in the primary sector of aquaculture farming. Of this total, 36 % were full time employed, 23 % part time, and the remainder were either occasional / seasonal or of unspecified status (FAO, 2016). Women accounted for 19 % of all people directly engaged in the primary sector in 2014, but when the secondary sector (e.g. processing and trading) is included women make up about half of the workforce (FAO, 2016).

For every tonne of aquaculture product produced worldwide, 0.17 jobs (full time, part time and occasional) are created in the primary farming sector (1 job per 5.6 tonnes produced). It can be argued that these labour figures are skewed by the large contribution from underdeveloped and poor populations where labour costs are cheap compared to South Africa and where the focus of aquaculture is on subsistence, people essentially 'work for their food' and labour figures cannot be applied to commercial aquaculture. It is therefore useful to also benchmark figures from developed countries with an established and mature commercial aquaculture sector where the majority of the produce is exported. Canada is an example with available statistics. The potential of aquaculture to have a significant socio-economic impact is unmistakeably illustrated by statistics produced by Fisheries and Oceans Canada (2013) where they have measured the economic contribution of the Canadian aquaculture sector using three key indicators: GDP, employment and labour income. The statistics for 2010 were as follows:

Aquacultural production output, live weight: (75% finfish, 26% mussels, oysters, clams, other shellfish)	**155 000 tn**
Farm gate value:	M CAD 881 (million Canadian Dollar)
Processing value added:	M CAD 232
Final product value:	**M CAD 1 113**
Trade flow generated through aquaculture (goods and services impact):	**M CAD 2 053**
Total GDP contribution (direct, indirect and induced):	**M CAN 1 064**
Employment:	
Fulltime (direct, indirect and induced):	**14 000**
Part time and occasional jobs	not available
Labour Income:	**M CAD 616**
Employment Ratios:	
Fulltime jobs per tonne production	**0.09** (1 job / 11 tn)
Part time and occasional jobs	not available

M = million; CAD = Canadian Dollar. Source: Fisheries and Oceans Canada (2013).

Aquaculture is widely recognised as a driver for the 'oceans economy', also referred to as the 'blue economy'. Worldwide, aquaculture has helped to produce more food and made fish and seafood more accessible to consumers around the world. Although it fluctuates, all in all, the price of cultured fish has declined over the past ten years, making farmed fish a more affordable food commodity to many.

One important feature of the aquaculture sector is that seafood is highly traded on international markets. According to the FAO (2012), 38% of fish produced in the world was exported in 2010. Although there are inherent imbalances in regional supply and demand for fish, international trade provides a mechanism to resolve these imbalances. The flow of seafood exports from developing countries to developed countries has been increasing and in 2012, 67% percent of fishery exports by developing countries were directed to developed countries.

In recent years, some developing countries in Asia and the Pacific (Myanmar and Papua New Guinea), Africa (Nigeria, Uganda, Kenya, Zambia and Ghana) and South America (Chilli, Ecuador, Peru and Brazil) have made rapid progress to become notable aquaculture producers in their regions. Aquatic products are increasingly traded globally. New markets and new products have emerged and with restrictions on capture fishing in certain seas, some aquaculture products found strong niche markets and became important commodities in the aquatic food trade.

Sub-saharan Africa, excluding Nigeria, produced 243 700 tn/yr of aquatic animals which equated to only 0.33% of the world production. South Africa's aquacultural production was ~6000 tn/yr in 2014 and is valued at R 400 million (DAFF, 2015; 2016). Production roughly[2] includes ~2300 tn/yr marine animals, ~700 tn/yr seaweed and ~3000 tn/yr freshwater species. About 2,227 people derive their livelihoods from aquaculture in South Africa; that is 1 livelihood per ~2.7 tonnes of production of animals and plants, or a livelihood ratio of 0.37 (livelihoods per tonne of production).

The South African aquaculture sector is performing below its potential and remains a minor contributor to national fishery products and the country's GDP (FAO, 2011) but progress has been made – production quadrupled in the last 10 years (FAO, 2011). The most established sub-sectors are trout, mussels, oysters and abalone. Other species that are cultivated in fairly limited quantities include catfish, tilapia, kob and freshwater crayfish. Prawns, yellowtail, sole, spotted grunter and scallops are also showing promise for commercial production in the near future. Abalone is the fastest growing sub-sector with new farms opening and some existing farms doubling production. Current production is estimated at ~2000 tn/yr (Britz, 2015), but is predicted to increase to ~3000 tn/yr by 2019 (Britz, 2015) and potentially to ~5000 tn/yr by 2023 (Vosloo, 2013).

Like in the rest of the world, the South African government has recognised the potential of aquaculture to provide increased food production and food security, job creation and export opportunities. Aquaculture has been highlighted in the South African Government's policy on food security and poverty alleviation.

It is the vision of South African government to promote and grow the domestic aquaculture sector in a manner that contributes to food and nutritional security, creates sustainable jobs, fosters economic development, stimulates rural development and supports livelihoods, attracts investment, safeguards the environment and creates opportunities for SMMEs and wealth-generation (Operation Phakisa and DAFF National Aquaculture Strategic Framework).

The Department of Agriculture, Forestry and Fisheries (DAFF) published the National Aquaculture Policy Framework for South Africa 2013 that contains a clear commitment to provide support for aquaculture development, commits DAFF to facilitate and support the optimal growth of the aquaculture sector and to promote research and the provision of support services. In 2016, the draft Aquaculture Bill was gazetted and public consultative workshops were conducted in all nine provinces. The aim of the bill (and eventually the act) would be to promote the development of an equitable, diverse, viable and competitive aquaculture sector; to create a harmonised enabling regulatory environment within a framework of sustainable development; to improve coordination in the regulation of the aquaculture sector; to promote the participation of historically disadvantaged individuals, and to establish an aquaculture development fund.

[2] *Adapted from available statistics in different reference sources, such as FAO SA country profile; DAFF, 2011; DAFF, 2016; DAFF, 2016; Britz, 2015).*

Through Operation Phakisa and the development of marine and inland aquaculture projects, DAFF is aiming to increase production to 20000 tn/yr, the value of the sector from R 400 million to R 6 billion/yr, and create up to 210 000 sector jobs by 2030 (DAFF, 2016).

Regardless of the planned regulatory reform, over regulation is still a key challenge for the sector and the time it takes to establish an income-generating aquaculture business. There are over 13 different permits and licences required by a potential developer before being able to operate. These permits and licenses are required from a number of different government departments and are currently issued in a cascading manner which extends the permitting period unnecessarily. After all the approvals and permits are in place, which could take years, it may take another 2-5 years before an aquaculture business starts generating an income. Abalone can take 4 years to grow to the ideal marketable size and tilapia 12 months. In this complicated regulatory environment with long lead times, potential aquaculture developers find it difficult to attract investment.

Aquaculture in the greater NMB Metro is not new, with oyster farming going back as far as 1893 at the Swartkops River. Oysters are still farmed in Algoa Bay in nets suspended on a system of ropes and anchored floats about 1 km out at sea. Abalone was farmed successfully from ~1997 to 2009 at Hougham Park (later Coega IDZ Zone 10). Prawns were produced from 2006 to 2009, also in Zone 10 of the Coega IDZ, but were plagued with high energy inputs and costs.

All of this begs the question: with the development potential and all of the government policy support – why is aquaculture not more successful, in South Africa, in the Eastern Cape and in NMB Metro?

In effect, the local aquaculture sector is not unique. Although aquaculture has been practiced since ancient times, it only began its boom in the 1990s with the introduction of more intensive rearing systems. As with any emerging industry sector, there has been testing and experimentation with new technologies, feed and species that led to some failures and some successes. The main failures have been around culture (living) conditions of the farmed species, animal health and control of diseases in the artificial conditions they live, production of species not suitable to local climatic conditions, reliance on large quantities of water in extensive production systems, energy inefficient production systems, lack of managing environmental impacts associated with the release of untreated waste water and solids to the environment, impacts on wild fish populations, and low quality feed with questionable ingredients that affected the quality of the products, caused disease outbreaks, resulted in the overuse of antibiotics and health scares about toxins in farmed fish.

Another important matter is the fact that around 17 Mtn of wild-caught fish, one fifth of the global fish catch, is used to produce fish feeds for aquaculture – feed is widely regarded as a potential constraint to the growth of aquaculture production. Although about half of the world's aquaculture production of animals and plants came from non-fed species such as carp and filter-feeding animals such as mussels, oysters and seaweeds, growth in production has been faster for fed species than for non-fed species (FAO, 2016). Reducing the reliance on wild-caught fish and providing fish farmers with well-balanced feed at cost effective prices is a prerequisite for successful aquaculture production. Formulation issues, and in particular the provision of species-specific feeds that meet the nutritional requirements of different life stages of the farmed species, remain important topics for both commercial and on-farm-made feed production sectors (FAO, 2016).

All of these issues caused extensive debate and negative publicity, and rightly so. The extent of this is illustrated by the WWF (World Wildlife Fund) getting involved in the debate in 1994, first focussing on research in the shrimp industry to investigate and compare the impacts of shrimp aquaculture and shrimp trawling and later on the development of better management practices. In 2004, the WWF initiated and coordinated the Aquaculture Dialogues, a series of roundtables that included over 2000 farmers, retailers, NGOs, scientists and other important stakeholders within the aquaculture industry. Together, the group committed to developing measurable and performance-based standards for responsibly farmed seafood. This led to the establishment of the Aquaculture Stewardship Council (ASC) co-founded in 2010 by WWF and the Dutch Sustainable Trade Initiative. The ASC is an independent not for profit organisation with global influence that works with aquaculture producers, seafood processors, retail and foodservice companies, scientists, conservation groups and consumers to: recognise and

reward responsible aquaculture through certification programme and seafood labelling; promote best environmental and social choice when buying seafood; and contribute to transforming seafood markets towards sustainability.

An internet search on the topic will quickly reveal the complexity and persistence of the debate about the good and bad of aquaculture with articles such as: *'10 reasons not to eat farmed seafood'* versus *'Why farmed salmon is healthier than you think'*; or *'Are farmed fish one of the most toxic foods…?'* and the rebuttal *'Clarification of toxins in farmed fish'*. In all of this there is an unsurprising common thread best summarised by the following statements taken from the WWF's website (wwf.panda.org):

'Aquaculture is a promising solution; producing enough food for a growing population without having to rely exclusively on wild fish stocks' (WWF).

'When produced responsibly, aquaculture can thrive alongside healthy wild fish populations and without harming the marine environment, for the benefit of both businesses and local people (WWF).

There is a strong resemblance between the aquaculture sector and the poultry sector that began its boom in the 1950/60s. The broiler chicken industry did not exist at the beginning of the 20th century. It began as a backyard hobby, and then small specialist companies started to shape what became the vertical integration model, which was then copied, improved and eventually applied on a mega-scale with growth that resulted in chicken becoming more and more affordable and eventually the most eaten animal protein worldwide. The same issues experienced in the aquaculture sector today, plagued the poultry sector during its boom years.

There are lingering issues and impacts inherent to intensive animal rearing of any kind but with little room for expanding the output from rangelands and the wild-caught seafood, producing more food for a growing and increasingly affluent world population has meant relying on more intensive rearing / growing systems and a major drive to producing food that are more land, water, energy and feed input efficient while keeping climate change impacts in check (Larsen, 2013).

Improvements and successes are often based on the lessons learned from past failures. Research and development in aquaculture is happening at an unprecedented pace[3] in the following areas, with a noticeable focus on sustainability and the reduction of environmental impacts:

- DAFF is conducting research on genetics, nutrition for aquaculture species (DAFF, 2016) and has commissioned risk assessments on a number of alien species to assess the viability and acceptability of introducing them to be cultured in South Africa.
- Animal welfare and disease prevention (as opposed to treatment of diseases) such as the use of probiotics and beneficial microorganisms to maintain a healthy cultured population rather than routine antibiotic use.
- Species selection and development of more robust strains.
- Marketing and development of lesser known and traditionally less popular species lower on the food chain, such as low-trophic catfish, carp, tilapia and bivalve mollusks versus high-trophic (predatory) species such as salmon or kob.
- Development of standardised off-the-shelf (or packaged) production systems, water treatment systems and waste water treatment systems. As little as 20 years ago, aquaculture systems had to be custom designed, mostly through trial and error. Today it is possible to invest in systems that have already gone through the trial and error process.
- Improved resource efficiency and reduced environmental impacts:
  - Finding beneficial uses for non-edible byproducts and waste.
  - Reducing external energy requirements, through initiatives such as biogas generation from production and processing waste, or generating hydropower as part of gravitational flow-through systems.

[3] *Statement based on extensive literature review and consultation with specialist in the sector, refer Reading List.*

- Integrated or multi-trophic aquaculture of multiple aquaculture species (using water more than once).
- Integration of other agricultural crops in the form of freshwater and seawater aquaponics. The 'waste' produced by 1 kg of finfish (edible weight) is contains nutrients to grow up to 9 kg of plant matter.

- Intensification of production with improved, lower energy use and lower water exchange, better water management and treatment to reduce the reliance on external water and energy sources and virtually isolates the system from its external environment, and thereby managing the inherent fundamental environmental risks associated with aquaculture production:
  - Improved biosecurity and animal health management, and thus improved product quality.
  - Reduced biodiversity risks.
  - Climate change adaptation – these systems allows for a wider selection of species to be reared in virtually any climatic region, for example: growing tilapia in Siberia[4].
- Replacement of wild-caught fish with alternative lipids and protein not only from plant based sources but from emerging sources such as produced algae, insects, or microbial biomass and the byproducts from farmed fish. The quality of feed directly affects the quality of the aquaculture product, including the nutritional value for consumers. Major strides have been made, but reducing the dependency on fishmeal and fish oil, without compromising the nutritional value – especially omega 3 long-chain fatty acids – requires new innovations in technologies and management. Most of all it requires a mindset change and industry acceptance of these emerging feed sources but the payoffs may be spectacular both in terms of profitability, product quality and nutritional value, food security and reduced environmental impact (Hall *et al*, 2011).

Due to its location on prime land in the Coega IDZ, close to a port and international airport, the ADZ is naturally aimed at commercial scale aquaculture farms, which again is likely to attract aquaculture investors focusing on high-value species for the export market to earn foreign currency, and maybe to also circumvent the relatively slow uptake of species such as catfish, carp, bass and tilapia in the local market. Over time this is likely to change as was the case with trout to some extent in South Africa, and with tilapia in the USA since the 1990s. The USA started producing tilapia in the 1980s and imports commenced in the 1990s; today tilapia is one of the four most eaten seafood products in the USA. There are about 15 operational tilapia recirculating aquaculture projects established in South Africa. They are generally on a fairly small scale but several have successfully introduced tilapia to market and the general feeling is that it is a fine product and the demand is there but refinements in packaging, presentation and format (whole, gutted, scaled, filleted) need to be considered (James, 2016).

Regardless of the expected initial focus on high-value species and the export market, the ADZ has potential to contribute to local food production, food security and climate change adaptation in various ways, such as:

- Aquaculture and aquaponic skills development
  - People working in the ADZ are bound to develop skills that could equip them to become aquaculture and/or aquaponic farmers in their own right. These people could export their skills, on a small or larger scale, to other parts of the Eastern Cape and South Africa, thus diversifying food production and improving water use efficiency. Scaled-down aquaponic systems are suitable for application by smallholders in an urban and rural application setting, which may play an important role in climate change adaption of communities. Aquaponics use water more efficiency than any conventional crop production and can be applied virtually anywhere (such as in a container, shed or indoors to compensate for climate) with very little resource inputs.

- Driving local aquaculture market adaptation and development
  - A number of potential investors in the ADZ have expressed interest in producing lower-trophic species. Eating species lower on the food chain is widely recognised as important to reduce the demand for fish meal and fish oil in the production of high-trophic (predatory) species, and to support climate change adaptation. The establishment of the ADZ is bound to expose the local market to a steady supply of lesser

[4] *Aquaculture Insight, a South African based company, has developed a 200 tn/yr tilapia farm in Siberia.*

known and currently less popular species, which is often the lower-trophic species. Chefs, restaurants and food-outlets chains drive the acceptance and eventual popularity of a specific food product, and for this to happen, there has to be a steady and reliable supply of the product. Elsewhere in the world this has proven successful, such as the adoption of tilapia in the USA.

- As these species become more popular, more aquaculture developers are likely to cease the opportunity and establish in the ADZ with products aimed at the local market.
- The price of currently popular but dwindling wild-caught seafood is bound to increase over time and aquaculture products are bound to become more competitive.

- Research and development
  - The ADZ, with its location on the doorstep of NMMU and Rhodes University, has the potential to become a centre for research and development in the aquaculture sector.
  - As food security and climate adaptation becomes more pressing, it is likely to become a topical research topic. Research on and eventual introduction of new species, multi-trophic aquaculture, seawater aquaponics, and feed and food produced from emerging protein and lipid sources such as algae, insects, or microbial biomass would be important to climate change adaptation.
  - The development of the vertically integrated business model in the poultry sector some years ago is widely used as an example of improvements that can still be made in the aquaculture sector to produce more affordable products.
  - Aquaculture systems and technologies developed or improved in the ADZ would become available for rollout to other parts of the country and for application by smallholder aquaculture farmers, especially in areas where traditional crop production is at risk due to climate change.

- Diversifying and supporting local agriculture production
  - Although some of the species farmed in the ADZ may be regarded as too high-priced as a locally affordable food source, their byproducts and waste could be applied to support the introduction of other species for the local market. This could be in the form of integrated or multi-trophic aquaculture, aquaponics, or providing stabilised manure to local farmers in and around the NMB Metro.
  - Due to the nutritional value of seafood, provision can be effective, even in small quantities, in addressing food and nutritional security among poor and vulnerable communities.

- Providing an investment ready platform for today and in a changed climate
  - Once the ADZ has been established, the structures and infrastructure would be available *ad infinitum*.
  - Obviously aquaculture developers establishing in the ADZ, as with any other farmer, will focus on species for which there is a market today and that are suitable to grow today, and not necessarily what would be potentially optimal to grow in decades to come under climate change conditions but, over time, new species could be introduced, utilising the structures and infrastructure developed upfront.

- Efficient use of local fresh water, land and agricultural feed inputs
  - A significant body of research, including various life cycle assessments, has shown that over the last number of years, huge improvements have been made in the aquaculture sector to improve feed, water, land, and energy efficiency (in intensive recirculating systems), animal health management to significantly reduce the need to for antibiotic and other medications, and development best practices and standards for responsible aquaculture. It shows that responsibly farmed aquaculture products are on par or better than responsibly farmed chicken, and has the potential to surpass the responsible chicken farming sector which is far more mature and has less room for improvement today than aquaculture. In terms of world food production and security, responsibly farmed fish and chicken are therefore the most efficient animal

proteins[5] for human consumption in terms of consumptive fresh water use and energy efficiency, feed efficiency (how efficient feed is converted to edible protein), greenhouse gas emissions, and waste production over the product life cycle, obviously including feed production in the life cycle.

- With climate change and increasingly scarce fresh water supplies on the horizon, the introduction of fresh water aquaculture production and aquaponics may just be the most efficient application of available fresh water resources for food production in the metro over the long term.
- Land-based aquaculture production of marine species and the introduction of seawater aquaponics provide a new dimension of food production, essentially independent from fresh water resources and not available in the NMB Metro today.

Development of a desalination plant will serve to supplement fresh water resources of the NMB Metro for the benefit of all commercial interests in the region, not only or specifically for the ADZ. Long-term economic growth in the NMB Metro will be greatly dependent on a sustainable source of water. Rainfall in the region is highly variable in spatial distribution and unpredictable, both within and between years and the area is prone to droughts. Bulk water supplies are largely provided via a system of large storage dams and inter-basin water transfer schemes. With climate change, a reduction in the amount and reliability of rainfall and increase in evaporation may exacerbate the already seriously limited fresh water resources in the Metro. According to the South African National Water Resource Strategy, South Africa will face serious water challenges in the near future if the economic growth envisaged for the country is to be achieved. The Water for Growth and Development Framework (DWAF, 2011) stated that water scarcity has been identified in the major urban centres. These major urban areas anchor the country's economy, and the Department has to invest heavily in the diversification of its water mix in order to prevent serious water shortages from adversely impacting on the economy. The NMB Municipality has undertaken studies to investigate the development of a 60 Ml desalination plant in the NMB Metro. Various sites including a site in the IDZ were investigated. Although the study is currently on hold, it is still in the medium-term plan of water supply to the NMB Metro. It appears that the development of a desalination plant in the NMB Metro at some point in time is inevitable. The CDC is therefore proposing to move forward with the planning by including desalination into the footprint area of the ADZ as an option to prevent future water shortages.

In conclusion, the CDC's proposal for the development of an ADZ in the Coega IDZ is in line with worldwide trends and national government policies and programmes. The overall purpose of the ADZ is to put in place an investment ready development platform for commercial aquaculture operations to be established within the Coega IDZ. With the lessons learned in the aquaculture industry over the past 30 years, and with research and development that are bound to take place during the initial years, the ADZ has the potential to kick-start and facilitate the growth of a responsible local aquaculture industry that could contribute to the economy in terms of GDP contributions, increased trade flow and delivery of goods and services, employment creation and labour income, without detrimental environmental impacts. As a result, food production in the NMB Metro will be diversified and be better adapted to meet the challenges of climate change.

[5] *Excludes emerging invertebrate and microorganism protein sources, such as crickets.*

1.5 Site Selection and Definition of the Development Footprint

The CDC's plans for the development of an aquaculture development zone in Zone 10 of the Coega IDZ follow years of planning and assessment. Various strategic, regional, IDZ-wide and project specific environmental and planning processes have been undertaken to provide context for the ADZ and the selection of the site within the coastal cluster of development in Zone 10 of the IDZ.

- Zone 10 was earmarked for aquaculture development in the 2006 rezoning EIA for the remainder of the land on the eastern side of the Coega River, which was approved by the DEA in 2007 (DEAT, 2007). This study assessed the general impacts of aquaculture development over the whole of Zone 10, with a narrow strip along the coast as open space / coastal buffer zone.
- The OSMP2006 delineated Zone 10 for aquaculture development, with only narrow strip along the coast as open space / coastal buffer zone.
- A pilot prawn facility was developed in Zone 10 in 2006 and operated until the end of 2009.
- In 2009, DEDEAT approved the development of an extensive aquaculture development for the grow-out of prawns (prawn farm) in Zone 10. The EIA included a detailed vegetation assessment that informed the revision of the OSMP.
- The Coega East Masterplan was completed in 2011 and submitted to the NMB Municipality. The study re-evaluated the delineation of the development zones within the IDZ and investigated synergies between different industries and industrial ecology, and maintained aquaculture in Zone 10.
- In 2014, the OSMP was revised in consultation with the various stakeholders and approved by the DEA. The revision was informed by various provincial, metro-wide, IDZ-wide and project level assessments and planning processes as described in Section 2. The following two revisions are of note:
    - It delineated a developable area along the coast of the IDZ, to the east of the Port of Ngqura, as a 'coastal cluster for development', earmarked for development of a CCGT power plant, a 400 m wide service corridor, and aquaculture in Zone 10.
    - It included a portion of the primary dune in Zone 10 as developable area into this coastal cluster for development, as provided for in the 2007 environmental and planning processes, to facilitate aquaculture in order to support national government policy initiatives for aquaculture (mariculture) (IPAP, 2012).

In essence, these and the other assessment and planning processes, for which more detail are provided below, served to evaluate alternative land uses in Zone 10 of the IDZ, including potential conflicts and synergies with other industries throughput the IDZ, and served as the site selection and delineation of a development footprint for the ADZ. As such, this EIA does not attempt to repeat an evaluation of site alternatives for the ADZ or of alterative land uses for Zone 10 of the IDZ.

1.6 Site Overview

A site orientation map with coordinates and aerial views of the ADZ are provided below. Further details about the ADZ footprint and surrounding areas are provided in Section 6.

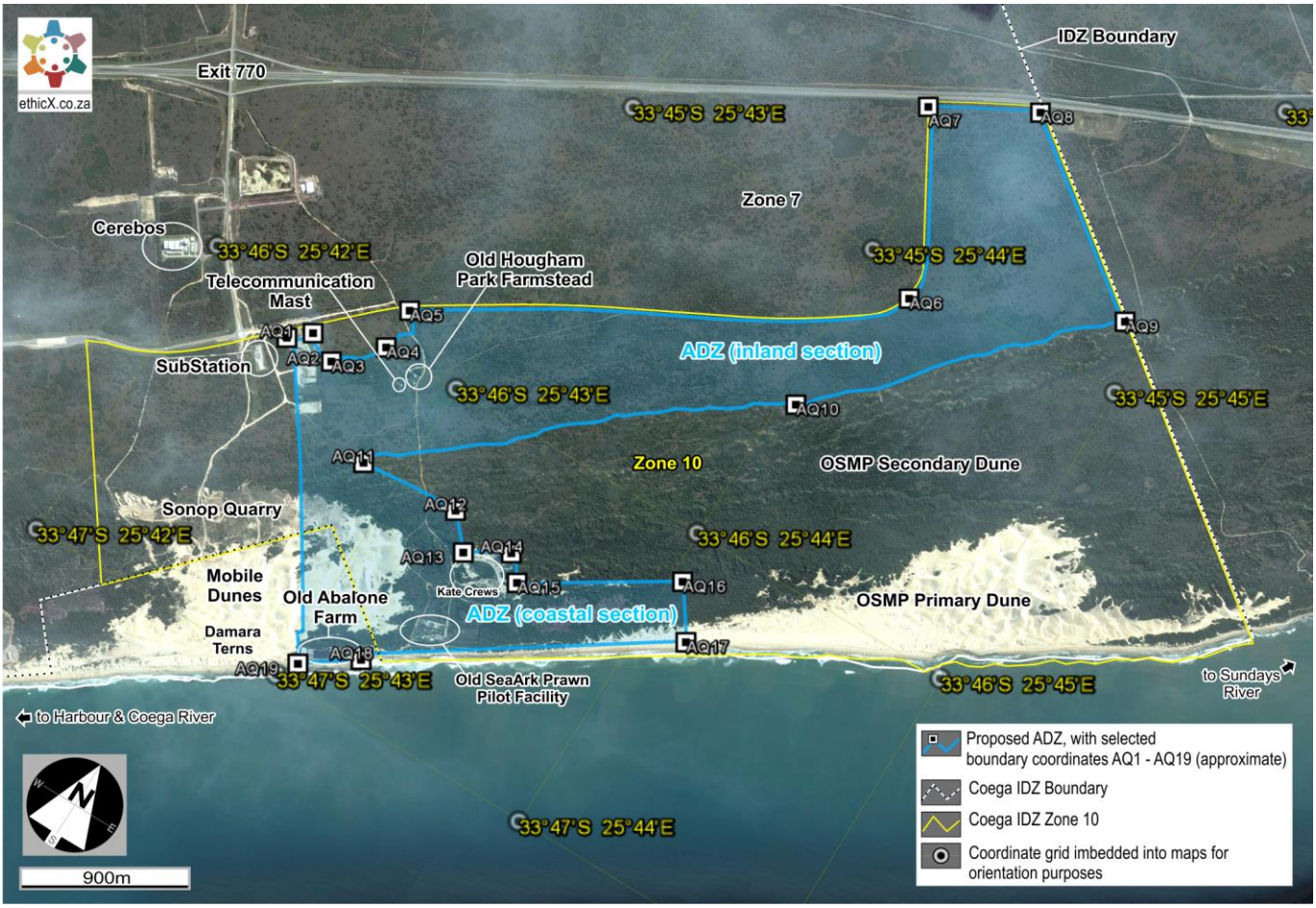


Figure 1-5: Orientation Map with Coordinate References

Figure 1-5: Ref	Latitude	Longitude
AQ1	33°46'7.41"S	25°42'24.47"E
AQ2	33°46'5.18"S	25°42'27.79"E
AQ3	33°46'7.35"S	25°42'34.18"E
AQ4	33°46'0.13"S	25°42'42.53"E
AQ5	33°45'52.30"S	25°42'42.58"E
AQ6	33°45'4.33"S	25°44'12.16"E
AQ7	33°44'32.49"S	25°43'53.98"E
AQ8	33°44'22.99"S	25°44'15.16"E
AQ9	33°44'48.00"S	25°44'54.03"E
AQ10	33°45'31.23"S	25°44'3.47"E
AQ11	33°46'19.90"S	25°42'51.63"E
AQ12	33°46'18.77"S	25°43'13.75"E
AQ13	33°46'24.44"S	25°43'19.90"E
AQ14	33°46'20.14"S	25°43'28.65"E
AQ15	33°46'24.14"S	25°43'33.03"E
AQ16	33°46'8.81"S	25°44'2.81"E
AQ17	33°46'17.72"S	25°44'10.15"E
AQ18	33°46'50.06"S	25°43'13.56"E
AQ19	33°46'56.44"S	25°43'2.64"E

Note: Coordinates are for orientation purposes only, to be used in conjunction with the various Google Earth images in the EIR. The actual boundary and extent of the ADZ is defined in the CDC mapping system.

Plate 1-2: Site Orientation Aerial View A

Credit: Belinda Clark

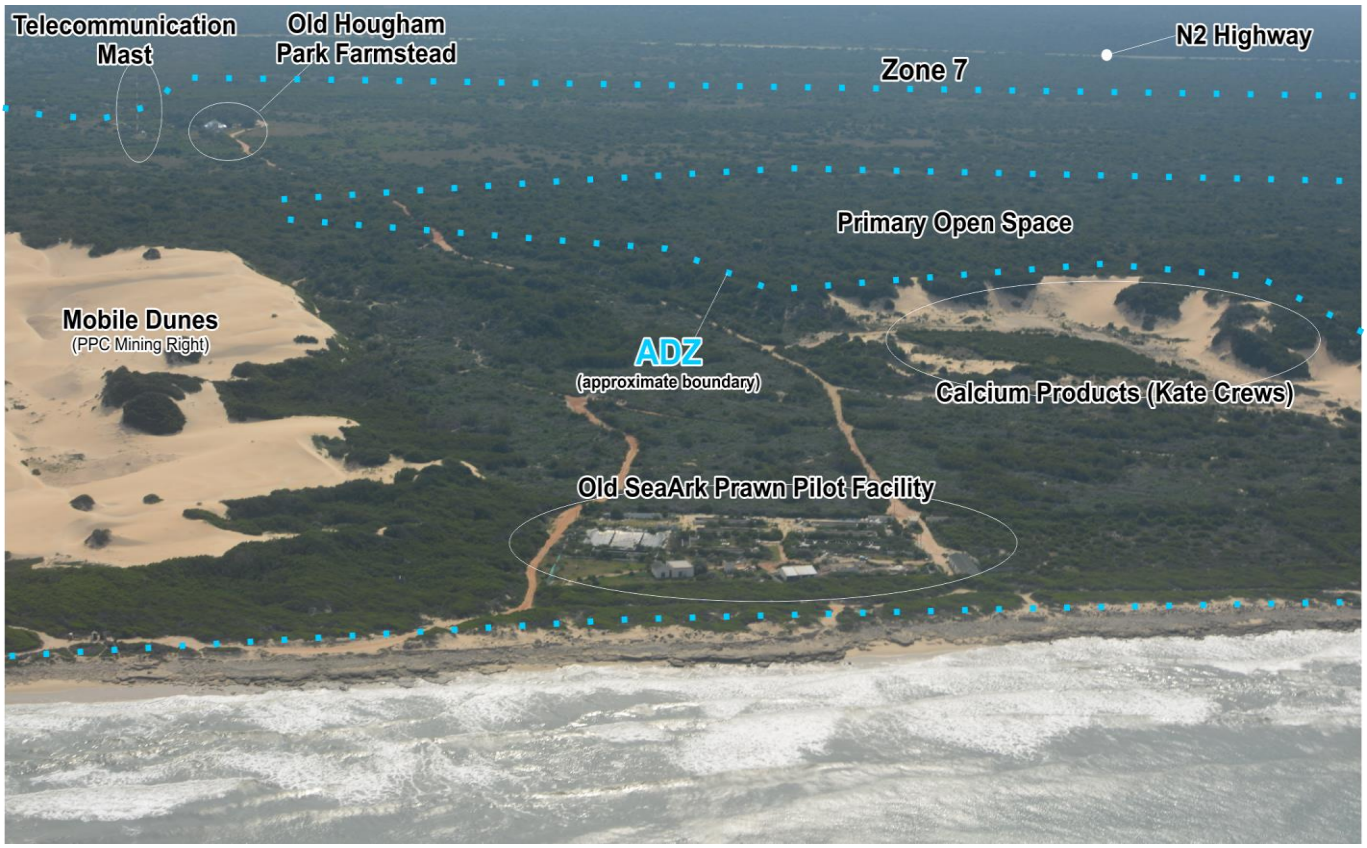


Plate 1-3: Site Orientation Aerial View B

Credit: Belinda Clark

Plate 1-4: Site Orientation Aerial View C

Credit: Belinda Clark

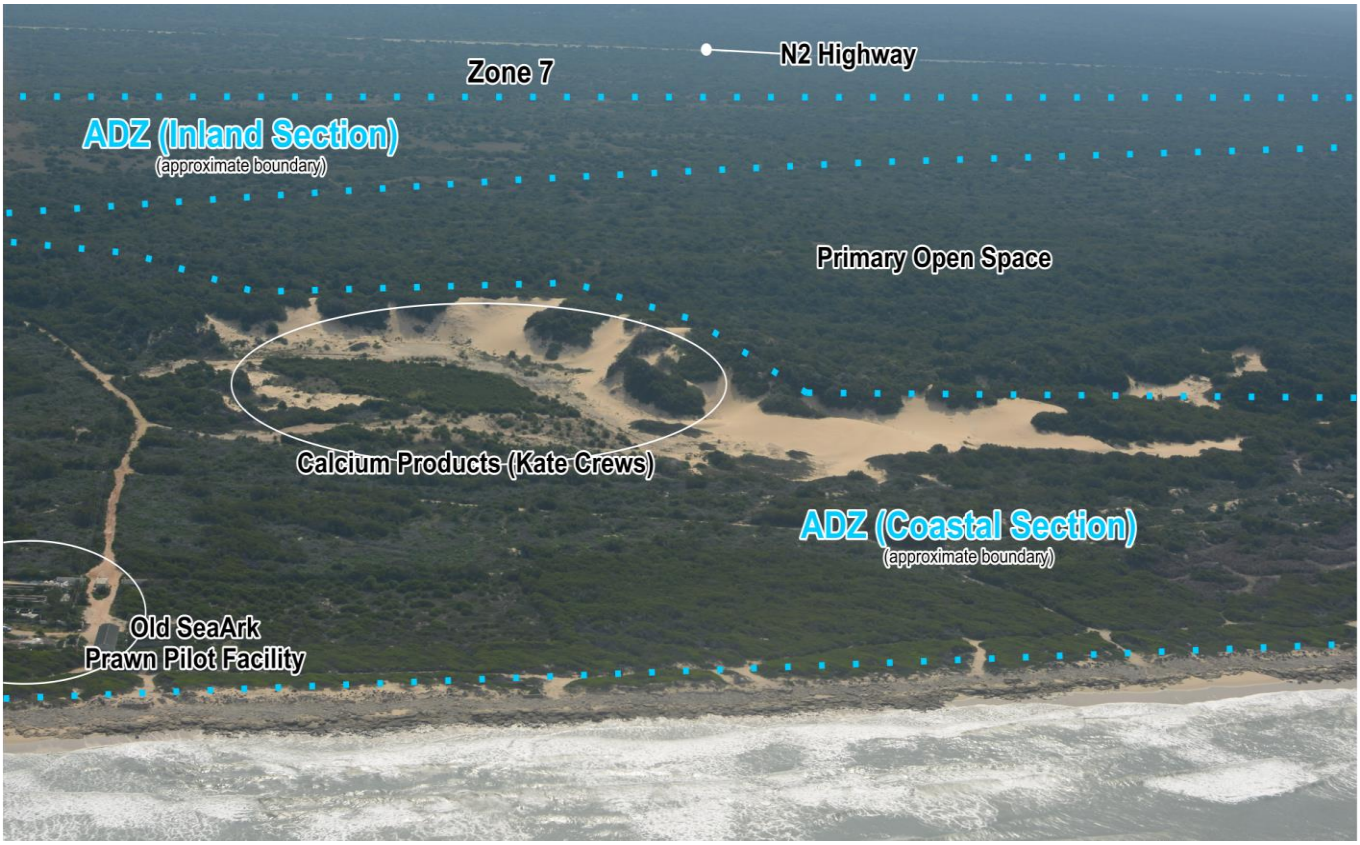


Plate 1-5: Site Orientation Aerial View D

Credit: Belinda Clark

1.7 Investigating the Feasibility of Aquaculture in the Coega IDZ

The CDC commissioned an independent concept design and feasibility study for an ADZ in Zone 10 of the IDZ. The study was undertaken by EOH Coastal and Environmental Services in 2014 and focused on cultivation of marine species. Various development scenarios and aquaculture species were evaluated and the overall conclusion reached was that Zone 10 of the Coega IDZ is favourable for aquaculture development. Key recommendations included:

1. There should be a focus on abalone culture as this sub-sector is well established and growing in South Africa.
2. The marine finfish sub-sector has definite potential but further research and development is needed.
3. The existing abalone farm and prawn pilot facilities (Marine Growers and SeaArk) could potentially be made available for smaller or pilot scale projects or for research and development.
4. Potential establishment of an IDZ multi-purpose seawater pipeline in order to share the very high upfront capital costs and operating costs amongst various industries in the IDZ. Preliminary design of pipeline alternatives has been completed by experienced marine pipeline engineers. Detailed studies into the oceanographic features of the coastline, particularly relating to offshore seawater temperatures and water quality are underway. Environmental studies are being undertaken to determine the best location, actual distance into the sea and depth needed to provide optimal water quality and to assess the environmental impacts – refer Section 1.10 for details of studies for marine pipeline servitude.
5. CDC to engage with aquaculture industry associations to gauge interest and requirements for establishing an ADZ in the Coega IDZ.
6. Environmental assessment and approval processes for the ADZ to be conducted.

The CDC has conducted market research, visited various aquaculture operations and interacted extensively with the aquaculture specialists, operators and potential investors, and there are a number of investors that are keen to establish in the ADZ to produce fresh water species and marine finfish and shellfish species, including abalone. Based on the feedback received and technological development to reduce water exchange and consumptive water use, the CDC is also including intensive fresh water and brackish water aquaculture in the ADZ, in addition to the seawater aquaculture.

Various potential investors have approached the CDC and have discussed and presented proposals for potential developments in the ADZ. In order to protect their business interest, business concepts and intellectual property, details of their proposed developments cannot be revealed in a public EIR at this point in time. However, the project description and design options described in Section 4 broadly cover their development concepts.

Each investor will be required to provide a detailed Operational EMPr based on the guidelines and EMPr that have been developed as part of this EIA as well as the various established CDC guidelines and specifications and to demonstrate their chosen technology and project's feasibility for consideration by the CDC.

1.8 Conceptual Layout and Main Components

The CDC has developed a conceptual layout plan for the ADZ, with marine species that require high volumes of seawater, such as abalone and seaweed, as well as the desalination plant, in the lower lying coastal section and intensive recirculating aquaculture on the higher lying inland areas.

Within the ADZ there will be aquaculture production systems consisting of hatcheries, nurseries and grow-out facilities, and processing plants, with associated water and waste management infrastructure, a desalination plant, and various supporting services and infrastructure. Figure 1-6 provides a schematic of the ADZ main components as well as the main inputs and outputs of the ADZ. A more detailed description of the ADZ and various development options, are discussed in Section 4.

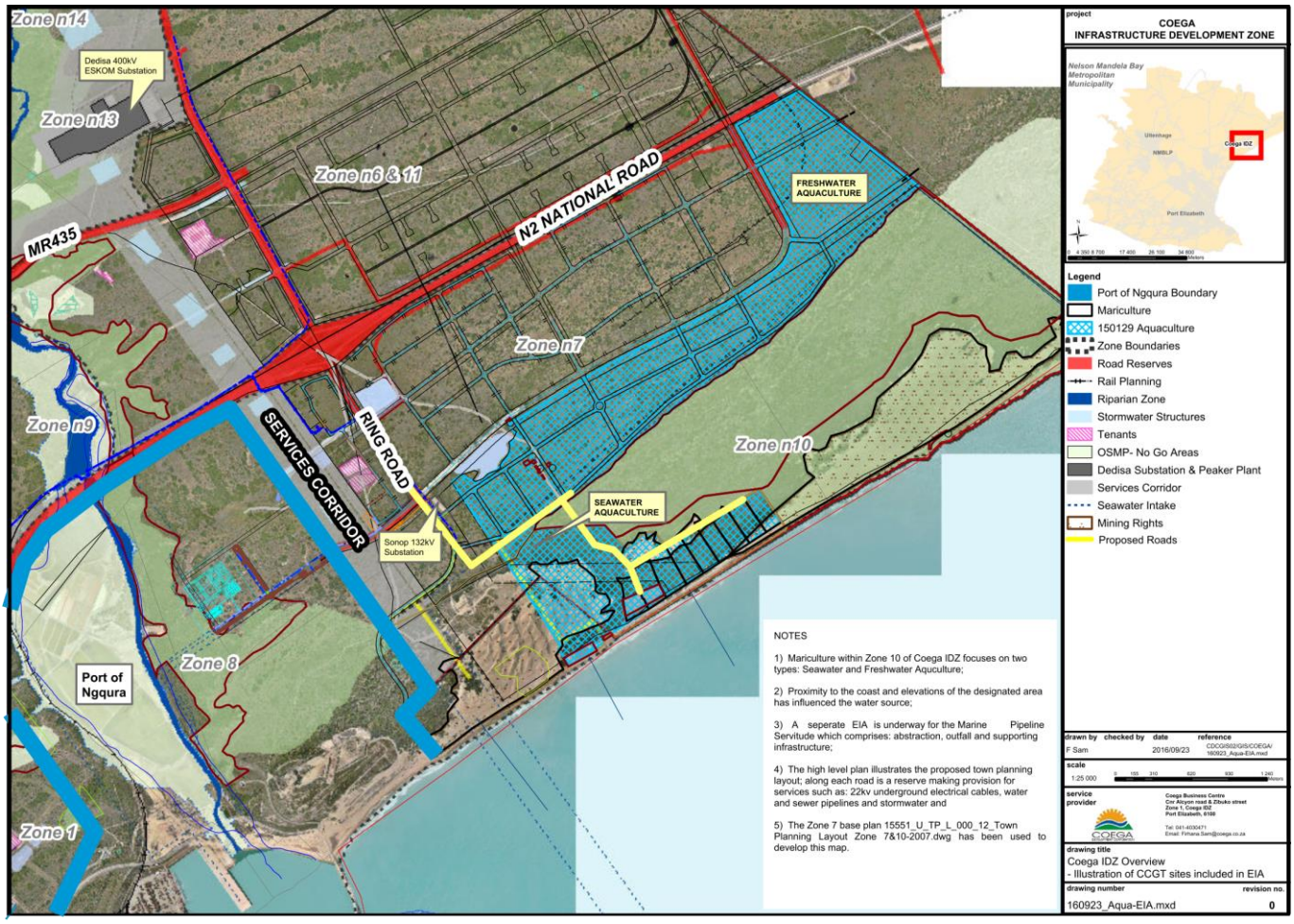


Figure 1-6: Conceptual Layout of the ADZ

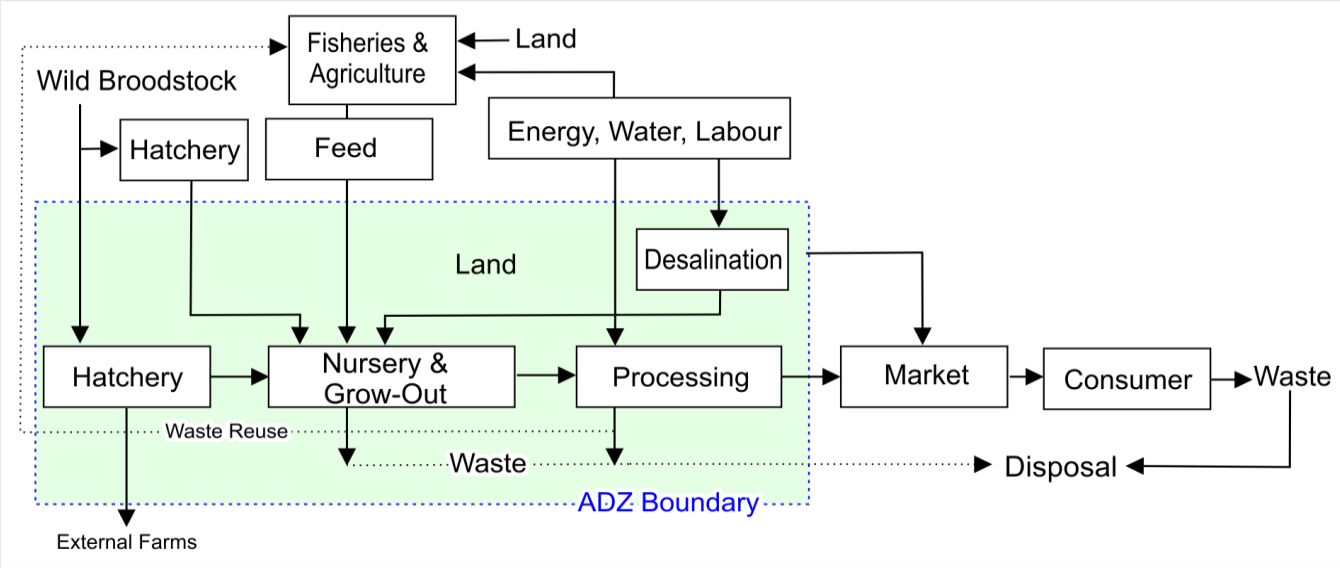


Figure 1-7: Schematic of ADZ Main Components and Key Inputs and Outputs

1.9 Scope of this EIA

This EIA covers all land-based activities and facilities associated with the ADZ, as schematically illustrated in Figure 1-7 and as further described in Section 4. The EIA considered impacts of aquaculture development throughout the ADZ footprint in line with the project parameters outlined in Section 4.10.

1.10 Marine Pipeline Servitude Planning and Assessment

A land-based aquaculture for marine species such as abalone, seaweed and marine finfish and a desalination plant require proximity and linkage to the sea as a source of water and for release of treated production water and brine effluent. The same applies to various other industries in the Coega IDZ.

The CDC plans to establish an integrated marine pipeline servitude in which current and future investors in the Coega IDZ can establish infrastructure to abstract seawater and discharge treated effluent as required by various industrial processes. It is possible that more than one pipeline will be established depending on water quality requirements. The project entails the selection of the servitude area, as well as the construction and establishment of associated infrastructure in the marine environment and on land (e.g. pipelines, pump stations, holding reservoirs).

Three alternatives are being assessed for the placement of the servitude(s) along the shore and in the marine environment adjacent to the Coega IDZ – north-east of the harbour, south-west of the harbour, and in the vicinity of the harbour, areas labelled 1 to 3 in the diagram below.

A specialist marine impact assessment and dispersion model is being undertaken to inform the preferred positioning of the servitude(s). The assessment will consider water quality and volume requirements for abstraction of seawater as well as effluent characteristics and volumes from four broad industrial types that may establish in the IDZ – i.e. aquaculture, desalination, industrial wastewater (including the planned Coega Waste Water Treatment Works), and thermal (e.g. the planned CCGT power plants).

Establishment of the marine pipeline servitude(s) will require an EA in terms of the NEMA and a coastal waters discharge permit in terms of Section 69 of the ICMA. A separate environmental assessment process is being undertaken for this project by CEN IEM Unit. This separate EIA will investigate the impacts associated with the pipeline(s) as it spans over land and coastal environments, as well as the impacts on the marine environment associated with the abstraction of water from the sea and, in particular, the impacts associated with the discharge of effluent into the sea. It will therefore include an assessment of the impacts of the ADZ effluent as well as

effluent from other industries and proposed waste water treatment plant in the Coega IDZ, as well as the physical impacts of the sea water intake and discharge pipelines to and from the boundary of the ADZ.

Figure 1-8: Alternative areas Assessed for the Marine Pipeline Servitude(s), taken from CEN, 2016

2 Environmental Assessment and Planning Framework

2.1 Strategic Environmental Assessment

A Strategic Environmental Assessment (SEA) was completed for the IDZ in 1997 to assess the opportunities for, and constraints to, developing the Coega IDZ and deep water Port of Ngqura. The aim of the SEA was to ensure that environmental issues were considered early in the planning and decision making process. The outcome of the SEA was that no environmental flaws were identified which would prohibit further planning in the Coega IDZ and Port of Ngqura.

2.2 Coega IDZ Rezoning and Change of Land Use Environmental Assessments

The Coega IDZ was proclaimed on 7 December 2001 (Government Gazette 225/29) and has been accepted by the NMB Municipality in terms of the municipal land use planning process.

2.2.1 IDZ Core Development Area

In the absence of a legal mechanism to obtain environmental authorisation based on a strategic impact assessment, an environmental impact assessment (EIA) process was followed to obtain environmental authorisation. The first environmental impact assessment (EIA) for the Coega IDZ was completed in 2001. This EIA assessed the impacts of rezoning 4 200 hectares (ha) of land as the Core Development Area, located to the south-west of the Coega River, from Agriculture or Undefined to Special Purposes. Approval of this EIA in 2002 facilitated the establishment of industrial development within Core Development Area. At the time of the EIA, specific details of individual projects and developments were obviously not known. Compared to a typical EIA for a specific project, the EIA for the Coega IDZ had to be done at a fairly strategic level based on a conceptual design for the IDZ. In order to overcome the limitations of an EIA based on a conceptual design, the EIA included references to various design criteria and environmental guidelines that the CDC, their investors and developers of individual projects have to adhere to. A Development Framework Plan (DFP) was also developed to provide an overall planning and development strategy for the Coega IDZ by identifying clear objectives to facilitate the implementation of the Coega IDZ from conceptual to detailed planning and design. The Development Framework Plan was accepted by the NMB Municipality[6] in terms of the Land Use Planning process.

2.2.2 Remaining Land in the IDZ on the eastern side of the Coega River (including Zone 10)

Due to increased investor interest in the areas outside the Core Development Area of the Coega IDZ, a second EIA process was completed for the change in land use of the remaining ~7 300 ha of the IDZ on the eastern side of the Coega River in 2006 (SRK, 2006). Authorisation of this EIA (DEAT, 2007) meant that the entire ~11 500 ha of the Coega IDZ was available to investors for industrial developments; in some instances dependent on project specific environmental approvals. The environmental assessment was associated with the 2006 Coega Development Framework Plan (DFP) (Revision 1, 2006) as depicted on Figure 2-1 and the 2006 version of the OSMP (OSMP 2006), with map revision 10 (COE/1072-OSMP) as depicted on Figure 2-2. The DFP identified the entire Zone 10 as developable with precautions, except for a narrow coastal buffer strip (Figure 2-1). The OSMP 2006 map revision 10 shows the primary and secondary dunes in Zone 10 to be part of the primary open space system, with the primary dunes as Area 1.03A and the secondary dunes as Area 1.03A for the length of the Zone 10 coastal strip.

[6] *Nelson Mandela Bay Metropolitan Municipality, refered to as NMB Municipality in this report .*

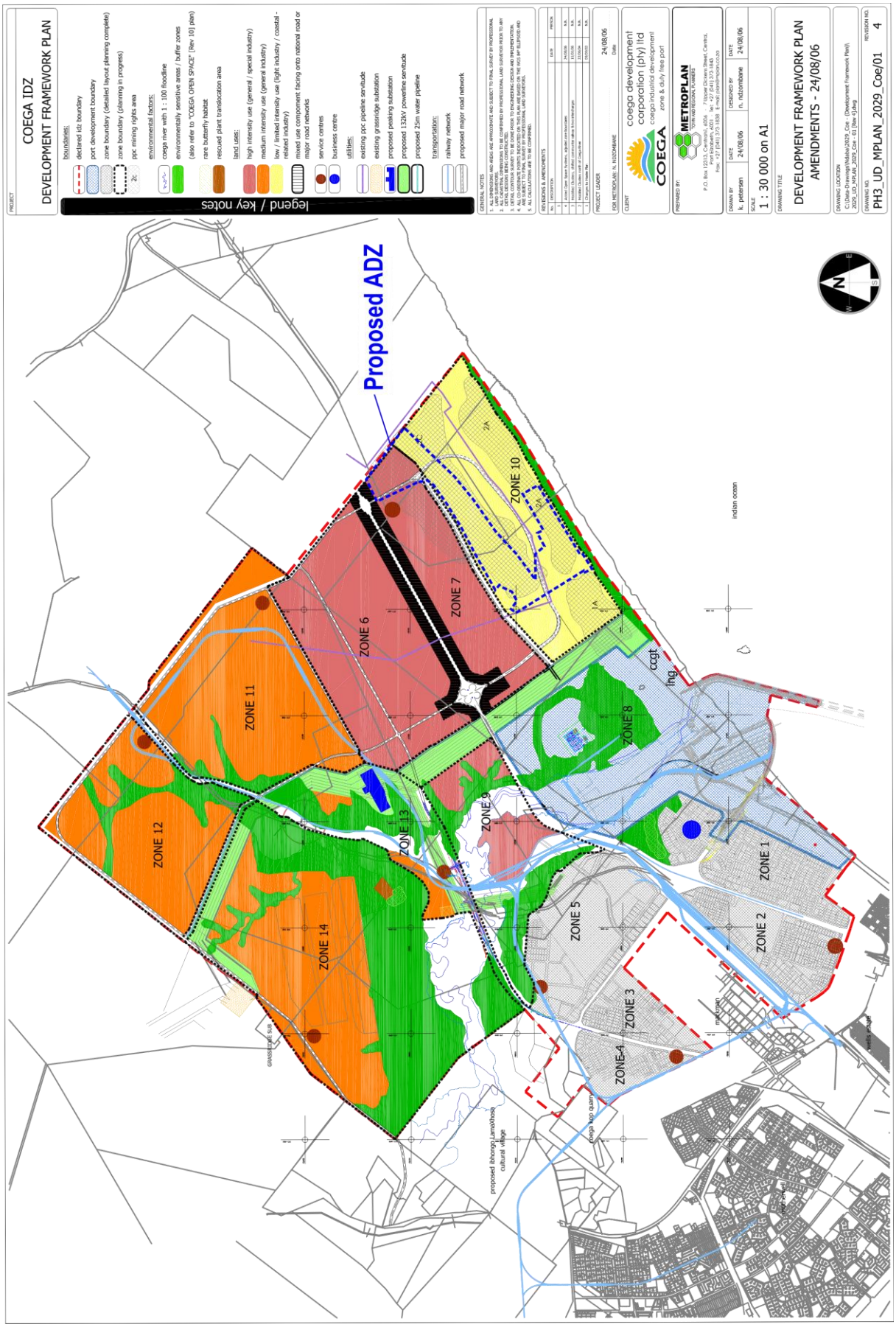


Figure 2-1: Development Framework Plan (2006)

Source: SRK, 2006

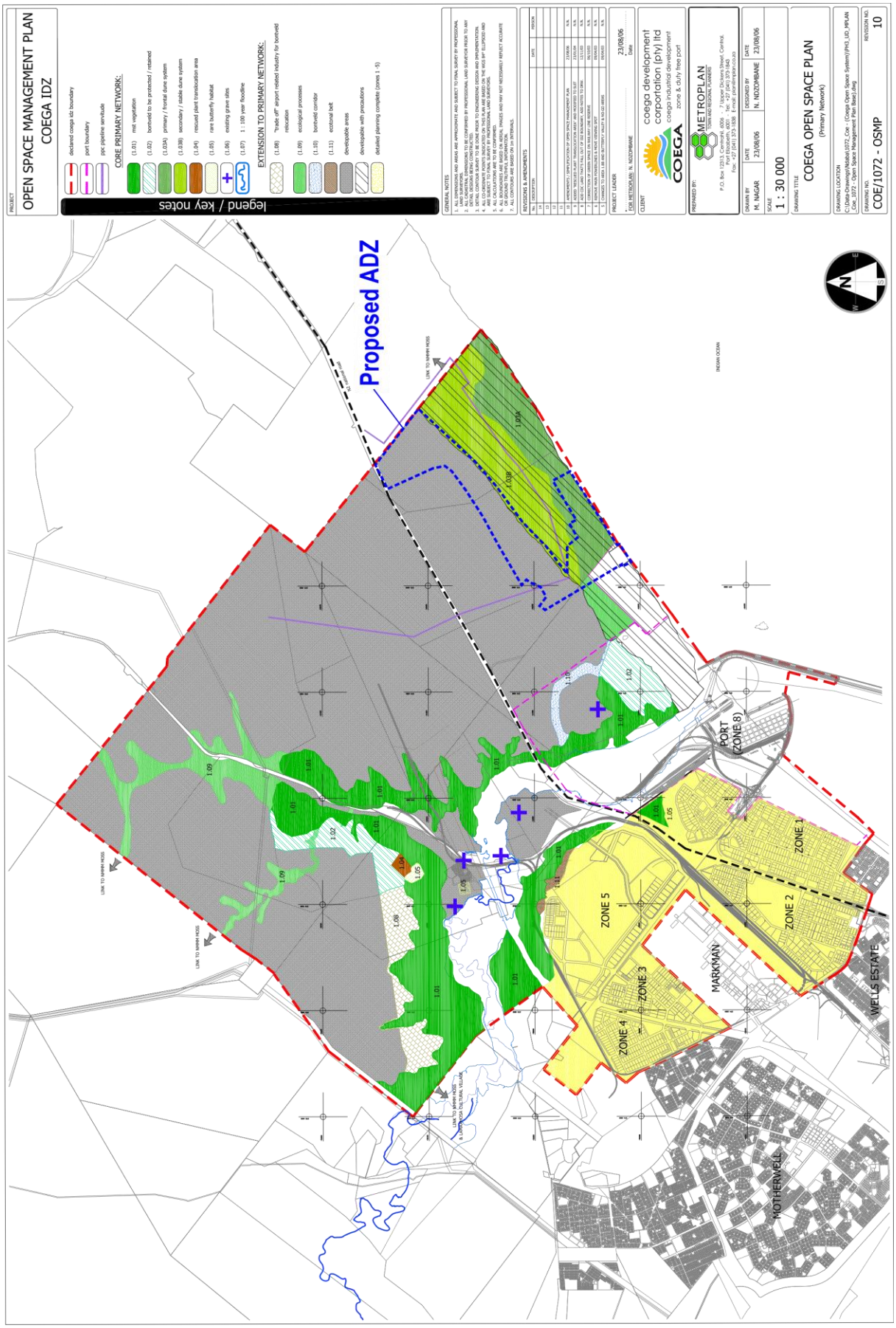


Figure 2-2: OSMP2006 (map revision 10)

Source: SRK, 2006

2.3 Previous and Existing Land Uses and Rights

Previous and existing land uses and rights had to be considered in the planning of future development in Zone 10 of the IDZ.

2.3.1 Coastal Farming and Recreation

Prior to the establishment of the Coega IDZ and Port of Ngqura, the Farm Coegas River Mouth 303 and Farm Hougham Park 304 (Uitenhage) where the ADZ and Zone 10 are located, were coastal farms used for inter alia beef cattle livestock and dairy farming. In addition to farming, oyster harvesting and mining was pursued, with mining rights for a large portion of the area being ceded to PPC. Mining included sand, calcrete and shell grit. Shell grit was collected for many years with evidence of original lime kilns still present in the area.

Hougham Park had an informally laid out campground, which accommodated 60 to 80 camping sites with beach collection wells for water supply. Dunes were stabilised using barriers of gravel, limestone, dead branches and sowing of red-eyed wattle (Rooikrans) seeds (Drysdale, 2016). Large areas of the farm, and most of the dunes, are heavily infested with alien *Acacia cyclops* (rooikrans) trees. A gravel track was created to provide access along the coast for recreation, mainly fishing. A spot known as Jan se Gat near the eastern boundary of the IDZ is still well known amongst fishermen. The remains of these historical land uses are further described in the section on Heritage Resources.

There are a number of gravel tracks within Zone 10 that provide access to mining areas, the old abalone farm and prawn pilot facility. The track parallel to the beach eastwards to the old campground and towards Jan se Gat is overgrown by alien wattles and vehicle access along the track is difficult. Access to Jan se Gat is via the beach.

Whilst dairy and beef cattle farming were pursued, the area is not considered to be a high potential agricultural area due to the relatively low rainfall in comparison to surrounding area. There is no significant evidence of agricultural degradation on the affected property and erosion on the farm is minimal.

2.3.2 Mining (Geological Resources)

Areas within Zone 10 have been used for sand mining and shell grit collection for more than 50 years.

The CDC OSMP outlines the un-vegetated dunes identified as mining areas (marked on the OSMP as 'mining rights') on all the un-vegetated dune areas, including substantial areas within the OSMP's Primary Dune Area 1.3A, (CBA-IDZ) and management objectives for the area are described therein.

PPC owns a portion of land in Zone 10 (erf 256 Coega) and has a mining right for limestone that covers multiple properties, stretching from the coast to Grassridge, about 20 km inland. The PPC mining right extends over a large area of Zone 10 and the ADZ. The PPC mining right and associated land uses are described within the CDC OSMP Revision 1, of 2014. In terms of Section 53 of the MPRDA, an application to the Minister of Mineral Resources will need to be made to develop land where mineral rights exist or where minerals of importance could be sterilised. This will include an evaluation of the limestone mining potential.

Sand mining under the Calcium Products (Pty) Ltd (Kate Crews) mining area started in a large patch of un-vegetated dunes in about 2000 and the area is now mined out as the maximum volumes permissible in terms of the EMP have been extracted.

Sand mining started at Sunshine Coast Quarries' Sonop Quarry (Sunshine Coast Quarries mining right)[7] on a small scale in the mid-1980s. This area is now virtually mined out up to the underlying sandstone and large parts have been rehabilitated.

Dove Mining Services CC was issued with a Mining Permit by the DMR on 7 April 2016, to mine sand, stone aggregate and gravel on erf 220 in Zone 10 of the IDZ. The EIA was completed and Dove Mining Services CC commenced mining in May 2016. Mining must be completed within 2 years of the commencement date, as per the lease agreement with the CDC.

Mandela Bay Sand and Stone (Pty) Ltd is in the process of making an application to the DMR for a mining permit to mine sand, stone aggregate and gravel on 5 ha of erf 220 in Zone 10.

Development on the dunes is theoretically possible but not advisable (Illenberger, 2016) so those parts of the ADZ that are covered with mobile sand dunes are essentially sterilised for development until they have been mined for sand – as per the example of the Sunshine Coast Quarries cc mining area where sand has been removed.

Sand mining could proceed at the current rate of mining but may intensify if there is an increase in demand for sand in the local construction industry. At the current rate of mining, it may take many years before all areas within the ADZ will be available for development. Buffer zones will have to be maintained around areas earmarked for mining. The initial aquaculture operations in the ADZ will have to be established on areas outside the mining areas and the buffer zones (see Section 7.11).

Figure 2-3: Sand Mining in Zone 10 of the Coega IDZ

[7] *For simplicity sake, the mining rights (under different legal entities) associated with Sunshine Coast Quarries are named 'Sonop Quarry' on maps and diagrams in this EIR.*

Plate 2-1: View of Sand Mining at Glendore's Sonop Quarry

2.3.3 Aquaculture

Abalone

At the time when the Coega IDZ was established, there was an abalone farm, the old Marine Growers facility with a seawater abstraction point along the beach. The farm operated from about 1997, before the first EIA regulations came into force in South Africa, and closed down in 2009. With the establishment of the Port of Ngqura, the land on which the abalone farm is located was bought, after a legal dispute, by Portnet and transferred to Transnet, and the company was later sold to a third party. Reportedly the farm successfully produced ~48 tn/yr of abalone and ~72 tn/yr of seaweed, as a first phase, on ~2.5 ha of land just above the HWM, and until it closed down it did not experience any notable issues with water quality as a result of the construction of the port (Willie de Wet, pers. comm.). In 2008 the pump station and one other building closest to the HWM were damaged during a storm event and needed improvement if the facility was to continue operations.

The facility was small in comparison to its competition and ideally it should have been expanded and production doubled to remain economically competitive (Willie de Wet, pers. comm.). Other farms in South Africa typically produce >100 tn/yr. In light of the above, it can be argued that the abalone farm had the potential to operate as an economically viable enterprise if its water intake was improved and it was expanded to optimise production capacity in line with industry norms.

According to Transnet they have had various requests from people interested in using the facility but have not acted on any of the requests as they are cautions of a repeat of past legal disputes and the potential repercussions should future port expansions affect the quality of water abstracted at the farm (Sujit Bhagattjee, pers. comm.) Transnet strictly controls access to the old abalone farm and there are no apparent signs of vandalism.

Prawns

In 2006 and 2009 two EIAs were conducted for aquaculture developments to produce prawns in Zone 10. The first was for a pilot prawn facility (CEN, 2006) approved by the DEDEAT in 2006 (DEDEAT, 2006). The second was for an extensive prawn roll-out facility for the grow-out of the prawn species *Litopenaeus vannamei* (CEN, 2009) that was approved in July 2009 (DEDEAT, 2009).

The pilot prawn facility was developed near the then Marine Growers abalone farm. Seawater was sourced from the abalone farm. During the operation of the pilot facility, Sea Ark Africa (Pty) Ltd contravened some conditions of the authorisation by the erection of structures outside of the environmental authorisation issued for the pilot prawn facility. In accordance with a directive issued by the Department of Economic Development and Environmental Affairs (Sea Ark Pre/D/07/09 of 29 July 2009), Sea Ark (Pty) Ltd demolished the structures and rehabilitated the area in question. In November 2009, the pilot prawn facility ceased operations, and the CDC assumed control of the infrastructure located on Erf 221, Coega. The pilot prawn facility is within the Coastal Cluster as approved by DEA (DEA 12/12/20/628/7/4 of 20 November 2014). The land use is approved within the special purposes zoning of the Coega IDZ as approved by TPA 6106 of 16 August 2007 in terms of the Land Use Planning Ordinance (Ordinance 15 of 1985). The CDC intends rehabilitating the pilot prawn site through re-commissioning of the remaining structures on the site. A dilapidation survey of the pilot prawn facility has been completed. Existing infrastructure will be repurposed in keeping with the recommendations of the dilapidation study and land uses associated with the Coega ADZ.

Impacts associated with the re-use of the old abalone farm and prawn pilot facility are assessed in this EIA report and management criteria for their use are proposed.

The establishment of the prawn roll-out facility never materialised but it was initially proposed to cover most of the ~1200 ha of land in Zone 10 with exception of the narrow buffer along the coastline, as indicated on the 2006 Development Framework Plan (Figure 2-1). Based on a detailed vegetation and ecological assessment, the EIA made recommendations about areas regarded as developable for aquaculture and areas to be kept as open space areas for conservation, as indicated on Figure 2-4. The EA for the prawn farm (DEDEAT, 2009) approved the development based on the layout plan depicted on Figure 46 in EIA Report (CEN, 2009), as reproduced on Figure 2-5 below. The EA excluded development within the OSMP areas but recognized that the OSMP was in the process of being revised based on specialist input and that a revised OSMP may be submitted to DEA for approval and as such the authorization made provision for the future consideration of an expanded footprint, should the revised OSMP, as approved by the DEA, allow for this. Subsequently, the revised OSMP has been approved and identifies the coastal cluster for development in Zone 10.

The conditions of the EA for the prawn farm (DEDEAT, 2009) were carefully considered in this EIA for the Coega ADZ and were incorporated into the EMPr where relevant.

The prawn pilot facility reportedly failed due to rapidly escalating energy prices, a situation not unique for that time in South Africa when increasing electricity prices and critical shortages in supply impacted on many businesses. The country as a whole has made significant progress in the fields of alternative energy, energy demand management measures and green building design. Market demand for aquaculture products is high as South Africa has imported approximately 8 Mtn/yr of crustaceans during the period 2005 to 2014, valued at more than R 600 million in 2014 (DAFF, 2015). Such market demand, locally and internationally, underpins the need to re-establish aquaculture in the ADZ.

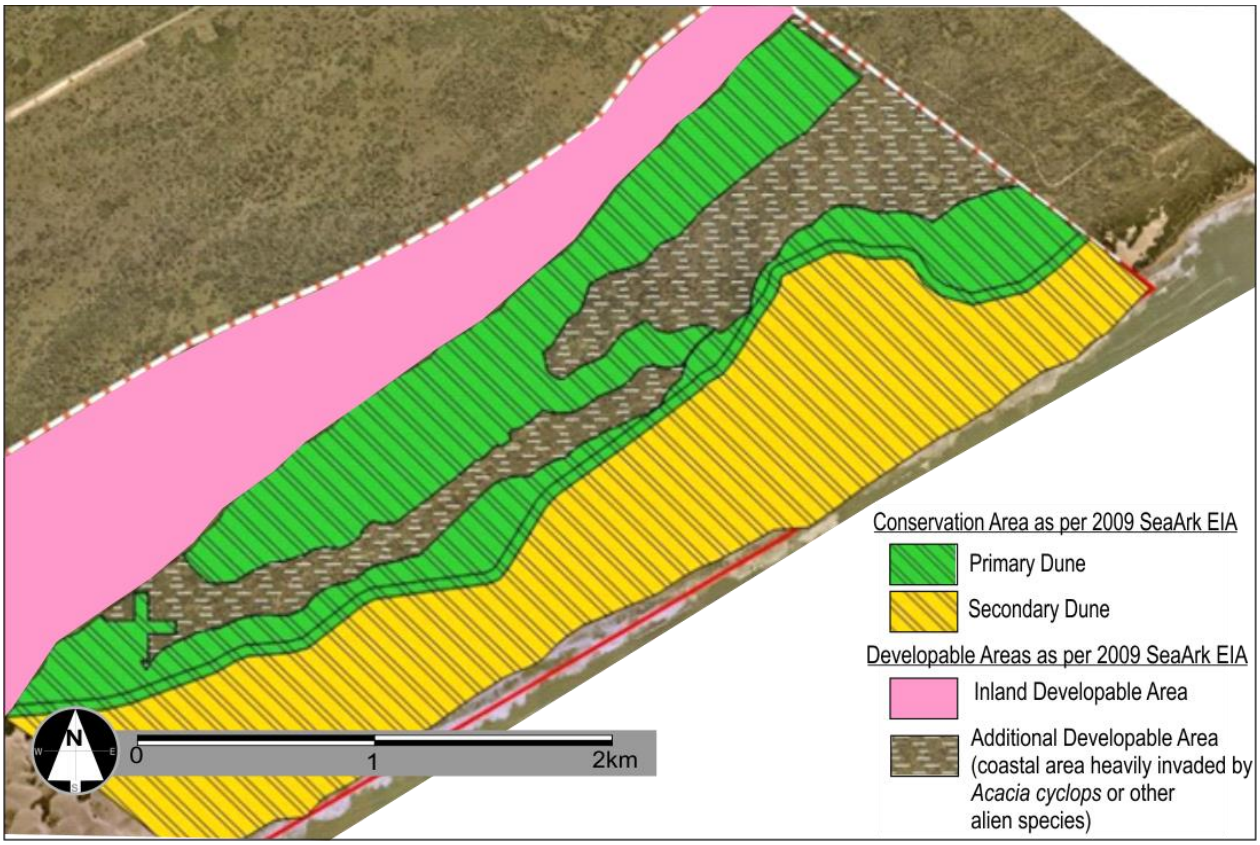


Figure 2-4: 2009 SeaArk Prawn Farm EIA vegetation assessment recommendations for Zone 10

(Source: Coega IDZ OSMP, 2014)

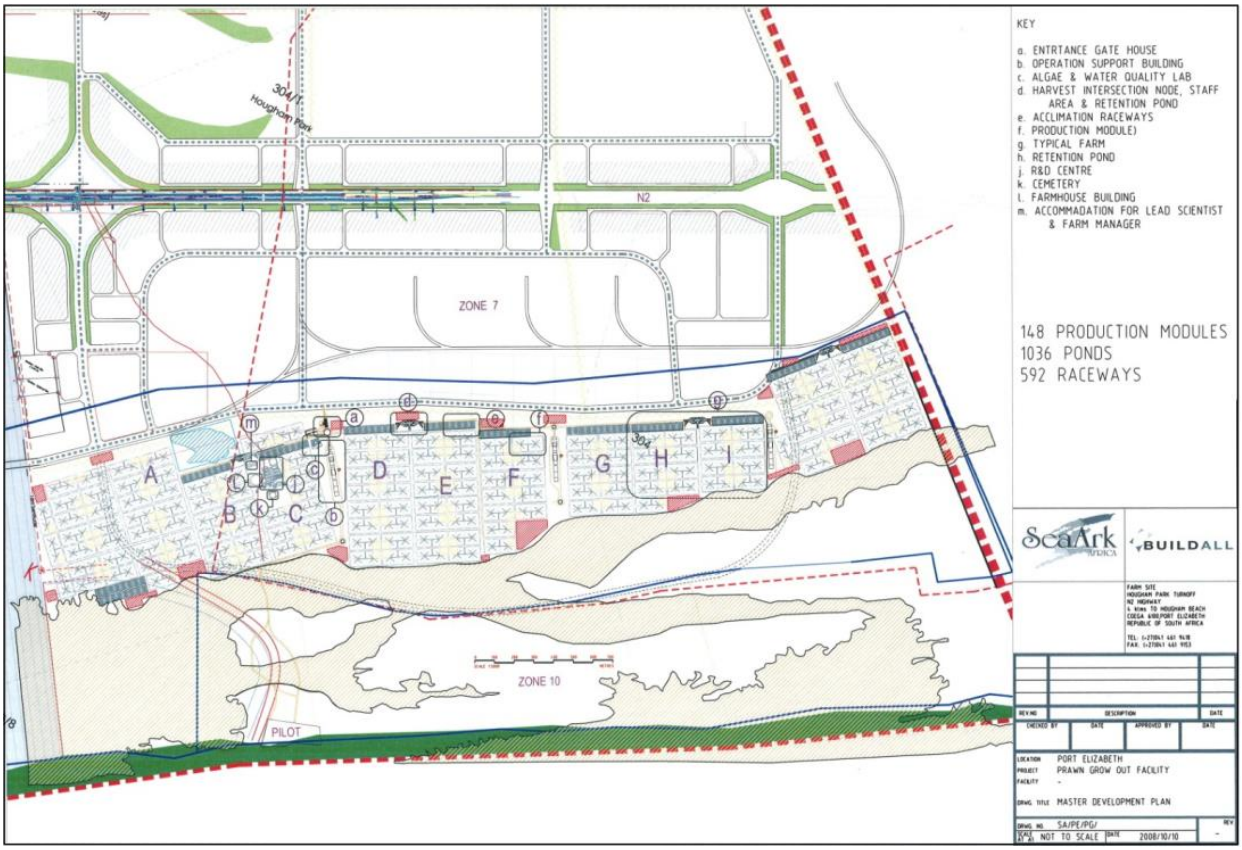


Figure 2-5: Approved Layout of the SeaArk Prawn Farm in Zone 10 (DEDEAT, 2009)

Source: SeaArk EIA Report Figure 46, CEN, 2009

Raceway *Constructed pond with aeration system*

Water purification unit *Feed culture, laboratory* *Water treatment*

Plate 2-2: Infrastructure at old SeaArk Prawn Pilot Facility during Operations (since abandoned and vandalized)

Source: CEN, 2009.

Figure 2-6: Remaining structures at the old pilot prawn facility during operation (Google Earth, 2007) and after it was closed (Google Earth, 2016)

Plate 2-3: Vandalised remains of the old prawn pilot facility

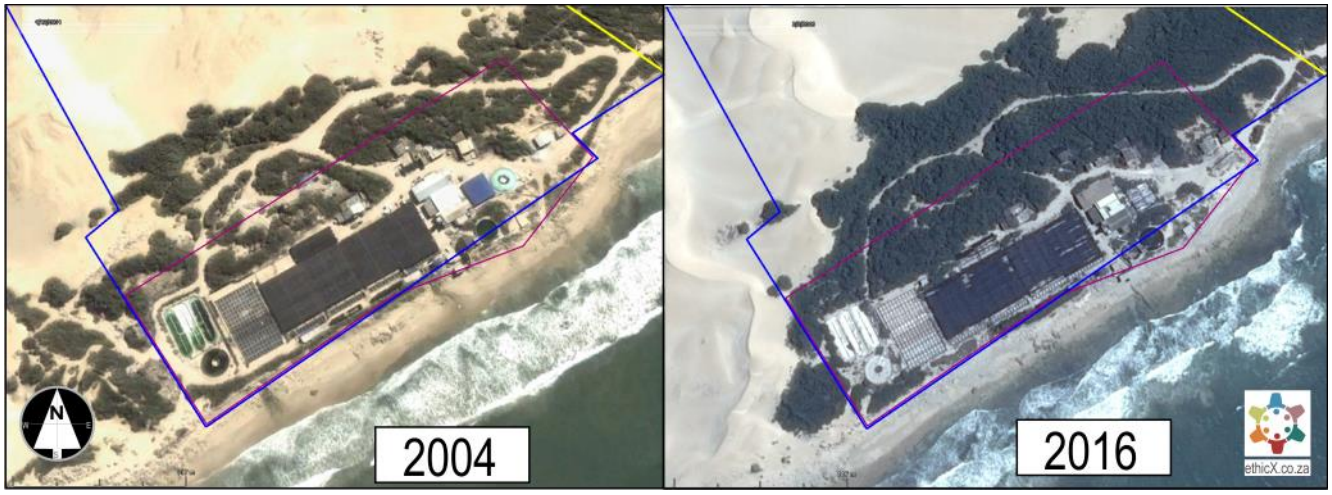


Figure 2-7: Remaining structures at the old abalone Farm during operation (Google Earth, 2004) and after it was closed (Google Earth, 2016)

Plate 2-4: Remains of the old abalone farm

2.3.4 Telecommunication

There is a telecommunication tower located near the old Hougham Park farm house.

2.4 Regional Conservation Planning

2.4.1 Eastern Cape Biodiversity Conservation Plan (ECBCP)

The Eastern Cape Biodiversity Conservation Plan (ECBCP) (Berliner & Desmet, 2007) has been adopted by DEDEAT as a bioregional plan. It identifies Critical Biodiversity Areas (CBAs) on two maps, one showing terrestrial (land-based) CBAs and the other showing aquatic (freshwater) CBAs.

The map of terrestrial CBAs was compiled by undertaking a systematic biodiversity planning analysis and adding biodiversity priority areas identified by other systematic biodiversity planning projects. On the terrestrial map, CBA1 represents the highest level of importance that includes critically endangered vegetation types, CBA2 represents endangered vegetation types, certain expert-mapped areas and ecological corridors, and other vulnerable and remaining natural vegetation is categorised as Other Natural Areas (ONA) (sometimes referred to as CBA3). The whole of the ADZ falls within habitats classified as CBA2 on the terrestrial map (Figure 2-10).

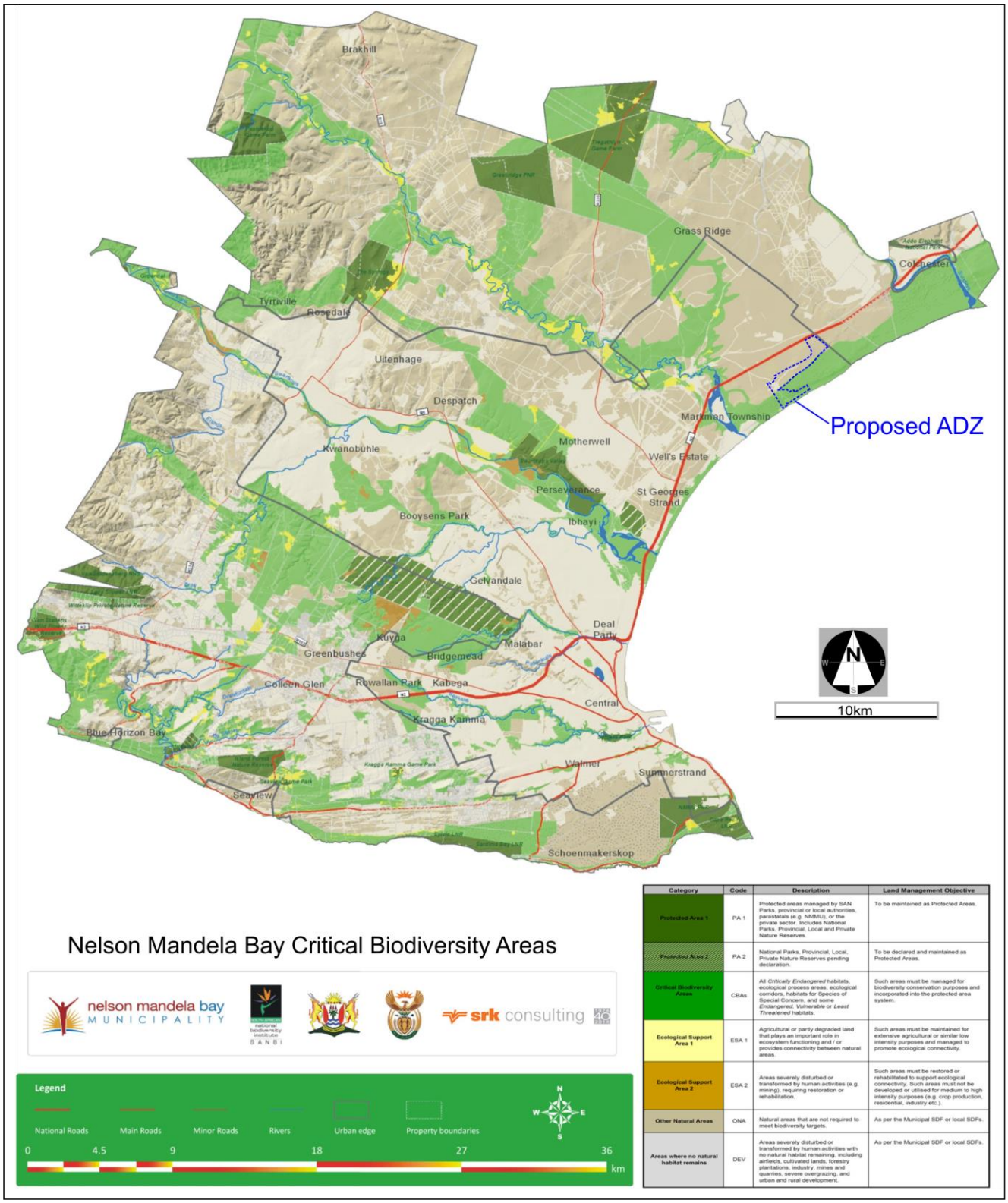
Aquatic CBAs were identified on the basis of sub-quaternary catchments, addressing the linkages between catchments, important rivers and sensitive estuaries. The aquatic map distinguishes between critically important wetlands, sub-catchments and estuaries as CBA1, and important sub-catchments, estuaries and free-flowing rivers as CBA2. The ADZ falls within sub-catchments M30B and N40F, which are both listed as aquatic CBA2 sub-catchments (Figure 2-11). However, no aquatic habitat was observed near the ADZ areas, thus the terrestrial map is the only one of relevance.

2.4.2 NMB Municipality Bioregional Plan

The NMB Municipality Bioregional Plan (SRK, 2014) (NMB MBP) integrated the ECBCP, the NMB MOSS, NMB Municipality Conservation Assessment and Plan (SRK, 2010) with its finer scale of vegetation units, and other important ecological features. The entire length of the coastal dune areas of the ADZ, falling in the Sandy Beaches and Algoa Dune Thicket vegetation units, are classified as a CBA in terms of the NMB MBP. The NMB MBP was adopted by DEDEAT and officially gazetted in March 2015.

Figure 2-8 provides an overview of the NMB MBP map of CBA's as per Appendix C of the NMB MBP and Figure 2-12 shows the location of the ADZ in relation to the CBAs as defined in the NMB MBP.

It is important to note that the CDC's revised OSMP applies to areas within the IDZ. Although the NMB MBP included the previous version of the OSMP, namely OSMP 2006, it makes reference to future versions which would replace OSMP 2006. At the time of publication of the NMB MBP, Revision 1 of the OSMP was submitted by the CDC to DEA for approval but it was still under consideration. As such, it could not be integrated into the NMB MBP CBA network at the time but the intention is to incorporate the latest version of the OSMP into the next revision of the NMB MBP. Hence, the NMB MBP accommodates the development of the ADZ in accordance with the latest version of the OSMP.



Category	Code	Description	Land Management Objective
Protected Area 1	PA 1	Protected areas managed by SAN Parks, provincial or local authorities, parastatals (e.g. NMMU), or the private sector. Includes National Parks, Provincial, Local and Private Nature Reserves.	To be maintained as Protected Areas.
Protected Area 2	PA 2	National Parks, Provincial, Local, Private Nature Reserves pending declaration.	To be declared and maintained as Protected Areas.
Critical Biodiversity Areas	CBAs	All *Critically Endangered* habitats, ecological process areas, ecological corridors, habitats for Species of Special Concern, and some *Endangered, Vulnerable* or *Least Threatened* habitats.	Such areas must be managed for biodiversity conservation purposes and incorporated into the protected area system.
Ecological Support Area 1	ESA 1	Agricultural or partly degraded land that plays an important role in ecosystem functioning and / or provides connectivity between natural areas.	Such areas must be maintained for extensive agricultural or similar low intensity purposes and managed to promote ecological connectivity.
Ecological Support Area 2	ESA 2	Areas severely disturbed or transformed by human activities (e.g. mining), requiring restoration or rehabilitation.	Such areas must be restored or rehabilitated to support ecological connectivity. Such areas must not be developed or utilised for medium to high intensity purposes (e.g. crop production, residential, industry etc.).
Other Natural Areas	ONA	Natural areas that are not required to meet biodiversity targets.	As per the Municipal SDF or local SDFs.
Areas where no natural habitat remains	DEV	Areas severely disturbed or transformed by human activities with no natural habitat remaining, including airfields, cultivated lands, forestry plantations, industry, mines and quarries, severe overgrazing, and urban and rural development.	As per the Municipal SDF or local SDFs.

Figure 2-8: NMB Municipality Bioregional Plan (NMB MBP) – Map of CBAs

Note: The CDC's revised OSMP applies for areas within the IDZ. Although the NMB MBP included the previous version of the OSMP, namely OSMP2006, it makes reference to future versions which would replace OSMP2006. At the time of publication of the NMB MBP, Revision 1 of the OSMP was submitted by the CDC to DEA for approval but it was still under consideration. As such, it could not be integrated into the NMB MBP CBA network at the time but the intention is to incorporate the latest version of the OSMP into the next revision of the NMB MBP. Hence, the NMB MBP accommodates the development of the ADZ in accordance with the latest version of the OSMP.

2.4.3 Revision 1 of the Coega IDZ Open Space Management Plan (OSMP)

Introduction

The development and implementation of an OSMP for the Coega IDZ became a mandatory requirement in terms of the various authorisations for development of the Coega IDZ, including:

- The environmental authorisation (EA) (previously called 'record of decision) for the change in land use of the Core Development Area of the Coega IDZ (May 2002).
- The EA for the Port of Ngqura (May 2002).
- Conditions associated with the rezoning of the IDZ in terms of the Land Use Planning Ordinance (85 of 1985) (LUPO).
- The EA for the change in land use of the remainder of the IDZ on the eastern side of the Coega River (March 2007) – associated with OSMP2006, with map revision 10 (COE/1072-OSMP) as depicted on Figure 2-2.

An area of ~2 260 ha, or ~20% of the surface area of the Coega IDZ, has been set aside as open space and is managed according to the guiding principles of the OSMP. The OSMP has been designed to protect the environmentally sensitive areas within the IDZ, but also to provide for active and passive recreation areas where the public can have freedom of movement.

At the time of writing this report, the current plan was 'Open Space Management Plan and Management Guidelines Revision 1, July 2014', with map revision 15 (drawing 01121 U_BAS_M_001_15_OSMP) as depicted on Figure 2-13.

Revision 1 of the OSMP represents an integration of all previous spatial plans for the Coega IDZ. It was developed based on the requirements of the authorisations listed above as well as the recommendations of EIAs and detailed vegetation and ecological investigations undertaken in the Coega IDZ, the ECBCP, NMB Metro Open Space System (NMB MOSS), NMB Municipality Bioregional Plan (NMB MBP), the Subtropical Thicket Ecosystem Programme (STEP) findings, especially information regarding ecological systems and irreplaceable vegetation. The revision process involved consultation with institutions such as the NMB Municipality, Wildlife and Environment Society of South Africa (WESSA), the CDC's independent ECO, representatives of the Department of Environmental Affairs (DEA), the Department of Economic Development Environmental Affairs and Tourism (DEDEAT), Transnet National Ports Authority, Department of Water and Sanitation, and South African National Parks (SANParks). Revision 1 of the OSMP was approved by the DEA in 2014. A detailed vegetation study was undertaken by CES in 2009. Spatial files associated with the study have been utilised to add further precision to the mapping associated with Revision 1 of the OSMP.

Revision 1 of the OSMP defines a 'primary open space' in Coega IDZ as a critical biodiversity area, labelled CBA-IDZ, and refers to those open space areas where the emphasis is on conservation to protect species and preserve ecological processes, and consists of environmentally sensitive areas such as Bontveld conservation areas, dense Mesic Succulent Thicket on steep slopes, butterfly habitats, grave sites, the riparian zone, portions of the primary and secondary dune fields, and areas below the 1:100 year floodline. Other open space areas, known as 'OSMP Features' include recreational and visually attractive areas to provide screening and softening of the visual impact of the developed areas as well as other man-made facilities close to open space areas that complement open space activities.

The CBA-IDZ areas can be regarded as a sub-category of the CBA category in the NMB MBP. It is the intention to integrate the Coega OSMP into the NMB MBP through the definition of the Coega IDZ as a Geographic Area in terms of the Environmental Management Framework Regulations, 2010.

Primary Open Space (CBA-IDZ) and Developable Areas in Zone 10

Two EIAs in particular had an influence on the revisions in the OSMP as it applies to Zone 10, namely the 2009 SeaArk EIA (CEN, 2009) and EA issued by DEDEAT for the establishment of the SeaArk Prawn Farm in Zone 10, and the EIA for establishment of a 400 m wide services corridor to the coastline in Zone 10.

As discussed above, the 2009 SeaArk EIA included a detailed vegetation assessment and analysis of the alien infestation and ecological status and sensitivity of the vegetation in Zone 10 and made recommendations for the delineation of primary and secondary dunes as primary open space. These recommendations were integrated into Revision 1 of the OSMP, with the delineation of CBA-IDZ areas 1.3A (primary dune) and 1.3B (secondary dune), as depicted on Figure 2-9.

The area indicated as additional developable area in the 2009 SeaArk EIA (Figure 2-4) is heavily invaded by *Acacia cyclops* and other alien species. Although indicated as 'developable' in the 2009 SeaArk EIA, the CDC has decided not to adopt this as such in Revision 1 of the OSMP, but rather to set it aside for long-term conservation as part of the CBA-IDZ. The OSMP envisages the removal of alien species and the re-establishment of indigenous vegetation to act as buffer zones to reverse incremental dune encroachment into the sensitive habitats.

Given the existing mining rights, recreational usage and previously approved mariculture activity, as well as the CDC's mandate in terms of the Industrial Policy Action Plan to facilitate the development of aquaculture in the Coega IDZ, the CDC's master layout planning process made provision for a 'coastal cluster' to be set aside for the development of aquaculture, mariculture, power generation (CCGT power plant), mining and servitudes to provide a linkage between the sea and the developable areas further inland. The coastal cluster is located between the Port of Ngqura and the coastal dune CBA-IDZ defined in Zone 10. The coastal cluster has been classified a 'developable area' in Revision 1 of the OSMP.

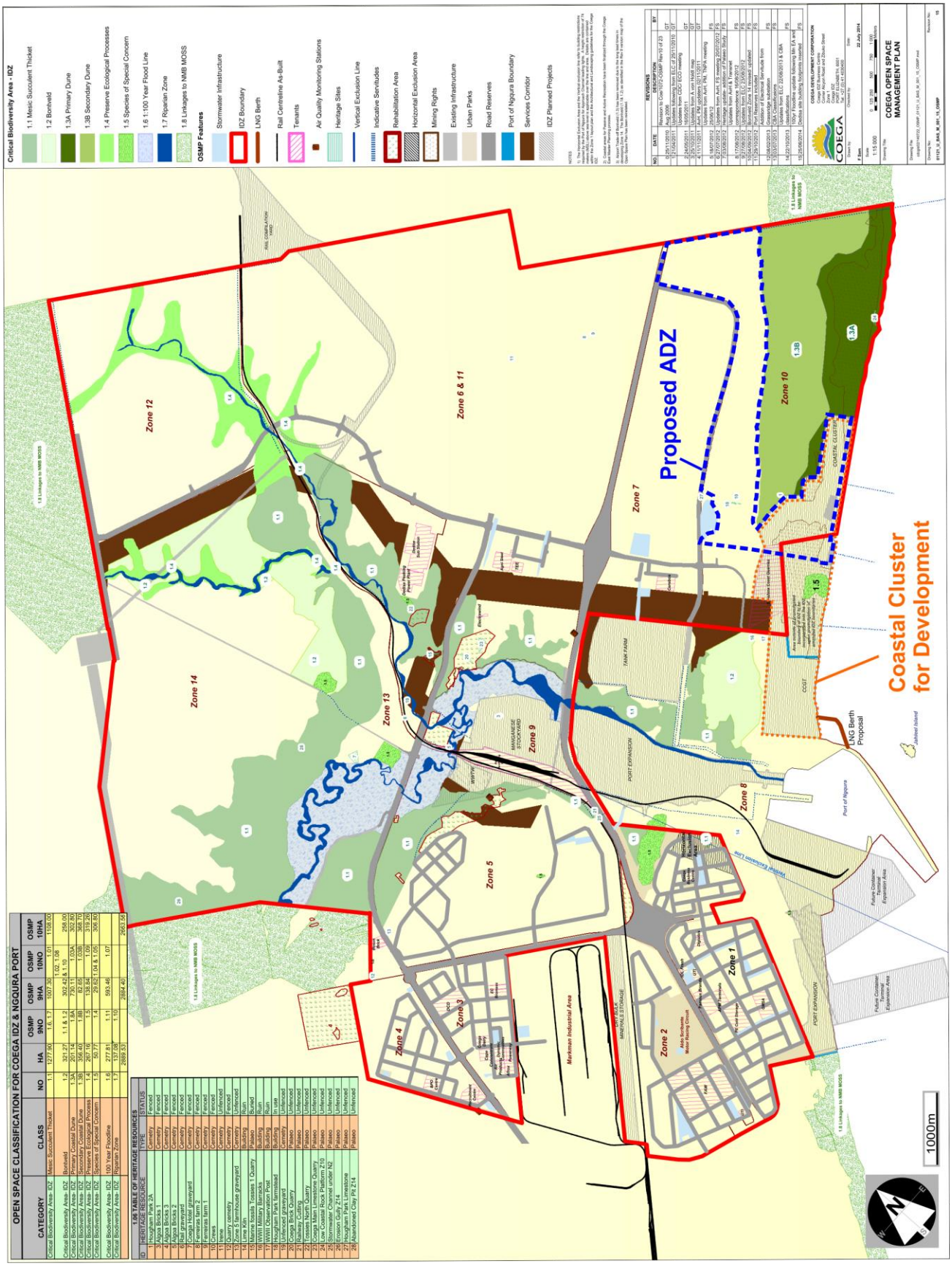


Figure 2-9: 2014 Coega IDZ OSMP (Revision 01, Map Version 15)

Source SC&A, 2016

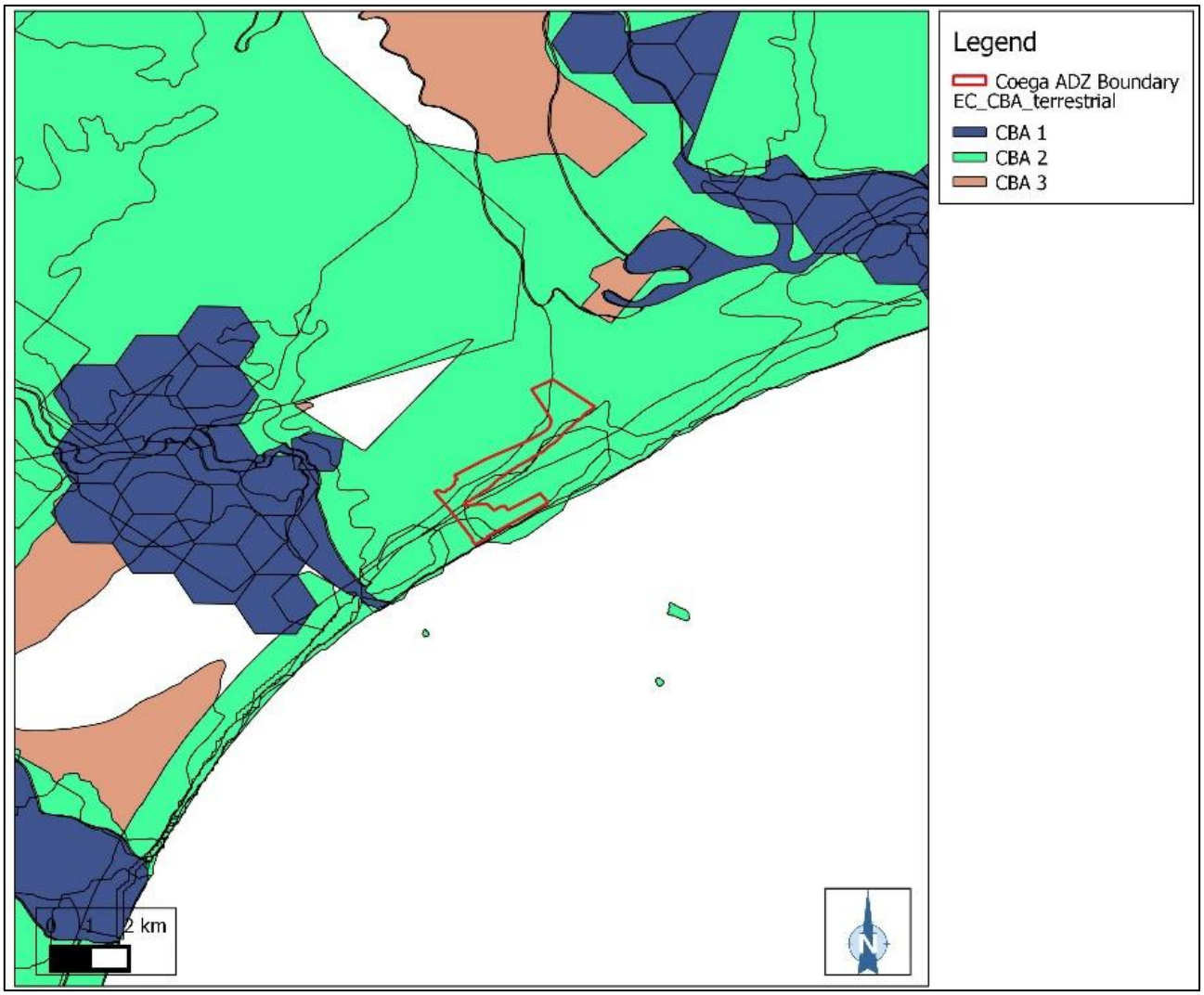


Figure 2-10: The ADZ in relation to Terrestrial CBAs described in the ECBCP

Source SC&A, 2016

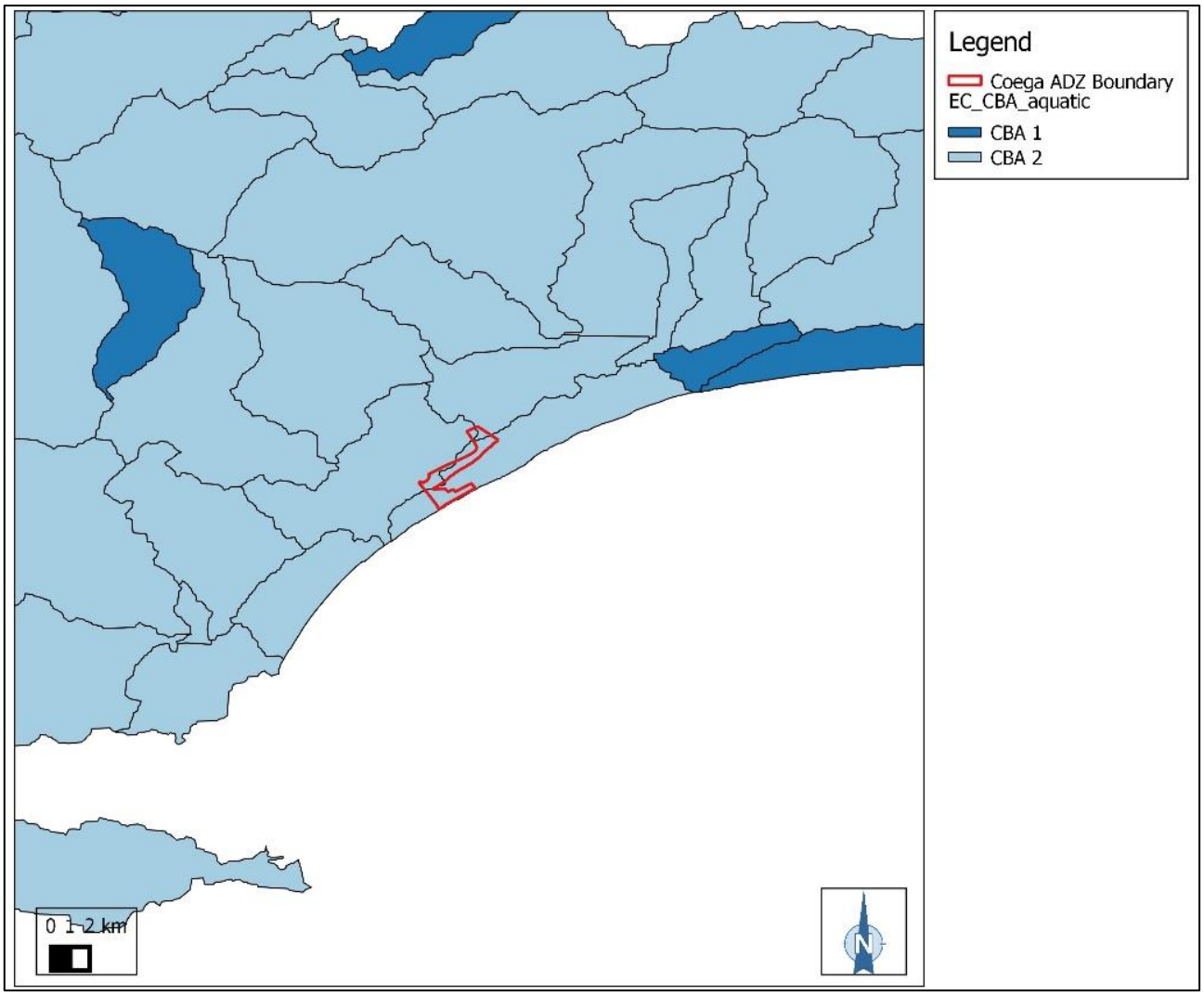


Figure 2-11: The ADZ in relation to Aquatic CBAs described in the ECBCP

Note: There are no watercourses or wetlands within 800 m of the ADZ

Source SC&A, 2016

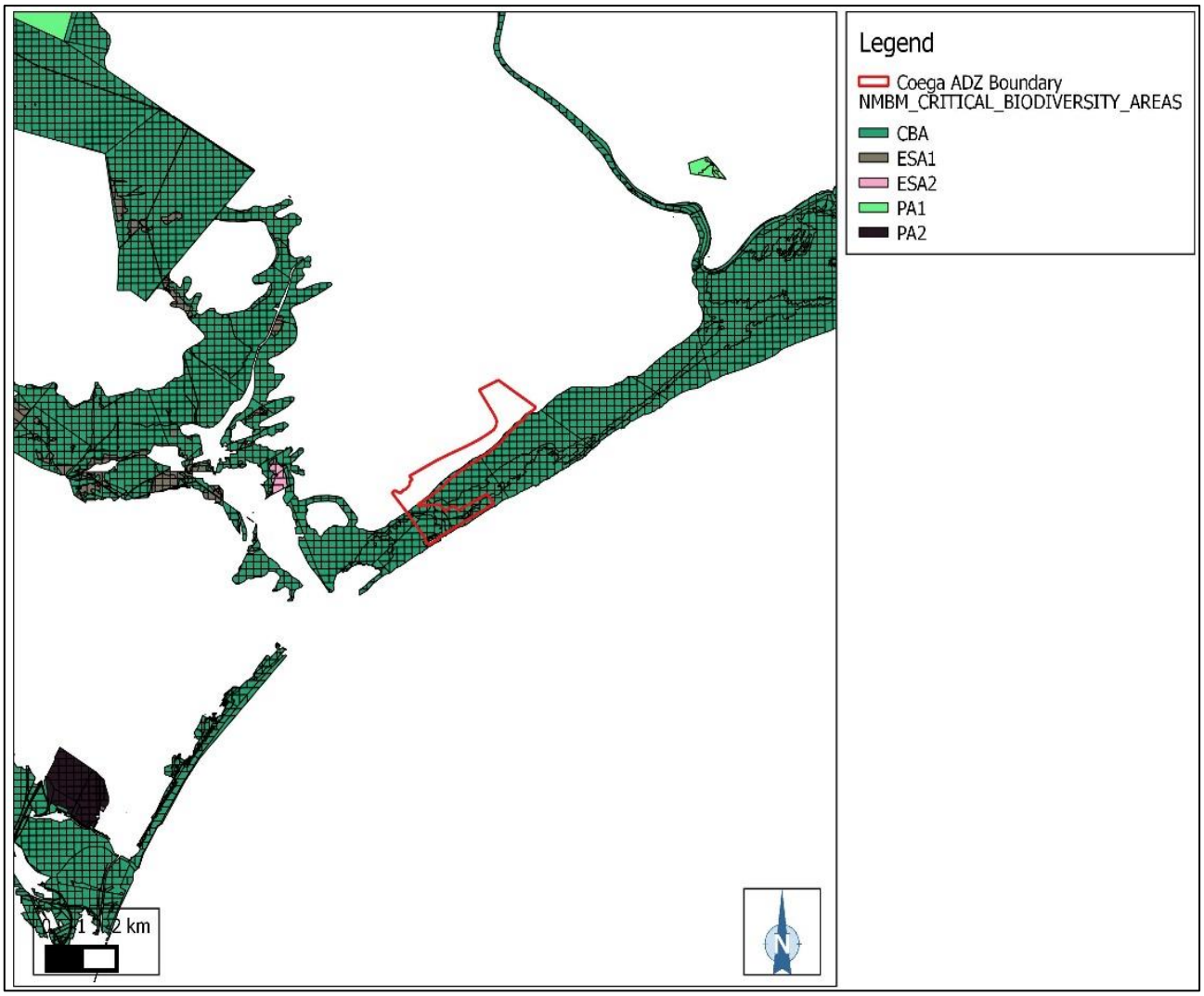


Figure 2-12: The ADZ in relation to CBAs in terms of the NMB MBP

Source SC&A, 2016.

Note: The CDC's Revision 1 of the OSMP applies for areas within the IDZ. Although the NMB MBP included the previous version of the OSMP, namely OSMP 2006, it makes reference to future versions which would replace OSMP 2006. At the time of publication of the NMB MBP, Revision 1 of the OSMP was submitted by the CDC to DEA for approval but it was still under consideration. As such, it could not be integrated into the NMB MBP CBA network at the time but the intention is to incorporate the latest version of the OSMP into the next revision of the NMB MBP. Hence, the NMB MBP accommodates the development of the ADZ in accordance with the latest version of the OSMP.

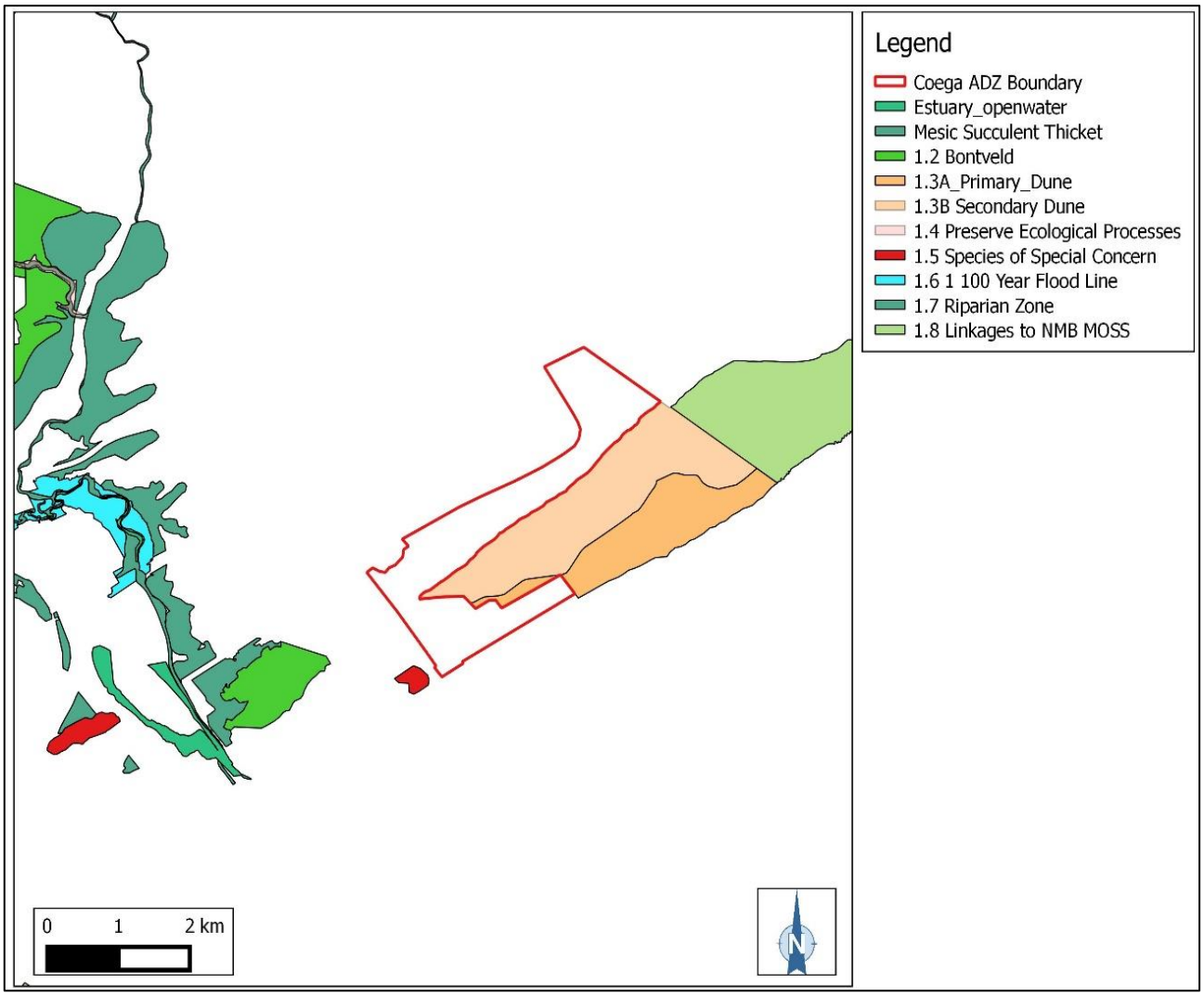


Figure 2-13: The ADZ in relation to the OSMP (Revision 01, Map Version 15)

Source SC&A, 2016

2.5 Coega IDZ Environmental Management

2.5.1 Environmental Management System

The CDC has an ISO 140001 accredited Environmental Management System that forms an overarching tool for dealing with environmental management matters in the IDZ.

2.5.2 Environmental Liaison Committee (ELC)

An Environmental Liaison Committee (ELC) has been established for the Coega IDZ. The ELC meets on a quarterly basis to discuss issues and evaluate progress made in respect of environmental studies and activities currently underway and/or proposed environmental studies to be conducted. The following government organs of state are represented on the ELC:

- Eastern Cape DEDEAT
- Coastal Pollution Management Division, DEA: Ocean and Coast
- Strategic Infrastructure Development, DEA
- Environmental Impact Management, DEA
- Environmental Project Manager, CDC

- Spatial Development Manager, CDC
- Environmental Manager, TCP
- Environmental Manager, TNPA
- Environmental Manager, NMB Municipality
- Air Pollution & Noise Control, NMB Municipality: Air Pollution and Noise Control
- Water Quality Management, DWS
- Mineral Regulation, DMR

Three presentations on the progress of this EIA have been made to the ELC to date (see Appendix F).

2.5.3 Independent Environmental Control Officer (ECO)

An independent environmental control officer (ECO) is appointed to monitor and report on environmental management and compliance with the various EA conditions, specifications and environmental management plans, conduct regular site inspections and audits, and to present audit results to the Coega Environmental Monitoring Committee (EMC).

2.6 Strategic Environmental Assessment for Aquaculture in South Africa

DEA in collaboration with the DAFF commissioned the Council for Scientific and Industrial Research (CSIR) to undertake an SEA for the development of aquaculture in South Africa. The SEA commenced in 2016 and is earmarked to be completed towards the end of 2017 (http://aquasea.csir.co.za/).

2.7 Related Environmental Assessments and Authorisations Relevant to the Development of the ADZ

Various environmental assessments have been undertaken for the Coega IDZ and for projects in and around Coega IDZ. Some of these were integral to the last revision of the OSMP and they provide environmental legal context for Coega ADZ EIA. A summary of relevant assessments is tabled below.

Table 2-1: Environmental Assessments and Authorisations Relevant to the Coega ADZ EIA Process

Environmental Assessment	Overview	Project Applicant	Completion Date	Approval Date
N/A (established prior to promulgation of EIA regulations in 1997).	Marine Growers abalone farm in Zone 10 developed prior to the establishment of the Coega IDZ. The structures of the abalone farm as well as and old seawater abstraction point are still in place.	N/A	N/A	N/A
Mining rights and EMPr's in terms of the MPRDA.	Sand mining operations as described in Section 2.3.2.	Individual Mining Companies	Varied	Varied
PPC EIA for amendment to mining rights.	EIA for amending the existing PPC EMPr and to obtain the necessary environmental authorisation, permits and licenses triggered by PPC's proposed changes to the mining operations.	PPC	Stopped / Lapsed	
Strategic Environmental Assessment for Coega IDZ and Port Ngqura.	No environmental flaws were identified which would prohibit further planning in Coega IDZ and Port of Ngqura.	N/A	1997	N/A
Coega IDZ Rezoning EIA for Core Development Area.	Approved the rezoning of ~4 200 ha of land as the Core Development Area, located to the south-west of the Coega River, from Agriculture or Undefined to Special Purposes. Facilitated the establishment of industrial development	CDC	2001	2002

Environmental Assessment	Overview	Project Applicant	Completion Date	Approval Date
	within Core Development Area.			
Coega IDZ Rezoning EIA for Areas East of the Coega River.	Approved the rezoning of ~7 300 ha of land East of the Coega River to facilitate the establishment of industrial development within the remaining extent of the IDZ.	CDC	2006	2007
Port of Ngqura EIA.	Establishment of a Deepwater Port of Ngqura.	TNPA	2001	2002
SeaArk Pilot Prawn Facility.	Establishment of a pilot prawn facility for prawn farm in Zone 10 next to the then Marine Growers abalone farm. Closed in 2009 but structures still in place.	Ballastrada Trade & Investments	2006	2006
SeaArk Prawn Farm.	Environmental authorisation issued for the project by the DEDEAT, over a development area of ~ 400 ha, stipulated that structures and infrastructure may not take place within the designated open space area as indicated on the then approved OSMP2006 (map revision 10) or future versions of the OSMP (thus Revision 1 of the OSMP). The establishment of the full prawn farm never materialised. Escalating electricity prices were mooted as one of the reasons.	SeaArk Africa	2009	2009
CDC Marine Pipeline Servitude EIA.	See Section 1.10 above.	CDC	Underway	
Waste Water Treatment Plant in Coega IDZ.	The NMB Municipality has commissioned engineering and environmental studies for the establishment of a waste water treatment facility in the IDZ. Effluent from the ADZ may therefore eventually be directed to this facility.	NMB Municipality	Underway	

3 Policies, Legislation and Standards

3.1 Government Policies and Programmes

Aquaculture development, especially in the Eastern Cape, forms part of the national government's Strategic Infrastructure Projects (SIP), in this case known as SIP 11. One of the key objectives of SIP 11 is the support for agricultural sectors and regions with high productive potential, with fisheries being one of the eight value chain areas.

In addition, Operation Phakisa places a large emphasis on aquaculture, as can be gleaned from President Zuma's speech on 19 July 2014:
"The Aquaculture work stream has underlined the high growth potential of South Africa's aquaculture sector due to increasing demand for fish. While aquaculture contributes to almost half of the global fish supply, it contributes less than one percent of South Africa's fish supply. …these projects are expected to grow the aquaculture sector's revenue from about half a billion rand today, to almost one point four billion rand (R1.4 billion) in 2019. Three further aquaculture initiatives relate to the creation of an enabling regulatory environment, including the establishment of an Inter-Departmental Authorisations Committee. The committee will co-ordinate aquaculture applications and approvals. The intention is to reduce processing time from the current periods of about 890 days to 240 days in future. Other initiatives focus on funding support, increasing the skills pool and awareness and improving access to markets. The stream has identified some initial targets as well. They recommend implementing nine projects in the Eastern Cape, North West, KwaZulu-Natal and Western Cape provinces."

The following key government policies and programmes have relevance to the development of an ADZ:

- National Aquaculture Policy Framework (NAPF)
- National Aquaculture Strategic Framework (NASF)
- DTI Aquaculture Incentive (proposed)
- DTI Business Support, Investment Promotion and Trade
  - Facilitation of Finance and Incentives for Aquaculture Industry
  - Aquaculture Development and Enhancement Programme (ADEP) in conjunction with DAFF
- Department of Health – Food safety and public health requirements for Aquaculture Products
- Public Enterprises – Transnet: Allocation of Sea Space with Commercial Ports
- Joint Marine Aquaculture Advisory Forum (MAAF)
- National Marine Aquaculture Animal Health Management Programme
- National Aquaculture Intergovernmental Forum (AIF)
- Provincial Aquaculture Intergovernmental Forum (PAIF)
- Aquaculture Value-Chain Round Table (AVCRT)
- Shellfish Monitoring and Control Programme (SM&CP)
- Finfish Monitoring and Control Programme (FM&CP)
- Aquatic Animal Health Programme (AAHP)
- Public Understanding of Aquaculture Programme (PUA)
- Policy for the development of sustainable inland aquaculture sector in South Africa

3.2 Regional and International Programmes

In addition to the national programmes listed above, the following regional and international programmes have relevance to aquaculture developments:

- SADC Protocol on Fisheries
- FAO Code of Conduct on Responsible Fisheries (CCRF)
- FAO Technical Guidelines for Aquaculture Certification
- NEPAD 'Fish for All' Action Plan for the Development of African Fisheries and Aquaculture

3.3 Environmental Legislation and Approvals Required

3.3.1 Aquaculture Bill

The draft Aquaculture Bill was gazetted in February 2016. The aim of the Bill (and eventually the Act) is to promote the development of an equitable, diverse, viable and competitive aquaculture sector; to create a harmonised enabling regulatory environment within a framework of sustainable development; to improve coordination in the regulation of the aquaculture sector; to promote the participation of historically disadvantaged individuals in the aquaculture sector; to establish an aquaculture development fund; and to provide for related matters. Matters dealt with in the Bill include:

- Management of aquatic animal diseases
- Aquatic animal food safety
- Health, welfare, safety and quality of aquatic organisms and products
- The aquaculture development fund, the national aquaculture development strategy and provincial aquaculture development plans
- Aquaculture development zones
- Aquaculture disease zones
- National aquaculture information system
- Licences and permits, including integrated aquaculture authorisations
- Maintaining environmental integrity
- Water quality management
- Protection of biodiversity
- Prohibition of release of live aquaculture organism
- Reporting of release or escape of live aquaculture organisms
- Import, export and movement of aquatic organisms and aquaculture products
- Transformation and social responsibility
- Inspection and enforcement

3.3.2 National Environmental Management Act (NEMA) and the EIA Regulations

EIA Regulations

The National Environmental Management Act (NEMA) is an all-encompassing framework act regulating various aspects of natural resource use, integrated environmental management and pollution control. The Act provides the framework for environmental assessments and authorisations.

The latest environmental impact assessment regulations (EIA Regulations) have been published in terms of section 24(5) and 44 of the NEMA on 4 December 2014 in GNR 982. The regulations outline the requirements for environmental impact assessment processes for all activities that have been identified as potentially having an adverse effect on the environment.

GNR 983, 984, and 985 (Listing Notices 1, 2 and 3) identifies activities that would require environmental authorisations prior to commencement of that activity and identifies the competent authorities in terms of

sections 24(2) and 24(D) of the NEMA. Listing Notices 1 and 3 list activities for which a basic assessment for environmental authorisation (EA) is required, while activities that require a full scoping and environmental impact assessment for environmental authorisation are listed in Listing Notice 2.

The Coega ADZ includes activities from all three listing notices and a full scoping and environmental impact assessment process was therefore undertaken in support of an application for environmental authorisation.

Refer Appendix A1.1, A1.2, A1.3 for listed activities in terms of Listing Notices 1, 2 and 3 respectively. These activities are included in the integrated application for authorisation submitted to the DEA.

Draft National Standards for land-based Abalone Aquaculture

Draft national standards for land-based abalone aquaculture were gazetted in May 2016. It provides for a sector standard for the land-based abalone sector and reflects activities identified in terms of NEMA that may be excluded from the requirement to obtain an EA from the competent authority, but must comply with the national land-based abalone standard and administrative notification and registration process.

The development of this Standard therefore aims to promote responsible abalone farming and to contribute to sustainable development by allowing the abalone aquaculture industry to pro-actively address environmental risks and impacts, while enabling economic development and achieving the objective of Operation Phakisa to unlock the potential of South Africa's oceans. The Standard is applicable in the Eastern Cape and aquaculture farms that fall within the scope of the standard will not be required to obtain an environmental authorisation in terms of NEMA, provided that they comply with all the administrative specifications of the standard.

Abalone farms in the ADZ need to take cognisance of the draft standards for land-based abalone aquaculture.

Environmental Impact Assessment Guideline for Aquaculture in South Africa

DEA published the EIA Guideline for Aquaculture in South Africa under section 24J of the NEMA. The primary objective of the guideline is to equip the aquaculture sector and other stakeholders with the required approach to deal with environmental management so that potential environmental impacts can be reduced. The guidelines were used to inform this EIA for the Coega ADZ.

3.3.3 National Environmental Management Biodiversity Act (NEM:BA)

The National Environmental Management: Biodiversity Act (NEM:BA) provides for the management and conservation of South Africa's biodiversity within the framework of the NEMA, 1998; and provides for and includes: the protection of species and ecosystems that warrant national protection; sustainable use of indigenous biological resources; fair and equitable sharing of benefits arising from bio-prospecting involving indigenous biological resources; and establishment and functions of a South African National Biodiversity Institute; and for matters connected therewith.

Geographical Areas with Sensitive Environmental Attributes

The ADZ's location in terms of applicable bioregional plans and defined CBAs are discussed in Section 2.4.

NEMA listed activities triggered as due to CBAs are detailed in Appendix A1.3 (Listing 3).

Threatened or Protected Ecosystems

The NEM:BA provides for listing of threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Protected. The purpose of listing threatened ecosystems is

primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to preserve witness sites of exceptionally high conservation value. In terms of the listing, the significance of impact on biodiversity, when there is a loss of natural habitats listed as either a Critically Endangered or an Endangered ecosystem, would be regarded as Highly Significant. The first list consisting of 225 threatened terrestrial ecosystems, based on vegetation type, was published on 9 December 2011 (Government Gazette 34809, Notice 1002). Expected future listings will deal with threatened ecosystems in the freshwater, estuarine and marine environments and with protected ecosystems in all environments. None of the currently listed threatened ecosystems were found within the ADZ or immediate surroundings.

Threatened or protected species (TOPS) Regulations

The Threatened or Protected Species Regulations (GNR 388 of 16 April 2013) provides for the declaration of threatened or protected species (TOPS) and for the restriction of certain activities involving those species (including keeping or breeding, killing, importing or exporting) through a permit system.

An activity which would affect the habitat of a threatened or protected species also requires a permit.

Individual aquaculture farms wanting to culture a listed threatened or protected species of fish or shellfish will have to obtain the required permit.

Alien and Invasive Species (AIS) Regulations

The AIS regulations (GNR 598, GG 37885) were gazetted in August 2014. It deals with different categories of species that are either prohibited, must be combatted or eradicated, controlled, requires a permit to carry out a restricted activity within specified areas, or is subject to certain exemptions and prohibitions.

Individual aquaculture farms considering alien or invasive species (AIS) must comply with these regulations. A risk assessment and permit may be required in terms of the regulations. Permits are issued by the DEA.

3.3.4 National Water Act (NWA)

The National Water Act identifies consumptive and non-consumptive water uses which must be authorised under a tiered water authorisation system. Section 27 of the NWA specifies that the following factors regarding water use authorisation must be taken into consideration:

- The efficient and beneficial use of water in the public interest;
- The socio-economic impact of the decision whether or not to issue a licence;
- Alignment with the catchment management strategy;
- The impact of the water use, resource directed measures; and
- Investments made by the applicant in respect of the water use in question.

Section 21 of the NWA identifies listed activities for which water authorisations and registrations may be required. Depending on the nature and scale of the water use, a water use license may be required or, for smaller water uses, a general authorisation may apply.

Water uses in the ADZ that would require authorisation in terms of the NWA Section 21 are listed in Appendix 1C.

3.3.5 National Environmental Management: Air Quality Act (NEM:AQA)

GNR 893 in terms of NEM:BA lists activities which may result in atmospheric emissions and may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage. Processes for the rendering cooking, drying, dehydrating, digesting, evaporating or

protein concentrating of any animal matter not intended for human consumption are included, for more than 1 tn processed a day.

The impacts of such processing have been addressed in Section 7.3. Each processing plant operator will be required to obtain their own AEL if their facility is above the threshold of 1 tn/day, and to implement the required best practice measures intended to minimize or avoid offensive odours must be implemented by all installations.

Details of activities triggered in terms of GNR 893 are provided in Appendix A4.

Draft National Greenhouse Gas Emission Reporting Regulations were published in June 2016. The regulations will set thresholds for greenhouse gas emission reporting for entities that exceed the thresholds will be required to submit an inventory of their emissions. The sectors that will be compelled to report are energy, industry, agriculture, waste and transport. The purpose is to build up an annual greenhouse gas inventory, an international obligation under the UN Framework Convention on Climate Change.

3.3.6 Nature Conservation Ordinance

CDC has obtained a permit to remove protected plant species from areas where infrastructure will be constructed in the Coega IDZ, in terms of the Nature Conservation Ordinance (19 of 1974). The permit is valid for 12 months, and is renewed on an annual basis but renewal is dependent on fulfilment of the conditions of the permit. The permit conditions require:

- The location of individuals of the various species to be identified, located with a GPS and be physically marked.
- The person responsible for the relocation to work ahead and physically remove the plants before vegetation clearance starts.
- If a species is represented by too many individuals to make relocation of the entire population feasible, plants should be taken from different parts of the site, from different habitats, both young and old individuals should be selected as well as individuals reflecting variability in the population to ensure the plants relocated will express the broadest genetic variation and maximize the chance of survival.
- For plants that cannot be successfully uprooted transplanted, seeds and/or small cuttings are to be collected and establish in a nursery for cultivation and later introduction into selected localities.
- Plants are to be translocated in the most appropriate form, not only as whole plants but also as bulbs, seeds and cuttings.
- Private individuals and or nurseries to be given the opportunity to collect plants that are not relocated and that would otherwise be destroyed during vegetation clearance of the site.

3.3.7 National Forests Act

The CDC has also obtained a licence, under the National Forests Act (84 of 1998) to cut and destroy protected trees (Milkwood and Cheesewood) for the purpose of developing infrastructure in the IDZ. The license is issued for 12 months, and is renewed on an annual basis. It covers tenants in the IDZ but requires the licensee (CDC) to monitor tenants' activities in respect of the licence.

3.3.8 National Heritage Resources Act (NHRA)

The NHRA requires that a heritage assessment be undertaken and for the responsible heritage resources authority to be informed and provide feedback before development of:

- Any development or other activity which will change the character of a site
  - Exceeding 5 000 m^2 in extent; or
  - Involving three or more existing erven or subdivisions thereof; or
  - Involving three or more erven or divisions thereof which have been consolidated within the past five

years; or
  - The costs of which will exceed a sum set in terms of regulations by the South African Heritage Resource Agency (SAHRA) or a provincial heritage resources authority;
- The re-zoning of a site exceeding 10 000 m^2 in extent; or
- Any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

In 2010, the CDC commissioned a heritage assessment for the Coega IDZ by Almond (2010), Bennie (2010) and Binneman (2010) that covered palaeontological, historical and archaeological heritage components respectively. The 2010 studies were reviewed by SAHRA and they issued a document (SAHRA, 2011) in which recommendations for the management of all the identified sites within the Coega IDZ were stipulated, as well as some general recommendations. The recommendations[8] specific to Zone 10 and the ADZ were incorporated into the EIA and EMPr.

In 2012, The ECPHRA became the assigned responsible heritage resources authority in the Eastern Cape. The scoping report for the Coega ADZ was submitted to both SAHRA and the ECPHRA.

Section 7.20 of this EIR contains a detailed summary of the 2010 Phase 1 heritage reports, with recommendations by the specialists and by SAHRA in 2011. The EIR will be submitted to ECPHRA and uploaded onto SAHRA's SAHRIS (online system) website.

3.3.9 National Environmental Management: Integrated Coastal Management Act (ICMA)

One of the main purposes of the NEM: ICMA is to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable.

Marine Outfall Pipelines

Establishment of the marine pipeline servitude requires an EA in terms of the NEMA and a coastal waters discharge permit in terms of Section 69 of the ICMA. A separate environmental assessment process is being undertaken for this. This separate EIA will investigate the impacts associated with the pipeline(s) as it spans over land and coastal environments, as well as the impacts on the marine environment associated with the abstraction of water from the sea and, in particular, the impacts associated with the discharge of effluent into the sea. It will therefore include an assessment of the impacts of the ADZ effluent as well as effluent from other industries and proposed waste water treatment plant in the Coega IDZ, as well as the physical impacts of the sea water intake and discharge pipelines to and from Zone 10. Discharges from the ADZ will therefore be covered under the coastal waters discharge permit for the IDZ.

Storm water Outfall

In terms of the CDC's storm water master plan, tenants in the IDZ are required to attenuate and store storm water on their sites. DEA O&C is planning to put in place a system of general coastal authorisations for certain low impact coastal discharges, which would include storm water outfalls.

If a storm water outfall for the ADZ is required in future, a general coastal authorisation will be required.

[8] *General recommendations for the IDZ, to be addressed by the CDC are not repeated in the EMPr for the ADZ.*

Coastal Lease

The sections of the NEM:PAA that regulate coastal authorisations for use of land in the coastal zone have not yet commenced at the time of drafting this guideline. When they do, these provisions will replace the system of coastal leases currently in place under the Sea Shore Act.

A coastal lease is required for activities below the HWM – refer Sea Shore Act below.

3.3.10 National Environmental Management: Waste Act (NEM:WA)

The ADZ will require a waste management license.

Listed waste activities are described in Appendix A2.

3.3.11 National Environmental Management: Protected Areas Act (NEM:PAA)

NEM:PAA was enacted to regulate the system of protected areas in South Africa and to provide for their management. Any commercial activity carried out in a protected area, which includes marine protected areas, requires the written authorisation of the management authority, which will usually be SANParks or a provincial conservation authority.

Nearby protected areas include the proposed marine protected areas and bird islands. The ADZ is land based with no activities planned for within the protected areas.

The separate EIA for the CDC's marine pipeline servitude covers impacts of the marine pipelines on the proposed marine protected area and bird islands (see Section 1.10).

3.3.12 Sea Shore Act

The Sea Shore Act (21 of 1935) currently makes provision for lease agreements for activities within the defined coastal public property. Where the ADZ requires such access, a lease agreement in terms of the act will be required. The pending amendment to ICMA will however repeal this act. Once ICMA has been amended, the applications will be in terms of the coastal permit system provided for in the proposed ICMA amendment.

Activities falling within public coastal property (areas below the HWM) for which a coastal lease will be required are listed in Appendix A5.

3.3.13 Genetically Modified Organisms Act (GMOA)

The Genetically Modified Organisms (GMO) Act (15 of 1997) provides for measures to promote the responsible development, production, use and application of genetically modified organisms; to ensure that all activities involving the use of genetically modified organisms (including importation, production, release and distribution) shall be carried out in such a way as to limit possible harmful consequences to the environment; to give attention to the prevention of accidents and the effective management of waste; to establish common measures for the evaluation and reduction of the potential risks arising out of activities involving the use of genetically modified organisms; to lay down the necessary requirements and criteria for risk assessments; to establish a council for genetically modified organisms; to ensure that genetically modified organisms are appropriate and do not present a hazard to the environment; and to establish appropriate procedures for the notification of specific activities involving the use of genetically modified organisms; and to provide for matters connected therewith.

The GMOA applies to the genetic modification of organisms as well as the development, production, release, use and application of genetically modified organisms (including viruses and bacteriophages). The Act might apply to both spat and feeds. A permit is required to undertake any activity in relation to genetically modified organisms. In order to undertake such an activity a suitable and sufficient assessment of the potential adverse effects to the

environment, human and animal health and safety must be undertaken. This includes an assessment of the socio-impact, cultural traditions as well as future security.

Individual aquaculture developers where GMOs are being used will need to ensure that they obtain the required registrations and permits prior to the introduction of the GMO.

3.3.14 Municipal Zoning

The Coega IDZ has been approved by the NMB Municipality in terms of Land Use Planning Ordinance (85 of 1985). No rezoning approvals are required for the ADZ.

3.4 Aquaculture Sector Legislation and Approvals

In addition to the environmental authorisations, permits and licenses listed above, certain sector specific permits and approval are required from the DAFF and/or DEDEAT. Import and export permits are issued in conjunction with the National Regulator for Compulsory Specifications (NRCS). The following legislation is of relevance to the aquaculture sector:

- Marine Living Resources Act
- Cape Nature and Environmental Conservation Ordinance
- Fertilizers, Farm Feed, Agricultural Remedies and Stock Remedies Act
- Animal Diseases Act
- Animal Protection Act
- Medicines and Related Substances Act
- National Health Act
- Standards Act
- National Regulator for Compulsory Specifications Act
- Foodstuffs, Cosmetics and Disinfectants Act

DAFF is responsible for overseeing and supporting South Africa's agricultural, fisheries and forestry sectors – including aquaculture (this involves promoting the development of the sector, issuing marine aquaculture rights and permits etc.). DAFF is also responsible for ensuring access to sufficient, safe and nutritious food by the country's population.

DAFF has jurisdiction over marine and sea water aquaculture developments, in terms of the Marine Living Resources Act, and the issuing of a marine aquaculture right or permit.

Regulations under the Marine Living Resources Act place restrictions upon various fish species. The restrictions may be size or use related. For instance, a prohibition is placed on controlling or being in possession of specimens of specified species below a certain size and an exemption in terms of the Act must be sought to do so. In addition, it is stipulated that permits are required for use of abalone and oysters in commercial operations. It also establishes an outright prohibition on any use of certain fish species (DAFF, 2013).

Freshwater aquaculture currently falls under the jurisdiction of DEDEAT in terms of provincial ordinances. The Cape Nature and Environmental Conservation Ordinance (14 of 1974) is applicable in the Eastern Cape. It imposes permitting requirements in respect of the sale or purchase of specific species of fish like endangered wild fish, live carp, bluegill, sunfish, trout, black bass, banded tilapia or exotic invertebrate freshwater fauna.

Aquaculture permits cover a wide spectrum of aspects, such as operation of a hatchery, scientific investigations, and experiments, ranching, fertiliser use, farm feeds, use of remedies and medications, animal health and welfare,

broodstock, aquaculture grow-out activities, aquaculture processing, local sale of undersized cultured products, transport, and imports and exports (international, provincial or regionally between DAFF management zones).

These permit requirements are generally applicable after an EA has been granted and it will be the responsibility of each aquaculture farm to ensure all the necessary permits are in place.

The permits are supported by various guideline documents, protocols, best practice guidelines, monitoring and control programmes, such the South African Live Molluscan Shellfish Monitoring and Control Programme as well as the South African Marine Aquaculture Fish Monitoring and Control Programme, and other species specific measures. Depending on the species farmed, the aquaculture developers may also be required to comply with the norms and standards that may be issued by DAFF or DEA from time to time, such as the forthcoming Land-based Abalone Aquaculture Norms and Standards as discussed above. Information on the permits and supporting documents are obtainable from DAFF.

3.5 Aquaculture Guidelines, Standards and Certification

Over recent years, a variety of standards, guidelines and reports on aquaculture water and effluent qualities have been published. Some are in draft or interim format. Some have been issued by governments, some by environmental NGOs, and others by the aquaculture sector itself. The list provided below is by no means complete since new and updated documents are issued on a regular basis but it does however, provide an indication as to the extent of environmental management control measures in the aquaculture sector.

3.5.1 South Africa

DAFF. 2016. South African Aquacultured Marine Fish Monitoring and Control Programme. Issue 3: January 2016.

DAFF. 2016. South African Live Molluscan Shellfish Monitoring and Control Programme. Issue 6: January 2016.

DEA. May 2016. Draft Standards for Land-based Abalone Aquaculture.

DWAF. 1995. Water Quality Guidelines for Coastal Marine Waters Volume 1 Natural Environment.

DWAF. 1996. South African Water Quality Guidelines Volume 6 Agricultural Use: Aquaculture.

Hinrichsen, E. 2007. Generic Environmental Best Management Practice Guideline for Aquaculture Development and Operation in the Western Cape.

MFFASA (Marine Finfish Farmer's Association of South Africa). 2011. Marine Fish Farming Environmental Impact.

Probyn, TA, Pretorius, M, Bernatzeder, A. 2014. Effluent Water Quality Characteristics of Land-based Abalone Farms in the Western Cape, South Africa.

DAFF. Guidelines for freshwater aquaculture and inland fisheries.

DAFF. Policy for the Development of Sustainable Inland Aquaculture Sector in South Africa

DAFF. Policy for the Development of a Sustainable Marine Aquaculture Sector in South Africa.

DAFF. Marine Aquaculture Policy Implementation Plan 2009 – 2014.

DAFF. Initial) Genetic Best Management practice guidelines for marine finfish hatcheries in South Africa of the Finfish Hatchery Management Protocol.

DAFF. 2011. Guidelines and Requirements on Applying for a Marine Aquaculture Right.

DAFF. Marine Aquaculture Permit Conditions: Abalone Grow Out (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Abalone Hatchery (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Finfish Grow-Out - Land Based (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Marine Aquaculture Fish Processing Establishments (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Marine Ornamentals Hatchery and Grow-Out (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Prawn Hatchery and Grow-Out – Land Based (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Seaweed Grow Out (standard conditions).

DAFF. Marine Aquaculture Permit Conditions: Standard Marine Aquaculture (standard conditions).

AFASA (Abalone Farmers Association of South Africa). 2010. Biosecurity Standard.

3.5.2 International

EPA. 2003. Aquaculture Management and the Environment Protection (Water Quality) Policy.

PHILMINAQ. 2008. Water Quality Criteria and Standards for Freshwater and Marine Aquaculture in the Philippines.

WWF. 2010. Abalone Aquaculture Dialogue Standards.

Global Aquaculture Alliance. Best Aquaculture Practice Standards (Finfish and Crustacean Farms, Mussel Farms, Mollusk Farms, Salmon Farms, Hatcheries and Nurseries, Feed Mills, Seafood Processing and Repacking Plants).

ASC. Aquaculture Certification Standards (Abalone, Bivalves, Fresh Water Trout, Salmon, Seriola and Cobia, Shrimp, Tilapia, Pangasius, Chain of Custody Certification, and Interim Standard for Marine Raw Material Requirements (wild caught fish use and inputs into feed manufacture).

FAO. Technical Guidelines on Aquaculture Certification

3.6 General Legislation

Aquaculture operators in the ADZ, as is the case for any legal entity in South Africa, need to comply with all national and provincial laws and regulations, local by-laws and standards as they apply to their businesses. These include but are not limited to:

- Building Standards and Regulations
- Occupational Health and Safety Act
- NMB Municipality Air Pollution By-Law
- NMB Municipality Noise Control By-Law
- NMB Municipality Draft Storm water Management By-Law
- NMB Municipality Water and Sanitation Services By-Law (permits may be required for releases to sewer)
- NMB Municipality Waste Management By-Law
- NMB Municipality Health By-Law
- NMB Municipality By-Law Relating to Fire Safety

4 Project Description and Design Options

4.1 Site Layout

The Coega ADZ is a land-based aquaculture development where use will be made of constructed culture units such as tanks, ponds and raceways built on land. Both marine and fresh water species will be cultivated. The CDC has developed a conceptual layout plan for the ADZ as illustrated in Figure 1-6. The ADZ development includes the utilisation of the old abalone farm and old pilot prawn facility.

Specific details, layout and designs of the facilities within the ADZ will only become available once the individual developers have made the decision to invest in the Coega IDZ and have completed their individual layout plans

and designs. However, the EIA considered impacts of aquaculture development throughout the ADZ footprint in line with the project parameters outlined in Section 4.10.

MITIGATION MEASURES AND DESIGN CRITERIA

- *The CDC to develop a master layout plan for the ADZ.*
- *Individual investors to develop a project-level site development plan and EMPr, based on the EMPr developed for this EIA and established CDC environmental specifications and procedures for construction and operation, for consideration by the CDC.*
- *CDC to put in place the necessary contractual agreements with Transnet to include re-use of the old abalone facility located on land owned by Transnet.*
- *The old abalone farm and a portion of the old pilot prawn facility are located on the seaward side of the NMB Municipality's coastal management line and the arbitrary 100 m line from the HWM. The Criteria for Development Decision-Making in Areas Potentially Affected by Sea Level Rise described in Section 7.21.2 would therefore apply to decision-making on the re-use and any potential upgrades to these facilities.*

4.2 Species Selection

The intention of the ADZ is to establish an investment ready platform where different species could be cultivated and where new species could be established over time with the advancement of research and development in the sector.

Potential investors in the ADZ have expressed interest in cultivating a number of different species in the ADZ, including the introduction of agricultural crops in aquaponic systems to diversify production, utilise nutrients in the fish production, improve water use efficiencies and also have a more robust business financially.

The CDC has developed the following list of potential species in response to investor interest, what has been produced, advice from researchers and specialists in the aquaculture sector, and previous lists produced by DAFF for the Eastern Cape.

GENERAL LIST OF POTENTIAL SPECIES

Freshwater species

- African catfish / Sharptooth catfish *(Clarias gariepinus)*
- European catfish *(Silurus glanis)*
- Goldfish *(Carasius auratus)*
- Ornamental fish
- Rainbow and brown trout *(Oncorhynchus mykiss and Salmo trutta)*
- Largemouth bass *(Micropterus salmoides)*
- Chinese grass carp *(Ctenopharyngodon idella)*
- Koi carp *(Cyprinus carpio)*
- Marron *(Cherax tenuimanus)*
- Tilapia *(Oreochromis mossambicus*)
- Tilapia *(Oreochromis niloticus*)
- Carp *(Cyprinus carpio)*
- Aquaponic crops
- Macro algae (pharmaceutical)

Marine species

- Abalone (*Haliotis midae*)
- Dusky Kob (*Argyrosomus japonicas*)
- Seaweed (*Ulva* and *Gracilaria* spp.)
- Pacific oyster (*Crassostrea gigas*)
- Sea urchin (*Tripneustes gratilla*)
- Yellowtail (*Seriola lalandi)*
- Silver Kob (*Argyrosomus inodorus*)
- Mediterranean mussel (*Mytilus galloprovincialis*)
- Prawn (*Penaeus monodon*)
- Prawn (all other species)
- Salmon species (Atlantic)
- Natal Stumpnose (*Rhabdosargus sarba*)
- White Stumpnose (*Rhabdosargus globiceps*)
- Rock Lobster (east and west coast)
- Spotted Grunter (*Pomadasys commersonni*)
- Sea Cucumber (indigenous species)
- Scallops (*Pectin sulcicostatus*)
- Macro algae (feeds and pharmaceutical)
- Sea-reared Rainbow Trout/Salmon
- Aquaponic crops

EVALUATION OF SPECIES

General List of Species

The biosecurity and biodiversity risk assessment (Paulet, 2016) included a high-level analysis of these species. Some were found not to be favourable, based on local climatic conditions and current knowledge of aquaculture production systems used and the biosecurity management associated with these current systems (see Section 7.13 and Appendix G5). With the research and development currently undertaken in the aquaculture sector, it is likely that new technologies could be developed to make the production of these species viable. Investors may also be interested in introducing a species or a specific strain not listed here. Some species may require a risk assessment and special permissions.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Individual aquaculture farms must comply with the Alien and Invasive Species (AIS) Regulations (GNR 598, GG 37885), which may include an operation specific risk assessment and approval by the relevant authorities prior to commencement of any operations.*
- *Individual investors to assess and demonstrate to the CDC the feasibility of their chosen species and production technology.*
- *The introduction of species to be considered on a case by case basis by the CDC.*

Discussion of a Selection of the Species

Abalone

Abalone was produced successfully within the ADZ footprint area for a number of years (Section 2.3.3). The feasibility study (EOH, 2014) recommended that abalone be produced in the ADZ as this sub-sector is well established and growing in South Africa. The CDC is aiming at a 600 tn/yr production capacity during the initial years, with possible expansion in later years. Since abalone utilises high volumes of water in flow-through systems, the development of marine abstraction and discharge pipelines are critical to abalone production at this scale in the ADZ. Engineering and environmental studies are underway to investigate the feasibility and options for development of such pipelines (Section 1.10).

Flow-through seawater systems are vulnerable to external factors such as water quality and water temperature and risk associated with hazardous algae blooms (HABs), commonly called red tide.

As was illustrated in 2014, Algoa Bay is susceptible to red tide *dinflagellate* blooms during warm water (>20°C) events. The dense red tide blooms from 2014, with recorded cell counts of up to 29,000 cells/ml of *Lingulodinium polyedrum*, persisted for 3 months in Algoa Bay with varying intensity, depending on the flow and mixing of currents. The highest risk would be to sea-based cage aquaculture.

DAFF, with input from various specialists, conducted a high-level (unpublished) risk assessment on what the impacts of a repeat bloom would be on sea-based cage aquacultural production of finfish in Algoa Bay. They concluded that low dissolved oxygen in the water from the red tide may produce both sub-lethal (reduced feeding, feed conversion ratios and health problems) and lethal effects (suffocation from anoxia) for finfish in cages, at least in some parts of the bay. The high cell density may result in gill clogging and irritation, mucous production, and toxicity to finfish. There are no mitigation measures to protect fish in sea-based cages from these effects, resulting in production risks and uncertainty. The issue needs to be put into perspective as Chile and various parts of the world also experience HABs and these are always going to be a risk but there is no certainty as to when these events will happen and we thus would never be able to have a sea-based finfish farm in South Africa if this is regarded as a fatal flaw (Michelle Pretorius, DAFF, pers. comm.).

Since abalone farms and desalination plants use a continuous supply of seawater, they are also vulnerable should the HAB affect the seawater intake point. Based on discussions with specialists in the abalone sub-sector it was concluded that as long as the red tide is not toxic to the abalone themselves, abalone exposed to the red tide can be canned. Cooking of the abalone flesh oxidises the toxin, rendering it harmless to consumers but red tides that have toxic impacts on the abalone will obviously have a disastrous impact on abalone farms due to complete dependence on incoming seawater. Incoming seawater could be ozonated prior to discharge into growing tanks to boost oxygen levels and possibly neutralise certain toxins (Louise Vosloo, pers. comm.). Water throughput could be increased to boost available oxygen to the abalone (Willie de Wet, pers. comm.). Due to their feeding habits as 'bottom grazers' (as adults) they are less vulnerable than finfish (gills and breathing) and filter feeders (ingestion), and if settling of the HAB organisms in the bottom of the abalone tanks can be prevented they are unlikely to ingest harmful HAB organisms (Andre Bok, pers. comm.). CDC has commissioned a HAB mitigation study (Keith du Plessis, pers. comm.).

MITIGATION MEASURES AND DESIGN CRITERIA

- *For flow-through aquaculture and desalination, the position and depth of the seawater abstraction pipeline is critical in terms of seawater temperature, oxygen levels and level of exposure to HABs and pollution incidences around the port and shipping routes. The CDC has already commissioned environmental and engineering studies to investigate design options for the marine abstraction pipeline.*
- *CDC and the individual aquaculture farms and desalination plant operator, in consultation DAFF, to put in place a monitoring and mitigation plan, including an advance warning system and emergency response plan, based on the results of the HAB mitigation study.*

- *Prospective investors to assess the risks of water supply and water quality on their respective development proposals as basis for their investment decisions.*
- *Individual investors to develop a project-level mitigation and emergency response plan.*

Seaweed

Abalone farming in South Africa has developed rapidly and South Africa is now the largest producer outside Asia, partly due to seaweed production. Kelp harvesting was reaching maximum sustainable limits as early as 2007 when abalone production in South Africa was only 850 tn/yr (Robertson-Andersson *et al*, 2007) compared to almost 2000 tn/yr in 2014. To mitigate for the reliance on wild harvesting, the South African seaweed aquaculture industry has grown rapidly over the past decade. The green seaweed *Ulva* is one of South Africa's most important aquaculture products, constituting an important feed source particularly for abalone and utilized as a bioremediation tool and other benefits such as biomass for biofuel production and for integrated aquaculture. Besides *Ulva* spp, *Gracilaria* spp. is also cultivated. In 2013, wild seaweed harvested in South Africa totalled 7602 tn, compared to 2015 tn of *Ulva* (Robertson-Andersson *et al*, 2013).

On-land integrated culture units, with paddle-wheel raceways, are widely viewed as the preferred method of production for the industry. The development of the seaweed aquaculture industry has paralleled the growth of the abalone industry, and has been successful largely because of bilateral technology transfer and innovation between commercial abalone farms and research institutions (Robertson-Andersson *et al*, 2013). South African seaweeds have been used commercially as feedstock for phycocolloid production, for the production of abalone feed, and the production of Kelpak® and Afrikelp®, which are plant-growth stimulants used in the agricultural sector. Additionally, *Ulva* is being investigated for large-scale biogas production (Robertson-Andersson *et al*, 2013).

Tank culture of seaweeds such *Ulva* is an option as a tertiary bio-filter for the polishing of effluent prior to discharge (FitzGerald, 2008).

Integrated Systems

The integration of multiple species into an aquaculture system as well as the introduction of vegetable crops in the form of aquaponics has been proposed by a number of investors. These systems can:

- Significantly reduce the consumptive water and energy used per unit of production (water used more than once, pumping costs reduced).
- Reduce the reliance on external feed inputs (one species would feed on the waste produced by another)
- Reduce the water treatment costs and improve the quality of the effluent released.

Integrated Multi-Trophic Aquaculture Systems

The general benefit of integrated multi-trophic aquaculture (IMTA) is the reduction of nutrients released to the environment. It utilises the waste produced by aquatic species as input feed for another. It combines fed aquaculture (e.g. finfish or shrimp) with extractive plant (e.g. seaweed) and extractive animal (e.g. mussels) aquaculture to create systems that have lower feed input, lower water and waste treatment requirements, improved output, resulting in lower costs and better product diversification.

As illustrated in the schematic below, finfish waste is used (yellow arrows) to grow bivalves, algae and echinoderms, which provides additional production outputs (green arrows) either as food or as biomass for biofuel production.

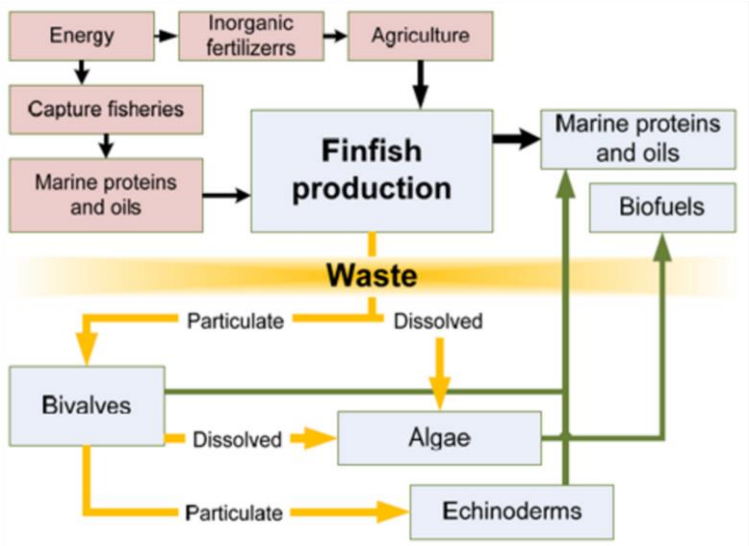


Figure 4-1: Schematic of an Integrated Multi-Trophic Aquaculture Example (Marine Species Example)

The technical and economic feasibility of IMTA using seaweeds as bio-filters in abalone farms is already well established in South Africa (Nobre *et al*, 2010). Research on the integration of seaweed and abalone (initially *Gracilaria gracilis* and later species of *Ulva*) culture started in 1993 by the University of Port Elizabeth (now NMMU). And in 2006, the two abalone farms in the Eastern Cape (Wild Coast Abalone and the old Marine Growers) were the only abalone farms that depended on their on-farm seaweed cultivation for abalone feed (Troell *et al*, 2006), mainly attributed to the lack of natural kelp resources to harvest in the area.

Seaweeds grown in abalone effluent have an increased nitrogen content (sometime as much as 40% protein dry weight content), resulting in value-added seaweeds of excellent quality to feed abalone (Naidoo *et al*, 2006; Robertson-Andersson, 2007; 2011 in Robertson-Andersson *et al,* 2013). The increasing demand for abalone feed has seen the need for sustainable production of seaweed in IMTA aquaculture with aquatic animals, especially with abalone (various sources in Robertson-Andersson *et al,* 2013).

Regardless of the technical and economic potential and successes, there are biosecurity, animal health and hygiene matters that need to be resolved. The opportunities to use abalone production water to grow seaweed for use as abalone feed are currently being restricted due to animal health management specifications aimed at avoiding the transfer of diseases from the seaweed ponds back to the abalone (Hymne Ferreira; Andre Bok; Louise Vosloo; Michael Joubert; and others, pers. comm.). The biosecurity specialist report (Appendix G5, Paulet, 2016) reflects these concerns and recommends that seaweed fed with abalone waste water not be fed back to abalone. Specific biosecurity and animal health and hygiene plans will be required for each farm to address these matters, especially for farms in the Eastern Cape.

Aquaponics

Aquaponics is a system that combines conventional aquaculture with hydroponics (cultivating various agricultural crops and plants in water) in a symbiotic environment and utilising the waste, or rather the by-products, produced by the farmed aquatic animals as feed for the aquatic plants, as illustrated below. The fish and plants grow in a symbiotic environment, reducing waste and resource utilization, which leads to cost savings and greater production yield ratios. Depending on feeding ratios and species produced, it is estimated that for every 1 kg finfish raised in an aquaculture system, there are sufficient nutrients to grow 6 to 9 kg of plant matter. Aquaponics systems can be extremely productive— yielding roughly 180 tonnes of produce per hectare, using 90% less water and land than dry-land farms, maturing products faster, and can be co-located with urban aquaculture near key distribution markets.

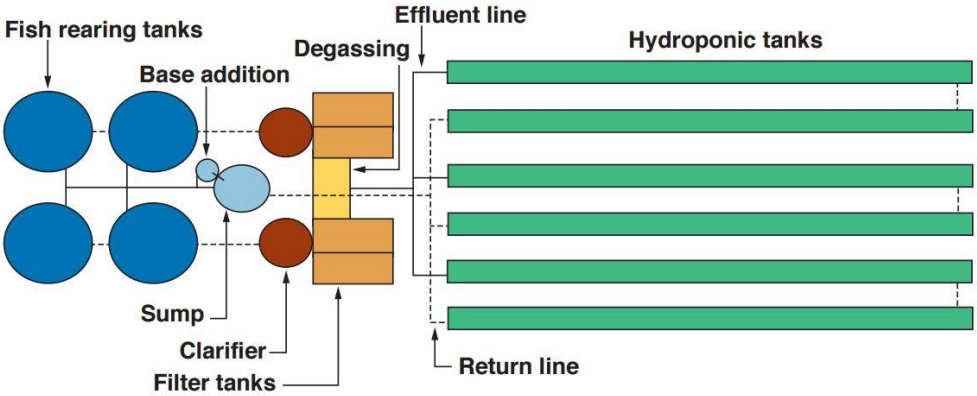


Figure 4-2: Schematic of an Aquaponics System Example

Plate 4-1 Example of Aquaponics System during Construction

Fish tanks in fore-ground, hydroponic plant tanks in the background

Plate 4-2 Example of Aquaponics System, with Floating Rafts

Research has been done in recent years to develop seawater aquaponics systems in order to replicate the benefits demonstrated in fresh water aquaponics to the marine species aquaculture, with promising results in some parts of the world, with species such as sea purslane and saltwort, as illustrated below.

Plate 4-3 Seawater Aquaponics Products, Sea Purslane and Saltwort

Source: Mote Marine Aquaponics

MITIGATION MEASURES AND DESIGN CRITERIA

- *Individual investors to address biosecurity, animal health and hygiene, and product quality considerations associated with the use of waste water, farm produced feed inputs and integration of species, and obtain the necessary aquaculture and veterinary approvals and permits.*
- *The beneficial integration of extractive plant (e.g. seaweed) and extractive animal (e.g. mussels) species to be explored and optimised, to reduce nutrient releases to the environment.*

4.3 Aquaculture Production Process

Aquaculture production processes vary depending on the species produced and the scale of the operation. The basic components are: hatchery, acclimation and nursery, and grow-out. Basic schematics of the life cycles and associated production steps for finfish and prawns are illustrated below, as examples.

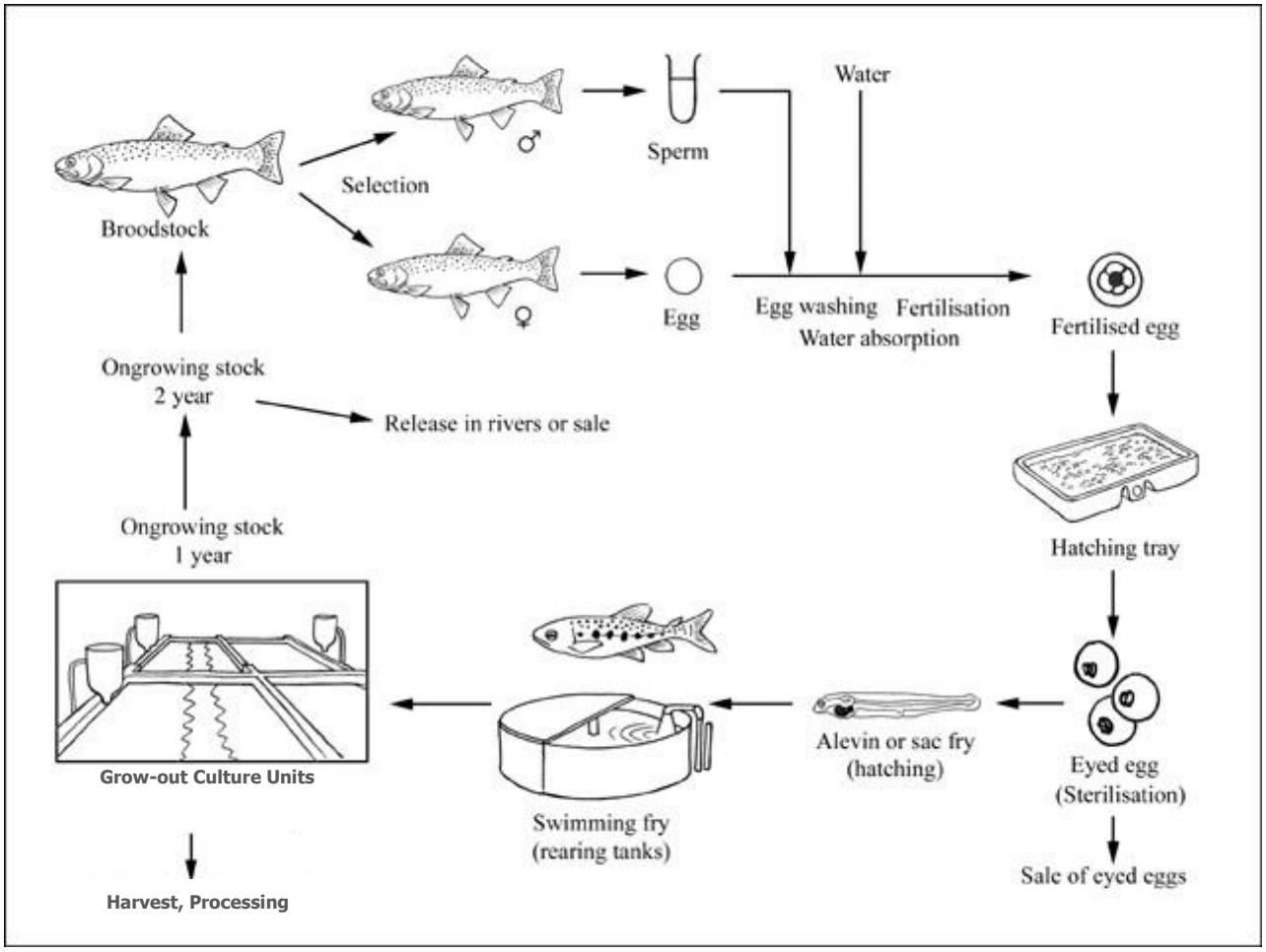


Figure 4-3: Schematic Example of Finfish (Rainbow Trout) Production Cycle

Source: FAO

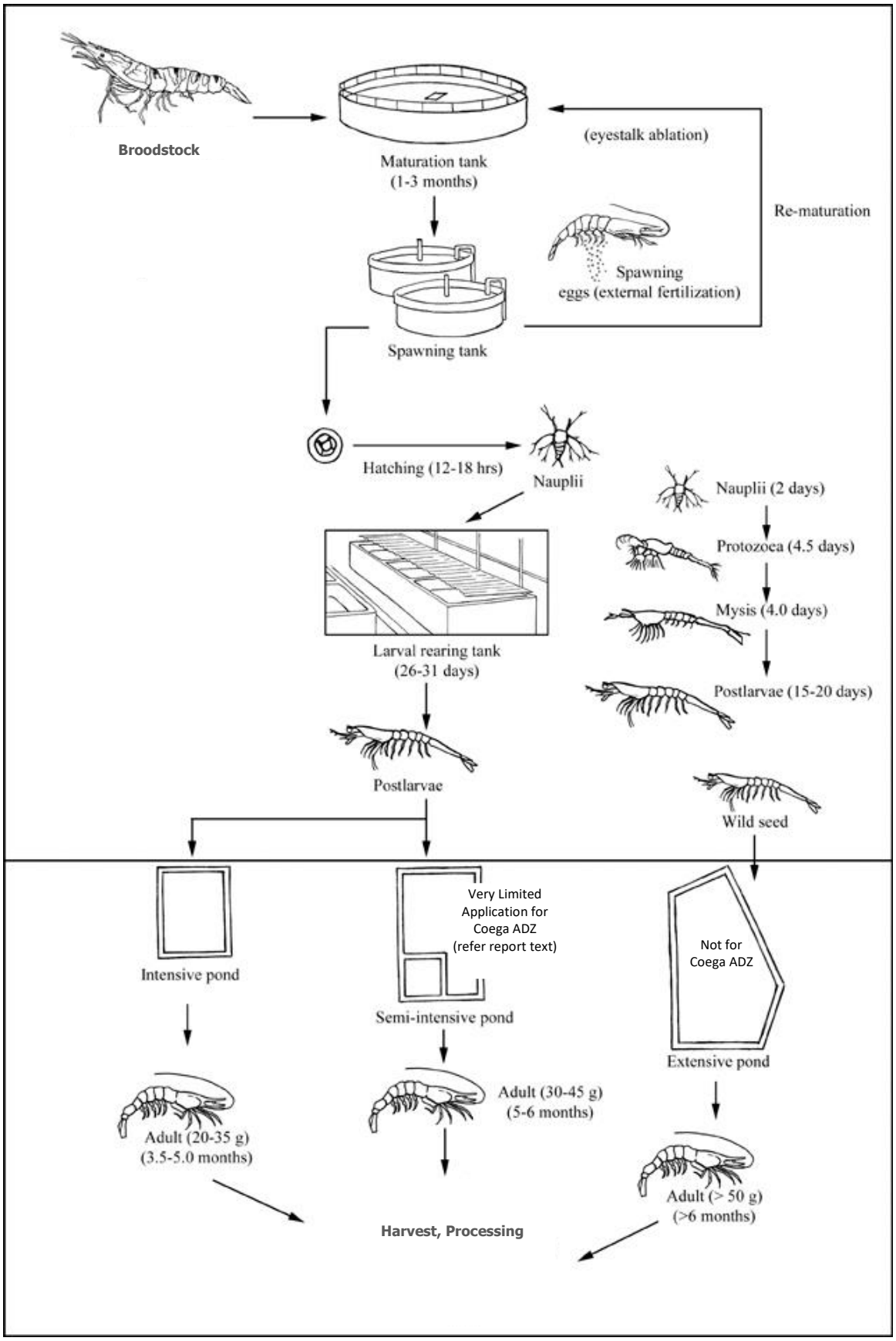


Figure 4-4: Simplified Overview of an Example Crustacean Production Cycle

Source: FAO

4.3.1 Hatchery

Hatcheries hold adult broodstock that are manipulated under controlled conditions to induce spawning, which results in egg and larval production. The design of a hatchery will be determined by the species being produced and the scale of the operation. A hatchery would typically contain a broodstock holding and spawning area, feed culture facility, larval culture area, juvenile culture area, pump facilities, laboratory and quarantine area.

Broodstock represents a group of mature individuals used in aquaculture for breeding purposes. They are carefully selected since these individual determine the genetic quality of their eggs and offspring. Primary or first generation broodstock are sourced from a wild population. Secondary broodstock or 'domesticated' broodstock have been reared for a breeding programme. Within a breeding programme, broodstock is kept in conditions and culture units optimal for reproduction and may involve applying species specific techniques to induce reproduction. These techniques have allowed farmers to breed and raise species that do not naturally reproduce in captivity, and to manipulate the timing of spawning and egg fertilization to suit production cycles. The culture environment is also manipulated to mimic important qualities of the cultured species' natural environment and the injection of hormones to stimulate spawning. This is the only stage in the aquaculture production cycle where there may be a procedural use of hormones in fairly small quantities (Andre Bok, per. comm.).

A hatchery may produce juveniles for sale or it may be part of a larger aquaculture operation. Within the ADZ, there are options for a centralised hatchery to supply other farms, while larger farms may opt to have their own hatchery.

Some aquaculture operations may import larvae internationally. Strict transportation, translocation and biosecurity protocols may apply when moving aquaculture stock between DAFF management control areas, provinces and internationally (Section 3.3).

A stand-alone abalone hatchery producing up to 200 000 abalone spat (10 mm in size) per month would require a land surface area of approximately 0.25 ha and a seawater supply volume of approximately 100 m^3/hr. A marine fish hatchery producing up to 100 000 juvenile dusky kob (2 grams) per month using seawater recirculation technology would require about 0.25 ha of land and a seawater supply volume of about 5 m^3/hr.

4.3.2 Acclimation and Nursery

From the hatchery, the young (i.e. larvae or fry) is taken to a nursery section (or conditioning area) that caters specifically for their feeding and living requirements and to ensure they are acclimated to the conditions of the final grow-out culture units. The duration of stay in the nursery section could be weeks or months depending on the specific species raised.

4.3.3 Grow-Out

The final phase of aquaculture production occurs in grow-out culture units where juveniles are grown to adulthood. Grow-out represents the longest production phase in aquaculture and is extremely sensitive to feed, feed conversion, nutrient retention, health and bio-security with feed, and health management costs. The matured aquatic organisms and fish are harvested once they have grown to a desired marketable size.

Culture units used in grow-out of intensive aquaculture systems vary widely and include tanks, race-ways, constructed ponds and wetlands, constructed from a variety of materials including concrete, various plastics, fiberglass, and metal.

4.4 Stocking Densities

Within the wide diversity of species and production practices in the aquaculture sector, two distinct practices have emerged during the past three decades. The first group includes commercial farms that primarily use intensive and semi-intensive methods to produce medium-value to high-value commodities for regional or global markets. The

other group generally comprises family and cooperative farms that rely on extensive and semi-intensive practices to produce lower-value species for household subsistence or local markets. Some divisions between these sectors are becoming blurred. In China and other parts of Asia, for example, many traditional small-scale farming operations have gradually intensified as land and water resources became increasingly scarce and valuable.

DESIGN OPTIONS

4.4.1 Extensive Systems

Extensive aquaculture is associated with large earthen ponds, often a series of ponds over a vast area, with low stocking densities and low production levels. Production is less than 1 tn/ha/yr and water use 20-40 m^3/kg of production. Production is based on the use of organic and inorganic fertilizer input. Fertilization of ponds promotes the growth of simple plants which form the base of the food chain in the pond. Fish stocked in these ponds feed on phytoplankton, zooplankton, bottom-dwelling invertebrates and smaller fish. At its most effective, this type of production can be integrated with other types of crop or livestock production, using animal manure and agricultural by-products as sources to stimulate primary production. Predation control is difficult and biosecurity and food safety quality control are low. These systems are both land and water intensive and typically only found in rural areas (FAO).

Extensive systems are not suitable for areas where land and water is at a premium and unlined ponds are not regarded suitable for the soil conditions found in the ADZ. As such, extensive systems are not recommended for the Coega ADZ.

4.4.2 Semi-Intensive Systems

Semi-intensive aquaculture aims to increase the stocking density and production levels of from that achieved in extensive systems through the use of supplementary feeds. Stocking densities are 1-5 kg/m^2 of pond area and water use is ~5 m^3/kg. Supplementary feeds range from cereals, agricultural and fishery by-products to formulated feeds. Traditionally these feeds are incomplete and would be inadequate as a sole source of food. Its function is to provide extra nutrients to complement those obtained from natural foods in the pond. Oxygen levels are affected by the fertilization in the ponds and reduced oxygen can affect the fish health/welfare in a negative way. Semi-intensive systems are often viewed as a means to produce low-cost fish which contributes to food security in rural areas with available land. Lower-trophic herbivorous and omnivorous species - low in the food chain - are typically cultured and can potentially supply food to a wide range of consumers as a regular food protein source. Food safety and quality control is moderate but customer preference is often high due to price (FAO). Predator control and biosecurity management is more difficult than in intensive systems. Ponds may be lined and equipped if aerators to improve water efficiency and stocking densities.

Due to the high water consumption, lower production and inefficient use of land, semi-intensive systems are better suited to rural areas and it very unlikely that semi-intensive fresh water systems would be economically viable in the Coega IDZ. These systems are more suitable for rural and semi-rural areas. However, synergies and linkages with other industries in the IDZ could be explored; such as utilising storm water runoff, treated waste water in the IDZ to assist with the tertiary treatment (polishing) of waste water and improve the quality of effluent and runoff, but species cultured in waste water should not be for human or livestock consumption unless it can be proven safe. Biomass production as feed to biogas plant could be used instead. Any such system should be designed to be as intensive as possible to optimise production and minimise the area of land needed.

4.4.3 Intensive Systems

The distinguishing factor of intensive aquaculture is that the nutritional requirements of the fish are provided by prepared commercial feeds or as part of an integrated or multi-trophic system where the waste from one cultured species serves as food for another cultured species. The existence of live food is generally not allowed in the system. Secondly, environmental conditions such as water temperature, dissolved oxygen, pH and salinity are strictly controlled through technological means. Stocking density varies widely and can range from 12 kg/m^3 to

50 kg/m^3 (and higher), are limited by species tolerance, the ability to grow at raised stocking densities and the maintenance of environmental parameters rather than the availability of a food supply. Intensive aquaculture can take place in a variety of constructed tanks, lined ponds and raceways. Although abalone utilises a flow-through water system, it is an intensive production system due to the high stocking densities and the reliance on an external feed source.

Worldwide, there is a trend to move to intensify production systems in and near urban areas. To date, potential investors in the ADZ have all shown interest in establishing intensive production systems. Such systems would be the most suitable to ensure land and fresh water supplies in the NMB Metro is used optimally.

EVALUATION OF DESIGN OPTIONS

Extensive Aquaculture Systems (Very Low Stocking Density)	**Semi-Intensive Systems** (Low to Moderate Stocking Density)	**Intensive Systems** (High Stocking Density)
Not Suitable for the Coega ADZ.	Limited Suitability for the Coega ADZ.	Best Suited for the Coega ADZ.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Only appropriately lined aquaculture ponds, constructed wetlands, tanks and raceways to be used in the ADZ.*
- *With the exception of storm water attenuation, no unlined ponds to be used. Unlined ponds only to be used in areas where geotechnical conditions have proven suitable and infiltration would not cause instability or collapse of nearby dune soils, and only where rainwater harvesting is not feasible.*
- *Individual developments by prospective investors in the ADZ to demonstrate efficient use of land and water resources.*
- *CDC to explore potential future options and linkages between aquaculture and with other industries in the IDZ, i.e. utilising waste water for biomass production, while improving the quality of waste water releases at the same time.*

4.5 Water Exchange Systems

Depending on the species farmed, flow-through systems with a continuous supply of 'new' or 'clean' water could be used or recirculating systems could be used involving the continuous treatment, reconditioning, aeration, and recirculation of water. In-between these, there are also low level systems where water is only partially recirculated. Indicative water consumption for different water exchange systems is tabled below but it should be noted that there are no formal divisions and the lines between the definitions are often blurred.

Type of System	Indicative consumption of new water in the system per kg fish produced per year
Flow-through: 100 % Water Exchange	~30 m^3
Partial Recirculating: Low Level	~3 m^3
Recirculating: Intensive	~1 m^3
Recirculating: Super Intensive to Zero Water Exchange	<0.3 m^3

4.5.1 Flow-Through Systems

Flow-through aquaculture systems such as used on abalone farms require a continuous high-volume intake of water. Water can either be pumped or gravitated through these systems. The location of these systems is critical to maximise water flow by gravity and to minimise the reliance of pumping of water. Flow-through systems will typically operate with an overall hydraulic residence time less than 1 to 3 hours.

A basic flow-through system, as illustrated below, consists of: treatment of inlet water (this will depend on the quality of the water feed and requirements of the cultured species but typically consist of screening and filtration); culture units (i.e. tanks, constructed ponds or raceways); feed input, optional oxygen control; and a system to screen, catch and collect mortalities and larger objects and to avoid escapees; and then the outflow of the culture water. Due to the high volume of water, the outlet water is typically not treated. Solids and nutrients are highly diluted.

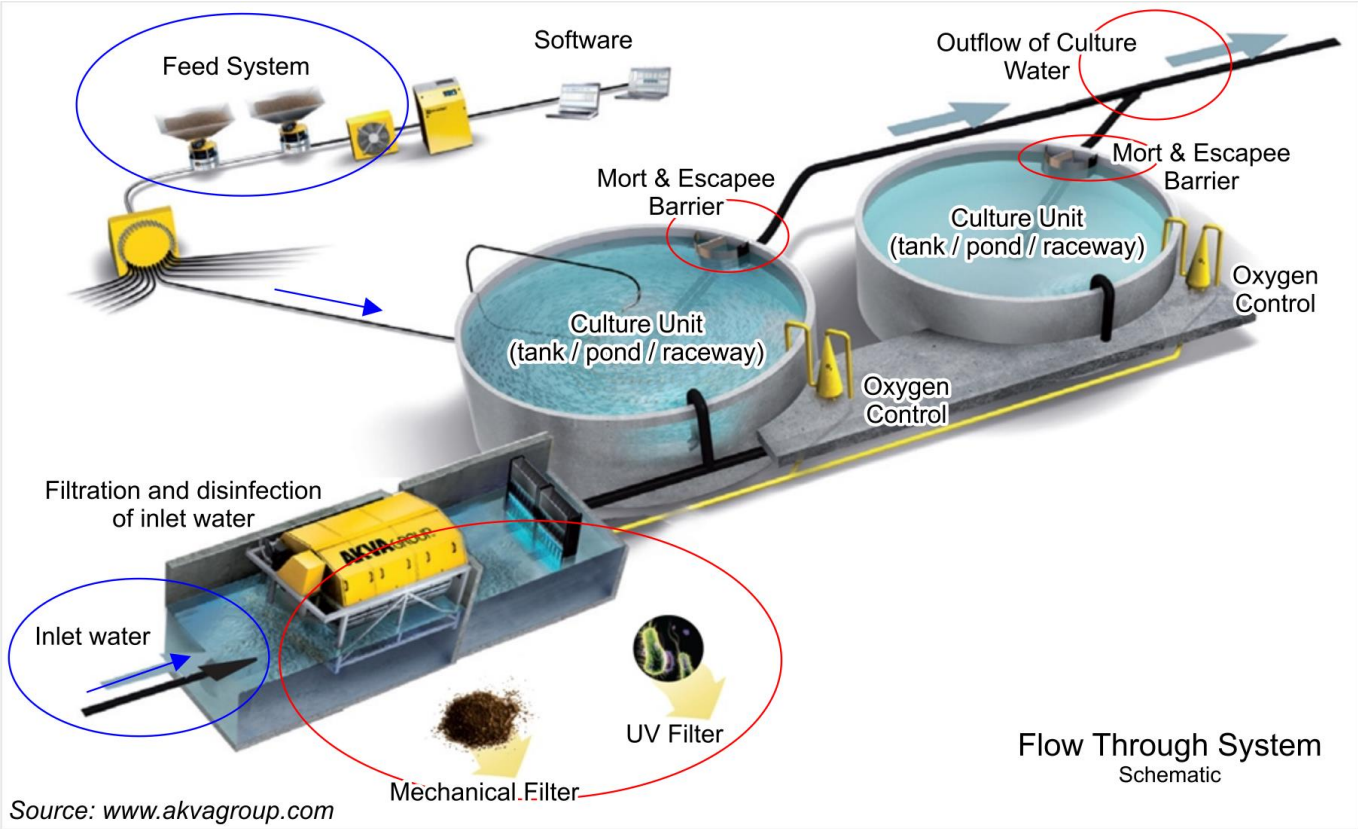


Figure 4-5: Schematic Example of a Flow-through System (example)

Note: Flow-through systems could be applied to a variety of culture tanks, ponds and raceways (schematic shows round tank culture units). Details such as the pre-treatment processed applied to inlet water, feeding systems used, need to control oxygen, culture unit design, etc. may vary widely.

(Blue: Water and feed inputs. Red: Waste components, including highly diluted waste material released in culture water outflow)

Examples of abalone flow-through farms and typical culture units are illustrated below.

a. Hermanus, Western Cape, urban (green outline) (Google Earth)

b. Wild Coast, Eastern Cape, rural (Google Earth)

c. Buffeljags, Western Cape, rural (www.vikingaquaculture.co.za)

Plate 4-4: Examples of Abalone Farms (Seawater Flow-through Systems)

a. Abalone Culture Units (New Zealand) *b. Abalone Culture Units, outdoor plastic tanks provided with netting* *c. Abalone Culture Units, outdoor concrete tanks*

Plate 4-5: Examples of Abalone Culture Units

4.5.2 Recirculating Systems

Due to limited fresh water supplies, flow-through fresh water aquaculture and traditional extensive pond systems are not suitable in the Coega ADZ and is unlikely to be feasible on a large-scale in the wider NMB Metro.

Recirculating aquaculture production systems offer an alternative. A recirculating system consists of a series of culture units where water is continuously recycled and monitored. Water is filtered and treated biologically to neutralise harmful chemicals and ensure optimal water quality. Recirculating system allows for rigorously controlled environmental conditions. They are most often enclosed in a building to control water temperatures. Either by design or through implementation of biosecurity practices, it is possible to exclude predators and to prevent escapees and exchange of pathogens between the facility and the environment (Summerfelt et al, 2015). They are also better protected against fluctuating inlet water quality such as HABs.

There is great heterogeneity among recirculating systems, in part due to the wide variety of species being cultured and the broad range of conditions under which the different species must be grown. Differences exist even among systems used to culture the same species but in different climatic regions. Water quality criteria required to maintain healthy and fast-growing fish is the basis for designing recirculating processes. The parameters of primary concern are temperature, dissolved gases (oxygen, carbon dioxide, and nitrogen), pH, and fish metabolites such as solids (both dissolved and particulate), dissolved nitrogen compounds (ammonia, nitrite and nitrate) and phosphates. These can affect fish growth and health. Maintaining high water quality standards within recirculating systems requires effective treatment of all waste metabolites that could compromise fish health. The requirements of different species vary.

Recirculating systems have been in existence, in one form or another, since the mid-1950s. However, only in the past few years has their potential for commercial-scaled applications been realised. New water quality technology, testing and monitoring instrumentation, and computer enhanced system design programs, much of it developed for the waste water treatment industry, are increasingly being incorporated into their design. In South Africa, there are a number of successful experimental, pilot and small-scale recirculating systems facilities but semi-intensive pond systems and flow-through systems are still more common. They have the potential to culture high volumes of fish at high-densities, but their ability to do so economically need to be demonstrated (James, 2016).

Depending on the scale and sophistication of the system, the main components would include: treatment of new (top-up) water added to the system (water exchange and top up for losses); water oxygen control and sterilisation / ozonation; the culture units (i.e. tanks, constructed ponds or raceways); feeding system; filtration and solid and suspended particle removal (including mortalities and preventing escapees); bio-filtration and nutrient removal (i.e. nitrogen, ammonia and phosphorus); temperature control; and sludge and effluent management.

With recirculating systems, wastes are put into a more concentrated form with relatively small volumes of effluent. The concentrated effluent reduces the volume to be treated and, thus, the size and cost of the wastewater treatment system. The concentrating effect may in some instances make it practical for recirculating fresh water aquaculture systems to discharge directly to the municipal sewage system.

The increased waste capture efficiency, small footprint and reduced water consumption significantly reduces the waste load discharged in the effluent and makes recirculating aquaculture systems viable in locations with strict environmental requirements since it places less pressure on the overall carrying capacity of the receiving environment. It allows aquaculture developments to be located closer to cities and markets (Summerfelt et al, 2015) and is central to the philosophy of 'urban aquaculture'.

However, these systems carry a much higher waste treatment burden than flow-through or net-pen systems. The costs of constructing and operating recirculating systems, and their high energy needs, can increase the cost of production to the point where these systems may not be able to compete economically against less costly technologies. For example, recirculating systems are not typically used to produce catfish, which is often more cost-effectively produced in semi-intensive ponds. The main challenge with recirculating systems remains regular, high-volume production to justify the high costs. There have been cases where the theoretical stocking densities were not achieved and thus the systems performed poorly in terms of production and profitability. At present, the maximum rate for tilapia seems to be 28 kg/m³ to 30 kg/m³ water (James, 2016).

Commercial recirculating aquaculture systems are typically used to produce higher-value seafood that can be effectively niche-marketed at a higher price (Summerfelt et al, 2015). Producers using recirculating technology generally do not attempt to compete in the same markets as pond system producers. However, in specialty high-value niche markets, such as gourmet foods, tropical or ornamental fish, or year-round supply of fresh product, re-circulating system products are finding a place. The key to niche market success is to identify the market size and meet commitments before market expansion (Foster, 2011).

A recirculating system with a hydraulic residence time of 12 hours would be considered an open system, yet this system would likely capture and remove >90% of the particulate solids produced while controlling culture tank water quality. A longer hydraulic residence time is indicative of a higher degree of water reuse, and particulate waste capture efficiencies will approach 100% as recirculating system hydraulic residence time approaches or exceeds 10 days. Therefore, to maintain suitable water quality, recirculating systems must assume the treatment burden for 90 to 100% of the ammonia and particulate waste produced.

A basic schematic of a recirculating system (example) is illustrated below and the different components in more detail in Figure 4-7.

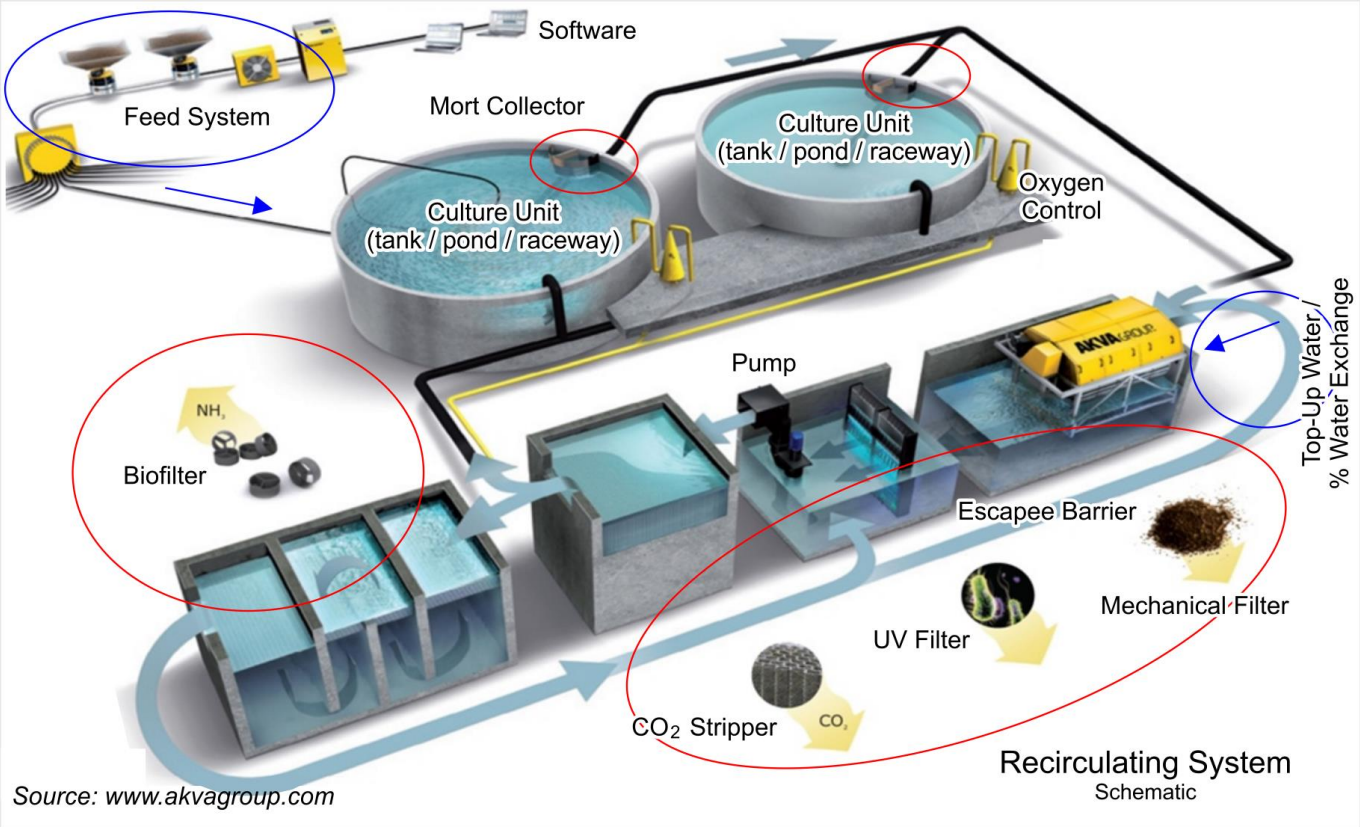


Figure 4-6: Schematic Example of a Recirculating System

Note: Recirculating systems can be applied to a variety of culture tanks and raceways, and certain constructed pond culture units (schematic shows round tank culture units). Details such as water treatment processes, feeding systems, escapee barrier, control oxygen, culture unit design, % water exchange, etc. vary widely. (Blue: Top-up water and feed inputs. Red: Waste components)

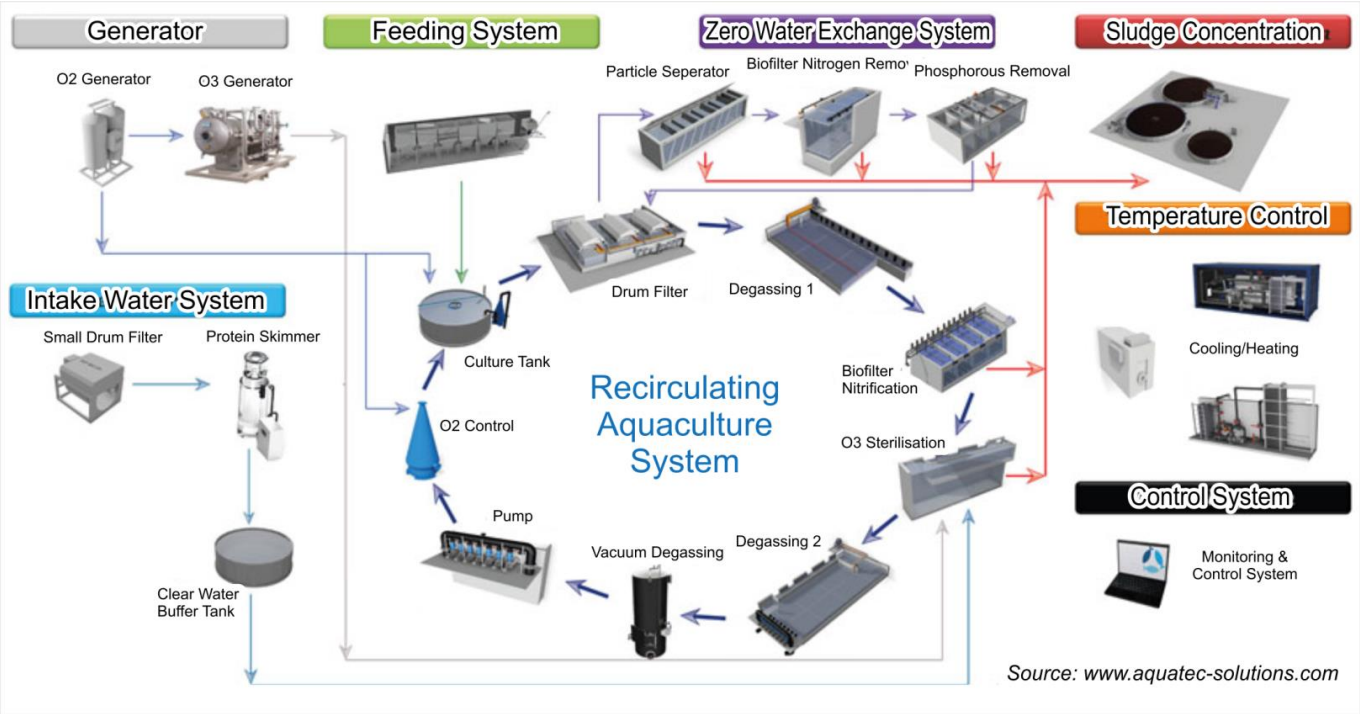


Figure 4-7: Schematic Example of Recirculating System Components (large-scale, super-intensive system)

Note: Details and arrangement of the various components will vary.

Examples of recirculating aquaculture farms and culture units used are pictured below.

Plate 4-6: Examples of Intensive Recirculating Aquaculture Systems and Intensive Culture Units

Plate 4-7: Examples of Intensive Recirculating Aquaculture System Buildings and Structures, East London IDZ

EVALUATION OF DESIGN OPTIONS

Obviously, on-farm water use in aquaculture can be very high in flow-through and partial recirculating systems but consumptive water use drops dramatically in intensive systems and these systems can actually use water equally or more efficient than terrestrial animal production systems. Technological development over the past decade has resulted in super intensive systems that are more and more water efficient and in so called zero water exchange systems, water is only added to compensate for water lost to evaporation and as moisture in biomass harvested and sludge removed from the system. These systems are highly dependent on sophisticated water and waste management systems.

Aquaculture of marine species in seawater is virtually independent of fresh water supplies, and presents an opportunity for adding to the food production without utilising regional fresh water resources.

Marine Species Cultivated in Seawater			
Flow-through 100 % Water Exchange (~30 m^3/kg/yr)	**Partial Recirculating** Low Level (~3 m^3/kg/yr)	**Intensive Recirculating** (~1 m^3/kg/yr)	**Super Intensive Recirculating to Zero Water Exchange** (<0.3 m^3/kg/yr)
Suitable for the ADZ.	Suitable for the ADZ.	Suitable for the ADZ.	Suitable for the ADZ.
Highest operational pumping costs. This necessitates a location at an elevation 'as low as possible'.	⟷		Virtually independent of seawater water pumping costs, can be located anywhere in the ADZ.
Requires highest upfront investment in large diameter marine abstraction and discharge pipelines.	⟷		Smallest abstraction and discharge pipelines required.
All seawater aquaculture operations are virtually independent of fresh water supplies. From a purely 'fresh water resource use' viewpoint, seawater aquaculture is the most efficient form of animal protein food to be produced.			

Fresh Water Species Cultivated Utilising Fresh Water			
Flow-through 100 % Water Exchange (~30 m^3/kg/yr)	**Partial Recirculating** Low Level (~3 m^3/kg/yr)	**Intensive Recirculating** (~1 m^3/kg/yr)	**Super Intensive Recirculating to Zero Water Exchange** (<0.3 m^3/kg/yr)
Only suitable if an alternative to the NMB Municipal fresh water supplies can be secured, i.e. linking to a desalination plant and/or other industries.	⟷	Suitable for the Coega ADZ.	Most Suitable for the Coega ADZ.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Individual developments by prospective investors in the ADZ to demonstrate efficient use of land and water resources.*
- *CDC to explore potential future options and linkages between aquaculture and with other industries in the IDZ, i.e. utilising waste water for biomass production, while improving the quality of waste water releases at the same time.*

4.6 Seafood Processing

The aquatic organisms and fish harvested from the grow-out facility are processed at a processing facility. The processing facility can be on the aquaculture farm itself, a central processing plant in the ADZ, or at an established external processing plant. Processing is a general term that defines post-harvest operations performed on fish after killing. Primary processing includes gutting, washing, grading, sorting and packing. Secondary processing includes de-heading, skinning, filleting, trimming and portion cutting. Primary and secondary processed products can be packed fresh, frozen, or can be vacuum-packed. Tertiary processing includes some form of heating, such as smoking, re-cooking, poaching in vacuum packed bags, or drying, canning, pickling, crumbing (i.e. fish fingers) and then packaging. Seafood products are highly perishable and have a need for immediate processing to avoid spoilage. Inputs include energy, water, cleaning agents, cooling agents, process chemicals, and packaging materials. Waste outputs include solid waste, energy, and waste water (containing organic effluent, cleaning agents and processing chemicals). Trimmings, scrapings, brown meat, bones, skin, silage could be recovered as by-products, but at smaller operations these are generally added to the waste stream as the low volumes do not warrant marketing of the by-products. A schematic overview of the process is provided below.

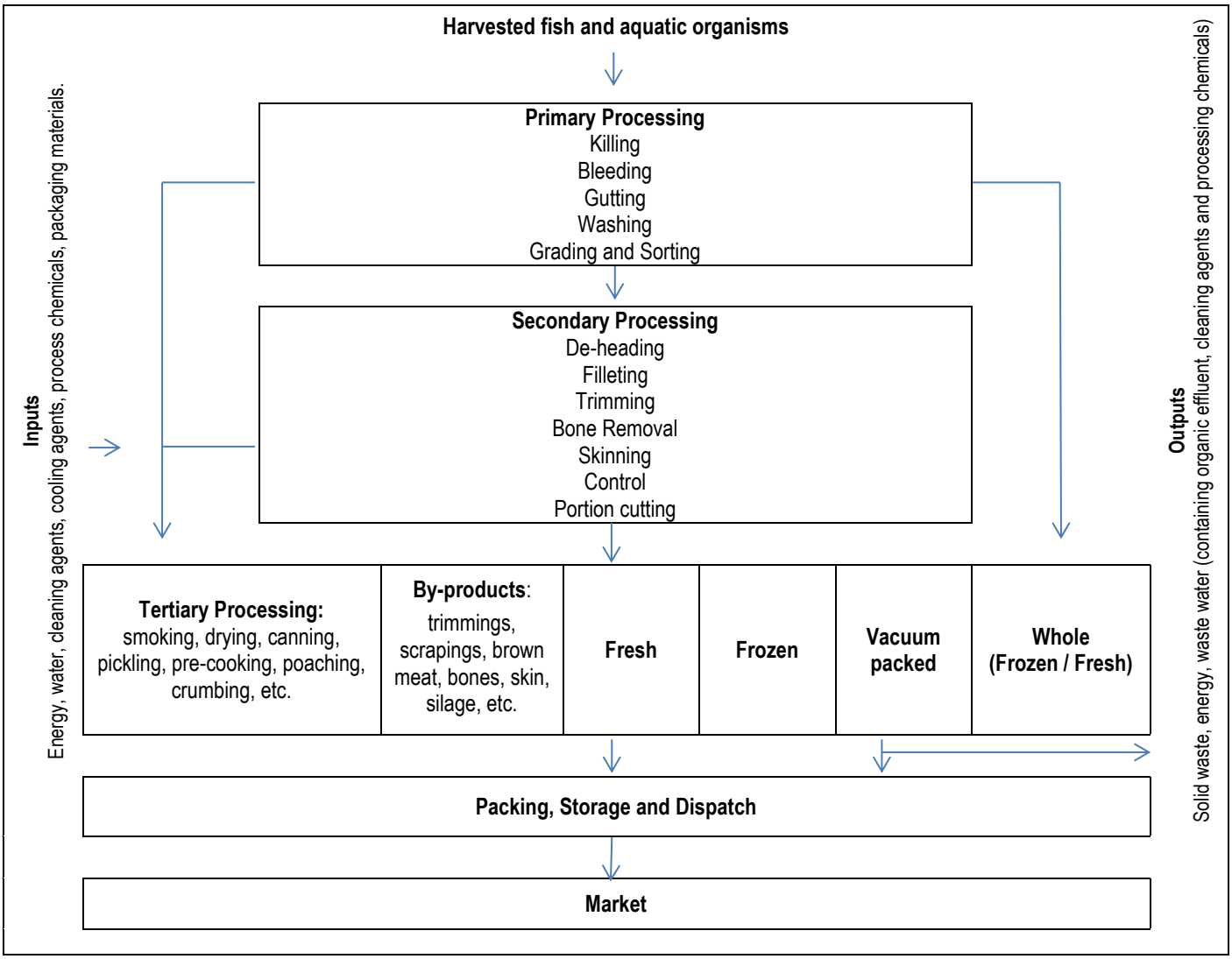


Figure 4-8: Schematic overview of Seafood Processing

4.7 Supporting Services and Infrastructure

There are currently no operational services within Zone 10. The proposed Aquaculture Development Zone (ADZ) requires services. The CDC's philosophy of providing services to its tenants will be crucial in the success of the ADZ, especially where capital intensive services, such as marine abstraction and discharge pipelines and secure sourcing of power and water is concerned. The CDC will provide services to the boundary of each investor's site within the ADZ.

4.7.1 Fresh Water Supply (Potable and Industrial)

The Coega IDZ gets it potable water supply from the NMB Municipality's water supply network. The NMB Municipality purchases water from the Department of Water and Sanitation (DWS), which is supplied from the Orange River Water Scheme.

The latest Coega IDZ water requirement projections from 2013 for potable and industrial (non-potable) quality water respectively, are shown in Table 4-1. Annual Average Daily Demand (AADD) of potable water and industrial (Non-Potable) water in 2015 was 13.7 Ml/d and 0 Ml/d respectively. In 2017, these figures are projected to increase to 18.2 Ml/d for potable water and 30.0 Ml/d for industrial water. However, in 2016 these projected figures were well above the actual usage in the IDZ which currently stands below 3 Ml/d for potable water. No non-potable water was used in 2016.

Table 4-1: Coega IDZ water requirement projections from 2013 for potable and industrial (non-potable) water

UPDATED COEGA IDZ DEMANDS [Ml / day]																
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coega IDZ Non-Potable	0	0	0	0	0	0	0	0	0.0	0.0	0.0	30.0	56.5	82.9	109.4	135.8
Coega IDZ Potable	0	0	0	0	2	4.0	5.7	7.5	8.2	11.0	13.7	18.2	22.7	27.2	31.7	36.2

Source: CDC

With the estimated fresh water use at the targeted production discussed in Section 4.10, which will in all likelihood only be reached in 2020, at approximately 17.6 Ml/d, the current projected water requirements from the NMB Municipality to the IDZ will be sufficient (based on information supplied by the CDC).

Currently bulk water infrastructure is available in Zone 7, with a bulk water pipeline terminating at the traffic circle in Zone 7 at the end of Ring Road 1. This bulk water pipeline will need to be extended into Zone 10, along the road reserve, to provide potable water to the ADZ. The water will be reticulated to the boundary of each investor's site in the IDZ.

There is an existing 70 mm uPVC water pipeline and connection available that previously supplied tenants in Zone 10. This service will be used to supply potable water to the ADZ until such time as the bulk water reticulation network is extended into Zone 10 and the ADZ.

Investors will be encouraged to capture and store rainwater on their sites and to utilise this water where possible in favour of municipal water.

4.7.2 Return Effluent Supply

The NMB Municipality, in collaboration with the CDC, is constructing a return effluent (RE) scheme, which will supply RE (Category 4 quality water) to users within the Coega IDZ. Once RE becomes available in the IDZ, investors will be required to utilise RE instead of potable water, where their industrial processes allow for this. This will also apply to aquaculture investors.

4.7.3 Seawater Supply and Reservoir

The CDC has commissioned an EIA for the abstraction and discharge of seawater in the IDZ, including the construction of the infrastructure, such as pipelines, pump stations and pumps, required to reticulate the sea water to a reservoir in Zone 10, from where users will be able to obtain sea water for their processes. The reservoir will be located at approximately 40 mamsl, from where seawater will be gravity-fed to tenants within the ADZ. The final location and size of the reservoir will be determined based on the ADZ site layout plan and the final engineering design of the marine pipelines.

4.7.4 Seawater Discharge

Tenants releasing water to the seawater discharge pipeline will be required to comply with the discharge standards that will be dictated in the coastal waters discharge permit to be obtained by the CDC. If required, tenants will need to treat the water prior to release. Once treated, tenants will be required to pump the treated seawater to a holding reservoir, from where it will be gravitated via the discharge pipeline for discharge to the marine environment via the marine outfall pipeline.

4.7.5 Sewer System

Current sewage infrastructure comprises a sewer pump station located in Zone 7. No sewer network exists in Zones 7 & 10. The pump station is located to adequately drain all the potential investors in Zone 7 and in the ADZ.

The investors who are not able to drain to the pump station will be required to install their own pumps to pump the sewage up to the pump station in Zone 7.

Up until such time as the sewer network in Zones 7 & 10 has been constructed, investors will be required to install their own conservancy tanks for sewage and effluent disposal. The demand will dictate the requirement for the installation of a sewer network system in Zones 7 & 10. Investors will be required to ensure that the effluent from their processes meets the standards of the NMB Municipality, before being discharged to the municipal sewer network.

Wherever possible, conservancy tanks will be installed in such a manner so as to be utilised as rain water harvesting tanks, once the sewer system has been completed in Zone 10.

4.7.6 Storm Water

The CDC has completed conceptual and preliminary storm water designs for Zones 7 and 10. The majority of Zone 7 drains in a westerly direction towards the Coega River, while two smaller portions drain towards the east and also towards Zone 10. About two-thirds of Zone 10 discharges toward the ocean in the south, while the remaining third drains westward into a depression that acts as a natural attenuation pond.

Currently no storm water services exist within Zone 10. Storm water will be accommodated within the road network. All designs will accommodate the 1:50 year storm recurrence. Where required, storm water will be attenuated in the electrical servitude/services corridor.

It is anticipated that rainwater will be harvested from some of the roofs and greenhouses within the ADZ where this water could be used for freshwater aquaculture production but there may be opportunities to use collected rainwater at marine aquaculture operations as well, such as at staff ablution facilities and for cleaning, obviously considering biosecurity and HACCP management system restrictions. Investors will need to provide for on-site attenuation and storage of storm water. Where the runoff is potentially contaminated, it should be treated before it is discharged. In the case of clean run-off this can be stored on site and be used for other purposes.

The targeted 600 tn/yr abalone production and seaweed production will occupy most of the coastal section of the ADZ. Existing abalone farms in South Africa and elsewhere generally consist of prefabricated tank systems with unpaved areas between tanks. Tanks are often placed directly onto levelled ground, with a gravel layer to control dust (Plate 7-2 and Plate 7-3, page 7-246). Such designs allow for rainwater infiltration and thus causing little additional runoff concentration. With this in mind, a storm water pipe outfall to the sea will not be required initially but as more aquaculture farms establish in the ADZ, the situation may change in later years.

4.7.7 Electricity

Aquaculture operations consume electricity for pumping water and for various operational activities such as the heating and cooling of water for their operations. The Coega IDZ receives its power at 132 kV from the NMB Municipality.

The power supply for the ADZ will be from the Sonop 22 kV/11 kV substation. This substation is supplied from Eskom's Dedisa substation via 2 x 132 kV power lines which will ultimately be converted from the existing single circuit lines to double circuit lines. The Sonop substation will be upgraded to increase the capacity for investments within Zone 10 and the ADZ. The CDC will supply electricity to the boundary of each investor's site within the ADZ.

4.7.8 Information and Communications Technology

The CDC provides Information and Communications Technology (ICT) services to the boundary of an investor's site. ICT services are installed within the road servitudes. The ICT infrastructure allows for the connectivity of

voice/data/internet and video services. The scope of the services includes the provision of fibre backbones and data centre access in the IDZ as well as external connectivity to other service providers.

4.7.9 Security and Fencing

The CDC will provide zone access control to the ADZ. Each investor within the ADZ will be required to fence off their site and provide security for their investment.

The CDC will provide high-mast lighting in strategic areas within the ADZ.

4.7.10 Road Network

Currently the main access to Zones 7 and Zone 10 is gained from the N2 via the Hougham Park Interchange, along Ring Road 1 to a traffic circle, from where a gravel road runs eastwards and then in a southerly direction into the proposed ADZ and to the Zone 10 coastline. The CDC will provide access to the boundary of each investor's site within the ADZ. The road network within the ADZ will be a combination of surfaced and unsurfaced roads. Roads will be designed to accommodate storm water flow.

4.7.11 Tenant Activities

The following would form part of the individual tenant activities and responsibilities:

- Earthworks and site preparation.
- Construction of structures and buildings.
- Seawater abstraction and discharge for aquaculture developments taking place before the IDZ pipeline is in place (separate coastal waters discharge permit / general authorization, and public lease required).
- Boreholes (separate investigation required to assess feasibility of boreholes, and a separate water use license / general authorization required).
- Pre-treatment of inlet water.
- On-farm water storage.
- On-farm hatchery and grow-out facilities (ponds, tanks, raceways).
- In-system water purification and treatment to maintain optimal conditions in the aquaculture system.
- On-farm processing facilities, refrigeration and storage.
- Staff facilities, change rooms, ablutions and canteen.
- Rainwater harvesting and storm water attenuation.
- Pre-treatment of effluent to the required standards of the CDC's coastal waters discharge permit standard and/or the NMB Municipality sewer system quality requirements and permit conditions.
- Distribution pipelines and pumps linking to the CDC sewer system (fresh water) and/or marine pipeline holding tanks.

4.7.12 Desalination

Desalination plants remove dissolved salts from seawater to produce fresh water. The most widely used technology today is reverse osmosis (RO). RO treatment involves four basic steps: seawater intake, pre-treatment (screening and filtration), RO membrane filtration, and post-treatment. An RO membrane is a highly engineered polymer film with a controlled distribution of pores. Membranes serve as a barrier permitting the passage of water molecules under high pressure but not larger particles such as microorganisms, metals, and minerals including salt, calcium and magnesium, fluoride, iron, and calcium, lead, manganese, bacteria and parasites.

The objective of post-treatment is to ensure that the product water is safe to drink, and non-corrosive. The product water from the plant will have a TDS generally less than 300 mg/L, and a pH of approximately 6, and will

require limited post treatment to correct the pH. In the plant, disinfection will be achieved by the addition of chlorine gas, and the correct pH and carbonate saturation is maintained by controlled dosing of soda ash and calcium chloride. These are normal water treatment processes and will provide potable water suitable for human consumption.

Cleaning of the membranes is required every few months. Cleaning agents are mixed with water and pumped through the membranes. The cleaning products are suitable for use in drinking water systems and are generally mixed with brine and thus diluted.

The process is schematically illustrated below. Inputs into the process include anti-fouling agents (acids and chlorine), flocculants and anti-scalants, RO membrane cleaning chemicals and re-mineralization agents added to the product water. These chemicals are all commonly used in conventional water treatments and not particularly hazardous in the quantities used and dilution levels achieved.

RO plants developed today are designed to include an energy recovery step, also called a double-pass RO system, where the pressurized membrane output stream is passed through a second RO system, thus utilising the energy already applied for a second time. The process is illustrated on the schematic below.

A plant with an eventual product water production capacity of 60 Ml/day is proposed, with a 15 Ml/day plant developed as a first phase. For a 60 Ml/day plant, 140 Ml/day seawater will be abstracted and ~80 Ml/day brine will be released. The plant will be located within the ADZ footprint at an elevation of <30 mamsl.

Current estimated cost of desalination is ~R 22/kl, for operational costs and capital recovery, of which operational costs are ~R 13/kl. Electricity usage is estimated at 3 to 5 kwh/kl (Case Studies: Mosselbay, Trekkopje, Rossing).

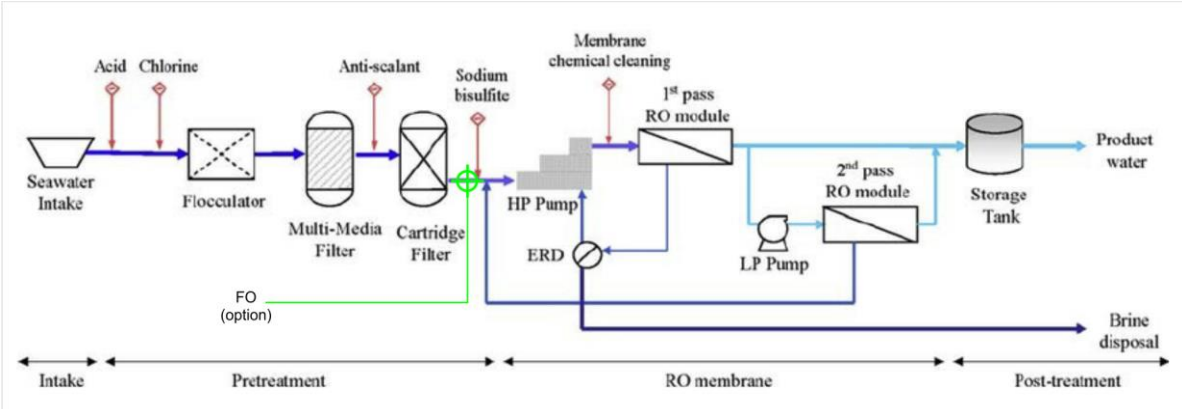


Figure 4-9: Schematic of a Reverse Osmosis (RO) Process

The NMB Municipality has undertaken studies to investigate the development of a 60 Ml desalination plant in the NMB Metro. Various sites including a site in the IDZ were investigated. Although the study is currently on hold, it is still in the long-term plan of water supply to the NMB Metro and it appears that the development of a desalination plant in the NMB Metro at some point in time is inevitable. The NMB Municipality's identified location is at Schoenmakerskop towards the southern part of the water distribution area where the water is most needed in terms of the overall distribution network, where it would be located on land under the control of the municipality, and where the sea conditions are favourable for mixing of the brine after its release.

Locating a desalination plant in the IDZ presents a number of potential future linkages and synergies and potential cost savings and resource use efficiencies:

- Access to and utilization of the proposed IDZ marine abstraction and discharge pipeline servitude(s).
- Linking to the proposed CCGT plant's release of cooling water.
- Linking to abalone flow-through aquaculture in order to optimize pumping of water. A 2012 study predicted possible cost savings of between R 0.15/m^3 and R 2.37/m^3 for the production of fresh water (depending on

site-specific design factors) when desalinating sea water effluent from on-shore abalone tanks (Steynberg, 2012).

- Sending brine to the nearby salt works, rather than release back to sea.
- Brine could be utilized for potential industrial use, such as a Chlor-Alkali plant, as was proposed for development in the IDZ some years ago. Integration with a desalination plant may make the establishment of such a plant in the ADZ more financially attractive in future.
- Within the IDZ, there are opportunities to explore utilization of emerging desalination technologies. For example: forward osmosis technology (FO) is emerging as an option for desalination and industrial water reuse. Various options exist but the arrangement illustrated in Figure 4-10 is an example of a system that integrates a seawater RO and industrial water reuse through the application of FO. FO is introduced as a step before the RO process (see green insert on Figure 4-10). In the FO step, seawater is used as a drawing agent to FO waste water, resulting in a concentrated waste water stream and diluted seawater stream. The FO process utilizes natural osmotic action, not pressurized, and is thus energy effective. RO treatment of diluted seawater (less saline than seawater) is less energy intensive than normal seawater RO treatment as less pressure is needed for it to pass through the RO step. Seawater pumping volumes are also reduced. Treatment of the concentrated waste water could also be more cost-effective than treating it in un-concentrated form.

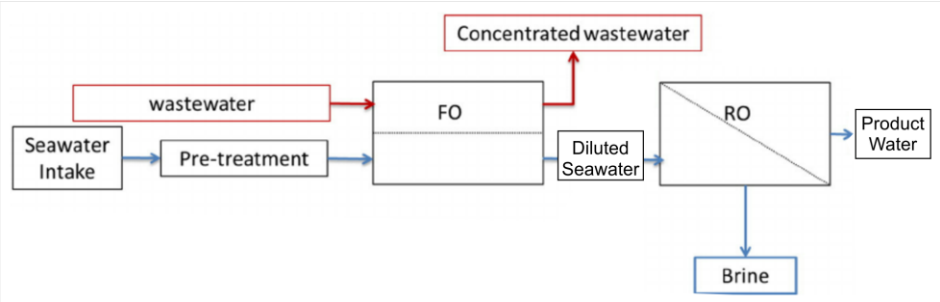


Figure 4-10: Schematic of a Hybrid FO-RO (Forward Osmosis - Reverse Osmosis)

It is unlikely that development of the desalination plant will be required in the next 5 years, but timing would ultimately depend on the fresh water supply situation in the NMB Metro and development of other industries such as the CCGT plant in the IDZ. Due to the high capital investment and important improvements in desalination technology it would be wise to delay a decision on the technology option and installing of the plant for as long as possible. However, when it does become necessary, it would be prudent to have a location and environmental approvals in place. CDC intends to appoint a design-and-build contractor for the desalination plant, as is common practice in this specialized sector. As such, the final design and technology options will only be decided during the tender phase. Different technology options and designs are thus not evaluated as part of the EIA but covered in the following:

MITIGATION MEASURES AND DESIGN CRITERIA

- *The master layout plan for the ADZ to incorporate the site for development of the desalination plant and provision of services to the site.*
- *Technology options and design of the desalination plant to be submitted to the CDC.*
- *CDC to explore potential options and linkages between desalination and waste water treatment, aquaculture, and other industries to improve resource use efficiencies (fresh water, energy) and reduce GHG emissions.*

4.8 Water Supply Options

4.8.1 Sea Water Intake Options

The CDC's intention is to establish a marine pipeline servitude for seawater intake in the IDZ. Once this is in place, it will serve the marine aquaculture developments in the ADZ. Flow-through aquaculture systems such as abalone farms are dependent on the development of a large-diameter marine pipeline but intensive and super-intensive recirculating systems require smaller volumes of water and there are a number of alternative water supply options available to them.

The following interim and alternative sea water intake options exist:

- Beach abstraction points, or beach wells.
- Boreholes into the saline aquifer.
- Development of a dedicated intake pipeline, with offshore intake structure at the seaward end of the pipe to supply the smaller and first aquaculture operators before the CDC marine pipeline is in place.

The feasibility and environmental impacts of the seawater intake pipelines are assessed in a separate EIA process.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Until such time as the CDC marine pipeline is in place, individual developers will need to explore alternative seawater supply options such as those listed in the EIR Section 4.8.1.*
- *Individual developers interested in establishing alternative seawater intake options to the CDC marine pipeline will be responsible to assess the feasibility of the options for their particular development and water requirements and to obtain the necessary water use and coastal authorisations.*

4.8.2 Fresh Water Supply Options

Fresh water aquaculture is completely independent of the establishment of a marine pipeline. The following are options for fresh water supplies to the ADZ:

- Municipal water supply as discussed in Section 4.7.1.
- Rainwater harvesting from roofs and greenhouses in the ADZ.
- Boreholes (separate investigation required to assess feasibility of boreholes, and a separate water use license / general authorization required). Aquifers and groundwater potential discussed in Section 6.2.
- Development of a desalination plant as and when required to supplement water supply in the NMB Metro.
- Utilization of 'clean' fresh water produced as a by-product at other industries in the IDZ. The Cerebos plant is a current example to be explored.
- Potential future options and linkages between aquaculture and other industries in the IDZ, i.e. utilizing waste water for aquaculture biomass production (health, biosecurity and product quality constraints may preclude this practice for food or feed production), while improving the quality of waste water releases at the same time.
- New developments in the field of waste water treatment, i.e. forward osmosis, could potentially be applied in future to provide an alternative and 'clean' source of water for aquaculture.

It is likely that a combination of these options will be used over the life of the ADZ. Obviously some of the potential sources will require further research and development. However, based on the projected water use in the IDZ and the NMB Municipality's longer term planning to meet projected water use to the IDZ and the broader NMB Metro, the current projected water requirements from the NMB Municipality to the CDC will be sufficient for the initial and targeted aquaculture production in the ADZ.

The water efficiency of intensive and super-intensive recirculating aquaculture is discussed in more detail in Section 7.18 on Resource Use.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Individual developers interested in establishing fresh water boreholes will be responsible to assess the feasibility of their proposal and to obtain the necessary water use authorisation.*

4.9 Waste Streams and Treatment Options

This section discusses waste streams as well as recommended feasible treatment options for each waste stream. All the treatment options discussed are regarded as potentially feasible but each aquaculture developer will have to develop, design and assess the feasibility of these processes for their specific aquaculture operation and production system.

4.9.1 Desalination

Inputs into the process include anti-fouling agents, flocculants and anti-scalants, RO membrane cleaning chemicals and re-mineralization agents added to the product water. These chemicals are all commonly used in conventional water treatment and are not particularly hazardous in the quantities used and dilution levels achieved. Cleaning of the membranes is required every few months. Cleaning agents are mixed with water and pumped through the membranes. The cleaning products are generally mixed with the brine and thus diluted.

For prevention of biofouling or the control of biological activity, an oxidation step may be needed. Chlorination and ozonation are among the oxidation processes that can be employed. Chlorine is typically added to the intake water to minimize biofouling of the pumping systems and intake pipelines.

Pre-treatment to desalination processes forms an important and integral part of desalination installations, and is often a major cost consideration in the selection of desalination as a water treatment alternative. A variety of pre-treatment methods may have to be employed to ensure that optimal desalination plant performance is achieved. For seawater, pre-treatment methods could include chemical treatment, clarification, dissolved air flotation, sand filtration and flocculation, and cartridge filtration (micro-filtration and ultrafiltration), or a combination of these depending on the final design of the plant. Dissolved air flotation (DAF) is a commonly used process, but so is chemical dosing and multimedia sand filtration, where sulphuric acid is used to lower the pH of the raw sea water to 7.0 to obtain proper flocculation, by adding ferric chloride, before the sea water is filtered through sand filters. Micro-filtration and ultra-filtration may be added, which are more energy intensive but provides extra protection to the RO membranes, minimises fouling of the RO membranes and provides additional mitigation against cases of HABs and high sediment loads in the feed water. However certain proprietary DAF designs systems are also mooted for their capability to handle 'challenging' feed water and ability to treat hazardous algae blooms (HABs).

The total dissolved solids (TDS) of seawater are typically in the order of 35 000 mg/L. The pH of seawater is slightly alkaline, between 7.5 and 8.5 but is corrected to 7.0 before it is pumped at high pressure through the RO membranes. Between 40 % and 50 % of the water content of the seawater is removed by the RO membranes and is produced as permeate (fresh) water. The resulting brine which has a TDS in the order of 65 000 mg/L, roughly double that of seawater, is typically returned back to the sea.

The objective of post-treatment is to ensure that the product water is safe to drink and non-corrosive. The product water from the plant will have a TDS generally less than 300 mg/L, and a pH of approximately 6, and will require some post treatment to correct the pH. Disinfection is achieved by the addition of chlorine gas, and the correct pH and carbonate saturation will be maintained by controlled dosing of soda ash and calcium chloride. These are normal water treatment processes that provide potable water suitable for human consumption but if the water

were to be fed directly to aquaculture operations, the post-treatment measures may have to be adapted to the need of the specific culture species.

Brine Waste Stream

Brine is concentrated seawater with salinity levels of roughly ~65000 ppm (TDS: 65 000 mg/L), from the RO process. The brine contains concentrated impurities originating from the feed water and may also contain trace residual levels of biocides, i.e. from chlorination of intake water, and their degradation / transformation products.

Release of the brine back to the sea via a marine discharge pipeline is the default brine management option. Brine is typically sent to a buffer tank before release.

Other potential management options to explore include:

- Linking to abalone flow-through aquaculture in order to optimize pumping of water. A 2012 study predicted possible cost savings of between R0.15/m^3 and R2.37/m^3 for the production of fresh water (depending on site-specific design factors) when desalinating sea water effluent from on-shore abalone tanks (Steynberg, 2012).
- Sending brine to the nearby salt works, rather than release back to sea.
- Potential future industrial use, such as a Chlor-Alkali plant, as was proposed for development in the IDZ some years ago. Integration with a desalination plant may make the establishment of such a plant in the ADZ more financially attractive in future.

Pre-Treatment Waste

The following waste streams are associated with pre-treatment

- Saline solids removal by course screens (macroalgae and other organic material that entered the seawater intake system);
- Saline sludge and backwash water from pre-treatment process system containing small amounts of biocides (i.e. acids, chlorine), coagulants, flocculants and anti-scalants.
- Membrane cleaning backwash water containing highly diluted cleaning chemicals in the solution, which will be used every few months.

The exact type and qualities of chemicals to used will be determined during the final design of the system and will depend on the choice of options such as sand filters, dissolved air flotation, or ultra-filtration, but the chemicals typically used are conventional water treatment process chemicals and their toxicity are relatively low.

The pre-treatment and cleaning backwash waste water is stored briefly in backwash buffer tanks before being mixed with brine stream for release via the marine outfall pipeline. Solids are typically not separated but disposed with the brine stream.

MITIGATION MEASURES AND DESIGN CRITERIA

The concentrations of chemicals and solids in the final brine disposal stream are very low, but the following mitigation measures may be implemented to improve effluent qualities and meet the overall marine pipeline discharge quality requirements:

- *Select the least environmentally damaging option for feed-water treatment and cleaning of plant components, thereby reducing discharges of hazardous components into the environment.*
- *pH correction if needed before backwash water is released from buffer tank and mixed with the brine stream.*
- *Membrane cleaning solutions, used every few months, must be pH corrected and fed slowly into the brine stream over a period of time to avoid a sudden release. Furthermore, if required to meet discharge standards, it could be kept in a separate tank for landfill disposal thus not mixing with brine stream.*

- *Investigate the feasibility and need for solids separation and dewatering.*
- *Pigging of intake and discharge pipelines as a routine management measure to reduce the reliance on biocides, and to avoid elevated levels of residual biocides in discharged effluent. If fouling occurs inside pipelines, this will need to be addressed through mechanical rather than chemical means.*
- *De-chlorination of effluent prior to discharge (in case of overuse of biocides).*
- *The quality of feed water, the brine stream, and product water should be monitored on a daily basis, based on the requirements of the CDC's coastal waters discharge permit.*

4.9.2 Aquaculture Production

4.9.2.1 Flow-Through Systems (Abalone)

Inflow water at abalone farms is typically pre-treated to achieve the required water quality standard for the culture (production) water. Treatment of inlet water will depend on the quality of the intake water but typically consist of the settlement of solids, screening and filtration. Mechanical filtration down to 100 microns (typically using a drum filter) is often used while hatchery water is further filtered down to ~20 microns and 'scrubbed' clean with foam fractionation and/or protein skimming (Louise Vosloo, pers. comm.).

Due to the high volumes of water that is pumped through the system on a continuous basis, production water outflows are typically not treated. Land-based abalone farming requires deliberate feed inputs, generally as kelp / seaweed or formulated diets. Given that abalone are invertebrate herbivores and rank low in the food chain, abalone farms generally produce very dilute effluents, usually containing small quantities of waste feed, abalone feces and dissolved nutrients. The majority of effluent water come directly from grow-out units containing abalone, which themselves are highly sensitive to water quality. This ensures that the effluent is relatively innocuous (WWF, 2010). The use of prepared commercial feed has assumed prominence in recent years but compared to other types of aquaculture (i.e. finfish and shrimp), the effluent from abalone farms have low environmental nutrient loads indicative of the efficient assimilation of feed and the low metabolic rates of abalone (Probyn *et al* 2014).

Some farms send their abalone production water, or part of that, to seaweed culture units where the seaweeds, such as *Ulva,* acts as a biofilter for the polishing of effluent prior to discharge (FitzGerald, 2008).

Solid particulates that accumulate in the tanks over time are released when tanks are cleaned. It has been estimated that ~100 kg of particulate waste per tonne of abalone produced are released during tank cleaning operations (Potgieter 2005, in Troell *et al* 2006). The solids are typically not separated from the production water outflow and are thus released with the effluent waste stream (Louise Vosloo pers. comm.).

Mortality (dead abalone) removal is a necessary step to reduce the decomposition of dead abalone in culture systems or in the environment. Mortalities and culled animals on a farm should be less than 1% over the lifetime of a batch of abalone but this could obviously be much higher under disease situations. Mortalities and culled animals are treated as potential infectious agents and are sent to landfill (Louise Vosloo pers. comm.). Correct temporary storage, such as in sealed refrigerated containers, and disposal is required to reduce the risk of disease within the farm and to help minimize odours, predation, attracting pests and external disease vectors.

Abalone farms in South Africa often have their own dedicated seawater discharge pipelines and the characteristics of their releases are well documented. The effluent qualities of existing farms in the Western Cape have been characterised by Probyn et al (2014) and their results serve as a general indication as to the qualities of effluent that can be expected from abalone farms in the ADZ. It indicates that abalone farm effluents are unlikely to exceed water quality targets for coastal marine waters beyond the effluent mixing zone (based on Probyn *et al* 2014). At the outfall local impacts such as sediment accumulation and algal growth may be observed, but these effects occur within a few meters of the outfall and are typically undetectable 50 meters from the outfall (Britz and Godfrey, 2008).

4.9.2.2 Recirculating Systems (Finfish and Shellfish)

As feed is introduced into the finfish or shellfish culture units, it is either consumed or left to decompose within the system. By-products of fish metabolism include carbon dioxide, ammonia-nitrogen and faecal solids. Water constituents in fish tanks effluents include dissolved organic matter and particulate organic matter, total suspended solids, nutrients such as nitrogen and phosphorous, and others specific organic or inorganic compounds. If uneaten feeds and metabolic by-products are left within the culture system, they will generate additional carbon dioxide and ammonia-nitrogen, increasing oxygen consumption as it undergo bacterial decomposition and have a direct detrimental impact on the health of the cultured product (Del Campo *et al* 2010).

A recirculating system consists of a series of culture units where water is continuously recycled and monitored. Water is filtered and treated to neutralise harmful chemicals and ensure optimal water quality. Maintaining high water quality standards within recirculating systems requires effective treatment of all waste metabolites that could compromise the health of the cultured organisms. Depending on the scale and sophistication of the system, a RAS could include: treatment of new (top-up) water added to the system; water oxygen control; ozonation or ultraviolet (UV) sterilisation; the culture units (i.e. tanks, constructed ponds or raceways); feeding system; solid and suspended particle removal, filtration, foam fractionation, bio-filtration and nutrient removal; temperature control; effluent management, and sludge separation and management.

In a RAS, a substantial component of the waste generated comes from feed inputs. A major component of any recirculation system is the removal of waste. The reuse of water in a RAS requires water to be treated to avoid self toxification by metabolites. Effective control of undissolved suspended solids and dissolved solids is important to ensure the successful operation of a RAS. RAS are designed to remove settled, suspended and dissolved solids produced by cultured organisms and return the treated water with a safety level into the culture unit. Larger particles of that float are generally skimmed from the tanks and those that settle are removed as they accumulate through sedimentation on bottoms of the culture units. A portion of the solids that are kept in suspension can be removed through means of settling, sedimentation, mechanical filtration or swirl separation. The rest of the finer particles and dissolved solids will increase the oxygen demand of the system and could cause irritation and harm to the cultured species. These small solids cannot be removed by sedimentation or mechanical filtration. They can however be removed by foam fractionation, ozone treatments or cartridge filtration (Del Campo *et al* 2010). A biological filter is then used to break down toxic ammonia into harmless nitrates which is safe to release.

A recirculating system with a hydraulic residence time of 12 hours would be considered an open system, yet this system would likely capture and remove >90% of the particulate solids produced while controlling culture tank water quality. A longer hydraulic residence time is indicative of a higher degree of water reuse, and particulate waste capture efficiencies will approach 100% as the recirculating system hydraulic residence time approaches or exceeds 10 days. Therefore, to maintain suitable water quality, recirculating systems must assume the treatment burden for 90 to 100% of the ammonia and particulate waste produced.

Recirculating systems have two different aquaculture production waste streams:

- Small volume of captured bio-solid slurry, or sludge. Un-thickened sludge has a total solid content of 1 to 3%.
- More dilute, but relatively larger volume of production water outflows.

Production water outflows

As water gets topped up in the recirculating system as part of the water exchange process, a portion of the water gets displaced and flows out of the process. If there is a 10% water exchange per day, 10% of the total volume of water in the system will flow out as waste water. The quality of this waste water would therefore be similar to the quality of the water in the system, which may vary from species to species (as per the requirements of each species), but since these organisms need clean conditions to remain healthy and grow, the production water

quality is generally of a good quality. In so called zero water exchange systems, new water is only added to the tanks to make up for splash out and evaporation and for water used to flush out waste materials.

The design of waste management systems must consider the specifics of each recirculating aquaculture system to successfully meet effluent quality standards based on the CDC's coastal water discharge permit.

Estimated seawater production water outflow parameters are provided below. The information was compiled and provided by Andre Bok (pers. comm.)

Estimated seawater effluent (production waster outflow) parameters (parameter concentrations calculated on a 5% holding volume replacement per day)	Concentrations
pH	5.5 to 9.5
Conductivity	~ 4800 ms/m [(a)]
Total Suspended Solids	<200 mg/l [(b)]
Total Settled Solids	0 [(c)]
Chemical Oxygen Demand COD	<100 mg/l [(d)]
Ammonia, Nitrites and Nitrates (as N)	50 mg/l [(e)]
Total phosphates	9.7 mg/l [(f)]
Faecal Coliforms	0 [(g)]

Note: Information supplied by Andre Bok (per. comm.)

(a) For seawater with naturally high conductivity due to salinity.

(b) Fish are fed at a maximum average rate of 1.5% bodyweight per day. Assuming 25% of feed is released as waste, 5% volume replacement per day, ozone addition and 90% of all particulates removed by drum filter, heterotrophic bacterial activity will reduce Total Suspended Solids levels significantly.

(c) Particulate waste is removed from the effluent water and disposed separately. Total Settled Solids are removed by the 100 µm screen of the drum filter as part of the standard bio-filtration process. Particulates less than 100 µm are not considered to be 'settleable solids' and so no settleable solids are expected in the effluent water stream. Settled solids form part of the sludge waste stream.

(d) Average estimate of recirculating aquaculture effluent water based on available research. This will reduce significantly to less than 50mg/l with the inclusion of ozonation in the seawater treatment system. Measurement of this parameter is required to obtain real data.

(e) 16% of protein is Nitrogen, 36% of protein that fish ingest gets absorbed (Timmons et al), 5% volume exchanged per day. Some de-nitrification is happening naturally on aerobic bio-filtration medium. This reduces Nitrate to a maximum of 50 mg/l total Nitrogen at a stocking density of 45 kg/m^3 @ 7-10% exchange per day with Gilthead seabream feeding @ 1.5% bodyweight per day (Zohar et al).

(f) Assumption that 10 kg of Phosphate produced per ton of fish at an FCR of 1.3 (Timmons et al). 50% of Phosphorous is found in the particulate waste with an additional proportion taken up by bacteria in the bio-filter. Therefore if the particulate waste is removed from the system, Phosphates can be reduced by 50% (Lekang et al). In a standard recirculation system, Phosphorous in the effluent water measures 9.7mg/l (Zohar et al). If additional filtration is added, more than 90% of phosphates end up accumulated in aerobic and anaerobic bio-filters (Tal et al).

(g) Not applicable to sea water.

Options for further treatment of aquaculture production water or the supernatant water from sludge dewatering process (see below) with potential application in the ADZ include:

- Constructed wetlands.
- Algae culture units where the plant matter acts as a biofilter.
- Integrated multi-trophic aquaculture.
- Aquaponics (fresh water and seawater).

Effluent from freshwater aquaculture operations can either be discharged to the municipal sewer system or the marine discharge pipeline, and would therefore be required to meet the requirements of these systems.

Sludge

Discussions with specialists in the aquaculture sector in South Africa to determine current practices for managing production water outflows and sludge revealed that the recirculating systems currently in existence in South Africa

are fairly small operations, pilot operations or a 'first phase' of an envisioned much larger project. At these smaller operations, sludge is typically mixed with the production water outflows without compromising permitting conditions (Andre Bok per. comm.). In the East London IDZ, production water from marine finfish aquaculture operations is sent to the municipal sewer line and is used to flush the system (Andre Bok per. comm.). Where sludge is separated, it is removed and sent to landfill for disposal.

Some of the tilapia aquaponics operations produce liquid fertilizers to sell as a by-product, or apply the sludge in agricultural operations. Aquaponics systems are designed for dissolved nutrients to be utilised by the plant matter and to facilitate nitrification, but solids need to be filtered from the system, especially in floating raft systems, or flushed out periodically from media beds. In aquaponics systems, mineralisation of the solids to basal, plant available nutrients are used to allow for further application of the sludge within the system.

For commercial scale recirculating aquaculture operations, the sludge needs to be kept separated from the effluent stream and treated as a potential infectious agent. A waste management plan should be developed to best deal with the risk. The default management route would be disposal. In virtually all applications, treatment and disposal are more economical if the dilute sludge stream is concentrated as much as possible, thus reducing the volume of material to be handled. The total solid content can be as low as 1% in un-thickened sludge, 5% in thickened sludge, 25% in dewatered sludge, and up to ~90% in dried sludge. The water that is separated (supernatant water) from the concentrated sludge can be treated for re-use or release. A rational sludge management and treatment process should be based on sludge volume, characteristics, concentration, and the degree of stabilisation required. While it is a potential infectious agent, the sludge contains high levels of nutrients and organic materials. Significant research and development are taking place worldwide to develop methods and systems to:

- Concentrate and dewater the sludge, and thus reducing the volume.
- Stabilize the sludge to restrict putrefaction, break down harmful residues and potential disease agents and make it suitable for land application.
- Utilize the organic material and nutrient content.

The following two options are of note, due to their prominence in applications worldwide, in commercial recirculating aquaculture and potentially for application in the Coega ADZ. Both options are energy efficient and require a small footprint area.

- **Anaerobic digestion, with or without heat recovery and biogas generation**

  Anaerobic digestion has definite potential for application in the ADZ for sludge digestion and stabilization. The process results in sludge mass reduction of up to 90%, in water and energy savings, as well as in potential biogas production which can serve as an alternative energy source and partially cover the RAS's energy demands. Various research studies show that anaerobic digestion has potential for the breakdown of harmful residues and potential disease agents in the sludge, thus rendering it suitable for land application. Testing of the treated sludge will however be required to confirm its characteristics and appropriate use.

  Anaerobic digestion can happen on a farm, centrally in the ADZ, or alternatively it can be linked to the NMB Municipality's planned Waste to Energy project or a similar scheme in the IDZ.

- **Geotextile dewatering systems**

  The use of geotextiles for sludge dewatering and stabilisation is gaining prominence worldwide in the form of geotextile bags, tubes, or geotextile lined skips and bins. In the USA, the use of geotube type system has been approved as a Best Management Practice for Aquaculture by the State of North Carolina. The benefit of the system is that it is easy to use, requires little technical expertise and it therefore provides a fairly secure treatment solution. It is adaptable and therefore suitable for small or large scale applications. It can also be applied as a temporary measure to deal with high sediment runoff from construction sites. The dewatered solids are typically suitable for land application or it can be disposed of in a landfill. Testing of the treated

sludge is obviously required before a final decision on its application. The size of the bag or tube can be designed around the specific requirements of the site and to allow for simple loading and haulage to its final destination.

4.9.2.3 Processing Plant Waste

Solid Waste and By-Products

The volume and nature of solid waste will vary based on species and the type of processing. For example:

- Processing of gutted and cleaned whole finfish would produce less waste at the processing plant than filleted portions. Filleted finish portions will result in ~60% edible meat and ~40% by-products and waste, but this will vary based on species. In order to assess the worst-case, the waste quantities estimated below are based on 100 % finfish processing to filleted portions, assuming that all not-edible parts are waste (no by-products).
- Only about a third (30 to 35%) of an abalone consists of edible meat, a third is offal, and a third is shell.

Correct temporary storage and disposal is required to reduce the risk of disease within the farm and to help minimize odours, predation, attracting pests and external disease vectors.

A portion of the waste, regarded as by-products, can be further processed into silage, animal feed, etc. Anaerobic digestion could be investigated for digestion and stabilization. Depending on the quantities, processing of this animal matter not for human consumption will require an air emission licence (see appendix A4) and thus an assessment of odour risks and impacts.

Waste Water

Wastewater from processing operations can have elevated dissolved and suspended organic materials and small amounts of cleaning chemicals used in the plant. The quality of the waste water will largely depend on the species processed, and the type of processing. A portion of the solids that are in suspension can be removed through means of settling, sedimentation and filtration. The rest of the finer particles and dissolved solids can be removed by foam fractionation, ozone treatments or cartridge filtration.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Effluent will not be released to the environment. It can be:*
  - *Treated on site and re-used.*
  - *Sent to another facility or industry in the IDZ to be re-used.*
  - *Stored in appropriately designed storage tanks, from where it is to be removed to an authorised disposal facility / sewage treatment works (interim solution until CDC sewer network has been expanded to Zone 10).*
  - *Discharged to the municipal sewer network, via the CDC sewer system. These discharges to meet the quality requirements and conditions of the municipal system (permit requirements and by-laws).*
  - *Discharged to the CDC marine pipeline, if a coastal water discharge permit is in place. These discharges to meet the quality requirements and conditions of the CDC's coastal water discharge permit.*
  - *Discharged to the dedicated marine discharge pipeline for which a coastal discharge authorisation (permit or general authorisation) has been obtained. These discharges to meet the quality requirements and conditions of the coastal waters authorisation.*
- *Storage of waste to be in accordance with the CDC's environmental specifications and procedures, this EMPr and the conditions of the DAFF permits.*
- *Each farm to identify and quantify each of their waste streams and keep records for volumes produced,*

stored and discharged and/or disposed.

- *Each farm to develop a water and effluent monitoring programme based on industry best practices and standards and the various DAFF permit conditions.*
- *Processing plant waste, sludge, mortalities and other potentially hazardous or infectious waste to disposed at an authorized landfill site, unless it can be demonstrated that an alternative sustainable use are available and the necessary approvals have been obtained from DAFF (permits), as well as any environmental, water and waste approvals triggered by the use or application of the waste.*
- *Processing plant waste and mortalities to be stored in leak proof, vermin proof, sealed containers and disposed of at an authorised landfill site within 48 hours of being created and less than 7 days if frozen.*
- *Processing plants to be operated in accordance with best available industry practices and HACCP management principles.*

4.10 Key Project Parameters

This EIA assessed the impacts of all land-based activities and facilities associated with the ADZ for development of the ADZ as a whole based on the project parameters outlined below. The totals and -term values as indicated with the note "(EIA)" were used to assess and rate the significance of the impacts in Section 7 of the EIR.

4.10.1 Total ADZ footprint size

	Size	Scope and Threshold for Assessment
ADZ Coastal Section	140 ha	**440 ha**
ADZ Inland Section	300 ha	
Total Footprint	**440 ha**	

4.10.2 Suitable land for development in the ADZ

	Initial	Long-Term (after mining and removal of sand and stockpiles)	Scope and Threshold for Assessment
ADZ Coastal Section			
< 20 mamsl in coastal section	18 ha	38 ha	105 ha
> 20-30 mamsl in coastal section	1.5 ha	11.5 ha	
> 30 mamsl in coastal section	27 ha	51 ha	
Use of existing abalone farm	2.5 ha	2.5 ha	
Use of existing prawn pilot facility	1.8 ha	1.8 ha	
Sub-Total	51 ha	105 ha	
ADZ Inland Section			
Sub-Total	255 ha	260 ha	260 ha
Total (excludes land below the Coastal Management Line)	**306 ha**	**365 ha**	**365 ha**
Percentage of ADZ coastal section of 140 ha	36 %	75 %	
Percentage of total ADZ footprint of 440 ha	69 %	82 %	

4.10.3 Land below the Coastal Management Line		Scope and Threshold for Assessment

Certain structures and infrastructure will be located below the coastal management line, such as:
 	
Key Service Infrastructure below the Coastal Management Line
 	
Seawater intake and reticulation infrastructure
• Intake structures:
  ○ Beach abstraction or beach wells
  ○ Boreholes into saline aquifer.
  ○ Dedicated intake pipeline, with offshore intake structure at the seaward end of the pipe. This pipeline would supply the first aquaculture operators before CDC marine pipeline is in place.
  ○ Link to the CDC marine pipeline servitude once this is in place (the pipeline servitude is the subject of a separate EIA process).
• Pumps and pump houses.
• Reticulation pipelines (from the seawater intake structure to the pump station and from there to a reservoir or to individual aquaculture farms and the desalination plant), with inspection and maintenance manholes, valves and other associated infrastructure.
• Electricity cables to the pump houses.
• Service and access track to pump houses, manholes and valves along the reticulation pipelines.
• Anti-fouling equipment and pipeline to the intake structure.
Waste water discharge infrastructure
• Reticulation pipelines for collecting pre-treated effluent and the desalination plant waste stream to the main discharge pipeline, with associated inspection and maintenance manholes, valves and other associated infrastructure.
• Release / discharge structures:
  ○ Dedicated release pipeline and outlet structure at the seaward end of the pipe to serve the first aquaculture operators before CDC marine pipeline is in place.
  ○ Link to the CDC marine pipeline servitude once this is in place (the marine pipeline servitude is the subject of a separate EIA process).
• Service and access road to manholes and valves along reticulation pipelines.
Storm water infrastructure
• Storm water outfall(s) into the surf zone (possibly needed in later years).
 	
Existing and Selected New Aquaculture Production Infrastructure Economically Sensitive to Height above Sea Level
 	
Any structures and infrastructure considered below the coastal management line need to be evaluated in terms of the Criteria for Development Decision-Making in Areas Potentially Affected by Sea Level Rise as recommended in Section 7.21.2 of the EIR.
 	
The existing old abalone farm and part of the pilot prawn facility falls within this area. These are earmarked for re-use but the future use needs to be evaluated in terms of these criteria to determine mitigation measures to be put in place I order to comply with the criteria.		

Total	**30 ha**	**30 ha**

4.10.4 Total Vegetation Clearance

	Total	Scope and Threshold for Assessment
Total development footprint	440 ha	**400 ha**
Area within the 425 ha area that consist of unvegetated dunes	40 ha	
Maximum Area of Vegetation Clearance (Including Areas Infested with Alien Species)	**400 ha**	

4.10.5 Buffers and areas not for Aquaculture Production or Desalination

Buffers around remaining pockets of intact indigenous vegetation in coastal zone. Exact position, size and linkages with nearby open space areas to be finalised in the site development plans.	5.2 ha [(a)]
Sand management area on the windward side of the ADZ, adjacent to the Damara Tern habitat.	5.8 ha
Other heritage, biosecurity and environmental buffer areas that would not be available for aquaculture production (include roads and storm water management areas).	34 ha [(b)]
Total	**45 ha** [(c)]

(a) Assuming 10 % intact indigenous vegetation remaining.
(b) High level estimate of the minimum land to be allocated towards buffer zones. Biosecurity requirements may dictate that additional more land be allocated to biological buffers. This will be determined during development of the individual site development plans.
(c) Excludes area below coastal management line, discussed separately.

4.10.6 Aquaculture Production

	Initial Years	Target	Long-Term Maximum [(a)]	Scope and Threshold for Assessment
Animal Matter				
Abalone	150 tn/yr	600 tn/yr	1520 tn/yr	**42370 tn/yr**
Marine Finfish and Shellfish	275 tn/yr	5500 tn/yr	40850 tn/yr	
Freshwater Finfish and Shellfish [(b)]	550 tn/yr	5500 tn/yr		
Total	**975 tn/yr**	**11600 tn/yr**	**42370 tn/yr**	
Potential Plant Matter Production				
Seaweed and other aquatic plants	675 tn/yr	2700 tn/yr	6840 tn/yr	6840 tn/yr (aquatic)
Other saltwater plant species	1925 tn/yr	38500 tn/yr	285950 tn/yr	285950 tn/yr (terrestrial)
Fresh water and brackish water plant species[(b)]	3650 tn/yr	38500 tn/yr		
Total	**6450 tn/yr**	**79700 tn/yr**	**292790 tn/yr**	**292790 tn/yr**

(a) 50 % of maximum available land utilised for animal matter production, assuming the remaining land utilised for cultivating plant matter and as biosecurity buffers.
(b) Assuming all fresh and brackish water aquaculture is finfish linked to plant matter production, i.e. aquaponics; 7 kg of plant matter produced per 1 kg of fish produced. These figures would vary with integrated multi-trophic production of shellfish.

4.10.7 Slaughtering of Animals

	Initial Years	Target	Long-Term Maximum (a)	Scope and Threshold for Assessment
Abalone (Molluscs)	150 tn/yr	600 tn/yr	1520 tn/yr	1520 tn/yr
Marine Finfish and Shellfish [(a)]	275 tn/yr	5500 tn/yr	40850 tn/yr	40850 tn/yr
Freshwater Finfish and Shellfish	550 tn/yr	5500 tn/yr		
Total	**975 tn/yr**	**11600 tn/yr**	**42370 tn/yr**	**42370 tn/yr**

(a) Shellfish includes Crustaceans

4.10.8 Desalination Plant Capacity

	First Phase	Target	Long-Term	Scope and Threshold for Assessment
Output (treated water)	**15 Ml/d**	**60 Ml/d** [(a)]	N/A [(c)]	**60 Ml/d** [(a)]
Seawater abstraction	35 Ml/d	140 Ml/d [(b)]		140 Ml/d [(b)]
Brine produced	20 Ml/d	80 Ml/d [(b)]		80 Ml/d [(b)]

(a) Bench-marked to NMB Municipality feasibility study RO Plant capacity considered.
(b) Volumes covered in the EIA for the marine pipeline servitude.
(c) Cannot be covered in this EIA without a strategic analysis of long-term future water needs in the IDZ and NMB Metro, by the CDC and NMB Municipality.

4.10.9 Operational Employment Creation

	Initial Years	Target	Long-Term Maximum
Desalination [(a)]	15 people	30 people	N/A
Abalone [(b)]	105 people	420 people	1065 people
Seaweed (linked to abalone production)	included in abalone		
Marine Finfish and Shellfish [(c)]	28 people	550 people	4085 people
Freshwater Finfish and Shellfish [(c)]	55 people	550 people	
Total	**203 people**	**1550 People**	**5150 people**
All plant species (other than seaweed linked to abalone farming)	excluded [(d)]		

(a) Based in industry examples.
(b) Employment ratio of 0.7 for abalone, from EOH (2014).
(c) Based on employment ratio of 0.1 for finfish, from EOH (2014). Employment figures for shellfish could be higher; some sources quote a ratio of 0.5 for prawns.
(d) Available employment figures are for small operations and cannot be applied to large scale operations, or figures are integrated with fish production employment figures.

These theoretical employment figures were calculated based on employment ratios that compare well with the South African and international employment statistics in the aquaculture sector (as per Section 1.4) as well as employment figures quoted for actual operational aquaculture projects in South Africa. Construction employment is discussed in Appendix G1 and the socio-economic benefits of employment creation in both the construction and operation phases are discussed in Section 7.19.

4.10.10 Water Requirements, Water Transfer Volumes and Waste Water Discharge

	Initial Years	At Target Production	Long-Term Maximum	Scope and Threshold for Assessment
4.10.10.1 Seawater (a)			Not Calculated *Ultimately dependent on technology development and the balance between seawater and fresh water species cultured, which cannot be determined at this stage. Water supply over and above the Target value would require separate feasibility investigation.*	449.3 Ml/d
Abalone	108 Ml/d	432 Ml/d		
Marine Finfish and Shellfish (water exchange)	0.9 Ml/d	17.3 Ml/d		
Total	**108.9 Ml/d**	**449.3 Ml/d**		
4.10.10.2 Fresh Water (a)				17.6 Ml/d
Fresh Water Finfish and Shellfish (water exchange)	1.7 Ml/d	17.3 Ml/d		
Abalone processing	0.006 Ml/d	0.024 Ml/d		
Marine seafood processing	0.007 Ml/d	0.144 Ml/d		
Freshwater food processing	0.007 Ml/d	0.144 Ml/d		
Staff and other uses	excluded (from rainwater harvesting)			
Total	**1.8 Ml/d**	**17.6 Ml/d**		**467 Ml/d**

(a) Volumes as provided by the CDC.
(EIA) Parameter used to assess and rate the significance of impacts in Section 7 of the EIR.

The water requirements for finfish and shellfish aquaculture as shown above were calculated assuming a water efficiency ratio of ~1.3 m^3/kg (1.3 Ml/tn) of live weight product produced, thus slightly above the range of intensive aquaculture production as discussed Section 4.5 and therefore present a fairly liberal or worst-case water use consumption for recirculating aquaculture in the ADZ.

Fresh water aquaculture developers that have presented business concepts to the CDC generally project water consumption efficiencies substantially lower than this. The use of super-intensive production systems, with water consumption of 0.3 m^3/kg for all fresh water aquaculture, the consumption of fresh water in the ADZ could drop from 17.6 Ml/d to less than 4.5 Ml/d, for the target production level of 5500 tn/yr.

In addition, if rainwater harvesting could be optimised, the reliance on external municipal water supply could be further reduced. Table 4-2 presents a maximum rainwater harvesting scenario applied to a super-intensive production system, as proposed by a potential aquaponics investor in the ADZ.

Table 4-2: Water Requirements for Super-Intensive Aquaponics, with Maximum Rainwater Harvesting

Theoretical 50 Hectare Aquaponics Production System	Total	Unit
Fish tunnels	5	ha
Greenhouses (vegetables)	45	ha
Initial water requirements (to fill culture units)	31.5	Ml
Evaporative water losses	0.47	Ml/d
Total consumptive water use		
Per day	0.54	Ml/d
Per year	195.38	Ml/yr
Average rainfall - Ngqura (Coega) (not PE)	412	mm/yr
Water harvesting at 75% efficiency (from tunnels and greenhouses) [(a)]	152.96	Ml/yr
Rainwater harvesting deficit (water needed from external source, i.e. municipal supply).		
Per day	0.12	Ml/d
Per year	42.43	Ml/yr

Theoretical 50 Hectare Aquaponics Production System	Total	Unit
Fish Production (180 tonnes / hectare)	810	tn/yr
Water efficiency (water use per fish product produced)	0.24	m^3/kg (Ml/tn)
Vegetable Production (at 7 kg plant matter per 1 kg of fish produced)	5670	tn/yr

(a) Efficiency based on study in Coega IDZ aby GSC (2013).

4.10.11 On-Farm Electricity Use

	Initial Years	Target	Long-Term (EIA)
Desalination	3-5 kWh/m^3		
Abalone, 9 kVA/tn [(a)]	1350 kVA	5400 kVA	13680 kVA
Recirculating Finfish and Shellfish, 2.2 kVA/tn [(a)]	1815 kVA	24200 kVA	89870 kVA
Seaweed, 1.1 kVA/tn [(a)]	742.5 kVA	2970 kVA	7524 kVA

(a) EOH (2014)

4.10.12 Waste Streams

4.10.12.1 Desalination

	Treatment	First Phase For a 15 Ml/d plant	Target (Long-Term) For a 60 Ml/d plant
Waste Water			
Total brine stream (include backwash water) 60 % of seawater intake	Not treated (to be released via permitted coastal waters discharge pipeline)	20 Ml/d	80 Ml/d
Pre-treatment backwash water (included in brine stream listed above) ~10% of seawater intake		3.5 Ml/d	14 Ml/d
Staff facilities and offices grey water	Not treated, may be reused for flushing of toilets, to be stored on site for removal by tanker, or to be released to municipal sewer)	1.5 m^3/d	3.0 m^3/d
Staff facilities and offices sewage	Not treated (use of conservancy tank with removal by tanker, or released to municipal sewer)	0.5 m^3/d	1.0 m^3/d
Solid Waste			
Solid content mixed in backwash water (when measured as dried to 30% = ~0.022 tn/Ml	Not treated or separated (typically released via permitted coastal waters discharge pipeline)	0.33 tn/d	1.32 tn/d
Waste water treated or separated		None anticipated unless specifically dictated by the coastal waters discharge permit requirements	
Solid waste treated or separated			

4.10.12.2 Abalone Flow-Through Aquaculture

	Treatment	Initial 150 tn/yr	Target 600 tn/yr	Long-Term Maximum 1520 tn/yr
Waste Water				
Abalone production water outflow	Not treated (released via permitted coastal waters discharge pipeline)	108 Ml/d	432 Ml/d	1100 Ml/d
Processing plant waste water (containing organic effluent, and small qualities of cleaning agents)	May require treatment depending on qualities before release to sewer or permitted coastal waters pipeline (as per options in Section 4.9 of EIR).	6 m^3/d	24 m^3/d	130 m^3/d
Staff facilities and offices grey water	Not treated, may be reused for flushing of toilets, to be stored on site for removal by tanker, or to be released to municipal sewer.	11 m^3/d	42 m^3/d	110 m^3/d
Staff facilities and offices sewage	Not treated (initial use of conservancy tank with removal by tanker, or released to municipal sewer)	3 m^3/d	13 m^3/d	34 m^3/d
Solid Waste				
Abalone production solid waste component (mixed with production water outflow)	Not treated or separated (typically released via permitted coastal waters discharge pipeline)	15 tn/yr	60 tn/yr	150 tn/yr
Processing plant solid waste (only 30-35% of an abalone is edible)	Removed to landfill site as the base case management option unless further processed (as per options in Section 4.9 of EIR).	105 tn/yr	429 tn/yr	1030 tn/yr
Waste water treated		None anticipated unless specifically dictated by the coastal waters discharge permit requirements		
Solid waste treated or processed as by-products		**Maximum 1030 tn/yr (if not disposed at landfill)** (Air emissions licence required, including an assessment of odour risks and impacts)		

4.10.12.3 Marine (Seawater) Recirculating Aquaculture

	Treatment	Initial	Target	Long-Term Maximum
		275 tn/yr production	5500 tn/yr production	20425 tn/yr production [c]
Waste Water				
Production water outflow	Production water circulated within the aquaculture system is continuously treated to ensure optimal conditions for fish health and growth. It is unlikely that further treatment of the outflow water (effluent) would be required. Depending on qualities of outflow water achieved, treatment of the outflow water (effluent) may be required before release to the sewer or permitted coastal waters pipeline (as per options in Section 4.9 of EIR).	0.6 Ml/d	11 Ml/d	44 Ml/d
Processing plant waste water (containing organic effluent, and small qualities of cleaning agents)	May require treatment depending on qualities before release to sewer or permitted coastal waters pipeline (as per options in Section 4.9 of EIR).	7.2 m^3/d (0.007 ML/d)	144 m^3/d (0.144 ML/d)	570 m^3/d (0.57 ML/d)
Staff facilities and offices grey water	Not treated, may be reused for flushing of toilets, to be stored on site for removal by tanker, or to be released to municipal sewer.	3 m^3/d	55 m^3/d	220 m^3/d
Staff facilities and offices sewage	Not treated (initial use of conservancy tank with removal by tanker, or released to municipal sewer)	1 m^3/d	17 m^3/d	70 m^3/d
Solid Waste				
Production solid waste (aquaculture sludge), measured as dry weight	Removed to landfill as the base case management option unless processed or treated (as per options in Section 4.9 of EIR).	90 tn/yr [a]	1788 tn/yr [a]	7100 tn/yr [a]
Processing plant solid waste (for filleted finfish)	Removed to landfill as the base case management option unless processed or treated (as per options in Section 4.9 of EIR).	193 tn/yr [b]	3850 tn/yr [b]	1500 tn/yr [b]
Waste water treated		Treatment of production water outflow not anticipated. But is dictated by the quality requirements of the coastal waters discharge permit, maximum of 44 Ml/d of effluent treatment may be required **Processing plant waste water is likely to require treatment: 0.57 Ml/d**		
Solid waste treated or processed as by-products		**Maximum 8600 tn/yr (if not disposed at landfill)** (Air emissions licence required, including an assessment of odour risks and impacts for fish processing waste)		

(a) dry weight equivalent, total weight would depend on moisture content and level of dewatering
(b) wet weight
(c) 50% of total long-term marine and fresh water finfish and shellfish production (tabled above)

4.10.12.4 Freshwater Recirculating Aquaculture

	Treatment	Initial 550 tn/yr production	Target 5500 tn/yr production	Long-Term 20425 tn/yr production [c]
Waste Water				
Production water outflow	Production water circulated within the aquaculture system is continuously treated to ensure optimal conditions for fish health and growth. It is unlikely further treatment of the outflow water (effluent) would be required but depending on qualities of outflow water achieved, treatment of the outflow water (effluent) may be required before release to to sewer or permitted coastal waters pipeline (as per options in Section 4.9 of EIR).	1.1 Ml/d	44 Ml/d	44 Ml/d
Processing plant waste water (containing organic effluent, and small qualities of cleaning agents)	May require treatment depending on qualities before release to sewer or permitted coastal waters pipeline (as per options in Section 4.9 of EIR).	15 m^3/d	570 m^3/d	570 m^3/d
Staff facilities and offices grey water	Not treated, may be reused for flushing of toilets, to be stored on site for removal by tanker, or to be released to municipal sewer.	6 m^3/d	220 m^3/d	220 m^3/d
Staff facilities and offices sewage	Not treated (initial use of conservancy tank with removal by tanker, or released to municipal sewer)	2 m^3/d	70 m^3/d	70 m^3/d
Solid Waste				
Production solid waste dry weight, in solution	Removed to landfill as the base case management option unless processed or treated (as per options in Section 4.9 of EIR).	179 tn/yr [a]	7100 tn/yr [a]	7100 tn/yr [a]
Processing plant solid waste (for filleted finfish)	Removed to landfill as the base case management option unless processed or treated (as per options in Section 4.9 of EIR).	385 tn/yr [b]	1500 tn/yr [b]	1500 tn/yr [b]
Waste water treated		Treatment of production water outflow not anticipated. But is dictated by the quality requirements of the coastal waters discharge permit, maximum of 44 Ml/d of effluent treatment may be required		
		Processing plant waste water is likely to require treatment: 0.57 Ml/d		
Solid waste treated or processed as by-products		**Maximum 8600 tn/yr (if not disposed at landfill)** (Air emissions licence required, including an assessment of odour risks and impacts for fish processing waste)		

(a) dry weight equivalent, total weight would depend on moisture content
(b) wet weight
(c) 50% of total long-term marine and fresh water finfish and shellfish production (tabled above)

4.10.13 Water, Waste Water and Solid Waste Storage

4.10.13.1 Desalination

	First Phase For a 15 Ml/d plant	Target For a 60 Ml/d plant
Fresh Water:		
Product Water [(a)]	0.46 Ml	1.83 Ml
Water Containing Waste :		
Brine [(a)]	0.61 Ml	2.44 Ml
Pre-Treatment backwash water [(a)]	0.11 Ml	0.43 Ml

(a) 30 minute buffer tanks, assuming 18 hours pumping per day

4.10.13.2 Intake Water Storage [(a)]

	Initial	Target	Long-Term [(EIA)]
Seawater intake water in reservoir	250 Ml	500 Ml	1000 Ml
Fresh water intake in reservoir or tanks	2 Ml	20 Ml	100 Ml
Total	**252 Ml**	**520 Ml**	**1100 Ml**

(a) 24 hour storage

4.10.13.3 Aquaculture Production Water Storage [(a)]

	Initial	Target	Long-Term
Seawater in various tanks, ponds and raceways [(a)]	95 750 ML	1 419 000ML	5 152 600 ML
Fresh water in various tanks, ponds and raceways [(b)]	71 250 ML	742 500ML	2 451 000 ML
Total	**167 000 ML**	**2 161 500 ML**	**7 603 600 ML**

(a) 30 kg/m³
(b) 60 kg/m³
(c) 30 kg/m³ with a 50/50 split between seawater and fresh water aquaculture production
(d) 60 kg/m³ with a 50/50 split between seawater and fresh water aquaculture production

4.10.13.4 Processing Plant Waste

	Initial	Target	Long-Term Maximum
Waste Water [(c)]			
Abalone	42 m^3 [(a)]	168 m^3 [(b)]	504 m^3 [(b)]
Finfish and Shellfish	101 m^3 [(a)]	114 m^3 [(b)]	2280 m^3 [(b)]
Solid Waste			
Scenario 1: If all waste is stored frozen for 7 days	13 tn	156 tn	3118 tn
Scenario 2: If all waste is cold stored for 48 hours	4 tn	45 tn	891 tn

(a) 7 day storage (interim)
(b) 1 day storage
(c) Can be above-ground tanks

4.10.13.5 Sewage and Grey Water (Offices and Staff Facilities)

	Initial	Target	Long-Term
Sewage	30 m^3 [(a) (b)]	N/A. Linked to sewer system	
Grey Water [(c)]	88 m^3 [(a)]	220 m^3 [(a)]	4400 m^3 [(a)]

(a) 4 day storage
(b) 5 x 6000 L conservancy tanks in the ADZ
(c) Can be above-ground tanks

4.10.13.6 Aquaculture Production Waste (Sludge)			
	Initial	Target	Long-Term
Sludge separated from process [(a)]			
Scenario 1: As dewatered solids	8 tn	60 tn	600 tn
Scenario 2: Slurry (~5% solids)	160 tn	1200 tn	12000 tn

(a) 7 day storage

5 Development Alternatives

5.1 Site Alternative and Development Footprint Definition for Aquaculture

As discussed in detail in Section 1.5 and Section 2 the CDC's plans for the development of an aquaculture development zone in Zone 10 of the Coega IDZ follow years of planning and assessment. Various strategic, regional, IDZ-wide and project specific environmental and planning processes have been undertaken to provide context for the ADZ and the selection of the site within the coastal cluster of development in Zone 10 of the IDZ. In essence, these and the other assessment and planning processes, served to evaluate alternative land uses in Zone 10 of the IDZ, including potential conflicts and synergies with other industries throughout the IDZ, and served as the site selection and delineation of a development footprint for the ADZ.

As such, this EIA does not attempt to repeat an evaluation of site alternatives for the ADZ or of alterative land uses for Zone 10 of the IDZ.

The fact that the EIA will not be investigating site alternatives was explained in the Scoping Report and the plan of study for EIA.

5.2 Site Alternatives for Seafood Processing

The CDC initially proposed to have the processing facilities located in Zone 3 of the IDZ. However, based on feedback received from prospective aquaculture investors, CDC has eliminated Zone 3 as a development option because investors specifically requested to have processing integrated on the same site as their aquaculture operations.

5.3 Technology Alternatives

The overall purpose of the project is to establish an 'investment ready' platform for planned commercial aquaculture operations to establish within the Coega IDZ. Specific details, layout and designs of the aquaculture facilities within the ADZ will only become available once the individual developers have made the decision to invest in the Coega IDZ and have completed their individual layout plans and designs.

Various options and technologies are listed and discussed in Section 4 but most of these are options that are open for consideration and not a discussion to select a preferred development alternative. Design criteria are provided where relevant to deal with decision-making regarding these options post the EIA phase.

5.4 The No-Go Development and Alternative Developments

The no-go development option is discussed in the impact assessment section of the report (Section 7). All the impact rating tables include a rating of the no-go development. The no-go development, if the land was left undeveloped it would obviously be beneficial in terms of conservation.

Being part of an IDZ earmarked for industrial development to stimulate economic growth, it is reasonable to assume the land may eventually be earmarked for developed of other industrial type developments should aquaculture development not materialise. These alternative industrial developments may have the same or higher impacts than the ADZ since aquaculture is generally regarded as a low impact sector for many environmental components such as visual, noise, air quality, groundwater and surface water impact components.

However, agro-processing is one of the priority sectors of the Coega IDZ. Aquaculture, food processing and food packaging are sub-sectors of the agro-processing sector. The CDC's plans for the development of an aquaculture development zone follow years of planning. Various strategic, regional, IDZ-wide and project specific environmental and planning processes have been undertaken to provide context for the ADZ and the selection of the site within the coastal cluster of development in Zone 10 of the IDZ. These and the other assessment and planning processes served to evaluate alternative land uses, including potential conflicts and synergies, throughput the IDZ and as the site selection process for the ADZ.

As described elsewhere in the report, the Coega IDZ and specifically Zone 10, is located on the doorstep of some sensitive 'immediate neighbours' such as the near-pristine primary and secondary dunes to the east of the ADZ (OSMP Area 1A and 1B), Algoa Bay and its various islands, a proposed marine reserve, the coastal section of Addo Elephant National Park, a critical habitat for the endangered African Penguin on St Croix Island, as well as tourism and recreation activities associated with these. With appropriate mitigation measures in place, aquaculture would be a relatively low impact activity and would be preferable to heavy industries near these sensitive immediate neighbours. It could be viewed as a buffer between these immediate neighbours and other heavier industries in the IDZ since it shares the pursuit of clean air and water, thus adding to the conservation voice of the sensitive immediate neighbours. If other heavier industries were established on the site the IDZ's sensitive immediate neighbours may be affected more than if the ADZ was allowed to be developed.

As illustrated through the detailed assessment of impacts in Section 7, the EIA did not identify reason to enforce the no-go development option.

6 Nature of the Affected Environment

6.1 Climate

The climate of the area is historically variable, both seasonally as well as year on year. This is largely due to the location of the area within a climatic transition zone between a summer rainfall regime (towards the east) and a winter rainfall regime (towards the west). The area exhibits a temperate climate that enjoys warm summers and temperate winters. Rainfall is distributed throughout the year with slight peaks in autumn and spring. According to the South African Weather Service data, annual rainfall[9] measured at the nearby Ngqura (Coega) weather station is 412 mm per year. The CDC rainfall monitoring data, from their air quality monitoring station near the salt works reflects a very similar annual average rainfall of 416 mm for the period 2003 to 2012 and 2016.

Precipitation

Monthly precipitation data received from South African Weather Service are provided in Table 6-1 and data collected by the CDC since 2003 in Table 6-2 below:

Table 6-1: Monthly Precipitation Data for the Coega Weather Station, SA Weather Service

Data (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Average (Overall)	24.7	36.9	38.1	35.4	32.9	40.2	26.5	29.7	17.3	57.7	33.2	39.8	34.3
Average	33	26	36	40	38	23	12	30	17	46	24	43	31

[9] *Environmental assessments undertaken by Transnet indicate the average rainfall near the Port of Ngqura to be ~400 mm per year (Coetzee et al. 1996, in Coastal & Environmental Services, 2001). Rainfall measured at the nearby Hougham Park (Crews quarry) indicates an average rainfall of ~425 mm per year (CEN, 2009).*

Data (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
(2003-2010)													
Maximum Total	87	49	87	84	104	44	30	151	39	88	82	136	82
Minimum Total	8	12	8	20	4	9	2	1	2	16	1	15	8
Maximum in 24 Hours	32	17	43	80	39	19	13	97	19	51	30	65	42

SA Weather Service data 2003-2010 for Coega (Station Ngqura, No 00352889), 33°48'S 25°40'E

Table 6-2: Precipitation Data Collected by the CDC

Data (mm)	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
2003	--	--	51.8	84.2	85	9	24.4	21.2	16.4	40.4	5	18.6	--
2004	16	33	20.8	53.6	23.4	21.4	7	9.8	39	26	22.6	136.2	408.8
2005	53.4	48.6	53.2	31	10.6	9	2	0.8	23	16	82	21.4	351
2006	87.2	12	7.6	52.2	104	25.8	18.8	151.2	30.2	72.4	16	25.2	602.6
2007	13.8	12.4	87	23.8	65.4	19.6	2.2	16.8	6.8	41	22.4	81.6	392.8
2008	32.2	24	16.4	34.2	8.2	16.2	3.2	20.4	2.4	41.8	33.8	14.6	247.4
2009	7.6	41.4	7.8	24.2	3.6	38.4	29.8	6	14.8	45.4	12.4	15.2	246.6
2010	21.4	11.6	42.2	19.6	7.6	43.8	8.2	11.4	3.6	87.6	1.2	34.2	292.4
2011	10	26.2	31.6	20.8	95.2	148.6	91.2	27.8	3	13	80.8	40.8	589
2012	14	93.2	79.6	46.4	11.2	95.2	--	--	--	--	--	--	--
2013	--	--	--	--	--	--	--	--	--	--	--	--	--
2014	--	--	--	--	--	--	--	--	--	--	--	--	--
2105	42	70	56.6	129.7	18.5	73.7	2.6	21.9	61.2	43.2	74.5	22.1	616
Monthly Average	29.8	37.2	41.3	47.2	39.3	45.5	18.9	28.7	20.0	42.7	35.1	41.0	--
Annual Average for 2004 to 2011 and 2015 (based on years with full datasets)													416

CDC Rainfall Data, Saltworks Air Quality Monitoring Station, 33°45'49.60"S 25°41'10.34"E

Temperature

The mean annual temperature for the Coega area is 17.9 °C. Average temperature, extreme temperatures and diurnal ranges, as obtained from the South African Weather Service for the period 2003 to 2010, are tabled below:

Table 6-3: Monthly Temperature Data for the Coega Weather Station

Temperatures (°C)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Average Daily	Max	25.5	26.2	25.5	24.4	23.1	21.6	21.4	21.3	21.4	22.1	23.6	24.4	23.4
	Min	17.4	17.8	15.6	13.2	10.6	7.8	7.0	7.8	9.3	12.3	14.2	15.4	12.4
	Mean Temp	21.4	22.0	20.6	18.8	16.9	14.7	14.2	14.6	15.4	17.2	18.9	19.9	17.9
	Diurnal Range	8.2	8.4	9.9	11.2	12.5	13.7	14.4	13.5	12.0	9.8	9.4	9.0	11.0
Extreme High Maximum	High	38.8	41.9	40.4	39.7	36.6	31.3	32.1	35.5	36.2	39.4	37.6	36.6	37.2

Temperatures (°C)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
	Mean	32.4	33.8	37.5	35.5	33.2	29.5	30.2	33.3	32.9	31.8	32.2	31.6	32.8
Extreme Low Minimum	Mean	11.6	12.8	9.8	7.6	5.3	2.8	2.4	3.1	4.3	6.1	8.7	10.2	7.1
	Low	9.2	10.8	8.0	4.8	3.7	0.7	1.1	2.0	2.6	4.3	5.9	8.9	5.2

SA Weather Service data 2003-2010 for Coega (Station Ngqura, No 00352889), 33°48'S 25°40'E

The region experiences between 240 and 270 sunny days per year. These days are defined as having more than 50 % of the possible sunshine duration. Less than 10 days a year are completely overcast.

Evaporation

Evaporation is about 1528 mm/yr (S-Pan evaporation in WRC, 2005) and exceeds rainfall in all months.

NMB is known for solar evaporation of seawater in shallow man-made ponds as part of the production of sea salt. Evaporation would be an efficient means of reducing the volume of brine or waste water associated with desalination and aquaculture (Sami, 2008).

Humidity

The coastal influence on the local climate is evident with mean annual relative humidity between 70 and 80 percent. Winter experiences a mean monthly relative humidity of between 60 and 70 percent and summer between 80 and 90 percent.

Wind

The wind regime is vigorous and fresh strong winds occur throughout the year. The prevailing wind is usually from the south-west. It blows all year, 40% of the time, and represents 70% of the total wind energy. The easterly winds become significant in spring and summer; it blows 30% of the time, and represents 24% of the wind energy. The north-westerly wind is minor. It blows in autumn, 30% of the time, and represents 6% of the wind energy. The windiest conditions occur from August to December and the calmest wind periods occur from March to May. For 1.5% of the time, winds are light (less than 0.5 m/s). The annual distribution of winds in the Coega IDZ, as measured at the CDC's Saltworks Air Quality monitoring station, is shown below.

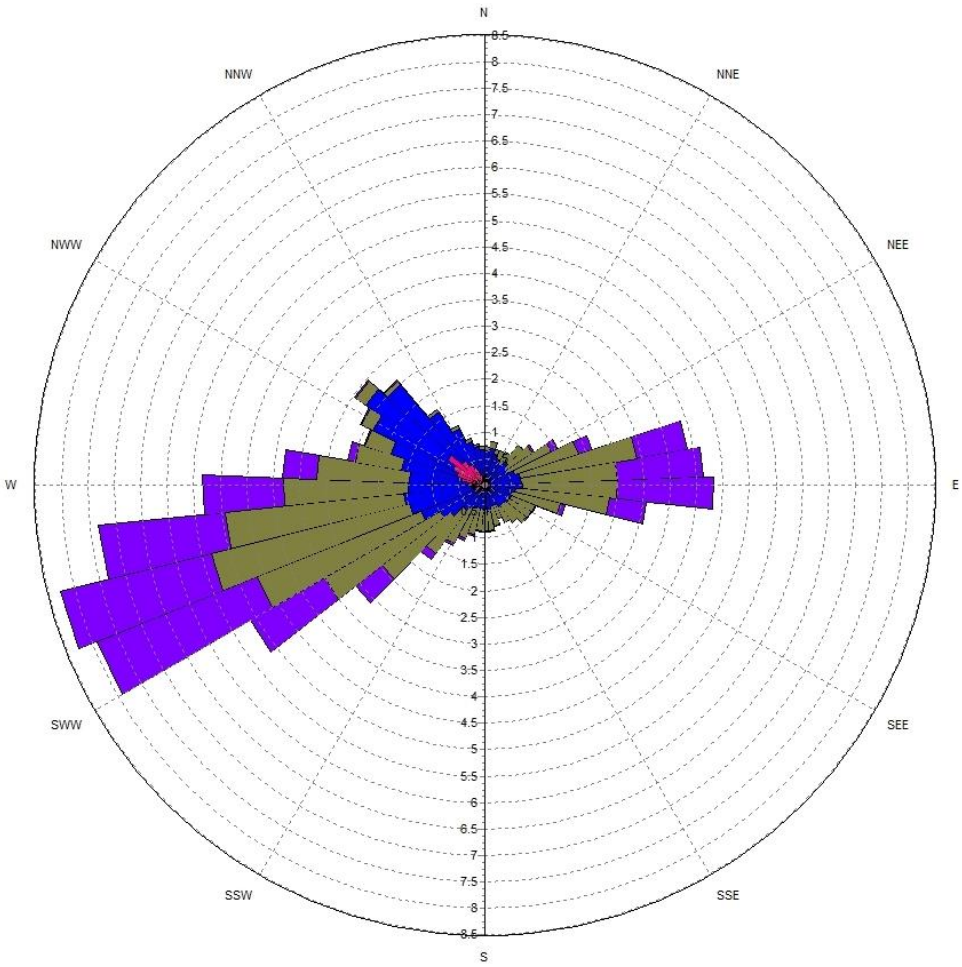


Figure 6-1: Annual Wind Distribution (wind speed in m/s)

Source: Air Quality Specialist Assessment, LAQS, 2016.

Ecoregion

The Coega IDZ is located in the South Eastern Coastal Belt, or Ecoregion 20 as per the Preliminary Level I River Ecoregional classification System for South Africa (Kleynhans, *et al* 2005). The Swartkops, Gamtoos and Keurbooms Rivers flow through this region, as illustrated below.

Extreme Events

High winds are the most common form of extreme weather conditions followed by frequent severe drought cycles.

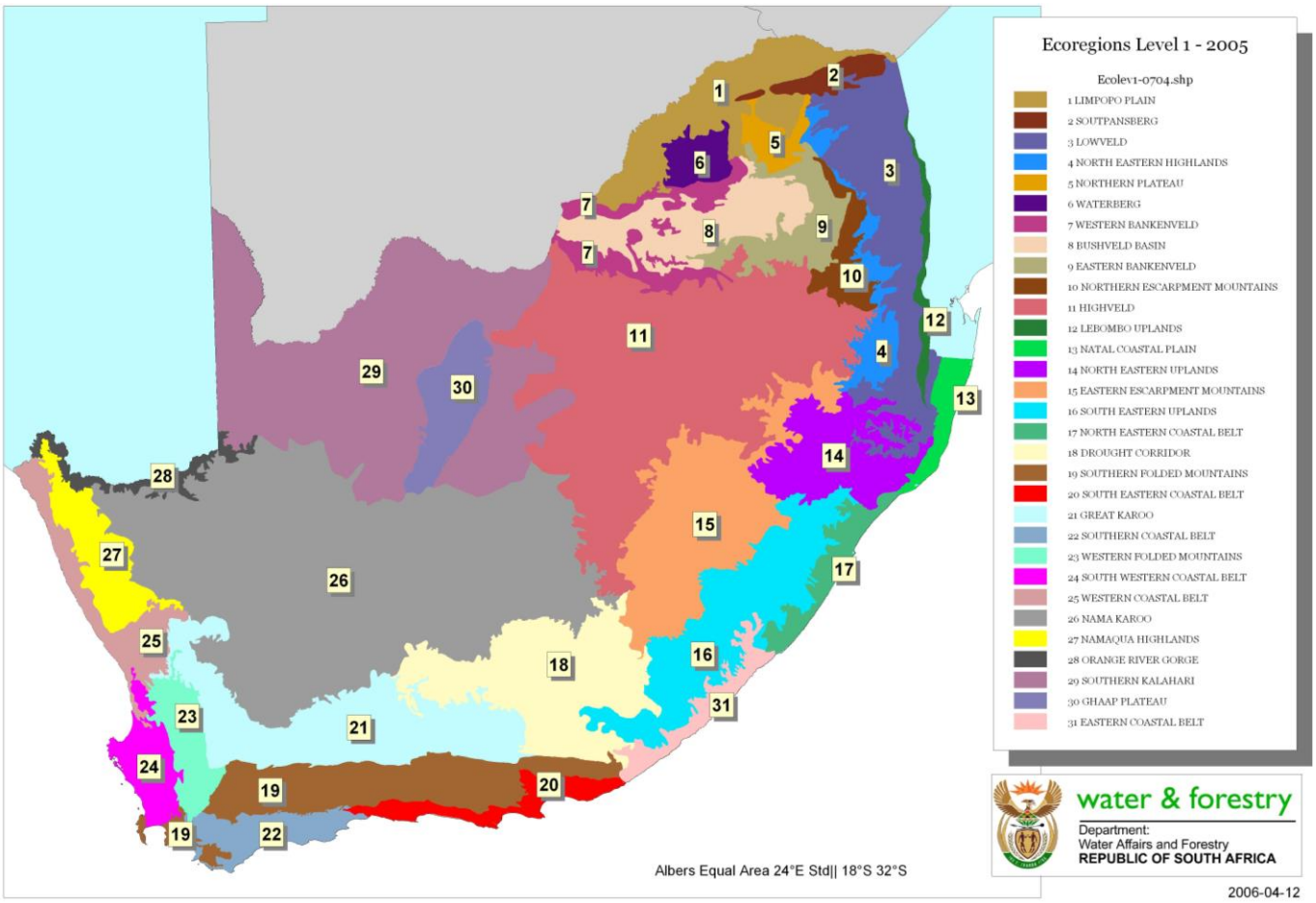


Figure 6-2: South African Ecoregions – Coega IDZ located in Ecoregion 20: South Eastern Coastal Belt
Source: www.dwa.gov.za/iwqs/gis_data/ecoregions/ecoregions_level1_300dpi.jpg

6.2 Geology and Groundwater

The Coega IDZ is underlain by sedimentary rocks that range in age from 470 million years ago to the present. These sediments are assigned to rock successions within the (oldest) Palaeozoic Table Mountain Group, the Mesozoic Uitenhage Group and the (youngest) Caenozoic Algoa Group. The geological formations found at surface in and around the ADZ are graphically illustrated on Figure 6-4. Figure 6-6 provides a simplified sectional schematic (stratigraphic column) of the different rock formations and successions, with a focus on the complex formations of the Algoa Group.

The Coega Fault extends from the west of the Groendal Dam eastwards and reaches the coastal area to the west of the Coega River and Port of Ngqura (Mitha *et al*, 2012). The ADZ is thus located outside of the area of influence of the Coega Fault.

Table Mountain Group

The base rock around NMB consists of the Peninsula Formation (fluvial quartzitic sandstones) of the Table Mountain Group. This formation consists of coarse-grained super-mature quartzitic sandstone and is relatively resistant to erosion. It forms the bedrock of Algoa Bay and emerges as outcrops in the bay as the islands of St Croix, Jahleel, Bird and Brenton and inland as the Coega Kop. The areas between these islands are filled with recent fluvial marine deposits of the Alexandria Formation (sandy limestone, beach deposits), which directly overlie the Sundays River (marine mudstone) and Kirkwood Formation (fluvial mudstone and sandstone).

The Table Mountain Group is associated with the Uitenhage Artesian Basin, which is a fractured rock aquifer formed by sandstones and quartzites of the deeper bedrock of the Table Mountain Group. It is South Africa's most

important artesian groundwater basin and covers an area of approximately 3 700 km^2, occurring mostly within the Port Elizabeth and Uitenhage areas, and is recharged by rainfall on the Groot Winterhoek and Zunga mountain ranges to the west. The basin enjoys a moderate mean annual precipitation of 636 mm with rain during all seasons, mostly due to orographic influences. The rainfall is, however, variable over the whole basin with the highest rainfall at 760 mm/yr in the mountainous catchment but decreasing to 435 mm/yr at Uitenhage. Average annual evaporation in the basin is 1 650 mm. It is sub-divided hydrogeologically by the Coega Fault into two main aquifer systems. The Coega Ridge Aquifer north of the Coega Fault and the deeper Swartkops Aquifer to the south of the fault. The two aquifer systems function independently from one another, with boreholes in one unit not being impacted by abstraction from boreholes in another unit. Large-scale abstraction occurs from the Coega Ridge Aquifer (e.g. at Uitenhage, Sandfontein, Amanzi Estate, Coega Kop and Wells Estate) and in the past, this aquifer has been over-exploited, resulting in a reduction of artesian yields. A strong degree of hydraulic connectivity exists between the boreholes along the Coega Ridge Aquifer. This artesian system was protected under Government Proclamation No. 260 of 1957 and No. 958 of 1958 when the Uitenhage Subterranean Groundwater Control Area was proclaimed. However, the rights of access to this water have altered in the light of the National Water Act 36 of 1998 (CSIR, 2013 and Saki, 2008).

The southern part of the IDZ is located over the Coega Ridge Aquifer but, based on the best available maps that delineate the aquifers (Maclear, 2001) the ADZ appears to be located just outside and to the north of it (Figure 6-5). There is a NMMU doctorate study underway which may shed light on the delineation of the Coega Aquifer and its groundwater delivery potential once the study results becomes available (Dr Maarten de Wit, pers. comm). The flow direction of the deeper Coega Ridge Aquifer is towards the sea into Algoa Bay and it is protected by an overlying thick aquiclude formed by the Sundays River Formation. The potential for contamination of the deep artesian aquifer is practically non-existent and it is not regarded as vulnerable to contamination (CSIR, 2013 and Saki, 2008).

Reportedly, the NMB Municipality is in the process of applying for a water use licence for abstraction of 20 Ml/day from the aquifer in the Coega Kop area and any abstraction in addition to this would be unlikely (Aurecon Engineers, various representatives, pers. comm.). Due to the flow direction towards Algoa Bay, groundwater abstraction from the deep aquifer in the vicinity of the ADZ may be possible without necessarily affecting abstraction near Coega Kop, if abstraction from these depths is not too costly. Until such time as further investigations are undertaken, this remains speculation.

Uitenhage Group

The bedrock of the Peninsula Formation quartzitic sandstones is overlain by the Sundays River Formation (marine mudstone) and Kirkwood Formation (fluvial mudstone) of the Uitenhage Group.

The Sundays River Formation is found at surface in the inland portion of the ADZ, while the deeper lying Kirkwood formation is only found at surface further south, close to the Coega River. The Sundays River Formation consists of Cretaceous age consolidated sandstones, siltstones and greenish-grey mudrocks. Past changes in sea level resulted in platforms being cut into the formation at various heights above the current sea level. These terraces have been filled with later deposits of sediments and fluvial deposits from the migration of the Sundays River. The Sundays River Formation is essentially impermeable with poor aquifer potential and high salinities. The Sundays River Formation ranges in thickness from approximately 10 m in the vicinity of Coega Kop to more than 1000 to 1200 m towards the coast and the centre of Algoa Bay, but the exact depth in areas close to Zone 10 and the ADZ is not specifically documented. It is regarded as an aquiclude between the underlying quartzitic sandstones and deep artesian aquifer and the overlying shallow saline aquifers.

Algoa Group

Along the coastal portion of the ADZ, the Sundays River Formation is mantled over by the Algoa Bay Group which includes the Alexandria (sandy limestone, beach deposits), Nanaga (sandy limestone, aeolian), Salnova (beach deposits), Nahoon (aeolianite) and Schelm Hoek (modern dunes) Formations.

The Alexandria Formation has an average thickness ranging from 7 to 10 m and was deposited on a shallow seafloor in the Late Tertiary Period. This sea floor has subsequently lifted by as much as 300 m above the present day sea level. It is limestone rich and consists of a highly cemented shelly conglomerate and gravel overlain by a medium to fine grained calcarenite. The Alexandria Formation rocks have a low permeability, leading to a high residence time of the groundwater in contact with the host rock, resulting in increased potential for leaching salts from the formation. Groundwater yields from the Alexandria Formation are generally limited and of poor quality. In the vicinity of Zone 10 and the ADZ, the Alexandria Formation is dry as it is overlain by calcrete which prevents the infiltration of rainwater. Hence the aquifer is discontinuous and generally perched, restricted to areas where rainwater can enter karstic solution channels.

Along the coastal section of the ADZ, the Schelm Hoek Formation forms the upper visible dune sands and overlies the Nahoon Formation. The Nahoon Formation consists of white to yellowish fine to medium grained consolidated dune sand and is overlain by calcrete. It is found at surface in places along the coast, such as near the old abalone farm. The Salnova Formation crops out intermittently along the coastline in the ADZ, as seen on Figure 6-4. The Salnova Formation comprises a spectrum of well-indurated sandy and conglomeratic beach deposits that form low rocky benches close to modern sea level and are locally rich in marine shell remains. A paleontological important stratotype section of the Salnova Formation has been identified in Zone 10 near the eastern boundary of the IDZ (Section 7.20).

The coastal dune strip is generally the only permeable rock formations in Zone 10, but is not a good aquifer due to high salinities and a very thin saturated thickness. The sands extend to 2.5 m below sea level, where a clay layer forms the base of the sands and the lower base is saturated with saline water. Water is generally encountered within the coarse beach sand below the dune sands. The area with the highest permeability occurs with the basal conglomerate and shelly beach sand at the base of the profile, which acts as the transmissive zone. As a result, the aquifer behaves as a leaky confined aquifer, exhibiting a rapid stability in a drawdown during pumping as leakage from the overlying fine sand is induced, followed by rapid recovery following pump shut down. Groundwater is generally about 3 to 7 m below surface, above the contact between the permeable sands and the underlying impermeable clays. Groundwater in the shallow aquifer flows in the same direction as the surface topography and surface runoff, as described in the Topography and Surface Water sections. Groundwater appears to be fairly constant due to the low transmissivity and storage and as a result of reduced infiltration of rainfall. These levels are nevertheless expected to rise and fall between 3 m and 4 m during substantial rainfall (CSIR, 2013).

The Department of Water Affairs (DWA) has geohydrologically classified the area as a fractured aquifer with a low borehole yield (0.1 – 0.5 L/s) but this refers to the borehole yields of the shallower geological formations and shallow semiconfined to unconfined, primary alluvial aquifer. The deeper fractured secondary Coega Ridge Aquifer of the Table Mountain Group is typically higher yielding. Borehole yields in the Coega Ridge Aquifer range from 2 to 10 L/s and the groundwater quality is excellent with low salinities. Water hardening, however, is required due to the acidic and corrosive nature of the groundwater, typical of other Table Mountain Group aquifers. Groundwater in the Coega Ridge Aquifer has been carbon fourteen dated between 1500 at 28000 years in, the with a calculated flow rate of 0.8 m/yr towards Algoa Bay. Water quality remains relatively constant along its flow path. From the chloride mass balance method, recharge rates are determined to be 25 to 55% of annual rainfall. Groundwater temperatures generally show that depths of groundwater strikes do not necessarily correspond with depth of origin, indicating a complex groundwater circulation pattern within the basin (Maclear, 2001). Currently, no groundwater from the aquifer is used in the Coega IDZ area. In the surrounding area, groundwater is used for agricultural purposes. Because of the protection afforded by clay aquicludes, water is of potable quality (CSIR, 2013). The NMB Municipality is targeting the deeper artesian Coega Ridge Aquifer, with boreholes near Coega Kop, to supplement water supply to NMB Metro (CSIR, 2013 and IDP, 2016). An historical groundwater investigation in the Hougham Park area by Morris in 1948 (Saki, 2008) suggested that very deep drilling to the Peninsula Formation quartzitic sandstones (Table Mountain Group) will be the only source of reliable water. However, for historical farming purposes, this was found too expensive and a shallow collector well system to collect shallow seepage from the sands was regarded as more cost-effective and sufficient to supply the volumes needed to supply the farm. A separate study will be required to investigate the feasibility, and acceptability, of

abstracting groundwater from the Coega Ridge Aquifer (CSIR, 2013) within the IDZ and for potential use in the ADZ.

The groundwater within the shallow aquifer is saline and in terms of domestic supplies is classified as a dangerous water quality. Boreholes that were drilled in the Hougham Park area in the past, into the elevated terrace, were either dry or saline. Boreholes drilled into the wave-cut platform had yields of less than 0.16 L/s. (600 L/hour), with conductivities of 400 to 650 millisiemens per metre (mS/m). The water in not potable and cannot be used for drinking purposes.

Historically, there were collector wells fed by a 220 m cut-off trench on Hougham Park farm, which collected water draining from the dunes above the low permeability Sundays River Formation. These were installed in 1948 to supply the then farming activities. The yield is relatively low and only 1 000 to 5 000 L/day can be obtained. Yields have decreased due to the introduction of vegetation to stabilise the dunes. This has had the effect of reducing recharge through the dunes. The water is relatively brackish at 192 mS/m. There are three old well points located near the old SeaArk pilot prawn facility where the water level is ~3.8 m below ground level. The wells are ~5.0 m deep. Due to the low yields, lack of use, and no down gradient users, Sami (2008) regarded the aquifer as of no significance for human use.

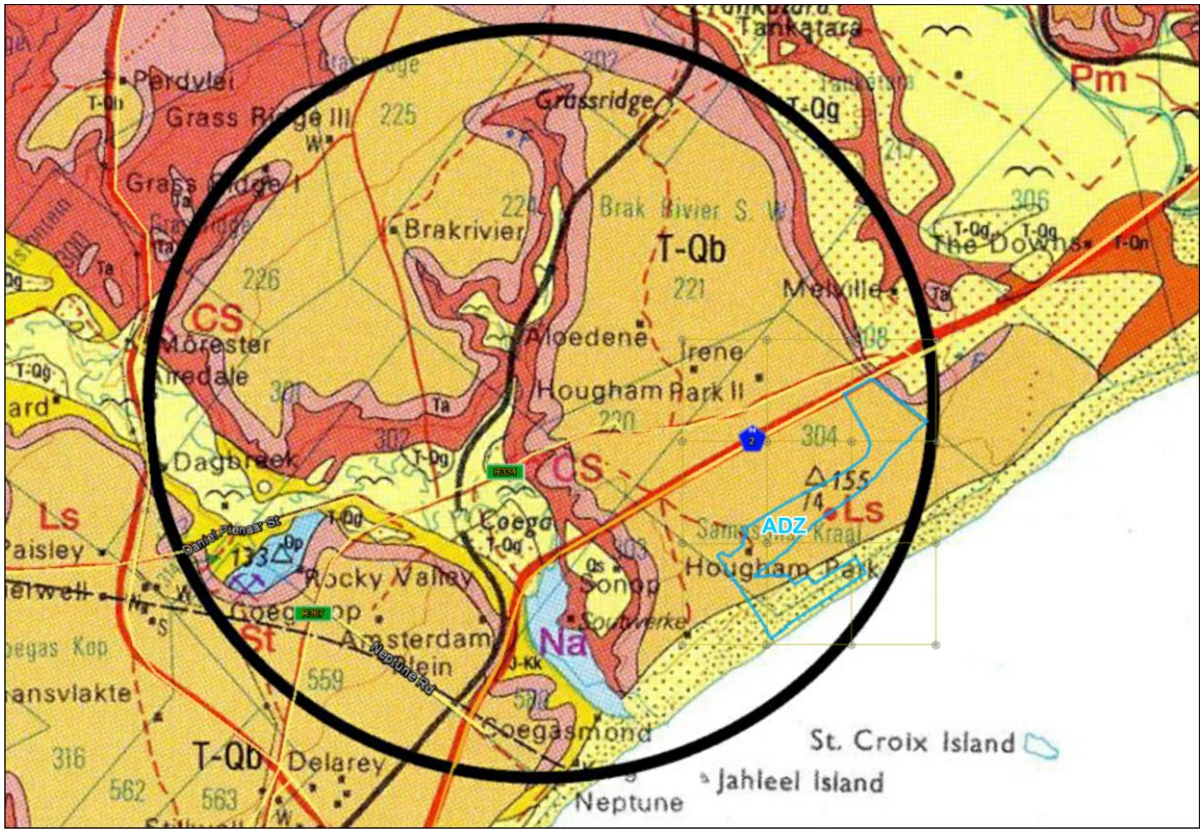


Figure 6-3: Overview of Geology

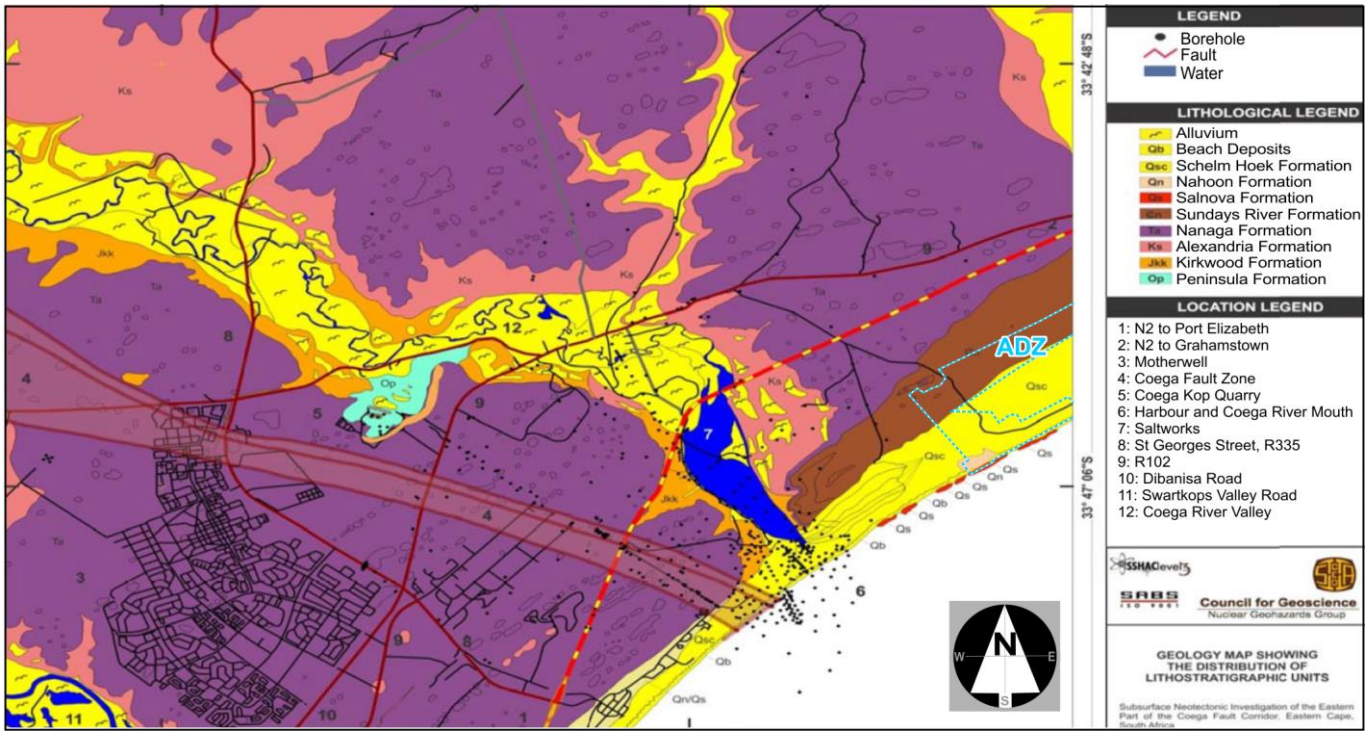


Figure 6-4: Geology of the Coega IDZ and ADZ

Source: Mitha, 2012

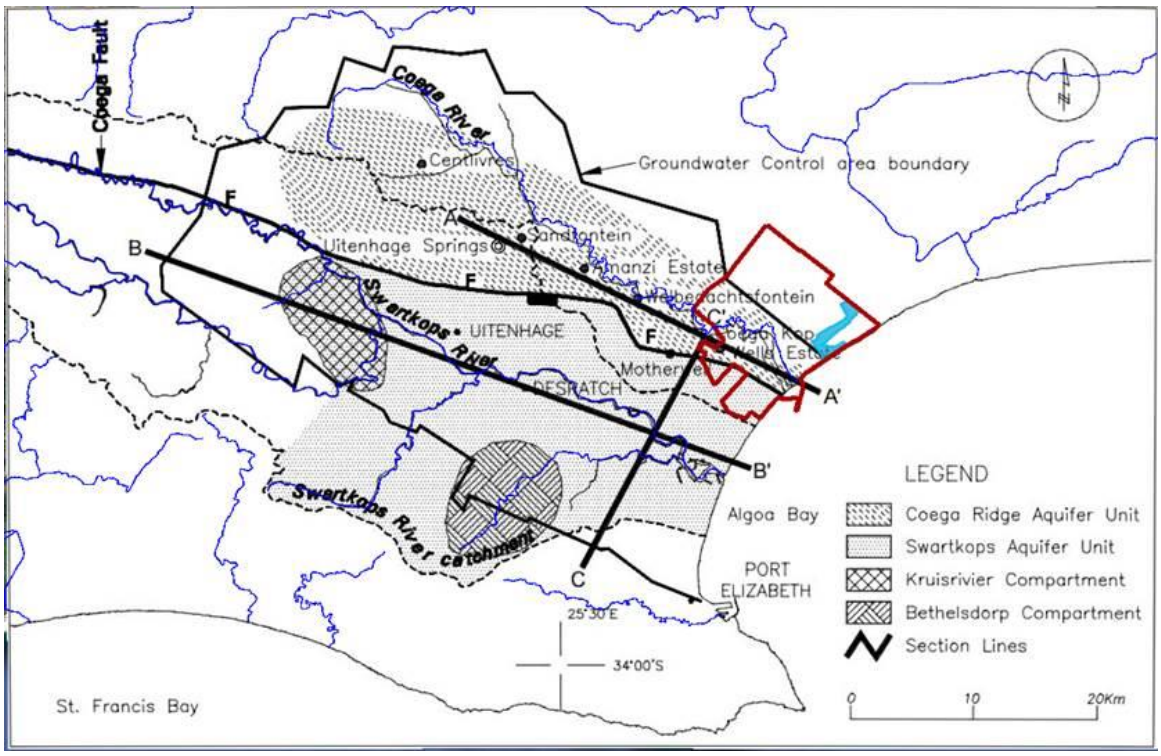


Figure 6-5: Location of the ADZ (blue polygon) and Coega IDZ (red outline) in relation to Coega Ridge Aquifer and old groundwater control area

Source: Maclear, 2001

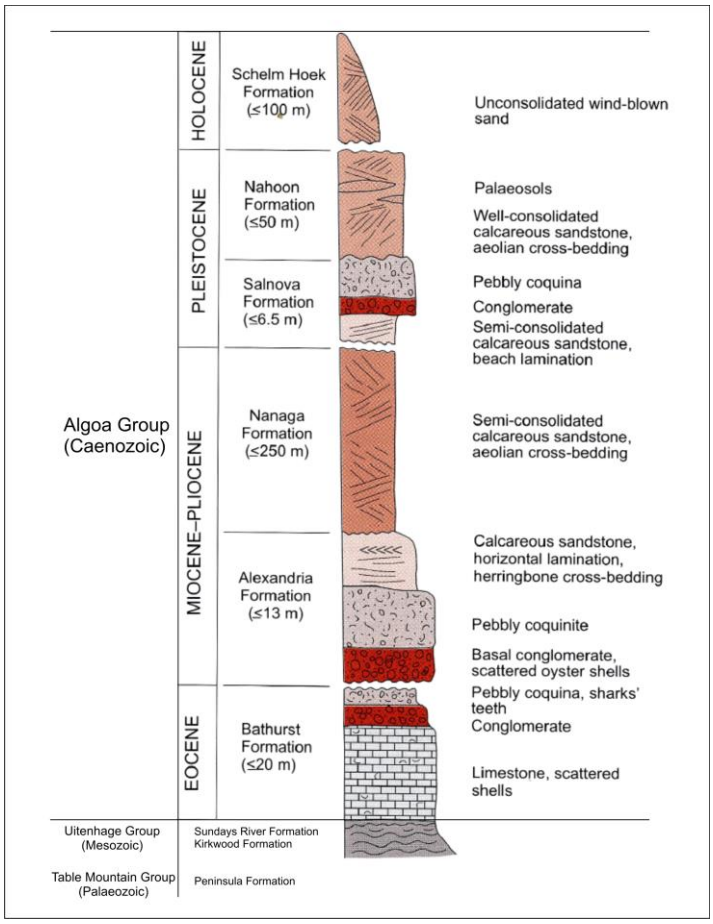


Figure 6-6: Simplified schematic stratigraphic column of the rock formations, focusing for the Algoa Group

Source: Roberts et al, 2006, in Almond, 2010.

Note this schematic is highly simplified, for example: the Alexandria and Nanaga Formations partially overlap in age, while the Salnova Formation interdigitates with the Nahoon and Schelm Hoek successions.

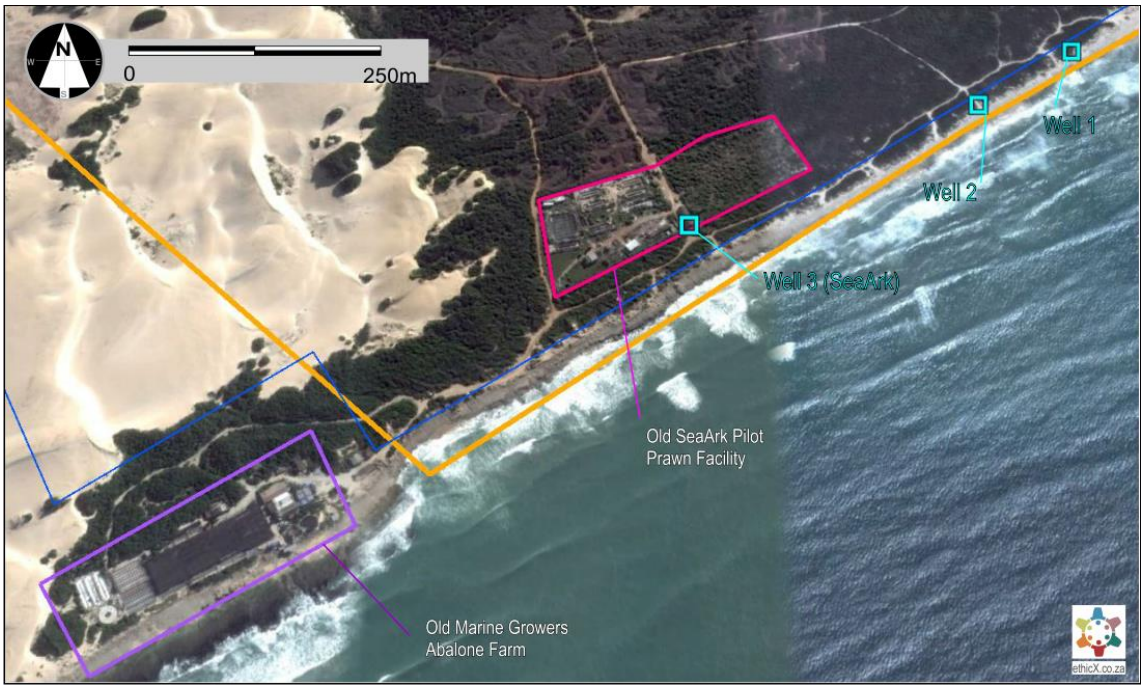


Figure 6-7: Location of old well points near the defunct SeaArk pilot prawn facility

Source: Saki, 2008.

6.3 Topography

The ADZ can be broadly subdivided into two topographical areas. There are the coastal dunes abutting the land-ocean interface and then a wave-cut plateau characterised by low palaeo-beach ridges extending roughly parallel to the coast (CDC ISWMP, 2010).

From the coastline the elevation rises relatively gently for the first ~250 m inland. Thereafter the gradient increases rapidly within a relatively short distance, at the edge of the wave-cut plateau. It then flattens out at a height of ~60 mamsl (Figure 6-8). Contours across Zone 10 and the proposed ADZ are illustrated on Figure 6-8. The majority of the ADZ is located on the relatively flat plateau above ~60 mamsl, with only ~100 ha of the allocated ~440 ha below the ~50 mamsl level. The highest point on the site is at ~75 mamsl.

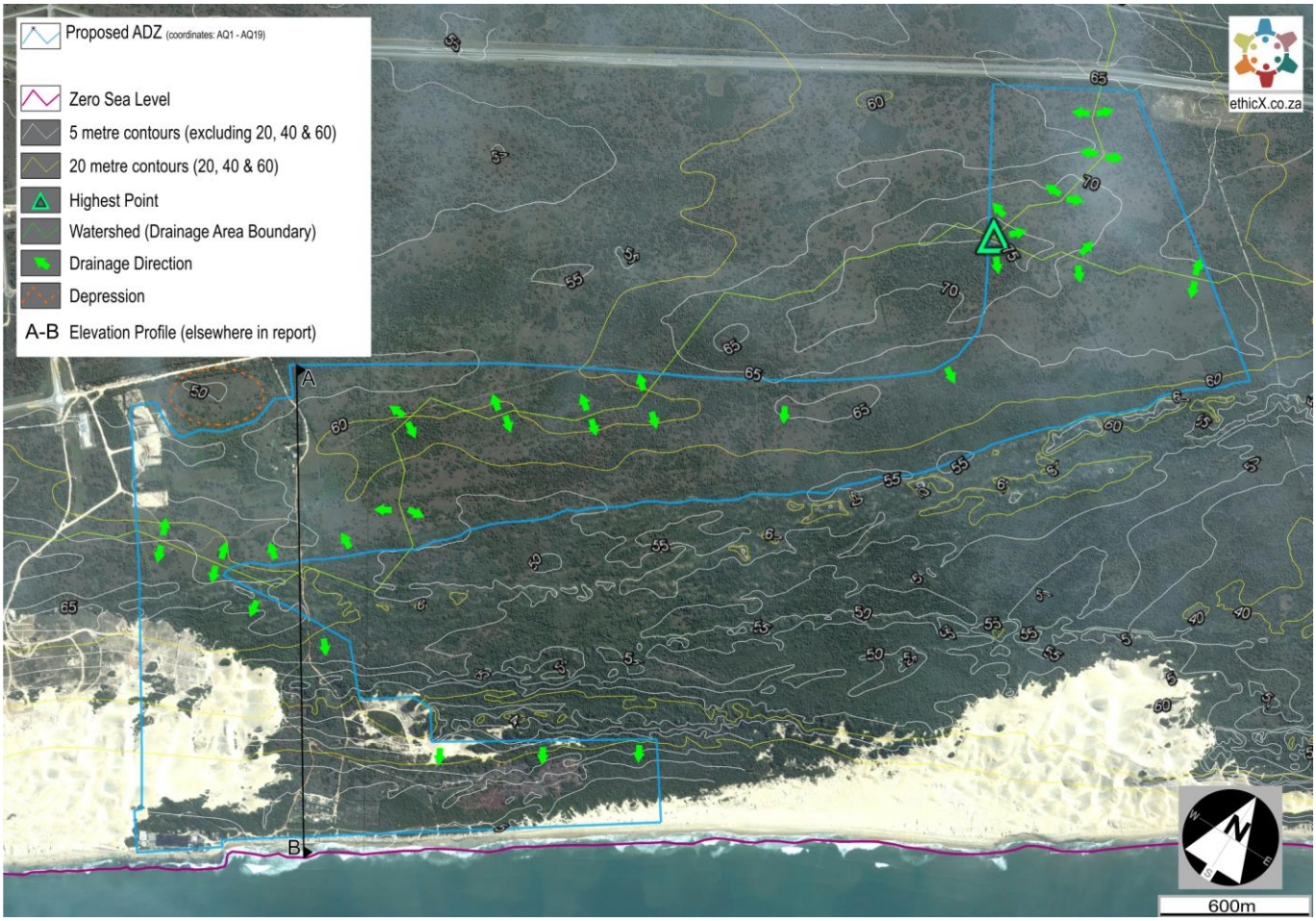


Figure 6-8: Contour Map
(5 m contour intervals)

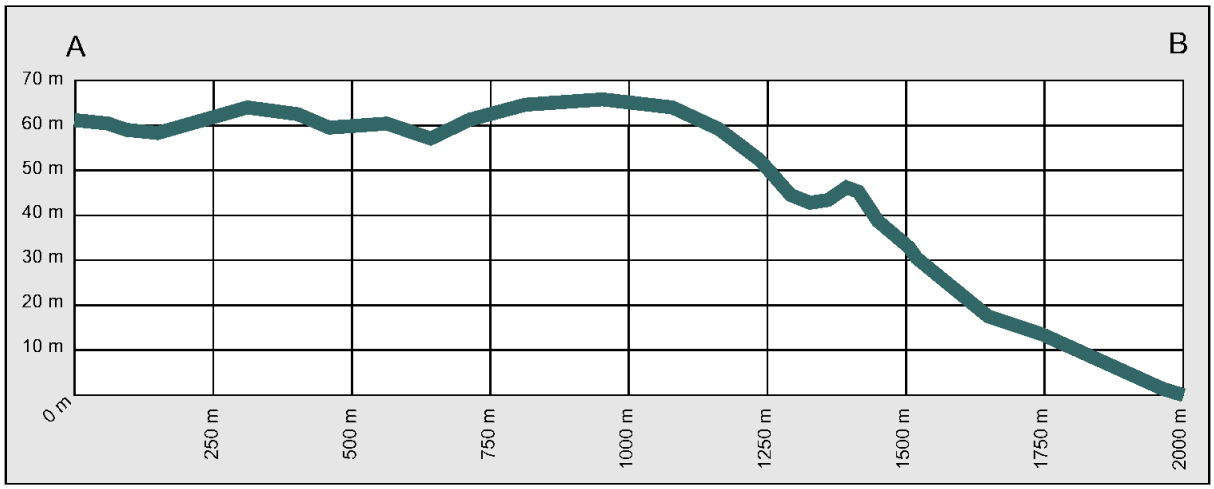


Figure 6-9: Schematic Elevation Profile
(Line A-B on Contour Map)

6.4 Surface Water

The ADZ lies between the Coega and Sundays River. The lower part of the Coega River is ~1.6 km to the west of the Zone 10 boundary and ~3 km from the ADZ. The Coega River has a catchment area of 550 km² and mean annual runoff of 13 x $10^6 m^3$. The lower portion of the Coega River is highly modified, and is presently used for solar salt reclamation with various saltern (evaporation) ponds in the river. The river course has been canalised and diverted past the saltern ponds. Due to the salt works, the salinity (salt content) of the water in many of the saltern ponds as well as the diversion canal is excessive and use of the surface water from that portion of the Coega River is not possible due to the generally excessive salinity of the water. The Coega estuary seldom opens to the sea, only after heavy rains, and then for a few days until the river flow subsides. The Sundays River is ~6 km to the east of the ADZ and Zone 10 boundary.

In terms of theoretical runoff directions, the site can be divided into three drainage areas. Land on the seaward side of dune crest drains toward the sea and forms the coastal section of quaternary catchment M30B. The western, inland part of the site, behind the dune crests forms part of the river drainage section of catchment M30B. It drains westwards in the direction of the Coega River. A small portion in the northern, far inland part of the site, near the N2, drains north-eastwards towards the Sundays River and falls in quaternary catchment N40F but any runoff from this area is intercepted by the drainage system associated with the N2 (Figure 6-8). The ADZ is thus located on the watershed between the river and coastal drainage areas of catchment M30B as well as the watershed between catchment M30B (draining to the Coega River) and N40F (draining to the Sundays River).

There are naturally wet areas in the dune slacks in the wider Zone 10. These are sparsely vegetated and some contain ponds of fresh water for parts of the year. Some are continually wet or marshy. The dune slacks are important environments that serve as micro habitats for plant and animal life in the dune field. As part of the Ecological (Terrestrial and Aquatic) Specialist Assessment (SC&A, 2016), Dr Brian Colloty verified that there are no watercourses, wetlands or dune slacks within or near the ADZ. Due to the sandy nature of the soils, no surface drainage exist (Saki, 2008) and there are no signs of water running into channels and onwards to the sea. Based on visual inspection of the site, the same applies to the deflated areas downwind of the mobile dunes and old drift fences (see Section 6.7). Water that infiltrates into the soil would follow the shallow aquifer flow directions, which for most parts of the site is towards the sea and into Algoa Bay (Sami, 2008).

Existing and past sand mining operations have altered the surface topography and runoff patterns to some extent as there are a depression that appears to have been created by past sand mining operations. In the west-north-west corner of the ADZ there is a depression that has been earmarked by the CDC as a storm water management area on Revision 1 of the OSMP and on the ADZ conceptual layout map. This depression acts as a natural storm water attenuation area for the most of the western inland section of the ADZ.

6.5 Water Quality

6.5.1 Surface Water

Storm water monitoring by SRK (2012), Aurecon (2014; 2015) and JG Africa (2016) conducted in the broader IDZ has, to date, focussed on detecting potential contaminated runoff from industries and has not indicated that there are signs of impacts from industrial air emissions.

There are no watercourses, water bodies or notable storm water runoff to monitor within the ADZ. The CDC monitors surface water at a number of monitoring points in the broader IDZ but since the site is located on two watersheds, as described above, it is isolated from external surface runoff influences.

The cumulative impacts that air emissions and chemical deposition from existing and reasonably anticipated industries in the IDZ may have on surface water bodies (i.e. storm water dams or aquaculture ponds) in terms of pH and leaching of metals are discussed in the Air Quality assessment section.

6.5.2 Groundwater

The general quality of groundwater in the shallow aquifer and deep artesian aquifer is discussed in the Geology and Groundwater section above. Groundwater flow in the shallow aquifer follows the surface topography and surface water flow directions (Saki, 2008). Since the ADZ is situated on two watersheds, the shallow aquifer underlying the ADZ is fairly isolated from external groundwater influences. The CDC monitors groundwater (representing the shallow aquifer water) at a number of monitoring points in the broader IDZ. The monitoring results support the general characteristics of the shallow aquifer as described above in the Geology and Groundwater section in that the water has a natural high salinity and total dissolved solids content and the hydrochemistry is dominated by sodium and chlorine, and naturally occurring traces of magnesium, potassium, phosphorus, iron, manganese and aluminum. This is as a result of the natural soil-water interactions, and not anthropogenic pollution.

Organic and bacteriological parameters monitored elsewhere in the IDZ is of no significance to the ADZ due groundwater flow directions being away from the ADZ.

Groundwater quality of the deep artesian aquifer is not monitored in the IDZ but potential for contamination of the deep aquifer is practically non-existent and it is not regarded as vulnerable to contamination (CSIR, 2013 and Saki, 2008).

6.5.3 Sea Water

Water temperature measurements were obtained from the South African Environmental Observation Network, Port Elizabeth, measured from July 2011 to May 2016. The measurements took place near St Croix Island, and formed part of the Algoa Bay long term research project. The information provides an overall indication of seawater temperature in Algoa Bay but more detail assessment will be provided in the EIA for the marine pipeline servitude EIA.

Monthly average temperatures are tabled below. January is typically the month with the warmest water, spiking an average by 3 ^{O}C from December.

Table 6-4: Average monthly water temperature (10 m below surface), at St Croix Island

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21.3 ^{O}C	20.0 ^{O}C	19.7 ^{O}C	18.5 ^{O}C	18.1 ^{O}C	17.0 ^{O}C	16.7 ^{O}C	16.2 ^{O}C	17.1 ^{O}C	17.8 ^{O}C	18.0 ^{O}C	18.4 ^{O}C

Temperature in
Offshore; Latitude: -33,82751, Longitude: 25,75143 and LatShore: -33,788, LongShore: 26,707.
Data taken at a depth of 10 m with a bottom depth of 30 meters (that is the sea floor).

The data from July 2011 to May 2016 were analysed for spikes in temperature. The lowest temperatures recorded were 11^0 C from 22 to 24 July 2015. The following periods had temperatures above 20 ^{O}C.

Table 6-5: Water temperature spike periods (above 22^{0}C at 10 m below surface) for the period 14/7/2011 to 13/5/2016, at St Croix Island

Start Date	End Date	Highest recorded during the period
06/01/2012	29/01/2012	23.8 ^{O}C
03/03/2012	04/03/2012	22.3 ^{O}C
08/03/2012	14/03/2012	22.9 ^{O}C
23/01/2013	03/02/2013	22.2 ^{O}C
05/02/2013	10/02/2013	23.1 ^{O}C
17/01/2014	04/02/2014	24.4 ^{O}C (red tide occurrence)
28/12/2014	03/02/2015	23.5 ^{O}C
04/01/2016	05/01/2016	24.2 ^{O}C
06/01/2016	13/01/2016	23.8 ^{O}C

Offshore; Latitude: -33,82751, Longitude: 25,75143 and LatShore: -33,788, LongShore: 26,707.
Data taken at a depth of 10 m with a bottom depth of 30 meters (that is the sea floor).

As was illustrated in 2014, Algoa Bay is susceptible to red tide *dinflagellate* blooms during warm water (>20°C) events. Dense red tide blooms, with recorded cell counts of up to 29,000 cells/ml of *Lingulodinium polyedrum*, persisted for 3 months in Algoa Bay with varying intensity, depending on the flow and mixing of currents. DAFF, with input from various specialists, conducted a high-level (unpublished) risk assessment on what the impacts of a repeat bloom would be on sea-based cage aquacultural production of finfish in Algoa Bay. They concluded that low dissolved oxygen in the water from the red tide may produce both sub-lethal (reduced feeding, feed conversion ratios and health problems) and lethal effects (suffocation from anoxia) for sea-based finfish in cages, at least in some parts of the bay. The high cell density may result in gill clogging and irritation, mucous production, and toxicity to finfish. There are no mitigation measures to protect fish in sea-based cages from these effects, resulting in with high production risks and uncertainty. The issue needs to be put into perspective as Chile and various parts of the world also experience HABs and these are always going to be a risk but there is no certainty as to when these events will happen and South Africa thus would never be able to have a sea-based finfish farm in South Africa if this is regarded as a fatal flaw (Michelle Pretorius, DAFF, pers. comm.).

6.6 Shoreline and HWM

The ADZ has a ~2100 m section of shoreline. In terms of the ICMA, the HWM is the highest line reached by coastal waters excluding any line reached as a result of exceptional or abnormal weather or sea conditions, and the seashore is the area between the LWM and the HWM, thus forming the interface between sea and land.

For most parts, the seashore along the ADZ is characterised by a wave cut platform of consolidated material above the HWM and a pebble beach environment below the HWM, with the edge of permanent vegetation marking the HWM as observed on site (vegetation line associated on the wave cut platform clearly visible on Google Earth satellite images). This 'observed' HWM is based on site visits by the EAP, including a visit during the 'super' moon spring tide on 14 November 2016, and various environmental monitoring expeditions along the IDZ sea-shore by Dr Paul Martin, the CDC ECO. It does not account for storm events such as those experienced along the coast in 2008/9. In areas where there are unvegetated dunes, the vegetation line is controlled by aeolian processes rather than wave processes and, based on site observations, the HWM appears to be at the foot of the fore dune. The HWM as observed on site is illustrated on Figure 6-10.

In 2012, a theoretical HWM was modelled as part pf the NMB Municipality's study process to establish coastal management lines for the NMB Metro (DEDEAT, 2016). Careful evaluation of this theoretical HWM revealed that for the seashore section in front of the ADZ, there appear to be variances between this theoretical HWM and the HWM as observed on site (Section 6.6). In front of the old abalone farm, the theoretical HWM is slightly lower than the HWM observed on site but for most of the remaining stretch of seashore in front of the ADZ, the

theoretical HWM is on average about 30 inland from the observed HWM. The theoretical HWM therefore covers a significant portion of permanent vegetation; something generally not seen along the rest of the NMB coast line. The difference between the observed and theoretical HWM is illustrated in Figure 6-10.

The extreme storm events that occurred in 2008/9 resulted in damage to the pump house and another building located virtually on the HWM at the old Marine Growers abalone farm which was still operational at the time but there were no damage to the SeaArk pilot prawn farm facility (Willie de Wet, pers. com, and CEN, 2009).

Land below the HWM is classified as coastal public property in terms Chapter 2 Part 1 of the ICMA to which members of the public has the right of reasonable access. No coastal access land has been declared in terms of Chapter 2 Part 3 of the ICMA to provide access to coastal public property within the Coega IDZ.

Infrastructure developments within the coastal public property require a coastal lease (Section 3.3.12). A description of infrastructure that will be located below the HWM is provided in Section 4.10.3.

Plate 6-1: View of Shoreline near the Old SeaArk Pilot Prawn Facility

Source: Dr Paul Martin

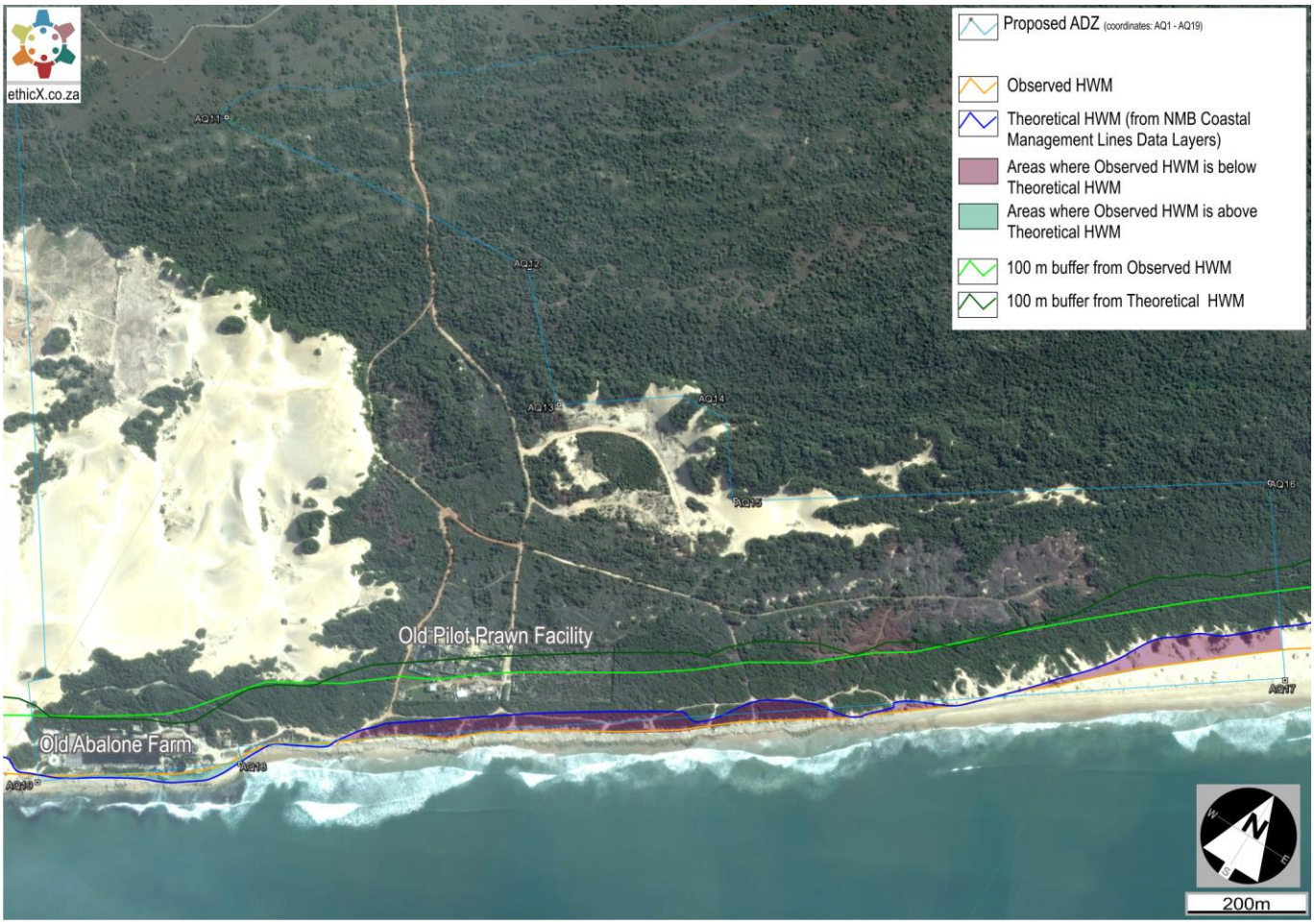


Figure 6-10: Theoretical HWM and Observed HWM along the ADZ shoreline, showing a 100 m line above both HWMs

6.7 Coastal Dunes and Littoral Active Zone

The coastal dune field on both sides of the Port of Ngqura, including Zone 10 is classified as critical biodiversity areas in terms of the NMB MOSS, the ECBCP and NMB MBP. The dune field is part of a greater sand process corridor stretching from the Sundays to the Swartkops Rivers, and is part of the Alexandria dune field which is of the largest active dune fields in the world (CEN, 2014).

In terms of the ICMA, the littoral active zone means any land forming part of, or adjacent to, the seashore that is unstable and dynamic as a result of natural processes; and characterised by dunes, beaches, sand bars and other landforms composed of unconsolidated sand, pebbles or other such material which is either un-vegetated or only partially vegetated. The mobile dunes and sand movement zone along the coast in the Coega IDZ and Zone 10 are therefore regarded as part of the littoral active zone.

The coastal section of the ADZ and the strip of land between the ADZ and the harbour form part of the IDZ's coastal cluster for development (OSMP). The ADZ has a ~2100 m coastal strip and shoreline, falling entirely in the coastal cluster for development. From the south-western (towards the harbour) side to the north-east the ADZ coastal strip can be divided roughly into the following three sections.

Figure 6-11: Details of the ADZ Coastal Sections

Western Section (600 m)

The observed HWM corresponds with the permanent vegetation line as clearly visible on Google Earth.

Observed HWM to 90 m:	Old abalone farm.
Observed HWM to 200 m:	Low dunes covered with a dense alien wattle infestation.
Inland of the low sparse dunes, up to 900 m inland of the observed HWM:	Extensively disturbed, high mobile dunes. Drift fences (1950-1990s) caused artificial build-up of a ridge about 25 m high. Sand mining rights over most of the area. Virtually all sand within Glendore's Sonop Quarry (Sunshine Coast Quarries mining area) removed, underlying calcrete layer exposed.

To the west of the ADZ boundary, there is a section of un-vegetated dunes that is known as a breeding area for Damara Terns and where a number of archaeological sites have been documented. The CDC maintains a 200 m buffer zone around this area. Sand mining takes place inland from this 200 m buffer zone. Due to the presence of the Damara Tern breeding area, this area has been earmarked for protection and will remain as an open space Species of Special Concern, Area 1.5 (Revision 1 of the OSMP). The overall direction of sand movement is towards the north-east, thus from the Damara Term breeding area towards the ADZ. The dunes within the ADZ are therefore not a source of sand for the Damara Tern breeding area.

Port of Ngqura's eastern breakwater is 2.5 km to the west of the ADZ boundary. The section of coastline land between the Damara Tern breeding area and the harbour is generally disturbed and earmarked for development of a 400 m wide service corridor to the coast, the CCGT power plant and possible extension to the eastern breakwater. The port is equipped with a sand bypass system to maintain littoral transport of sand from the

western to the eastern side of the port to maintain the natural movement of sand and prevent accretion and erosion on the western and eastern sides of the harbour respectively.

Central Section (1000 m)

The observed HWM corresponds with the permanent vegetation line as clearly visible on Google Earth.

From the observed HWM to 300 m inland and beyond in places:	Drift fences (1950-1990s) on the windward side of this area caused the area to be deflated and virtually devoid of sand. Mostly infested by dense alien wattle infestations.
360 m from the observed HWM:	Some mobile dunes occur on the edge of the OSMP Primary Dune Area 1.3A. Falls within the Calcium Products (Pty) Ltd mining area, which mined out.
Inland of the ADZ:	OSMP Primary Dune Area 1.3A and Secondary Dune Area 1.3B inland of the ADZ.

Eastern Section (500 m)

For this section, the observed HWM appears to be at the foot of the fore dune (not easily visible on Google Earth).

From the observed HWM inland for up 70 m on the far eastern boundary:	Un-vegetated low sparse dunes up to 70 m inland from the observed HWM at the foot of the fore dune.
Above the un-vegetated low sparse dunes to 360 m inland:	As for the central section, this area is mostly deflated and infested by dense alien wattle infestations.
360 m inland of observed HWM:	Some partially vegetated dunes on the edge of the OSMP Primary Dune Area 1.3A.
Inland of the ADZ:	OSMP Primary Dune Area 1.3A and Secondary Dune Area 1.3B inland of the ADZ.

To the east of the ADZ's coastal section, is a ~2.8 km long section of OSMP Primary Dune Area 1.3A up to the eastern boundary of Zone 10 and the IDZ itself. Beyond the IDZ boundary to the Sundays River is a 20 km section of undeveloped coastline that is part of the NMB MOSS, which leads to the coastal section of the Addo Elephant National Park.

The importance and current state of the dunes and reasonably anticipated future impacts due to other land uses, most notably mining, and historical attempts to stabilise the dunes are discussed in the impact assessment chapter, together with an assessment of the ADZ's impacts on the dunes (Section 7.5).

6.8 Soils

Dune sand is highly susceptible to erosion when exposed but the calcareous base below the dunes is not readily susceptible to erosion. The calcrete below the sand dunes will be susceptible to a minimal amount of erosion when exposed (CDC ISWMP, 2010).

The development and operation of the old abalone farm and the pilot prawn facility resulted in no notable soil erosion or destabilisation of the underlying soil layers, other than direct wave action on and below the HWM.

Erosion associated with historical agricultural use of the land is minimal.

6.9 Coastal and Marine Environment

6.9.1 General Description of Algoa Bay

Aquatic Ecosystem Services, Dr Russell Charmers, conducted a specialist assessment to determine the impacts of the land-based Coega ADZ on the marine environment and provided the following background baseline information. The specialist report is in Appendix G4 (Charmers, 2016). The IDZ, and Zone 10, are located in the north-western corner of Algoa Bay which is the largest and best formed logarithmic-spiral bay on the Cape south

coast. Algoa Bay occurs centrally within the warm-temperate Agulhas Bioregion which extends from the Mbashe River on the Wild Coast to Cape Point (Figure 6-12).

Within the Agulhas Bioregion, Algoa Bay is located within the Agulhas Inner Shelf Ecozone with the Agulhas Current playing a major role in the ecology within this area. The marine fauna and flora within Algoa Bay are therefore characteristic of this Bioregion and a brief synopsis is presented below.

The Algoa Bay coastline consists predominantly of sandy beaches (64%) interspersed with rocky outcrops (8%) and mixed rock and sand habitats (12%), with some stretches having been transformed through industrial development (16%) (Figure 6-13). Sandy beaches are predominantly intermediate and consist of well sorted fine to medium sized quartz sands (McLachlan *et al.* 1977; 1981a in Chalmers, 2016). The Woody Cape headland is located on the eastern edge of Algoa Bay and consists of calcareous sandstones of Aeolian origin. The Alexandria Coastal Dune Field is situated along the northern shore of Algoa Bay and is the largest of its kind in South Africa, ranging from 2 to 3 km in width along approximately 50 km of shoreline encompassing an area of approximately 120 km^2 (Illenberger and Rust 1988; Watson *et al.* 1996 in Chalmers, 2016). The dune field is a unique feature of Algoa Bay with transverse dunes ranging from 10-90 m in height (Illenberger and Rust 1988 in Chalmers, 2016). Two major estuaries, the Sundays and Swartkops, are located within Algoa Bay and are regarded as being in fair and good ecological condition respectively and are of high conservation importance (Turpie *et al.* 2002 in Chalmers, 2016), yet their threat status is considered critically endangered (van Niekerk and Turpie 2011 in Chalmers, 2016). They play an important ecological role in the nearshore marine ecology of Algoa Bay. A further three estuaries are highly degraded and modified (Baakens, Papkuils and Coega).

Two island groups (each with three islands) are located within Algoa Bay, and being the only islands between Cape Agulhas and Mozambique they are of considerable ecological importance. The Islands of the Cross (St Croix Islands) are situated within the western sector of Algoa Bay adjacent to the project development area and include St Croix, Jahleel and Brenton islands which are comprised of quartzitic Table Mountain Sandstone (Beckley and McLachlan 1979b; DEAET 1996, in Chalmers, 2016). St Croix is the largest of the three islands and is situated approximately 4 km directly offshore from ADZ. It supports the world's largest breeding colony of African penguins (*Spheniscus demersus*) (DEAET 1996; Pichegru *et al.* 2010 in Chalmers, 2016). Jahleel and Brenton islands are smaller rocky outcrops which are located approximately 2.5 and 6 km from the project development site respectively. All islands drop steeply to the seafloor. The Islands of the Cross were proclaimed as South Africa's first island marine reserve in 1981 and included the marine environment within 300 m around each island (DEAT 1981; DEAET 1996 in Chalmers, 2016). The reefs surrounding these islands support reef fish communities as well as an aggregation and nursery area for kob (*Argyrosomus spp.)* (Chalmers 2012 in Chalmers, 2016).

The Bird Island group (Bird, Stag and Seal) is located 10 km offshore of the Woody Cape headland in the eastern sector of Algoa Bay and is approximately 50k m from the ADZ. Bird Island supports the world's largest breeding colony of Cape gannets (*Morus capensis*) (DEAET 1996 in Chalmers, 2016), and together with Stag and Seal islands are important to several other birds including the African penguin and several species of migrant terns, including the endangered roseate tern (*Sterna dougallii*). Black Rocks (situated off Bird Island) is home to the eastern-most breeding colony of Cape fur seals (*Arctocephalus pusillus*) in the region (DEAET 1996 in Chalmers, 2016). The terrestrial component of the Bird Island Group was proclaimed a Provincial Nature Reserve in 1987 (ECPB 1999 in Chalmers 2016), and the Bird Island Marine Protected Area (MPA) was proclaimed in June 2004 (DEAT 2004).

Both island groups (including the marine components) were incorporated into the Addo Elephant National Park in 2005, with management of these areas becoming the responsibility of the SANParks.

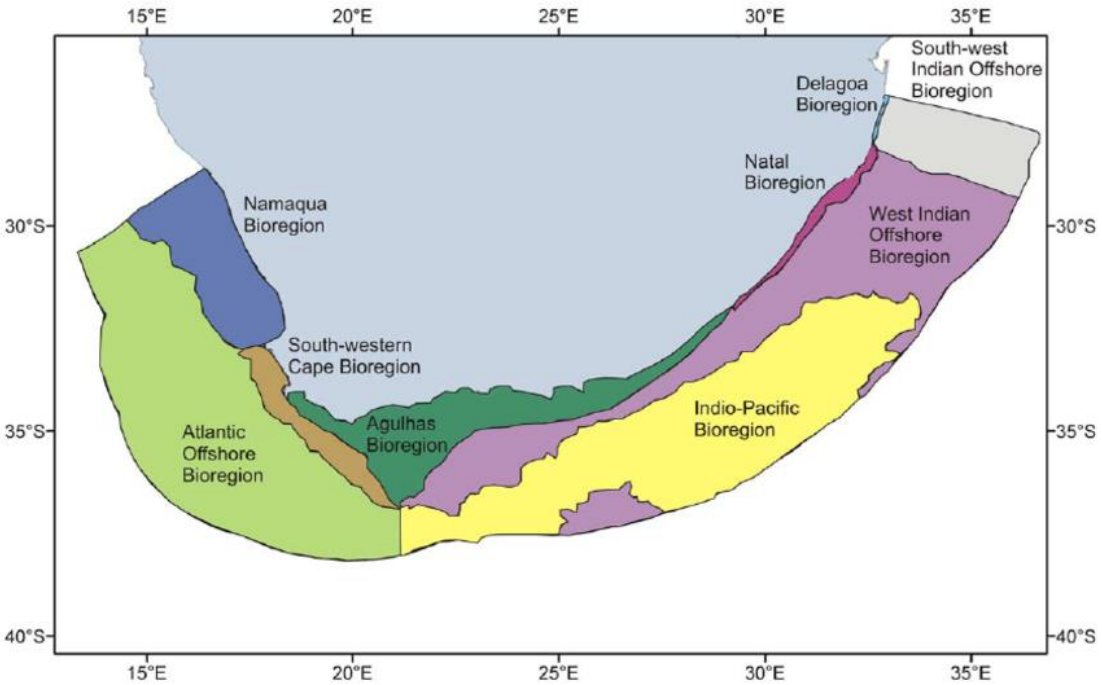


Figure 6-12: Location of the Warm-Temperate Agulhas Bioregion

6.9.2 Subtidal Geomorphology

Subtidally Algoa Bay is dominated by coarse sands which are interspersed with fine silts and clays (Bremner 1991b; Bremner 1991c; Illenberger 1992 in Chalmers, 2016). Gravel beds are limited to areas adjacent to the islands and rocky outcrops (Bremner 1978; Bremner 1991a in Chalmers, 2016). The majority of the bay is between the 20 and 50 m isobaths, with a maximum depth of 73 m across its mouth (Harris 1978 in Chalmers, 2016).

6.9.3 Oceanography

Tides within Algoa Bay are semi-diurnal with a mean spring amplitude of 1.6 m and a maximum of 2.1 m (Talbot and Bate 1987a in Chalmers, 2016). Freshwater inflow from rivers draining into Algoa Bay is negligible and has little influence on the local oceanographic conditions and salinity is relatively consistent throughout the bay (Schumann *et al.* 2005 n Chalmers, 2016). The Agulhas Current and predominant winds are the main driving forces which influence the local oceanic conditions within Algoa Bay. Wind driven upwelling occurs following strong easterly winds in summer (Schumann *et al.* 1988; Lutjeharms *et al.* 2000 in Chalmers, 2016) which leads to the formation of intense thermoclines (Schumann *et al.* 2005 in Chalmers, 2016). Stronger westerly winds during winter months cause greater mixing of the water column leading to a more homogenous temperature structure (Schumann *et al.* 2005 in Chalmers, 2016). Average minimum water temperatures within Algoa Bay are in the order of 14-15°C in winter, while maximum averages are in the range 20-22°C in summer (Beckley 1983; Beckley 1988b; Schumann *et al.* 2005 in Chalmers, 2016).

Oceanographic forces are important drivers in Algoa Bay. Nutrient rich water derived from a combination of current and wind induced upwelling drives primary productivity. This primary production forms the foundation for the ecosystem supporting the higher trophic levels which in turn support numerous fishery activities.

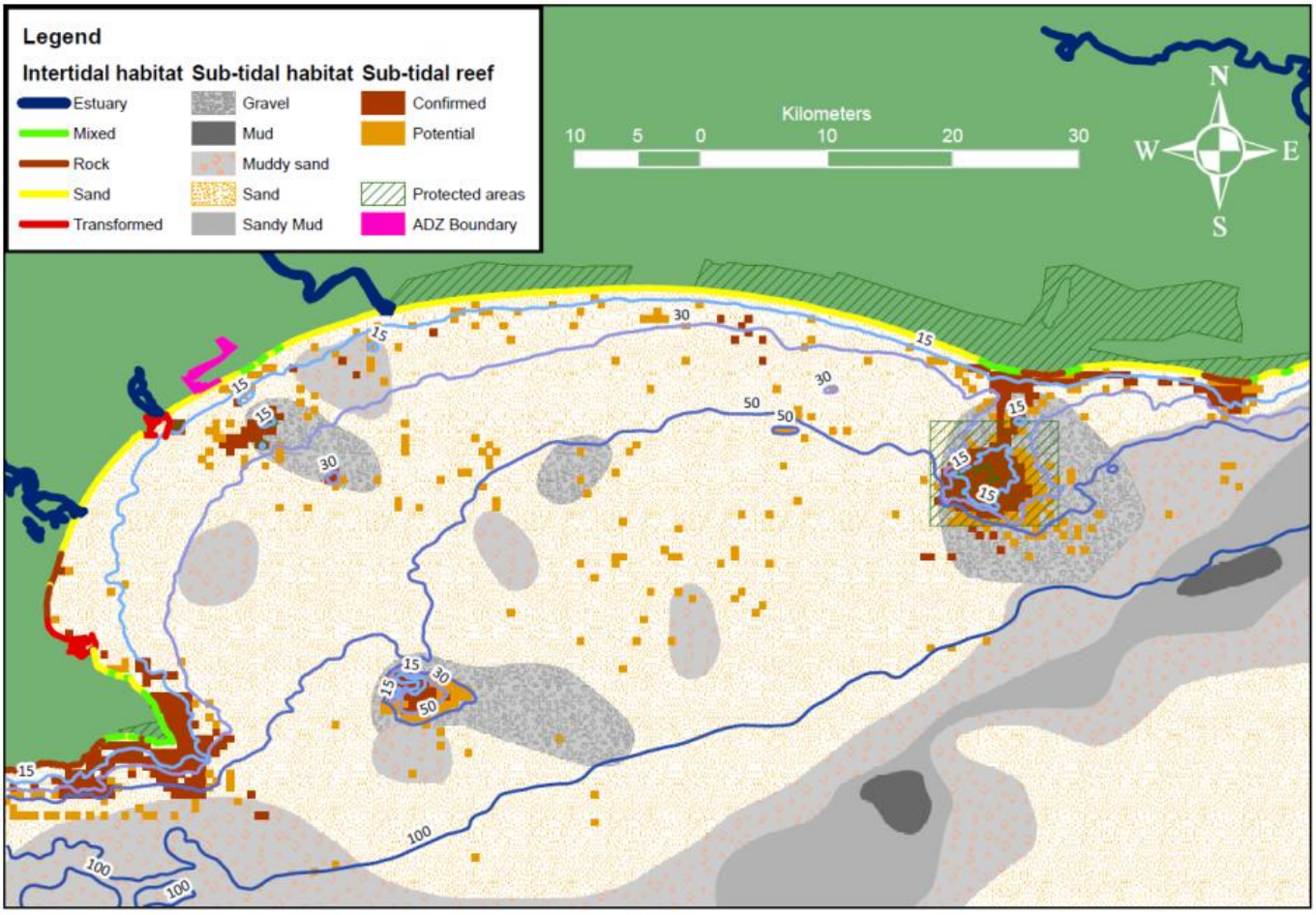


Figure 6-13: 1 Key Biophysical features in Algoa Bay in relation to the ADZ

6.9.4 Biological characteristics of Algoa Bay

Sandy beaches, the surf zone and nearshore

Sandy beaches and the associated surf zones comprise the dominant shoreline habitat within Algoa Bay (Figure 6-13). They are dynamic ecosystems and strongly influenced by wave action (Branch and Branch 1983 in Chalmers, 2016). Due to the absence of any macro-algae, surf diatoms (e.g. *Anaulus australis*) are the main source of primary production. Rip currents and the flow of nutrient rich groundwater into the surf zone drive the formation of dense aggregations of diatoms (McLachlan and Lewin 1981; Talbot and Bate 1988a; Campbell and Bate 1991; 1998 in Chalmers, 2016) which are an important food source for filter feeding macro fauna (Branch and Branch 1983 in Chalmers, 2016).

Several taxa comprise the zooplankton communities along the sandy beaches of Algoa Bay, including holo-, mero- and facultative planktonic forms (Romer 1986 in Chalmers, 2016). Two mysids (*Gastrosaccus psammodytes* and *Mesopodopsis wooldridgei*) and one penaeid shrimp (*Macropetasma africanus*) form the bulk of the zooplankton biomass and occur in dense concentrations in the inshore waters (Wooldridge 1983 in Chalmers, 2016). These taxa form an important trophic link connecting the surf zone phytoplankton blooms with higher trophic levels (Russow 1983; Lasiak 1983a in Chalmers, 2016).

Filter feeders, scavengers or predators constitute the macro faunal communities of sandy beaches (McLachlan 1977a; 1977b; 1983 in Chalmers, 2016), with the intertidal region supporting the greatest biomass of benthic fauna (McLachlan *et al.* 1981a in Chalmers, 2016). Bivalve filter feeders, *Donax serra* and *Donax sordidus*, contribute to 95% of the total biomass in the intertidal (McLachlan 1977a; McLachlan 1983 in Chalmers, 2016). The macro fauna are mobile, typically undertaking a tidal migration (McLachlan 1983 in Chalmers, 2016), and contribute significantly to the higher trophic levels being a major source of food for numerous birds and fishes

(Lasiak 1981; Lasiak 1983a; Lasiak 1983b in Chalmers, 2016). The sand prawn, *Callianassa kraussi*, occurs subtidally within the surf zone within the sheltered western sector of Algoa Bay and is a major food source for benthic feeding fish (Cockcroft and Tomalin 1987 in Chalmers, 2016).

The extensive surf zones in Algoa Bay are important habitats for larval fishes with estuarine dependent species dominating (Beckley 1986, Watt-Pringle and Strydom 2003; Strydom and d'Hotman 2005; Pattrick and Strydom 2008 in Chalmers, 2016). Juveniles of several teleost species occur within the surf zone throughout the year, while larger individuals are less common, suggesting an offshore movement with growth and maturity (Lasiak 1983b; Lasiak 1984a; Lasiak 1986 in Chalmers, 2016). Differences in the juvenile species composition between the nearshore, surf zone and estuaries within Algoa Bay highlights the importance of the surf zone as a nursery area for marine ichthyofauna, with the high productivity playing an important role in this function.

Diverse fish communities representing several trophic levels occur along the sandy beaches of Algoa Bay, but are dominated by few species of planktivores or benthic feeders (Lasiak 1981; McLachlan 1983; Lasiak 1983b; Lasiak 1984a; Romer 1990 in Chalmers, 2016). Filter feeding Mugilidae feed on the dense accumulations of diatoms within the surf zone, forming an important link between the primary producers and the top predators in the food web (Romer and McLachlan 1986 in Chalmers, 2016). Benthic feeding teleosts include the blacktail (*Diplodus sargus capensis*), white and sand steenbras (*Lithognathus lithognathus* and *L. mormyrus*) spotted and olive (piggy) grunters (*Pomadasys commersonnii* and *P. olivaceum*) and the slender baardman (*Umbrina robinsoni*) (Lasiak 1984b). However, the chondrichthyans, the lesser guitarfish (*Rhinobatos annulatus)* and the eagle ray (*Myliobatis aquila)*, are the most important benthic predators in the surf zone of sandy beaches in Algoa Bay (Russow 1983). Piscivorous fish in the surf zone which prey on the smaller teleosts include the dusky kob (*Argyrosomus japonicus*), leervis (*Lichia amia*) and elf (*Pomatomus saltatrix*) (Lasiak 1984b). Several important fishery species occur along the sandy beaches, two being of particular socio-economic importance, namely the white steenbras and the dusky kob.

Sub-tidal soft benthic communities

Interstitial meiofauna of sub-tidal soft sediments is dominated by nematodes and herpacticoid copepods (McLachlan *et al.* 1977 in Chalmers, 2016).

Nearshore ichthyofaunal species composition is dominated by teleosts including white seacatfish (*Galeichthys feliceps*), piggy, kob (*Argyrosomus spp*.) and elf with elasmobranches only accounting for a small proportion of the community (Wallace *et al.* 1984b). Ten estuarine associated species account for the major proportion of the community (Wallace *et al.* 1984a), and juvenile white seacatfish, kob and elf have been shown to rely on the nearshore coastal waters as a nursery area (Wallace *et al.* 1984a; Wallace *et al.* 1984b). Algoa Bay has been shown to be a regionally important area for kob (Wallace *et al.* 1984a; Wallace *et al.* 1984b, Chalmers 2012 in Chalmers, 2016).

The nearshore (<50m depth) regions of bays are important spawning and nesting areas for the chokka-squid (*Loligo reynaudii),* and several spawning locations and egg beds have been identified in Algoa Bay (Sauer *et al.* 1992; Sauer 1995 in Chalmers, 2016). These sites are generally re-used over several spawning seasons (Sauer *et al.* 1992 in Chalmers, 2016) and chokka-squid are heavily targeted in these areas by commercial vessels. Based on the assessment of chokka-squid catch data (Chalmers 2012 in Chalmers, 2016), no spawning grounds are apparent in the immediate vicinity of the proposed project development area.

Rocky intertidal shorelines

Rocky shores display strong zonation patterns across the intertidal zone due to the environmental gradients created by periodic inundation and exposure over the tidal cycle. Organisms which are more tolerant of exposure and desiccation are found near the high water mark, while those less tolerant occur in the lower intertidal near the low water mark where they are inundated by water for longer periods of time.

Macroalgal communities in the littoral zone on the Bird, St Croix and Jahleel rocky shorelines is dominated by purple laver (*Porphyra capensis*) interspersed with patches of sea lettuce (*Ulva rigida*). Development of the Coega breakwater has, however, altered the composition of algal species due to a change in the level of exposure. Six other algal species are present in the upper and lower balanoid zones, while the cochlear zone is dominated by the limpet *Scutellastra cochlear* on all islands, with *Cheilosporum sagitattum* being the dominant algal species (Campbell 2009 in Chalmers, 2016).

Limited mainland rocky shoreline habitat occurs within Algoa Bay and, unlike the sandy beaches little research has been conducted locally. Studies have indicated that the intertidal communities on St Croix Island and the nearby mainland rocky shore are similar in composition (Beckley and McLachlan 1979b in Chalmers, 2016) and that zonation of macrofaunal and macroalgal communities is strongly influenced by wave exposure (Beckley and McLachlan 1979a; Beckley and McLachlan 1979b; McLachlan *et al.* 1981b in Chalmers, 2016). Thirteen macroalgal and 67 macrofaunal species have been identified in Algoa Bay, with zonation typical of other temperate South African rocky shores (McLachlan *et al.* 1981b; Bolton and Stegenga 1987; Beckley 1988a in Chalmers, 2016). Filter feeders, grazers and algae dominate the lower shore with carnivores and deposit feeders occurring throughout (McLachlan *et al.* 1981b in Chalmers, 2016). The rocky shore intertidal zone is an important area for many ichthyofaunal species which may be resident in rock pools throughout the year, transient, using rock pools during specific periods of the year or their life cycle. Rock pool ichthyofaunal communities within Algoa Bay consist of up to 44 species from 20 families, with individuals typically being either small species, or juveniles of larger sparid species (Beckley 1985a; 1985c, Watt-Pringle 2009 in Chalmers, 2016).

Subtidal reef communities

Few sub-tidal macroalgal assessments have been undertaken in Algoa Bay. At Bird Island, 120 species and three distinct communities were identified (Anderson and Stegenga 1989 in Chalmers, 2016). *Gelidium pteridifolium* dominates in the exposed regions, while *Plocamium corallorhiza*, *P. rigidium* and *Pachychaeta brachyarthra* are most abundant in the shallow waters, with a third deepwater community dominated by *Peysonnelia capensi*s (Anderson and Stegenga 1989 in Chalmers, 2016).

Limited information is available on the invertebrate community structure and diversity of subtidal reefs in Algoa Bay. The macrofauna is comprised of numerous soft-bodied sessile sponges, ascidians and bryozoans. However, due to the paucity of taxonomic information for these invertebrate groups and the limited subtidal surveys conducted both nationally and locally within Algoa Bay, the diversity and community structure is largely unknown (Parker-Nance 2003 in Chalmers, 2016). Past visual assessments have documented shallow reefs to be dominated by seaweeds, with ascidians, octocorals, hydrozoans and sponges becoming more abundant on deeper reefs (Beckley and Buxton 1989 in Chalmers, 2016).

A combination of controlled angling and underwater visual censuses (UVC) of linefish communities conducted within Algoa Bay identified 64 species from 24 families on sub-tidal reefs (Chalmers 2012 in Chalmers, 2016). The Spariade were the most speciose and abundant family and included fransmadam (*Boopsoidea inornata*), santer (*Cheimerius nufar*), roman (*Chrysoblephus laticeps*) and steentjie (*Spondyliosoma emarginatum*). In the western region of Algoa Bay (extending to St Croix Island) non-cryptic ichthyofaunal reef communities comprised 45 teleost and four elasmobranch species (Buxton 1987; Beckley and Buxton 1989 in Chalmers, 2016) with sparids dominating the subtidal reef ichthyofauna with 22 species observed (Beckley and Buxton 1989 in Chalmers, 2016). Several juvenile sparids were observed on subtidal reef complexes (Beckley and Buxton 1989 in Chalmers, 2016) which have not been recorded in tide pools (Beckley 1985a; 1985c in Chalmers, 2016), estuaries (Beckley 1984b in Chalmers, 2016) or the surf zone (Lasiak 1981 in Chalmers, 2016). Furthermore, juvenile abundance was typically greater on shallow inshore reefs suggesting that these areas may serve as an important nursery area (Buxton 1987 in Chalmers, 2016).

Offshore pelagic environment

Chlorophyll levels within localised areas around Algoa Bay are consistently more elevated than other regions along the east coast (Shannon *et al.* 1984; Probyn *et al.* 1994 in Chalmers, 2016). This has been attributed to the persistent upwelling of cooler nutrient rich water resulting in higher levels of production in the Algoa Bay area than that of surrounding regions on the east coast (Shannon *et al.* 1984 in Chalmers, 2016).

Phytoplankton production and the associated zooplankton communities are important food sources for pelagic fish species and largely determine their distribution patterns. Pelagic fish species which may occur in the Algoa Bay region include the sardine (also known as pilchard) (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus)*, red-eye round herring (*Etrumeus whiteheadi*) and the horse mackerel (*Trachurus trachurus capensis*).

The most common pelagic elasmobranchs found within Algoa Bay include the bronze whaler (*Carcharhinus brachyurus*), dusky shark (*Carcharhinus obscurus*) and the hammerheads (*Sphyrna spp.*), with the spinner shark (*Carcharhinus brevipinna*) being common in summer (Smale 1991; Heemstra and Heemstra 2004 in Chalmers, 2016). The adults of these species usually occur in deeper waters while the juveniles are common in the coastal waters which serve as nursery areas (Smale 1991). Although there is little published research on great white sharks (*Carcharodon carcharias*) (IUCN: Vulnerable) in Algoa Bay, the Bird Island Group is reported to be an area of high abundance (Klimley and Ainley 1996 in Chalmers, 2016), particularly over winter months when seal pups are present.

Marine mammals

A breeding population of approximately 4,000 Cape fur seals occurs on Black Rocks within the Bird Island Group (DEAET 1996; Newman and Klages 2001 in Chalmers, 2016). Bottlenose (*Tursiops truncates*), common (*Delphinus delphis*) and humpback (*Sousa chinensis*) (IUCN: Near threatened) dolphins occur within Algoa Bay. Common dolphins occur in low densities in the Eastern Cape throughout the year (Cockcroft and Peddemors 1990 in Chalmers, 2016). Humpback dolphins are more resident coastal dolphins which occur in shallow coastal waters and are reliant on the inshore resources (Karczmarski *et al.* 2008 in Chalmers, 2016). Although it is evident that they occur in small groups and exhibit low population growth, little is known about the status of the different populations and it is thought that due to their inshore preference they are susceptible to anthropogenic impacts (Karczmarski *et al.* 2008 in Chalmers, 2016). They have been reported to calf in Algoa Bay in summer (Karczmarski *et al.* 2008 in Chalmers, 2016) and the inshore shallow reefs are their main foraging areas. Bottlenose dolphins are transient, occurring within 10 km of the shoreline in Algoa Bay showing a preference for water depths of less than 30 m (Ross *et al.* 1987 in Chalmers, 2016). Four species of baleen whales are regularly observed within Algoa Bay, the southern right whale (*Eubalaena australis*), Bryde's whale (*Balaenoptera edeni*), minke whale (*Balaenoptera acutorostrata*) and the humpback whale (*Megaptera novaeangliae*).

Regional ecological importance of Algoa Bay

Algoa Bay has several biophysical characteristics which contribute to its ecological importance in the Agulhas Bioregion. The Port Alfred upwelling cell plays an important role bringing cool nutrient rich water to the surface which drives primary production in and around the Algoa Bay area. Surf zone diatoms, which are fed by nutrient rich waters originating from coastal aquifers, contribute significantly to the primary production in Algoa Bay. Prolific accumulations of surf zone diatoms have only been identified along twelve beaches in South Africa, with the Sundays surf being the longest and least impacted sandy shoreline where *A. australis* occurs (Newman and Klages 2001 in Chalmers, 2016). The Alexandria Dune field is a unique feature in Algoa Bay being the largest and least degraded dune field in South Africa (Kerley and Boshoff 1997 in Chalmers, 2016). The long stretches of sandy beaches host diverse macrofaunal communities with 14 of the 25 major sandy beach species occurring along the Sundays surf beaches. The presence of numerous habitat types, including large open estuaries, the surf zone, intertidal and subtidal reefs and unconsolidated benthic substrates, within Algoa Bay and the interconnectivity between them contributes to the diverse ichthyofaunal communities and rich biodiversity present. The two island groups are unique along the east coast of South Africa. They support rich intertidal and subtidal diversity, and are important roosting and nesting sites for several bird species. Together these features contribute the regional

ecological importance of Algoa Bay which resulted in detailed biological and conservation assessments (2006-2013) being undertaken by the SANParks. As a result large sections of the coastline, the nearshore and offshore marine environments in Algoa Bay have been proposed for inclusion into the Addo Elephant National Park as a Marine Protected Area. The Notice of intention to declare the Addo Elephant MPA was Gazetted on 3 February 2016 (GN 39646).

6.9.5 Description of the Local Area around the ADZ

The ADZ in Zone 10 of the Coega IDZ is situated adjacent to a sandy and mixed rock and sand intertidal coastline (Clark and Lombard 2007 in Chalmers, 2016) (Figure 6-14). Shore-based recreational angling catches in the Hougham Park area were dominated by the lesser guitarfish (*Rhinobatos annulatus*) and white seacatfish (*Galeichthys feliceps*) with few reef associated species captured suggesting the dominance of sandy substrata in the inter-tidal and shallow sub-tidal areas adjacent to the project area (Figure 6-15) (Chalmers 2012 in Chalmers 2016). The Sundays and Swartkops estuary mouths are located approximately 12 km to the north-east and south-west respectively, with the Coega Estuary located within the Port of Ngqura and being highly modified. Both the Sundays and Swartkops estuaries play an important role for numerous linefish species serving as nursery and feeding areas (Cowley et al. 2009 in Chalmers, 2016).

The bathymetry drops off gradually and consistently to 15 m and 30 m in depth approximately 1.5 and 6.5 km offshore respectively (Figure 6-16). The nearshore sub-tidal substrate adjacent to the project area consists predominantly of coarse sands, with gravel beds occurring around the offshore islands (Bremner 1978 in Chalmers, 2016). Scattered reef complexes are also located within the nearshore, being more substantial adjacent to and between the offshore islands (Chalmers 2012 in Chalmers, 2016). The islands and island surrounds (300 m radius) are designated as formal protected areas currently under the management of SANParks. A Notice of intent to declare the Addo Elephant Marine Protected Area, which adjoins the proposed development site, was released on the 3rd of February 2016. This Marine Protected Area encompasses large areas of coastal, nearshore and offshore habitats as well as the Sundays estuary and is considered a biodiversity hotspot (GN 39646). The proposed MPA plays an important role in ensuring connectivity between the large permanently open Sundays estuary which is utilised as nursery and feeding areas by several depleted linefish species and contributes significantly to the representation of marine protected areas in the bioregion and on a national scale.

The ADZ encompasses an area previously utilised by Marine Growers for abalone farming on the eastern side of the Port of Ngqura and an area in which the SeaArk pilot prawn farming project was developed. These facilities and infrastructure have been decommissioned. The Port of Ngqura is located to the south-west of the ADZ and is a highly modified environment with a breakwater extending approximately 2.5 km offshore.

The ADZ is situated adjacent to an area determined to be of priority conservation importance for marine conservation within Algoa Bay (Chalmers 2012, in Chalmers 2016) (Figure 6-16) and is considered a biodiversity hotspot (GN39646). This has resulted in the area being formally incorporated into the Addo Elephant Marine Protected Area (Ané Oosthuizen pers. comm.) with the Notice of intention to declare the Addo Elephant MPA being Gazetted on 3 February 2016 (GN 39646). The proposed boundary of the Addo Elephant MPA is depicted in Figure 6-17. The aims of declaring the Addo Elephant Marine Protected Area are listed as follows (GN39646):

- To contribute to a national and global representative system of marine protected areas, by providing protection for species, habitats and ecosystem processes in a biodiversity hotspot, to form a contiguous conservation area between marine, estuarine and terrestrial habitats,
- to facilitate fisheries management by protecting spawning stock, allowing stock recovery, enhancing stock abundance in adjacent areas, in particular linefish and abalone stocks ; allowing the development of sustainable aquaculture in a confined area, and
- for the protection of fauna and flora or a particular species of fauna or flora and the physical features on which they depend, including the African Penguin and Cape Gannet.

The shoreline of the proposed marine protected area within the study are is designated as a controlled zone, with the offshore area, extending to approximately 10 km from the shoreline, being proposed as a restricted zone in

which no resource utilisation will be allowed (Figure 6-18). The restricted zone was developed in this area to protect slow growing and resident reef species occurring around the St Croix islands as well as to protect an important nursery area for juvenile linefish, most notably dusky kob (*Argyrosomus japonicus*) (Chalmers 2012 in Chalmers, 2016) which occur adjacent to the ADZ.

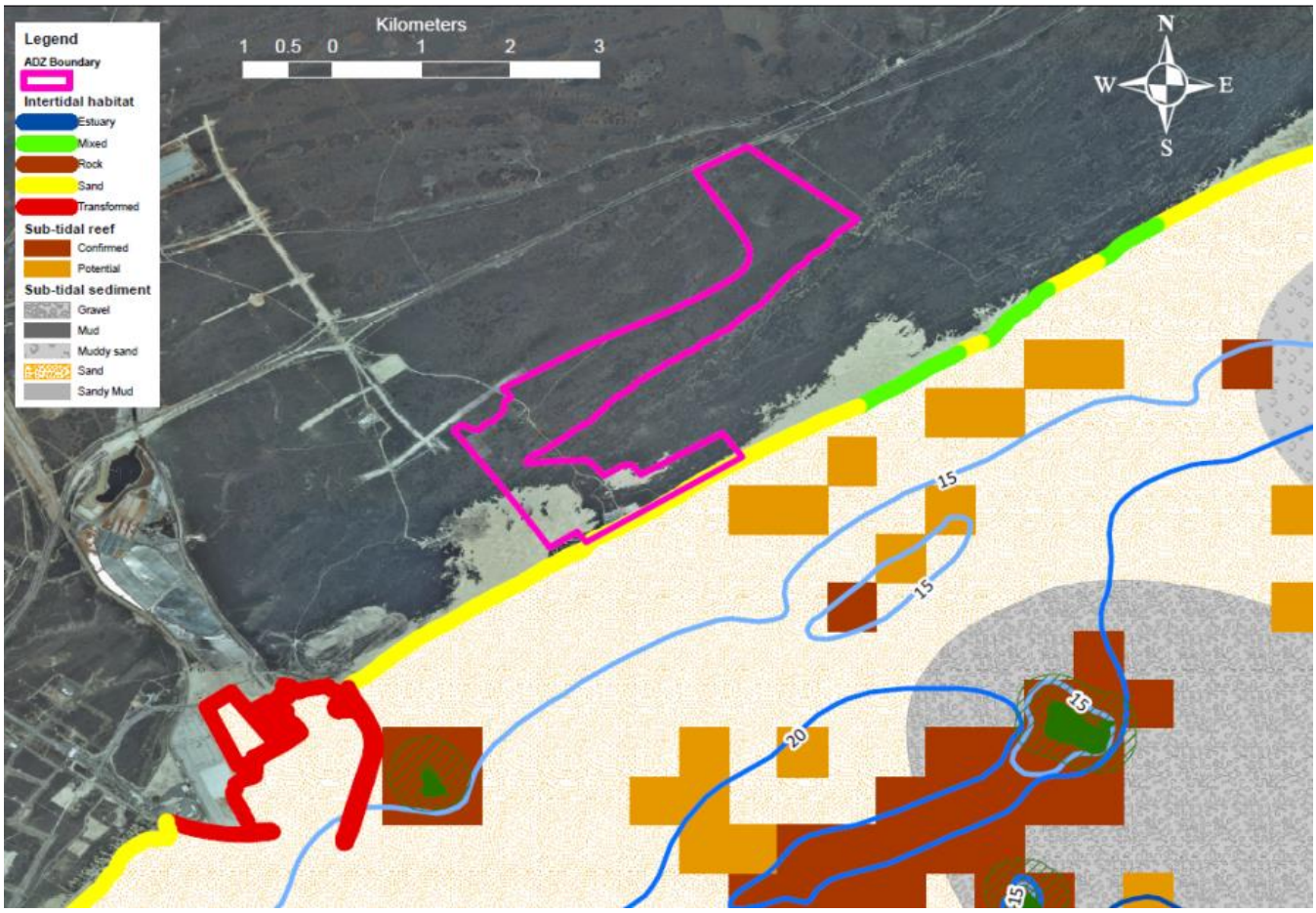


Figure 6-14: 2 ADZ in relation to the Port of Ngqura and adjacent Marine Biophysical Features

Source: Inter-tidal habitats Clark and Lombard 2007; sub-tidal habitats Bremner 1978; sub-tidal reefs Chalmers 2012, in Chalmers, 2016.

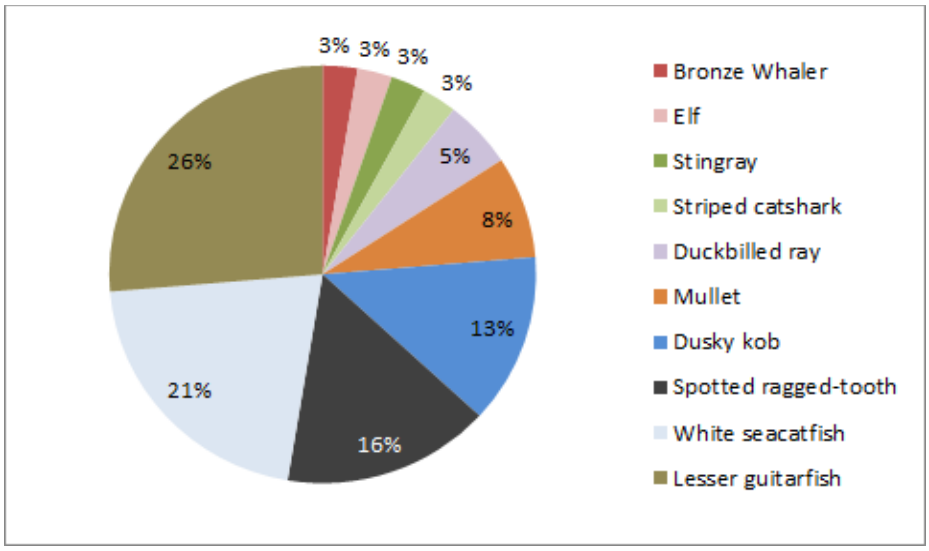


Figure 6-15: 4 Recreational shore based catches from the Hougham Park, adjacent to the ADZ

Source Chalmers, 2012 in Chalmers, 2016.

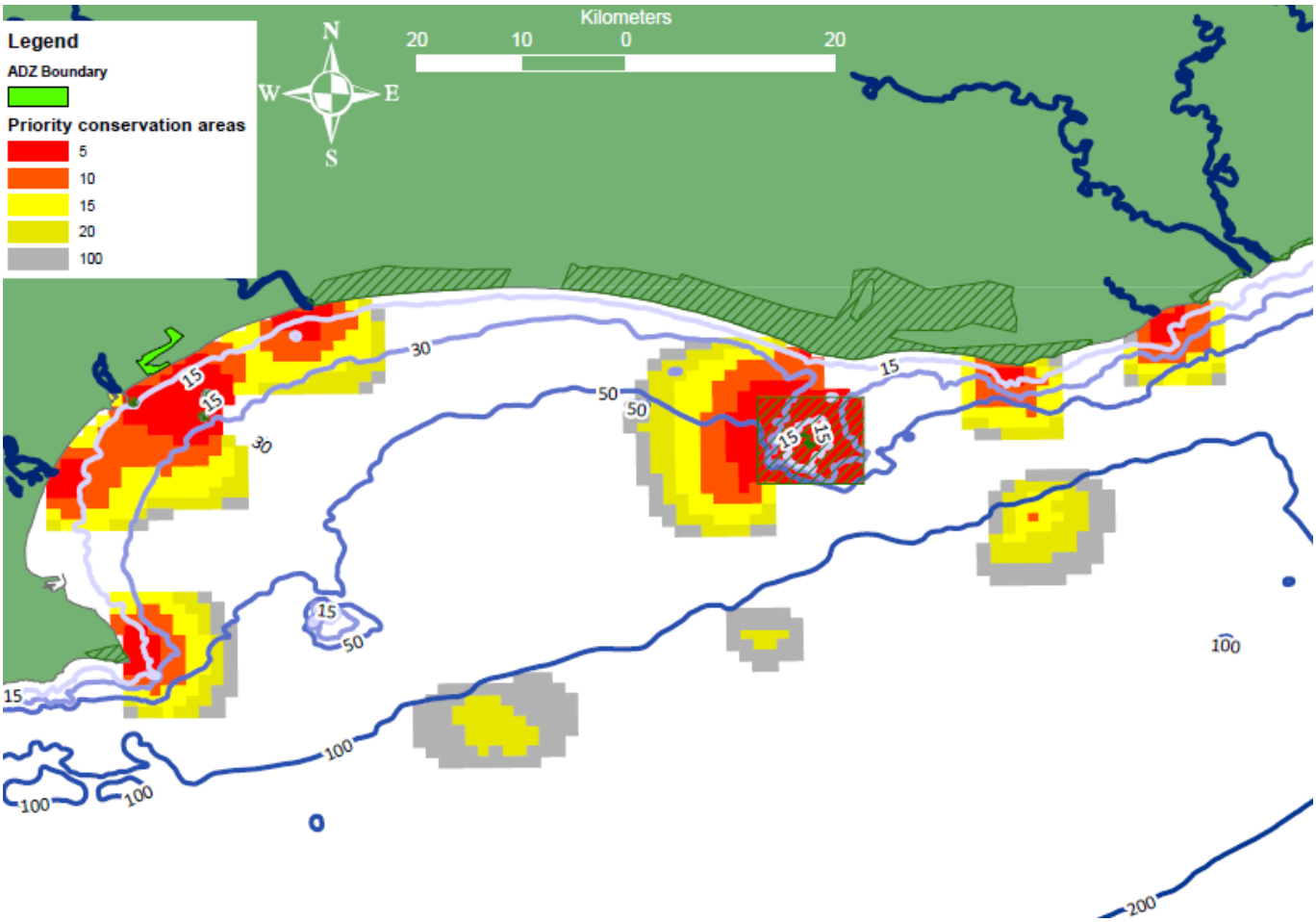


Figure 6-16: 5 Priority areas identified for marine conservation in Algoa Bay

Source: Chalmers 2012, in Chalmers 2016. Red most important, all shaded areas required to meet desired conservation targets in Algoa Bay. Bathymetry contours in blue.

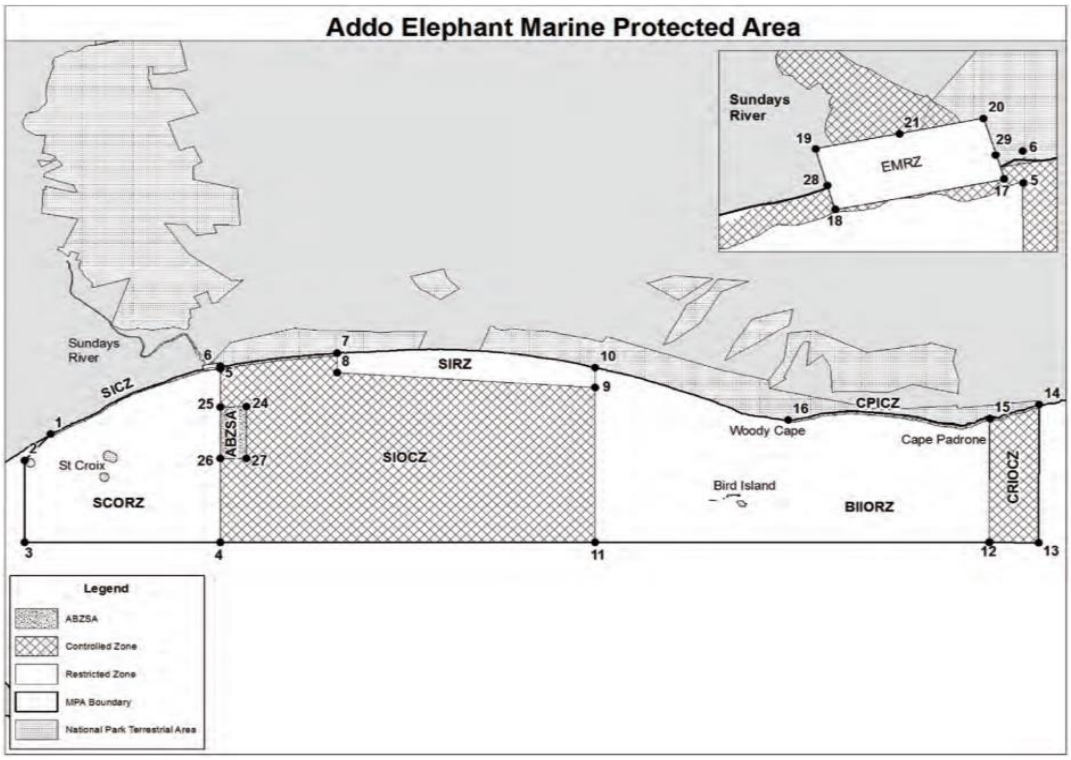


Figure 6-17: 6 Addo Elephant Marine Protected Area boundaries as per the Notice of intent to declare (GN39646)

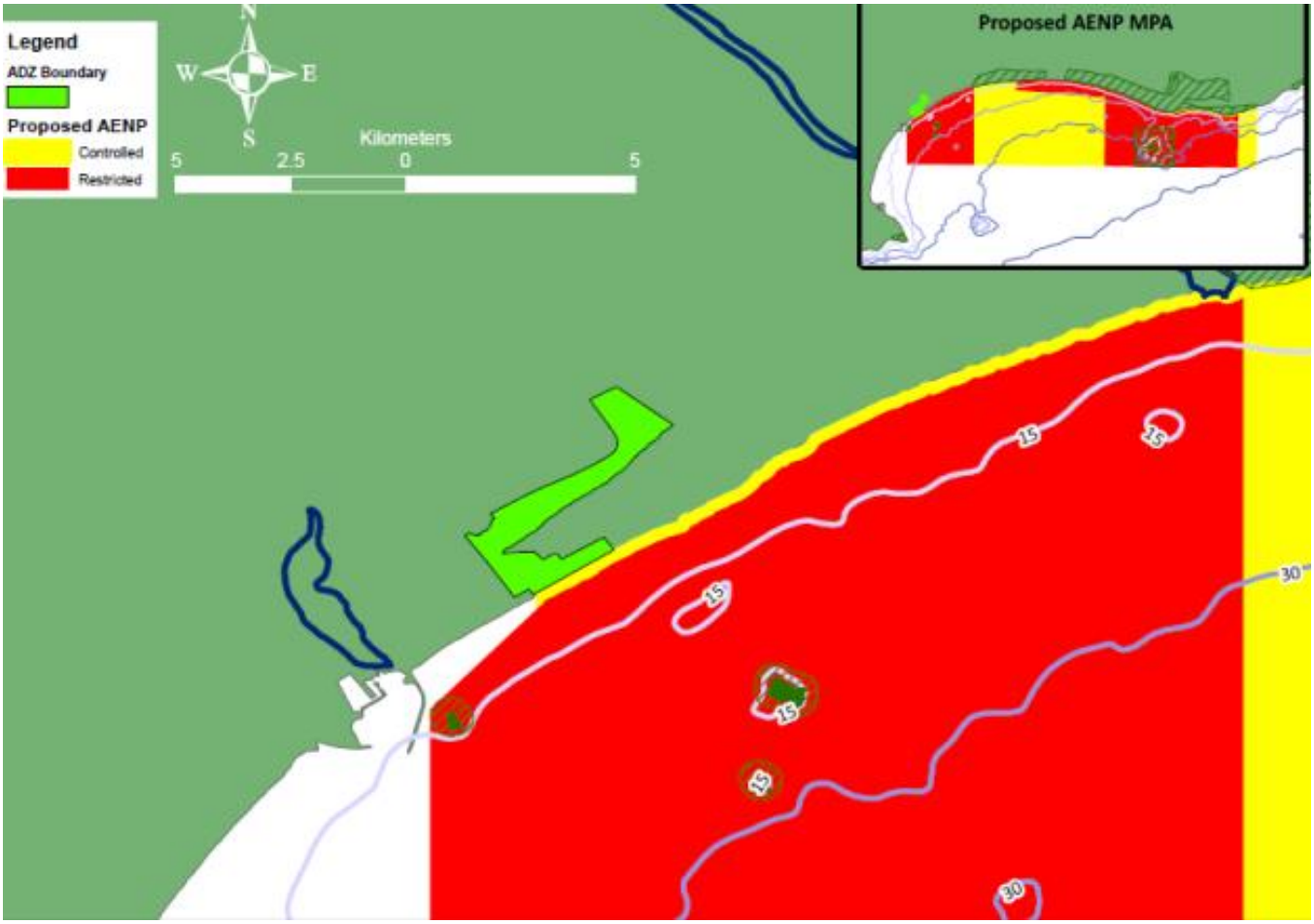


Figure 6-18: 7 Proposed Addo Elephant Marine Protected Area zoning (SANParks 2016)

6.10 Ecology and Biodiversity

6.10.1 Terrestrial Vegetation

The vegetation of the ADZ was classified by Mucina and Rutherford (2006) at a national scale, and more recently at a finer regional scale, in the NMB Bioregional Plan (NMB MBP) for the NMB Municipality (SRK, 2014). The different vegetation types and their ecosystem threat status at the time of classification are tabled below. The Bontveld vegetation is found furthest inland. The location and sequence of occurrence of the different vegetation types, from the furthest inland parts of the ADZ to the shoreline are also indicated.

Table 6-6: Vegetation Types of the ADZ

Location in ADZ	NMB Bioregional Plan (2014)		Mucina and Rutherford (2006)	
Inland	Grass Ridge Bontveld (unit 19)	*Vulnerable*	Coega Bontveld (unit AT 7)	*Least Threatened*
↕	Colchester Strandveld (unit 14)	*Vulnerable*	Algoa Dune Strandveld (unit AZ 5)	*Least Threatened*
	Algoa Dune Thicket (unit 2)	*Vulnerable*		
	Sandy Beach [Dune field] (unit 36)	*Least Threatened*	Cape Seashore Vegetation (unit AZd 3)	*Least Threatened*
Shoreline	Areas below the HWM fall within Coastal, unit 10			

Note: The NMB MBP was adopted by DEDEAT in terms of the NEM:BA in March 2015 (Eastern Cape Provincial Gazette No 3362).

The scoping report that preceded this report, contained a description of the vegetation types according to the Mucina and Rutherford (2006) with detail on the species observed, particularly any rare or threatened species, during the ecological assessment conducted for previous EIA processes (CEN, 2009) in the same area.

Scherman Colloty & Associates (SC&A) reviewed the previous reports, conducted a field assessment and incorporated information collected over the five years working on other assessments in the IDZ. The results of their assessment are presented below. Their specialist report is in Appendix G3.

6.10.1.1 Vegetation Types

Based on the NMB MBP, SC&A describes the broad vegetation units that remain in a near natural state in the ADZ as follows:

Grass Ridge Bontveld (NMB MBP unit 19) – Vulnerable

Grass Ridge Bontveld, as seen in flat to gently sloping plains in most of the study area, occurs on deeper, calcareous, gravelly, paleo-dune sands (Plate 6-2), where it becomes Algoa Dune Thicket vegetation towards the ocean (Plate 6-3). Grass Ridge Bontveld also occurs on shallower, gravelly clayey soil inland towards the Coega Estuary (Plate 6-2 to Plate 6-5). Grass Ridge Bontveld is restricted to the karst landscape created in the underlying limestone, and consists of scattered, low bushclumps of Thicket species, in a matrix of open grassland which contains species characteristic of Fynbos, Grassland and Succulent Karoo vegetation types. Bushclumps are dominated by *Aloe africana*, *Chrysanthemoides monilifera, Colpoon compressum*, *Euclea undulata*, *Pterocelastrus tricuspidatus* and *Sideroxylon inerme*. The grassy matrix in Grass Ridge Bontveld is dominated by *Cynodon dactylon*, *Eustachys paspaloides*, *Themeda triandra*, *Ficinia truncata*, *Acmadenia obtusata*, *Disparago ericoides*, *Euryops ericifolius*, *Gazania krebsiana*, *Gibbaria scabra*, *Jamesbrittenia microphylla*, *Lobostemon trigonus*, *Monsonia emarginata*, *Nylandtia spinosa*, *Osteospermum imbricatum* and *Pteronia incana*.

Algoa Dune Thicket (NMB MBP unit 2) – Vulnerable

Algoa Dune Thicket (Plate 6-4) is dominated by *Chrysanthemoides monilifera, Pterocelastrus tricuspidatus, Olea exasperata* and *Sideroxylon inerme* and is found in the secondary dune areas along the coastline.

Colchester Strandveld (NMB MBP unit 14) – Vulnerable

Colchester Strandveld is a vegetation type that broadly contains Algoa Dune Thicket components in a matrix of grassy shrubland. These areas are dominated by *Cynodon dactylon* and *Lycium cinereum*, and found on aeolianite / calcareous sandstone / sand.

Sandy Beach (NMB MBP unit 36) – Least Threatened

Sandy Beach vegetation type is dominated by large portions of exposed mobile sand dunes with isolated pockets of dune ticket. These areas are important breeding habitat for the Damara Tern (*Sternula balaenarum*) and Pygmy hairy footed gerbil (*Gerbillurus paeba*).

SC&A found all the vegetation types listed above with large stands of alien invasive *Acacias*, with only small areas of natural vegetation remaining mostly just outside of the ADZ footprint.

Plate 6-2: Grass Ridge Bontveld in the higher lying, level areas of the ADZ towards the northern boundary of the ADZ, on gravelly, calcareous sandy soil, early Spring 2013 after significant rainfall

Plate 6-3: Grass Ridge Bontveld, in close proximity to site of Plate 6-2, but after a significantly dry period in 2016

Plate 6-4: Grass Ridge Bontveld in foreground and Algoa Dune Thicket (red arrow) towards the ocean

Plate 6-5: Grass Ridge Bontveld pockets the lower part of the site, looking towards the Coega Estuary

6.10.1.2 Plant Species of Special Concern

Several important plant species are known to occur within the region and these are listed by SANBI under the Threatened Species Programme (accessed via the SANBI Threated Species Programme – Red data list via their online database accessed October 2016).

Any plant species of special concern were actively searched for during the field survey conducted by SC&A and they reported a high number of conservation worthy plant species associated with the thicket vegetation types and Bontveld clumps. The plant species of conservation concern and protected plant species observed by SC&A were primarily within Algoa Dune Thicket and Grass Ridge Bontveld vegetation types. A full list is provided in Appendix G3: Ecological (Terrestrial and Aquatic) Specialist Report for the Coega ADZ (SC&A, 2016), Table 1.

The most noteworthy species of special concern are the Port Elizabeth / Uitenhage endemics, namely *Agathosma gonaquensis* (Critically Endangered), *Cyrtanthus spiralis* (Endangered), *Euryops ericifolius* (Endangered), *Syncarpha recurvata* (Endangered) and *Rhombophyllum rhomboideum* (Endangered).

SC&A observed a particularly large population of *Syncarpha recurvata* (Endangered) near the port control tower some distance outside the boundary of the ADZ footprint. The species occurs on calcrete outcrops, where these outcrops have been disturbed. Little is known on how to rehabilitate these disturbed areas as this species cannot be transplanted or regrown ex situ. Although the population near the port tower falls outside of the proposed ADZ boundary, this population has grown significantly (40% increase in areas covered) over the past 5 years that SC&A has been conducting assessments within the area. Thus, the potential for *Syncarpha* to grow within the ADZ is notable as these plants prefer disturbed areas, with the new plants being observed along new roads and tracks within the calcrete areas. The same could happen along the new tracks that have appeared over time in and around the ADZ.

CDC has obtained a permit to remove protected plant species from areas where infrastructure will be constructed in the Coega IDZ, in terms of the Nature Conservation Ordinance (19 of 1974). The permit is valid for 12 months, and is renewed on an annual basis but renewal is dependent on fulfilment of the conditions of the permit. The permit conditions require:

- The location of individuals of the various species to be identified, located with a GPS and be physically marked.
- The person responsible for the relocation to work ahead and physically remove the plants before vegetation clearance starts.
- If a species is represented by too many individuals to make relocation of the entire population feasible, plants should be taken from different parts of the site, from different habitats, both young and old individuals should be selected as well as individuals reflecting variability in the population to ensure the plants relocated will express the broadest genetic variation and maximize the chance of survival.
- For plants that cannot be successfully uprooted transplanted, seeds and/or small cuttings are to be collected and establish in a nursery for cultivation and later introduction into selected localities.
- Plants are to be translocated in the most appropriate form, not only as whole plants but also as bulbs, seeds and cuttings.
- Private individuals and or nurseries to be given the opportunity to collect plants that are not relocated and that would otherwise be destroyed during vegetation clearance of the site.

The CDC has also obtained a licence, under the National Forests Act (84 of 1998) to cut and destroy protected trees (Milkwood and Cheesewood) for the purpose of developing infrastructure in the IDZ. The license is issued for 12 months, and is renewed on an annual basis. It covers tenants in the IDZ but requires the licensee (CDC) to monitor tenants' activities in respect of the licence.

6.10.1.3 Threatened Terrestrial Ecosystems

The NEM:BA provides for listing of threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Protected. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to preserve witness sites of exceptionally high conservation value. In terms of the listing, the significance of impact on biodiversity, when there is a loss of natural habitats listed as either a Critically Endangered or an Endangered ecosystem, would be regarded as Highly Significant.

The first list consisting of 225 threatened terrestrial ecosystems, based on vegetation type, was published on 9 December 2011 (Government Gazette 34809, Notice 1002). Expected future listings will deal with threatened

ecosystems in the freshwater, estuarine and marine environments and with protected ecosystems in all environments.

None of the currently listed threatened ecosystems were found within the ADZ or immediate surroundings.

6.10.1.4 Alien Invasive Species

SC&A observed several invasive or alien plant species that included the wattles (*Acacia cyclops)* (rooikrans) *and A. decurrens*), Prickly pear (*Opuntia spp*), Gums (*Eucalyptus spp*) and Pines (*Pinus spp*). These are being managed by clearing teams from the CDC. The work is in accordance with the Alien and Invasive Species Regulations, 2014 (GNR 598) in terms of NEM:BA. Developments in the ADZ will need to subscribe to these regulations and the CDC's permitted alien clearing and monitoring programme.

The increase in wattle within the study area is most notable, particularly in areas with past disturbance or areas associated with new roads, tracks and mining operations. Of concern is the high level of wattle encroachment (around 90% infestation) in Zone 10 and particularly within the Algoa Dune Strandveld areas possibly due to artificial stabilization of the dunes occurred in the past.

Little natural vegetation, estimated at around 10% of the area, remains within the ADZ.

6.10.2 Terrestrial Fauna

SC&A's assessment of terrestrial fauna was largely desktop, based on known distribution records, past assessments and local expertise, supported by field observations.

Lists of various faunal groups, with species likely to occur within the study area, together with their associated habitat and conservation status were compiled and are provided in Appendix G3: Ecological (Terrestrial and Aquatic) Specialist Report for the Coega ADZ (SC&A, 2016) (Table 2 and 3).

6.10.2.1 Mammals

Most mammals present in the Coega IDZ area are small or medium sized. Sixty-three mammal species are known or expected to occur in the area, 13 of which are Red Data Book (RDB) species (4 vulnerable, 5 rare and 4 intermediate species) (IUCN accessed November, 2016). Five of these RDB species are medium too large, occupying relatively large ranges, and will be adversely affected by development as their ranges become restricted (SRK, 2005 in SC&A, 2016).

Duthie's golden mole, *Chlorotalpa duthiae* and the pygmy hairy-footed gerbil, *Gerbillurus paeba exilis* are endemic to the region. However, both are only likely to be found in the dune areas (the former in the dune woodland, and the latter in the open dune sand where there is little or no vegetation). The dune woodland habitat should be specially protected from development and disturbance and should be granted special conservation status (Van Teylingen, *et al*. 1993 in CEN, 2009). Dune woodland habitat occurs in the same area referred to as Algoa Dune Strandveld (see vegetation section above).

The African wild cat, *Felis Iybica* (Vulnerable) is found throughout the Eastern Cape and has a wide habitat tolerance (Smithers, 1983) and may occur in the Coega area. Additional wide-ranging mammals, listed as rare or vulnerable in the South African Red Data Book that may occur in the study area are, aardvark, *Orycteropus afer* (Vulnerable), honey badger, *Mellivora capensis* and the African hedgehog, *Atelerix frontalis* (Rare).

The Blue duiker, *Cephalophus monticola* (Rare) is confined to forests, thickets or dense coastal bush (Smithers, 1983) and probably occurs in the area in low numbers. The largest mammals likely to be found in this habitat are the Grysbok, *Raphicerus melanotis* and the Common duiker, *Sylvicapra grimmia*, both small antelope. Both the

Grysbok and Common duiker have been observed in this and past assessment conducted by SC&A in the study area and surroundings.

A unique population of Pygmy Hairy Footed Gerbils (*Gerbillurus paeba*) has been confirmed within the dunes near the Port of Ngqura as part of the Transnet Urban Raptor Project. Although the IUCN RDB lists this species as Least Concern, genetic studies of this isolated population have shown that these could be a sub-species, and thus a rare endemic (Times Media, Herald April 2015, in SC&A, 2016). Previously this species was identified as *Gerbillurus paeba exilis* (Perrin *et al*., 1999, in SC&A, 2016) and only found between St Georges Strand and Sundays River Mouth. This further illustrates the conservation importance of the dunes and beach areas as well as the need to assess the genetics or intraspecific variations of these populations within the Algoa Bay region.

6.10.2.2 Birds

Based on the South African Bird Atlas Project (SABAP2), 145 bird species has been recorded from the quarter degree grid cells that overlap with the study area. However, recent data suggests that the diversity of habitat types prevalent on the study sites is more likely to sustain ~184 species (www.sabap2.adu.org.za). However, Dr Paul Martin, the Coega ECO, has recorded 207 species in the area as part of a long term monitoring programme. Of these, 72 species are of conservation concern (Appendix G3, Table 3).

There are three important bird areas of international importance in the region, which contain habitat for a species of conservation concern and/or are endemic to a region and/or where the habitat is under threat, namely:

- Alexandria Coastal Belt including the dune systems.
- Algoa Bay Islands, falling under the Addo Elephant National Park.
- Swartkops Estuary, including Redhouse Chatty Solar Salt Works.

The link between these habitats and Zone 10 of the IDZ is the beach, coastal dunes and fore dune areas that are similar to the Alexandria Coastal Belt, and contain nesting sites for birds such as the Damara Tern, directly within Zone 10 (Dr Paul Martin, pers. comm, and Appendix 1 in SC&A, 2016). The Damara tern is listed as regionally Critically Endangered, and globally Near Threatened (Birdlife South Africa, 2015). In 2000, it was estimated that there were about 120 to 150 breeding pairs in South Africa but in 2011 it was concluded that the numbers could be as low as 36 pairs, with 4 to 11 pairs breeding at De Mond Reserve in Western Cape, and 25 pairs breeding in Eastern Cape, with the Alexandria dune field listed as having the largest concentration of Damara terns (Birdlife South Africa, 2015). They breed in coastal dunes and are threatened by habitat loss and human disturbance. Old records indicate a nesting site to the east of the Coega River mouth (Watson and Randall, 1995), and suitable breeding habitat in dune fields along the seaward margin of the area designated as port (Watson and Kerley, 1995, in CEN, 2009). The breeding sites in Zone 10 are located outside the ADZ footprint, to the west of the old abalone farm (indicated as a 'species of special concern' habitat in the OSMP), and some distance to the east of the ADZ near the eastern end of the IDZ, at Jan se Gat towards the Sundays River. Based on data provided by Dr Martin, a number of Damara Terns bred at these two locations within Zone 10 of the IDZ during the 2015/2016 breeding cycle and it appears that terns have favoured the beach areas of Zone 10 as opposed to other traditional breeding sites in the Alexandria dune field. Although located outside of the ADZ, the Damara Tern breeding sites will have to be considered during the location of any supporting infrastructure such as pipelines close to the beach areas.

6.10.2.3 Herpetofauna

The Eastern Cape supports nearly a third (approximately 133 species) of the reptile species recorded in South Africa. More than half of the Eastern Cape's endemic reptile species occur in the Algoa Bay area, giving the region a high conservation value. A total of 63 reptile species are believed to occur within the Coega IDZ. The majority of these are found in Succulent Thicket and riverine habitats. Only a few reptile species occur in the coastal dunes and estuarine habitats. More than a third of the species are described as relatively tolerant of disturbed environments, provided that migration corridors of suitable habitat are maintained to link pristine habitats.

Twenty two reptiles are of special concern and include five endemic species (two of which may also be endangered), four endangered sea turtles, eight species listed with CITES, one rare species and four species at the periphery of their range. Fourteen of these species of special concern are confirmed as occurring on or within 2 km of the Coega IDZ (CES, 2001, in CEN, 2009).

The snake skink, *Scelotes anguina,* a common burrower in sandy soils from Port Elizabeth to the Bushman's River and the Tasman's girdled lizard, *Cordylus tasmani* which lives in old trees and aloe stems in the Sunday's River Valley are endemic to the Algoa Bay coastal region and are found in the development area.

The Eastern Cape has the richest diversity of land tortoises in the world, and three of the five species can be found along the coastal belt, namely *Geochelone pardalis* (mountain or leopard tortoise), *Chersina angulata* (angulate tortoise) and *Hompus areolatus* (parrot-beaked tortoise). The latter is one of the smallest land tortoises in the world (Branch, 1988b, in CEN, 2009).

The giant leatherback sea turtle *(Dermochelys coriacea)* and the loggerhead sea turtle *(Caretta caretta)* have been recorded feeding in Algoa Bay (Branch, 1997 in CEN, 2009) but there are few records of any southern African sea turtles breeding on Eastern Cape beaches. A single, possible vagrant, leatherback sea turtle was observed nesting on the Woody Cape beach during 1990. Only the green sea turtle *(Chelonia mydas)* utilizes estuarine habitats, where it feeds on *Zostera* beds. It is known to occur in the Sundays River estuary. The closed and degraded estuarine habitat of the Coega River is not suitable for this species.

A total of 32 amphibian species and sub-species occur in the Eastern Cape, representing almost a third of the species recorded in South Africa. However, none of the species are endemic or Red Data Book Species. Based on previous studies in the area, it is estimated that approximately 17 amphibian species occur within the Coega IDZ. Four species are listed as peripheral, but none are threatened internationally. These include the Natal puddle frog *(Phrynobatrachus natalensis),* the bullfrog *(Pyxicephalus adspersus),* the yellow-striped reed frog *(Hyperolius semidiscus)* and the bubbling kassina *(Kassina senegalensis)* (SRK, 2005).

The general absence of permanent water with vegetated margins within the areas west of the Sundays River, either as small dams or perennial streams, severely constrains the presence of breeding amphibians, and the aquatic species *Xenopus laevis.* Most species require standing water for a minimum of 6 - 10 weeks for successful breeding to occur. Only the rain frog *(Breviceps adspersus pentheri)* is a terrestrial breeder, whose breeding does not require standing water even for short periods (Branch, 1988b, in CEN, 2009). A number of poorly drained areas may form temporary ponds following heavy rain and may be suitable for breeding by *Tomopterna delanadei,* both *Bufo* species, *Strongylopus grayii, Cacosternum boettgeri* and C. *nanum* (Branch, 1988c, in CEN, 2009).

The invertebrate fauna of the coastal dune fields of Algoa Bay and associated vegetation has not been extensively studied. The nature and distribution of the terrestrial invertebrates found along the coast is dependent to a large degree upon the extent and composition of the vegetational groundcover (Gess and Gess, 1988, in CEN, 2009). Of concern in the development are two species of the rare *Lycaenid* butterfly.

In southern Africa the butterflies most at risk are the *myrmecophilous* (ant associated) *Lycaenidae.* These species are often local and rare, as they require the presence of host ant and host plant as well as optimal climatic conditions. These species are particularly vulnerable to any disturbance of their preferred habitat. One such species is *Lepidochrysops bacchus,* which is endemic to the Eastern Cape and is located in the Uitenhage and Coega areas (Henning and Henning, 1989). Other members of *Lycaenidae* are *Aloeides clarki,* inhabiting coastal flats to the north of Port Elizabeth and along the Sundays River, and *Poecilimitis pyroeis hersaleki.* All three species are listed as Rare in the Red Data Book for Butterflies (Henning and Henning, 1989, in CEN, 2009). The species are also recorded as rare in the IUCN Red Data Book.

Lepidochrysops bacchus has a complex life cycle. The female lays her eggs on the unopened flowers of its food plant, *Walafrida geniculata.* The larva feeds on the buds and flowers until the third larval instar stage when it is

taken underground by the ants of the Genus *Camponitus.* At this stage the larva becomes carnivorous feeding on the immature stages of its host ant.

The larva only surface again when it is time to pupate, shortly before emerging as adults. This process ensures that the larvae are safe from adverse weather, veld fires and predation. The butterfly appears to regulate its emergence from the ant colony and will only appear after adequate spring rains have fallen thereby ensuring that the food plant would have flowered. This is usually during mid-October. If sufficient rain does not fall, the larva does not pupate and hold over until the following spring. Hiatus periods of up to five years have been noted between the emergences of the butterfly. The life cycle of *Aloeides clarki* is also complex. The female lays her eggs on the food plant, a species of *Aspalathus.* After emergence the larva feeds on the leaves of the plant, hiding itself by spinning small shelters between the leaves. The larva only develops a honey gland from the third instar stage and it is probable that from this stage onwards the larvae cohabit with their host ant, *Acantholepis capensis.*

The life cycle of *Aloeides clarki* is unknown from this point but from similar species it is speculated that the larva live in nests of the host ants under stones emerging, closely escorted by the ants at night, to feed on the leaves of their food plant. They are then escorted back to the nests before daybreak. The larva pupates and the butterfly can be found throughout the warmer months from September to April. One grasshopper species, *Acrotylos hittus,* is endemic to the dune fields.

6.10.3 Aquatic Environments (Fresh Water, Land-Based)

As described in Section 6.4, the ADZ is located on the watershed between quaternary catchment M30b (coastal and inland section) and the N40F, and there are no watercourses or drainage lines within the ADZ due to the high infiltration rate of rainwater into the sandy soils.

SC&A confirmed that there are no natural wetlands are found in the ADZ or within 800 m from the ADZ. The National Wetland Inventory, currently being updated for the Eastern Cape by SC&A, still indicates two wetlands within the ADZ but SC&A confirmed these to be an old quarry, now storm water pond, and the abandoned ponds at the old abalone farm.

6.10.4 Ecological Sensitivity

The ADZ is largely covered in alien vegetation with small pockets of intact vegetation remaining. SC&A rated the remaining intact habitats as Moderately Sensitive to development since they still contain large numbers of protected plants species (as listed in Appendix G3, SC&A, 2016).

Sensitive habits rated as Highly Sensitivity to development have been excluded from the ADZ footprint and form part of the Primary Dune and Secondary Dune areas of Revision 1 of the OSMP (Area 1.3A and 1.3B) and the Damara Tern habitat indicated as a Species of Special Concern area. The buffer zone that is maintained around the Damara Tern habitat also falls outside the ADZ.

6.11 Heritage Resources

An assessment of existing heritage resources are discussed in the impact assessment chapter (Section 7.20), together with recommendations by various specialists and SAHRA for their protection.

6.12 Air Quality

The Eastern Cape coast's warm, temperate climate is predominantly controlled by the semi-permanent continental high pressure cell and low pressure systems in the form of westerly waves. Dispersion of pollutants can occur horizontally and vertically in the atmosphere. Horizontal dispersion is a result of wind speed and topography whilst vertical dispersion is controlled by the level of atmospheric stability. Dispersion is most effective with unstable conditions where vertical mixing is initiated. Stable conditions are conducive to shallow mixing

depths and poor atmospheric dispersion. High pressure systems are associated with clear, calm and stable conditions as a result of subsidence. With persistent stable conditions, atmospheric dispersion is poor, resulting in the accumulation of pollutants. The occurrence of westerly waves is associated with unstable conditions and strong winds. These conditions promote the dispersion of pollutants (Tyson, P.D. and Preston-Whyte, R.A. in WSP, 2014).

The air quality in the Coega area is generally good, as a result of ocean air that recirculates into the area, removing impurities and transporting pollutants offshore. The area is described as having generally good dispersion potential during summer as a result of a deepened mixing layer, a lower frequency of surface inversions and a higher occurrence of stronger winds. Surface cooling during winter, however, is conducive to the formation of surface inversions at night. This narrows the mixing layer and traps pollutants between the ground and the inversion layer. Associated light wind speeds exacerbate the accumulation of pollutants. After sunrise, convective mixing is initiated and the surface inversions break down such that pollutants may disperse (Tyson, P.D. and Preston-Whyte, R.A. in WSP, 2014).

The Coega IDZ has an air quality monitoring network consisting of three monitoring stations at Saltworks, Amsterdamplein and Motherwell. Ambient air quality monitoring was undertaken from 2000 to 2012, and after a two-year interruption, resumed in 2015. Monitoring results reflect that ambient concentrations of criteria pollutants Sulphur Dioxide, Nitrogen Dioxide, Ozone and fine particulate matter (PM10) are below the South African National Ambient Air Quality Standards (Government Gazette 32816, December 2009) (SA-NAAQS) (WSP, 2014 and LAQS, 2015).

The existing emission sources in and around the Coega IDZ area include industrial activity, biomass burning, domestic fuel burning, vehicle use, agricultural activities and construction activities. The various proposed developments within the Coega IDZ will cumulatively impact on the future air quality in the area, which will need to be monitored.

The CDC has identified the need to ensure that the effect of emissions from tenants' activities within the IDZ are known and managed so that ambient air quality standards are not exceeded and that health and environmental risks are understood and managed, and has commissioned an independent consultant to develop an air emissions inventory and air dispersion model. It was developed in 2014 and updated twice after that. The model determines emission levels and the effect of the various developments on the ambient air quality in the IDZ and surrounding areas to assist with screening of developments and decision making on the desirability of proposed developments.

Refer Section 7.3 for a description of the existing and reasonably anticipated cumulative assessment of air quality in and around the Coega IDZ and the nearby St Croix Island.

6.13 Noise

Human induced noise generation in Zone 10 and part of the ADZ is limited to the sand mining activities and associated movement of trucks along the haul roads towards the N2 road. The N2 is a source of noise where it runs past the north-eastern corner of the ADZ. Noise levels in the remaining inland part of the ADZ, behind the crest of the plateau are low, except for natural noises such as wind and birds. Ambient noise levels in this area are expected to be on par with so-called rural areas, namely 45 dBA during the daytime and 35 dBA at night. The noise environment on the seaward side of the plateau is dominated by the natural noise of waves and wind. Background wave noise can be significant, and has been measured to be over 85 dBA at 10 m inland from the HWM on a fairly windless day and over 95 dBA on a windy day.

6.14 Landcover

Existing landcover based on the NMB MOSS and Coega OSMP is mapped below:

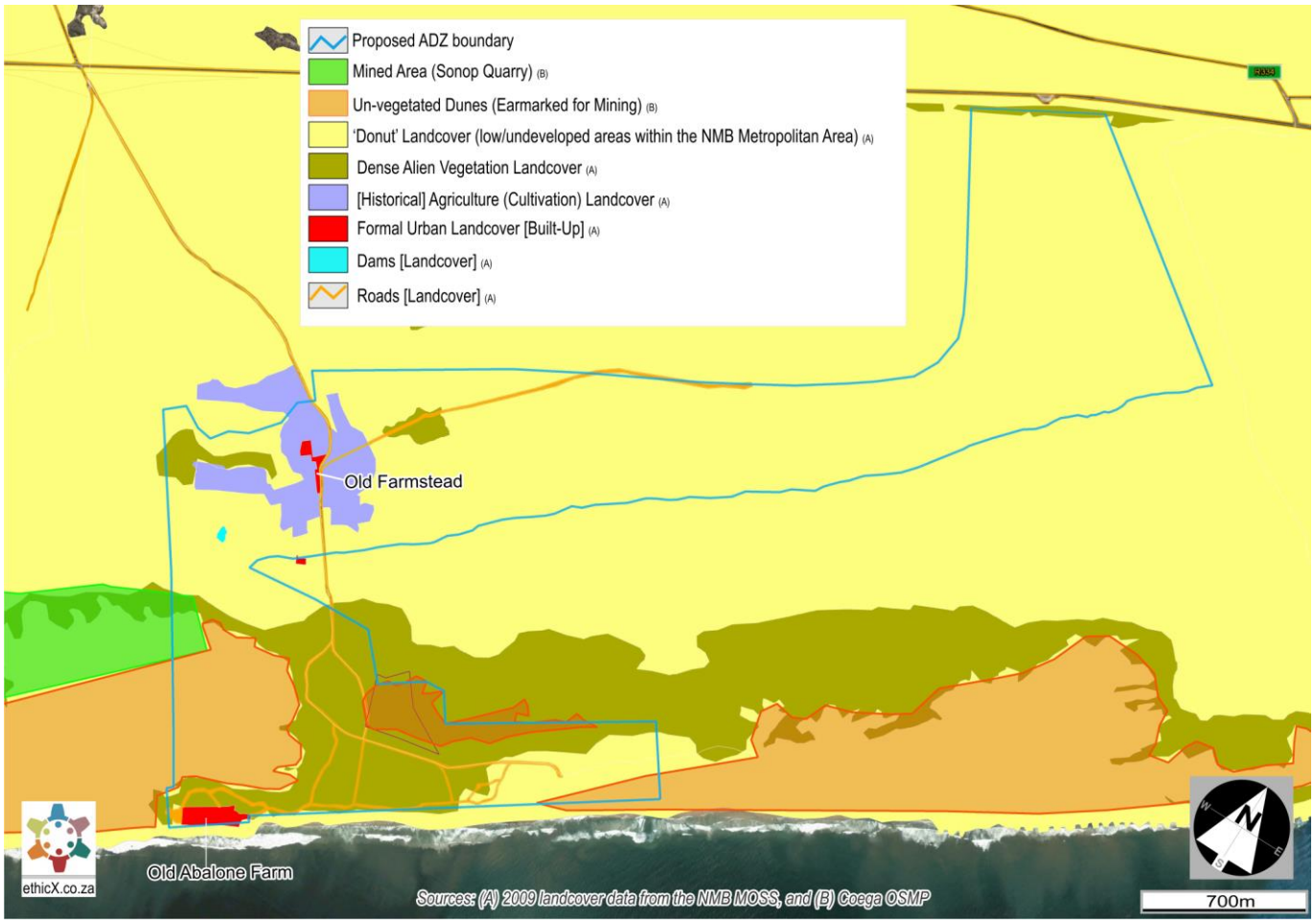


Figure 6-19: Landcover Map

Sources: (A) 2009 landcover data from the NMB MOSS, and (B) Coega OSMP

6.15 Socio-Economic

The following socio-economic information was obtained from the Social Impact Specialist Assessment for the Coega ADZ, undertaken by Dr Anton De Wit (De Wit, 2016b).

The NMB Metro is the largest urban agglomeration in the Eastern Cape Province. This province is generally known as one of the poorest in South Africa (second poorest to be precise after the Limpopo Province) (HSRC, 2014 in De Wit, 2016) and contributes only 7.8% of the country's Gross Domestic Product (GDP) (ECSECC, 2013 in De Wit, 2016b).

The economy of the NMB Metro maintains a strong industrial character and is traditionally dominated by the manufacturing sector with significant automotive and allied components. This sector recently (2013) accounted for almost a quarter of the NMB Metro's GGP. Government / community services; finance; wholesale/retail; and the transport sector follow in this order (ECSECC, 2014 in De Wit, 2016b). The Metro's economy experienced its heyday about four-and-a-half decades ago, but following the country as a whole, it has since been in steady decline (Müller, 2000 in De Wit, 2016). This trend has shown little change in the first decade of the new millennium and a key contemporary attribute of the local economy therefore is its weak performance; having managed an annual average growth rate between 2000 and 2013 of barely one percent (ECSECC, 2014 in De Wit, 2016). The economic decline of the NMB Metro currently shows no sign of abating. This is reflected by the dramatic decline in local investment and the subsequent reduction in the annual number and value of business plans that are submitted to the NMB Municipality (NMB Municipality, 2014 in De Wit, 2016b).

The NMB Metro, as far as its population is concerned, is the sixth largest Metropolitan Municipality in the country. Its contemporary total population number is somewhere in the vicinity of the 2013 estimate of just below 1.2 million people (ECSECC, 2014 in De Wit, 2016b) and the 2016 projection of slightly more than this figure (Simpkins, 2006a in De Wit, 2016b). The ethnic composition of the NMB Metro reveals nothing extraordinary. African people represent 60.1% of the total population; the figure for Coloured people stands at 23.6%; the share of Asians is 1.1%; and that of White people 14.4% (Stats SA, 2011 in De Wit, 2016). What is however remarkable about NMB Metro's population is that it is not growing much compared to some of the other industry heavy metropolitan municipalities in South Africa. With an annual growth rate of only about 0.5% over the last decade (ECSECC, 2014 in De Wit, 2016b) and a projected rate over the next five years of even less than that (Simpkins, 2006a in De Wit, 2016b), the NMB Metro is not likely to add a significant number of people to its total population for some time. Although a number of factors contribute to an explanation of this trend, such as HIV/AIDS and lower fertility rates for example, relatively high out-migration levels combined with low in-migration levels are critical factors (ECSECC, 2014; NMB Municipality, 2014 in De Wit, 2016b).

The relatively bleak state of the NMB Metro's economy and its poor performance over time is needless to say well-mirrored by employment growth trends. For example, the contribution of the manufacturing sector to local employment growth between 2000 and 2010 was only in the region of one percent (Rand International Capital, 2011 in De Wit, 2016b). These economic dilemmas are of course reflected by allied indicators such as the employment status of people and local levels of poverty. According to the latest census results, the Metro as a whole has an unemployment rate of 36.6% (Stats SA, 2011 in De Wit, 2016b). In 2013, the unemployment rate in the Metro roughly translated into an estimated 140:000 people; 20:000 people more than the figure about decade ago (ECSECC, 2014 in De Wit, 2016b). This metro-wide image however hides local extremes within allotment areas or suburbs such as the Ibahi townships, Motherwell, KwaNobuhle and elsewhere, where unemployment figures are sometimes much higher than the official rate (Africoast, 2007, 2008; Development Partners, 2006; 2010 in De Wit, 2016b).

Considering the above, it is not surprising that the NMB Metro has a poverty rate of 44.2%; in other words, almost half-a-million people in the Metro live in poverty (ECSECC, 2014 in De Wit, 2016b). A host of other problems are of course associated with poverty, such as poor educational attainment. About a tenth of the Metro's adult population in this case is illiterate according to the NMB Metro Socio-economic Profile Report. At the same time, the number of people in the above-mentioned less affluent areas of the Metro with some kind of tertiary education or any post-school training qualification generally dwindles to less than a percentage of all adults (Africoast, 2007, 2008; Development Partners, 2006; 2010 in De Wit, 2016b).

The particular emphasis of this section highlights some of the most pressing socio-economic issues of the NMB Metro at the moment. Much of the hope of addressing these and the local economic decline continues to lie in the industrial development of the NMB Metro, amongst others in the strategically important Coega IDZ (Müller, 2000 in De Wit, 2016b). The socio-economic attributes and challenges that were noted above act as sensitive receptors in the case of development proposals in the Metro. Collectively, they also define the social environment that would receive the proposed development of an ADZ. This development by virtue of its scale and cost is likely to play a modifying role in the receiving environment and is therefore expected to generate a number of social impacts in return.

6.16 Coega IDZ Economic Performance and Outlook

News headlines and media statements[10] issued by the CDC in 2016 generally paints an optimistic picture about the Coega IDZ's economic performance and outlook:

- "The CDC achieved not seen before numbers by any other IDZ in Southern Africa; where in the last 3 years the CDC signed 37 new investors with a combined value of R4.94-billion and created 44,465 jobs well exceeding its targets over the same period for investment and jobs," says Dr Ayanda Vilakazi, CDC Unit Head marketing and communications.
- The CDC has developed an investment pipeline valued at R181-billion; these are projects under discussions with the various companies locally and internationally.
- The CDC's contribution to job creation has seen the organisation win a number of national prestigious awards in the country. One which speaks to the priorities of the NDP is the Job Creation Award, which was presented to the CDC at the 14th Annual Oliver Empowerment Awards and at the Annual Exporters Club (Exporters of the Year) awards in 2015.
- Despite the economic tide, the CDC exceeded its jobs target by 101% in the 2014/15 financial year, creating over 14 765 jobs (bringing the total to 96 776 since inception). These jobs were created through activities both within and outside of the IDZ. The CDC exceeded its training and development targets by providing training to more than 8 147 (71 445 people since inception). As regards SMME achievements, 46.17% contracts were awarded to SMME by the CDC (CDC Media Statement, 2016).
- The CDC broke ground to mark the historic Beijing Automobile International Corporation (BAIC) R11 billion investment at the Coega IDZ on 30 August 2016. This transaction is the biggest automotive investment in Africa in the last 40 years and reaffirms South Africa as a top investment destination for global automotive producers. A Cabinet statement said the project positions the Eastern Cape as an automotive hub and has the potential of deepening the component supply chain, job creation and economic development. The plant will occupy 54 hectares of land in Zone 1 of the Coega IDZ, with an expectant number of jobs totalling 2,500 directly, and more than 10,600 jobs indirectly. "When adding the induced effect of the wage income, the impact of the economy-wide effect is estimated at R3.3 billion for the Eastern Cape Province" says Dr Vilakazi. Local supply will be prioritised, with plans for the BAIC facility including the future construction of a supplier park in Coega IDZ to facilitate supply. Local component manufacturers will supply many of the steel chassis components and assemblies, as well as panel and pressed components, interior and exterior trim, wheels and tyres, automotive glass components and electrical and electronic components.
- Coega IDZ was appointed as one of the locations for the gas-to-power programme with 1000 MW of the power facility allocated to the IDZ. This project is key for energy security, diversity and socio-economic development. Coega expects the investment associated with the zone's selection as one of two locations for the first phase of government's Liquefied Natural Gas Independent Power Producer Procurement Programme (LNG IPPPP) to total R25 billion.

6.17 Climate Change Outlook

This section is based on a report: Synopsis of the impact of climate change on the Eastern Cape Provence and the NMB Metro, prepared by Dr Anton de Wit (De Wit, 2016).

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[10] *Coega Development Corporation Performance (March 2016). http://www.coega.co.za/NewsArticle.aspx?objID=121&id=525.*
Coega Development Corporation marks historic R11 Billion Investment (August 2016). http://coega.co.za/NewsArticle.aspx?objID=106&id=555.
Coega Development Corporation says it had a successful 2016 (15 December 2016). http://www.rnews.co.za/article/12335/coega-development-corporation-says-it-had-a-successful-2016 .
Coega puts R25bn value to proposed gas-to-power investment into zone (October 2016). http://www.engineeringnews.co.za/article/coega-puts-r25bn-value-to-proposed-gas-to-power-investment-into-zone-2016-10-06.

Regional Context

Informed by (amongst others) Midgley *et al*. (2007), Huq *et al*. (2007), Petersen and Stephen (2010), Johnston *et al*. (2011), Mather and Stretch (2012), Carter and Gulati (2014), DEA (2014), Stevens et al. (2015), and Hoogendoorn *et al*. (2016) (as referenced in De Wit, 2016), the main climate change outcomes expected for the Eastern Cape are as follow:

- An increase in average temperatures across the Eastern Cape Province is predicted. The northwest interior of the province is likely to experience the highest temperature increase, while less severe increases will occur along the coast where the proximity of the ocean tends to moderate temperature extremes.
- The estimated overall increase in temperature is naturally associated with heightened evaporation rates. This will of course amplify the severity of droughts and related consequences (socially, economically, and environmentally).
- Rainfall patterns are expected to change due to a general reduction in the number of rainfall events that is likely to happen, as well as a reduction in the average amount of rainfall in relation to current rates. The eastern region of the province is however predicted to receive more precipitation in the future.
- Climate change is likely to increase the frequency and intensity of erratic and extreme weather events. Droughts and heat-waves, as well as storm events and floods (including flash floods) are therefore not only predicted to increase in number, but also in the duration of such episodes when it occurs as well as the intensity and destructiveness thereof.
- With changing rainfall patterns and generally increasing temperatures come changing disease vectors. The incidence of diseases such as cholera is projected to increase, while insect-related disease, particularly malaria, is likely to be introduced to the province in future.
- Indigenous species distribution, vegetation types and ecosystems are predicted to be significantly affected by climate change, largely via geographical shifts and biodiversity loss. It must however be emphasised that the primary driver of biodiversity and habitat loss in the province is not climate change as such, but an increase in agricultural activity and urban development, as well as other important drivers such as alien invasive species, the over-extraction of water, overgrazing and land degradation, overfishing, frequent fires, and so on. What climate change does in this case is to intensify the effect of such drivers and thus intensify the anthropogenic pressures on the biological environment to critical and sometimes irreversible levels.
- At more than 820 km long, the coastline of Eastern Cape Province is one of its prominent geographical features. This vast extent of coast will have to face increasing sea levels and higher sea temperatures as a result of climate change. These impacts will in turn result in an increase in coastal erosion, coastal inundation as well as changing marine ecosystems.
- In view of the above points, some of the urgent consequences of climate change in the Eastern Cape Province would revolve around decreasing water security (following less rainfall, higher temperatures, increasing pressure on water resources, and so on). Problems surrounding food production and crop failure are naturally associated with the last-mentioned dilemmas, which are likely to end up in decreasing food security.
- Water security is a critical limiting factor in the process of economic development and industrialisation. The expected negative impact of climate change on water security in the Eastern Cape Province, one of South Africa's poorest regions, means that any significant addition to its Gross Geographical Product via large scale future industrialisation is not likely to happen. It follows that the creation of employment opportunities on a scale that will make a noticeable difference to the province's unemployment rate, is equally unrealistic. The maintenance and development of the Eastern Cape's tourism industry, a vital driver of economic development, could also be complicated by some of the above-mentioned challenges, such as biodiversity and habitat loss, as well as coastal erosion, coastal inundation and changing marine ecosystems.

NMB Metro Climate Change Outlook

The provincial outlook discussed above provides the regional context for the following view on the consequences of climate change in the NMB Metro (De Wit, 2015). From a bio-physical point of view, a very significant attribute

of the NMB Metro) is its location on a stretch of coast along Algoa Bay. As such, the NMB Metro's biodiversity and relevant geomorphological processes (such as sand bypass systems) are noteworthy attributes, while, as with most coastal cities, it hosts numerous coast and ocean based activities which add to its distinctive social and economic character. This includes tourism and recreation, a well-developed fishing industry and mariculture operations, and industrial activities linked to markets abroad via two relatively sophisticated ports.

Given its major attributes, and as seen in the case of the Eastern Cape Province above, climate change is expected to have an equally large variety of consequences in the NMB Metro. Following are some of the main outcomes that are expected to manifest here, informed (amongst others) by McLachlan *et al*. (1994), Mukheibir and Ziervogel (2006), Rouault *et al*. (2010), DEA (2014), Douglas *et al*. (2008), DEDEA (2011), Mather and Stretch (2012), Dallas and Rivers-Moore (2014), NMB Municipality (2015), and Williams-Bruinders and De Wit (2015) (as referenced in De Wit, 2016). Emphasis is mainly on local impacts, that is, climate change impacts that are specifically associated with the geographical and other attributes of the NMB Metro (its climate, economy and location for example). The impacts of climate change that manifest elsewhere, but with some local consequence by way of a system of regional linkages, are not accounted for:

- The future climate of the NMB Metro is notoriously difficult to predict because of its above-mentioned historic variability. However, there seems to be some consensus that the climate of the NMB Metro is indeed changing and that the impacts that can be expected here are very much similar to those being predicted for comparable urban arrangements elsewhere. This includes the general increase of both average day and night temperatures; shifts in rainfall patterns (concerning both the timing of events as well as the amount of rainfall); an increase in the number and intensity of erratic and extreme weather events (including droughts, floods and heat waves); as well as increasing sea levels and changes in storm surge patterns and sea temperatures.
- When the question of rainfall is specifically considered, the NMB Metro is reasonably certain to expect a decrease in both the average amount of rainfall over the area (resulting in drier winters for example) as well as the actual number of rainfall events. When it happens however, rainfall events will likely be more intense and damaging in nature. Under this scenario, urban flooding and flash-floods will become more of a reality than before. This is especially relevant in the NMB Metro since its surface hydrology includes several small rivers (Chatty, Papenkuils, and the Shark River), the larger Swartkops River, as well as numerous historical drainage ways and wetlands that are either now built-up and/or interrupted by transport networks.
- Future flooding in the NMB Metro is not only associated with its system of rivers and traditional drainage features, but also with its location along a low relief coast. This makes low lying areas in the NMB Metro exceptionally vulnerable to coastal flooding as a result of climate change induced sea level increase. Although the anticipated rates and magnitude of future sea level increase are still debated, there is consensus about the fact that sea levels will definitely rise. In the case of the Metro, this could be as much as between 580 and 750 mm by the year 2100.
- In the context of the NMB Metro's coastal location, climate change is expected to influence pressure gradients (leading to stronger surface winds) through greater differences in place-to-place temperatures (including sea water temperatures). Even slight increases in ocean temperatures can provide enough energy to intensify coastal storms significantly. At the same time, stronger winds naturally increase the size and height of waves. This in turn causes heightened storm surges and coastal inundation**;** an extended HWM and increased wave action encroaching further up beach areas; and ultimately an increase in shoreline erosion processes. The greater intensity of storms has the capability to alter a shoreline in a matter of hours.
- Flooding of low-lying coastal areas through increased sea levels may also affect groundwater as well as estuarine habitats. Both may be contaminated with salt water, impacting fresh water supplies (boreholes) on the one hand and aquatic species that are dependent on estuaries as breeding grounds on the other.
- There is an added concern of the effect of increasing ocean temperatures in that it influences the buoyancy of sea water and subsequently the regular functionality of oceanic currents. This combined with increased atmospheric CO_2 and resulting ocean acidification is bound to impact marine ecosystems and fish and other species that are sensitive to these conditions.
- On a regional scale, the NMB Metro is situated within the biodiverse Thicket biome, which is home to several

local sub-classifications. However, the NMB Metro's terrestrial biodiversity includes several vegetation types which manifest at a larger (more local) geographical scale, such as the easternmost occurrence of Fynbos in the country. Although the Thicket biome, largely by virtue of its succulence, is more resilient in the face of local climate change impacts (such as higher temperatures, less rainfall, greater environmental desiccation, and more frequent fires), the more sensitive vegetation types such as Grassy Fynbos are not. Added to this pressure is another threat that appears to thrive on increased temperature and higher concentrations of atmospheric CO_2, namely alien invasive species. Alien vegetation is already prevalent along the Metro's coastline. Alien species generally out-compete indigenous flora, and has the potential to exacerbate coastal erosion. In this case, invasive plants are very efficient to stabilise dune fields and sand bypass systems, which in effect prohibits the transfer of sediment in order to starve downwind beaches of sand.

- Considering the above points, the NMB Metro is likely to experience a great variety of knock-on effects sometime in the future. This includes the following:
  - Anything that will be influenced by warmer temperatures and less rainfall: from human health, architecture, and urban agriculture, to suburban gardens, indigenous fauna and flora, and biodiversity.
  - Anything that will be influenced by more frequent and prolonged drought episodes (including local water stress and compromised water security): from sporadic difficulties with domestic water supply to the ability of the local economy to industrialize the NMB Metro out of its economic woes, and its high unemployment and poverty levels.
  - Anything that will be influenced by more frequent and intense adverse weather events, such as storms and flash floods; and
  - Anything that will be influenced by coastal storm surges and coastal inundation and erosion: including formal and informal settlements, livelihoods, private and public infrastructure, economic activity on low lying areas and floodplains, and estuarine habitats and biodiversity.
  - Anything that will be influenced by sea level increase and changes in other oceanic parameters such as sea temperature and acidity: including urban planning and development; private and public infrastructure (including harbours) through increased wave action and coastal erosion, tourism and recreation through increased beach erosion, and the local fishing industry and mariculture operations due to changing marine habitats.

7 Assessment of Potential Impacts and Risks

7.1 Issues Raised during the Public Participation Process

The public participation process undertaken to date and planned for the rest of the EIA process is described in Section 12. All comments received to date have been incorporated into a Comments and Response Report (CRR) (Version 3), which is appended to this report (Appendix C). The CRR will be updated (to Version 4), based on the public review of the DEIR for inclusion into the FEIR. The following is summary of the key comments and issues raised to date.

- Waste Management and Discharge
  - Discharge of effluent into the marine environment
  - Fish deaths, processing waste, feed, transport water, ice
  - Disease control and genetic isolation from stock imports
  - Waste management plan

- Water
  - Water quality at outlet from facility
  - Water source, quality and disposal

- Ecology
  - Concern over the small colony of Damara Terns
  - Concern over African Penguin colonies and other sea birds located on St Croix and Bird Island specifically
  - Shifting sand dunes in Zone 10

- Biosecurity
  - Introduction of invasive species and diseases
  - Risk of cross infection caused by other tenants/investors in the Coega IDZ

- EIA Process
  - Timeframes for the completion of the intake and discharge pipelines
  - Implementation date of this project?
  - Need to be kept informed on progress of the project

- Power and Security
  - How will the high power demands be met
  - Provision of a security perimeter fence

- Economics
  - Can previously disadvantaged organizations/ individuals venture into aquaculture?
  - I&APs should be up to speed on Operation Phakisa Aquaculture Lab Report dated 19th September 2014
  - Questions around the economic viability of the ADZ and the commissioning of the EIA
  - Advantages of ADZ over private land based options

7.2 General Impacts Assessed in the 2006 EIA

The EIA process for the change in land use on the eastern side of the Coega River (SRK, 2006) considered and assessed the impacts of aquaculture development over 1200 ha – the whole of Zone 10, except for a narrow coastal buffer strip as defined in the Development Framework Plan (Figure 2-1). A summary of the impacts for Zone 10 is tabled below:

Table 7-1: Impacts of 1200 ha Aquaculture Development in Zone 10, as assessed in the EIA process for the Change in Land Use on the Eastern Side of the Coega River (SRK, 2006)

Impact	Significance without mitigation	Significance with mitigation	Comment
Impacts general to the IDZ (assessed in 2006)			
Water consumption	High	Medium	Current water supply options discussed in Section 4.8.
Traffic and access	Medium	Low	Managed by the CDC on an IDZ-wide basis.
Loss of agricultural land	Low	None	N/A
Influx of people into the area	High	Medium High	A specialist study was conducted to re-assess socio-economic impacts of the ADZ (Appendix G1), as summarised in Section 7.19.
Employment creation	Positive High	Positive High	
Establishment of new businesses	Positive High	Positive High	
Heritage impacts	High	Positive High	Based on the 2006 study, a Phase 1 heritage assessment was conducted throughout the IDZ to provide specifics for each zone. These specialist assessments were used to rate impacts of the ADZ in more detail in Section 7.6.
Impacts specific to 1200 ha Aquaculture Development in Zone 10 (assessed in 2006)			
Water quality impacts	Very Low	None	The 2006 rating is indicative of the relatively low risk of aquaculture in comparison to other industries in the IDZ. Impacts of the ADZ assessed in Section 7.16.
Visual impacts	Medium	Low	The 2006 study considered tourism around islands as a receptor and recommended that structures be designed not to be intrusive.
Air quality impacts	Low	Low	The 2006 study recommended that the general IDZ management measures for dust control during construction be applied. For all industries, this is managed by the CDC on an IDZ-wide basis through their EMS and established environmental specifications.
Noise impacts	Very Low	Very Low	The 2006 study recommended that the general IDZ management measures for noise control be applied. For all industries, this is managed by the CDC on an IDZ-wide basis through their EMS and established environmental specifications.
Ecological impacts (terrestrial vegetation)	High	High	The 2006 assessment was based on aquaculture development over 1200 ha – the entire Zone 10 except for a narrow coastal buffer strip. Impacts on terrestrial vegetation was rated high and offsets were proposed based on specific vegetation type as no on-site mitigation was possible if the whole of Zone 10 was to be developed. Subsequent to the 2006 study, a detailed vegetation assessment was conducted in Zone 10 and the OSMP was revised in consultation with various stakeholders and approved by the DEA. The ADZ footprint was determined based on the revised OSMP (see Section 2.4.3) and reduced from 1200 ha to 440 ha. Impacts of ADZ, based on this footprint, are assessed in Section 7.4.

The EA (DEA, 2007) provided the CDC with approval for:

- Rezoning of the land from Agriculture or Undefined to Special Purposes.
- The installation of ancillary infrastructure, including service roads, storm water drainage systems, water supply, sewerage systems, electrical and telecommunication infrastructure associated with the establishment of an IDZ as indicated in the 2006 EIA.
- The 'zone splitter road' and the main access roads from the N2 highway to the proposed Zone 10 and Zone 7, as indicated in the EIA.

Since the installation of ancillary infrastructure within the IDZ was covered in the 2006 EIA and subsequent EA, development of such infrastructure as part of the ADZ is therefore already authorised and do not trigger any listed activities for Coega ADZ EIA process (Section 2.2).

The conditions of the 2007 EA apply to developments in the ADZ. These were carefully considered and those applicable to the ADZ were incorporated into the EMPr.

7.3 Air Quality

INFORMATION SOURCES AND PREVIOUS STUDIES

Air quality assessments have been undertaken as part of EIAs for a number of developments in the Coega IDZ. Lethabo Air Quality Specialists (LAQS) was appointed by CDC in 2014 to compile an extensive emission database for the area and to conduct all cumulative air quality impact assessments for new industrial developments in the Coega IDZ.

SPECIALIST STUDY UNDERTAKEN

For the Coega ADZ EIA, LAQS was requested to carry out a cumulative air quality impact assessment of emissions from all sources within the boundaries of the IDZ. The impact assessment focused on those air pollutants common to most industries and for which official ambient air quality standards have been published by the DEA. These are particulates smaller than 10 micrometre (PM10), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO). All of the gases mentioned above are soluble in water to a greater or lesser extent, forming acidic solutions that could have a negative impact on the water quality used for aquaculture activities. In addition, air-borne particulate matter may contain metals which could be leached from the particles in acidic solutions and could accumulate in various fish species. LAQS's scope of work was expanded to include additional components for which ambient air quality standards have not been set, but which show similar characteristics. As a result carbon dioxide (CO_2), nitrogen monoxide (NO) and total particulate matter (TPM) were included in this study.

All emissions were calculated and dispersion modelling conducted according to the requirements of the Air Dispersion Modelling Regulations, GNR 533, in terms of the NEM:AQA. LAQS modelled the impacts of the pollutants of industries on the ADZ and on St Croix Island, and odour impacts from fish processing operations.

Refer Appendix: Coega ADZ Air Quality Specialist Assessment (LAQS, 2016).

CURRENT STATE OF ENVIRONMENT

Emission Inventory

LAQS compiled a comprehensive emissions inventory of all sources within the IDZ boundary. Where industries were provided with an AEL, LAQS calculated emissions according to the requirements of GNR 533. Emissions from all other industries outside the IDZ were estimated from production rates and emission factors published internationally, e.g. USEPA, Australian NPI, etc. The proposed combined-cycle gas turbines in Zones 10 and 13 were included, as well as potential emissions from a hypothetical 500 000 tn per year ferromanganese smelter that could be located in Zone 5, if such a plant was to settle in the IDZ.

LAQS calculated the deposition of the various pollutants in order to determine the mass of each pollutant that would impact on open water sources. The maximum annual concentration within the ADZ was assumed to prevail over the whole area and that all of the gases would dissolve in, or react with water, thus following a worst-case approach.

The emissions attached to the various unit operations are based on either design data, specification contained in GNR 533 or on internationally published emission factors. None of the emission values have, therefore, been verified by means of emission measurements. Calculating emissions from allowed emission limits can easily result in an over-estimation of annual emissions as actual emissions may be well below the maximum limits set in individual AELs.

Point Sources

The total emissions from point sources located within the IDZ used in this study are:

- Total particulate matter (TPM) 850 tn/yr
- Sulphur dioxide (SO_2) 21 240 tn/yr
- Nitrogen monoxide (NO) 1 177 tn/yr
- Nitrogen dioxide (NO_2) 1 858 tn/yr
- Carbon monoxide (CO) 6 122 tn/yr
- Carbon dioxide (CO_2) 9 552 260 tn/yr

Line Sources

On-site line sources consist of various roadways as well as the Port of Ngqura. The total emissions from line sources located within the IDZ are:

- Total particulate matter (TPM) 66 tn/yr
- Sulphur dioxide (SO_2) 415 tn/yr
- Nitrogen monoxide (NO) 240 tn/yr
- Nitrogen dioxide (NO_2) 360 tn/yr
- Carbon monoxide (CO) 166 tn/yr
- Carbon dioxide (CO_2) 56 770 tn/yr

Area Sources

On-site area sources consist of a number of stockpiles and sand mining operations. Emissions consist solely of particulates and the total mass associated with on-site area sources is estimated to:

- Total particulate matter (TPM) 199.3 tn/yr

Air Emissions

Particulate Matter (PM10)

Particulate matter can either be directly emitted into the air or be formed in the atmosphere through chemical reactions of gaseous pollutants such as SO_2 and NO_2.

PM10 is a commonly used indicator, describing particulates that are relevant to health; that refers to the mass concentration of particles with a diameter of less than 10 micrometres. PM10 particulates form a sub-set of total particulate matter (TPM). The maximum annual average TPM concentration anywhere within the ADZ was estimated to be 9.6 µg/m^3, which is well below the air quality standard of 40 µg/m^3 set for PM10 particulates.

Sulphur Dioxide (SO_2)

The maximum annual average SO_2 concentration anywhere within the ADZ was estimated to be 10.7 µg/m^3 which is also well below the ambient air quality standard of 50 µg/m^3.

Nitrogen Monoxide (NO)

The maximum annual average NO concentration anywhere within the ADZ was estimated to be 1.3 µg/m^3. No official ambient air quality standard exists for this compound.

Nitrogen Dioxide (NO_2)

The maximum annual average NO_2 concentration anywhere within the ADZ was estimated to be 2.6 µg/m^3 which is well below the ambient air quality standard of 40 µg/m^3.

Carbon Monoxide (CO)

The maximum 8-hour average CO concentration anywhere within the ADZ was estimated to be 87.9 µg/m^3 which is well below the ambient air quality standard of 10 000 mg/m^3.

Carbon Dioxide (CO_2)

The maximum annual average CO_2 concentration anywhere within the ADZ was estimated to be 3 810 µg/m^3. As is the case with NO, there is no official ambient air quality standard for this compound but the occupational health time-weighted average limit is 9 000 mg/m^3.

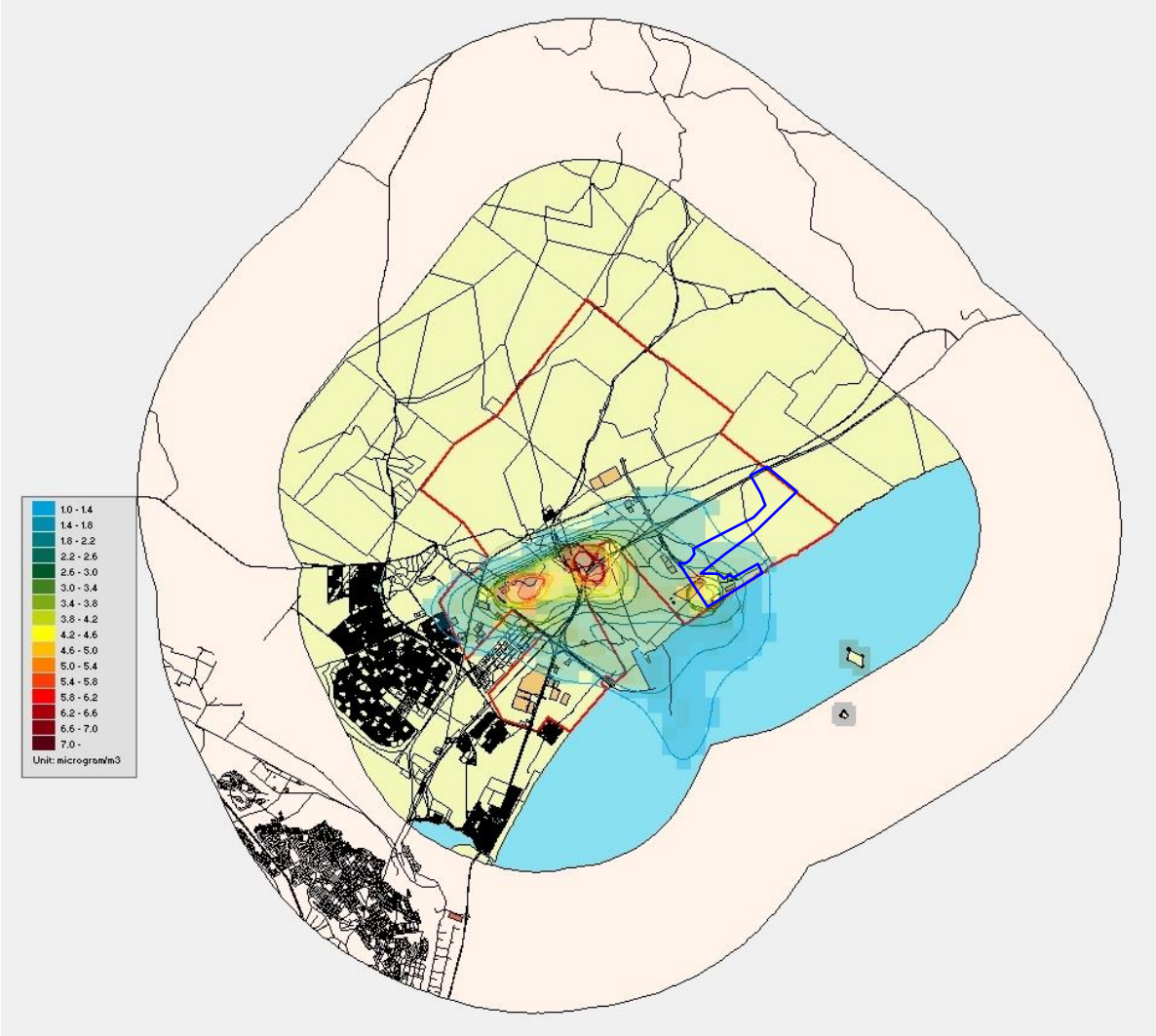

Figure 7-1: Annual Average TPM Concentrations predicted over the ADZ
(ADZ levels: < 9.6 µg/m^3, Air Quality Standard for PM10: 40 µg/m^3)

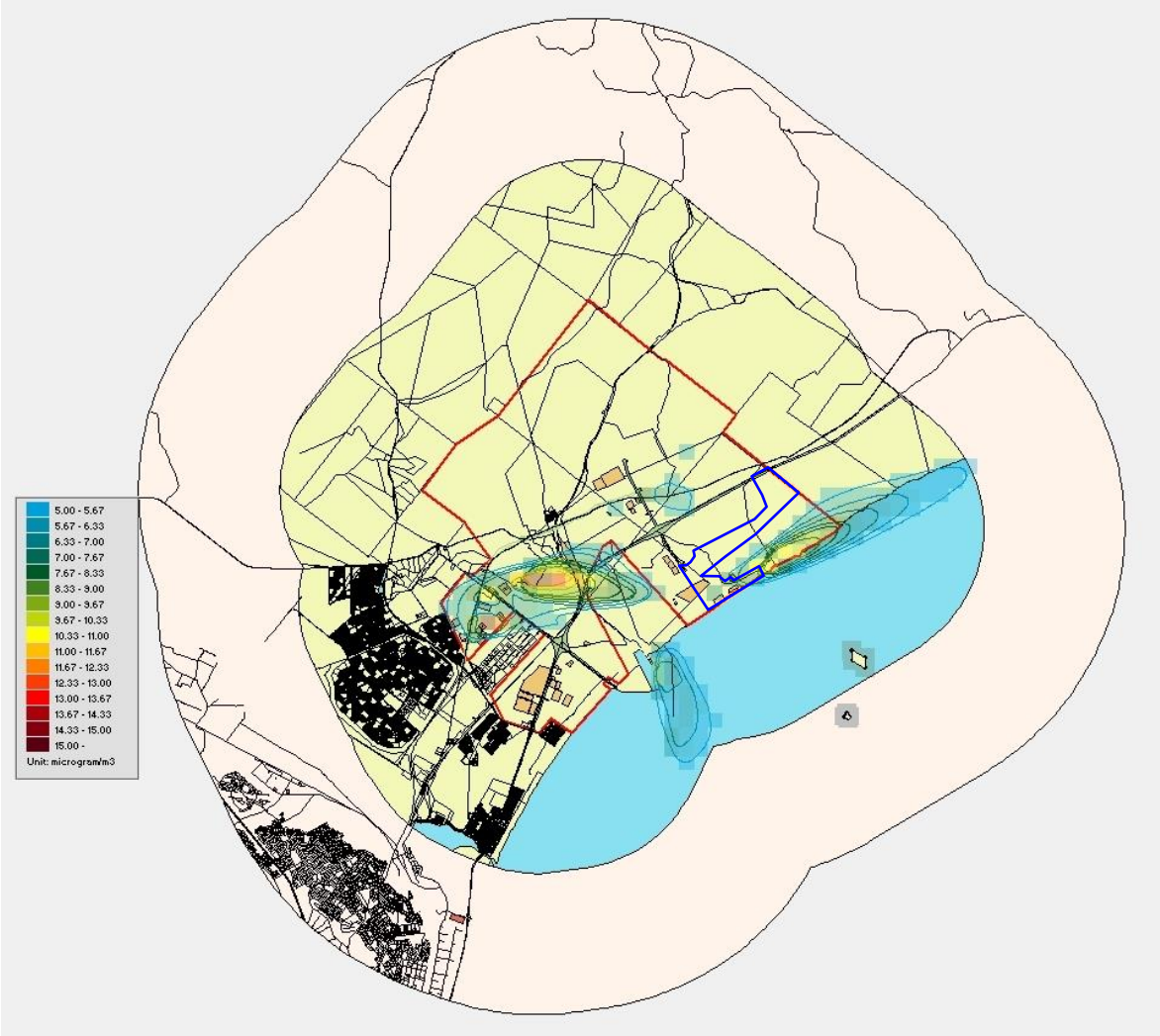

Figure 7-2: Annual Average SO_2 Concentrations predicted over the ADZ

(ADZ levels: < 10.7 µg/m^3, Air Quality Standard: 50 µg/m^3)

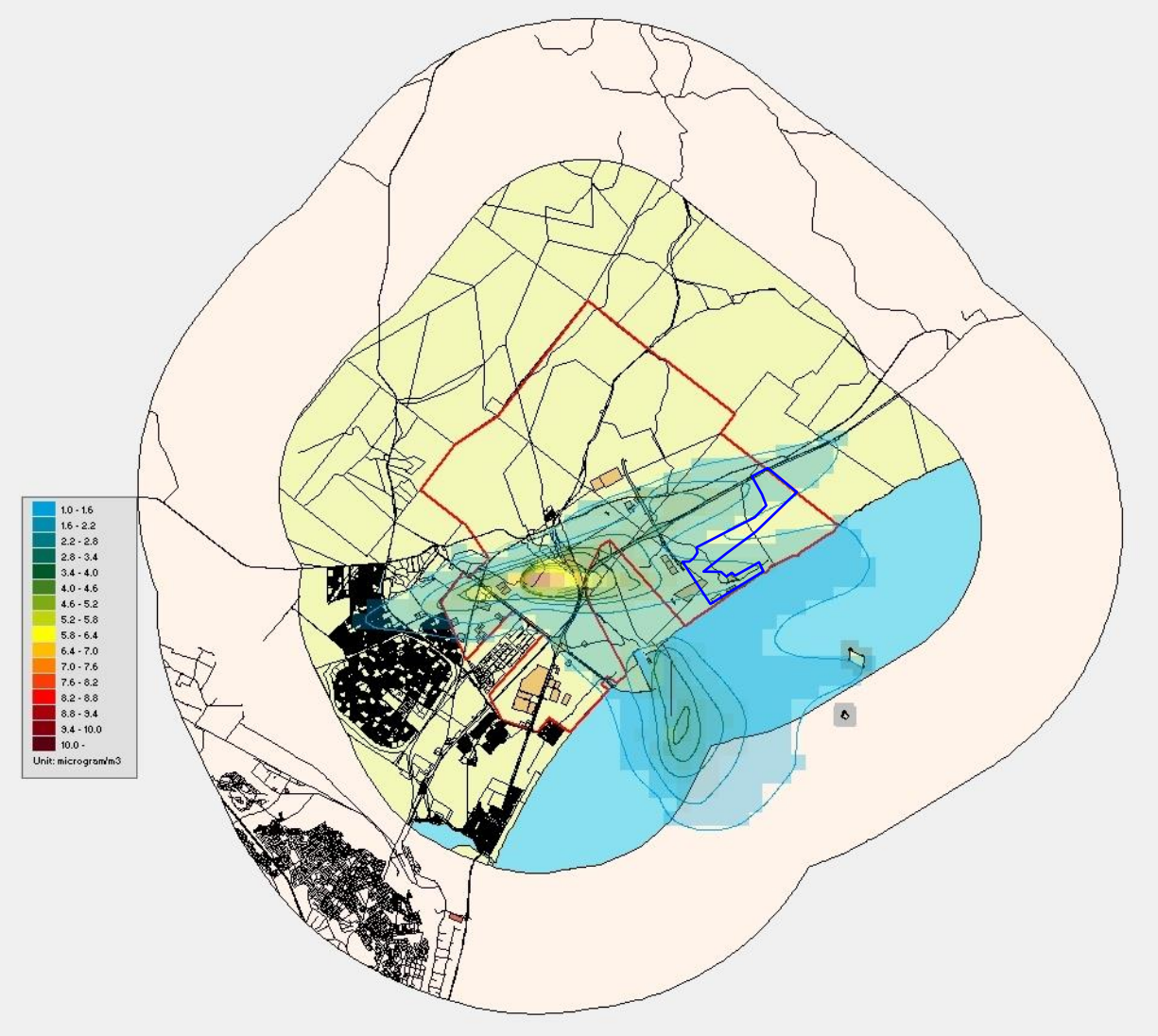

Figure 7-3: Annual Average NO Concentrations predicted over the ADZ

(ADZ levels: < 1.3 µg/m^3, occupational health time-weighted average limit: 30 mg/m^3)

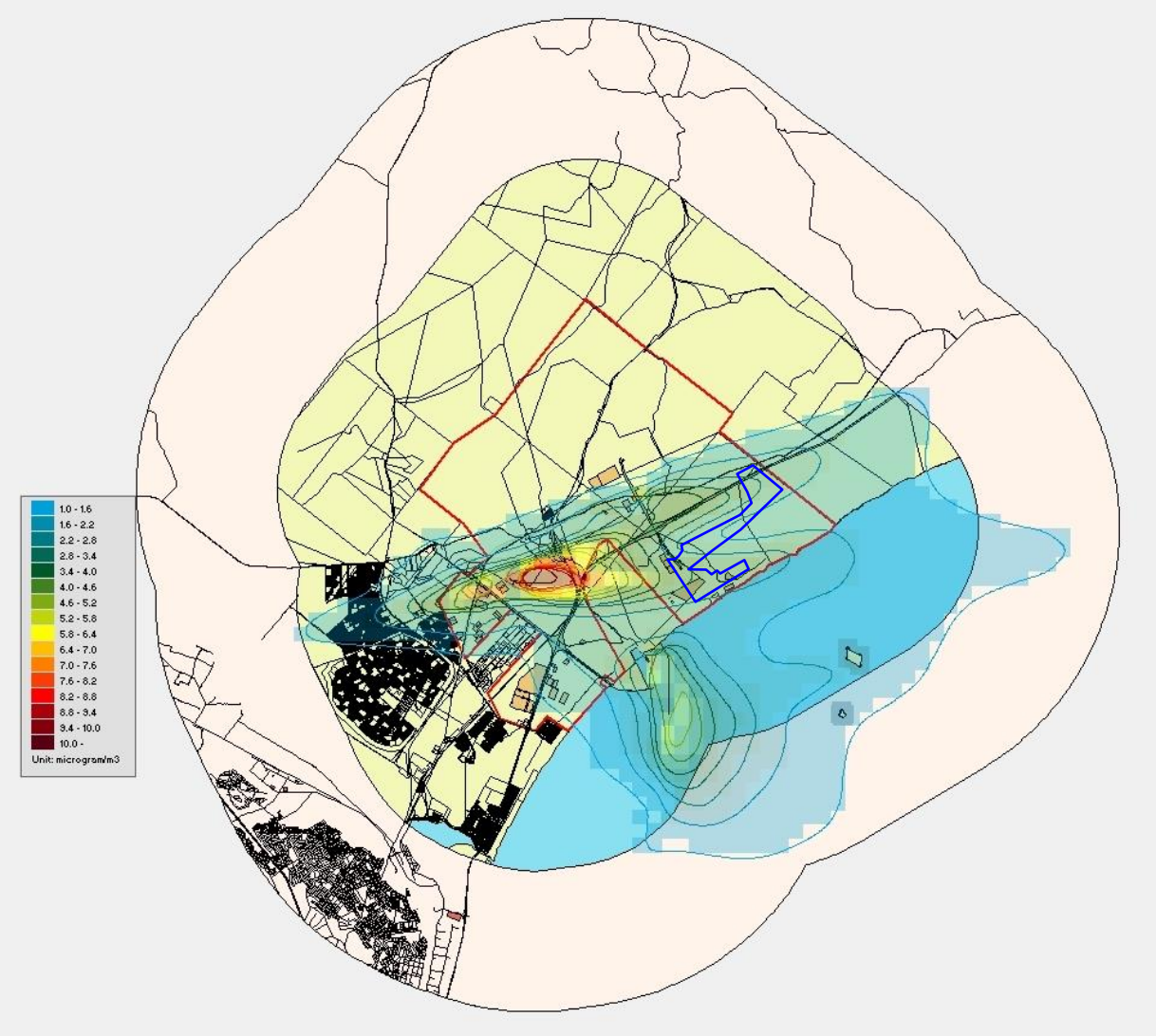

Figure 7-4: Annual Average NO_2 Concentrations predicted over the ADZ

(ADZ levels: <2.6 µg/m^3, Air Quality Standard: 40 µg/m^3)

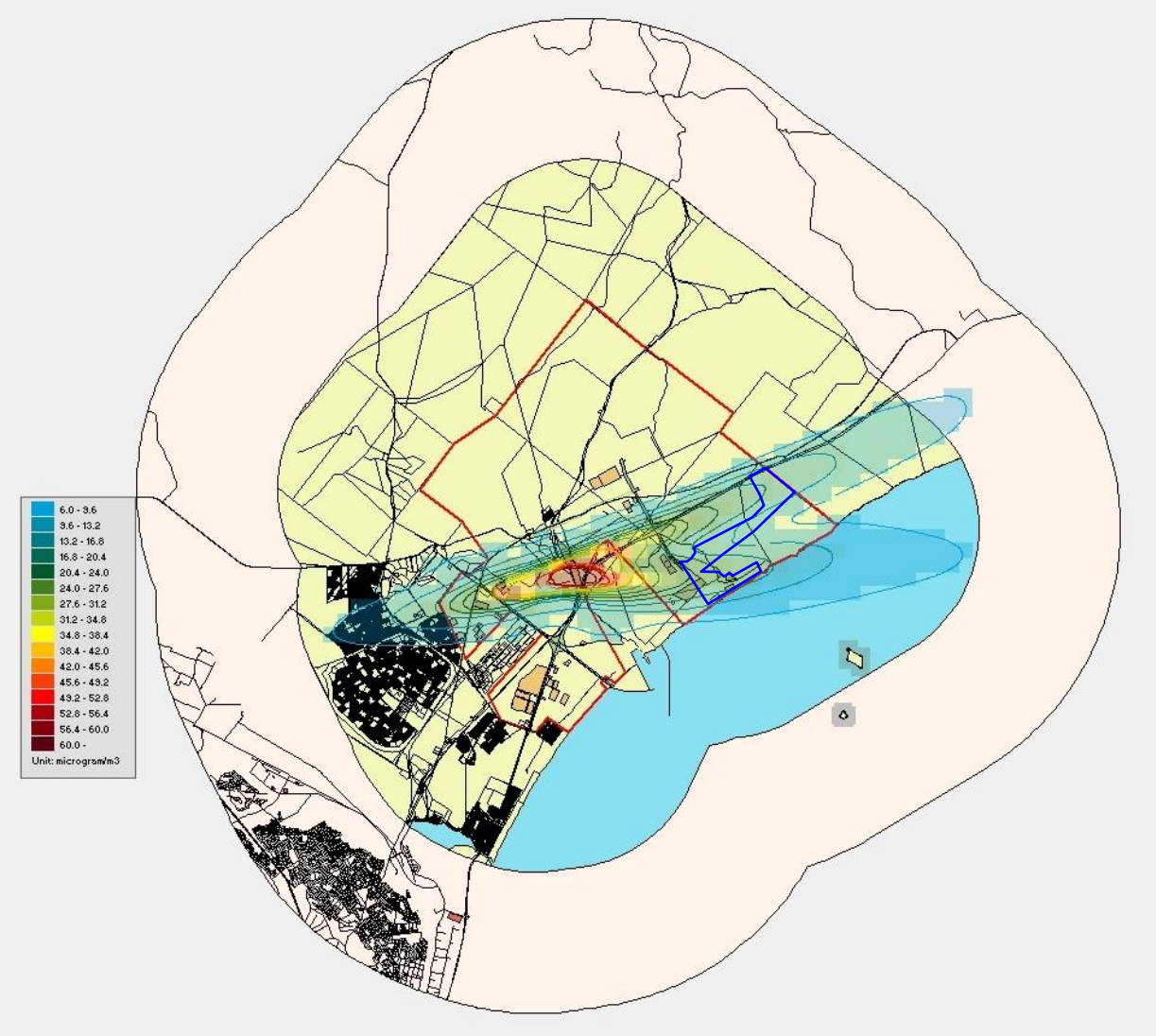

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Figure 7-5: 8-hour Average CO Concentrations predicted over the ADZ

(ADZ levels: < 87.9 µg/m^3, Air Quality standard: 10 000 µg/m^3)

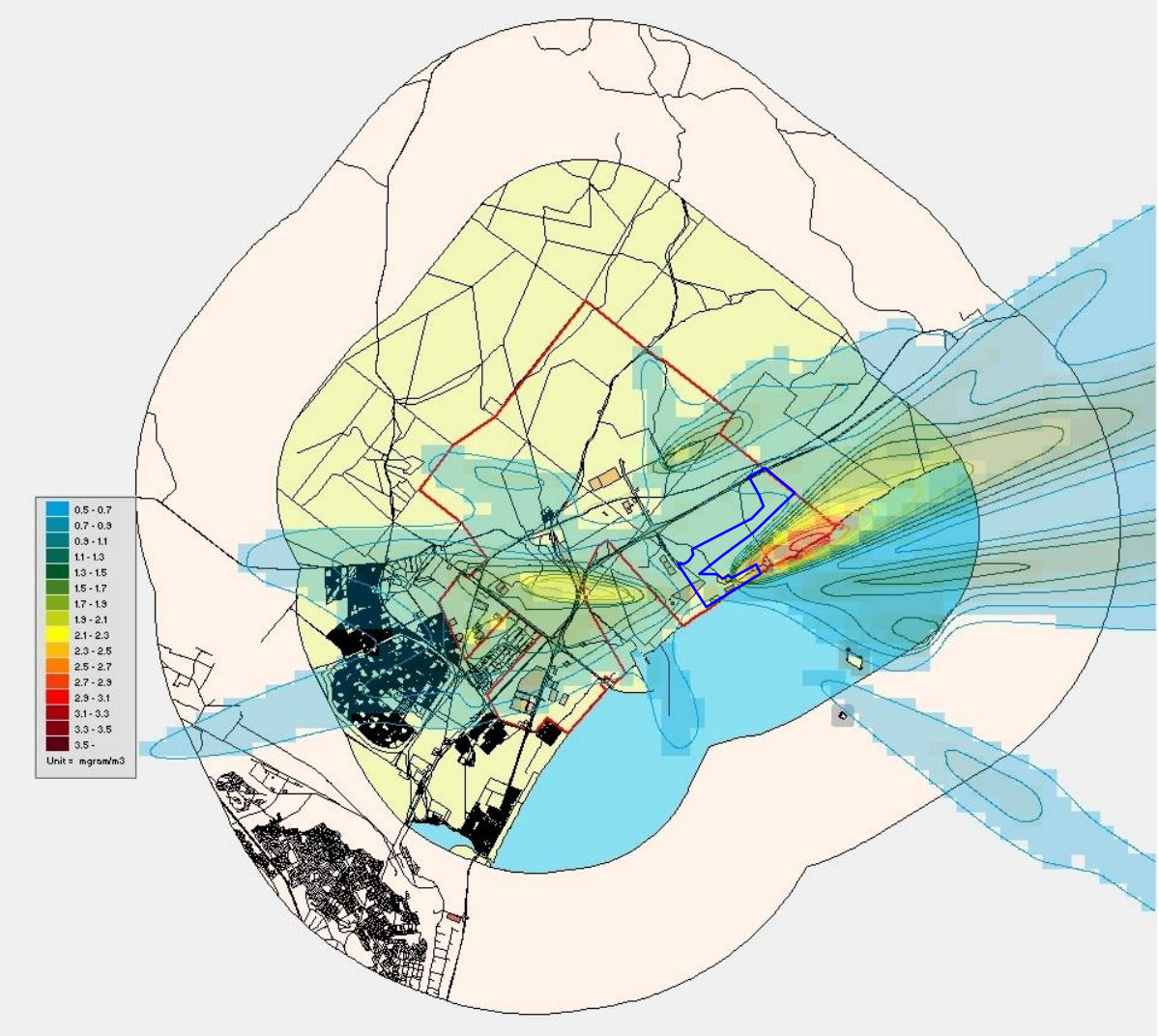

Figure 7-6: Annual Average CO_2 Concentrations predicted over the ADZ
(ADZ levels: < 2.7 µg/m^3, occupational health time-weighted average limit: 9 000 mg/m^3)

Deposition of Pollutants

LAQS investigated the deposition of pollutants on possible water sources as an indication of potential negative impact of air pollutants on the quality of water used for aquaculture activities. In calculating the annual deposition rates, LAQS assumed that the maximum annual average concentration of each pollutant within Zone 10 occurred throughout the whole of the zone instead of in about 5% of the area. It is accepted that this will result in an overestimation, but if the impact was shown to be acceptable the actual impact will be even less.

Deposition of Particulates

LAQS conservatively assumed that the bulk of the particles calculated, i.e. 90%, have diameters smaller than 10 micrometres (µm) as no specific particle size distribution data is available. In addition, LAQS assumed an average air temperature of 20 °C and pressure of 101.3 kPa. Applying these assumptions and variables LAQS calculated the total deposition rate of particulate matter to be 878 mg/m^2/day in the ADZ, which is below the allowable dust fall of < 1 200 mg/m^2/day for non-residential areas but above the residential dust fall range of < 600 mg/m^2/day as prescribed in the 2013 National Dust Control Regulations (GNR 827).

Deposition of Gases, Impact on pH and Heavy Metals Leaching Potential

LAQS calculated to total deposition rate of the gaseous pollutants on open water (zero vegetation cover) in the ADZ to be:

- SO_2 0.30 kg/m^2/yr
- NO 0.12 kg/m^2/yr
- NO_2 0.08 kg/m^2/yr
- CO 0.12 kg/m^2/yr
- CO_2 97.6 kg/m^2/yr

ASSESSMENT OF IMPACTS

7.3.1 Industrial emissions affecting aquaculture production

LAQS used the calculated masses and deposition rates to estimate the impact that total absorption in water would have on the pH of the water as this parameter is a key water quality issue in aquaculture operations; a range of 6 to 8 being stated as the preferred pH values of water for aquaculture.

Based on the current emissions scenario LAQS's conservative approach found that the gases will have less than 0.1 pH unit effect on fresh water sources and is, therefore, not expected to impact negatively on water sources within the ADZ. The low impact on pH limits the potential to leach heavy metals from airborne particulates that may deposit on water surfaces. LAQS is therefore of the opinion that the risk to water quality is low.

As a result of the small impact on pH and resulting limitation of leaching of metals into the water, LAQS is of the opinion that the deposition of particulate matter will not have a detrimental effect on the quality of the water used for aquaculture in the ADZ.

7.3.2 Aquaculture posing constraints to development of heavy polluting industries

The air quality assessment undertaken by LAQS, as described above, assessed all existing industries within the IDZ boundary as well as industries outside the IDZ. It also included two potential future high emitting industries namely the combined-cycle gas turbines in Zones 10 and 13, as well as a hypothetical 500 000 tn per year ferromanganese smelter that could be located in Zone 5, if such a plant was to settle in the IDZ.

Based on this emissions scenario, LAQS's conservative approach found that there will be no detrimental impact on the ADZ but also cautioned that the situation could change if additional heavy industries are allowed to settle in areas from where their emissions could impact on the ADZ.

Agro-processing is one of the priority sectors of the Coega IDZ. Aquaculture, food processing and food packaging are sub-sectors of the agro-processing sector. The CDC's plans for the development of an aquaculture development zone follow years of planning. Various strategic, regional, IDZ-wide and project specific environmental and planning processes have been undertaken to provide context for the ADZ and the selection of the site within the coastal cluster of development in Zone 10 of the IDZ.

- Zone 10 was earmarked for aquaculture development in the 2006 rezoning EIA for the remainder of the land on the eastern side of the Coega River, which was approved by the DEA in 2007 (DEAT, 2007).
- The OSMP2006 delineated Zone 10 for aquaculture development, with only narrow strip along the coast as open space / coastal buffer zone.
- A pilot prawn facility was developed in Zone 10 in 2006 and operated until the end of 2009.
- In 2009, DEDEAT approved the development of an extensive aquaculture development for the grow-out of prawns in Zone 10.
- The Coega East Masterplan was completed in 2011 and submitted to the NMB Municipality. The study re-evaluated the delineation of the development zones within the IDZ and investigated synergies between industries and industrial ecology, and maintained the aquaculture in Zone 10.
- In 2014, the OSMP was revised in consultation with the various stakeholders and approved by the DEA (Section 2.4.3). The following revisions are of note:

- Revision 1 of the OSMP delineated a 'developable' area along coast of the IDZ, to the east of the Port of Ngqura, as a 'coastal cluster for development', earmarked for development of a CCGT power plant, a 400 m wide service corridor, and aquaculture in Zone 10.
- Revision 1 of the OSMP included a portion of the primary dune in Zone 10 as a 'developable' area into this coastal cluster for development, as provided for in the 2007 environmental and planning processes, to facilitate aquaculture in order to support national government policy initiatives for aquaculture (mariculture) (IPAP, 2012).

- The CDC completed a feasibility study in 2014 that found the Coega IDZ Zone 10 to be favourable for land-based aquaculture.

In essence, these and the other assessment and planning processes - more are provided below - served to evaluate alternative land uses, including potential conflicts and synergies, throughput the IDZ and as the site selection process for the ADZ.

As described elsewhere in the report, the Coega IDZ and specifically Zone 10, is located on the doorstep of some sensitive 'immediate neighbours' such as the near-pristine primary and secondary dunes to the east of the ADZ (OSMP Area 1A and 1B), Algoa Bay and its various islands, a proposed marine reserve, the coastal section of Addo Elephant National Park, a critical habitat for the endangered African Penguin on St Croix Island, as well as tourism and recreation activities associated with these. With appropriate mitigation measures in place, aquaculture would be a relatively low impact activity and would be preferable to heavy industries near these sensitive immediate neighbours. It could be viewed as a buffer between these immediate neighbours and other industries in the IDZ since it shares the pursuit of clean air and water, thus adding to the conservation voice of the sensitive immediate neighbours.

Modern enclosed, recirculating aquaculture and aquaponic production systems create a controlled interface between the project and the environment in which it operates – both the natural environment and anthropogenic environment, including industries. Obviously, controlling this interface is possible to some extent and it would be wise for the CDC to carefully plan the mix of industries throughout the IDZ since it is not only aquaculture that would be sensitive to air emissions; certain high-tech manufacturing concerns may be even more affected, especially by elevated particulate matter.

It can also be argued that, if heavy polluting industries in the Coega IDZ were allowed to establish and operate in such a manner that aquaculture in Zone 10 would be detrimentally affected, so would the IDZ's sensitive immediate neighbours. The constraints that the development of an ADZ in Zone 10 would place on of heavy polluting industries can therefore be viewed as a positive impact or a constraint/negative impact depending if the issue is looked at from a conservation or heavy polluting industry point of view.

Worldwide, there is a drive to bring aquaculture closer to their markets and good transportation infrastructure to reduce production costs, greenhouse gas emissions and make the products more affordable and, for those products earmarked for the export, more competitive in the world market. The location of aquaculture projects in industrial zones is often viewed as an important measure to minimise user and land use conflict and thus to reduce the risk and uncertainty that are usually associated with aquaculture projects (FAO, 2009 in De Wit, 2016b).

7.3.3 Dust from mining operations impacting on aquaculture

Dust fall in the ADZ was calculated to be below the allowable dust fall of < 1 200 mg/m^2/day for non-residential areas but above the residential dust fall range of < 600 mg/m^2/day (discussion on Deposition of Particulates above). The majority of dust fall in the ADZ is from the nearby sand mining operations. These impacts will continue and the location and extent will change as sand mining operations progress through the areas earmarked for mining. Sand mining could proceed at the current rates mined but may intensify if there is an increase in demand

for sand from the local construction industry. At the current rate of mining, it may take many years before all areas within ADZ will be available for development.

The future of limestone mining in Zone 10 is uncertain but if a quarry similar to the Grassridge limestone quarry is to be established, heavy to very heavy dust fall could be expected for 200 m and even 500 m from the quarry activities, depending on the scale and nature of the operations. Whoever establishes limestone mining will have to determine the actual impacts. The CDC is in the process of consulting with PPC on their plans for mining and the use of the land on which they have mining rights.

7.3.4 Dust generation

Dust is an issue that comes with all construction projects. When you excavate and loosen soil, winds are bound to pick it up and transport it to somewhere across the landscape or through the air. With the windy local climatic conditions, dust control needs to be a high priority. Although the area is naturally exposed to high levels of windblown sand, it is not the case for fine particulates that could be mobilised with disturbance of the calcrete and silty soils on the site. Dust is generated by vegetation removal plus wind or mechanical movement of soil.

There are no immediate anthropogenic receptors on and around the site and the closest other industries are located in Zone 7 about a kilometre away from the northern boundary of the ADZ. Due to the fact that developments within the ADZ will happen over time, the situation could change and construction work on one site in the ADZ could happen immediately adjacent to an established operation. In addition to the anthropogenic receptors, the local fauna and flora is also a receptor. SANParks have specifically raised a concern regarding construction dust generated within the IDZ and how it could be impact on the health of the penguin population on St Croix Island about 4 km from the shoreline (addressed below).

The first line of control needs to be the strict limit of the extent of vegetation clearance and soil disturbance – the smallest possible area should be cleared at any point in time, and only those areas that are going to be actively worked. Past experience with a recent mega construction project in the IDZ has shown that this is not always possible due scheduling activities. Clearing of large tracks of land has happened in the IDZ, resulted in significant but short-term dust issues that were difficult to manage. It was further exacerbated by the fact that engineering specifications for earthwork and compaction reportedly placed restrictions on the application of water for dust suppression (Andrea Shirley pers. comm.).

Once an area has been disturbed, control measures are aimed at preventing the material from being picked up and transported across the landscape or through the air. This is particularly important for sites with dry exposed soils which may be exposed to wind or vehicular traffic. Such areas will require active management on a daily basis.

Due to the low vehicle numbers, the remote location and extent of the ADZ it is anticipated that the internal roads in the ADZ may remain gravel. Within an aquaculture development, there could also be areas where it is not practical or necessary to pave or establish a vegetation cover between the culture units.

7.3.5 Air emissions affecting the health of penguin population on off-shore islands

SANParks raised concern regarding dust generated during construction of all the different developments within the IDZ and the potential impact this may have on the health of penguins on St Croix Island. They reported that the penguins often suffer from a lung condition that would make them more susceptible to the impacts of suspended and inhalable particulates. There are no specific emission guidelines or standards to rate the effect of emissions on penguins or birds in general, but various scientific research studies confirm that birds suffer from air pollution just like humans. They are also more exposed than humans because they have a higher breathing rate and spend more time in the open air (Qin, 2015).

Emissions that occur during construction are temporary by nature and LAQS could therefore not include it in the air emission modelling. However, LAQS modelled the cumulative effects of all calculated operational emissions and determined the concentrations of the pollutants at the St Croix Island. The following values were obtained.

Table 7-2: Air emissions predicted for St Croix Island (Penguin Habitat) (µg/m^3)

Pollutant	Worst-case extreme (99-percentile)		Annual average	
	Predicted Level for St Croix Island	Air Quality Limit	Predicted Level for St Croix Island	Air Quality Limit
PM10	0.4	75	<0.1	40
SO_2	21.8	350	1.1	50
NO_2	1.7	200	<0.1	40
CO	4.6	30 000	0.3	10 000
CO_2	5950	--	440	--

As can be seen from the table above, all of the concentrations estimated are well below the corresponding ambient air quality standards. These standards are for obviously for humans but have been designed to include vulnerable groups such as people with compromised health and lung conditions. The values appear very low, even for birds with compromised health that spends all their time in the open air.

7.3.6 Odours from processing of by-products and handling and treatment of aquaculture and fish processing waste

Fresh fish and seafood don't have a particularly strong odour, maybe a hint of ocean or lake water. Fish rely on dissolved minerals inside their cells to maintain to correct fluid balance in their bodies. Ocean species tend to rely on trimethylamine oxide (TMAO) for this purpose. After the fish are killed, bacteria and fish enzymes convert TMAO into trimethylamine (TMA), which gives off the characteristic 'fishy' odour. Freshwater fish generally do not accumulate TMAO because their environment is less salty than their cells. As a result their flesh tends to be milder, and they do not get as 'fishy' as ocean fish. However, freshwater fish sometimes have an unpleasant 'muddy' aroma. This often occurs in bottom-feeders such as catfish, and is caused by two compounds produced by blue-green algae (geosmin and methylisoborneol). These chemicals concentrate in the skin and dark muscle tissue of the fish.

When fish and other seafood are processed on the day they are harvested, the process plant is correctly cleaned on the day, and waste is handled correctly and not left to decompose, unpleasant odours can be avoided. This has been demonstrated at various established aquaculture operations and processing plants.

The main source of odours would be from stale fish and the processing of fish waste. Two odorous compounds are associated with such processing namely trimethylamine (TMA) and hydrogen sulphide (H_2S). In South Africa, there are a number of examples of fishmeal processing plants are that have attracted complaints and drawn-out community action due to ongoing and long-lasting odour issues. The production capacity of these plants is in the order of a 1000 to 1200 tonnes per day, or 300 000 tonnes of fish per year, roughly ten times the expected production in the Coega ADZ, and processing obviously involve the cooking, dewatering and drying of all the fish.

Humans are sensitive to the smell of TMA (fishy smell) and H_2S, (rotten egg smell) at concentrations significantly lower than would be harmful to their health. As such, these odours can be regarded as an annoyance rather than a direct health impact. However, excessive and prolonged exposure to odours may result in physiological stresses that may result in a variety of symptoms including headache, nausea, loss of appetite and emotional disturbance. In extreme cases, offensive odours can lead to deterioration of personal and community well-being, interference with human relations, and may deter development in the affected area. Continued exposure to noxious odours can also cause 'odour-related stress-induced illness' (Shusterman, 1992).

Odour thresholds are defined in several ways, including absolute perception thresholds, recognition thresholds, and objectionability thresholds. At the perception threshold, one is certain that an odour is detected but it is too faint to identify further. Recognition thresholds are normally given for 50% and 100% recognition by an odour panel (group of people). Reported odour threshold data vary considerably, as much as by four orders of magnitude for certain chemicals. Reasons for this variability include differences in experimental methods used, and in human responses to smell.

Potential odour impacts were modelled using USEPA air pollutant emission factors and odour thresholds published by the American Industrial Hygiene Association[11]:

- TMA: 0.8 µg/m^3
- H_2S: 0.7 µg/m^3

For the purposes of the EIA, the levels were also compared to threshold values for H_2S, as published in the 2014 South African State of Air Report:

- 100% recognition threshold: 1430 µg/m^3
- 50% recognition threshold: 11.2 µg/m^3

As well as an international guideline:

- WHO 30 minute guideline value: 7 µg/m^3

LAQS assessed the worst-case odours for the ADZ by assuming the processing, including some form of heating or cooking of all the fish produced in the ADZ at the long-term maximum production capacity (>40 000 tn/yr). In reality, the CDC's targeted production capacity is only a quarter of this (11 600 tn/yr) and only a portion of the fish would be heated (i.e. steamed or smoked) as some will be sold fresh or frozen where processing will only involve gutting, cleaning, fileting and packaging. In addition, it was assumed all fish were marine species (freshwater species may produce less odours that the fish on which the USEPA emission factors were based).

Two scenarios where assessed:

- Processing of all fish produced, as fresh fish
- Processing of all fish produced, as stale fish or stale fish waste

The dispersion of odours from all on-site sources is shown graphically below. For modelling purposes, the assumption was made that the fish processing unit will be placed in the approximate centre of Zone 10. Should this not be the case, the area over which odours may spread will move according to the point where such a plant is located.

Figure 7-7 and Figure 7-8 show the annual average and worst case extreme ground-level concentrations of odours above the threshold limit of 0.75 µg/m^3 (the average of the H_2S and TMA threshold limits) when fresh fish waste is processed.

Figure 7-9 and Figure 7-10 show the annual average and worst case extreme ground-level concentrations of odours above the threshold limit of 0.75 µg/m^3 when stale fish waste is processed.

[11] *'Odor Thresholds and Irritation Levels of Several Chemical Substances: A Review' published in the Journal of the American Industrial Hygiene Association (47) March 1986*

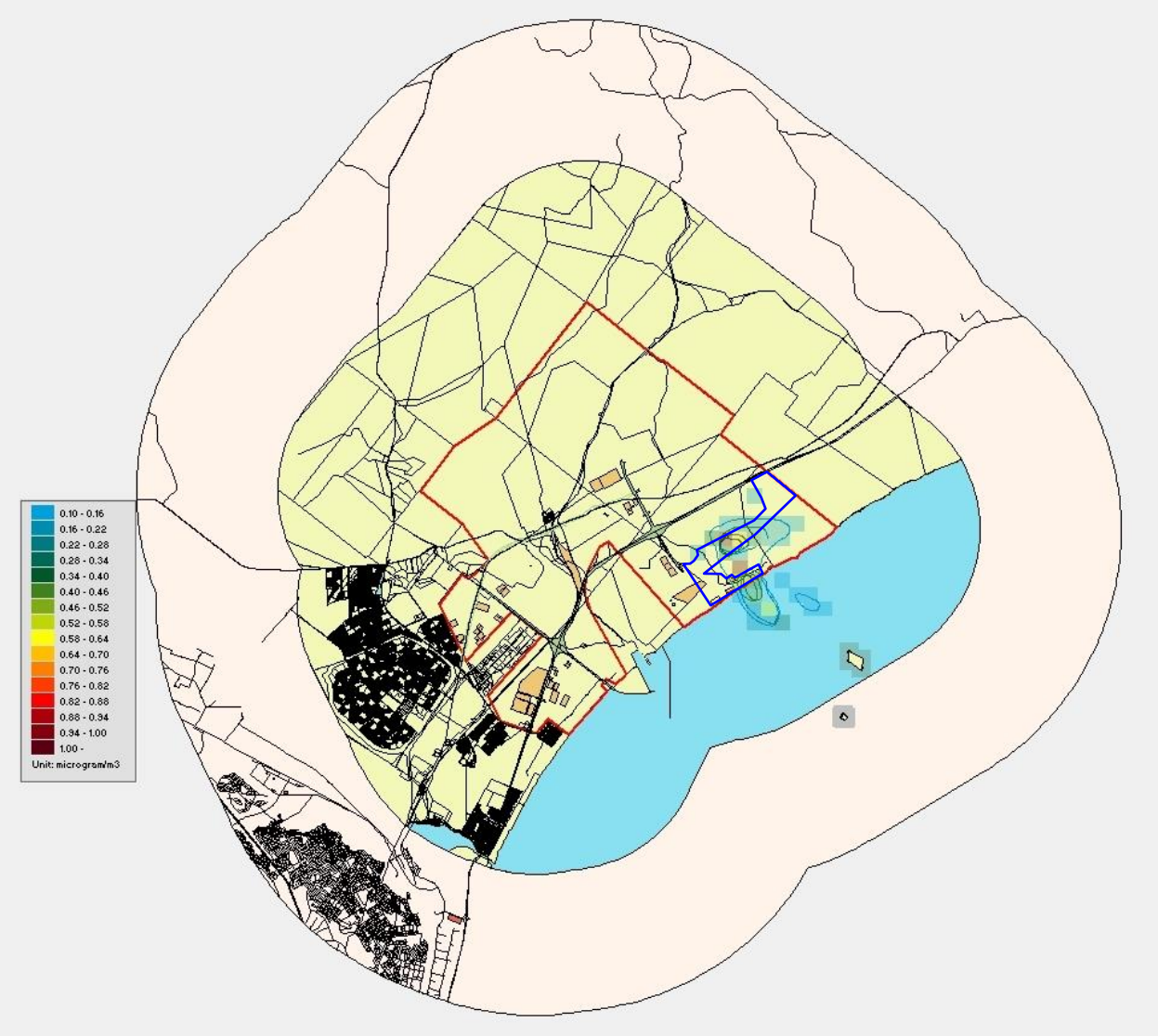

Figure 7-7: Annual average spread of odours (>0.75 µg/m^3) from fresh fish processing in the ADZ (maximum long-term production >40000 tn/yr)

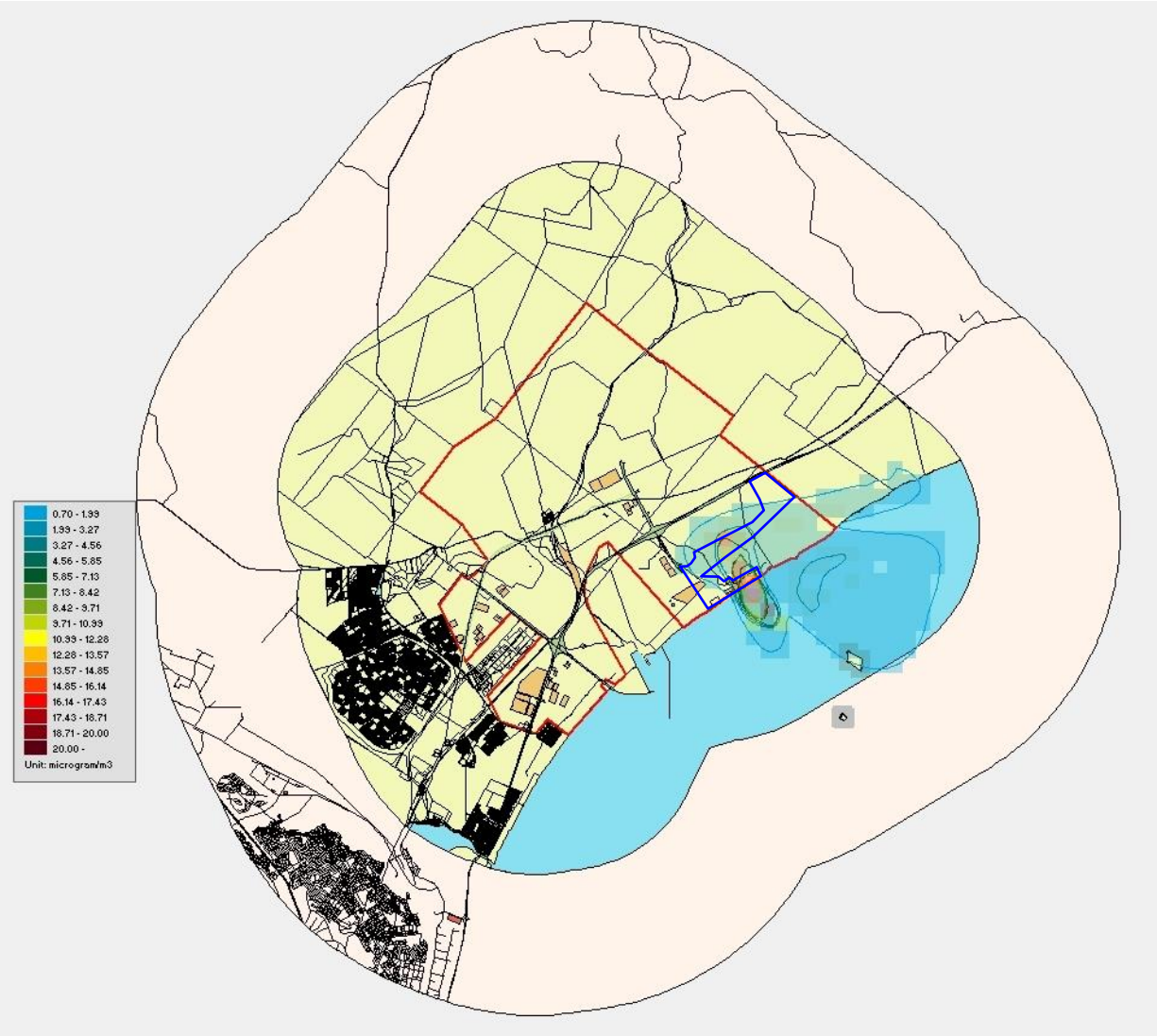

Figure 7-8: Worst-case extreme (99-percentile) spread of odours (>0.75 µg/m^3) from fresh fish processing in the ADZ (maximum long-term production >40000 tn/yr)

The worst-case extreme spread of odours as presented above presents a 99-percentile event that would occur during an upset or 'bad odour day' at a fish processing plant.

The 50% recognition threshold and the WHO 30 minute guideline value of 7 µg/m^3 may be reached within in a fairly limited area around the plant, during upset conditions.

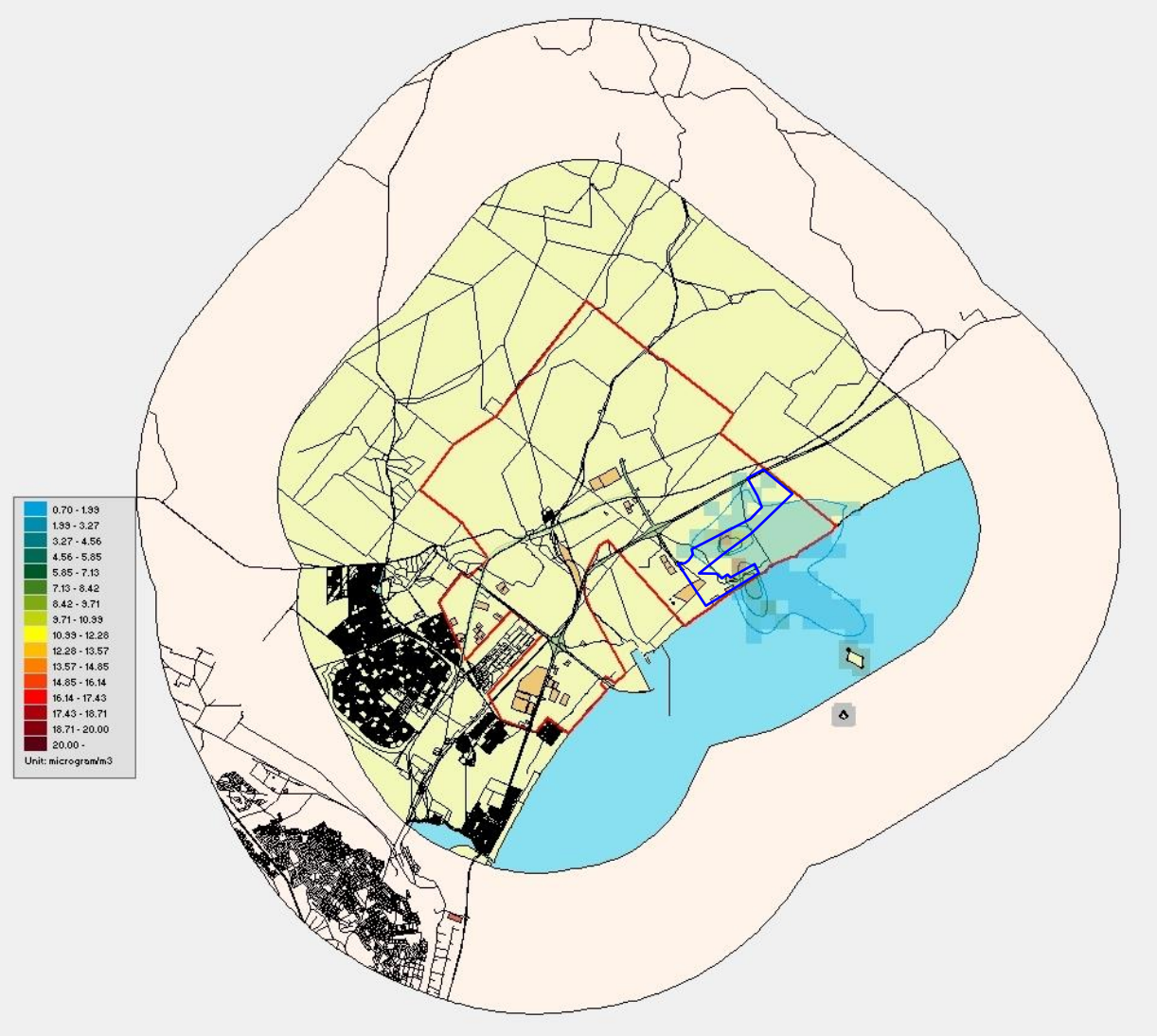

Figure 7-9: Annual average spread of odours from stale fish waste processing in the ADZ (maximum long-term production >40000 tn/yr)

For processing of stale fish, the 50% recognition threshold and the WHO 30 minute guideline value of 7 µg/m^3 may be reached within in a fairly limited area around the plant but the unpleasant smells will be present under normal operating conditions and thus present most of the time. As such, complaints from neighbouring industries in Zone 7 and other aquaculture farmers in the ADZ are to be expected.

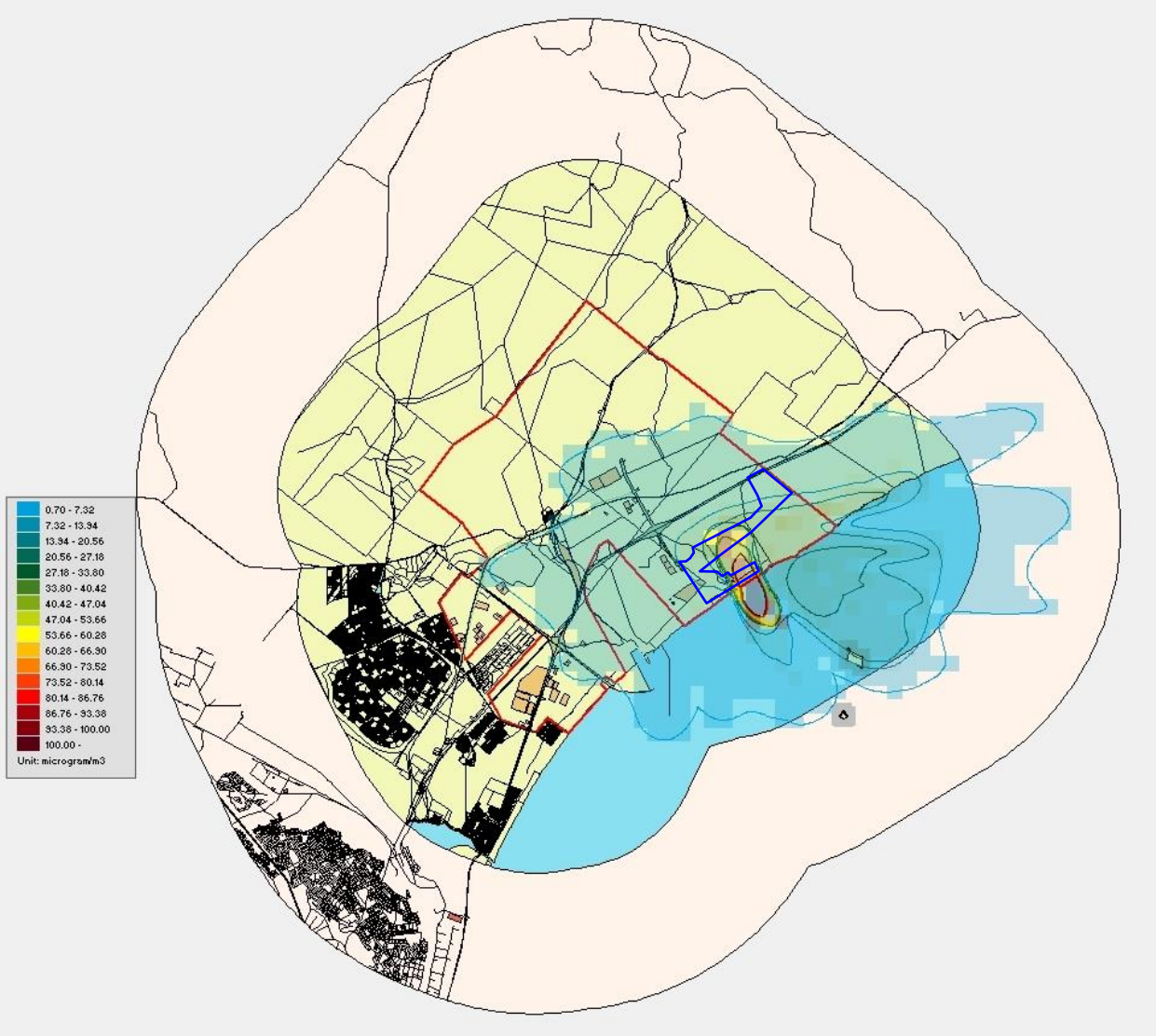

Figure 7-10: Worst-case extreme (99-percentile) spread of odours from stale fish waste processing in the ADZ (maximum long-term production >40000 tn/yr)

During an upset or 'bad odour day' at a fish processing plant processing stale fish or stale waste, the 50% recognition threshold and the WHO 30 minute guideline value of 7 µg/m^3 will be reached over large parts of the Coega IDZ, the harbour, over Colchester, and St Croix Island.

LAQS concluded that the potential spread of odours is minimal if fresh fish is processed but when stale fish waste is processed the potential spread of odours can cover a substantial area.

As discussed elsewhere in the report, there are opportunities for optimising resource use efficiency, stabilise and reduce waste through the processing of by-products and the treatment of waste rather than disposal to landfill. This could include anaerobic digestion of aquaculture production or processing waste, production of liquid fertilizer or compost, biofuel production, or production of fishmeal or animal feed. These type of facilities are covered under Category 10 of the List of Activities which could result in atmospheric emissions which have or may have a significant detrimental effect on the environment (GNR 893) as published in terms of the NEM:AQA. Facilities that process, including rendering cooking, drying, dehydrating, digesting, evaporating or protein concentrating, more than 1 tonne/day of raw animal matter not intended for human consumption require an AEL and must be operated in accordance with the minimum requirements for such plants as outlined in GNR 893.

7.3.7 Air emissions generated by aquaculture impacting on local ambient air quality

Various scientific papers on the life cycle assessment, energy use, and greenhouse gas emissions associated with aquaculture operations worldwide were consulted as part of this EIA. The general consensus is that aquaculture production, other than odours associated with processing of stale fish or waste discussed above, is a very low emitter that would have virtually no impact on ambient air quality in the area the facility operates.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Specific attention to be paid to the emission controls of industries that may emit acidic fumes, e.g. galvanizing processes, as such emissions may have a detrimental effect on the pH of water sources in the ADZ (LAQS, 2016).*
- *CDC's positioning of industries in the IDZ to consider both potential linkages and conflicts between different industries.*
- *The master layout plan for the ADZ to take cognisance of:*
  - *Buffer zones to be maintained around areas earmarked for mining, especially on the downwind side.*
  - *Initial aquaculture operations in the ADZ to focus on those areas outside potential mining areas and their respective buffers.*
  - *Feedback from PPC regarding their plans for mining in and around Zone 10 and the ADZ.*
- *Fish to be processed on the same day as harvesting / slaughtering.*
- *Fish by-products and waste earmarked for processing to be kept in cold conditions to avoid decomposition and odours until such time it is processed. Any fish waste processing facility to be designed to have zero redundancy, even if it means providing duplicates of key process steps.*
- *Fish waste for disposal to be kept in cold conditions to avoid decomposition and odours until such time it is disposed.*
- *EMPr section on Waste Management to ensure correct storage, handling, processing, treatment or disposal of waste to be applied.*
- *Facilities for the processing of more than 1 tn/day of raw animal matter not intended for human consumption to operate under a valid AEL and the minimum requirements outlined in GNR 893 in terms of the NEM:AQA.*

- *Over the life of the ADZ, a combination of dust control measures would need to be applied. Each situation needs to be evaluated on a case by case base and the appropriate strategy to be defined based on the time of exposure (short-term during construction or longer term during operations), the extent of the affected area, the proximity to sensitive receptors and the potential to establish a stabilising vegetation cover. These include:*

Temporary

- *Wetting of soils to temporarily bind particles (only effective when sufficiently damp, needs to be re-applied daily or even multiple times a day depending on weather conditions).*
- *Control or reduce the effect of the wind (net fences or other barriers placed in strategic positions and at right angles to the prevailing winds).*
- *Confine or limit vehicle and equipment movement during high winds.*
- *Limit the active handing of loose soils, such as grading, loading and dumping during high winds.*
- *Good housekeeping (sweeping or other form of removal of loose material from areas where it can be entrained by vehicles or picked up by the wind).*
- *Covering of bare soils and other fine loose particulates (mulching or gravel cladding).*
- *More permanent binding of fine particles through the application of environmentally benign polymers and chemicals binders and tackifiers (typically only used in areas where there are extensive longer-term dust issues).*
- *Establishing a stabilising vegetation cover as soon as possible once disturbance of an area has ceased.*

More Permanent

The following falls outside the scope of the ADZ but is recommended in light of the concern raised by SANParks regarding the impact of regular construction in the ADZ:

- *PM10 monitoring results in the IDZ to be evaluated for a spike in PM10 values due to recent construction activities as this could provide a better understanding of short-term construction impacts over the Algoa Bay Islands and the penguin habitats.*
- *Based on the PM10 monitoring results at the existing stations, CDC to discuss the merits of PM10 monitoring on St Croix Island with SANParks.*

RATING OF IMPACTS

Construction Phase

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Dust generation during construction*				
Impact status	Negative	Negative	Negative		
Intensity	Major	Moderate	Moderate		
Duration	Medium-term	Short-term	Short-term		
Extent	Local	Local	Local		
Consequence	High	Low	Low		
Probability	Highly Likely	Certain	Highly Likely		
Frequency	Regular	Regular	Occasional		
Significance	Negative Medium	Negative Low	Negative Very Low	Negative Low	As Existing

Operational Phase

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Odours from processing of by-products and handling and treatment of aquaculture and fish processing waste*				
Impact status	Odours from other industries	Negative	Negative		
Intensity		Major	Moderate		
Duration		Long-term	Long-term		
Extent		Local	Site		
Consequence		High	Medium		

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Odours from processing of by-products and handling and treatment of aquaculture and fish processing waste*				
Impact status	Odours from	Negative	Negative		
Probability		Highly Likely	Possible		
Frequency		Regular	Sporadic		
Significance	Very Low	Negative High	Negative Very Low	Very Low	As Existing or Unknown
Nature of Impact	*Air emissions generated by aquaculture impacting on local ambient air quality*				
Significance	N/A	N/A	Negative Insignificant	N/A	N/A
Nature of Impact	*Cumulative industrial development and IDZ air emissions affecting the health of penguin population on off-shore islands*				
Impact status	Negative	Insignificant	Insignificant		
Intensity	Minor to Eliminated (at St Croix Island)				
Duration	Long-term				
Extent	Local				
Consequence	Low				
Probability	Certain				
Frequency	Always				
Significance	Negative Low	Negative Insignificant		As Existing	As Existing or Unknown
Nature of Impact	*Aquaculture posing constraints to the development of heavy polluting industries*				
Significance	Impact can be viewed as positive and/or negative, but negative impacts are not regarded as significant based on the strategic planning and direction of development in the IDZ over the past decade.				

External Impacts on the Development (Development Restrictions)

	Existing and Reasonable Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Air emissions from industries affecting aquaculture production*				
Significance	Negative Low	N/A (External Impact on the ADZ)		Negative Low	N/A
Nature of Impact	*Dust from mining operations impacting on aquaculture developments*				
Significance	Negative High if Unmitigated Negative Low if Mitigated	N/A		Negative High if Unmitigated Negative Low if Mitigated	N/A

ASSESSMENT OF RISKS

Likelihood of mitigation measures being implemented successfully (mitigation reliability)	Highly likely.
Degree to which impacts can be avoided, managed, or mitigated	Can be mitigated.
Degree to which impacts can be reversed	Can be reversed.
Degree to which impacts could cause irreplaceable loss of resources	Highly unlikely.
Assessment confidence	Medium to high.

GAPS AND LIMITATIONS

Information adequate for EIA decision-making.

CONCLUSIONS

Based on the outcome of the air quality assessment, and given the conservative approach taken, LAQS concluded that there is no reason why the development of an aquaculture development zone should not be authorized.

7.4 Terrestrial and Aquatic Ecology

SPECIALIST STUDY UNDERTAKEN

Detailed assessments of the area have been undertaken in the past, including terrestrial vegetation assessment undertaken as part of the EIA for the SeaArk prawn farm located in the same area. Dr. Brian Colloty of Scherman Colloty & Associates (SC&A) reviewed the previous reports, conducted a field assessment and incorporated information collected over the five years working on other assessments in the IDZ. The results of their assessment are presented below. Their specialist report is in Appendix G3 and a summary of the results is presented below.

CURRENT STATE OF THE ENVIRONMENT

As described in more detail in Section 6.10, little natural vegetation remains within the ADZ footprint. Based on previous planning and assessment processes, CDC's definition of the ADZ footprint has taken cognisance of important bird and open space management habitats and the majority of the ADZ footprint is in an area presently covered in alien vegetation. The ADZ coastal section is located in coastal cluster for development as defined in Revision 1 of the OSMP.

ASSESSMENT OF PROJECT IMPACTS

The most sensitive habitats, rated as having a High ecological sensitivity, have been excluded from the ADZ footprint and form part of Revision 1 of the OSMP, as the Primary Dune and Secondary Dune areas and the buffer area that is maintained around the Damara Tern habitat as an area for a Species of Special Concern.

Although most the ADZ footprint is covered in alien vegetation with only small pockets of intact vegetation remaining, the remaining intact terrestrial habitats are rated as having a Moderate ecological sensitivity. The Moderate rating is because the remaining areas still contains large numbers of protected plants and species (as defined in the specialist Assessment, Appendix G3).

7.4.1 Loss of Vegetation and Open Space Management Habitats

It is anticipated that extensive vegetation clearance will take place within the ADZ footprint, within the coastal cluster for development. However, due care has been taken to avoid the Primary Dune and Secondary Dune areas and the buffer area that is maintained around the Damara Tern habitat as an area for a Species of Special Concern on Revision 1 of the OSMP.

The construction phase would have the greatest impact and will result in the disturbance of the vegetation and soils. The overall significance of the impact would be rated as Negative High should vegetation be cleared throughout the Colchester Strandveld and Sandy Beach (Dune field) areas in the ADZ footprint to remove the remaining pockets of intact vegetation. With the mitigation measures proposed below, the impact on the vegetation would remain localised resulting in a Negative Moderate impact.

The operational phase of the project would have limited impact on the surrounding vegetation with the overall impact rated as Negative Low.

7.4.2 Loss of Species of Special Concern and their Habitats

Several protected plants occur in the pockets of remaining intact indigenous vegetation and in the surrounding open space management areas. The dune fields provide habitat for important species including breeding Damara Terns, Duthie's golden mole and the pygmy hairy-footed gerbil which occur in dune thicket. The Damara Terns are known to nest in an area adjacent to the ADZ footprint.

The construction phase could have the greatest impact on habitats due to vegetation clearance.

Any disturbance of the Damara Tern breeding area would also happen during the construction phase, due to noise and construction activities and while the beach is being accessed should any infrastructure please placed within these areas. The overall significance of the impact would be rated as Negative High should vegetation be cleared throughout the Colchester Strandveld and Sandy Beach (Dune field) areas in the ADZ footprint to remove the remaining pockets of intact vegetation. With the mitigation measures proposed below, the impact on the vegetation would remain localised resulting in a Negative Moderate impact.

The operational phase of the project would have limited impact on the habitats with the overall impact rated as Negative Low.

7.4.3 Increased risk of alien plant invasion

Most of the areas assessed are covered by alien trees as listed in this report and the CDC Alien Plant Management Plan, particularly in the secondary dune areas and along roads or other previously disturbed areas. The disturbance of the vegetation and soils during the construction phase would allow for the further spread of alien plants if not curtailed.

Due to the present state of the vegetation the potential impact would be Negative High considering the regional importance of the terrestrial plant species found. Impacts are applicable to both the construction and operational phases. With the proposed mitigation measures in place, the impact would remain localised, resulting in a low risk and Negative Low impact significance in the construction and operational phases.

7.4.4 Increased animal road mortality

Increased vehicle activity will result in mortality of animals that cross the road. In the case of this study area mammals and reptiles would be the most frequent road kills, for reasons that include searching for food, basking during the day, moon basking which occurs when reptiles lie on roads at night to absorb warmth from the road surface, or merely to cross to the other side. The risk to amphibians would be lower in the study area due to the lack of available habitat, which limits the need for migration events usually seen in the breeding season.

The significance of the impacts due to the potential species occurring in the region, the diversity of habitats and food sources that are still relatively intact increases the potential for road kills. Without mitigation, the impact would be rated as Negative Moderate. With mitigation, the impact would be rated as Negative Low.

7.4.5 Changes to migration corridors

The installation of the boundary fencing would pose as a barrier to the animals that move within and through the area. This would restrict those species that are not able to move through the fencing such as the medium sized mammals.

If not managed and designed correctly, the processing facilities and open ponds may also affect the surrounding bird population, by attracting birds. This could alter migration routes and may result in the abundance of certain species that would disturb or out-compete smaller birds already living within the area.

This impact would only have significance in the operational phase; should small mesh type fencing be used (<10 x 10 cm) be used for the ADZ boundary fence – then impact would have a Negative Moderate rating for terrestrial animals and movement corridors. This rating is based on the low number of medium sized animals found in the area. With the correct fencing installed, the impact would be reduced to Negative Low.

Disturbance of any of the species of special concern and bird species living in the area, which could also see an increase in the number of predators affecting their breeding sites, would be rated a Negative High. With mitigation in place, this impact is reduced to a Negative Moderate impact for the impact of bird aggregations at the ADZ.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Development in the Colchester Strandveld and Sandy Beach (Dune field) areas to be limited to within the coastal cluster for development as indicated on the approved OSMP, thus within the defined footprint of the ADZ.*
- *Development, in the coastal cluster for development, to take cognisance of the remaining pockets of indigenous vegetation. Site development plans to be developed with the following objectives:*
    - *Alignment of access roads to follow existing tracks where practical.*
    - *Buildings, structures and linear infrastructure to be focused, as far as reasonably possible, in areas where vegetation has already been disturbed by historical farming, sand mining and the establishment of alien vegetation.*
    - *Pockets and strips of indigenous vegetation to be maintained to serve as buffers between individual aquaculture operations.*
    - *Maintain a 200 m buffer between the aquaculture operations and the Damara Tern habitat and breeding area.*
- *Construction to take place within the framework of an approved site development plan.*
- *Re-vegetation as part of a rehabilitation plan is advocated. It is suggested that the shallow topsoil layer be stockpiled separately from the subsoil layers. All stockpiles should not exceed a maximum of 2 m in*

height and be properly maintained in accordance with the CDC environmental specifications. When the construction has been completed, the topsoil layers, which contain seed and vegetative material, should be reinstated thus allowing plants to rapidly re-colonise the bare soil areas.

- *Monitoring should be undertaken on bare soil areas for signs of erosion, such as rilling, and suitable mechanisms to abate erosion in line with the CDC construction specifications.*
- *During the operational phase, it is recommended that maintenance of rehabilitated areas be undertaken in accordance with the CDC established rehabilitation and landscaping procedures, as well as a project specific environmental specification to be prepared for the ADZ.*
- *Clearing of vegetation during construction to be to a minimum, keeping to the width and length of the planned earthworks areas only.*
- *Beach and dune field areas, although excluded from the development footprint, may be disturbed during the installation of essential linear infrastructure such as the marine abstraction and discharge pipelines. These should avoid active breeding areas of known species of special concern habitats. The affected areas to be surveyed by an ecological specialist and the final routes, layout and site development plan to be developed based on the input from the ecological specialist and the CDC ECO.*
- *Alien and invasive plant regrowth should be monitored, and any such species should be removed during the construction and operational phases in line with the relevant CDC environmental specifications.*
- *CDC to continue with on-going alien and invasive clearing and maintenance practices as per established management practices and procedures.*
- *Soil in which alien vegetation is growing, is contaminated with the seed and is a potential source of seed for new invasions. Care must be taken when removing or disturbing this soil, as it would perpetuate the spread of alien vegetation.*
- *The CDC's permit to remove protected plant species from areas where infrastructure will be constructed in the Coega IDZ, in terms of the Nature Conservation Ordinance (19 of 1974), must be current and all vegetation clearance to be in accordance with the following permit conditions:*
    - *The location of individuals of the various species to be identified, located with a GPS and be physically marked.*
    - *The person responsible for the relocation to work ahead and physically remove the plants before vegetation clearance starts.*
    - *If a species is represented by too many individuals to make relocation of the entire population feasible, plants should be taken from different parts of the site, from different habitats, both young and old individuals should be selected as well as individuals reflecting variability in the population to ensure the plants relocated will express the broadest genetic variation and maximise the chance of survival.*
    - *For plants that cannot be successfully uprooted and transplanted, seeds and/or small cuttings are to be collected and established in a nursery for cultivation and later introduction into selected localities.*
    - *Plants are to be translocated in the most appropriate form, not only as whole plants but also as bulbs, seeds and cuttings.*
    - *Private individuals and or nurseries to be given the opportunity to collect plants that are not relocated and that would otherwise be destroyed during vegetation clearance of the site.*
- *The CDC's licence, under the National Forests Act (84 of 1998) to cut and destroy protected trees (Milkwood and Cheesewood) for the purpose of developing infrastructure in the IDZ and that covers tenants in the IDZ must be current. All activities under this license to be strictly monitored by the CDC ECO.*
- *Mitigation with respect to minimising animal road mortalities is not always practical. Therefore,*

awareness should be created during the staff induction programme. Staff should be made aware of the general speed limits as well the potential animals that may cross and how to react in these situations.

- *Mountable kerbing to be used to allows for the movement of animals across any roads, especially the smaller species of rodent, tortoises, snakes and lizards.*
- *The ADZ boundary fencing should allow for the passage of small and medium sized mammals and all forms of mesh fencing should be avoided. The present design of the adjacent port fence complies with this requirement while meeting ISPS requirements. The fence design should also allow for migration of tortoises, and thus tortoise holes must be provided. Mesh fencing should not be used around the boundary of the ADZ.*
- *Small mesh fencing may be used around areas on individual farms where there is little or no natural habitat to keep rodents and other animals that may have been introduced (in feed, etc.) from escaping to the surrounding natural areas. It also prevents litter, etc from leaving the investor's premises.*
- *Suitable methods of solving the aggregation of birds to the ADZ must be investigated and may include means of complete exclusion (complete covering of ponds / raceways) or impeding (spines or wires) where suitable. This would also be in the interest of the facility since predation would have an economic effect on such operations and could compromise biosecurity controls. A monitoring programme is to be developed so that suitable adjustments can be made to prevent impacts from escalating.*
- *Off-road driving and access into surrounding open space areas, i.e. the Primary and Secondary Dune areas and areas demarcated for Species of Special Concern to be strictly controlled.*
- *Site specific rehabilitation measures to be developed for the various buffer zones and open areas within the ADZ.*

RATING OF IMPACTS

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Loss of Vegetation and Open Space Management Habitats*				
Overall Significance of Impacts	Negative High	Negative High	Negative Moderate	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Loss of Species of Special Concern and their Habitats*				
Overall Significance of Impacts	Negative Moderate	Negative Low	Negative Low	Negative Low	Negative Moderate to Unknown
Nature of the Impact	*Risk of increased alien plant invasion*				
Overall Significance of Impacts	Negative High	Negative High	Negative Low	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Increased animal road mortality*				
Overall Significance of Impacts	Negative Low	Negative Moderate	Negative Low	Negative Low	Negative Low to Unknown
Nature of the Impact	*Changes to migration corridors*				
Overall Significance of Impacts	None	Negative Moderate	Negative Low	Negative Low	None to Unknown

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Loss of Vegetation and Open Space Management Habitats*				
Overall Significance of Impacts	Negative High	Negative Low	Negative Low	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Loss of Species of Special Concern and their Habitats*				
Overall Significance of Impacts	Negative Moderate	Negative Low	Negative Low	Negative Moderate	Negative Moderate to Unknown
Nature of the Impact	*Risk of increased alien plant invasion*				
Overall Significance of Impacts	Negative High	Negative High	Negative Low	Negative Moderate	Negative High to Unknown
Nature of the Impact	*Increased animal road mortality*				
Overall Significance of Impacts	Negative Low	Negative Moderate	Negative Low	Negative Low	Negative Low
Nature of the Impact	*Changes to migration corridors and resulting impacts on species of special concern*				
Overall Significance of Impacts	None	Negative High	Negative Moderate	Negative Moderate	None to Unknown

ASSESSMENT OF CUMULATIVE IMPACTS

Existing impacts on terrestrial vegetation are Negative High due to past and current disturbances in the area and the level of alien infestations. As such, the cumulative impacts will also be Negative High if these past and current disturbances remain. With ongoing long-term alien and invasive eradiation and rehabilitation efforts the overall impacts can be reduced. Due to the increased activity and presence in the area, it is likely that there would be an increased focus on these issues, thus benefitting the overall situation.

ASSESSMENT OF THE NO-GO DEVELOPMENT

Existing impacts on terrestrial vegetation will remain if the ADZ is not developed. Being part of an IDZ, the area is likely to be developed for an alternative industrial use over the long term, which may have the same or higher impacts than the ADZ.

GAPS AND LIMITATIONS

Information adequate for EIA decision-making.

CONCLUSIONS

Terrestrial Ecology

CDC's definition of the ADZ footprint, has taken cognisance of several important bird and open space management habitats and the majority of the ADZ footprint is in an area presently covered in alien vegetation. The ADZ coastal section is located in the coastal cluster for development as defined in Revision 1 of the OSMP. This resulted in a reduction of potential impacts on sensitive habitats and species of special concern while maintaining important regional open space corridors and critical biodiversity areas.

Within the coastal cluster for development, although the area is heavily disturbed, it remains important to maintain pockets and strips of the remaining Colchester Strandveld and Sandy Beaches (Dune field) areas as buffers between the different aquaculture operations. A buffer of at least 200 m to be maintained around the Damara Tern habitat. This will allow for the additional protection of coastal corridors and the Critical Endangered Damara tern and Hairy Footed Gerbils.

If the mitigation listed in the impact assessment are upheld, the overall impacts were all rated as Low or Moderate, and should the development take cognisance of avoiding any important bird / gerbil habitats, together with continuous monitoring the author would not object to the development proceeding.

Aquatic Ecology

From an aquatic perspective, the project will have no impact on any known or observed wetlands or water courses.

7.5 Coastal Dunes, Sand Movement and Sediment Dynamics

SPECIALIST STUDY

Dune Geomorphology Specialist Report for the Coega ADZ, by Illenberger & Associates (Illenberger, 2016).

Dr. Werner Illenberger, formerly of the Department of Geology at the University of Port Elizabeth, has conducted research on several aspects the dune fields along the northern shores of Algoa Bay that has been published in various reports that informed this specialist report. The sediment dynamics of dune fields along the northern shores of Algoa Bay is therefore well documented. The information on the current state of the dunes and the impacts of developing the ADZ was extracted from the Dune Geomorphology Specialist Report for the Coega ADZ by Illenberger & Associates (Illenberger, 2016).

EXISTING AND REASONABLY ANTICIPATED IMPACTS DUE TO OTHER LAND USES

The dunes between Coega River mouth and Sundays River mouth is a transgressive dune system consisting of a number of active dune fields (sand sheets) that move through an area of naturally vegetated dunes. Transverse dunes are the dominant dune type in the active dune fields. These dunes lie at ninety degrees to the dominant south-westerly wind. Superimposed on the transverse pattern is a longitudinal pattern. The longitudinal dunes are generally vegetated and lie parallel to the dominant south-westerly wind. The Coega/Hougham Park dune fields are of relatively recent origin (about 6500 years), and were (and still are) formed by marine sands deposited onto the beach being blown by wind inland. The dune fields are partly accretionary, that is, sand that is blown into the dune fields accumulates vertically as well as transgressing landward. The estimated average yearly sand budget off the beach into the Hougham Park dune field system is about 9 000 m^3/yr.

Mean grain size within the active dune field at Hougham Park is 0.19 mm. The sands are well sorted, and have a slight positive skewness. The sands consist of about 62% quartz, 38% of calcium carbonate (derived mostly from seashells) and less than 1% heavy minerals (mostly ilmenite). The area is characterised by high dune mobility (Illenberger, 1998, in Illenberger, 2106), because rainfall is low, resulting in low vegetation vigour, while wind energy is high, dominated by the year-round south-westerly winds (Figure 6-1).

It is estimated that the potential wind-blown sand transport rate for the area based on wind energy is corroborated by dune movement rates based on aerial photograph records covering a 40-year period. A 5 m dune would have a net movement of on average 9 m/yr in a north-easterly direction, a 10 m high dune would move at half this speed and a 20 m dune would move at one quarter of this speed. Easterly winds would cause some reversal of dune movement in the summer months. The autumn north-westerly winds have little effect on the dunes.

Figure 7-11 shows the current state of the dunes in and around the ADZ. There is a band of low sparse dunes about 200 m wide along the shoreline. Inland of this band of dunes are higher dunes that reach 25 m in places (Plate 7-1). The dunes are extensively disturbed. Starting about 1950, drift-fences were built across the mobile dune field to stop and trap wind-blown sand. Over the years the accumulating sand built a ridge about 25 m high. In the 1990s this practice was discontinued, and the accumulated sand is slowly moving north-eastward.

The area down-wind of the drift-fences was deflated of sand, until the underlying calcrete surface was exposed. This was partly naturally vegetated, and partly planted with rooikrans (*Acacia cyclops*). Rooikrans was planted on mobile dunes in the area over an extensive period from about 1950, including the belt of low dunes along the shore. Rooikrans seed is also spread naturally, mainly by birds distributing the seed. As a result rooikrans has now invaded much of the area. As described in Section 2.3.2, sand mining has taken place within the ADZ footprint for many years. The dunes within the proposed ADZ have been modified extensively (Illenberger, 2016) and will, over time, be further modified by mining activities.

Figure 7-11: The current state of dunes on and around the ADZ

Source: Illenberger, 2016

Plate 7-1: View from top of high mobile dune created by successive drift-fences used to stop dune movement, 1950-1990, looking at the deflated (devoid of sand) downwind area, with the old SeaArk Pilot Facility in the middle ground, and Algoa Bay Islands in the distance

Source: Illenberger, 2016

SUITABILITY FOR DEVELOPMENT ASSESSMENT OF ADZ IMPACTS

Earlier developments in the area, i.e. the abalone farm and the pilot prawn facility, were located in areas that had previously been artificially stabilised. It was necessary to stabilise dunes upwind of the abalone farm, using drift-fences and planting rooikrans, to stop dunes blowing onto the premises and this proved satisfactory to control the sand (Illenberger, 2016). Although abandoned for some time, there is still no sign of sand encroachment or build-up at the old abalone farm or at the prawn pilot facility.

Dr Illenberger concluded that not much is to be gained from an attempt to conserve the mobile dunes within the proposed ADZ, and that there are virtually undisturbed dunes of a similar nature further east along the coast that are conserved as part of Coega OSMP primary open space network – Primary Dune Area 1.3A (CBA-IDZ) and Secondary Dune Area 1.3B (CBA-IDZ), as well as the dunes further east that forms part of the NMB Municipality open space network and the coastal zone of the Addo Elephant National Park.

The CDC's strategic planning processes (Section 1.5) made provision for a 'coastal cluster' to be set aside for the development of aquaculture, CCGT power plant, mining and servitudes to provide a linkage between the sea and the developable areas further inland. The coastal cluster is located in the disturbed area between the Port of Ngqura and the virtually undisturbed dunes further east. In Revision 1 of the OSMP, the coastal cluster has been classified a 'developable area' and the undisturbed dunes as part of the primary open space network.

In his previous studies, Dr Illenberger concluded that the dunes are partly accretionary, i.e. sand that blows onto the dune fields by the dominant south-westerly wind accumulates vertically as well as transgressing landward and that mining of the dune field in the Coega/Hougham Park area would have no effect on the regional coastal sediment dynamics, because this dune field acts as a sand sink with respect to sand moving along the coast (Illenberger, 1994; 2007 in 2016).

From a physical and sedimentary perspective, Dr Illenberger did not identify any sensitivities to development of the ADZ as proposed.

Levelling off the dunes and developing on top of the levelled surface is feasible, but one would have to work on an unstable substrate of unconsolidated sand. The best option is to mine the sand as it is a valuable resource, and then develop on the underlying calcrete surface. The nuisance value of loose sand will thereby be removed, as will possible problems with wind-blown sand; like sand-blasting (Illenberger, 2016).

The conditions of the EA for the old SeaArk pilot prawn facility required that a 20 m vegetation buffer be maintained between the development and the gravel track parallel to the beach. This appears to have been adequate.

MANAGEMENT MEASURES ALREADY IN PLACE IN THE IDZ

- The Coega IDZ OSMP (2014) provides for the fairly undisturbed dunes - primary and secondary dune areas, located to the east of the ADZ and the Coastal Cluster, to be designated as primary open space. These areas are designated as: Primary Dune Area 1.3A and Secondary Dune Area 1.3B (both CBA-IDZ).
- The CDC maintains a 200 m buffer around Damara Tern nesting sites (The ADZ falls outside this buffer zone).
- The Coega IDZ ECO conducts monitoring of Damara Tern nesting sites and monitors mining activities for compliance with their respective approved mining areas and the 200 m buffer zone around the Damara Tern nesting sites.

MITIGATION MEASURES AND DESIGN CRITERIA

- *No development of ADZ structures and infrastructure to take place in areas where there are unvegetated dunes until the sand has been be removed. Mining to be in accordance with a valid mining right or mining permit.*
- *The ADZ structures and infrastructure to be developed on the underlying calcrete surface once exposed (Illenberger, 2016).*
- *A 50 m wide buffer zone to be maintained around mobile dune areas (Illenberger, 2016).*
- *Drift-fences to be erected in the buffer zones to trap sand moving from the mobile dunes.*
- *Build up of sand in the buffer zones to be controlled by removing the sand every 5 years or as required (Illenberger, 2016).*
- *A beneficial use of the removed sand to be found, i.e. for future construction projects in the IDZ (Illenberger, 2016).*
- *Removal of sand from buffer zones to be in accordance with a valid mining right or mining permit, unless an exemption in terms of the Section 106 of the MPRDA applies, i.e. where sand is removed for own use or in the IDZ itself, and not sold commercially.*

RATING OF IMPACTS

	Existing and Reasonable Anticipated Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of Impact	*Impact on dunes within in ADZ footprint*				
Impact status	Negative	Negative	Negative		
Intensity	Major	Low	Low		
Duration	Permanent	Permanent	Permanent		
Extent	Local	Site	Site		
Consequence	High	Low	Low		
Probability	Certain	Possible	Highly Unlikely		
Frequency	Always	Always	Always		
Significance	Negative High	Negative Low	Negative Very Low	As Existing	As Existing
Nature of Impact	*Impact on regional dune dynamics and sand movement*				

Impact status	Negative	Negative	Negative		
Intensity	Moderate	Minor	Minor		
Duration	Long-term	Long-term	Long-term		
Extent	Regional	Local	Local		
Consequence	Medium	Low	Low		
Probability	Certain	Highly Likely	Possible		
Frequency	Always	Always	Always		
Significance	Negative Medium	Negative Low	Negative Very Low	As Existing	As Existing

ASSESSMENT OF RISKS

Likelihood of mitigation measures being implemented successfully (mitigation reliability)	Highly likely.
Degree to which impacts can be avoided, managed, or mitigated	Can be mitigated.
Degree to which impacts can be reversed	Existing impacts cannot be reversed.
Degree to which impacts could cause irreplaceable loss of resources	Unlikely.
Assessment confidence	High.
Gaps and limitations	Information adequate for decision-making.

7.6 Heritage Resources

PREVIOUS STUDIES

The heritage resource impact of aquaculture developments in Zone 10 were assessed as part of two previous environmental assessments for: the Change in Land Use of the Remaining Area within the Coega IDZ (SRK, 2006); and the Aquaculture Operation for the Grow-Out of Prawn Larvae (CEN, 2009). A study by Binneman (2008) supported the assessment by CEN (2009). The recommendations of these assessments were considered in this EIA.

The 2006 Change in Land Use EIA by SRK recommended that a Phase 1 heritage assessment be undertaken. In 2010, the CDC commissioned such a heritage assessment for the whole of the IDZ by Almond (2010), Bennie (2010) and Binneman (2010) that covered palaeontological, historical and archaeological heritage components respectively. The 2010 studies were reviewed by SAHRA and they issued a document (SAHRA, 2011) in which recommendations for the management of all the identified sites within the Coega IDZ were stipulated, as well as some general recommendations. The recommendations[12] specific to Zone 10 and the ADZ were incorporated into the EIA and EMPr.

A recent heritage screening study by CTS Heritage Specialists (2015) concluded that the previous heritage assessments provided a high level of coverage throughout the IDZ, including Zone 10 and the ADZ. It should be noted that the 2010 archaeological study by Binneman as well as previous archaeological surveys also covered the portion of land (~22 ha) where the ADZ overlaps with Farm Coegas River Mouth 303 Portion 8 owned by Transnet, located outside the boundary of the IDZ. This portion of land is occupied by the old abalone farm along the coast, dense alien vegetation to the back of the abalone farm, and then high mobile dunes where different entities have mining rights and a section of the dunes has already been mined as part of Glendore's Sonop Quarry.

Some of the identified archaeological sites are located in areas earmarked to be mined prior to the establishment of the ADZ infrastructure and structures. The activities of the mining companies are monitored by the CDC and their independent ECO. The impacts of mining and the destruction of these sites by third-party mining companies therefore fall outside the scope of this EIA.

CURRENT STATE AND DESCRIPTION OF HERITAGE RESOURCES

[12] *General recommendations for the IDZ to be addressed by the CDC are not repeated in the EMPr for the ADZ.*

Palaeontology

Palaeontological heritage is not site-specific but related to entire geological units or formations and is therefore linked to the bedrock geology of the area, which is discussed and illustrated in Section 6.2. Natural levels of bedrock exposure within the Coega IDZ are generally very low due to extensive cover by overlying drift material; soil, alluvium, in situ weathered material, surface calcrete (pedogenic limestone) and dense vegetation. Man-made excavations such as road and railway cuttings, storm water drainage channels, reservoirs and quarries provide opportunities to examine and sample fresh, potentially fossiliferous bedrock. Fresh excavations made during construction in fossil-bearing formations are quite likely to expose fossil heritage of palaeontological significance. Almond (2010) described the paleontological potential and sensitivity of the different formations that are found at surface on and around the ADZ as follows:

Kirkwood Formation – Early Cretaceous age (136 million years old)

Important, but rare fossils of dinosaurs and plants are also known from the Kirkwood Formation, but so far only outside the IDZ. Not found on surface on or near the ADZ, only to the south closer to the Coega River.

Sundays River Formation – Early Cretaceous age (136 million years old)

The grey to greenish-grey mudrocks and subordinate calcareous sandstones of the Sundays River Formation were laid down in a range of estuarine to offshore marine shelf settings. Of the dozen or more natural and artificial exposures of these sediments examined within the Coega IDZ, mostly along the eastern escarpment of the Coega River Valley, almost all yielded a range of shelly invertebrate fossils. The palaeontological sensitivity of this formation is therefore rated as high.

Alexandria Formation of Miocene / Pliocene age (7 to 5 million years old)

The Alexandria Formation is known to be richly fossiliferous, and a number of the key fossil localities within this unit are situated in the region. However, field evidence suggests that much of this lime-rich succession has been diagenetically altered in the area and most new excavations expose few or no fossils of value.

Salnova Formation of Mid Pleistocene to Holocene age (less than a million years old)

This formation is the youngest highly fossiliferous marine succession within the Coega IDZ and has a proven fossil record of high scientific importance. It crops out intermittently along the coastline in Zone 10. The formation comprises a spectrum of well-indurated sandy and conglomeratic beach deposits that form low rocky benches close to modern sea level and are locally rich in marine shell remains. The overall palaeontological sensitivity of the Salnova Formation is judged to be high, although many occurrences are not especially shell-rich or contain mainly fragmentary remains.

A geologically important section of the Salnova Formation has been identified in Zone 10 on the eastern boundary of the IDZ (Figure 7-12). Here the conglomeratic and sandy Salnova beds unconformably overlie the Sundays River Formation and are overlain in turn by consolidated aeolianites of the Nahoon Formation. This low coastal rock platform is indicated on the Coega OSMP, Figure 2-9 (label 24), and is further discussed in Table 7-3 (item P01 (GS10)) below. It is located some distance away from the ADZ but similar fossil-bearing sediments may occur elsewhere along the coast. Routes for marine pipelines and infrastructure close the seashore may intersect this formation.

Nanaga, Nahoon and Nahoon and Schelm Hoek Formations

These formations have a low palaeontological sensitivity.

Historical

Hougham Park Farm

The farm was originally called Samson's Kraal and was owned by a T.I. Ferreira. The core of the homestead has been dated back to 1817. Hougham Hudson bought the farm from the Ferreiras in the 1830s and renamed it Hougham Park. Three families owned farm since that date; the Hudsons for 60-70 years, the Denfords and the Crews from 1945 to 2007. The farm was bought by the CDC in 2007.

According to Drysdale (2015), during the time the Crews owned the farm, a shaft was sunk through the limestone and tunnels were made to find fresh water streams flowing to the sea from the mountains; Edgar Crews introduced oyster farming to Port Elizabeth and he supplied many restaurants all over the country for a number of years; dunes were stabilized using barriers of gravel, limestone, dead branches and sowing of rooikrans seeds; a gravel road down to the beach was cleared to transport shell grit which was sifted and dried in a kiln for the poultry industry; the gravel road was extended to open up the beachfront to visitors, mainly fisherman; and a camping ground was established.

The 2010 heritage assessment for the Coega IDZ included a survey of Zone 10 by Bennie (2010). The sites recorded in the report are listed in Table 7-3 below and consists of the Hougham Park farmstead, including the Main House, reputedly built in the 1830s by 1820 settler Hougham Hudson, as well as the an outbuilding known as the 'Egg House', which is thought to be the first house on the site (named the 'Cottage' by Bennie (2010)). There are two burial grounds; the cemetery of the Hudson and Crews families, and a cemetery used by Hougham Park farm workers. The CDC has constructed palisade fencing around the existing grave sites and reasonable access are provided for families / communities.

In July 2015, the CDC was informed that the Hougham Park Main House had been vandalized. The remote location and isolation of the area makes it difficult to control vandalism as security guards are often intimidated, as was the case at the old SeaArk pilot prawn facility, but repairs to the roof of the house have been completed and further repairs are planned based on the recommendations by an independent heritage specialist (Andrea Shirley, pers. comm).

Maritime History

No exact localities of shipwrecks along this part of the coast have been plotted. Three shipwrecked sailors from the Amsterdam, which were grounded in 1817, are known from the records to be buried in the dunes and have not been found. These skeletal remains could be displaced by excavation either by natural or man-made means.

Archaeology

Zone 10 has been investigated several times by Binneman (1994, 2008, 2010), Webley (2007) and Kaplan (2007) (as referenced in Binneman, 2010) but the impenetrable alien vegetation in the coastal dune area as well as in large parts of the areas inland of the dunes made it difficult to survey the area. Archaeological materials are usually associated with exposed calcrete floors or black soils ('old vlei deposits') in the bays between the slow eastward moving sand dunes. The calcrete bedrock covered by a thin layer of dark soil does not allow for any deep archaeological deposits.

In general, the study site is relatively poor in large and important archaeological sites but the area between the shifting sand dunes and the Coega River mouth to the west, is rich in small shell middens and accumulations of hundreds of stone tools. However, the sites found may represent only a small number of sites that exist because most of the sites are likely to be covered by dunes and dense vegetation. Development of the ADZ may expose more sites. All the archaeological sites recorded to date in Zone 10 are located in the coastal dune area (Figure

7-12). The coastal strip in Zone 10 is one of the most sensitive areas of the Coega IDZ and the possible incidence of occurrence of archaeological material is high (SAHRA, 2011).

The shell middens found were small with little depth of deposit, dominated by one shellfish species and with virtually no cultural or food remains. Although the 'quality' of the archaeological remains and features were in general poor, it is possible to conclude that the remains date mainly from the past 5 000 years. The stone tools in the shifting dunes and along the exposed beach areas were in secondary context and consisted mainly of quartzite flakes and chunks. The evidence from occasional well patinated (weathered through use) Middle Stone Age stone artefacts indicated that the area was also inhabited between 30 – 120 000 years ago. Although Earlier Stone Age tools (older than 120 000 years) are common in the wider area, none were found in Zone 10.

Along the western beach and adjacent dune fringe, occasional weathered/sand polished Middle Stone Age and Later Stone Age stone tools were found along the immediate beach area where the calcrete floor was exposed or covered thinly by dune sand. These stone tools are of low cultural significance (Binneman 1994, 2010).

Not many sites were found in the high moving sand dunes. It appears the sites are associated with 'dune deflation bays' and most of the sites that were found in earlier surveys could no longer be located in the 2010 survey (Binneman, 2010), assuming these have been covered by moving sand. More sites could be covered by sand and vegetation. Specific sites documented by Binneman (2010) are tabled below. An area with midden scatters that was recorded in centre of the Zone 10 vegetated coastal foreland in 1994 could not be located during the 2010 survey and is assumed to be covered by sand and vegetation. The eastern beach and dune areas in Zone 10, to the east of the ADZ, are associated with wide, open, flat sand field with small low dunes where there are calcrete and quartzite gravels exposed by the wind. Occasional stone tools, chunks and flaked pieces have been found on the exposed gravels but these hard surfaces have been damaged / demolished by off-road vehicles over the years. Areas with randomly scattered stone tools recorded by Binneman (2010) are tabled below.

Table 7-3: Heritage Sites Documented in Zone 10, within or near the ADZ

No	OSMP No	Site Description	Specialist Recommendations	Latitude Longitude	SAHRA Requirements for Site (SAHRA, 2011)
Archaeological (Binneman, 2010)					
A01	N/A	Mobile Dunes (Outside ADZ) Three small low sensitivity shell midden scatters *of Perno perno.* Located outside ADZ within the Sonop Quarry mining area.	Low sensitivity. Site to be recorded before destruction.	As per Figure 7-12. 33.46.632S 25.42.732E	The following is required prior to disturbance: Site to be recorded and report to be submitted; Destruction permit needed; Based on outcome of site recording, a Phase II permit and survey may be required.
A02	N/A	Mobile Dunes (Outside ADZ) A scatter of few quartzite stone tools and pottery fragments. Located outside ADZ within the Sonop Quarry mining area.	Low sensitivity. Site has been sufficiently recorded.	As per Figure 7-12. 33.46.659S 25.42.767E	Destruction permit needed prior to disturbance.
A03 (023)	N/A	Mobile Dunes (**Inside ADZ**) A scatter of very likely KhoeSan pottery fragments among the grass on a large deflation bay with few fragments of *Donax serra* nearby. Same as site Site 87057 (Coega 023) Grade IIIc as per CTS Heritage	Low sensitivity. Pottery to be collected before destruction.	As per Figure 7-12. 33.46.629S 25.42.855E	The following is required prior to disturbance: Site to be recorded and report to be submitted; Destruction permit needed; Based on outcome of site recording, a Phase II permit and survey may be required.

No	OSMP No	Site Description	Specialist Recommendations	Latitude Longitude	SAHRA Requirements for Site (SAHRA, 2011)
		Specialists (2015).			
A04	N/A	Mobile Dunes (**Inside ADZ**) *Perno perno* shell scatter with few associated bone fragments.	Low sensitivity. Site to be recorded before destruction.	As per Figure 7-12. 33.46.589S 25.42.874E	The following is required prior to disturbance: Site to be recorded and report to be submitted; Destruction permit needed; Based on outcome of site recording, a Phase II permit and survey may be required.
A05	N/A	Mobile Dunes (**Inside ADZ**) *Perno perno* shell midden scatter with few associated possibly KhoeSan pottery fragments and stone tools.	Low sensitivity. Site to be recorded before destruction.	As per Figure 7-12. 33.46.692S 25.42.148E 33.46.662S 25.42.125E	The following is required prior to disturbance: Site to be recorded and report to be submitted; Destruction permit needed; Based on outcome of site recording, a Phase II permit and survey may be required.
A06	N/A	Eastern Dunes (Outside ADZ) Small midden scatters.	Low sensitivity. Site to be recorded before destruction.	As per Figure 7-12. 33.46.692S 25.42.148E	The following is required prior to disturbance: Site to be recorded and report to be submitted; Destruction permit needed; Based on outcome of site recording, a Phase II permit and survey may be required.
A07	N/A	Eastern Dunes (Outside ADZ) Stone tools on exposed calcrete floor. Midden scatter.	Low sensitivity. No further recording required.	As per Figure 7-12. 33.46.056S 25.44.373E	Destruction permit needed prior to disturbance.
Old/ Other	N/A	Sites marked as Old/Other on Figure 7-12 (blue dots). Include sites indicated on Map 10 & 11 in Binneman (2010) but where no details or coordinates were provided, also include sites mapped and observed in earlier surveys, but that could not be found during recent surveys by Binneman (2008, 2010) (Figure 7-13 and Figure 7-14). **Two old sites in the ADZ**: Two sites were plotted in the ADZ in the Calcium Products (Pty) Ltd mining area but may have been destroyed during past mining.	General recommendations, see below.	As per Figure 7-12.	General recommendations, see below.
Historical (Bennie, 2010)					
H01a	OSMP 18	Hougham Farm House and Homestead. Main House recently vandalised. CDC in process with repairs based on	Hougham Park farmstead, the Main House and the Cottage (Egg House) and most of the grave sites, to be	33°46'3.20"S 25°42'51.46"E	-

No	OSMP No	Site Description	Specialist Recommendations	Latitude Longitude	SAHRA Requirements for Site (SAHRA, 2011)
		recommendations by independent specialists.	preserved and conserved. SAHRA to be informed of any alterations to buildings or other built structures older than 60 years.		
H01b		The Cottage (Egg House) at Hougham Farmstead. High significance building, to be preserved.			-
H02	OSMP 10	Family Cemetery. Demarcated by a vibracrete fence and wooden gate.		33°46'3.01"S 25°42'55.57"E	General recommendations for burial grounds (already adopted by CDC).
H03	OSMP 01	Hougham Park 2A Cemetery. Demarcated with a vibracrete wall. Located some distance from the road.		33°46'17.17"S 25°43'12.59"E	
H04	N/A	Four reputed artesian wells and freshwater springs (Kate Crews, pers. comm, in Bennie, 2010).	N/A		-
		a) Near the beach with a pump house and building that supplied the main house		Not known	-
		b) covered by SeaArk facility		33°46'40.44"S 25°43'22.54"E	-
		c) near campsite		33°46'28.74"S 25°43'43.80"E	-
		d) not known		Not known	-
H05	N/A	Oyster House Remains	N/A	33°46'37.28"S 25°43'35.33"E	-
Palaeontological (Almond, 2010)					
P01 (GS10)	OSMP 24	Along beach on eastern boundary of Zone 10, some distance away from the ADZ. Low coastal rock platform with exposure of the contact between the Salnova and the Sundays River Formations and an ancient fossiliferous dune of Nahoon Formation. Officially designated stratotype E locality of Salnova Formation (Le Roux, 1991, in Almond, 2010).	Protect outcrop from development or disturbance.	33°45'53.82"S 25°44'58.72"E	This area must be protected from damage and development.
P02 (GS09)	OSMP 27	Near ADZ on boundary with Zone 7. North of Hougham Park farmstead, on eastern side of the gravel track. Hougham Farm Limestone. Long trench into surface limestones. Exposures of large fossilized root systems in ancient dune sands of Nanaga Formation. Abundant shells of land snails.	Protect northern face of trench from damage or development. Trace fossils are easily degraded; therefore they should be studied soon.	33°45'50.40"S 25°42'43.20"E	-

Note: For sites A01 - A07, the coordinate points and locations mapped on Map 10 & 11 in Binneman (2010) do not correspond. Sites marked on Figure 7-12 in this report were plotted using Map 10 & 11 in Binneman (2010). These maps are provided below for reference purposes.

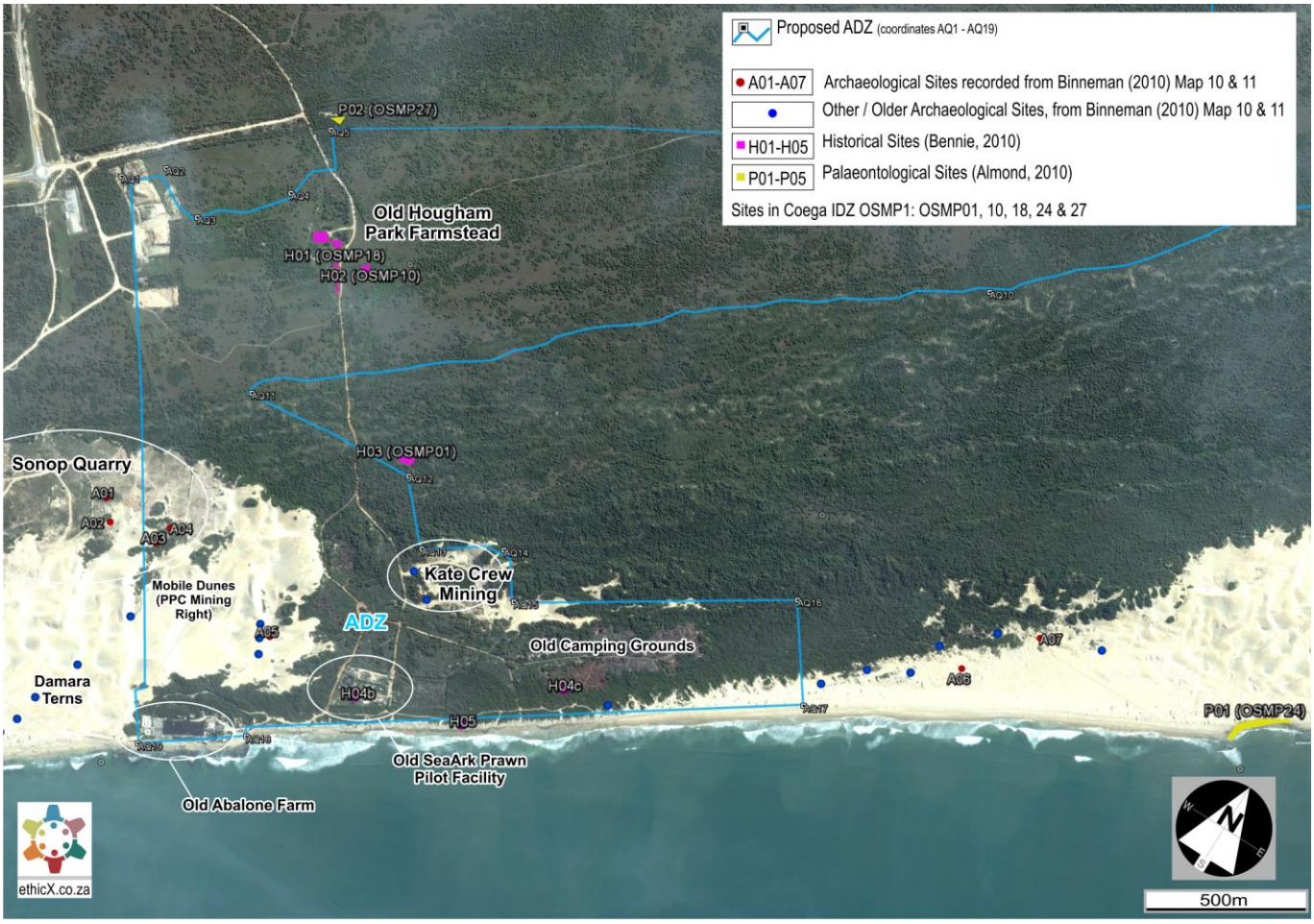

Figure 7-12: Heritage Sites Recorded in or near the ADZ (as detailed in Table 7-3)
(Map optimised to be viewed electronically)

IDENTIFICATION AND ASSESSMENT OF IMPACTS

The remote and isolated location of the site has led to vandalism of historical buildings (existing impact). Appropriate development and added human presence in the area, with associated security and access control, could reduce the likelihood and extent of vandalism occurring again.

There are a number of known heritage sites located within and close to the ADZ. With the recommended mitigation measures in place and planning of the ADZ master layout plan with these sites in mind, any significant negative impacts can be avoided.

There is a real possibility that unknown and unmarked heritage sites could be discovered / unearthed during the development of the ADZ, particularly during the early stages of construction associated with vegetation clearance, site grading and excavations. With correct management and mitigation measures in place, the discovery of further heritage sites would provide opportunities to document the sites and enhance the heritage knowledge base of the area.

MITIGATION MEASURES AND DESIGN CRITERIA

General

- *The EIR will be submitted to ECPHRA and uploaded onto SAHRA's SAHRIS (online system) website.*
- *For recorded heritage sites, adhere to specific recommendations for each of the sites as per specialist reports by Almond (2010), Bennie (2010) and Binneman (2010), and SAHRA (2011), as summarised above.*
- *There is a likelihood that new heritage discoveries are made during construction (vegetation clearance*

and site grading). If any evidence of heritage sites or remains (e.g. shell middens, remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, shipwrecks, marine shell and charcoal/ash concentrations), unmarked or marked human burials, fossils or other categories of heritage resources are found during construction, ECPHRA to be alerted immediately, and an accredited professional archaeologist or palaeontologist must be contacted as soon as possible to inspect the findings (SAHRA, 2010).

- *If newly discovered heritage resources prove to be of significance, a Phase 2 rescue operation might be necessary. On receipt of a satisfactory mitigation (Phase 2) permit report from the archaeologist and/or palaeontologist, SAHRA to make further recommendations in terms of the possible destruction or preservation of the heritage resources (SAHRA, 2010).*

Archaeology

- *Recorded sites A03, A04 and A05 are located within the footprint of the ADZ. The following is required before disturbance to the sites may take place.*
  - *Sites to be recorded and a report to be submitted to the ECPHRA.*
  - *A destruction permit needed prior to disturbance.*
  - *Based on outcome of the site recording, a Phase II permit and survey may be required.*
- *Vegetation clearance in the ADZ to be done under the supervision of an archaeologist and in short strips, either by hand or with small machinery or with the least invasive method reasonably possible. This is to allow for documentation and/or rescue of any new discoveries (SAHRA, 2011).*
- *An archaeologist to be present on site to monitor earth moving activities (SAHRA, 2011).*
- *General recommendations for new heritage discoveries to be followed if evidence of heritage sites or remains is found (see above, as recommended by SAHRA, 2011).*

Palaeontology

- *A palaeontologist or an ECO trained by a palaeontologist on how to search for possible fossil remains in freshly excavated material, to monitor earth moving activities involving contact with the Salnova Formation (Almond, 2010 and SAHRA, 2011).*
- *An ECO trained by a palaeontologist on how to search for possible fossil remains in freshly excavated material, to inspect excavations in the Alexandria Formation and notify a palaeontologist if rich fossil remains are encountered. Unless rich fossil remains, such as seen at the main Coega limestone quarry, are encountered during excavation, general palaeontological mitigation is not automatically required for the Alexandria Formation (Almond, 2010).*
- *Any excavations in the Salnova Formation, Sundays River and Kirkwood Formations to be examined by a professional palaeontologist while fresh bedrock is still exposed. The presence of a palaeontologist is required on site soon after exposure. The palaeontologist may make recommendations for further action to safeguard fossil heritage of the exposed material (Almond, 2010).*

Historical Sites

- *Hougham Park homestead, the Main House and the Cottage (Egg House) and most of the grave sites, to be preserved and conserved (Bennie, 2010).*
- *The master layout plan for the ADZ to take cognisance of historical buildings and burial grounds and need to allow reasonable access by family members and historical interested groups.*
- *Potential uses of the buildings as part of the ADZ and options to safeguard them from vandalism to be explored, with input by a heritage specialist.*
- *SAHRA to be informed of any alterations to buildings or other built structures older than 60 years (Bennie, 2010).*
- *Extreme care to be taken when excavating in the dune, beach and intertidal areas. Activities in these areas to be monitored by a maritime archaeologist. If any shipwreck material or human remains are found, work is to be stopped immediately and a representative of ECPHRA or a maritime archaeologist to be informed immediately. Work not to resume until the site has been investigated (Bennie, 2010).*

- *All graves, including the unmarked ones, must be protected and conserved (SAHRA, 2011).*

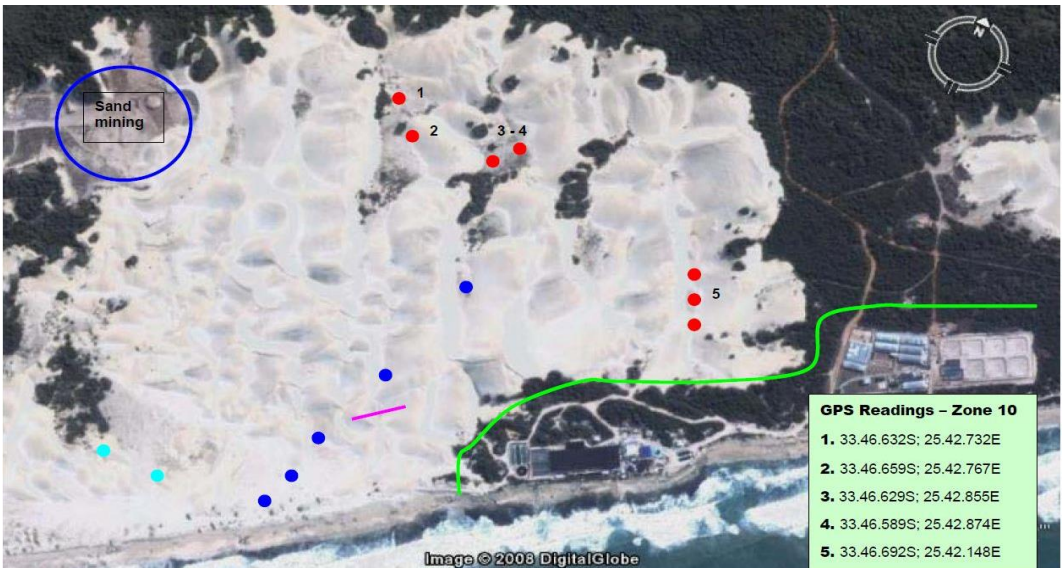

Figure 7-13: Map 10 from 2010 Archaeological Report (Binneman, 2010) showing archaeological sites in the western mobile dune area of Zone 10

[Green] Highly disturbed area, [Pink] Possible area where human remains were found, [Turquoise] Sites recorded during 1994 (Binneman). [Blue] Sites recorded during 2007 (Webley), [Red] Sites recorded during 2008-10 (Binneman). Most of earlier sites not found during recent surveys.

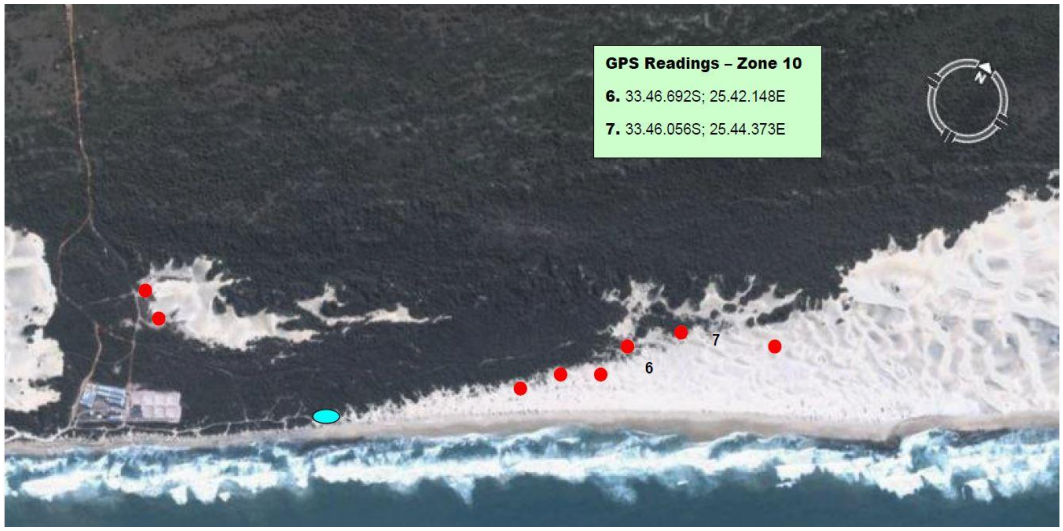

Figure 7-14: Map 11 from 2010 Archaeological Report (Binneman, 2010) showing sites and material along the eastern dune area in Zone 10

[Blue] Shell midden scatter and stone tools recorded in 1994 (Binneman) but not found again in 2010. [Red] Sites recorded in 2008-10 (Binneman).

RATING OF IMPACTS

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Risk of vandalism due to limited human presence and lack of security. Destruction of heritage sites during site clearance, grading, earthworks and excavations. Discovery of undocumented heritage sites and opportunities to enhance heritage knowledge base.*				
Impact status	Negative	Negative	Positive	Positive	
Intensity	Major (vandalism)	Major	Major	Major	
Duration	Permanent (unless repaired to original condition)	Permanent	Permanent	Permanent	
Extent	Site	Site	Site	Site	
Consequence	High	High	High	High	
Probability	Certain	Certain	Highly likely	Highly likely	
Frequency	Sporadic	Sporadic	Sporadic	Sporadic	
Overall Significance of Impacts	Negative Medium	Negative Medium	Positive Low	Positive Low	Same as Cumulative

ASSESSMENT OF RISKS

Once heritage sites are destroyed, impacts cannot be reversed. Management measures are aimed at avoidance of impacts and on documenting heritage finds before removal or destruction to improve heritage knowledge base.

NO-GO DEVELOPMENT

If the ADZ was not developed, the negative impacts will be avoided but the potential opportunities will also not materialise. If other industries were to develop on the site, the impacts would likely be the same since the impacts are associated with the physical footprint of the development and not the type of industry.

CONCLUSIONS

There are no unacceptable risks or impacts. With the proposed mitigation measures implemented, the overall impacts could be positive as there is potential to enhance heritage scientific knowledge base if new heritage sites are found and researched.

7.7 Visual

PREVIOUS ASSESSMENTS

The visual impacts of aquaculture development throughout Zone 10, and of industrial development in the IDZ as a whole, were assessed in the 2006 change of land use EIA for the Coega IDZ remaining areas (SRK, 2006). The study considered tourism in Algoa Bay, including visitors to the nearby bird islands, as a receptor. The study concluded that based on viewing distances, the presence of the port and IDZ as a whole and thus expectations of visitors, the visual impacts of aquaculture development in Zone 10 would be low if structures were designed not to be intrusive.

ASSESSMENT OF IMPACTS

Based on the development proposals by prospective investors in the ADZ, visits to various aquaculture developments and desalination plants in the Eastern and Western Cape, and a comparison of the development plans and photographs of aquaculture development, as well as observations by the EAP during a tourism boat trip to St Croix Island, the overall impact rating of the 2006 EIA is supported but the actual footprint of the ADZ is smaller, especially the section along the coast, than the development footprint assessed in 2006.

A small portion of the site, in the north, is located immediately adjacent to the N2 but due to the topography that slopes away from the road reserve down to the shoreline, and the road level that is below the land in the ADZ, visual exposure is very limited. The only notable impacts are towards the shoreline. The shoreline is not routinely accessed by visitors or tourists due to its location in the IDZ. Visual impacts could arise along the shoreline during construction of infrastructure such as marine pipelines and pump stations but these impacts are local and

temporary. The port infrastructure and other developments in the IDZ dominate the local scenery as tourists travel past the IDZ on boat trips to and from the Algoa Bay Islands. Development of the ADZ will have a minor impact on the visual character of this part of the coastline.

Lighting could increase the visibility of the development at night and thereby affect local fauna. Strong beams of light can cause birds to circle in confusion and collide with structures and could affect fauna along the shoreline.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Design of buildings and structures, and the choice of paints, finishes and textures to be in accordance with the CDC Visual Guidelines for Development and the Architectural Guidelines.*
- *Lighting design to consider and minimise impacts:*
  - *Sky glow, light spill and glare towards the shoreline and the N2 to be minimised.*
  - *Lighting to not exceed, in number of lights and brightness, the minimum required for safety and security.*
  - *Timer switches or motion detectors to be considered in areas that are not occupied continuously.*
  - *Outside lighting to be appropriately directed where required. Uplighting to be avoided.*
  - *Where possible, interior lighting to be switched off or dimmed at night and designed to minimize light escaping through windows and plastic sheeting.*
  - *Light spill and glare, from light fixtures and from vehicles on internal roads, should not reach into the 200 m buffer zone around the Damara Tern habitat as a precautionary measure to avoid disturbance to the birds at night.*

RATING OF IMPACTS

Construction Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Visual exposure towards the shoreline and tourist boat routes in Algoa Bay. Very limited exposure towards a section of the N2.*				
Overall Significance of Impacts	Negative Moderate	Negative Very Low	Negative Very Low	Negative Moderate	Same as Cumulative

Operational Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Visual exposure towards the shoreline and tourist boating routes in Algoa Bay. Very limited exposure towards a section of the N2.*				
Overall Significance of Impacts	Negative Moderate	Negative Low	Negative Very Low	Negative Moderate	Same as Cumulative

NO-GO DEVELOPMENT

If the ADZ was not developed, the minor negative visual impacts will be avoided. Development of other industries on the site, as part of the long-term development of the IDZ, may result in similar but most likely in more pronounced visual impacts.

ASSESSMENT OF RISKS AND CONCLUSIONS

The visual impact is not a potential significant impact or notable risk.

7.8 Noise

PREVIOUS ASSESSMENTS

Noise impacts of aquaculture development in Zone 10 were assessed in the 2006 change of land use EIA for the remaining areas in the Coega IDZ (SRK, 2006). It concluded that noise impacts would be very low and recommended that noise impacts, as for all industries in the ADZ, be managed by the CDC on an IDZ-wide basis through their EMS and established environmental specifications.

ASSESSMENT OF IMPACTS

Aquaculture developments are not noise generating activities. The potential exception to this is the high pressure pumping of water and waste water required as well as potential back-up generators. High pressure pumps and generators are typically enclosed, with the housing specifically designed to contain noise.

Desalination plants involve pumping of water under high pressure, and components such as compressors, membrane trains, an energy recovery system, electrical substation, motor control centre, local instrumentation and controls. The plant buildings are typically designed to contain noise to acceptable levels within close quarters of the building.

Visits to desalination plants and various aquaculture operations confirmed that noise levels inside the pump housings and buildings can be high but typically the levels drop substantially within a few meters from the housing our buildings.

Near the shoreline where the larger pumps will to be located to pump the bulk of the seawater, natural noise levels dominate. Background wave and wind noise can be significant, and has been measured on site to be over 85 dBA 10 m inland from the HWM on a fairly windless day and over 95 dBA on a windy day. During construction, there will be additional noise from the construction equipment.

Noise generated in close proximity to the Damara Tern breeding areas could disturb these birds and need to be avoided. The CDC is maintaining a 200 m buffer around the area, which is regarded as sufficient to mitigate against noise impacts generated from construction and operational activities in the ADZ, particularly in light of the high ambient / background noise levels created by wave and wind action.

There are no other sensitive receptors such as residential developments near the site.

The routes of the marine pipeline from the ADZ boundary to the sea intake point and the positions of the pumps and pump houses outside the ADZ are being investigated in the separate EIA for the marine pipeline servitude and noise impacts from these pump outside the ADZ is therefore not assessed in this EIA as the positions are not known at this stage.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Noisy activities near the Damara Tern breeding area to be avoided during construction and operational phases. Maintain the 200 m buffer zone around the Damara Tern breeding area.*
- *High pressure pumps, generators and noise generating components at the desalination plant to be enclosed in structures where sound attenuation properties have been considered for the walls, roofs, access doors and ventilation outlets.*
- *Comply with the r South African noise standards (SANS 10103).*

RATING OF IMPACTS

Construction Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Localised and short-term noise created by construction equipment.*				
Overall Significance of Impacts	Negative Low	Negative Low	Negative Very Low	Negative Low	Same as Cumulative

Operational Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Localised noise created by high pressure pumps, generators and certain desalination plant equipment.*				
Overall Significance of Impacts	Negative Low	Negative Moderate	Negative Very Low	Negative Low	Same as Cumulative

NO-GO DEVELOPMENT

If the ADZ was not developed, the negative impacts will be avoided. Development of other industries on the site, as part of the long-term development of the IDZ, may result in similar but most likely in more pronounced noise impacts.

ASSESSMENT OF RISKS AND CONCLUSIONS

The noise impact is not a potential significant impact or notable risk.

7.9 Traffic

Traffic and access related matters have been assessed for the IDZ as a whole during previous EIA processes and are managed by the CDC on an IDZ-wide basis.

7.10 Access and Ancillary Service Infrastructure

Access to the site is via exit 770 along the N2 highway, about 2 km north-east of the Coega River and salt works, then a tar road from the exit southwards for ~1.5 km, past the Cerebos plant, to a traffic circle, and gravel tracks from there to Hougham Park and further south along a gravel road to the coastal section of the ADZ.

The "installation of ancillary service infrastructure, including service roads and storm water drainage systems, water supply, sewerage systems, electrical and telecommunication infrastructure associated with the establishment of and IDZ'' is authorized in terms of the EA (DEA, 2007) for the 2006 change of land use EIA for the Coega IDZ remaining areas (SRK, 2006).

Impacts associated with the construction of the marine pipelines, outside the ADZ boundary, are assessed in a separate EIA process and will require specific construction and maintenance method statements to be developed based on the final positioning and design.

7.11 Physical Suitability of the Land for Development

Based on the specialist assessments and the characteristics and sensitivities of the ADZ footprint described in preceding sections of the report, an assessment of the general physical suitability of the site for development was completed. The results are discussed and illustrated below.

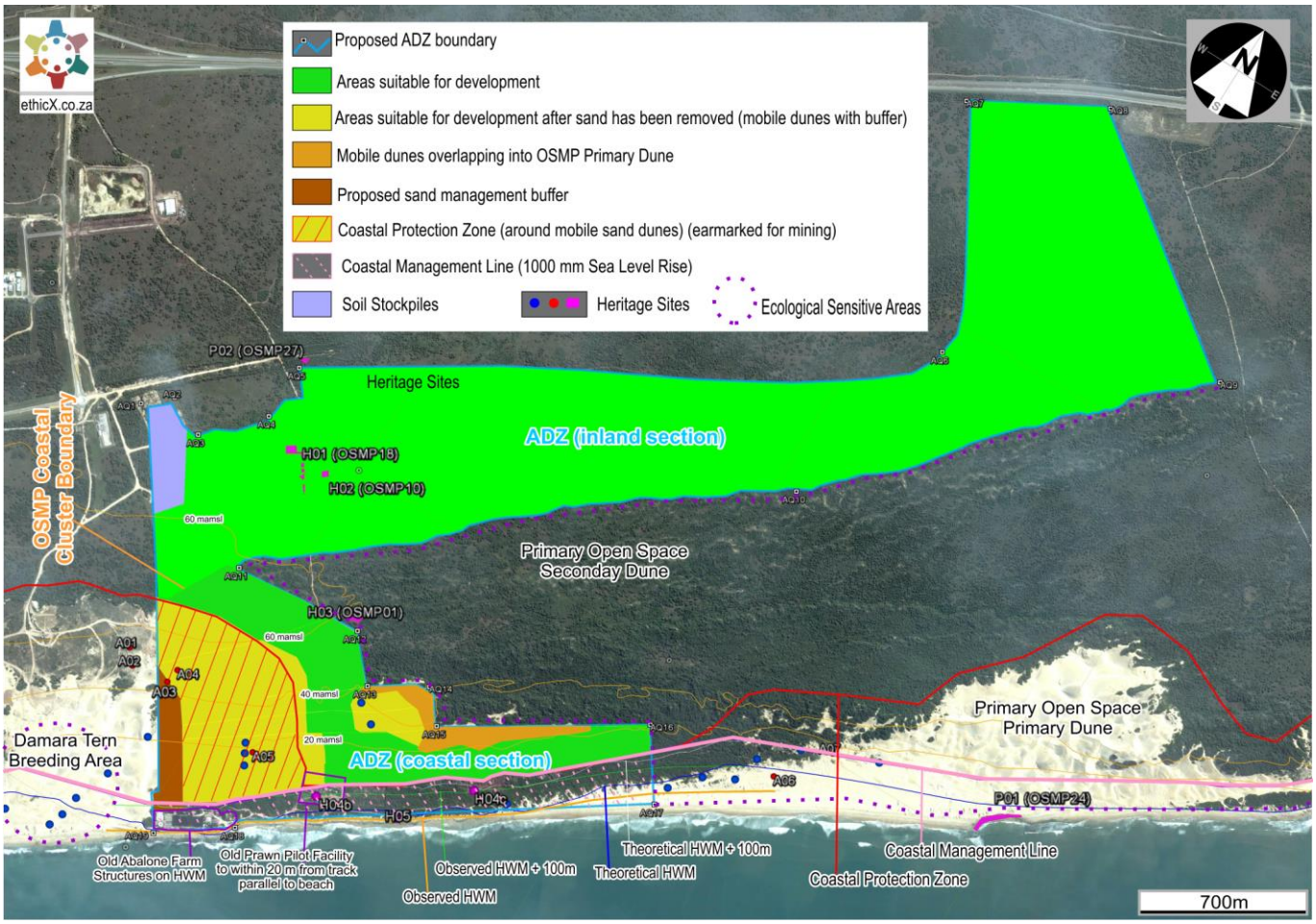

Figure 7-15: ADZ Site Suitability for Development

ADZ areas suitable for development

ADZ Coastal Section

< 20 mamsl = 20 ha (2 ha preliminary reserved for buffer around intact vegetation)

> 20 to 30 mamsl = 1.7 ha (0.2 ha preliminary reserved for buffer around intact vegetation)

> 30 mamsl = 30 ha (3 ha preliminary reserved for buffer around intact vegetation)

ADZ Inland Section

> 60 mamsl = 255 ha

(excludes land used for roads, storm water management, sand stockpiling, historical sites etc.)

Note: CDC to confirm the extent of PPC's mining right and to obtain approval from PPC to develop on areas where they have mining rights.

IDZ soil stockpile area

ADZ Area suitable for development once the site is no longer used for stockpiling.

> 60 mamsl = 5 ha

ADZ areas suitable for development once sand has been removed (outside coastal protection zone)
These areas consist of mobile dunes with a 50 m buffer zone, earmarked for mining.
Once the sand has been mined, development can take place on the relatively flat and stable calcrete base.
These areas would be suitable for development once sand has been removed.

ADZ Coastal Section
< 20 mamsl = 2 ha
> 20 to 30 mamsl = 7 ha
> 20 to 30 mamsl = 2 ha

ADZ areas suitable for development once sand has been removed, above the coastal management line (1000 mm sea level rise retreat) but below coastal protection zone
The coastal protection zone includes the mobile dune areas part of the littoral active zone. These dunes have been earmarked for sand mining and once the sand has been removed, the delineation of the littoral active zone could be altered.
These areas would be suitable for development once sand has been removed.

ADZ Coastal Section
< 20 mamsl = 18 ha
> 20 to 30 mamsl = 3 ha
> 30 mamsl = 22 ha

ADZ areas below the coastal management line

Key service infrastructure as listed in Section 7.21 will be located in this area.

Any other structures and infrastructure considered below the coastal management line need to be evaluated in terms of the criteria for development decision-making in areas potentially affected by sea level rise as recommended in Section 7.21.

The existing old abalone farm and part of the pilot prawn facility falls within this area. These are suitable for re-use but need to be evaluated in terms of the criteria for development decision-making in areas potentially affected by sea level rise as recommended in Section 7.21 and mitigation measures to be put in place where required to meet the criteria.

(30 ha)

Mobile dunes in ADZ that stretch into OSMP Primary Dune
This area consists of partially vegetated dunes that stretch into the OSMP Primary Dune area, and includes a buffer zone around the dunes. Mining and development in this area up to the boundary of the ADZ may therefore affect the stability of the dunes in the Primary Dune area. Development in this area is not recommended unless it can be demonstrated that OSMP requirements in terms of offsets for disturbance to the Primary Dune area can be met and that sand movement can be accommodated.

ADZ proposed sand management buffer
This area is not recommended for development. It is located immediately downwind (dominant wind direction) of the dunes around the Damara Tern habitat, and provides for a sand management buffer on the edge of the ADZ. Recommendations for sand management provided in Section 7.5.

Heritage Sites (Table 7-3)

Development of areas near heritage sites to take cognisance of the specific design criteria and mitigation measures applicable to specific sites, as listed in Section 7.20.

All Areas

All areas previously not mined may contain protected species, archaeological heritage sites and vegetation.Site clearance to take place as per the prescribed mitigation measures in the EMPr.

All excavations, even in previously mined areas, to take cognizance of paleontological mitigation measures.

7.12 Marine Environment

SPECIALIST STUDY UNDERTAKEN

Dr. Russell Charmers of Aquatic Ecosystem Services conducted as marine specialist assessment, which is attached as Appendix G4 (Chalmers, 2016). The results of his assessment are presented below.

CURRENT STATE OF THE ENVIRONMENT

Described in Section 6.9.

ASSESSMENT OF IMPACTS

7.12.1 Construction activities leading to increased erosion and sedimentation

Construction Phase

The activities leading to impacts of sedimentation and turbidity are generally limited to the construction phase. It is assumed that good industry practices will be maintained in line with established management specifications and procedures developed by the CDC. However, it is still highly likely that construction activities will result in some erosion and sediments being washed down with storm water, leading to increased turbidity and sedimentation in the short-term without mitigation. Sand movement in the nearshore marine environment is a natural phenomenon influenced by seasons, tides and storm events, and the nearshore biota is therefore tolerant and likely to be resilient to additional and localised input of sediments to the marine environment over the short-term. Non-mobile filter feeding benthic invertebrates will be most susceptible to smothering by sediments. Through appropriate mitigation and management on site this impact can be reduced to a minor impact.

Operational Phase

Storm water run-off from the ADZ may introduce pollutants and sediments to the nearshore marine environment. Any spillages of toxic substances within the ADZ may be washed into the storm water system during periods of heavy rainfall and may therefore enter the marine environment and lead to mortality of biota. Erosion of un-vegetated areas may also introduce sediments into the storm water system leading to increased turbidity and sedimentation in the nearshore which may smother non-mobile benthic invertebrates. This is likely to be short-term and localised.

MITIGATION MEASURES AND DESIGN CRITERIA

Specialist recommendations were incorporated into the Storm Water Management and Erosion Control section (Section 7.14).

7.12.2 Spillage of hydrocarbons and chemicals entering the nearshore

Construction

Construction activities may result in accidental spillages of hydrocarbons and potentially other material used during the construction phase. The impact of these spillages on marine biota is dependent on the types of hydrocarbons/chemicals spilt, method and volume of transmission to the marine environment, dispersion rates in the nearshore and the sensitivity of individual species. Hydrocarbons and other chemicals are toxic to marine fauna and may cause mortality should sufficient quantities enter the marine environment.

Operations

The operation of aquaculture projects will require the use of plant and equipment which require fuels as well as the use of other chemical and products for maintenance, cleaning and sterilisation of infrastructure. Any spillages of these substances could result in contamination of the nearshore marine environment and lead to impacts on the marine biota. Through appropriate management on site it is unlikely that this impact will occur, however it is possible that sporadic spills may occur.

MITIGATION MEASURES AND DESIGN CRITERIA

Specialist recommendations were incorporated into the Soil and Groundwater section (Section 7.16).

7.12.3 Suitability of Potential Aquaculture Species

The cultivation of both marine and freshwater species is being considered for the Coega ADZ. The actual selection of species would however be determined based on investor interest, expertise and capabilities. The impacts of the ADZ project on the marine environment will be strongly linked to the culture species selected by various investors which in turn dictates the culture technology to be employed and the mitigation measures required to ensure a biosecure culture environment. As the ADZ will have multiple aquaculture developers each with their own investment interests, it is likely that there will be a combination of species cultured within the ADZ, and a range of techniques will be used. Non-native and non-endemic species present a higher risk of impact to the marine environment due to the possibility of escapees establishing functional populations in the local marine environment. Escapees of indigenous species from different genetic populations to the local wild stocks also pose the risk of genetic pollution. Cultured species may introduce new diseases, pathogens and/or parasites to the resident marine biota which may be more susceptible to infection as they have had no prior exposure to these. Furthermore, the high density culture environment in aquaculture facilities increases the chances of disease outbreaks which may be transmitted to the marine environment through the discharge of effluent water or other vectors (e.g. sea birds) thereby placing the natural biota at increased risk of infection.

The CDC has developed a list of potential species in response to investor interest, what has been produced in the past, advice from researchers and specialists in the aquaculture sector, and previous lists produced by DAFF for the Eastern Cape. A high level assessment of the risk associated with these species, as determined by the marine specialist (Chalmers, 2016) is presented in Table 7-4.

Table 7-4: High Level Escapee and Disease and Pathogen Risk Assessment of the List of Potential Aquaculture Species

Potential marine species/group	Indigenous	Regional Endemic	Escapee risk	Disease and pathogens risk
Dusky kob *Argyrosomus japonicus*	Yes	Yes	No. All these species are indigenous to South African marine waters and occur within, or in close proximity to the study area. Risk of escapes on the wild populations does not pose a major risk (besides disease transfer) provided that the farm animals originate from the same genetic stock as local population. Strict adherence to relevant guidelines for wild brood stock collection must be followed to ensure they originate from the same genetic stock as adjacent wild populations.	**Yes.** High density aquaculture increases risk of disease outbreaks which may be transmitted to marine environment via effluent water, escapees or via other vectors (e.g. sea birds).
Yellowtail *Seriola lalandi*	Yes	Yes		
Natal Stumpnose *Rhabdosargus sarba*	Yes	Yes		
White Stumpnose *Rhabdosargus globiceps*	Yes	Yes		
Spotted Grunter *Pomadasys commersonnii*	Yes	Yes		
Rock Lobster (east and west coast)	Yes	Yes		
Abalone *Haliotis midae*	Yes	Yes		
Sea Urchin *Tripneustes gratilla*	Yes	Yes (extends from sub tropics to East London)		
Scallops *Pectin sulcicostatus*	Yes	Yes		
Sea Cucumber	Yes	No species provided, but unlikely to be endemic as they are typically small	Unknown as species information is unavailable.	

Potential marine species/group	Indigenous	Regional Endemic	Escapee risk	Disease and pathogens risk
		species.		
Salmon	**No**	**No.** Exempted from the AIS Regulations.	**Yes.** Escapees of non-indigenous species pose a risk to the marine environment and wild populations. However, the risk of salmon posing a significant risk is low as they are unlikely to survive long periods and would not be able to reproduce.	**Yes**. Introduction of new diseases or pathogens from non-native and non-endemic species to the local biota is a major risk to the marine ecology. Oyster spat and prawns are usually imported from hatcheries around the world increasing the risk of introduction of new diseases, pathogens and parasites.
Pacific Oysters	**No**	**No**	**Yes.** Although current farming activities in Algoa Bay utilise this species, no self-sustaining marine populations are known in South Africa (Anchor Environmental in Chalmers 2016). However, establishment of populations in estuaries has been reported (Keightley *et al*. 2015 in Chalmers 2016) and is therefore possible. This species was rejected for potential introduction during the DAFF Biodiversity Risk and Benefit Assessment (Anchor Environmental in Chalmers 2016).	
Prawns (all species)	No species provided.	No species provided.	**Yes.**	
Macro algae (feeds and pharmaceutical)	No species provided.	No species provided.	Uncertain	Yes, may harbour waterborne diseases and act as a transmission vector if released from the facility into the local marine environment.
Potential Freshwater Species/Group	**Indigenous**	**Regional Endemic**	**Escapee Risk**	**Disease and pathogen risk.**
Nile Tilapia *Oreochromis niloticus*	No	No. Listed as an prohibited AIS, Gazette 36683	No, although tolerant of higher salinities unlikely to establish itself in the marine environment. *O. niloticus* poses a significant risk to freshwater bodies. *O.mossambicus* may survive extended periods of elevated salinities in estuaries.	It is uncertain if diseases, pathogens and parasites from freshwater species will survive in the marine environment. It is assumed that they present a lower risk.
Nile Tilapia Niloticus GIFT strain	No	No		
Mozambique Tilapia *Oreochromis mossambicus*	Yes	No		
Sharptooth catfish *Clarias gariepinus*	Yes	No	No. Unable to survive for prolonged periods at salinities above 10 ppt (Britz and Hecht 1989 in Chalmers 2016).	
Vietnamese Catfish *Pangasius hypophthalmus*	No	No	No. Unable to survive for prolonged periods at salinities above 13 ppt (GAA, 2010 in Chalmers 2016).	
Rainbow Trout *Oncorhynchus mykiss*	No	No. Exempted from the AIS Regulations.	No. Although able to survive in marine waters it is unlikely that they will survive long periods, and they are unable to reproduce.	
Macro algae pharmaceutical	No species provided	No species provided	Uncertain.	

Source: Chalmers, 2016.

7.12.4 Marine Ecological Impacts

Impacts due to Escapees

Despite land-based aquaculture systems being more biosecure than cage aquaculture operations, there is still a risk of farmed organisms escaping into the adjacent marine environment. Escapees from aquaculture operations which are endemic to the region have the potential to breed with the wild population, and if they originate from a different genetic population they have the potential to cause genetic impacts on the wild stocks. The degree of genetic difference between the cultured and wild stocks will determine the significance of the potential impact. Hatchery operations also pose a threat as eggs and larvae may escape the facility in effluent water, and should they survive, they may mix and integrate with wild stocks.

Escapees from aquaculture facilities can also be a vector for transferring diseases, pathogens and parasites to wild populations. High density aquaculture operations exacerbate the risk as the risk of disease outbreak in the culture environment increases.

Non-native and endemic species may also establish breeding populations, and become invasive depending on their environmental tolerances and life history traits. Once established they may compete with wild stocks for food and space. Large species may also out-compete and predate on wild stocks placing them under additional pressure.

The degree of impact of escapees on the marine environment is highly dependent on the types of species cultivated, the cultivation methods utilised, and the system design which will influence the number and frequency of escapees into the adjacent marine environment. Several non-indigenous and freshwater fin-fish species are unlikely to survive extended periods in the nearshore marine environments (Table 7-4) and therefore pose less risk of establishing breeding populations and are unlikely to compete with wild stocks. However, the risk of transmitting diseases and pathogens to the ecosystem remains (discussed below).

Recirculating land-based aquaculture operations typically pose low risk for escapees entering the natural environment provided that facilities are designed appropriately and stringent management protocols are put in place and followed throughout the operational phase. The types of mitigation measures to be employed vary greatly depending on the nature and scale of the operation. It is therefore essential that an overarching biosecurity management plan for the ADZ is developed to which all individual operations must conform. In addition an overarching monitoring programme for the ADZ is to be put in place to assess compliance with permit conditions of effluent water quality standards, incoming water quality, biological monitoring of the adjacent nearshore areas as well as disease and fish health monitoring across individual operations. Individual operations must develop farm specific biosecurity management plans and disease and animal health management plans taking into account the design of the facility and the culture organisms.

Impacts due to the Transfer of Diseases, Pathogens and Parasites to Wild Stocks

The introduction of diseases, pathogens and parasites is a major threat to wild stocks. The use of non-native and non-endemic species in the aquaculture facilities increases the risk of introduction of new diseases, pathogens or parasites to wild populations to which they may be highly susceptible due to limited natural resistance. Aquaculture facilities increase the risk of disease outbreak as they amplify the pathogen levels due to the high stocking densities and poor water quality which may occur due to poor management practices. Transfer between individual operations may also occur particularly if infrastructure is shared or if stringent biosecurity protocols are not adhered to. Diseases, pathogens and parasites may be transferred to adjacent receiving waters through effluent discharges, escapees of cultured organisms, poor biosecurity management practices and external vectors (e.g. birds).

Mitigation measures for the prevention of disease, pathogen and parasite transfer include the development of ADZ level biosecurity management plan and disease and animal health management plan as well as farm level biosecurity management plans and disease and animal health management plans. These plans need to be

developed taking into consideration the culture species and types of aquaculture operations to be developed and they need to be stringently enforced to reduce the risk of transfer to wild stocks.

MITIGATION MEASURES AND DESIGN CRITERIA

Mitigation measures for managing ecological impacts due to escapees and disease, pathogen and parasite transfer include the development of ADZ level biosecurity management plan and disease and animal health management plans as well as farm level biosecurity management plans and disease and animal health management plans. These plans need to take into consideration the culture species and types of aquaculture operations to be developed and they need to be stringently enforced. Information on mitigation measures for different types of aquaculture facilities can be found in the biosecurity risk section (Section 7.13), but those measures applicable to the management of the impacts of escapees, and disease, pathogen and parasite transfer include:

- *Develop and implement a biosecurity management plan and disease and animal health management plan for the ADZ which covers all aquaculture operations within the ADZ.*
- *Develop a comprehensive monitoring programme for the ADZ to include water quality in incoming water sources and effluent discharges, sediment physical and chemical characteristics, biological monitoring at the intake and discharge points (benthic invertebrates, phytoplankton etc.), assessment of exotic and invasive species in adjacent water, health monitoring and monitoring the compliance of individual farms with disease and fish health standards in accordance with the ADZ biosecurity management plan and disease and animal health management plan. The monitoring programme must incorporate both baseline assessments prior to impact, reference points outside of the local area of impact, action thresholds and performance assessment criteria.*
- *Individual aquaculture farms must comply with the Alien and Invasive Species (AIS) Regulations (GNR 598, GG 37885), which may include an operation specific risk assessment and approval by the relevant authorities prior to commencement of any operations. No species on the Prohibited Species List should be considered for culture in the ADZ.*
- *Individual investors to develop and implement a biosecurity management plan and disease and animal health management plan for their operations in the ADZ.*
- *All organisms obtained from other hatcheries or imported to be sourced only from certified disease, pathogen and parasite free sources.*
- *In order to minimise negative genetic impacts, broodstock and grow-out organisms should originate from the same genetic stock as the wild populations adjacent to the facility. The respective national Genetic Best Management Practice Guidelines for collection and husbandry of the culture species and the DAFF permit conditions for broodstock collection and facility operation should be followed at all times (e.g. Genetic Best Management Practice Guidelines for Marine Finfish Hatcheries in South Africa, 2016). This includes adherence to movement restrictions of specimens between disease and genetic management zones.*
- *Culture facilities must be designed to have multiple redundancy exclusion barriers or screens fine enough to contain the live stages of the organisms being cultured (eggs, larvae, juveniles etc.).*
- *Incoming water must be treated and sterilised to prevent the amplification of naturally occurring diseases and pathogens.*
- *Exclusion barriers to be maintained through a farm specific standard operating procedure and in accordance with the ADZ biosecurity management plan.*
- *Consider sterilisation of fish through hybridisation or single sex production to provide genetic security from invasive species.*
- *Effluent water from hatcheries and grow-out facilities should be treated to prevent escapees and the transfer of pathogens and diseases into the nearshore marine environment. The type of treatment is dependent on the culture organisms, culture methods, discharge volumes and biosecurity risk and need*

to be developed on an individual basis per aquaculture operation. Possible methods include sand filtration, ozonation or UV filtration but will be farm specific based on the culture species, design (flow through/re-circulating), water volumes and flow rates and must be determined in each farm level biosecurity management plan. Where there is a risk, and depending on the species, effluent water to be filtered and sterilised prior to discharge to prevent the escape of eggs, larvae and juveniles.

- *Effluent water from individual operations to comply with effluent discharge and water quality standards as per CDC coastal wasters discharge permit before release to the marine pipeline.*
- *Individual operations to develop farm specific monitoring programmes, including water quality, disease and fish health monitoring, pathogens in the facility, escapee trap performance, and incorporate action thresholds and performance assessment criteria.*
- *Brood stock of indigenous species must be obtained from the same disease and genetic management zone in which the study area is situated.*
- *Ongoing monitoring of escapee management control measures on individual farms and at the ADZ level to monitor compliance and performance of the management measures is required.*
- *Open, non-enclosed farms must have effective physical barriers to exclude birds and other wildlife in order to prevent potential disease transfer vectors from accessing holding tanks and waste water sources. Non-lethal bird netting and screens may be used to ensure isolation of individual operations from each and prevent transmission vectors from accessing water sources.*
- *Quarantine and disease treatment tanks must be effectively isolated for other production sections of the facility and stringent sterilisation of the effluent water must be undertaken. Staff accessing these areas must comply with the biosecurity standards.*
- *All organisms introduced to the facility should be isolated in a quarantine system for a period of six weeks and subject to regular health inspections to monitor for disease.*
- *The effluent discharge point has yet to be determined as part of a separate EIA but should be sited as far as possible from the intake location to reduce the risk of re-introduction of pathogens.*

7.12.5 Interim abstraction and effluent discharge

Water abstraction and effluent discharge for the ADZ are planned to be via the CDC marine abstraction and discharge pipelines, the impacts of which are being assessed in a separate EIA. The timeframe for the authorisation and construction of the CDC pipelines is not known but it is possible that aquaculture investors may wish to begin development and operation within the ADZ prior to the completion of the CDC marine abstraction and discharge pipelines.

In order to accommodate the smaller investors, the existing seawater abstraction infrastructure which was developed previously by the Marine Growers and SeaArk aquaculture projects, may be utilised. It is not possible to assess this impact with confidence. This impact will therefore not form part of this assessment and being undertaken as a component of the CDC marine pipeline servitude EIA. Please refer to this study for further details.

7.12.6 Abstraction of seawater for the ADZ

This impact does not form part of this assessment and being undertaken as a component of the CDC Marine pipeline servitude EIA. Please refer to this study for further details.

7.12.7 Discharge of ADZ effluent waters

This impact does not form part of this assessment and being undertaken as a component of the CDC Marine pipeline servitude EIA. Please refer to this study for further details.

RATING OF IMPACTS

Detailed ratings of the impacts in terms of intensity, duration, extent, consequence, probability, frequency and significance were completed as part of the specialist study (Appendix G4, Chalmers, 2016b). A summary is provided below.

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Construction activities leading to increased erosion and sedimentation*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Spillage of hydrocarbons and chemicals during construction*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Construction below the HWM*				
Overall Significance of Impacts	N/A	Negative Medium	Negative Medium	Negative Medium	None to Unknown
Note	Low assessment confidence: Insufficient information. Measures to address low assessment confidence: Separate EIA for the CDC Marine Pipeline Servitude EIA.				

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Chemical pollutants entering the nearshore*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Storm water runoff*				
Overall Significance of Impacts	N/A	Negative Very Low	Negative Very Low	Negative Very Low	None to Unknown
Nature of the Impact	*Ecological impacts due to escapees*				
Overall Significance of Impacts	N/A	Negative Very High	Negative Medium	Negative Medium	None to Unknown
Note	Low assessment confidence: No technologies have been decided on, and could therefore not be assessed in detail. The impacts of the ADZ project on the marine environment will be strongly linked to the culture species selected by various investors which in turn dictates the culture technology to be employed and the mitigation measures required to ensure a biosecure culture environment. Measures to address low assessment confidence: – Each aquaculture project will require individual permits from DAFF and/or DEA which will have certain conditions based on the culture species and farm design. – Development of ADZ and farm level biosecurity management plans and disease and animal health management plans. – Individual aquaculture farms to comply with the Alien and Invasive Species (AIS) Regulations (GNR 598, GG 37885). No species on the invasive species list to be cultured on any farm in the ADZ without the operation conducting a risk assessment specific to the operation and species and receiving approval from the relevant authorities.				
Nature of the Impact	*Transfer of diseases, pathogens and parasites to wild stocks*				
Overall Significance of Impacts	None	Negative Very High	Negative Medium	Negative Medium	None
Note	Low assessment confidence: No technologies have been decided on, and could therefore not be assessed in detail. The impacts of the ADZ project on the marine environment will be strongly linked to the culture species selected by various investors which in turn dictates the culture technology to be employed and the mitigation measures required to ensure a biosecure culture environment.				

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
	Measures to address low assessment confidence: – Each aquaculture project will require individual permits from DAFF and/or DEA which will have certain conditions based on the culture species and farm design. – Development of ADZ and farm level biosecurity management plans and disease and animal health management plans.				
Nature of the Impact	*Interim abstraction and effluent discharge*				
Overall Significance of Impacts	N/A	Negative Medium	Negative Medium	Negative Medium	None to Unknown
Nature of the Impact	*Abstraction of seawater for the ADZ*				
Overall Significance of Impacts	Assessed in Separate EIA for the CDC Marine Pipeline Servitude EIA				
Nature of the Impact	*Discharge of ADZ effluent waters*				
Overall Significance of Impacts	Assessed in Separate EIA for the CDC Marine Pipeline Servitude EIA				

ASSESSMENT OF RISKS

Ecological impacts due to escapees

The ADZ and each individual operation will need to develop a biosecurity management plan which provides mitigation measures to reduce the likelihood of escape occurring. However, these plans will need to be implemented successfully to ensure the impact does not occur, should it occur it may be permanent depending on the species and whether or not it can establish itself. This is why action thresholds and performance assessment criteria that identify potential red flags before they occur are an essential component of each plan. If species become permanently introduced into the marine environment the impact is irreversible as it is unlikely that they can be removed.

Impacts can be partially mitigated. Implementation of all biosecurity management plans will be subject to human error (over flows etc.) and infrastructure failure (problems with filters and sterilizers) on an ongoing basis. Despite land based aquaculture being considered biosecure if all mitigation and biosecurity measures are followed, it is still possible that escapes will occur due to these and other factors. The overall significance of the impact is strongly dependent on the species concerned. Mitigation will be the responsibility of the ADZ and individual farms.

The potential for permanent irreversible impacts are dependent on the species involved, indigenous and endemic species pose far less risk of permanent impacts should they escape than exotic or potentially invasive species.

Genetic impacts are a major concern and should cultured organisms from a different genetic stock inter-breed, it could lead to long term impacts on the population. In addition escapees may transfer new diseases or parasites to wild stocks to which they have no natural resistance.

Transfer of diseases, pathogens and parasites to wild stocks

A stringent biosecurity management plan and disease and animal health management plan for the ADZ must be developed and enforced. Individual operations must also develop their own biosecurity management plans and disease and animal health management plans. It is critical that these are adhered to at all times as a temporary lapse in control can result in disease or parasite transmission to wild stock which will be irreversible.

Mitigation is based on implementation of stringent biosecurity protocols and disease management, as well as sterilisation of effluent water. Failure to implement the protocols or infrastructure failure (pumps, filters and sterilizers) on an ongoing basis for the duration of the project may lead to disease and parasite transfer to wild stocks which will be irreversible.

The degree to which transfer of diseases or parasites to wild stock will affect the population in the long-term is unknown.

GAPS AND LIMITATIONS

Aquaculture Species and Technology Alternatives

The impacts of the ADZ project on the marine environment will be strongly linked to the culture species selected by various investors which in turn dictates the culture technology to be employed and the mitigation measures required to ensure a biosecure culture environment. As the ADZ will have multiple aquaculture developers each with their own investment interests it is likely that there will be a combination of species cultured within the ADZ, and a range of technologies will be used. No technologies have been decided on, and could therefore not be assessed in detail. However, Chalmers (2016) concluded that from a marine ecology perspective, technology alternatives will have very limited influence on the severity of impacts, since many of the impacts are associated with system failure and human error, which are ubiquitous to all technologies. Each aquaculture project will require individual permits from DAFF which will have certain conditions based on the culture species and farm design. The development of ADZ and farm level biosecurity management plans and disease and animal health management plans is critical. Successful implementation and compliance to these plans must be ensured if the impact is not to become permanent. ADZ and individual operations must take on the responsibility for this.

Marine Pipelines and Infrastructure Linking to the Pipelines (infrastructure below the HWM)

The impacts of the marine abstraction and release pipelines are addressed in a separate EIA. Impacts of infrastructure below the HWM linking to these pipelines also form part of the scope of the separate EIA.

The impacts of an interim abstraction and release pipeline were assessed at a high level but due to lack of information, the assessment confidence was rated as low – these impacts will also be assessed separately in the separate EIA for the marine pipeline servitude.

CUMULATIVE IMPACTS

Cumulative impacts of the seawater abstraction and discharge by multiple industries on the marine environment are assessed as part of the separate EIA process.

Impacts from land-based activities such as erosion, sedimentation, chemical spills and contamination of storm water flowing into the marine environment were rated as very low with mitigation measures in place. The overall contribution to cumulative impacts of these impacts is therefore seen as insignificant.

NO-GO DEVELOPMENT

The no-go alternative would obviously result in zero negative impacts in terms of aquaculture related impacts described in the previous section, particularly those related to the risk of escapees, and transfer of diseases, pathogens and parasites to wild stocks.

However, this means that the area could be used for alternative industrial land-uses in the future. In the absence of any information on these possible future industrial developments, the unique impacts of those potential industries on the marine environmental are unknown.

CONCLUSIONS

From a marine ecology perspective, it is possible that the impacts can be managed to an acceptable level through stringent implementation of the mitigation measures. Development of biosecurity management plans and disease and animal health management plans will be critical in this aspect and compliance must be ensured through an appropriate monitoring programme. Farm specific plans have to be developed taking into account the culture, technology and species to be used. The site and proposed activity is deemed to be suitable only if mitigation, management and monitoring measures in both the marine ecological specialist report and the biosecurity and biodiversity risk assessment are adhered to in full. These measures have been incorporated into the EIA report.

This assessment has been undertaken at a strategic level for the ADZ as no project specific information is available at this stage. Based on this information the construction phase of the project will result in impacts of very low significance on the marine environment with implementation of appropriate mitigation measures. Infrastructure below the HWM linking to these pipelines also forms part of the scope of the separate EIA.

During the operational phase of the ADZ, impacts from storm water runoff and chemical or hazardous substances entering the marine environment are considered to be of very low significance and mitigation measures can be implemented to ensure that minimal disturbance occurs to the marine environment.

Impacts arising from the escape of culture organisms into the marine environment and transfer of diseases, pathogens and parasites are considered to be of very high significance but through appropriate and ongoing mitigation, management and monitoring through the implementation of biosecurity management plans and disease and animal health management plans this significance can be reduced to medium. Contingency plans are also required to deal with any infrastructure failure which may allow culture organisms to escape more readily or allow the transfer of unsterilized effluent to the marine environment. Mitigation of these impacts requires ongoing human intervention throughout the life of project and any escapees or transfer of diseases, pathogens or parasites could result in permanent impacts to the wild stocks.

Impacts associated with water abstraction and discharge of effluent have not been assessed as part of this EIA and are being assessed in the CDC marine pipeline servitude EIA as the CDC wishes will develop common abstraction and discharge pipeline servitudes which will service industries in the IDZ.

Both these activities potentially pose important threats to the marine ecology of the project area if they are not designed and managed with due consideration of the important habitats and ecological processes that occur in the project area and greater Algoa Bay area.

The proposed project location is situated adjacent to a marine ecosystem rich in biodiversity, and considered a biodiversity hotspot. Due to its ecological importance the marine environment has been subject to numerous biological and conservation assessments leading to the desired formal inclusion of a large section of the marine environment in Algoa Bay (and adjacent to the project site) into the Addo Elephant National Park by SANParks.

A Notice of intention to declare the Addo Elephant MPA was Gazetted on 3 February 2016. The proposed Addo Elephant Marine Protected Area encompasses waters supporting important habitats for resident long-lived reef species as well as nursery areas in which dense aggregations of dusky kob (*Argyrosomus japonicus*), a depleted linefish species, occur.

The ADZ must be managed in a manner that minimises the risk of any impacts which may affect the linefish stocks and the other marine biodiversity from occurring throughout the life of project. Establishment of populations of invasive species as a result of escapees from the aquaculture facilities and the transfer of new and foreign diseases to wild populations may be irreversible. The potential introduction of non-indigenous and non-endemic species to Algoa Bay as a result of escapees from the ADZ, as well as the potential transmission of diseases, pathogens and parasites to wild stocks presents a risk to Addo Elephant MPA achieving its objectives of protecting spawning stocks and contributing to stock recovery.

7.13 Biosecurity and Biodiversity Risk Assessment

INTRODUCTION

Aquatic animal diseases cost the agricultural sector, including the aquaculture sub-sector millions of dollars each year worldwide. In response, stakeholders in aquaculture, from the individual farmer to policy-makers, are promoting and implementing biosecurity programmes to combat the diseases responsible for these losses and to protect the environment in which they operate.

Biosecurity may be defined as all measures which protect the health of cultured species as well as that of the surrounding environment and therefore refers to management systems designed to protect the environment against potentially harmful organisms and biological materials. In an agricultural context, the term has come to represent the protection of valued biological resources from foreign, harmful or invasive organisms. Biodiversity in the context of this report refers to potential negative effects of farmed organisms on wild populations found in the surrounding environment through disease transfer and genetic contamination. Biosecurity risk assessments focus on preventing the infection of wild stocks from diseases and parasites, chemical toxicities and production diseases. Production diseases arise from detrimental effects of the production system or husbandry practices.

SPECIALIST STUDY

A specialist biosecurity and biodiversity risk assessment was undertaken by Guy Paulet, Aquatic Ecosystem Services, which is attached as Appendix G5 (Paulet, 2016). The risk assessment identified potential biosecurity and biodiversity risks which may result from the planned aquaculture practices relevant to species assessed in this study using a standard risk assessment methodology. As far as possible, these risks include those arising from outside the ADZ, those arising within the ADZ, and those arising within individual aquaculture operations. The large scale of the proposed ADZ necessitates strictly controlled biosecurity measures in order to reduce the chance of contamination between farms and between the ADZ and the receiving environment. Finally, recommendations in respect of mitigation measures have been suggested for identified risks and alternatives suggested where possible. The study provided a broad assessment of potential aquaculture operations within the ADZ and should be considered in that light. Every aquaculture operation is different and will present a unique set of biosecurity and biodiversity challenges. Due to the strategic level at which the risk assessment has been undertaken each future aquaculture project will need to consider and address these at a farm, ADZ and industry level. This assessment is therefore the first step in risk identification, mitigation and management at a strategic level, and further studies, as outlined below, will be required once potential investors have identified candidate species and culture methods.

SUITABILITY OF POTENTIAL AQUACULTURE SPECIES

While it is outside of the scope of this document to determine feasibility of a particular species, those that are highly unlikely to be chosen by investors have been omitted from the biosecurity assessment. Highly unlikely species are categorised as Poor in the table below. It will ultimately be the responsibility of each investor to demonstrate the feasibility of a species in relation to the culture methods to be used and to undertake specific biosecurity and biodiversity assessment as required.

Table 7-5: High Level Biosecurity and Biodiversity Suitability Assessment of the List of Potential Species

Species	Candidate (Good/OK/Poor)	Comment	Relevant Risk Assessment
Fresh Water Species			
African catfish / Sharptooth catfish *(Clarias gariepinus)*	**Poor**	Indigenous but not endemic to the catchment. Economic feasibility needs to be determined.	RAS
Goldfish *(Carasius auratus)*	**OK**	Exotic.	RAS
Ornamental fish	**Good**	Excludes fish prohibited in terms of the Alien and Invasive Species Regulations (GNR 598, GG 37885, Biodiversity Act, 10 of 2004).	RAS
Rainbow and brown trout *(Oncorhynchus mykiss and Salmo trutta)*	**Poor**	Exotic, invasive species.	RAS
Largemouth bass *(Micropterus salmoides)*	**Poor**	Exotic, invasive species.	RAS and PC
Chinese grass carp *(Ctenopharyngodon idella)*	**Poor**	Exotic, invasive species.	PC
Koi carp *(Cyprinus carpio)*	**OK**	Exotic, but more economically feasible.	RAS and PC
Marron *(Cherax tenuimanus)*	**Poor**	Exotic, invasive species.	PC

Species	Candidate (Good/OK/Poor)	Comment	Relevant Risk Assessment
Tilapia *(O. mossambicus)*	**OK**	Endemic.	RAS and PC
Tilapia *(O.niloticus)*	**Poor**	Exotic, invasive species. Potential for hybridisation with other species of *Oreochromis*. Should not be considered.	RAS and PC
Carp *(Cyprinus carpio)*	**Poor**	Exotic, invasive species. Economic feasibility needs to be determined.	PC
Rainbow Trout *(Oncorhynchus mykiss)*	**Poor**	Exotic.	RAS
Aquaponics	**OK**	Uncertain of species.	RAS
Macro algae (pharmaceutical)	**OK**	Uncertain of species.	RAS
Marine Species			
Abalone *(Haliotis midae)*	**Good**	Endemic.	FTS
Dusky Kob *(Argyrosomus japonicas)*	**OK**	Endemic. Economic feasibility needs to be determined.	RAS
Seaweed *(Ulva and Gracilaria spp.)*	**Good**	Endemic. Not for abalone feed if grown in waste water due to biosecurity risk.	RAS and FTS
Pacific oyster *(Crassostrea gigas)*	**Good**	Exotic species, but extensively cultured in Algoa Bay, established wild populations only known in estuaries in South Africa.	FTS
Sea urchin *(Tripneustes gratilla)*	**OK**	Endemic.	RAS
Yellowtail *(Seriola lalandi)*	**OK**	Endemic.	RAS
Silver Kob *(Argyrosomus inodorus)*	**Poor**	Endemic.	RAS
Mediterranean mussel *(Mytilus galloprovincialis)*	**Poor**	Alien invasive species.	Excluded from assessment
Prawn *(Penaeus monodon)*	**Poor**	Indigenous. Potential for transfer of diseases depending on origin of stock.	RAS
Prawn (all other species)	**Poor**	Exotic. Potential for disease transfer and escapees.	RAS
Salmon species (Atlantic)	**OK**	Exotic, but unlikely to survive extended periods in marine environment and unable to breed.	RAS
Natal Stumpnose *(Rhabdosargus sarba)*	**OK**	Endemic.	RAS
White Stumpnose *(Rhabdosargus globiceps)*	**OK**	Endemic.	RAS
Rock Lobster *(east and west coast)*	**Poor / OK**	Endemic.	RAS
Spotted Grunter *(Pomadasys commersonni)*	**Ok**	Endemic.	RAS
Sea Cucumber *(indigenous species)*	**OK**	Endemic.	RAS
Scallops *(Pectin sulcicostatus)*	**Ok**	Endemic.	RAS
Macro algae (feeds and pharmaceutical)	**Poor / Ok**	Very High biosecurity risk as fresh food for abalone grown in waste water. Pharmaceutical and other uses has potential.	FTS
Sea-reared Rainbow Trout / Salmon	**OK**	Exotic, but unlikely to survive extended periods in marine environment and unable to breed.	RAS

RAS: Recirculating Aquaculture System; PC: Pond Culture Systems; FTS: Flow-Through System.

Potential species listed above have been grouped according to the most appropriate culture method in order to undertake a generic biosecurity risk assessment per culture method since the culture species is investor dependent and there is considerable overlap in mitigation strategies between species for any given culture

method. Where relevant, specific mitigation measures for a particular species or group are provided. The assessment does not discount additional species that may be considered in the future as the assessment is broad enough to cover biosecurity and biodiversity risks for each culture method.

AQUACULTURE SYSTEMS ASSESSED

Recirculating Aquaculture Systems (RAS)

This sophisticated technology involves filtering and re-using water to ensure the system requires less than 10% water replacement per day. Recirculating systems are used to grow aquatic products under limited water exchange conditions, where water filtration techniques are used to maintain water chemistry and flow conditions that are optimal for a particular product's growth requirements. Under recirculating rearing conditions, the aquatic product is grown at high density with strict management control over the water quality and flow through, careful management of filtration and sterilisation. The volume of water lost to the system is minimised, thereby ensuring a low requirement for water input into the system when compared with other aquaculture systems.

Species typically selected for growth in recirculating systems are usually high value in order to compensate for the high capital and running outlay (e.g. Dusky kob, yellowtail and possible sea-run trout and salmon). Seaweed culture in South Africa is focussed almost entirely on production of food for Abalone (Bolton et al, 2006, in Paulet, 2106). The green seaweed, Ulva, is one of the most important species and is also utilized as a bioremediation tool and has other benefits such as biomass for biofuel production. Gracilaria species are also cultivated (Amosu et al., 2013, in Paulet, 2106). Ornamental fish are cultured in recirculating systems due to their requirement for varied and specific environmental conditions.

Because the systems are closed to the environment, strict biosecurity controls are possible and treating disease is easier than in other aquaculture system types. It is possible to exclude most disease agents from entry into these systems through system design and management. Recirculating systems can theoretically be developed to be completely bio-secure but biosecurity can only be ensured if all the protocols are strictly adhered to and rigorously enforced throughout the life of project. Major biosecurity risks associated with recirculating systems include the potential for rapid spread of disease due to relatively high stocking densities and difficulty in treating diseases when they occur due to the sensitivity of the biological filtration systems. As such, good husbandry techniques are very important.

Flow-through systems (FTS)

Flow-through systems are used for Abalone farming in South Africa and for various freshwater species in places where freshwater is abundant. A continuous flow of water passes though tanks or raceways without recirculation i.e. single pass usage of water. The risk of on-farm disease outbreaks is lower than for recirculating systems as the tanks can be isolated from each other but due to the very high flow of water and open nature of the system, there is a possible biosecurity risk to the receiving environment. This risk is often low as the pathogen concentrations are diluted in a large volume of water and most often the disease originated from abstracted water which is usually the same as the receiving environment.

The use of flow through systems for seaweed culture using effluent water from abalone farms is currently conducted in South Africa and can have a beneficial effect on effluent water quality due to reduced nutrient levels. However, this method of producing seaweed for abalone feed is considered to present a high biosecurity risk to the cultured abalone due to disease cycling (Mouton, 2010 in Paulet, 2016). Cultivation of seaweed in Abalone effluent water was therefore not assessed or recommended by Paulet (2016) in the specialist risk assessment. These risks need to be assessed and addressed in the biosecurity management plans developed for individual aquaculture operations. Nevertheless, the use of flow-through systems for the independent production of seaweed for other uses is covered in this report.

Extensive or Semi-Extensive Freshwater Pond Culture (PC)

Freshwater pond culture is an extensive or semi-extensive aquaculture method used for some freshwater species as well as Dusky kob (marine) aquaculture in warmer environments. This system is the least capital intensive but carries additional biosecurity risk for the operator and environment related to the fact that it is often not possible to see the animals in the ponds and early warning signs of disease can be missed. In addition, organic waste build up in the pond substrate can interfere with therapeutant efficacy. Static ponds require a lot of water due their size and because they need to be flushed from time to time to reduce algal blooms and poor water quality.

ASSESSMENT OF RISKS

Due to the strategic nature of this study (culture species not known list of potential species varied) the risk assessment has been categorised and undertaken according to the three types of aquaculture systems most likely to be proposed by investors for establishment in the ADZ, namely:

- Recirculating Aquaculture Systems (RAS)
- Flow-through systems (FTS)
- Open pond culture systems (PC)

Each system has differing levels of biosecurity and biodiversity risks which are broadly pertinent to the culture species to be produced; however, risks may differ between species, particularly for non-indigenous and invasive species. A risk assessment has been undertaken for each aquaculture rearing system in terms of the following risks:

- Disease Management
  - Influent water supply as a disease vector
  - Introduction of disease agent through new broodstock or juveniles entering the facility
  - Contaminated feed as a potential disease vector
  - Disease transmission between aquaculture operations within the ADZ
  - Wastewater / storm water / system flooding as a potential disease vector
  - Undetected spread of disease agents/ deterioration of animal health
  - Spread of disease agent within the facility
  - Seabirds and other animals as a vector for disease
- Biodiversity and Genetics
  - Disease and parasite transfer to wild populations via effluent water
  - Transfer of disease and parasites to native species through escaped fish
  - Genetic pollution of the local stocks through escapees
  - Introduction of invasive non-native species through escapees
- Fish Health Management
  - Poor husbandry practices leading to disease/parasite outbreak
- Bio-Active Compounds
  - Drug and therapeutant treatment risk to the environment

The risk assessment pertains to the operational phase of the project as there are no construction related impacts or risks which need to be assessed. The full assessment is available in Appendix G5 (Paulet, 2016) and a summary of the results is presented below.

Summary of Impact Rating Scores for Recirculating Systems (RAS)

Category	Identified Risk	With or Without Mitigation	Intensity	Duration	Extent	Consequence	Probability	Frequency	Impact Status	Significance
DISEASE MANAGEMENT	*Influent water supply as a disease vector*	Unmitigated	Major	Long	Site	High	Highly likely	Regular	Negative	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Introduction of disease agent through new broodstock or juveniles	Unmitigated	Major	Long	Region	High	Highly likely	Regular	Negative	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Low
	Contaminated feed as a potential disease vector	Unmitigated	Moderat	Long	Site	Medium	Possible	Sporadic	Negative	Very low
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Disease transmission between operations within the ADZ	Unmitigated	Extreme	Long	Site	High	Highly likely	Occasion	Negative	Medium
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Wastewater/storm water / system flooding as a potential disease vector	Unmitigated	Major	Long	Site	High	Highly likely	Regular	Negative	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Undetected spread of disease agents/ deterioration of animal health	Unmitigated	Major	Long	Site	High	Highly likely	Regular	Negative	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Spread of disease agent within the facility	Unmitigated	Extreme	Long	Site	High	Highly likely	Occasion	Negative	Medium
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Seabirds and other animals as a vector for disease	Unmitigated	Major	Long	Region	High	Highly likely	Regular	Negative	High
		Mitigated	Minor	Long	Region	Medium	Highly unlikely	Sporadic	Negative	Very low
BIODIVERSITY AND GENETICS	*Disease and parasite transfer to wild populations via effluent water*	Unmitigated	Major	Permanent	Region	Very high	Highly likely	Regular	Negative	Very high
		Mitigated	Minor	Permanent	Region	Medium	Highly unlikely	Sporadic	Negative	Very low
	Transfer of disease and parasites to native species through escaped fish	Unmitigated	Major	Permanent	Region	Very high	Highly likely	Regular	Negative	Very high
		Mitigated	Eliminate	Permanent	Region	None	Eliminated	Sporadic	None	None
	Genetic pollution of the local stocks through escapees	Unmitigated	Major	Permanent	Region	Very high	Highly likely	Regular	Negative	Very high
		Mitigated	Eliminate	Permanent	Region	None	Highly unlikely	Sporadic	None	None
	Introduction of invasive non-native species through escapees	Unmitigated	Extreme	Permanent	Nation	Very high	Certain	Regular	Negative	Very high
		Mitigated	Minor	Permanent	Nation	None	Highly unlikely	Sporadic	None	None
FISH HEALTH MANAGEMENT	*Poor husbandry practices leading to disease/parasite outbreak*	Unmitigated	Extreme	Long	Local	High	Certain	Regular	Negative	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low
BIO-ACTIVE COMPOUNDS	*Drug and therapeutant treatment risk to the environment*	Unmitigated	Major	Long	Local	High	Highly likely	Sporadic	Negative	Low
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low

Summary of Impact Rating Scores for Flow-Through Systems (FTS)

Category	Identified Risk	With or Without Mitigation	Intensity	Duration	Extent	Consequence	Probability	Frequency	Impact Status	Significance
DISEASE MANAGEMENT	*Influent water supply as a disease vector*	Unmitigated	Major	Long	Site	High	Highly Likely	Regular	Negative	High
		Mitigated	Moderate	Long	Site	Medium	Highly unlikely	Occasional	Negative	Very low
	Introduction of disease agent through new broodstock or juveniles	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negative	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low
	Contaminated feed as a potential disease vector	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negative	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low
	Disease transmission between operations within the ADZ	Unmitigated	Major	Long	Site	High	Highly Likely	Regular	Negative	High
		Mitigated	Moderate	Long	Site	Medium	Possible	Sporadic	Negative	Very low
	Wastewater/storm water / system flooding as a potential disease vector	Unmitigated	Major	Long	Local	High	Highly Likely	Occasional	Negative	Medium
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low
	Undetected spread of disease agents/ deterioration of animal health	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negative	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low
	Spread of disease agent within the facility	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negative	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negative	Very low
	Seabirds and other animals as a vector for disease	Unmitigated	Major	Long	Region	High	Highly Likely	Regular	Negative	High
		Mitigated	Minor	Long	Region	Medium	Highly unlikely	Sporadic	Negative	Very low
BIODIVERSITY AND GENETICS	*Disease and parasite transfer to wild populations via effluent water*	Unmitigated	Major	Permanent	Regional	Very high	Highly Likely	Regular	Negative	Very high
		Mitigated	Moderate	Permanent	Regional	High	Highly unlikely	Sporadic	Negative	Low
	Transfer of disease and parasites to native species through escaped fish	Unmitigated	Moderate	Permanent	Regional	High	Highly Likely	Regular	Negative	Medium
		Mitigated	Minor	Permanent	Regional	Medium	Possible	Sporadic	Negative	Very low
	Genetic pollution of the local stocks through escapees	Unmitigated	Major	Permanent	Regional	Very high	Highly Likely	Regular	Negative	Very high
		Mitigated	Minor	Permanent	Regional	Medium	Highly unlikely	Sporadic	Negative	Very low
	Introduction of invasive non-native species through escapees	Unmitigated	Moderate	Permanent	National	High	Possible	Regular	Negative	Medium
		Mitigated	Minor	Permanent	National	Medium	Highly unlikely	Sporadic	Negative	Very low
FISH HEALTH MANAGEMENT	*Poor husbandry practices leading to disease/parasite outbreak*	Unmitigated	Extreme	Long	Local	High	Certain	Regular	Negative	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low
BIO-ACTIVE COMPOUNDS	*Drug and therapeutant treatment risk to the environment*	Unmitigated	Major	Long	Local	High	Highly likely	Sporadic	Negative	Low
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negative	Very low

Summary of Impact Rating Scores for Freshwater Pond Culture (PC)

Category	Identified Risk	With or Without Mitigation	Intensity	Duration	Extent	Consequence	Probability	Frequency	Impact Status	Significance
DISEASE MANAGEMENT	*Influent water supply as a disease vector*	Unmitigated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Mitigated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Introduction of disease agent through new broodstock or juveniles	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negativ	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negativ	Very low
	Contaminated feed as a potential disease vector	Unmitigated	Moderate	Long	Site	Medium	Highly Likely	Regular	Negativ	Medium
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negativ	Very low
	Disease transmission between operations within the ADZ	Unmitigated	Major	Long	Site	High	Highly Likely	Regular	Negativ	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negativ	Very low
	Wastewater/storm water / system flooding as a potential disease vector	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negativ	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negativ	Very low
	Undetected spread of disease agents/ deterioration of animal health	Unmitigated	Major	Long	Local	High	Highly Likely	Regular	Negativ	High
		Mitigated	Minor	Long	Site	Low	Highly unlikely	Sporadic	Negativ	Very low
	Spread of disease agent within the facility	Unmitigated	Major	Long	Site	High	Highly Likely	Regular	Negativ	High
		Mitigated	Moderate	Long	Site	Low	Highly unlikely	Sporadic	Negativ	Very low
	Seabirds and other animals as a vector for disease	Unmitigated	Extreme	Long	Regional	Very high	Highly Likely	Regular	Negativ	Very high
		Mitigated	Minor	Long	Regional	Medium	Highly unlikely	Sporadic	Negativ	Very low
BIODIVERSITY AND GENETIC	*Disease and parasite transfer to wild populations via effluent water*	Unmitigated	Major	Permanent	Regional	Very high	Highly Likely	Regular	Negativ	Very high
		Mitigated	Minor	Permanent	Regional	Medium	Possible	Sporadic	Negativ	Very low
	Transfer of disease and parasites to native species through escaped fish	Unmitigated	Moderate	Permanent	Regional	High	Highly Likely	Regular	Negativ	High
		Mitigated	Eliminated	Permanent	Regional	None	Highly unlikely	Sporadic	None	None
	Genetic pollution of the local stocks through escapees	Unmitigated	Extreme	Permanent	Regional	Very high	Possible	Regular	Negativ	Very high
		Mitigated	Minor	Permanent	Regional	Medium	Highly unlikely	Sporadic	Negativ	Very low
	Introduction of invasive non-native species through escapees	Unmitigated	Extreme	Permanent	Regional	Very high	Possible	Regular	Negativ	Very high
		Mitigated	Minor	Permanent	Regional	Medium	Highly unlikely	Sporadic	Negativ	Very low
FISH HEALTH MANAGEMENT	*Poor husbandry practices leading to disease/parasite outbreak*	Unmitigated	Extreme	Long	Local	High	Certain	Regular	Negativ	High
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negativ	Very low
BIO-ACTIVE COMPOUNDS	*Drug and therapeutant treatment risk to the environment*	Unmitigated	Major	Long	Local	High	Highly Likely	Sporadic	Negativ	Low
		Mitigated	Minor	Long	Local	Low	Highly unlikely	Sporadic	Negativ	Very low

RISK ASSESSMENT AND CONTROL

7.13.1 General Risk Management Measures

ADZ Level General Risk Management

- *Develop and implement an ADZ level biosecurity management plan that would include:*
  - *A biosecurity standard for the ADZ.*
  - *An ADZ monitoring programme for influent and effluent water. This should include the monitoring of harmful algal blooms, pollution events, and banned bio-active compounds in effluent water.*
  - *A disease management and animal health management plan for the ADZ, to be adapted as new operations come online to keep pace with new developments.*
  - *An ADZ code of conduct for the responsible use of bio-active compounds and a list of banned substances.*
  - *Seawater effluent quality standards based on the CDC's coastal water discharge permit.*
  - *Effluent quality standards for releases to the municipal sewer system, based on permit conditions and by-law requirements.*
  - *The plan to incorporate all the aquaculture operators and be adapted as required when new aquaculture operators establish in the ADZ.*
- *Consider establishing a biosecurity committee with representatives from each farm to discuss biosecurity issues and coordinate activities.*
- *High risk and invasive species will require detailed risks assessments should they be considered. Individual aquaculture farms to comply with the Alien and Invasive Species (AIS) Regulations (GNR 598, GG 37885). No species on the invasive species list to be cultured on any farm in the ADZ without the operation conducting a risk assessment specific to the operation and species and receiving approval from the relevant authorities.*
- *Enforce a ban on the sale of live fish to the general public (with the exception of ornamental fish) with particular reference to live tilapia sales.*

Farm Level Risk Management

- *High risk and invasive species will require detailed risks assessments should they be considered. Individual aquaculture farms to comply with the Alien and Invasive Species (AIS) Regulations (GNR 598, GG 37885). No species on the invasive species list to be cultured on any farm in the ADZ without the operation conducting a risk assessment specific to the operation and species and receiving approval from the relevant authorities.*
- *Each farm to develop a farm biosecurity management plan prior to the commencement of any farming activities, that would include:*
  - *A farm disease management plan.*
  - *A farm monitoring programme.*
  - *A clear plan for prevention of escapees with redundancy in place in case of failure.*
  - *Quarantine standard operating procedures.*
  - *Feed testing and storage standard operating procedures.*
  - *Measures for the exclusion of local wildlife, including monitoring of the effectiveness' of the measures.*
- *Each farm to develop and implement an animal health management and monitoring programme and with input from an aquatic veterinary specialist.*
- *Each farm to participate in the biosecurity committee and attend meetings to ensure that all role*

players are aware of issues as they crop up, including issues around animal health and diseases.

- *Adhere to existing industry specific biosecurity standards if applicable.*
- *Consider sterilisation of fish through hybridisation or single sex production to provide genetic security from invasive species of fish such as tilapia.*
- *Comply with species specific DAFF permit conditions for broodstock collection and holding, hatchery production, grow-out, waste disposal and effluent quality etc.*
- *Appropriate buffer zones to be maintained around individual aquaculture operations. The extent of the buffers will depend on the species cultured and its specific risks, the design of the operations and the culture systems used and the risk pathogen transfer between farms, including the risk of aerosol contamination. With the input of an aquaculture specialist, the design and layout of each development and its buffer zones to the considered on a case by case basis by the CDC and DAFF during the evaluation of permit applications. Larger buffer zones would be needed around high-flow outdoor systems such as abalone culture.*

7.13.2 Disease Management

7.13.2.1 Influent Water Risk Management

Monitoring and treatment of influent water is critical to managing water borne diseases. Ensuring that the influent water does not contain disease is the first step in disease management, and results in the protection of the surrounding aquatic environment. Water borne diseases pose the greatest risk to aquaculture in the ADZ but with good management practices and mitigation, this risk can be minimised. Untreated influent water may contain diseases which naturally occur in the aquatic environment, but more commonly diseases come from adjacent aquaculture operations. Cross contamination of influent water with effluent water (from the ADZ as a whole or from a neighbouring farm) is the main source of risk but risks of transfer from the natural environment also exist.

All Culture Systems

- *Seawater intake points to be situated as far away from the effluent (wastewater) pipeline as practically possible – optimal and feasible positions to be determined as part of the CDC marine pipeline servitude EIA.*
- *Abstracted seawater held in storage reservoirs should be filtered using drum filters to a minimum of 200 µm in order to facilitate additional filtration/sterilisation at each farm.*

Recirculating Systems

- *At the farm level, filtration and sterilisation of influent seawater must be conducted. Ideally seawater should be passed through pressurised sand filters to remove particulate matter followed by ozonation and UV filtration to exclude most pathogens from entering the facility.*
- *Filtration and sterilisation of all influent water is very good practice but it may not kill 100% of the pathogens which is why farm-level biosecurity measures for disease control are so important. Species that are particularly susceptible to diseases introduced with influent seawater, such as trout and salmon, would greatly benefit from ozonation and UV filtration at the farm supply point.*
- *Appropriate treatment of freshwater influent water to be in place, dependent on the source of the water.*

Flow-Through Systems

- *Drum filtration to at least 100 µm at each operation. Drum filtration excludes some potential vectors of disease but not the agent of disease and prevents pipe blockages which affect water supply. Good husbandry practices such as regular pipe and tank cleaning reduce this risk. The high rate of water turnover in culture tanks is itself a mitigation and disruption of water supply must be avoided at all costs.*

- *An ADZ level abalone biosecurity standard to be put in place based on industry and DAFF standards and guidelines in order to minimise the risk posed by other tenants in the zone. All abalone tenants must be required to demonstrate adherence to both these standards.*

Pond Systems

- *The water supply to be sterilised and to contain no pathogens.*

7.13.2.2 Managing the Introduction of Disease Agents through new Broodstock or Juveniles Entering the Facility

Broodstock fish originating from the wild are usually infected with a wide range of pathogens and parasites which poses a high risk to farmed fish and it is virtually impossible to rid wild-caught fish of all potential pathogens and strict biosecurity is required to manage this risk (Mouton, 2010 in Paulet, 2016). Any live animal brought into the Coega ADZ as future broodstock or as juveniles for on-growing, brings with it the risk of disease. Some of the aquaculture facilities will likely operate solely as on-growing facilities and will regularly transport batches of larvae or juveniles into the ADZ and onto their premises. Some of the potential disease agents affecting marine finfish include: skin/gill flukes, protozoans, various parasitic worms (trematodes, nematodes, and tapeworms), parasitic cnidarians (myxozoans), crustaceans such as sea lice, protozoans, dinoflagellates, various viruses and bacteria. A comprehensive list of parasites affecting both farmed and cultured Dusky kob has been included as Appendix 1 (Christison & Mouton, 2009 in Paulet, 2016) to give an indication of the number of potential parasites that can affect marine finfish. Ornamental fish farms are particularly at risk due to their wide variety of species often sourced from all over the world and having been held with many different species at various export centres.

The movement of abalone is restricted by three DAFF disease management zones.

All Culture Systems

- *On delivery, broodstock and juvenile fish to be kept isolated in a quarantine system for at least six weeks with regular health inspections before they are stocked into the grow-out area.*
- *The quarantine section of the facility to be able to hold several different batches of juveniles and freshly caught broodstock independently of each other and of the rest of the farm.*
- *Broodstock holding facilities to be isolated from the rest of the farm and breeding groups of broodstock to be kept separate from each other. Failure to adhere to this could result in loss of all broodstock if a disease outbreak occurs amongst them.*
- *A quarantine standard operating procedure to be developed and strictly followed and effluent water from the quarantine sections to be treated and should not come into contact with any of the farm water effluent until it is sterilised and ready for release.*

7.13.2.3 Managing the Risk of Contaminated Feed as a Potential Disease Vector

Historically, aquaculture has relied on marine protein sources for feed mainly due to the nutritional requirements of the species being reared. Supplementing broodstock diets with live foods such as live mullet or prawns is very risky from a biosecurity perspective. Frozen fish can be a vector of disease since the freezing process does not sterilise the feed. Disease transmission can occur when the feed itself contains pathogens (e.g. live feed contaminated with white spot syndrome virus) or indirectly when pathogens in the feed enter the culture water and establishing a mechanism for indirect infection through contact. Pathogens that are less host-specific (e.g. white spot syndrome virus, Vibrio species) present a greater risk of indirect transmission as they can establish reservoirs of infection in multiple species (OIE, 2010 in Paulet, 2016).

Seaweed grown in abalone effluent is considered a potential disease vector.

All Culture Systems

- *Where possible, use only processed / prepared feeds and perform regular sampling of stored and delivered feed to ensure low bacterial counts, no contamination and optimal quality.*
- *Feed to be stored under the correct conditions in order to prevent bacteria, fungi and parasites from contaminating stocks.*
- *Feed only be procured from reputable feed companies with the required HAZOP certification. In cases where fresh (unprocessed) feed must be used, freezing the food item first will offer some protection. This feed should be treated as though it is an infectious agent.*

7.13.2.4 Preventing Disease Transmission between Aquaculture Operations the ADZ

Close proximity of farming operations within the ADZ carry a high risk of disease transfer between these operations especially if some of the infrastructure is shared. Attention to biosecurity protocols and health management programs will be critical to ensuring that this risk is controlled. The risk of disease transmission between aquaculture operations within the ADZ is greater for Flow-Through Systems than Recirculating Systems due to the impracticality of pathogen exclusion in the influent water in Flow-Through Systems. Many pond culture systems rely on the use of aeration devices which can be a source of disease transmission as they can create aerosol particles which blow into neighbouring ponds and farms.

<u>All Culture Systems</u>

- *All farms to adhere to the ADZ biosecurity management plan for the ADZ; this includes visitors to the sites and contractors working between sites.*
- *Seawater discharge points to be situated as far away from the abstraction pipelines as practically possible – optimal and feasible positions to be determined as part of the CDC marine pipeline servitude EIA.*
- *Systems must be designed in order to minimise the risk of aerosol contamination between different farms and bio-secure sections of the same facility.*
- *Appropriate buffer zones to be maintained (see ADZ level risk management).*

7.13.2.5 Wastewater, Flooding, and Storm water as a Potential Disease Vector

On an ADZ-wide level, waste water from other industries released to the CDC marine discharge pipeline is a major risk to all aquaculture operations if it comes in contact with aquaculture influent water. On individual farm level, effluent water backing up from some kind of obstruction and overflowing is another major biosecurity risk to other operations that come into contact with it. Effluent water from processing plants and laboratories is a particularly high biosecurity risk as it could contain high concentrations of pathogens. A blocked pipe or overflowing Recirculating Systems can cause water from different bio-secure areas to come into contact with each other. This can happen on a farm level and between adjacent facilities especially those occupying lower elevations. Disease agents will be transferred between systems if the proper controls are not in place.

The planned area set aside for abalone culture is at the lowest elevation in the ADZ putting them at a higher risk than those facilities situated higher than them. Due to the high water volumes used for abalone culture, potential overflows from supply and blocked drains is a risk.

<u>All Culture Systems</u>

- *The effluent streams from each aquaculture operation to be designed in a way that there is no opportunity for wastewater from one farm to come into contact with any part of another operation.*
- *Wastewater pipeline routes (subdivisions) to be designed and maintained to ensure there will be little or no backflow up the drainage line and overflow into the other operations in the case of overflows, leaks, breakages and blockages.*

- *Wastewater from the individual facilities to be effectively screened to isolate and cull any escaped fish and, where appropriate (i.e. recirculating aquaculture, depending on species), be sterilised using ozone or UV.*
- *Effluent channels returning water to the common CDC effluent pipeline to be covered to prevent birds from transferring disease.*
- *Effluent water from processing plants and laboratories is a particularly high risk and to be sterilised before release into the effluent line.*
- *Storm water management to be planned to avoid overflows into biosecure areas.*

Pond Culture Systems

- *Mitigation measures as those listed for Recirculating Systems (above), and*
- *Wastewater pipelines from any PC facilities to be designed to accommodate large flood volumes in the case of a catastrophic collapse of a pond and to accommodate the volumes created during drainage for harvesting.*
- *Local climatic conditions to be taken into account during pond design phase to ensure that they are built with sufficient freeboard to allow for a 1:100 year storm event without over flowing.*
- *Proper drainage design to control potential water flow and controlled drainage for rainwater is required. Drains to be able to accommodate high volumes of water and to be screened to prevent escapees from leaving the individual farms via this route.*

7.13.2.6 Managing Undetected Spread of Disease Agents and Deterioration of Animal Health

Diseases may initially be a farm level risk and if left undetected for long enough could become a risk to neighbouring farms.

The risk to Flow-Through Systems is lower than for Recirculating Systems due to the single pass through of water resulting in slower passage of disease if normal biosecurity procedures are adhered to. Tanks can be rapidly flushed and optimal environmental conditions restored to affected areas.

It is likely that in the case of Pond Culture disease outbreaks, the stock of the entire pond will need to be condemned, and in such cases additional steps to ensure that the disease has been successfully eradicated from the pond sediments may be required. The use of specialist veterinarian services in such cases should be sought to ensure the disease does not spread further in the ADZ or beyond.

All Culture Systems

- *Develop and implement the disease management and animal health management plans as discussed in the general risk management measures. In terms of these plans, develop and implement an animal health monitoring programme specific to the farm design and husbandry techniques employed. The programme will include weekly sampling of animals from all the different areas on the farm and checks for the presence of disease agents and measure animal health. Farms to work closely with veterinary specialists to assist with the analysis of results and to develop sampling techniques*

7.13.2.7 Spread of Disease Agent within the farms and wider ADZ

Once a disease has been detected its spread within the facility and wider ADZ must be prevented.

All Culture Systems

- *Each aquaculture facility within the ADZ needs to be divided into separate operational units with strict biosecurity standard operating procedures in place to prevent contamination of uninfected areas.*

- *These separate sections should have separate staff, plumbing and equipment with footbaths and hand washing stations at entry/exit points.*
- *Once a disease is detected, declare the infected farm off-limits to visitors, particularly from neighbouring farms and determine the cause of the infection/infestation.*
- *Isolate and treat infected stock using environmentally acceptable methods e.g. Hydrogen Peroxide bath treatments.*
- *Harvesting the infected fish may well be a feasible option and if so, it will be necessary for the processing site to handle these fish as infectious agents and for them to follow the necessary biosecurity protocols.*
- *Participate in a health management program with a recognised specialist veterinary practitioner.*

7.13.2.8 Seabirds and Other Animals as a Vector for Disease

Seabirds and other animals such as rodents are known to be vectors of disease between farms and the natural environment both through their faeces and contact with water. Insects such as water-boatmen as well as rodents are responsible for disease transfer between bio-secure areas.

<u>All Culture Systems</u>

- *Individual farms to develop and implement a pest control standard operating procedure specific to their farm, with the CDC's specification and procedures on pest control as framework.*
- *Non-lethal control of birds through exclusion physical barriers will reduce the chance of disease transfer via these methods. Non-lethal bird netting and barriers are commonly used.*
- *Effluent flows are a particularly easy risk to overlook and should be covered to exclude birds and feral cats etc.*

7.13.3 Biodiversity and Genetics

7.13.3.1 Disease and parasite transfer to wild populations via effluent water

High production densities in recirculating systems make the cultured animals susceptible to disease outbreaks, and effluent from these facilities therefore has the potential to release pathogens into the ocean. This can threaten wild stocks, and often unrelated species. There are no records of this having happened in South Africa due to the relatively new aquaculture sector, but numerous examples occur around the world (particularly within the salmon sub-sector). The discharge of pathogens (microbes that can cause disease) does not necessarily lead to a disease or infection in the local population. The health of the wild population and the immunological status of the host, the dose and the virulence of the pathogen as well as interaction with environmental conditions will determine the probability of infection. The culture of non-native species or species out of their natural range can result in introduction of new pathogens to the wild populations and is of particular concern. Effluent water from freshwater recirculating systems will be discharged to the common CDC marine effluent pipeline or to a waste water treatment works (separate EIAs are being undertaken for both the marine pipeline servitude and for a proposed new waste water treatment works in the IDZ), and thus the same risks apply for all (marine and fresh water) recirculating systems in this regard.

Effluent water from abalone culture has the potential to release pathogens into the ocean which could threaten wild stocks, and often unrelated species. There are no records of this having happened in South Africa but there are isolated cases of this happening elsewhere in the world relating to abalone (Theil et al., 2004 in Paulet, 2016). There are no known cases of an abalone disease being transferred to other shellfish species (Theil et al., 2004 in Paulet, 2016) but the potential risk remains. The health of the wild population and the host's innate resistance, the dose and the virulence of the pathogen as well as interaction with environmental conditions will determine the likelihood of infection. Abalone broodstock, if collected locally is likely to already carry any potential pathogens

released back into the environment from the flow-through systems. Parasite transfer to the receiving environment has been described for abalone farming in California but not for Australia or South Africa and has been attributed to collection of non-endemic broodstock.

All Culture Systems

- *Once a tenant is identified, a species specific risk assessment based on the proposed culture method to be undertaken to assess the potential for contamination of wild populations.*
- *Farms to adhere to industry standards applicable to their respective species and culture methods, such as abalone standards, or marine finfish standards and monitoring programmes.*
- *Processing plants and laboratories will require strict biosecurity standards and standard operating procedures in order to prevent discharge of potentially infectious water into the receiving environment.*
- *Disposal of sludge filtered from effluent water should also be treated as an infectious agent and a waste management plan should be developed to best deal with the risk.*
- *Provision of a healthy culture environment will reduce the risk that cultured animals succumb to disease and parasite infections which in turn reduces the risk of transfer to the receiving environment.*

Recirculating Systems

- *Each farm to define appropriate and practical solutions for treatment of effluent water based on the species and proposed culture method. Generally, ozonation or UV filtration is acceptable methods commonly used but it is not always practical. Thus, a situation specific risk assessment and biosecurity and biodiversity management and monitoring plan must be prepared and approved by DAFF prior to the commencement of any activities.*
- *Effluent water from the culture of ornamental species in recirculating systems in particular, must be sterilised before release into the common CDC effluent pipeline.*

Flow-Through Systems (Abalone)

- *Farms must develop their own biosecurity management plans, and disease and animal health management plans in accordance with industry standards.*
- *Appropriate methods for effluent management must be identified in the farm level biosecurity management plans and approved by DAFF prior to the commencement of any activities.*
- *Collection of broodstock locally will mitigate the risks of disease and parasite transfer to the wild population.*

7.13.3.2 Transfer of disease and parasites to native species through escaped fish

Escaped fish can be vectors for both diseases and parasites. There is also a risk of 'hitchhiker' organisms being brought in with imported stock.

Due to the relatively small effluent discharge from recirculating systems, prevention of escapees is achievable through appropriate management.

Escaped fish from PC are a reality and even though freshwater species such as goldfish and koi cannot live in seawater, escapees might be predated on and transfer disease to the wild. Prevention of escapees is achievable through mitigation.

Recirculating Systems and PC

- *Culture systems to be designed to have multiple redundancy barriers and screens fine enough to contain the life stage of the animals being cultured (eggs/larvae/juveniles etc.). Barriers must:*
    - *Be designed to pass flow and exclude the animal being cultured.*

- *Maintained using standard operating procedures.*
- *Checked frequently to remove escaped fish that may have passed the first screens.*

- *Methods to prevent escapes from hatcheries include inclined belt filters that self-clean into a debris box (from where no fish can escape) as well as membrane filters.*
- *Enforce a ban on the sale (and giving away) of live fish to the general public (with the exception of ornamental fish), particularly tilapia and especially O. niloticus which has been identified as a significant biodiversity risk to native fish species.*

Flow-Through Systems (Abalone)

- *Collection of broodstock locally will mitigate the risks of disease and parasite transfer to the wild population.*
- *Good health management and biosecurity practices ensure that those animals that might escape are healthy.*
- *Sterilise water containing excess eggs and larvae from hatchery.*

7.13.3.3 Genetic pollution of the local stocks through escapees

The risk of selectively bred animals breeding with wild stocks, as well as the risk of hybridisation with a similar species, could lead to genetic pollution of the wild stocks. However, for cultured fish to breed in the wild environment they first have to survive until sexual maturity and with many species this is unlikely to occur (Tucker and Hargreaves, 2009 in Paulet, 2016). However, if hybridisation does occur between escaped fish and wild conspecifics (individuals of the same species) it can reduce the fitness and size of the wild population. These genetic effects can have a greater negative effect for wild stocks that are geographically separated. In general, the risk of potential adverse genetic effects on natural populations of conspecifics is not as severe as the ecological impact resulting from predation and competition from large numbers of escapees from an aquaculture facility (Tucker and Hargreaves, 2009 in Paulet, 2016). Genetic effects on the wild population through interaction with culture populations are relatively easy to prevent through good management practice and biosecurity standard operating procedures. Species under consideration for the ADZ and relevant to this risk are:

Dusky kob (A. japonicus) – genetic considerations

According to Annexure 4: (Initial) Genetic Best Management practice guidelines for marine finfish hatcheries in South Africa of the Finfish Hatchery Management Protocol (2015): "Dusky kob's South African range extends from Cape Point eastwards into Mozambique. Recent genotyping using microsatellite markers developed specifically for dusky kob (Mirimin et al., 2013 in Paulet 2016) confirm the findings of Griffith (1995, in Paulet 2016), suggesting the presence of a homogenous genetic stock of dusky kob along the South African coastline (Mirimin et al., unpublished data in Paulet 2016)". The implications of this data support the current regulation that kob broodstock can be collected anywhere along the South African coastline for the purposes of aquaculture.

Yellowtail (S. lalandi) – genetic considerations

According to Annexure F1 (DAFF, 2011 in Paulet 2016), yellowtail broodstock collection must preferably occur as close to the farm as possible. Yellowtail comes from a single stock and so this is merely a precautionary measure. Movement of juveniles between distant facilities is common practice in South Africa due to limited supply and this would have the potential to interfere with the local gene pool if escapees found their way into the sea.

Tilapia

It is unlikely but theoretically possible that tilapia could escape into the Coega River if strict biosecurity measures are not enforced. Introductions in other water bodies resulting from live tilapia sales or give aways may lead to hybridisation with local tilapia species.

Abalone

The risks associated with cultured abalone include the interacting with wild stocks, genetically modified organisms (from selective breeding programmes), and hybridisation with similar species. The general consensus is that the risk of potential adverse genetic effects on natural populations of conspecifics is not as severe as the ecological impact resulting from predation or competition of large numbers of escapees from an aquaculture facility (Tucker and Hargreaves, 2009 in Paulet 2016). Thus, competition for food and habitat are a larger impact than interbreeding in most cases. Collection of Abalone broodstock is carefully controlled and the South African coastline has been divided into genetic zones.

Dusky kob and Yellowtail

- *Managed as per measures to prevent the transfer of disease and parasites to native species through escaped fish (above).*
- *Comply with species specific DAFF permit conditions for collection of broodstock to reduce the risk of negative genetic effects, particularly for species with distinct geographical populations.*

Tilapia

- *Strict adherence to the biosecurity management plan, preventing sales and giving away of live tilapia will eliminate this risk.*
- *Sterilisation of fish through hybridisation or single sex production offers genetic security from some species of fish such as tilapia.*

Abalone

- *Abalone farms to collect their broodstock according to the DAFF management zones and from as close to their facilities as possible in order to reduce any genetic effect from escapees.*
- *Abalone farms to comply with species specific DAFF permit conditions for collection of broodstock to reduce the risk of negative genetic effects. Excess eggs and larvae from the spawning of broodstock should be culled and not released live into effluent water.*
- *Effluent water containing eggs and larvae to be sterilised prior to release.*

7.13.3.4 Introduction of invasive non-native species through escapees

There is a high risk of introduction of a non-native invasive species if they are to be considered for culture in the ADZ. Although domesticated native species may present genetic risks if they escape, non-native species have the potential to become invasive and alter the local ecosystem. The risk presented by non-native species varies considerably. Trout and salmon, for example, would not be able to survive long enough in the ocean to be a significant risk and they would not breed in the local ecosystem even if they did survive long enough to reach maturity. However, a potentially highly invasive species such as barramundi (*Lates calcarifer*) would represent a very high risk (Barramundi is on Alien Invasive Species List).

The Pacific Oyster (*C. gigas*) is an alien species, and in South Africa*, C. gigas* populations growing outside culture infrastructure are restricted to estuaries in the Eastern Cape and Western Cape provinces, with no evidence of occurrence in marine shelf environments. They have not displaced or competed with indigenous populations during a period of nearly four decades of repeated introductions through the aquaculture industry (Keightley et al, 2015 in Paulet, 2016). The effect of introductions into South Africa has had a very small localised effect, none of which are negative to the receiving environment. Grow-out occurs in the open ocean and gametes are spread widely from these operations.

Freshwater escapees are generally a larger risk than marine species but one of the main benefits of land based aquaculture is the theoretical ability to completely contain the cultured animals and prevent escape through mitigation. Nile tilapia (*O. niloticus*) for example is considered to be highly invasive (Shipton et al. 2008 in Paulet 2016) and quite likely to find its way into the local catchment if biosecurity standard operating procedures are not

followed and policed. It is not uncommon for people to sell or give away live fish from the farm or at the farm gate. This must be banned and very strictly controlled.

Recirculating Systems and PC

- *Managed as per measures to prevent the transfer of disease and parasites to native species (above).*
- *Cultivation of invasive non-native species requires particular attention to the design of redundancy barriers to make sure that nothing gets past them, such as passing all effluent through sludge collecting / dewatering geo-textile bags, through which no escapees can pass.*
- *Strict adherence to the farm's Biosecurity Management Plan and preventing sales of live tilapia will eliminate this risk.*
- *Sterilisation of fish through hybridisation or single sex production offers genetic security from some species of fish such as tilapia.*

Flow-Through (Pacific Oyster)

- *Sterilise effluent water from the broodstock and larval areas with ozone and screen juvenile rearing areas with redundant screens.*

7.13.4 Fish Health Management

7.13.4.1 Poor husbandry practices leading to disease outbreaks

Husbandry practices include control of all the physical and environmental conditions necessary to keep cultured animals healthy and growing well. Poor husbandry practices such as poor water quality, poor hygiene and disinfection and a lack of biosecurity protocols increase the chance of disease outbreak which would threaten all the facilities in the ADZ, and increases the risk of disease transmission to the wild stocks.

All Culture Systems

- *Apply measures for disease management (above).*
- *Develop and implement farm-specific disease and animal health management plans and standard operating procedures to give effect to the plans. These plans need to take into consideration the culture species and types of aquaculture operations to be developed and they need to be stringently enforced.*
- *Staff to be trained to strictly implement the standard operating procedures at all times.*
- *Develop and implement a plan for diagnosis and treatment and work with reputable veterinary professionals to develop a clear treatment plan.*

7.13.5 Bio-Active Compounds

7.13.5.1 Drugs and therapeutant treatment risk to the environment

Bio-active compounds are compounds defined as having an effect upon a living organism, tissue, or cell. Biologically active antibiotic, enzymes, and vitamins, chemotherapeutants (for disease treatment), disinfectants and hormones are all bioactive substances. No drugs are registered for use in aquaculture in South Africa (Mouton, 2010 in Paulet 2016). Drugs and therapeutants administered into the culture water persist in the effluent in many cases; up to three quarters of orally administered antibiotics reach the receiving environment (Mouton, 2010 in Paulet 2016). A list of potential therapeutants used for aquaculture can be found as an attachment to biosecurity and biodiversity risk assessment (Appendix G5, Paulet, 2016).

All Culture Systems

- *Bio-active compounds should only be used when treatment cannot be avoided and where possible direct application is preferable to bath-type treatments.*

- *Health management should be the first line of defence and best management practice should help to reduce the incidence of disease on farms.*
- *Chemicals banned for use elsewhere in the world such as malachite green, chloramphenicol and nitrofurans should never be used in the ADZ.*

ASSUMPTIONS

The risk assessment had to make certain assumptions. For seawater abstraction, it was assumed that influent seawater is of optimal quality. The risk associated with external pollution of influent water is not a biosecurity or biodiversity risk and is therefore not assessed in this document. Risks related to HABs are not a biosecurity or biodiversity risks related to the ADZ but rather to the water quality as supplied by the ADZ which is not covered by this assessment. For freshwater, it has been assumed that the bulk water supply will be disease free. Each operator will be required to monitor and pre-treat influent water as required and to put in place contingency measures to compensate or influent water qualities.

Indirect risks to biodiversity through aquaculture-related environmental degradation, due to poor effluent quality being abstracted via the intake pipelines, are assumed to be covered by the separate CDC marine pipeline servitude EIA study being undertaken simultaneously and the modelling to determine the abstraction points and discharge points and depths.

GAPS AND LIMITATIONS

The biosecurity and biodiversity risk assessment is not a biosecurity management plan or biosecurity standard as these plans must be developed based on species and culture methods and technologies. However the identified risks and mitigations will assist with the future development of these documents for individual aquaculture operations as they are being implemented.

The CDC marine pipeline EIA, currently being conducted separately, is responsible for impacts associated with seawater abstraction and effluent discharge and these risks are outside of the scope of the risk assessment.
The CDC has initiated feasibility studies for various freshwater fish species and these results are not available at this time. Species identified through the feasibility study but not included in the scoping document project description will fall into one of the three categories assessed in this specialist assessment.

CUMULATIVE IMPACTS

Cumulative impacts of the seawater abstraction and discharge by multiple industries on the marine environment are assessed as part of the separate EIA process.

NO-GO DEVELOPMENT

The no-go alternative would obviously result in zero negative impacts in terms of potential biodiversity risks related impacts described in the previous section, particularly those related to the risk of escapees, and transfer of diseases, pathogens and parasites to wild stocks.

However, this means that the area could be used for alternative industrial land-uses in the future. In the absence of any information on these possible future industrial developments, the unique impacts of those potential industries on the marine environmental are unknown.

CONCLUSIONS

Overall the biosecurity and biodiversity risks can be mitigated through appropriate farm design and management and through the strict adherence to biosecurity standards and standard operating procedures which need to be developed for each operation and strictly applied at all times.

7.14 Storm Water Management and Erosion Control

The majority of the ADZ drains to the ocean in the south, while the remaining inland part drains westward into a depression that acts as a natural attenuation pond, with exception of a small portion that drains north-eastwards towards the N2. The marine environment is thus the main receptor of storm water runoff from the site. Inadequate storm water management could compromise biosecurity and biodiversity of the ADZ. Impacts of storm water were therefore assessed in both the Marine Environment, and the Biosecurity and Biodiversity Risk sections of the report.

Large-scale recirculating aquaculture and aquaponics are associated with extensive green houses; grow tunnels and buildings, which would result in a significant increase in runoff from these areas. It is however anticipated that rainwater will be harvested from some roofs and greenhouses within the ADZ, mainly for use in freshwater aquaculture production. There may be opportunities to use collected rainwater at seawater aquaculture operations as well, such as at in staff ablution facilities and for cleaning, obviously considering biosecurity and HACCP management system restrictions.

Biosecurity management control measures require buffer zones to be maintained between different aquaculture units and farms. These areas provide opportunities for natural storm water infiltration to take place.

The targeted 600 tn/yr abalone production as well as seaweed production will occupy most of the coastal section of the ADZ. Existing abalone farms in South Africa and elsewhere generally consist of prefabricated tank systems with unpaved areas between tanks. Tanks are often placed directly onto the levelled soil (Plate 7-3; Plate 4-4c and Plate 4-5c), sometimes with a gravel layer to control dust. Such designs allow for rainwater infiltration with little additional runoff.

The CDC has completed conceptual and preliminary storm water designs for Zones 7 and 10. Currently no storm water services exist within Zone 10. Storm water will be accommodated within the road network. All designs will accommodate the 1:50 year storm recurrence. Where required, storm water will be attenuated in the electrical servitude/services corridor. In terms of the CDC storm water management strategy, individual developers in the CDC are required to attenuate storm water on their individual premises. With this in mind, a storm water pipe outfall will not be required in the initial years of the ADZ but as more aquaculture farms establish in the ADZ, it may be required in later years.

Activities such as vegetation clearance, grading and earthworks can lead to erosion and high turbidity water runoff from the site. Contaminated storm water run-off from the ADZ may introduce pollutants and sediments to the surrounding environment. Any spillages of toxic substances within the ADZ may be washed into the storm water system during periods of heavy rainfall.

ASSESSMENT OF IMPACTS

As per the Marine Environment section on the impacts of increased erosion and sedimentation (Section 7.12.1).

MITIGATION MEASURES AND DESIGN CRITERIA

The aim is for storm water to be controlled and attenuated to allow for particulates to settle in sediment traps or silt curtains to ensure that water released from the site has turbidity levels less than 10% above ambient levels (DWAF 1995) or less than 50 mg/l (IFC General Environmental, Health and Safety Guidelines 2007) (Chalmers, 2016).

- *The CDC's site layout plan and storm water management plan for the ADZ to take cognizance of the potential biosecurity and biodiversity risks and the recommendations made in that section of the report.*
- *Individual site development plans for each site in the ADZ to also take cognizance of the potential biosecurity and biodiversity risks and the recommendations made in that section of the report.*
- *Individual developers in the ADZ are required to attenuate storm water on their individual premises and to*

comply with the CDC's specifications for storm water management and erosion control during construction and operational phases.

- *Adequate infrastructure to be provided for storm water management, attenuation, and accommodation of first flush volumes and contaminants.*
- *Clean and dirty storm water need to be kept separated.*
- *Where storm water is potentially contaminated, it should be contained and treated before it is discharged.*
- *Clean storm water can be stored on site and used for other purposes.*
- *Individual developers to be encouraged to optimise rainwater harvesting and re-use on their premises.*
- *All storm water management structures to be inspected, maintained and emptied of sediment, sand and debris on a regular basis.*
- *All driving in the coastal zone to be in accordance with the approved site development plan and to be strictly monitored by the ECO.*
- *No driving allowed below the HWM during construction and operation, unless the reason for this has been motivated to the CDC EM and the necessary permit has been obtained.*
- *A site specific storm water management and erosion control procedure is to be developed and implemented during the construction phase.*
    - *Erosion control and protection measures to be adapted for each area and specific situation. Measures to slow down runoff and prevent erosion to be put in place. This may include silt traps / silt curtains / geotextile bags where required for construction activities taking place in close proximity to the shoreline.*
    - *ECO to be on site during the construction phase and to strictly monitor storm water management activities, particularly during downpours.*
    - *Avoid erosion by implementing the specifications for vegetation clearance and rehabilitation (minimise areas cleared and rehabilitate as soon as possible).*
    - *Impacts on adjacent and downslope areas to be monitored. When erosion is observed, corrective measures to be implemented based on recommendations of the ECO. Where required, the ECO to obtain advice from a rehabilitation specialist.*
- *Routine monitoring of water leaving the storm water management system towards to shoreline, particularly following a downpour, was recommended by the marine ecologist (Chalmers, 2016). The ECO to determine the frequency and parameters to be monitored as this may differ for the construction and operational phases and depend on the type of activity taking place. Typically monitoring would include turbidity, total suspended solids and pH but may be expanded to dissolved oxygen, hydrocarbons and trace metals (Chalmers, 2016) in areas of concern.*
- *The CDC's water monitoring programme, which includes storm water monitoring, needs to reviewed and updated to cover developments in the ADZ.*

RATING OF IMPACTS

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Construction activities leading to increased erosion and sedimentation*				
Overall Significance of Impacts	N/A	Negative Moderate	Negative Very	Negative Very	None to Unknown

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Operational activities leading to increased erosion and sedimentation*				
Overall Significance of Impacts	N/A	Negative Moderate	Negative Very Low	Negative Very Low	None to Unknown

7.15 Surface Water

There are no water courses on or near the ADZ. Surface flow of water is addressed under Storm water Management and Erosion Control and impacts of storm water runoff onto the seashore are addressed in the Marine Environment section.

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Impacts on Surface Water Resources (Excluding Marine Environment)*				
Overall Significance of Impacts	N/A	None	None	None	None to unknown

7.16 Soil and Groundwater

ASSESSMENT OF IMPACTS

Construction activities involve the use of fuels, oils, lubricants, paints, solvents, cement, wet concrete and other potential hazardous substances. Chemical toilets are used as temporary ablution facilities during construction.

The operation of aquaculture systems will require the use of plant and equipment which require hydrocarbons, chemicals, bioactive compounds and other potentially hazardous substances for maintenance, cleaning and sterilisation of infrastructure.

Any spillages of these substances could result in infiltration into the soil, and contamination of soils and eventually the groundwater and the marine environment due to groundwater flow direction being towards the sea.

Operation of the aquaculture systems with its various tanks, dams, raceways, pipes, storage reservoirs could result in spillages of the culture water, effluent and sludge over time due to overflows, water splashes, leaks and breakages along the pipelines, and pump malfunctions. Water containing high suspended solids, salts (seawater) and nutrient levels will infiltrate into soil.

Up until such time as the sewer network has been constructed, conservancy tanks for sewage and effluent disposal will have to be used.

Aquaculture operations are highly dependent on constant pumping of water through the system and thus sensitive to power interruptions and failures. It is likely that investors will require back-up generators and as such they may require the storage of fuel on site.

There are no current anthropogenic groundwater users on or around the ADZ.

MITIGATION MEASURES AND DESIGN CRITERIA

The focus is on preventing spills and on prompt containment and clean-up should it occur.

- *Keep an inventory of all hazardous, bioactive and controlled substances used and stored on the site, with details about emergency response in case of spillage to the environment or personnel exposure (MSDS sheets). Maintain records of the quantity of the materials purchased, used and records of the wastes and empty containers sent for disposal.*
- *A hazardous and chemical management plan to be prepared for each farm, addressing the storage, handling and application, potential risks and emergencies for all high risk substances listed in the*

inventory.

- *Ensure appropriate location of the hazardous substance and hazardous waste storage areas, including chemical toilets and conservancy tanks. No such areas to be located in high risk exposure areas within 100 m of the shoreline or where a spill or the remands of a spill could run into the storm water or rainwater collection system.*
- *Drainage around hazardous storage areas to be designed to ensure spills and the substances used for cleaning up spills can be contained and prevented from entering the storm water or rainwater collection system.*
- *Appropriate spill kits to be available at all times in areas where hazardous substances are stored, as well as where these are used in high risk exposure areas.*
- *Access to and use of hazardous substances must be controlled by an appropriately trained individual.*
- *Emergency preparedness procedures to be put in place for the containment of spills, prevention of contamination of the storm water management system and clean-up procedures.*
- *Emergency contact details to be readily available on each farm, and to include the municipal and regional hazardous waste response team / disaster management teams in event of large spills.*
- *All personnel dealing with hazardous substances (including fuel) to be adequately trained to identify a potential risk and how to respond in case of a spill.*
- *Conduct regular inspections of all areas where hazardous substances are stored or handled.*
- *If fuel is stored on site, it should be as far away as practically possible from the shoreline. The storage area must be designed and bunded in accordance with industry best practice.*
- *The design of bunds for fuel and hazardous substance storage areas to be based on the volume and nature of substances stored, the risk of spillages and the following minimum design criteria:*
    - *The bunded area to effectively accommodate 110 percent of the stored liquids.*
    - *The bund floor and wall to be impervious and appropriate for the substance, even in the case of a fire.*
    - *Prevent the integrity and capacity of the bunded areas being compromised by rainwater and storm water.*
    - *Bunded areas that are not covered, to be provided with sumps and lockable valves for controlled release of clean rainwater.*
    - *The integrity of the bunds to be tested to ensure that it is impervious and that valves and sumps are fully functional.*
- *On-site refuelling of vehicles and equipment to be kept to a minimum, i.e. only for vehicles and equipment that stay on site for the duration of the construction period.*
- *Self bunded fuel tanks are recommended for the construction phase as this eliminates the need for construction of a temporary bund.*
- *Vehicle and equipment refuelling areas on the outside of a bunded area, to be designed to contain leaks and spills that may occur during refuelling.*
- *All tanks, dams, ponds, and culture units to be impervious (or lined) and sized with an appropriate freeboard and safety margins to avoid seepage, leaks and overflows of effluent, slurry and culture water containing high suspended solids and nutrient levels.*
- *Effluent and sludge pumps, pipelines and buffer tanks to be designed with appropriate safety margins and backup systems to accommodate down-time, maintenance and repairs and power failures.*
- *Conduct regular inspections and maintenance of all pumps, pipelines, tanks and culture units to minimise the risk of leaks and breakages.*
- *The necessary water use authorisations to be in place for conservancy tanks.*

- *The CDC's water monitoring programme, which includes groundwater monitoring, needs to reviewed and updated to cover developments in the ADZ.*

RATING OF IMPACTS

Construction Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Spillage of hydrocarbons and chemicals infiltrating into the soil and groundwater.*				
Impact status		Negative	Negative		
Intensity		Major	Major		
Duration		Short-term	Short-term		
Extent		Site	Site		
Consequence		Medium	Medium		
Probability		Highly likely	Possible		
Frequency		Regular	Sporadic		
Significance	N/A	Negative Medium	Negative Very Low	Negative Very Low	As Cumulative

Operational Phase

	Existing and Reasonably Anticipated Impacts	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Hazardous spills and leaks infiltrating into the soil and groundwater.*				
Impact status		Negative	Negative		
Intensity		Major	Major		
Duration		Long-term	Long-term		
Extent		Local	Local		
Consequence		High	High		
Probability		Highly likely	Highly likely		
Frequency		Occasional	Sporadic		
Significance	N/A	Negative Medium	Negative Low	Negative Very Low	As Cumulative

NO-GO DEVELOPMENT

If the ADZ was not developed, the negative impacts will be avoided. Development of other industries on the site, as part of the long-term development of the IDZ, may result in similar or more pronounced pollution risks, depending on the type of industry.

ASSESSMENT OF RISKS AND CONCLUSIONS

Soil and groundwater risks due to hazardous spillages are a real but overall low risk if appropriate mitigation measures are put in place. It does however need vigilance, awareness and management control.

7.17 Waste Management

The impacts of the wastes produced in the ADZ (as described in Section have been assessed in various preceding sections of the report. Additional mitigation measures for waste management are provided below.

MITIGATION MEASURES AND DESIGN CRITERIA

Desalination Plant

- *Select the least environmentally damaging option for feed-water treatment and cleaning of plant components, thereby reducing discharges of hazardous components in the effluent stream.*
- *pH correction if needed before backwash water is released from buffer tank and mixed with the brine*

stream.

- *Membrane cleaning solutions, used every few months, must be pH corrected and fed slowly into the brine stream over a period of time to avoid a sudden release. Furthermore, if required to meet discharge standards, it could be kept in a separate tank for landfill disposal thus not mixing with brine stream.*
- *Investigate the feasibility and need for solids separation and dewatering to meet the requirements of the CDC coastal water discharge permit.*
- *Pigging of intake and discharge pipelines as a routine management measure to reduce the reliance on biocides, and to avoid elevated levels of residual biocides in discharged effluent. If fouling occurs inside pipelines, this will need to be addressed through mechanical rather than chemical means.*
- *De-chlorination of effluent prior to discharge (in case of overuse of biocides).*
- *The quality of feed water, the brine stream, and product water should be monitored on a daily basis, based on the requirements of the CDC's coastal waters discharge permit.*
- *Develop a monitoring programme*

7.18 Resource Consumption and Greenhouse Gas Emissions

This section follows on from the general discussion on land, water, energy and feed efficiency of the aquaculture sector in the Need and Desirability Section (1.4). All animals reared in intensive agricultural systems and thus fed formulated diets indirectly consume land, water and energy and produce greenhouse gas emissions during their lives on the farm they are reared on, but the production of their feed is a major contributor to resource use and the production of greenhouse gas emissions. Due to the variety of species that is likely to be produced in the ADZ, it is only possible to discuss resource consumption and greenhouse gas emissions produced at a high and theoretical level.

Feed Input

Worldwide, the animal feed sector faces three main environmental challenges. Firstly to reduce the reliance on wild caught fish as a protein source (fish meal is used in feeds for poultry, pigs, ruminants and farmed fish). Protein inputs in animal feed not from wild caught fish, are sourced from agricultural crops and therefore the second challenge is to address issues around sustainable use of land and water, and climate change risks to future agricultural crop production. The third and related issue is to manage greenhouse gas emissions. The efficiency with which feed is used makes it important to manage these challenges and is often measured in protein conversion ratio – the ratio between feed proteins used per edible animal protein produced. But the issue is more complex than that – nutritional value, food safety and cost are of critical importance.

Fish are cold blooded and don't use energy to warm their bodies, they float and don't spend energy to fight gravity, they have fewer bones and inedible parts compared to terrestrial animal protein sources. All in all they are energy efficient and thus food efficient. Salmon is often described as the most feed-intensive farmed fish. Cultivation of Salmon is currently estimated[13] to use about 1.3 to 2.5 kg of wild caught fish (live weight) per 1 kg of cultured fish (live weight). Obviously this is dependent on the manufacture and formulation of the feed, but figures today appear to be down from about 5 kg wild fish used per 1 kg Salmon grown two decades ago. Due to the fact that intensively cultured fish is kept in optimal (as possible) living conditions where they don't have to hunt or flee from predators, their energy and thus feed requirements are lower than their wild counterparts who would eat ~10 kg wild fish per 1 kg growth (various sources; Andre Bok, pers. comm.). The feed use efficiency of different species is illustrated below. Feed conversion ratio is given as the kg of dried feed (~10% moisture content) used to grow 1 kg of live weight fish product. For Dusky Kob produced in South Africa, the food conversion ratio is 1.3 kg of dried food per 1 kg of fish produced (Andre Bok, pers. comm.).

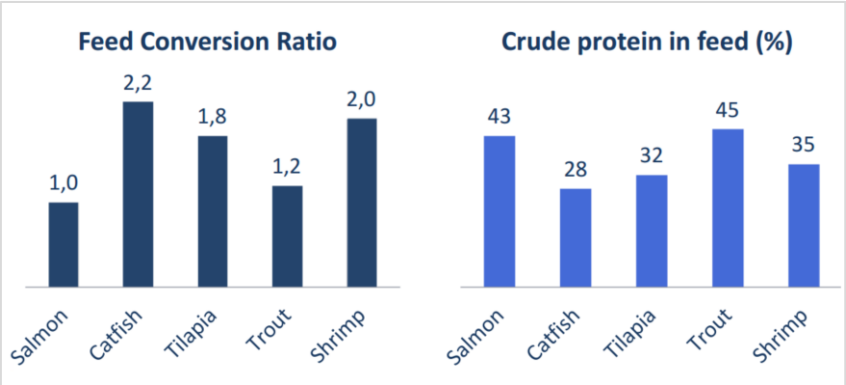

Figure 7-16: Feed Use Efficiency (Feed Conversion Ratio and Protein Use) in Common Aquaculture Species

Source: As adapted from Boyd et al, Reviews in Fisheries Sci. 2007, 15, 327-360 in Alberts, 2010)

One of the most comprehensive studies on food production, diet choices and sustainability to date (Tilman and Clark, 2014) draws together over 500 hundred of life cycle assessments of more than 80 types of crops and animal products. The study considered diet-related GHG emissions per gram protein, per kilocalorie and per serving from

[13] *Estimate based on various scientific papers and discussions with aquaculture specialists.*

'cradle to farm gate' and includes projected increases in global population to forecast global environmental implications of current dietary trajectories and to calculate the environmental benefits of diets. Their comparison of the protein conversion ratio of terrestrial livestock, Salmon and three other fish species well-known in South Africa are tabled below.

Table 7-6: Mean Protein Conversion Ratios of Terrestrial Livestock Production Systems and a Selection of Farmed Fish Production Systems

Food Item	Protein Conversion Ratio *(feed protein used per edible animal protein produced)*
Beef	20
Mutton and Goat	14
Pork	5.7
Poultry	4.7
Salmon	4.6
Trout	4.1
Tilapia	5.7

Source: Tilman and Clark, 2014

In reality all arguments about the relative efficiencies of feed, and of animals to convert protein into biomass can be somewhat misleading and narrow in its focus. It fails to consider the nutritional value, food safety and costs, and most importantly the sustainability of the wild resource and also; what initiatives the aquaculture industry is implementing to improve feed efficiency, nutritional value and to develop emerging protein sources such as produced algae, insects, or microbial biomass and the by-products from farmed fish.

The wild caught species used in the production of fish feed ingredients (fish meal and fish oil) are generally small pelagic forage species. The dominant species in South Africa are sardines, anchovy and round herring found in the continental shelf waters between Hondeklip Bay on the West Coast and Durban on the East Coast. Anchovy and round herring are mostly reduced to fish meal and oil in industrial-scale factories and used as a protein supplement in animal food. Sardines are mainly canned for human and pet consumption, with a small amount packed whole for bait or as cutlets for human consumption. The total annual combined catch of the three species varies dramatically from year to year but the long-term average is 335 000 tn/yr (DAFF, 2014). Processing 12 kg of raw feed grade fish produces approximately 1 kg of fish oil and 2.4 kg of fishmeal (Schipp, 2008).

Fishery resources are managed by DAFF on a national level. In the 2014 report on the Status of the South African Marine Fishery Resources (DAFF, 2014), it was reported that both anchovy and herring were regarded as having an Abundant stock status with Light fishing pressure and sardines as Optimal in terms of both stock status and fishing pressure. The report highlighted the importance of managing the forage fisheries in a manner that accounts for their high degree of variability and importance to the ecosystem. In the past DAFF's primary approach has been to limit fishing through a specified annual total allowable catch but they have been revising their approach to incorporate spatial ecosystem considerations with harvest strategies that include spatial management of species to prevent local forage fish depletion and heightened competition between dependant predators and the fishing industry. In attempting to quantify the effect of fishing on the ecosystem, African penguins were chosen as a key predator species for consideration because they feed predominantly on anchovy and sardine and because of their endangered conservation status. Penguins are sensitive to changes in pelagic fish abundance and distribution as a consequence of their land-based breeding sites and their limited foraging range during breeding. DAFF is utilising a model of penguin dynamics in conjunction their small pelagic fish management procedures (DAFF, 2014).

South Africa is a nett exporter of fish meal at 45 000 tn/yr (AFMA 2016) but also an importer of feed for the currently small but growing aquaculture sector. In terms of food production in South Africa and overall economic contribution, it would be more beneficial to the country to apply the small pelagic forage fishery resources to a

local aquaculture sector to support food production and to beneficiate these fishery resources into high value products for the export.

For abalone, seaweed consumption values will vary based on the seaweed source and the market size of abalone produced but, as a rough estimate, an abalone farm in steady state will require 4 to 5 kg of seaweed per 1 kg abalone production per year, measured in wet weight, and thus compares favourably with terrestrial animal farming feed conversion rates (various sources in FitzGerald, 2008).

Fresh Water Input and Efficiency of Use

Globally, about 1.2 m^3 of water is needed to produce 1 kg of grain used in animal feeds (feed efficiencies discussed above). On-farm water use for terrestrial animals, including drinking, but excluding water for cooling animals or cleaning their sheds is only 1% of feed-associated water use. Obviously, on-farm water use in aquaculture can be very high in extensive culture systems but intensive aquaculture production systems are equally water-efficient as terrestrial animal farming systems. However, technological development over the past decade has resulted in more and more intensive systems and so called zero water exchange systems.

All seawater aquaculture operations are virtually independent of fresh water supplies. From a 'fresh water input' perspective, marine aquaculture is the most efficient form of animal protein food production.

Energy Use and Greenhouse Gas Emissions (GHG)

The actual energy use and greenhouse gas emissions can only be predicted once the details and designs of individual farms are known. For this reason, various literature sources were consulted. In the South African aquaculture context, only one life cycle assessment for abalone production could be found in the public domain. This study (Nobre, 2010) calculated both on farm GHGs due to electricity consumption in farm operations (aeration, pumping, agitation, and wastewater treatment), as well as GHGs emission due to electricity consumption in preparation of prepared commercial feed for a facility producing 240 tn/yr of abalone. Seawater is pumped from the sea into top header tanks at a rate of 1 200 m^3/hr then gravity fed unfiltered through the abalone tanks. The study concluded that the farmed produced 48.3 kg CO_2e per 1.0 kg abalone at the farm gate. The biggest impact on this number is the use of Eskom generated electricity with an emission factor of 0.95 kg CO_2e/kWh. These results were for the mono-culture of abalone and thus no integration of seaweed for on-farm feed production.

Various studies are available internationally but not very useful to compare in the South African context. Since the major contributors namely food production, transportation and on-farm energy use are only useful within a regional or country by country context. For example: in Nordic countries, the average emission factor for generated electricity (NORDEL) is 0.18 kg CO2e/kWh and thus five times less than locally generated electricity.

It is only useful to compare studies within one country in order to determine the efficiencies and impacts of aquaculture versus capture fisheries and terrestrial animal livestock production in that country. One of most comprehensive life cycle assessments available (Winther, 2009) quantified the carbon footprint and energy use for 22 Norwegian seafood products most of which constitute important components of Norwegian seafood export, including farmed Blue Mussel and Salmon. It considers feed inputs and on-farm inputs for aquaculture and fuel use for capture fisheries, a variety of processing options (fresh, frozen, round, gutted or fillet product), refrigeration, as well as transport to the respective country and city where the wholesaler is located.

As can be seen from the results depicted below, the two categories (farmed fish and capture fisheries) energy use and carbon footprint, were highly correlated, indicating that the use of fossil fuels dominated the carbon footprint results. The range in carbon footprint was 1 to 14 kg CO_2e per 1 kg of edible product delivered to the international wholesaler. For aquaculture, the single biggest contributor is feed manufacture. Lastly, the study also compared the results with terrestrial animal meat. In comparison with land-based meat production systems for chicken, pig and beef, the seafood production systems studied had a carbon footprint in the range of chicken or lower.

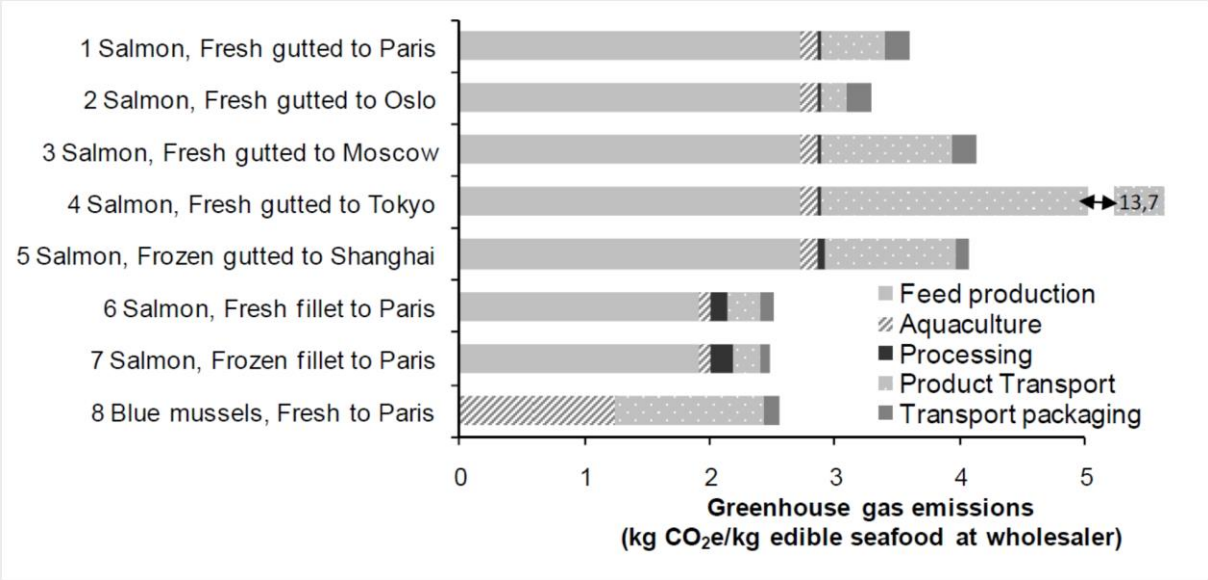

Figure 7-17: Overall carbon footprint results for Norwegian products from aquaculture

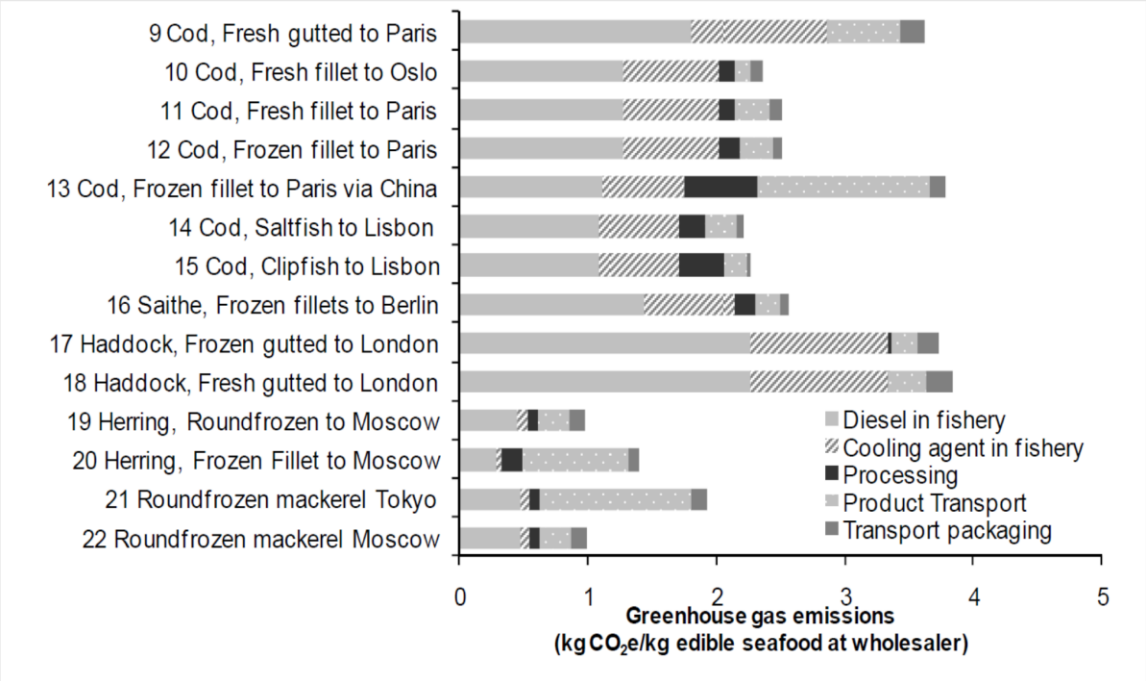

Figure 7-18: Overall carbon footprint results for Norwegian products from capture fisheries

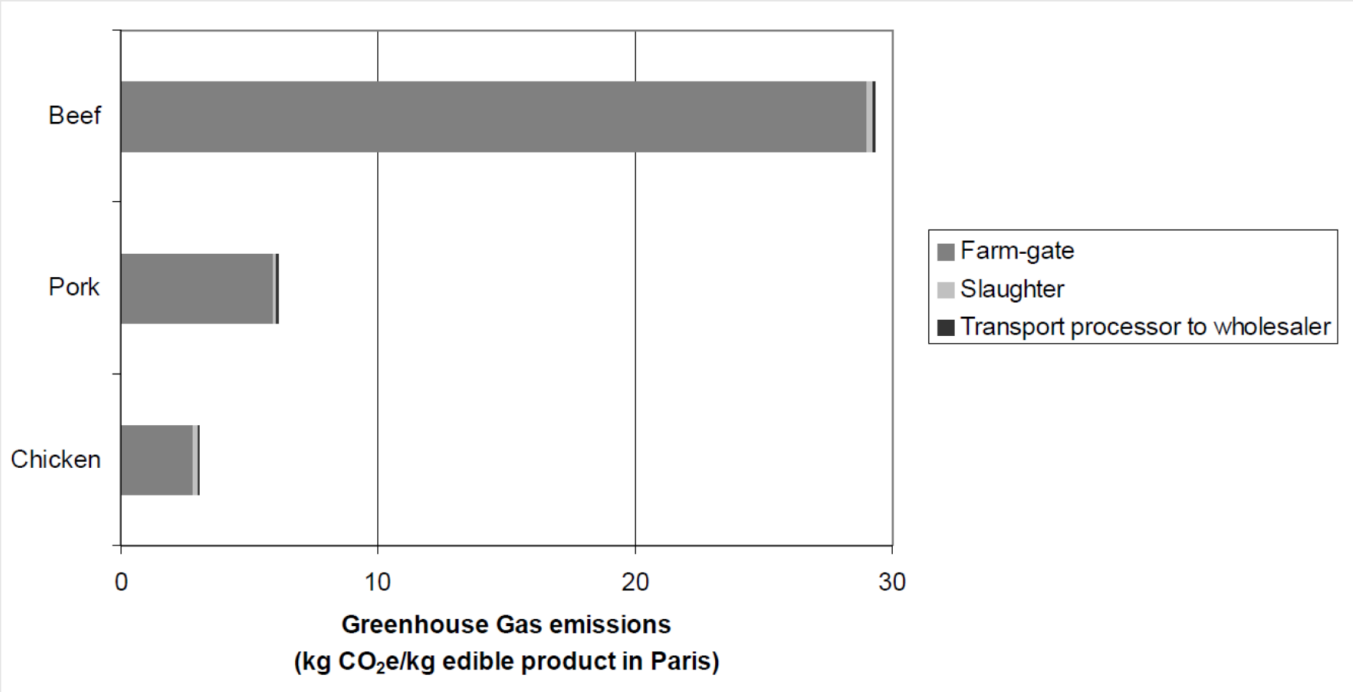

Figure 7-19: Overall carbon footprint results for Norwegian Meat products trucked to Paris

The results for farmed Salmon in the Norwegian study (Winther, 2009) reflect the use of recirculating systems for smolt production and sea-based marine pens for the grow-out phase, with transport of the smolt to the marine pens. For a land-based finfish farm using a recirculating grow-out system, the on-farm energy may be higher and dependent on the time it takes for the cultured species to reach a marketable size. Studies on recirculating aquaculture systems are fairly limited. Tilman and Clark (2014) compared the results from 5 studies on recirculating aquaculture with that of non-recirculating aquaculture systems and terrestrial animal protein products, as tabled below.

Table 7-7: Mean Carbon Footprint for Terrestrial Livestock Production, Farmed Fish Production and Capture Fisheries

Food Type	kg CO_2e per 1 kg protein	*Number of Studies Consulted*
Non trawling capture fisheries	8.6	*77*
Trawling capture fisheries	26	*35*
Non-Recirculating Aquaculture [(a) (b)]	12	*25*
Recirculating Aquaculture [(b)]	30	*5*
Ruminant Meat	62	*64*
Poultry	10	*30*
Pork	10	*27*

Source: Tilman and Clark, 2014

(a) Production systems used not specified, but based on the results, it appears obvious that these are systems with low energy requirements, either water-based net pens or cage systems, or extensive pond systems relying on gravity for flow of water through the system.

(b) Species not specified.

Based on an evaluation of the results of all these studies (Tilman and Clark, 2014; Winther, 2009; Nobre, 2010), it is apparent that the two main variables in terms of energy use and GHG emissions up to the farm gate, are feed production and on farm energy use for pumping of water.

EVALUATION OF DEVELOPMENT OPTIONS

High-volume pump and gravitate flow-through systems (as per abalone) and recirculating systems (pumping to continuously recirculate water and energy use for water purification and treatment as per intensive or super-

intensive land-based systems) are obviously more energy intensive than non-recirculating systems that do not rely on pumping of water. In the wider NMB Metro, options for non-recirculating systems would be sea-based cage or net pen aquaculture in Algoa Bay or fresh water cage or net pen aquaculture in dams. The feasibility of sea-based cage or net pen aquaculture in Algoa Bay has been the topic of a separate EIA and falls outside the scope of this EIA. Freshwater aquaculture within dams in NMB Metro will also require separate investigations.

For land-based aquaculture in the Coega IDZ, and wider NMB Metro, all seawater used will require pumping via a seawater intake point to a high point from where it can be gravitated, and freshwater used would have either been pumped via the NMB Municipal water supply network or pumped from a borehole in the case of groundwater.

The results presented above are all for mono-culture systems, i.e. just salmon or just abalone (without seaweed). Integrated and multi-trophic aquaculture and the integration of other agricultural crops in the form of aquaponics (seawater and fresh water) all have huge potential to reduce overall resources use (water, land, feed input and energy use) and GHG emissions per unit product produced. The following examples illustrated the potential:

- Water use and pumping costs could be halved if pumped water is used twice to grow two species rather than one.
- The waste (mainly feces) from every 1 kg finfish produced contains sufficient nutrients to produce 9 kg of vegetable matter. Introduction of aquaponics would utilize the nutrients as opposed to it having to be treated and/or released to the environment.

Within the IDZ, there are also potential linkages and synergies between different industries that could, over time, be explored to reduce the energy requirements associated with pumping and to generate alternative energy. These include:

- Utilizing ‘clean’ fresh process water released from the Cerebos Plant that is currently released back to the salt works.
- Integrating flow-through aquaculture and desalination, where water is first pumped to height and used for aquaculture and then fed to a desalination plant, thus sharing pumping costs. However, to be useful such a system necessitates that the flow-through aquaculture system is located at a higher elevation than the desalination plant.
- Generating hydro-power along the gravitational path the water follows before being releases back to the sea. Reportedly this option is being explored for an expansion at an existing abalone farm in the Western Cape, where the expansion area is located higher than the existing farm (Keagan Halley (DAFF), per. comm.)
- Using treated industrial water as feed for growing plants (seaweed / algae) in biogas generation, with possible linkages to the proposed biogas developments in the IDZ.
- Anaerobic digestion with heat and biogas generation (heat can potentially be utilised to heat aquaculture production water for species requiring warmer water).
- Utilizing ‘clean’ cooling seawater released from proposed CCGT power plant.
- Utilizing storm water runoff from areas in the broader IDZ, quality dependent.
- Utilizing rainwater harvested from roofs and greenhouses (tunnels) in the ADZ.
- As for Cerebos, future industries in the IDZ may present opportunities through ‘clean’ fresh process water releases (i.e. the Chlor-Alkali plant that was once considered for the IDZ and that may prove economically feasible in future).

MITIGATION MEASURES AND DESIGN CRITERIA

- *CDC to explore potential options and linkages between different industries in the IDZ to improve resource use efficiencies (fresh water, energy) and reduce GHG emissions.*
- *Fresh water aquaculture developments in the ADZ to demonstrate concerted efforts to reduce their*

fresh water consumptive use.

7.19 Socio-Economics

PRESENT STATE

Refer Section 6.14.

SPECIALIST STUDY

The Social Specialist Assessment, conducted by Dr Anton de Wit (De Wit, 2016b; Appendix G1).

Against the background of the body of existing experience, research and assessments (including Pollnac et al., 2006; CSIR, 2007; CEN, 2009; Umcebisi Business Advisers, 2012, 2013; EOH, 2014 in De Wit, 2016b), Dr de Wit established that it is relatively safe to say that the proposed ADZ is likely to exert much of its social influence at the local level. The affected environment, as far as the development of an ADZ in the Coega IDZ is concerned, therefore primarily involves the urban areas that collectively constitute the NMB Metro ('local' in this case means the NMB Metro). These include Uitenhage and KwaNobuhle in the northwest as well as the neighbouring town of Despatch; and the City of Port Elizabeth in the south with the Ibahi townships on its northern periphery. Directly southwest of the Coega IDZ is Motherwell, its relatively large residential neighbour.

Dr de Wit highlighted two key conclusions that played an important role during his identification and assessment of impacts:

- The ADZ, by virtue of its land-based nature, does not appear to be in conflict with other locally significant or highly valued land-use and/or activity such as tourism, leisure, residential functions, and so on. Aquaculture developments, when proposed for an offshore / marine environment (mariculture), often compete with tourism and leisure related land use and functions for example, as well as socio-spatial processes that may affect people's sense of place, and subsequently generate a wide variety of social impacts (Burbridge *et al*., 2001; Frankic, & Hershner, 2003; Umcebisi Business Advisers, 2012; 2013 in De Wit, 2016b).
- The proposed development will be located and contained within an existing IDZ and will eventually contribute to the establishment of an investment-ready zone. The location of aquaculture projects in such development zones is often viewed as an important measure to minimize user and land use conflict and thus to reduce the risk and uncertainty that are usually associated with aquaculture projects (FAO, 2009 in De Wit, 2016b).

ASSESSMENT OF IMPACTS

7.19.1 Socio-economic impacts

A project such as the proposed ADZ usually generates increased economic activity within a region as well as a range of employment opportunities and other economic impacts due to knock-on effects.

7.19.1.1 Creation of employment opportunities

Construction Phase

The proposed development of an ADZ in the Coega IDZ represents a civil engineering and construction project of considerable proportions. For that reason, a noteworthy outcome of this development throughout its construction phase will be the creation of various employment opportunities.[14] Table 1 subsequently shows some of the main attributes of employment creation in this case. Although jobs will be created in each of the three main categories, it is the semi-skilled category (as the case often is with large construction projects) that accounts for most of the 3:250 direct employment opportunities that will be created.

[14] *Although the exact duration of the construction phase of the proposed ADZ is not known at this stage, it should take not less than at least four years when compared with similar projects. Employment creation will thus not come in the form of a single momentous impact, but will be spread out across the duration of the construction phase.*

Of the 3:250 direct employment opportunities that will be created throughout the proposed ADZ's construction phase, 2:486 will go to semi-skilled workers from local communities in the NMB Metro (Table 7-8). It can safely be assumed that semi-skilled work in this case will be performed by workers from the Metro's less affluent residential areas and could quite possibly include people who are currently unemployed. The wage bill in this case would be slightly more than R238 million per year (2:486 semi-skilled workers earning ±R8:000 per month for at least a year).

Table 7-8: Employment creation during the construction phase

Direct employment opportunities [a]			Origin of workers [d]		
Category	**Remuneration pm**	**Number created [b]**	**NMB Metro**	**Elsewhere in the RSA**	**Abroad**
High level	±R40:000	163 (5%) [c]	8 (5%)	122 (75%)	33 (20%)
Mid-level	±R30:000	325 (10%)	16 (5%)	244 (75%)	65 (20%)
Semi-skilled	**±R8:000**	**2 763 (85%)**	**2 486 (90%)**	**276 (10%)**	**–**
TOTAL	–	3:250	2:511	642	98

a Direct employment refers to employment that is directly related to the construction phase and would, amongst others, include artisans such as carpenters, brick layers, plumbers, electricians, etc.

b The number of direct employment opportunities (3 250) was estimated using the total construction budget of the proposed ADZ (R1.8 billion) and the latest (2014) Average Sectoral Employment Multipliers of the Industrial Development Corporation (IDC, 2016). The applicable multipliers for Building Construction and Civil Engineering were specifically applied in this case.

c The percentage breakdown per employment category (high level / mid-level / semi-skilled) was provided by the CDC (2015b in De Wit, 2016b).

d The percentage breakdown per origin of workers (NMB Metro / elsewhere in RSA / abroad) was provided by the CDC (2015b in De Wit, 2016b).

It is clear that a substantial impact of the proposed development as far as employment during the construction phase is concerned, relates to the creation of (direct) semi-skilled jobs in the NMB Metro. When this figure tabled above is considered in the context of the current unemployment situation in the Metro (6.14 Section), the importance thereof is substantiated.

The essence of employment creation as an impact is however not only illustrated by its effect on local unemployment figures; the multiplication of the income earned by these employed people into the local economy and subsequent increased economic activity should also be noted. Accordingly, if 90% of all semi-skilled workers will come from the NMB Metro, then much of the income earned by them will be spent locally on consumer goods, living expenses, accommodation, entertainment, and so on. The increased local economic activity in this case amounts to slightly more than R247 million.[15] This secondary impact of employment creation is however not the only one.

Given the extent of the proposed development and the costs involved, the creation of indirect and induced employment opportunities would naturally follow. Whereas a direct job is something that is directly related to the construction of a project for example (Table 7-8, note a), indirect jobs are created due to the provision of goods and services by suppliers and distributers to the on-site construction activities. Induced jobs lastly result from the spending and consumption by direct and indirect workers (IFC, 2013 in De Wit, 2016b). At least 45% of the proposed ADZ's construction budget will be spent on local service providers (CDC, 2015b, in De Wit, 2016b), and using the same methodology as noted in (Table 7-8, note b), the number of indirect (local) employment opportunities that will be created by the proposed development's construction phase and activities is estimated at 338. The number of induced employment opportunities is estimated at about 1480.[16]

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15 This estimate was determined by first allowing for an arbitrary leakage (i.e. income spent beyond the geographical parameters of the local economy) of 20% from the total wage bill (direct employment). The IDCs Average Sectoral GDP multiplier for Wholesale and Retail Trade (IDC, 2016) was finally applied to estimate the increase in local economic activity affected by the construction wages per annum.

16 Note that since more than half of the ADZ's construction budget will be spent on service providers from outside the NMB Metro, not all of the induced jobs will benefit the local economy.

In view of the above descriptions, it is clear that the proposed ADZ by virtue of its scale will culminate in relatively large scale (predominately local) employment creation during its construction phase. This is likely to have a considerable social impact in the form of increased economic activity, poverty alleviation and favourable socio-economic implications (such as improved access to and consumption of goods and services, greater freedom of choice, better quality of life, and so on) for the affected individuals and their dependants.

Operational Phase

The proposed ADZ is destined to project the crucial impact that it is likely to have during its construction phase into its operational future as well, but predicting accurate operational phase employment can be notoriously difficult. Employment figures and ratios depend on a variety of factors, such as:

- The scale of the operation – large scale operations could be more automated and less labour intensive than a smaller one.
- The type of aquaculture system and species produced – employment rations for abalone farms in South Arica are well documented, but for newer technology and species, figures are less certain.
- Aquaculture investors are expected to establish in the ADZ in a phased manner as the market demand for aquaculture products matures. Employment figures will grow accordingly.

In order to err on the conservative side, employment figures are that are slightly lower than the CDC's targeted aquaculture production levels as discussed in Section 4.10 and presented here, and not the employment figures associated with the long-term full production capacity of the ADZ (Section 4.10.9). At the targeted production, the ADZ is expected to create more than 1:200 direct employment opportunities, of which the majority (918) will go to semi-skilled workers from local communities in the NMB Metro. It can also be assumed with a high degree of certainty that semi-skilled employment will mostly be performed by workers from the NMB Metro's less affluent residential areas. These workers could also come from the ranks of people that are currently unemployed. The wage bill in this case would be slightly more than R 88 million per year (918 semi-skilled workers earning ±R 8 000 per month over a year).

Table 7-9: Employment creation based on targeted aquaculture production in the ADZ

Direct employment opportunities [a]			Origin of workers [d]		
Category	**Remuneration/ mo**	**Number created [b]**	**NMB Metro**	**Elsewhere in the RSA**	**Abroad**
High level	±R40:000	60 (5%) [c]	3 (5%)	45 (75%)	12 (20%)
Mid-level	±R30:000	120 (10%)	6 (5%)	90 (75%)	24 (20%)
Semi-skilled	**±R8 000**	**1 020 (85%)**	**918 (90%)**	**102 (10%)**	**–**
TOTAL	–	1:200	927	237	36

a Direct employment refers to employment that is directly related to the operational phase of the ADZ.
b The number of direct employment opportunities (1:200) was sourced from CDC (2015a in De Wit, 2016b).
c The percentage breakdown per employment category (high level / mid-level / semi-skilled) was provided by the CDC (2015b in De Wit, 2016b).
d The percentage breakdown per origin of workers (NMB Metro / elsewhere in RSA / abroad) was provided by the CDC (2015b in De Wit, 2016b).

It is clear that a substantial impact of the proposed ADZ as far as employment during its operational phase is concerned, relates to the creation of (direct) semi-skilled jobs in the NMB Metro. When the figure in question is considered in the context of the current unemployment situation in the NBM Metro, the importance of this impact is substantiated.

As remarked in above, employment creation also has other noteworthy implications such as the multiplication of the income earned by employed people into the local economy and subsequent increased economic activity. Accordingly, if 90% of all semi-skilled workers in the ADZ's operational phase will come from the NMB Metro, then

much of the income earned by them will be spent locally on consumer goods, living expenses, accommodation, entertainment, and so on. The increased local economic activity in this case amounts to about R 91.5 million.[17]

As in the case of the construction phase of the proposed ADZ, a number of indirect and induced employment opportunities would needless to say also result from the operational phase, especially since 30% of the ADZ's annual maintenance budget is earmarked for spending on local service providers (CDC, 2015b in De Wit, 2016b). This detail is naturally not available and the number of employment opportunities can thus not be estimated.

In view of the above account, it is clear that the proposed ADZ will culminate in relatively large scale employment creation during its operational phase. This is likely to have a considerable social impact in the form of increased economic activity, poverty alleviation and favourable socio-economic implications (such as improved access to and consumption of goods and services, greater freedom of choice, better quality of life, and so on) for the affected individuals and their dependents.

7.19.1.2 Creation of opportunities for provision of goods and services by local service providers

Construction Phase

The demand for goods and services by relatively large construction projects is certain to affect the local economies which play host to such developments. Higher levels of local economic activity normally follow and this in turn is likely to culminate into various socio-economic benefits, such as employment creation and poverty reduction. The extent of this impact is of course a factor of the size and health of the local economy in question and the subsequent ability of local service providers to meet such demands. It follows that the more limited this ability, the more leakage will take place from the local economy as developers would be compelled to source relevant goods and services elsewhere (DBIS, 2008 in De Wit, 2016b).

The economy of the NMB Metro in general and local service providers in particular will benefit substantially from the demand for goods and services by the construction phase of the proposed ADZ. However, given the current economic state of the NMB Metro as well as the status of its hosting province as one of the poorest in the country, a certain amount of leakage from the local economy in favour of service providers elsewhere would obviously be inevitable. Considering the impact of the proposed ADZ's construction phase on the NMB economy, the following aspects nevertheless count in favour of the latter:

- The proposed development is a sizeable construction project that forms part of the Coega IDZ's ongoing quest to be a leading catalyst for socio-economic development.
- The economy of the NMB Metro currently exhibits a high potential for growth in the construction industry (ECSECC, 2014 in De Wit, 2016b).
- Although the local economy may not be able to meet all the needs of the ADZ's construction phase, with some leakage that will inevitably take place, at least 45% of the ADZ's construction budget is allocated to specifically benefit the suppliers and distributers of local goods and services (CDC, 2015b in De Wit, 2016b).

The 45% share of the construction budget of the proposed ADC translates into a considerable investment in local service providers, something that would be especially valuable against the background of poor local economic growth and bleak economic forecasts. It will enable higher levels of local economic activity, leading to much desired socio-economic benefits such as employment creation and poverty reduction, and will undoubtedly be a stimulant for economic growth via the relevant multipliers into the local economy.

[17] *This estimate was determined by first allowing for an arbitrary leakage (income spent beyond the geographical parameters of the local economy) of 20% from the total wage bill (direct employment). The IDCs Average Sectoral GDP multiplier for Wholesale and Retail Trade (IDC, 2016) was finally applied to estimate the increase in local economic activity caused by the operational wages per annum.*

Operational Phase

The demand for goods and services by the proposed ADZ's infrastructural and other maintenance requirements is certain to have some positive impact on the local economy which will host this development. The CDCs (2015b) estimate that 30% of the ADZ's annual maintenance budget will go to local service providers means that considerable leakage will take place from the local economy. This reflects the relatively limited ability of the NMB economy to meet the demand for goods and services during the ADZ's operational phase. However, in view of the physical extent of the ADZ, 30% of the maintenance budget per year should nevertheless translate into a considerable local investment. The consequence is similar to the relevant impact during the ADZ's construction phase, i.e. it will enable higher levels of local economic activity, leading to socio-economic benefits such as employment creation and poverty reduction, and will undoubtedly be a stimulant for economic growth via the relevant multipliers into the local economy.

7.19.1.3 Contribution to the GGP of the NMB Metro

Construction Phase

Gross Geographic Product (GGP) provides a measure of the total economic and sectoral activity within a particular area (municipalities, regions, *etc*.). Expressed as the Rand (market) value of all final goods and services that are produced and sold within a given period of time, GGP is a well-known measure of a municipality's economic activity. It can therefore be used to reflect the capability of a municipality to create, sustain and develop its own economy. Major contributions to the GGP of any particular place therefore carry an obvious importance, something that is particularly associated with the economic impact of large construction projects (Nhlapo, 2013 in De Wit, 2016b).

The GGP of the NMB Metro is in the vicinity of R 48.2 billion (2013) and accounts for slightly more than 40% of the GGP of the Eastern Cape Province (ECSECC, 2013 in De Wit, 2016b). The latter in turn contributes about 8% to South Africa's GDP. The South African share of the proposed ADZ's construction budget is 90%, while the remaining 10% is to be spent abroad (CDC, 2015b in De Wit, 2016b). The South African component of the construction work therefore amounts to R 1.62 billion which is likely to have a total impact on national GDP of about R 1.76 billion, given the relevant multiplier effect in the economy.[18] Of this expenditure, 45% will be spent within the economy of the NMB Metro and will subsequently account for almost 2% of the Metro's GGP. This would obviously be a contribution of note and it is not uncommon to find such associations between relatively large construction projects in the NMB Metro and the local GGP (NMB Municipality, 2015a in De Wit, 2016b).

7.19.2 Empowerment impacts

Construction Phase

Empowerment impacts result from the social or economic empowerment of vulnerable and other groups. Investors in the ADZ will have to engage in an economic empowerment process in order to supply the proposed ADZ with the necessary local labour.

Operational Phase

The CDCs corporate objective of socio-economic development and transformation is equally applicable to the operational phase of the proposed ADZ. As far as employment creation in this phase is concerned, it is also mainly in the area of semi-skilled work that the CDC will have its biggest potential impact. However, since the local limiting factors of illiteracy and low levels of post-school education and/or training are equally applicable to the ADZ's operational phase, the developer will most likely have to engage in a large-scale process of skills development and transfer if it is to create 918 jobs.

[18] *The IDCs Average Sectoral GDP multiplier for Building Construction (IDC, 2016) was applied to estimate the contribution of the ADZs construction work to the national GDP.*

Against the background of existing poverty and unemployment rates in the NMB Metro as well as the fact that many of the unemployed may be unemployable without some form of intervention, skills development and transfer are likely to have a substantial socio-economic impact discussed above. The benefits would basically revolve around the improved socio-economic mobility of people relative to their former limited occupational prospects, as well as the fact that they would be vocationally empowered in an industry which is likely to experience increased and continued growth in the future (Frankic, & Hershner, 2003; Mahieu, 2015 in De Wit 2016b).

7.19.2.1 Skills development and transfer

Construction Phase

The commitment by developers to recruit local labour, as far as possible, in order to benefit local communities in general and the unemployed in particular, is almost standard practice in South Africa when large construction projects are proposed. The proposed ADZ is of course no different and a sizeable number of employment opportunities will subsequently be created within the semi-skilled category. This is likely to have a considerable social impact in the form of poverty alleviation and favourable socio-economic implications (improved access to and consumption of goods and services, greater freedom of choice, better quality of life and so on) for the affected individuals and their dependants.

The CDC, directed by its corporate objective of socio-economic development and transformation, has already achieved more than 85% local labour absorption on all existing construction projects under its management (CDC, 2015c in De Wit, 2016b). The procurement of a predominantly local labour force during the construction phase of the proposed ADZ can therefore be predicted with a reasonable amount of certainty, especially since the CDC in this case aims to recruit 90% of all semi-skilled workers from the population of workers that reside in the NMB Metro. One limiting factor that is expected to complicate the prioritisation of local labour during the construction phase of the proposed ADZ is the educational attainment of the prospective labour force, particularly in the case of semi-skilled workers. The twin problems of illiteracy and low levels of post-school education and/or training are clear obstacles in this case. Thus, in order to supply the construction phase of the proposed development with the necessary local labour, the developer will most likely have to engage in a process of skills development and transfer.

In a Metropolitan area burdened by poverty and high unemployment rates and where many of the unemployed may actually be unemployable without some form of intervention, skills development and transfer are likely to have a substantial socio-economic impact. The benefits would essentially revolve around the improved socio-economic mobility of people and should extend well beyond the construction phase of the proposed development. Relevant individuals would for example be able to sell their newly acquired skills within and beyond the boundaries of the local economy long after the completion of the construction phase.

Operational Phase

The CDCs corporate objective of socio-economic development and transformation is equally applicable to the operational phase of the proposed ADZ. As far as employment creation in this phase is concerned, it is also mainly in the area of semi-skilled work that the CDC will have its biggest potential impact. However, since the local limiting factors of illiteracy and low levels of post-school education and/or training are equally applicable to the ADZ's operational phase, the developer will most likely have to engage in a large-scale process of skills development and transfer if it is to create 918 jobs.

Against the background of existing poverty and unemployment rates in the NMB Metro as well as the fact that many of the unemployed may be unemployable without some form of intervention, skills development and transfer are likely to have a substantial socio-economic impact. The benefits would basically revolve around the improved socio-economic mobility of people relative to their former limited occupational prospects, as well as the

fact that they would be vocationally empowered in an industry which is likely to experience increased and continued growth in the future (Frankic, & Hershner, 2003; Mahieu, 2015 in De Wit 2016b).

7.19.3 Population related impacts

The socio-economic implications of the proposed ADZ, particularly the creation of employment opportunities, are likely to attract employment seekers from within NMB Metro as well as from places further afield. Impacts revolve around the role of induced migration.

7.19.3.1 Induced migration and conflict between local unemployed people and employment seekers from elsewhere

Construction Phase

Induced migration refers to the movement of people who are compelled (by socio-economic hardship for example) to migrate to a place or region that offers relatively better (socio-economic) opportunities. Induced migration in South Africa occurs commonly and is sometimes referred to as temporary circular migration. This involves temporary migrants who leave a socio-economically deprived place or region to find work elsewhere (usually a town or city), from which they eventually remit money back to their places of origin (Stats SA, 2006). It is against this background that the proposed development of the ADZ is almost certain to attract employment seekers, not only from within the boundaries of the NMB Metro, but probably also from elsewhere in the Eastern Cape Province. This attraction is driven by existing poverty and unemployment levels elsewhere in the province and possibly even beyond and is difficult to prevent (Kok & Aliber, 2005 in De Wit, 2016b). The migration of employment seekers to the NMB Metro from places further afield can therefore happen in spite of a commitment or policy by the developer to recruit most of its workforce locally.

High unemployment, poverty and destitution levels, combined with unrealistically high expectations of finding employment, are already a source of competition between people originating from the same area. If unemployed people with equally high expectations from elsewhere are introduced to the situation, conflict between such so-called *'outsiders'* and local employment seekers or *'insiders'* can be expected due to a fierce and unhealthy competition for scarce employment opportunities (Ndletyana *et al*., 2013 in De Wit, 2016b).[19] This conclusion applies well to the proposed ADZ's construction phase. The reason lies in the number of semi-skilled employment opportunities that the proposed ADZ is expected to create, as well as the appeal that this is likely to have for unemployed people both within and outside the NMB Metro.

Operational Phase

The construction phase impacts that are associated with induced migration are likely to apply to the proposed ADZ's operational phase as well. Employment creation during the ADZ's operational phase, especially in the case of semi-skilled work, represents a substantial impact. The associated driver that compels people to migrate to the NMB Metro will therefore be as strong, if not stronger, than during the ADZ's construction phase. Conflict between migrants, or so-called *'outsiders',* and local employment seekers, or *'insiders,* can subsequently be expected due to a fierce and unhealthy competition for scarce employment opportunities.

7.19.3.2 Induced migration and the spread of HIV/AIDS

Construction Phase

It is well-documented that any development activity which requires and/or compels workers to migrate from one place to another on a temporary basis (including the familiar examples of mining and construction) is likely to contribute to the spread of disease. Single young men are in this case often associated with the introduction of

[19] *Occasional conflict between the poor and unemployed in many of the NMB Metro's less affluent residential areas (particularly its townships) and newcomers into these environments from elsewhere, fuelled amongst others by competition for scarce resources, has been well-reported by the local and national media since 2009.*

HIV/AIDS to host communities and/or the spread of this disease to areas elsewhere (SAMP, 2005 in De Wit, 2016b).

Although the majority of the workforce associated with the construction phase of the proposed ADZ will be sourced locally, some employees (including 10% of the semi-skilled workforce) will originate from elsewhere in the country (CDC, 2015b in De Wit, 2016b). The possibility furthermore exists that a number of employment seekers (driven by poverty and unemployment elsewhere and attracted by the ADZ's employment prospects) will be compelled to migrate to the NMB Metro. The issue of migrant labour is especially relevant because it has least two important social consequences that are usually singled out in most SIAs: one refers to the question of conflict between employment-related insiders and outsiders; and the other, particularly in a South African context, involves the spread of HIV/AIDS as noted above.

That the proposed ADZ will source some of its workers from elsewhere and given the likelihood that it is bound to attract much more than just the envisaged 10% of its semi-skilled workforce from beyond the NMB Metro, ultimately means that a contribution to the spread of HIV/AIDS may be an important consequence of this development. This possibility is particularly relevant in view of the fact that HIV/AIDS currently continues to have a devastating effect on the social and economic development of the Metro's population (NMB Municipality, 2015b in De Wit, 2016b).

Operational Phase

The same semi-skilled labour ratios that applied to the construction phase of the proposed ADZ will also apply to its operational phase. As a result, 10% of the ADZ's operational semi-skilled workforce will originate from outside the NMB Metro (CDC, 2015b in De Wit, 2016b). Since the question of migrant labour is associated amongst others with the spread of disease, particularly HIV/AIDS, this construction phase impact is likely to apply to the operational phase of the proposed ADZ as well.

7.19.3.3 Induced migration and the increased demand for housing and municipal infrastructure and serviced

Construction Phase

Urban policy makers and planners in South Africa often view the question of migration (urbanization) as problematic. Two key reasons for this include firstly that the migration of people to towns and cities cannot easily be stopped or even redirected, and secondly of course that migration adds to the existing demand for urban infrastructure, services and housing (Stats SA, 2006 in De Wit, 2016b). That the proposed ADZ will source some of its semi-skilled workers from elsewhere and the likelihood that it could attract much more than just the envisaged 10% of this labour component from places other than the NMB Metro, means that the migrants in question will add to the local demand for infrastructure, services and housing.

According to the latest census, the NMB Metro is home to 30:202 informal households while 1:488 households occupy informal structures in backyards (Stats SA, 2011 in De Wit, 2016b). These figures collectively define a considerable housing backlog which mainly plagues the Metro's less affluent areas. In addition to this reality, the Metro's infrastructure, including services such as transport, energy, telecommunications, water, sanitation and health, is generally deficient. This situation is exacerbated by inadequate maintenance and prematurely deteriorating installations and services (NMB Municipality, 2015b in De Wit, 2016b).

In view of the existing backlogs and deficiencies as far as housing and infrastructural services in the NMB Metro's less affluent areas are concerned, migrants in the numerically dominant semi-skilled cohort are likely to add to the demand for these relatively scarce and currently underprovided resources. Apart from the influx of hopeful employment seekers into the Metro, this demand would also be fueled by the possibility that not all the employed semi-skilled workers from elsewhere will necessarily leave the Metro once their contracts expire.

Operational Phase

Against the background of the existing housing and infrastructural services backlogs in the NMB Metro's less affluent areas, migrant workers (including hopeful employment seekers) are likely to extend the increased demand for these relatively scarce resources well into the proposed ADZ's operational phase.

7.19.3.4 Induced migration and increased criminal activity

Construction Phase

It is relatively common, according to the South African Police Service and SIA practitioners alike, that an increase in local criminal activity could accompany the construction phase of most large development projects. This association usually follows the sudden increase in the availability of cash wages, especially in less affluent areas (or wherever semi-skilled workers are accommodated), which provides the necessary stimulus for criminal behaviour. This may vary from petty crime to organised crime (involving drugs and prostitution for example) in the case of large developments (WBCSD, 2005 in De Wit, 2016b). The influx of a potentially large and temporary semi-skilled workforce in the case of the proposed ADZ, and the availability of cash wages, could therefore contribute to an increase in crime, particularly where such workers stay.

The NMB Metro as a whole is generally known as one of the safer metropolitan areas in South Africa. However, when the question of crime in the NMB Metro is examined at the neighbourhood level, certain 'problem' areas challenge the position of even the most unsafe in the country. Examples are Kwanobuhle south of Uitenhage, the Ibahi townships of KwaZakhele and New Brighton, and Motherwell to the south-west of the Coega IDZ. These areas outperform the rest of the Metro when it comes to crime against the person (especially murder) and crime against property (including robbery and hijacking (Rnews, 2014 in De Wit, 2016b). With labour migrants swelling the ranks of people in the NMB Metro's less affluent areas, and very likely those mentioned above, a further increase in criminal activity can therefore be expected.

Operational Phase

Given the positive link between an increase in the availability of cash wages and criminal behaviour, and also considering the wage bill for semi-skilled workers, the proposed ADZ's operational phase may go hand-in-hand with an increase in crime in some of the NMB Metro's less affluent areas or wherever semi-skilled workers are accommodated.

7.19.4 Public health and safety impacts

7.19.4.1 Public health and safety impacts due to increased vehicular traffic

Construction Phase

With more than 2:000 local employment opportunities involved in its construction phase, the proposed ADZ will generate a substantial amount of traffic as far as the daily movement of its workforce is concerned. It is anticipated that most workers will use mass public transport (busses) to commute to and from the construction site. Some workers are likely to commute via the regular bus service from the Coega Village at Wells Estate, while the majority who will probably stay in Port Elizabeth's less affluent areas will have to rely on the bus routes that are established by the Algoa Bus Service. It will take an estimated number of between 60 and 70 bus trips to transport workers to and from the construction site per day.

The transport of workers will of course supplement the other construction related (mostly heavy) vehicular traffic that is expected to coincide with the ADZ's construction phase. It can be expected that much of the total traffic volume that will be produced by the ADZ at this stage will share the existing N2 National Road with regular road users. Construction related traffic within the Coega IDZ, notably on Neptune and Ring Road amongst others, would also increase markedly. The capacity of the N2 National Road in the area of the Coega IDZs entrance is in the vicinity of 4:000 vehicles per hour per direction, well below its current level of utilisation. Traffic movement within the Coega IDZ is also at relatively low levels. Although the N2 National and other relevant roads therefore appear

have the capacity to absorb the added traffic, the addition of mostly heavy construction related vehicles can nevertheless potentially affect existing mobility patterns. This could culminate in health and safety impacts through the potential increase in motor vehicle and pedestrian related accidents.

Operational Phase

Not significant.

ESTABLISHED MANAGEMENT PRACTICES IN PLACE IN THE COEGA IDZ

Between 2002 and 2015, construction projects in the Coega IDZ and Port of Ngqura have generated over 60 million man hours and during this time the CDC's labour and economic statistics reflect lost time due to industrial action notably lower than the national average that demonstrates effective project stakeholder management and good labour relations as well as international best practice in infrastructure development (The Project Manager, 2016).

- Since the first construction projects took place in the Coega IDZ in 2002, the CDC has development policies, procedures and systems to manage labour relations, recruitment and the potential for induced migration of job seekers associated of large-scale developments. Integral to this success, is the Coega IDZ Zone Labour Agreement (ZLA), an agreement that has been negotiated between various stakeholders in the South Africa construction industry. It serves as a labour management framework that contractually binds all parties and provides standards for employment relations. It ensures that the interests of employees and the interest of employers are maintained while working on the Coega IDZ (The Project Manager, 2016). The ZLA includes measures to limit induced migrants attracted to the IDZ, specifically through:
- Operation of a recruitment centre.
- Commitment in terms of preferential recruitment of local labour, specific to job certain categories.
- Induction training.
- The CDC has established a Labour and Business Management Services unit to mitigate the influx of people. This is in accordance with the requirements of the original environmental authorisation issued for the Port of Ngqura, which stipulated that the CDC and NPA, in collaboration with the NMB Municipality must plan for the influx of job seekers.
- The CDC operates a Recruitment and Induction Centre where job seekers can register, and recruitment 'at the gate' or 'on-site' is not allowed.
- The CDC runs awareness programmes to communicate its recruitment processes and to advise job seekers on the proper channels to use to register and apply for a job.

ADDITIONAL MANAGEMENT PRACTICES RECOMMENDED FOR THE COEGA IDZ (DE WIT, 2016B)

- The CDC recruitment of labour process to be aligned with the ISO 31000 (Risk Management) and SANS 16001 (Wellness and Disease Management) standards and benchmarks.
- The CDC to establish communication linkages with:
    - NMB Municipality Safety and Security Directory.
    - NMB Municipality Public Health Directorate and Eastern Cape Department of Health on HIV/AIDS management matters.
    - NMB Municipality Human Settlements Directorate on matters related to land, infrastructural services and housing planning processes of the NMB Municipality.

MITIGATION MEASURES AND DESIGN CRITERIA

- *The CDC to communicate their labour and recruitment policies, procurement and processes to Contractors and Operators.*

- *Recruitment to only take place through established CDC structures and procedures. Prospective job seekers that attempt to gain employment 'at the gate' or 'on-site' are to be advised to use the formal process through a CDC Recruitment Centre.*
- *Operators and Contractors to communicate the exact extent and nature of the required labour force to the CDC to facilitate sourcing of labour through the established CDC structures.*
- *Preference to be given to local labour, suppliers, contactors and service providers as per CDC policies and procedures, and the requirements of the ZLA.*
- *If inflated and/or unrealistic expectations regarding employment become apparent, this is to be communicated to the CDC Labour and Business Management Services for their prompt attention.*
- *The CDC to communicate the particulars of the proposed ADZ's construction phase, such as its nature, extent, construction schedule, and anticipated size and composition of the labour force, to relevant stakeholders in order to plan for and address the potential for increased criminal activity. This includes the Safety and Security Directorate of the NMB Municipality, South African Police Service, relevant Ward Councillors and Community Police Forums, representatives of the local private security service industry, and the Eastern Cape structure of Business Against Crime.*
- *Adhere to the CDC Standard Health and Safety Specification for Construction (SES) and the requirements of applicable legislation, including the Occupational Health and Safety Act, Construction Regulations, and National Road Traffic Act.*

RATING OF IMPACTS

Detailed ratings of the impacts in terms of intensity, duration, extent, consequence, probability, frequency and significance were completed as part of the specialist study (Appendix G1, De Wit, 2016b). A summary is provided below.

Construction Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Employment creation*				
Overall Significance of Impacts	Negative High	Positive Medium	Positive Medium	N/A	As Existing
Nature of the Impact	*Provision of goods and services by local service providers*				
Overall Significance of Impacts	Negative High	Positive Medium	Positive Low	N/A	As Existing
Nature of the Impact	*Contribution to the GGP of the NMB Metro*				
Overall Significance of Impacts	Negative Medium	Positive Low	Positive Low	N/A	As Existing
Nature of the Impact	*Skills development and transfer*				
Overall Significance of Impacts	Negative High	Positive Medium	Positive Medium	N/A	As Existing
Nature of the Impact	*Induced migration and conflict between local unemployed people and employment seekers from elsewhere*				
Overall Significance of Impacts	Negative Medium	Negative Low	Negative Very Low	As Existing	As Existing
Nature of the Impact	*Induced migration and the spread of HIV/AIDS*				
Overall Significance of Impacts	Negative High	Negative Low	Negative Very Low	As Existing	As Existing
Nature of the Impact	*Induced migration and increased demand for housing and municipal infrastructure and services*				
Overall Significance of Impacts	Negative High	Negative Medium	Negative Very Low	As Existing	As Existing

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Employment creation*				
Nature of the Impact	*Induced migration and increased criminal activity*				
Overall Significance of Impacts	Negative High	Negative Medium	Negative Low	As Existing	As Existing
Nature of the Impact	*Public health and safety impacts due to increased construction related vehicular traffic*				
Overall Significance of Impacts	Negative Very Low	Negative Low	Negative Very Low	As Existing	As Existing

Operational Phase

	Existing Impact	Project Impact		Cumulative Impacts with Project Mitigation	No Go Development
		Unmitigated	Mitigated		
Nature of the Impact	*Employment creation*				
Overall Significance of Impacts	Negative High	Positive High	Positive High	N/A	As Existing to Unknown
Nature of the Impact	*Provision of goods and services by local service providers*				
Overall Significance of Impacts	Negative High	Positive High	Positive High	N/A	As Existing to Unknown
Nature of the Impact	*Skills development and transfer*				
Overall Significance of Impacts	Negative High	Positive High	Positive High	N/A	As Existing to Unknown
Nature of the Impact	*Induced migration and conflict between local unemployed people and employment seekers from elsewhere*				
Overall Significance of Impacts	Negative Medium	Negative Medium	Negative Very Low	As Existing	As Existing to Unknown
Nature of the Impact	*Induced migration and the spread of HIV/AIDS*				
Overall Significance of Impacts	Negative High	Negative High	Negative Very Low	As Existing	As Existing to Unknown
Nature of the Impact	*Induced migration and increased demand for housing and municipal infrastructure and services*				
Overall Significance of Impacts	Negative High	Negative High	Negative Very Low	As Existing	As Existing to Unknown
Nature of the Impact	*Induced migration and increased criminal activity*				
Overall Significance of Impacts	Negative High	Negative High	Negative Medium	As Existing	As Existing to Unknown
Nature of the Impact	*Public health and safety impacts due to increased construction related vehicular traffic*				
Overall Significance of Impacts	Negative Very Low	Negative Low	Negative Very Low	As Existing	As Existing to Unknown

ASSESSMENT OF RISKS

A detailed assessment of risks was completed as part of the specialist study (Appendix G1, De Wit, 2016b). No unacceptable risks were identified.

CONCLUSIONS

As with any large-scale development project, there are potential social and economic benefits and there are potential risks. Potential risks are associated with the development are largely based around labour and induced migration and the secondary negative spin-offs thereof. These issues are not unique to the aquaculture sector – they are faced by any development and construction project and the CDC appears to have a good track record of managing these impacts within the IDZ over the past decade (see Section 6.16). Positive impacts are related to employment creation, opportunities for the provision of goods and services, skills transfer, etc. again issues typical of many development projects. Overall socio-economic benefits are expected.

7.20 Social Impacts of Climate Change

INFORMATION SOURCES

The assessment in this section is based on the report: Synopsis of the impact of climate change on the Eastern Cape Provence and the NMB Metro, prepared by Dr Anton de Wit (De Wit, 2016) and the Social Specialist Assessment by Dr De Wit (2016b), attached as Appendix G1.

ASSESSMENT OF IMPACTS

NMB Metro is likely to experience a variety of knock-on effects associated with climate change in the future. This in summary includes the following (De Wit, 2016):

- Anything that will be influenced by warmer temperatures and less rainfall: from human health, architecture, and urban agriculture, to suburban gardens, indigenous fauna and flora, and biodiversity.
- Anything that will be influenced by more frequent and prolonged drought episodes (including local water stress and compromised water security): from sporadic difficulties with domestic water supply to the ability of the local economy to industrialize the NMB Metro out of its economic woes, and its high unemployment and poverty levels.
- Anything that will be influenced by more frequent and intense adverse weather events, such as storms and flash floods; and anything that will be influenced by coastal storm surges and coastal inundation and erosion: including formal and informal settlements, livelihoods, private and public infrastructure, economic activity on low lying areas and floodplains, and estuarine habitats and biodiversity.
- Anything that will be influenced by sea level increase and changes in other oceanic parameters such as sea temperature and acidity: including urban planning and development; private and public infrastructure (including harbours) through increased wave action and coastal erosion, tourism and recreation through increased beach erosion, and the local fishing industry and mariculture operations due to changing marine habitats.

Based on the above, De Wit (2016b) concluded that there is really not much that will escape the effects of climate change in the NMB Metro's future, including the proposed development of an ADZ in the Coega IDZ. The question however is how and to what extent the viability of the ADZ will be affected.

Since the impact of more frequent and intense adverse weather events (a possible effect on infrastructure development) can be mitigated by more appropriate engineering solutions, the only critical impact as far as the ADZ is concerned seems to be the question of sea water quality (a possible climate change impact via changing temperature and water chemistry). If this in future turns out to be a significant limiting factor (and due to a lack of information it is not really possible to make any definitive declaration on the matter at this stage, particularly in Algoa Bay), then mitigation could include the cultivation of more suitable and/or adaptable fish species. It would be wise to focus research and development efforts on the development of technologies to cultivate such adaptable species.

CONCLUSIONS

Climate change appears to be less of a limiting factor at this stage than other factors such as the political stability of the country and the relative value of the local currency. Therefore, until more information is available that will influence the consequence and significance of social impacts, climate change is unlikely to have much bearing on any of the social and economic impacts described in Section 7.19.

7.21 Climate Change Adaptation

Developments situated too close to the sea are threatened by erosion and wave attack and over time to sea level rise induced by climate change. The EIA Regulations recognises the need for protection of the coastal zone by way of requiring, with certain exceptions, an environmental assessment and EA for developments taking place in the littoral active zone and/or within 100 m from HWM.

Both the EIA Regulations and the ICMA allow for the pro-active determination of coastal management lines, (called setback lines in EIA Regulations and previously in the ICMA), and definition of a coastal protection zone to introduce area-specific flexibility and refinement to the use of the arbitrary 100 m line from the HWM. In areas where a coastal management line has been adopted, an environmental assessment and EA is required, with certain exceptions, for most infrastructure development on the seaward side of the line. A coastal management line (or 'setback' line) provides protection to properties against coastal flooding and erosion by ensuring that buildings and structures are not located in an area susceptible to these hazards and allows room for the HWM to naturally move inland through sea level rise throughout the economic lifetime of the property (Linham and Robert, 2010).

Realistic coastal management lines have the potential to maintain both the economic and ecological functioning of the littoral active zone and to mitigate the impacts of climate change. They also provide buffers around aquatic ecosystems which can then act as important ecological corridors. Allowing developments to encroach beyond ecologically determined setback lines will often necessitate expensive protection of these developments against disasters such as flooding. Construction of structures to protect properties and other infrastructure cannot be considered long term solutions for any existing or future developments (Theron and Rossouw, 2008 in DEDEAT, 2016). In 2012, the NMB Municipality through DEDEAT embarked on a study process to establish coastal management lines and to define the coastal protection zone limit for the NMB Metro. This culminated in the publication of the NMB Coastal Management Lines by DEDEAT in terms of the ICMA on 19 December 2016 (Eastern Cape Provincial Gazette No 3777). The study defined:

- A theoretical HWM.
- The maximum scour envelope (or retreat HWM).
- Future regression of the HWM under three sea-level rise scenarios: 300, 600 and 1000 mm rise.
- A coastal management line.
- Coastal protection zone limit.

A maximum sea level rise of 1000 mm over a 100 year period combined with a 1 in 10 year sea storm was used to define the coastal management line, which represents the hazard zone and environmental buffer inland from the current HWM to maintain a functional coastal ecosystem under a future sea level rise scenario of 1000 mm.

For Zone 10 and the ADZ, the coastal protection zone limit was drawn to include the mobile dune areas that form part of the littoral active zone. Some of the mobile dunes are earmarked for sand mining and once the sand has been removed, the delineation of the littoral active zone will have been altered.

Figure 6-10 illustrates the coastal management line, or hazard zone, at the 1000 mm (100 year) sea-level rise scenario (in yellow), the coastal protection zone around and inland of the mobile dunes (in red), the current theoretical HWM (in blue), as well as two other scenarios for a climate change induced sea-level rise at 300 mm (30 year), 600 mm (60 year) sea-level rise (in pink).

As discussed in Section 6.6, there appear to be major variances between this theoretical HWM and the HWM as observed on site. The difference between the observed and theoretical HWM is illustrated in Figure 6-10. In light of the following discussion on economic development and risk management for infrastructure below the coastal management line, this 30 m difference could have notable implications for decision-making regarding the positioning of infrastructure in the lower lying coastal part of the ADZ.

Coastal zones in many parts of the world are centres of critical economic activity (Linham and Robert, 2010). Adapting to climate impacts and trying to mitigate risks today includes the potential risk of maladaptation in the future; an integrated approach is needed to ensure appropriate adaptation from a broader perspective (Andersson-Sköld, 2015). Social and economic considerations cannot be ignored. By nature, certain infrastructure need to be close to the seashore, below the HWM, close to or within a source of sea water supply, at a low

elevation to reduce water pumping costs, or at an elevation lower than other developments in the area to facilitate water/waste water to be gravity fed – particularly those aquaculture systems that require large volumes of seawater but would not be economically viable if pumping costs are excessive.

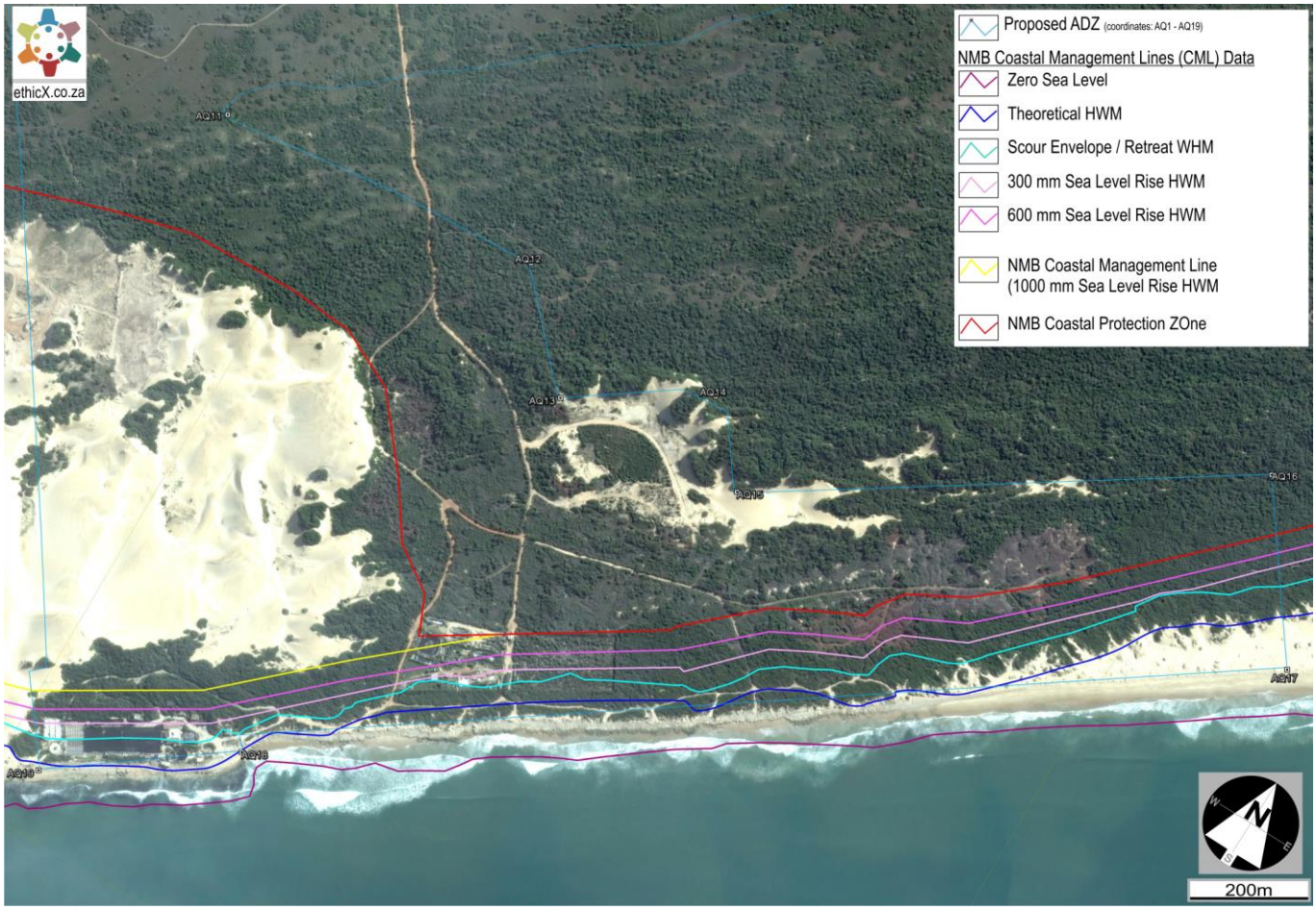

Figure 7-20: NMB Municipality Coastal Management Line
(Eastern Cape Provincial Gazette No 3777)

7.21.1 Development components below the coastal management line, within 100 m of the HWM and Below the HWM

7.21.1.1 Key Service Infrastructure below the Coastal Management Line

The following essential service infrastructure will be located, or partially located, on the seaward side of the coastal management line and within 100 m of the HWM.

Seawater intake and reticulation infrastructure

- Intake structures:
  - Beach abstraction or beach wells
  - Boreholes into saline aquifer.
  - Dedicated intake pipeline, with offshore intake structure at the seaward end of the pipe. This pipeline would supply the first aquaculture operators before CDC marine pipeline is in place.
  - Link to the CDC marine pipeline servitude once this is in place (the pipeline servitude is the subject of a separate EIA process).
- Pumps and pump houses.
- Reticulation pipelines (from the seawater intake structure to the pump station and from there to a reservoir or to individual aquaculture farms and the desalination plant), with inspection and maintenance manholes,

valves and other associated infrastructure.

- Electricity cables to the pump houses.
- Service and access track to pump houses, manholes and valves along the reticulation pipelines.
- Anti-fouling equipment and pipeline to the intake structure.

Waste water discharge infrastructure

- Reticulation pipelines for collecting pre-treated effluent and the desalination plant waste stream to the main discharge pipeline, with associated inspection and maintenance manholes, valves and other associated infrastructure.
- Release structures:
  - Dedicated release pipeline and outlet structure at the seaward end of the pipe to serve the first aquaculture operators before CDC marine pipeline is in place.
  - Link to the CDC marine pipeline servitude once this is in place (the marine pipeline servitude is the subject of a separate EIA process).
- Service and access road to manholes and valves along reticulation pipelines.

Storm water infrastructure

- Storm water outfall(s) into the surf zone (possibly needed in later years).

7.21.1.2 Selected Aquaculture Production Infrastructure Economically Sensitive to Height above Sea Level

Aquaculture production of marine species necessarily involves a link to the sea for seawater abstraction and release of treated effluent and production water. Flow-through aquaculture systems such as abalone farms require a continuous high-volume intake of seawater for their flow-through production systems. Their location in terms of height above sea level is of critical importance as it dictates the height to which water has to be pumped, and thus significantly affects operational costs.

Based on discussions with various specialists in the abalone aquaculture sector, it was confirmed that recirculation technology has not been successfully applied for abalone to date. All abalone farms that experimented with and invested in recirculating systems for the grow-out of abalone in South Africa have failed. Recirculating technology is only used during some of the hatchery stages and for a short period during the pre-harvest of the grown abalone. One such experimental recirculating farm located at 30 mamsl that failed was not able to convert to a flow-through system since the >30 m pumping elevation was regarded as prohibitive to financial success of the farm.

Height above sea level is regarded as a development constraint for high-volume flow-through seawater aquaculture production systems. In a flow-through seawater aquaculture system, all water is 'pumped at height' from the level of the seawater intake point to the highest point on the farm from where the water then gravitates through the aquaculture production area until it is released back to sea.

The EOH (2014) feasibility study indicated that abalone farms need to be located below 20 mamsl in order to avoid excessive pumping costs and to be economically feasible. Traditionally, the older abalone farms are at even lower elevations, and some are well within the arbitrary 100 m from the HWM management line. In Zone 10 of the ADZ, the old Marine Growers abalone farm was built virtually on the HWM line with all the buildings and structures within 100 m from the HWM and below the 5 mamsl contour line. Elsewhere there are abalone farms where most buildings and structures are below 12 mamsl and as close as 40 m horizontally to the HMW. The EIR and engineering layout plans for the proposed Qolora ADZ place the abalone production area of the ADZ at an elevation of 11 to 12 mamsl, but notably outside the 100 m from the HWM control line (CES, 2011; Element Engineering, 2014).

The fact of the matter is that the lower the pumping elevation, the lower the costs and more likely the farm is to be economically competitive with other farms in the country and worldwide. In comparison with the elevation of existing abalone farms as well as the planned abalone farms in the Qolora ADZ, an elevation of 20 mamsl appears to be at the higher end of the scale for abalone development to be financially competitive; and should be approached with caution (based on CDC comments at ELC meeting; Graham Taylor, pers. comm).

Suitable land below the 20 mamsl contour level but above the coastal management line (or the 100 m from the HWM control line in case no management line has been defined) where there is no conflict with conservation, residential, recreation and tourism land uses, is notoriously scarce along the coast of the NMB Metro and most of the South Africa. Within the Coega IDZ and the ADZ there is no conflict with these other land uses, but there is only a narrow segment of land below the 20 mamsl contour and above the coastal management line and the arbitrary 100 m from the HWM control line, as depicted on Figure 7-15. A notable portion of this land segment is covered by mobile sand dunes and will only become available for aquaculture developments at some point in future once the areas have been mined to remove the sand and expose the stable underlying calcrete base. A narrow segment of land parallel to the contour lines is also not ideal for a production system dependent on maximising opportunities for gravity feeding water once it has been pumped at height.

The acceptability of a development on the seaward side of the coastal management line is often an issue of risk appetite and a trade-off between the risk of damage to or loss of the structures versus functionality and cost (Mather, 2014). The benefit of being close to the shoreline might justify the long term costs associated with having to decommission and rebuild or relocate developments to higher ground, the infrastructure being destroyed, and the cost of flood insurance premiums (or the cost of not being able to secure insurance).

Since this EIA is for a 'development zone' and not a specific aquaculture project, it is unclear if aquaculture operators will have the 'risk appetite' to establish aquaculture production infrastructure below the coastal management line. To cover this eventuality it is essential to have structured decision-making criteria in place. Risk management criteria for evaluating the merits of locating structures and infrastructure in areas potentially affected by sea level rise are therefore proposed below.

7.21.1.3 Existing Structures and Infrastructure

The old abalone farm and portion of the old pilot prawn facility is located on the seaward side of the NMB Municipality's coastal management line and the arbitrary 100 m line from the HWM.

The criteria for development decision-making in areas potentially affected by sea level rise in Section 7.21 would therefore apply to decision-making on the re-use and any potential upgrades to these facilities.

7.21.2 Criteria for development decision-making in areas potentially affected by sea level rise

A: Always assume a managed retreat approach to sea level rise adaptation

A coastal management line, or setback line, forms part of the 'managed retreat' approach to sea level rise adaptation. Managed retreat implies moving development away from a rising sea level to allow the water to advance unimpeded, and involves the following three principles:

1. The planned abandonment of threatened areas, including a ban on new developments in areas likely to be inundated in future.
2. The eventual abandoning, demolishing or moving of existing buildings and infrastructure to higher ground, and
3. Strict control that allows only certain types of relocatable or floodable structures in areas likely to be inundated in future (Tam, 2009) – this principle will apply to proposed developments associated with the ADZ.

The opposite of managed retreat would be the 'defend' approach to sea level rise adaptation, which is typically associated with hard or semi-hard engineering options and building of coastal defences such as seawalls, storm surge barriers, and beach protection structures such as groynes, breakwaters, artificial reefs and artificial dunes. Adoption of a 'defend' approach to sea level rise adaptation would require extensive planning and strategic assessment of the regional implications, which fall outside the scope of this local level EIA. The managed retreat approach is thus assumed as the default approach to sea level rise adaptation for developments in the ADZ.

The CDC and aquaculture farmers need to accept that the actual rate of sea level rise is uncertain and so is the time window before the structures has to eventually be abandoned, decommissioned and or moved to higher ground in line with a managed retreat approach.

B: First explore alternatives

Finding alternatives to locating developments within an area prone to sea level rise should be explored first. This includes options to make the development less sensitive to the costs of pumping water at height and reducing overall resource use efficiency, thus making the development better suited to locate on land at higher elevations in the ADZ. For example:

- Adopting integrated aquaculture or seawater aquaponic systems, where water is used more than once to grow multiple species.
- (Partial) recirculation or re-use of production water where possible.
- Finding alternative uses for the water pumped at height before it is gravitated and released back to sea. Such as:
  - Integrating flow-through aquaculture and desalination, where water is first pumped to height and used for aquaculture and then fed to a desalination plant, thus sharing pumping costs. However, to be useful such a system necessitates that the flow-through aquaculture system is located at a higher elevation than the desalination plant.
  - Generating hydro-power along the gravitational path the water follows before being releases back to the sea. Reportedly this option is being explored for an expansion at an existing abalone farm in the Western Cape, where the expansion area is located higher than the existing farm (Keagan Halley (DAFF), per. comm.)
  - Using the water as feed for growing seawater-adapted plants (seaweed / algae) as input for biogas generation, with possible linkages to the proposed biogas developments in the Coega IDZ.
- Using alternative energy sources to make the development less sensitive to rising electricity prices and pumping costs over time, such as solar, wind, and biogas generation from waste.
- Continued improvement and adoption of new technologies to reduce the overall operational costs and improve resource use efficiency. Based on a plethora of research projects in the field, there appears to be a drive worldwide to develop improved technologies for the aquaculture sector. These may not be viable during the initial years of the ADZ but may be become viable in time for implementation at an individual farm or ADZ level, and include:
  - Biogas generation from aquaculture production waste and aquaculture processing waste.
  - Integrated or multi-trophic aquaculture.
  - Improved aquaculture feed and feeding ratios, and options to replace wild-caught fish with alternative lipids and protein sources such as produced algae, insects, or microbial biomass and the byproducts and waste from farmed fish.
  - Improved production water treatment processes that are less energy intensive and allows for more intensive aquaculture systems (more recirculation of the water and lower water exchange levels).

C: Strict control that allows only certain developments (or parts of developments) in areas prone to sea level rise

Based on the principles of a managed retreat, the following risk management guidelines for developments in the ADZ on areas on the seaward side of the coastal management line are proposed.

C1: Assess the risks based on infrastructure value, lifespan, impact of failure, and a planned sea level rise window

The NMB coastal management line study process and report (DEDEAT, 2016) recognised that there is an inherent need to determine the economic requirements of the coast and those economic demands may require a trade off with environmental aspects at a particular site. The study report included a decision matrix, as tabled below, for risk selection to sea level rise for coastal developments to deal with the possible conflicts between the desire for environmental protection and the need for economic activities. The matrix was developed by eThekwini Municipality, and includes criteria such as infrastructure value, lifespan, impact of failure, and a planned sea level rise window as decision-making criteria and essentially deals with managing the third principle of managed retreat – strict control that only allows certain types of structures in areas potentially affected by sea level rise.

Table 7-10: Risk matrix for decision-making and risk selection criteria in areas potentially affected by sea level rise

Value of Infrastructure	Life of Infrastructure	Impacts of Failure of the Infrastructure	Planned amount of sea level rise
Low (up to R 2 million) i.e. recreational facilities, car parks, board walks, temporary beach facilities.	**Short Term** (less than 20 years)	**Low** Minor inconvenience, Alternative facilities in close proximity, short rebuild times	**0.3 m**
Medium (>R 2 to R 20 million) i.e. tidal pools, piers, recreational facilities, sewerage pump stations.	**Short to Medium Term** (>20 to 50 years)	**Medium** Local impacts, loss of infrastructure and property	**0.6 m**
High (>R 20 to R 200 million) i.e. beachfronts, small craft harbours, residential homes, sewerage treatment works.	**Medium to Long Term** (>50 to 100 years)	**High** Regional impacts, loss of significant infrastructure and property	**1.0 m**
Very High (greater than R 200 million) i.e. ports, desalination plants, nuclear power stations.	**Long Term** (in excess of 100 years)	**Very High** Major disruption to the regional and national economy, failure of key national infrastructure	**2.0 m**

Source: Andrew Mather, eThekwini Municipality, in Mather, 2014 and DEDEAT, 2016.

Since the matrix was developed for a local municipality, most of the infrastructure examples are for public infrastructure but it provides principles that could be applied to any private development projects (or parts thereof), including aquaculture.

C2: Developments to be adaptable and designed with decommissioning in mind

All developments located on the seaward side of the coastal management line should either:

- Be designed to accommodate sea level rise; be floodable, or flood protected without creating unacceptable risk to the seashore. This would typically apply to marine pipelines that would be specially designed to accommodate and remain functional within certain sea level rise window.
- Be movable to higher ground before sea level rise occurs; such as 'lightly constructed' low impact structures without extensive foundations or concrete work, movable prefabricated tanks and aboveground piping, containerised water treatment plants, and prefabricated buildings (see examples pictured below).
- Be associated with structures and infrastructure that have a finite design life, again this involves lightly

constructed structures, aquaculture tanks and systems with say maximum 30 year life, which can be decommissioned and replaced, if so required, on higher ground (see examples pictured below).

- Be a high income generating development (but sensitive to elevation above the HWM) where the eventual cost of demolition and replacement at a different location can be financially justified.
- For all developments, unless the development is designed to be flooded or flood protected (as per the marine effluent or intake pipelines mentioned above), all developments should be planned and designed with eventual closure, decommissioning and rehabilitation in mind. This implies that:
  - A decommissioning plan and site rehabilitation plan is to be developed up front as part of the risk assessment and decision-making phase, including a cost estimate for the decommissioning, including removal of all structures, and rehabilitation of the site. The plan and cost estimate need to be reviewed and revised every three years or whenever changes are made that may affect the cost of decommissioning or rehabilitation.
  - If successful decommissioning without unacceptable environmental impacts cannot be demonstrated, the development should not be allowed to take place.
  - The developer needs to demonstrate that financial provision is being made in the business plan for eventual closure and decommissioning, including removal of all structures and rehabilitation of the site.
  - CDC to ensure that the necessary assurances are in place to avoid developers abandoning a site and leaving it in an un-rehabilitated state (as was the case with the old SeaArk pilot prawn facility).

C3: Avoid unacceptable risks

Since the rate of sea level rise and occurrence of storm surges are difficult to predict, developments should be designed and operated to avoid unacceptable risks.

- Employee safety must not be compromised during storm surges and flooding. This includes the location of high human traffic areas such as office and security guard buildings and processing plants outside the risk zone and putting in place an evacuation and emergency response plan.
- Biosecurity and biodiversity risks associated with storm surges and sea level rise to be strictly avoided. This would include a restriction on the production of high risk species where escapees during flooding, or system overflow water could pose a risk to biodiversity in Algoa Bay.
- Damage to and washing away of structures should not be able to cause unacceptable environmental damage.
- Site specific measures to prevent erosion and sedimentation, spillage of hydrocarbons and chemicals or contaminated storm water entering the nearshore to be put in place. A site specific risk assessment and mitigation plan to be developed.

C4: Accommodate mobile dunes, indigenous vegetation and windblown sand

The design and layout of all developments on the seaward side of the coastal management line need to carefully consider dune stability and movement, and measures to manage and accommodate windblown sand, and should:

- Comply with the design criteria and mitigation measures contained in Section 7.5 on Coastal Dunes and Sediment Dynamics.
- Detailed site layout plan to be developed in conjunction with vegetation specialist to ensure that the remaining pockets of natural indigenous vegetation are accommodated into buffer zones.

C5: Allow only suitable components of a development

The criteria for risk management need to be applied selectively to certain components within an aquaculture farm. Higher risk, higher value and more sensitive components, such as office buildings, processing plants, laboratories, water treatment and waste water treatment plants could be placed at a higher elevation while lower elevations are used for lightly constructed low impact structures such as the examples pictured below.

Plate 7-2: Example of prefabricated, potentially relocatable aquaculture tanks and piping at a recently developed commercial abalone farm

Plate 7-3: Example of lightly constructed aquaculture tanks with a limited design life and potentially relocatable, at a commercial abalone farm in SA

Plate 7-4: Example of lightly constructed seawater aquaponics system at a commercial scale installation, USA

Plate 7-5: Example of a containerised mobile water treatment plant

Plate 7-6: Example of a geotextile sludge dewatering and stabilisation system, designed for easy removal from site when full

D: Consider cumulative impacts on the coastal zone and marine environment

Particularly relevant to the ADZ is consideration of cumulative impacts on the marine environment, from all the developments in the ADZ and rest of the IDZ coastal cluster for development. Allowing one development in the coastal zone should not be seen as approval of all other development proposals. Cumulative impacts need to be considered.

MITIGATION MEASURES AND DESIGN CRITERIA

- *All structures and infrastructure considered in areas on the seaward side of the coastal management line to be considered based the above-mentioned Criteria for Development Decision-Making in Areas Potentially Affected by Sea Level Rise (EIR Section 7.21.2).*
- *A risk assessment to be undertaken based on these criteria, with mitigation plan to address all risks.*

7.22 Construction Management

The preceding sections of the report highlighted various construction-related impacts and recommendations for mitigation. These recommendations form part of the EMPs for the ADZ. Other general construction-related matters have been dealt with in previous EIAs for the Coega IDZ and are therefore already written into the CDC's

environmental specifications and procedures pertaining to construction. These matters are not repeated in this EIR or in the EMPr.

7.23 Managing Decommissioning

Over the life of the ADZ, some structures and infrastructure and investor facilities may have to be decommissioned in part or in full if it has reached the end of its useful life. The impacts of the decommissioning will be very similar to the construction impacts described in preceding sections of the report.

MITIGATION MEASURES AND DESIGN CRITERIA

- *Structures and infrastructure that have reached the end of its useful life and that cannot be repurposed or justifiably used for another purpose are to be demolished or dismantled and removed from the ADZ, and the land rehabilitated unless another use for the land has been identified.*

8 Environmental Impact Statement

Provided in the front of the report, as the executive summary.

9 Conclusion and Recommendations

Based on the outcome of the various specialist studies and a detailed assessment of all potential significant impacts (Section 7 of the EIR), the EAP concluded that there is no reason why the development of the proposed ADZ should not be authorized. The EAP carefully evaluated all impacts as well as all the issues raised during the public participation process and included mitigation measures and design criteria to address all of these. The recommendations made by the various specialists were carefully considered all were integrated into the mitigation measures and design criteria as presented in the EIR.

It is recommended that the proposed ADZ be authorised on condition that the mitigation measures and design criteria contained in the EIA and EMPr be implemented.

10 Environmental Assessment Practitioner Declaration

Mari Wolmarans, the undersigned, has been active in the environmental consultancy field since 1992, and has been a registered professional environmental scientist since 2001, and certified as an environmental assessment practitioner since 2004.

The undersigned declares that this EIR represents an objective and complete assessment of the environmental impacts associated with the proposed Coega ADZ in Zone 10 of the Coega IDZ.

Neither Ethical Exchange Sustainability Services (Pty) Ltd nor the undersigned have any material present or contingent interest in the outcome of environmental impact assessment process for the proposed Coega ADZ, nor do they have any pecuniary or other interest that could be reasonably regarded as being capable of affecting their independence.

Mari Wolmarans, as independent environmental assessment practitioner, has completed and submitted a declaration of interest, as part of the application form for environmental authorisation. Details regarding her qualifications and relevant professional experience above are listed in Section 11.1 of the report. A full CV and a declaration signed under oath are included in Appendix H.

Mari Wolmarans
BL Arch, MSAIE&ES, EAPSA Certified
DIRECTOR
Ethical Exchange Sustainability Services (Pty) Ltd

11 Study Team

11.1 Environmental Assessment Practitioner

Name	Mari Wolmarans
Company	Ethical Exchange Sustainability Services (Pty) Ltd
Contact Details	Tel: 041 823 9010, Fax: 086 562 0165 Email: mari@ethicx.co.za
Abbreviated CV	
Position	Director
Expertise	Mari Wolmarans has been active in the environmental consultancy field since 1992. She has been a registered professional environmental scientist since 2001, and certified as an environmental assessment practitioner since 2004. Mari has written and reviewed numerous environmental assessment reports, environmental management programme reports and environmental audit reports over the past 15 years. She specialises in the management of environmental impact studies, multi-disciplinary teams of specialists and all aspects related to the environmental legal and procedural requirements of projects as well as the development of environmental management programmes and systems and environmental audits during construction and operation.
Career History	Ethical Exchange Sustainability Services (Pty) Ltd, from July 2011, Director and Founding Member. Synergistics Environmental Services (Pty) Ltd (now part of SLR), Feb 2004 to June 2011, Director and Founding Member. WSP Environmental (previously Walmsley Environmental Consultants), Jan 1999 to Feb 2004, Associate, Head of Environmental Assessment Unit (2002-2004), Senior Consultant (1999-2002). Ninham Shand Consulting Engineers (now part of Aurecon), 1996-1998, Senior Environmental Scientist. Van Riet & Louw (now V&L Landscape Architects and Environmental Planners), 1990-1996, Consultant.
Qualifications	Bachelor in Landscape Architecture: Faculty of Natural Science, UP, 1991. Negotiation and Business Management, one-year postgraduate diploma, 2003.
Continued Education	Integrated Water Resource Management, Water Use Authorisations and Water Use License Applications, CBSS, 2015. Integration of HIV and Gender-Related Issues into the EIA Process Workshop, SAIEA. ISO14001 Awareness Course, Advantage. A.C.T, 2012. IEMA approved Carbon Footprint Management Course, Aspects International, 2011. Environmental Impact Assessment: Project Management Short Course, CSIR, 2002. IEMA accredited Environmental Management System Implementation Course, WSP, 2001. IEMA accredited Internal Environmental Management System Auditing Course, WSP, 2001. IEMA accredited Environmental Auditor Training Course, Aspects International, 2000.
Professional Affiliations	Environmental Assessment Practitioner, certified by Interim Certification Board (EAPSA) since 2004. Professional member of the South African Institute of Ecologists and Environmental Scientists (SAIE&ES) since 2001. Member of the International Association for Impact Assessment (IAIA). Registered Carbon Assessor with the Carbon Protocol of South Africa.

11.2 Environmental Study Team and Specialists

Name	Role
Mari Wolmarans	Environmental Assessment Practitioner, Project Lead
Wim Schroeder	Consultation Process
Brendon Steytler	Assistant Project Manager
Dr Brian Colloty	Ecological (Terrestrial and Aquatic) Specialist Assessment (with input on Avifauna by Dr Paul Martin)
Deborah Vromans	
Dr Werner Kurt Illenberger	Dune Geomorphology Specialist Assessment
Dr Russell Chalmers	Marine Specialist Assessment
Timothy Guy Paulet	Biosecurity and Biodiversity Risk Assessment
Dr Anton de Wit	Social Impact Assessment Synopsis of Climate Change Outlook
Various (quoted in text)	Waste Streams and Management Options for Aquaculture The initial intention was for an aquaculture industry specialist to provide an assessment of waste management options and to make recommendations. This would have been feasible if the assessment was focused on a specific aquaculture project, but since the ADZ is for a wide-spectrumof possible aquaculture designs and systems as well as for desalination, it was more appropriate to consult with various people with a diverse background working with different aquaculture designs and systems. Ethical Exchange compiled the information based on consultation with various aquaculture industry specialists and an extensive literature review of international research on the topic of waste management in the aquaculture sector.

12 Study Approach and Methodology

12.1 Impact Assessment, Ranking and Rating System

The identification and assessment of environmental impacts is a multi-faceted process, using a combination of quantitative and qualitative descriptions and evaluations. It involves applying scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The process involves consideration of, *inter alia*: the purpose and need for the project; views and concerns of I&AP's; social and political norms, and general public interest.

The methodology used for assessing impacts associated with the proposed project followed the philosophy of environmental impact assessment as described in the booklet 'Impact Significance, Integrated Environmental Management Information Series 5' (DEAT, 2002b). The philosophy is summarised by the following extracts:

- "The impact magnitude [or intensity] and significance should as far as possible be determined by reference to legal requirements, accepted scientific standards or social acceptability. If no legislation or scientific standards are available, the EIA practitioner can evaluate impact magnitude based on clearly described criteria. Except for the exceeding of standards set by law or scientific knowledge, the description of significance is largely judgemental, subjective and variable. However, generic criteria can be used systematically to identify, predict, evaluate and determine the significance of impacts." (DEAT, 2002b).
- "Determining significance [of impacts] is ultimately a judgement call. Judgemental factors can be applied rigorously and consistently by displaying information related to an issue in a standard worksheet format." (Haug et al., 1984 taken from DEAT, 2002b).

The purpose of undertaking an impact assessment is to ensure that the project proactively considers environmental issues as part of the project planning and decision-making processes and throughout the project life cycle.

For each environmental component, impacts were identified and assessed in terms of: detectability / visibility of the impact, exposure of receptors to the impact, compliance with legislation and standards, other applicable targets, limits or thresholds of concern, the level of change / intrusion imposed, and receptor sensitivity. The impact assessment considered:

- Physical, biological, social and economic components of the environment and their interrelationships;
- The ability of receptors and affected parties to adapt to changes and thus maintain livelihoods after the operation has closed;
- The effects of all stages of the project life cycle, including planning construction, operation, and decommissioning and post closure must be considered;
- Positive and negative environmental and social impacts;
- Direct, indirect, induced and cumulative impacts;
- Short- and long-duration impacts within the zone(s) of influence, and extreme events;
- Potential trans-boundary effects and global impacts (e.g. air pollution, withdrawal of water from an inter-provincial and international waterway and emission of greenhouse gasses);
- Potential impacts on local communities and/or other vulnerable individuals or groups;
- Socio-political risks (e.g. political instability);
- Impacts associated with supply chains where the resource(s) utilised by the project are sensitive.

The perceived sensitivity of receptors (people and/or receiving environment) were professionally judged based on available scientific data (fact) and feedback from public participation processes (views, opinions, attitudes, and concerns).

12.1.1 Existing Impacts and Reasonably Anticipated Impacts

Defining the current level of degradation associated with existing developments is essential to understand and enable the assessment of cumulative impacts. The ADZ is located in an area affected by sand mining, previous aquaculture activities, stabilisation of dunes using drift fences and alien vegetation species. In addition, it is located within an IDZ where other industries are located. Where relevant, the assessment of existing impacts considered the current level of environmental degradation associated with existing activities, as well as reasonably anticipated impacts of developments under construction and new developments for which the impacts have been defined.

12.1.2 Incremental Impacts (Project Impacts)

Incremental impacts refers to the impacts of an activity looked at in isolation (impacts of an individual project), thus not considering the combined, cumulative or synergistic impacts of the activity, or the cumulative impacts of the activity with other activities or the existing impacts. It is essential to assess incremental impacts on order to understand a development's overall contribution to cumulative impacts.

12.1.3 No-Go Development Impacts

The no-go development was assessed as an alternative in the EIA.

12.1.4 Cumulative Impacts

In terms of regulatory requirements and the principles of integrated environmental management, the EIA process for the proposed project must consider cumulative impacts. For this project, cumulative impacts will be determined as:

Existing Impacts	+	**Reasonably Anticipated Impacts**	+	**Incremental (Project) Impacts**	=	**Cumulative Impacts**
Existing impacts (current level of degradation) associated with existing developments and other land uses.		*Reasonably anticipated impacts of anticipated developments that are under construction or that have been approved and where the impacts have been defined.*		*Impacts of the only the ADZ.*		*Existing impacts PLUS Reasonably anticipated impacts PLUS ADZ project impacts.*

12.1.5 Mitigation Measures

Mitigation measures were identified based on the recommendation of the team of specialists, comments from I&AP's, discussions with CDC and stakeholders, and Ethical Exchange's extensive experience with the development and auditing of environmental management programmes and systems. The significance of environmental impacts will be rated before and after the implementation of mitigation measures. The impact rating system considers the confidence level that can be placed on the successful implementation of the mitigation.

12.1.6 Rating of the Significance of Environmental Impacts and Mitigation Measures

The following system was used for evaluating impact and risks of

. Ethical Exchange has been using this system successfully on various impact assessments over the years and has aligned it to meet the requirements of 2014 EIA Regulations. The system has been developed to be rigorous, transparent and consistent, and thus it can be independently reviewed and audited.

Table 12-1: Impact Rating Criteria and Assessment Process

Impact Rating Criteria		Explanation of Impact Rating Criteria and Assessment Process	
Step 1:		**Identify and Describe the Nature of the Impact**	
Type of Impact	Existing Impacts	Current levels of degradation or pollution, associated with existing developments, or developments under construction.	
	Project Impacts	Impacts of the proposed project and associated activities and infrastructure (also known as incremental impacts).	
	Reasonably Anticipated Future Impacts	Impacts associated with developments where the impacts are known and defined in an approved EIA and where project implementation is eminent or reasonably expected. Impacts associated with developments where the impacts are known and have been defined in an approved EIA.	
	Cumulative Impacts	The combined effect of existing impacts, project impacts and reasonably anticipated future impacts.	
Environmental Aspect		Impact source. An 'element of an organisations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an environmental impact.	
Project Phase		Pre-Implementation	Planning and Design, including Pre-Construction
		Implementation	Construction, including and major refurbishing and expansion
			Operation, including routine maintenance
			Rehabilitation (after Construction, Refurbishing and Decommissioning)
		Decommissioning	
Impact Status		Negative	Impacts with a potential negative / adverse effect
		Neutral	Impact is not positive or negative / No impact
		Positive	Impacts with a potential positive / beneficial effect
Step 2:		**Identify and Discuss Mitigation / Impact Management Measures**	
Mitigation Measures		Measures to avoid, reduce or remedy adverse impacts, or compensate for residual adverse impacts. Measures to expand and augment (enhance) the effect of positive impacts.	
Step 3:		**Rating of Impact Consequence and Significance (using Impact Rating Matrix)**	
Unmitigated		Impact rating assuming the proposed mitigation measures are not in place.	
Mitigated		Impact rating assuming the proposed mitigation measures are in place and project is implemented in accordance with the design parameters outlined in the EIR.	
Intensity (Negative Impacts)	Eliminated	The impact was considered and assessed but found to be not applicable to the project site or surroundings.	
	Minor	Slight change, disturbance or nuisance. Targets, limits and thresholds of concern never exceeded. Impacts are rapidly and easily reversible. Require no or only minor interventions or clean-up actions if these impacts occur. No complaints expected when the impact takes place.	
	Moderate	Moderate change, disturbance or discomfort. Large enough to have a real effect. Targets, limits and thresholds of concern may occasionally be exceeded. Impacts are reversible but may require some effort, cost and time. Sporadic complaints can be expected when the impact takes place.	
	Major	Substantial change, disturbance or degradation. Real and prominent effects. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Regular complaints can be expected when the impact takes place.	
	Extreme	Extreme change, disturbance or degradation. Serious disruption to the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope. Potentially catastrophic. Legal requirements and key EMPr targets, limits and thresholds of concern continually exceeded. Interest group or community mobilisation against project can be expected when the impact takes place. May result in legal action if impact occurs.	

Impact Rating Criteria		Explanation of Impact Rating Criteria and Assessment Process
Intensity (Positive Impacts)	Eliminated	The impact was considered and assessed but found to be not applicable to the project site or surroundings.
	Minor	Slight change or improvement. Minor benefits.
	Moderate	Moderate change or improvement. Real but not substantial benefits.
	Major	Prominent change or improvement. Real and substantial benefits. General community support.
	Extreme	Considerable large-scale change or improvement compared to current conditions. Widespread benefit. Favourable publicity and/or widespread support expected.
Extent	Spatial (geographical) scale of the impact.	
	Site	Impact limited to within the boundaries of the project site. Not notable impact on receptors beyond the site boundary.
	Local	Impact notable in the immediate area (< 5 km) around the project site. Individual sensitive receptors may be affected. Does not affect an entire neighbourhood, habitat or community. Does not affect large numbers of people in nearby townships.
	Regional	Widespread impact within province / district or quaternary catchment. Large area or large numbers of sensitive receptors affected. May affect an entire community, neighbourhood or habitat. May affect large numbers of people in nearby residential areas.
	(Inter)national	National and or international (transboundary) impacts.
Duration	Risk or impact period. Total length of time (i.e. number of months or years) that the impact or risk will be present.	
	Short-term	Less than 5 years. Impact may occur for the first few years of the project, during construction, or for up to five years. Once the impact source has been removed, the effects are reversible within a one year period.
	Medium-term	> 5 to 10 years. Impact may occur for up to ten years. Once the impact source has been removed, the effects are reversible within a three year period.
	Long-term	> 10 years, and for < 10 years after decommissioning or rehabilitation. May occur throughout the operational life of the project, but will cease after operations ceases either because of natural processes or human intervention / remediation. Once the impact source has been removed (i.e. decommissioning and rehabilitation) the effects are reversible within a ten year period.
	Permanent	Permanent. Irreversible (residual impacts will remain for more than 10 years after the impact source has been removed.
Probability	Likelihood that the impact will occur.	
	Eliminated	The impact was considered and assessed but found to be not applicable to the project site or surroundings.
	Highly Unlikely	Conceivable but will only happen in exceptional circumstances (<20% chance of happening).
	Possible	Plausible. Could happen and has occurred here or elsewhere (20 to 50% chance of happening).
	Highly Likely	Probable (>50 to 80 % chance of happening).
	(Near) Certain	Definite or expected. The impact cannot be prevented. (>80 % chance of happening).
Frequency	How often (number of occurrences) the impact would manifest over the impact duration period.	
	Sporadic	< 5% of the time. Once off occurrence. Effects only present for a short period of time, no residual effects.
	Occasional	5 to 30% of the time. Occurring from time to time without specific periodicity or pattern. Effects are reversed quickly and easily.
	Regular	> 30 to < 80% of the time.
	(Near) Always	> 80 to 100% of the time.
Significance	Significance = Consequence x (Probability + Frequency)	
	Negative Very High	Widespread negative effect. Negative impact that is of the highest order. Potential fatal flaw. Unacceptable impact / loss of a resource will occur.
	Negative High	Substantial negative impact.
	Negative Moderate	Negative impact that is real but not substantial.
	Negative Low	Low to negligible negative impact with little real effect.
	Positive Low	Low to insignificant positive impact.
	Positive Moderate	Positive impact that is real but not substantial.
	Positive High	Substantial positive impact.
	Positive Very High	Widespread/substantial beneficial effect.

Impact Rating Criteria		Explanation of Impact Rating Criteria and Assessment Process	
Step 4:		**Comment on Risks**	
Degree to which impact could cause irreplaceable loss of resources:		None	Risk considered and assessed but found to be not applicable to the project site or surroundings.
		Highly Unlikely	Conceivable but will only happen in exceptional circumstances (<20% chance of happening).
		Possible	Plausible. Could happen and has occurred here or elsewhere (20 to 50% chance of happening).
		Highly Likely	Probable (>50 to 80 % chance of happening).
		(Near) Certain	Definite or expected (>80 % chance of happening).
Degree to which impact can be avoided, managed, or mitigated:		Can be fully mitigated	
		Can be partially mitigated	
		Mitigation not possible	
Degree to which impact can be reversed:		Can be fully reversed	
		Can be partially reversed	
		Cannot be reversed, permanent impact	
Likelihood of mitigation measures being implemented successfully (Mitigation reliability):		(Almost) Certain	
		Highly likely	
		Possible	
		Unlikely	
		Uncertain	
Assessment Confidence		High	
		Medium	
		Low	
Degree to which assessment supports decision-making:		Incomplete data for decision-making	
		Acceptable / adequate data for decision-making	
		Complete	
Step 5:		**I&AP interest based on comments and feedback received during the public participation process**	
I&AP Interest	Negative Very High	Widespread concern and/or specific concerns of very high importance. Concerns difficult to be addressed to satisfaction of authorities or concerned parties. Various substantiated appeals against project anticipated / highly likely if issues are not resolved and addressed to the satisfaction of the concerned parties.	
	Negative High	Several concerns and/or specific concerns of high importance. Real and substantial appeals against project possible if not addressed.	
	Negative Moderate	Limited concerns. All concerns addressed. Unsubstantiated appeals possible.	
	Negative Low	Minor concerns.	
	Neutral	No interest.	
	Not defined	Level of interest has not been tested.	
	Positive Low	Very little support for project.	
	Positive Moderate	Limited support for project.	
	Positive High	General support. May be associated with high community expectations.	
	Positive Very High	Widespread support. May be associated with extremely high community expectations.	

Impact Rating Criteria	Explanation of Impact Rating Criteria and Assessment Process

Impact Rating Matrix

CONSEQUENCE = Intensity + Duration + Extent	INTENSITY:	DURATION:	EXTENT: Site	Local	Regional	(Inter)national
	Extreme	Permanent	High			
		Long-term	High	High		
		Medium-term	High	High	High	
		Short-term	Medium	High	High	High
	Major	Permanent	High	High		
		Long-term	High	High	High	
		Medium-term	Medium	High	High	High
		Short-term	Medium	Medium	High	High
	Moderate	Permanent	Medium	Medium	High	High
		Long-term	Medium	Medium	Medium	High
		Medium-term	Low	Medium	Medium	Medium
		Short-term	Low	Low	Medium	Medium
	Minor	Permanent	Low	Low	Medium	Medium
		Long-term	Low	Low	Medium	Medium
		Medium-term	Low	Low	Low	Low
		Short-term	Low	Low	Low	Low
	Eliminated	Permanent	None			
		Long-term				
		Medium-term				
		Short-term				

SIGNIFICANCE = Consequence x Probability + Frequency	PROBABILITY:	FREQUENCY:	CONSEQUENCE: None	Low	Medium	High	Very High
	(Near) Certain	Regular / Always	None	Low	Medium	High	
		Occasional	None	Low	Medium	High	
		Sporadic	None	Very Low	Low	Medium	High
	Highly Likely	Regular / Always	None	Low	Medium	High	
		Occasional	None	Very Low	Low	Medium	High
		Sporadic	None	Very Low	Very Low	Low	Medium
	Possible	Regular / Always	None	Very Low	Low	Medium	High
		Occasional	None	Very Low	Very Low	Low	Medium
		Sporadic	None	Very Low	Very Low	Very Low	Low
	Highly Unlikely	Regular / Always	None	Very Low	Low	Medium	High
		Occasional	None	Very Low	Very Low	Low	Medium
		Sporadic	None	Very Low	Very Low	Very Low	Low
	Eliminated	N/A	None				

Precautionary Weighting	The significance of negative impacts may be increased when there is, based on professional judgment by the specialists and EAP, a potential understatement of the significance of a negative impacts.

12.2 Competent Authority

The competent authority is the DEA, who will be administrating and the EIA process, make a decision to grant or refuse the project, and define conditions for the development.

12.3 Overview of the Environmental Assessment Process

Ethical Exchange Sustainability Services has been appointed by the CDC to complete an EIA for the establishment of an ADZ and associated processing facilities, including the public participation process, and the applications to obtain the necessary government approvals such as the environmental authorisation, water use licence and waste management licence, and coastal authorisation in terms of the National Environmental Management Act and the National Water Act, National Environmental Management Waste Act, and National Environmental Management Integrated Coastal Management Act respectively.

In terms of environmental authorisations and licensing, the purpose of this EIA is to put in place the required environmental authorisations as part of the establishment of the 'development platform' so as to avoid each individual developer having to undertake their own EIA process, streamlining investments in the ADZ and reduce high entry costs for startup aquaculture operations. It will also allow investors to go to market quicker, therefore making it a more attractive investment opportunity and securing Coega ADZ as a preferred site for aquaculture development. In line with the principles of integrated environmental management, it will avoid the fragmentation of environmental assessments and approvals.

The establishment of a 'development platform' does however imply that specific project details and designs will only become available once the individual developers have made the decision to invest in the Coega IDZ and have completed their individual designs and layout plans – in principle this is similar to the two rezoning EIAs that were approved for the establishment of the IDZ. As in the case of the rezoning EIAs, this limitation was overcome with the establishment of design criteria for developments within the ADZ. The established CDC EMPr and environmental guidelines serves as a basis for environmental management in the ADZ, especially with regards to general activities that are common to developments in the IDZ, such as noise management, visual design guidelines, general construction activities, vegetation management, etc. This EIR and EMPr did not attempt to repeat the work that has been already completed and the environmental specifications and procedures that already in place. Rather, it focusses on issues specific to aquaculture developments and specific to Zone 10 in the IDZ. The EIR and EMPr therefore contain specific design criteria and requirements for the ADZ.

The EIA was undertaken in accordance with the National Environmental Management Act and the 2014 EIA Regulations published on 4 December 2014 in Government Notice Regulation (GNR) 928, read together with the Listing Notices 1, 2 and 3 published in GNR 983, 984 and 985 respectively. Listing Notices 1 and 3 lists activities for which a basic assessment for environmental authorisation (EA) is required, while activities that require a full scoping and environmental impact assessment for environmental authorisation are listed in Listing Notice 2.

The Coega ADZ includes activities from all three listing notices (Appendix A) and as such, the EIA process was conducted in two phases – an initial scoping phase, with a scoping report (final report issued in July 2016) followed by a full EIA phase, specialist studies and public participation process, culminating in this environmental impact report (EIR) for submission to the DEA.

The overall purpose of an EIR is to provide the decision-making authorities with sufficient information on which to base their decision to grant or refuse the project, and if granted, to define conditions for the development. The contributions made by interested and affected parties (I&AP's) and stakeholders from all sectors of society, as part of the public participation process, have been captured to ensure informed decision-making.

Information contained in the various EIAs and specialist investigations already completed for Coega IDZ and Zone 10 in particular were utilised during this EIA process – most notable is the extensive database of baseline information about the site and affected environment. The information was supplemented with focused specialist

investigations as part of this EIA. For details regarding the planned studies and the way forward for the EIA refer to Section 1.10.

The CDC marine pipeline EIA, is a separate EIA currently underway, to identify a servitude for sea water intake and discharge pipelines that will serve not only the ADZ but also those investors that require seawater for cooling purposes or for desalination. It investigates the impacts associated with the pipelines as it spans over land and coastal environments, as well as the impacts on the marine environment associated with the abstraction of water from the sea and, in particular, the impacts associated with the discharge of effluent into the sea. The marine pipeline EIA will thus assess the impacts of the anticipated ADZ effluent as well as effluent from other industries and the proposed waste water treatment plant in the Coega IDZ, as well as the physical impacts of the sea water intake and discharge pipelines to and from Zone 10. The impacts of the release of effluent to the marine environment will therefore not be assessed as part of the Coega ADZ EIA.

The Coega ADZ EIA therefore focused on impacts associated with the land-based infrastructure associated with the ADZ in Zone 10, including the establishment of a desalination plant and seafood processing plants in Zone 10.

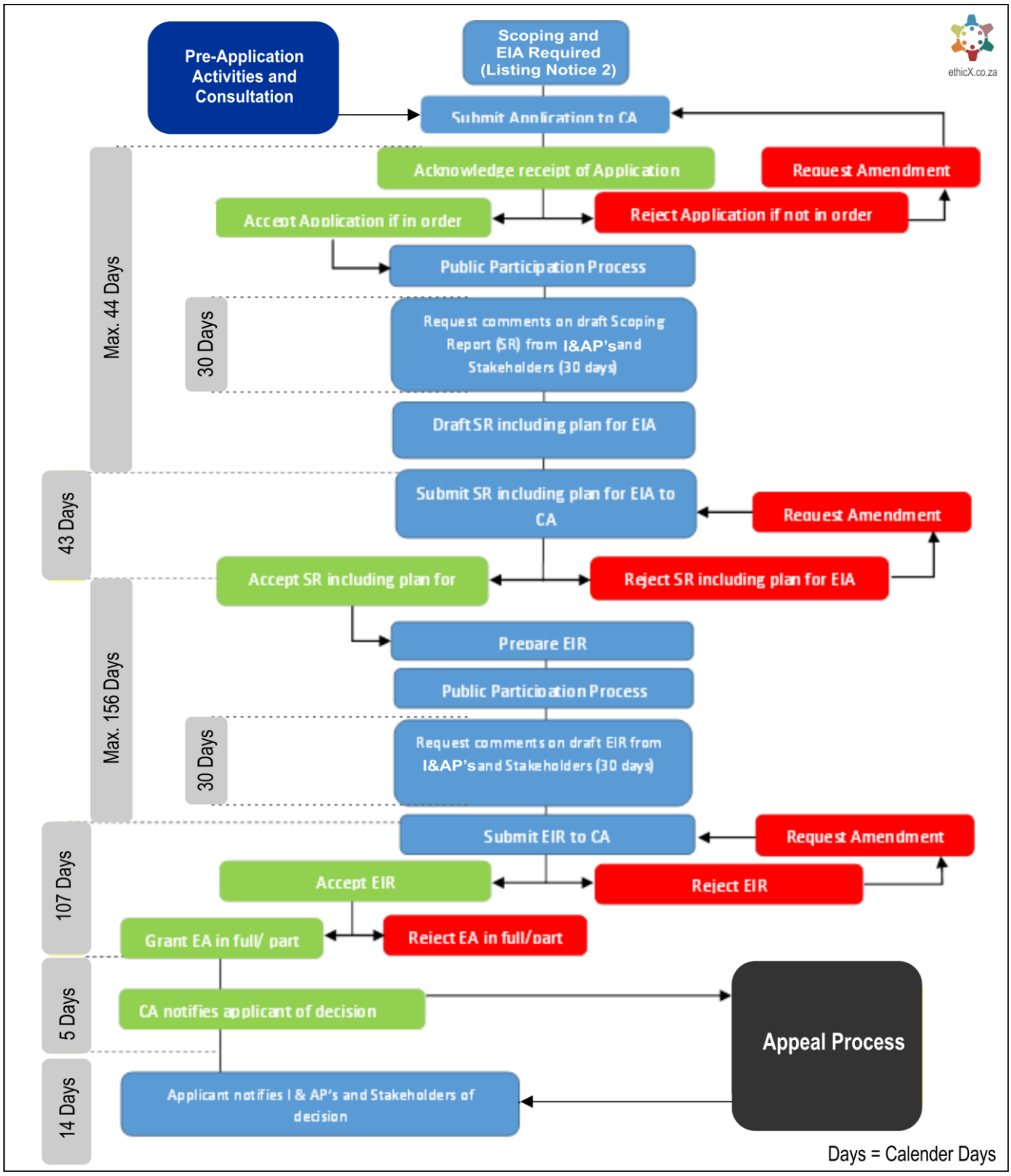

Figure 12-1: EIA Process

12.3.1 Scoping Process

A final scoping report was submitted to the DEA in July 2016 and was accepted by the DEA in September 2016.

Overview

The main activities during the scoping phase included:

- Initial identification of I&AP's and update of the CDC I&AP database.

- Announcement of the project and dissemination of background information notice to I&AP's, stakeholders, the competent authority and other organs of state.
- Registration of I&APs.
- Introduction of the project to the competent authority and key organs of state at a pre-application consultation meeting and an ELC meeting.
- Recording of all comments received from all I&AP's and compilation of an initial Comments and Response Report (CRR), Version 01.
- Review of previous environmental studies conducted for the Coega IDZ, in particular the previous EIA approved for the roll out of a prawn farm in Zone 10 (2009 SeaArk EIA), and extraction of relevant baseline information into the scoping report.
- Identification of environmental authorisations, licenses and permits required for the project.
- Identification of potential impacts to be addressed in the EIA phase.
- Development of a scope of work for the EIA phase (plan of study for EIA).
- Submission of the application for environmental authorisation to the DEA.
- DEA issuing a reference number for the project.
- Compilation of the draft scoping report as per the requirements of the 2014 EIA Regulations Appendix 2.
- Distribution of the draft scoping report to I&AP's, stakeholders, the competent authority and other organs of state.
- Advertisement in a regional newspaper, announcing the project, the public meeting and draft scoping report review period.
- Public notice displayed in CDC reception, Coega Business Centre, announcing the project, the public meeting and draft scoping report review period.
- Public meeting.
- Discussions and liaison with I&APs, stakeholders and competent authority.
- Recording of all comments received at public meeting and during the draft scoping report review period.
- Presenting the results of the scoping phase to the competent authority and key organs of state at an ELC meeting on 19 November 2015.
- Updating the CRR with new comments received (CRR Version 02a) attached to the final scoping report.
- Submission of final scoping report to the DEA, with CRR Version 02a appended.

Review of Scoping Report

In October 2016, a notification about the draft scoping report comment period was placed in 'The Herald', a regional newspaper, and was sent to all identified and registered I&APs listed in Appendix D.

In May 2016, a notification about the revised scoping report comment period was sent to all identified and registered I&APs listed in Appendix D.

Both reports were made available at the following locations in October 2015 and May 2016, for a 30 day review period:

• Internet site: www.ethicx.co.za.	Electronic version of full report (main report and appendices) for download as individual files. Due to size of files, low resolution maps are used for these downloads.
• CDC Head Office. Coega Business Centre, Corner Alcyon Road and Zibuko Street, Zone 1, Coega IDZ, Port Elizabeth	1 printed copy of full report and appendices for review at the location (documents not to be removed from the location).

• For collection from CDC or Ethical Exchange offices upon request.	Electronic version of full report (main report and appendices) on CD for collection by I&APs (full report with high resolution maps).
• Via email, from adz@ethicx.co.za.	Low resolution electronic files of the main report and selected individual report annexures will be emailed (please note that there are limitations due to file size via email).

Authority Comment and Review

The draft scoping report (October 2015), and revised scoping report (May 2016) were issued to the competent authority and the organs of state listed below, for a 30 day review period.

Provincial Department (Copy to Provincial Department)	Printed Copy	Electronic CD	Delivered
Department of Economic Development Environmental Affairs and Tourism (DEDEAT) Att: Leon Els Regional Director of the Sarah Baartman Region.	1	1	Deliver 10/2015 & 05/2016

Coega IDZ Environmental Liaison Committee (ELC) Members	Printed Copy	Electronic CD	Delivered
Department of Environmental Affairs (Coega IDZ ELC Member) Att: Mrs Masina Litsoane AND Wayne Hector	1	2	Courier 10/2015 & 05/2016
Department of Environmental Affairs Oceans and Coast (Coega IDZ ELC Member) Att: Nitasha Baijnath-Pillay AND Reuben Molale	1	2	Courier 10/2015 & 05/2016
Department of Economic Development Environmental Affairs and Tourism (DEDEAT) Att: Jeff Govender Andries Struwig	1	2	Deliver 10/2015 & 05/2016
of Economic Development Environmental Affairs and Tourism (DEDEAT) Bisho Att: Lyndon Mardon	1	1	Courier 10/2015 & 05/2016
Transnet National Ports Authority (Coega IDZ ELC Member) Att: Mandilakhe Mdodana (revised scoping report, May 2016) Nomkhitha Kwinana (draft scoping report, October 2015) Renee de Klerk	1	2	Deliver 10/2015 & 05/2016
Department of Water and Sanitation (Coega IDZ ELC Member) Att: David Bligh Tel: 041-5010737		1	Deliver 10/2015 & 05/2016
NMB Municipality Environmental Manager (Coega IDZ ELC Member) Att: Joram Mkosana	1	1	Deliver 10/2015 & 05/2016
NMB Municipality Air Pollution & Noise Control (Coega IDZ ELC Member) Att: Joannie Black	1	1	Deliver 10/2015 & 05/2016

Other Organs of State	Printed Copy	Electronic Copy CD	Delivered
Department of Water and Sanitation Att: The Director-General Ms Margaret-Anne Diedricks		1	Courier 10/2015 & 05/2016
Department of Rural Development and Agrarian Reform Attention: Head of Department Lumkile Ngada - SUPERINTENDENT GENERAL		1	Courier 10/2015 & 05/2016
Department of Agriculture Forestry and Fisheries Att: Office of the Director-General Mr KCM Mannya, Acting Director General		1	Courier 10/2015 & 05/2016

Comments received during the review period are provided in Appendix D and have been incorporated into the Comments and Response Report (Appendix E).

Public Meeting

A public meeting was held at Walmer Town Hall on 16 November 2015 at 18:00.

An advert about the public meeting was placed in the 'The Herald', a regional newspaper, on 28 October 2015 and a notice was sent to all identified and registered I&APs listed in Appendix D of the draft scoping report.

The presentations made at the meeting, the attendance register and notes from the meeting are provided in Appendix F.

Comments made at the meeting have been incorporated into the Comments and Response Report (Appendix E).

12.4 Public Participation Process

12.4.1 Scoping Phase Public Participation Process

Public Participation Task	Status
• Initial identification of I&AP's and update of the CDC I&AP database.	From February 2015. Ongoing as new I&APs are identified.
• Announcement of the project and dissemination of background information notice to I&AP's, stakeholders, the competent authority and other organs of state.	Throughout March 2015.
• Registration of I&AP's.	Phase 1: 28 October 2015. Phase 2: 20 November 2015. Ongoing as new I&APs are identified.
• Introduction of the project to the competent authority and key organs of state at a pre-application consultation meeting (minutes provided in Appendix F) and an ELC meeting (presentation to ELC provided in Appendix F).	19 February 2015.
• Recording of all comments received from all I&AP's and compilation of an initial Comments and Response Report (CRR), Version 01 (Appendix E).	November 2015 to January 2016.
• Advertisement in a regional newspaper, announcing the project, the public meeting and draft scoping report review period.	28 October 2015.
• Public notice to be displayed in CDC reception, Coega Business Centre, announcing the project, the public meeting and draft scoping report review period.	From October 2015 to date.

Public Participation Task	Status
• Distribution of the draft scoping report to I&AP's, stakeholders, the competent authority and other organs of state.	First draft: November 2015 Second draft: May 2015
• Public meeting.	16 November 2015.
• Discussions and liaison with I&AP's, stakeholders and competent authority.	From March 2015, ongoing as required.
• Recording of all comments received at public meeting and during the draft scoping report review period.	November 2015 to January 2016. May to July 2016.
• Presenting the results of the scoping phase to the competent authority and key organs of state at an ELC meeting.	19 November 2015.
• Updating the CRR with new comments received (CRR Version 02).	July 2016.
• Submission of final scoping report to the DEA, with CRR Version 02 appended.	July 2016.

12.4.2 EIA Phase Public Participation Process

Public Participation Task	Status
• Maintain database on I&APs.	Ongoing.
• Presenting the results of the EIA phase to the ELC.	17 November 2016.
• Competent authority meeting and site visit.	23 November 2016.
• Distribution of the draft EIR report to I&AP's, stakeholders, the competent authority and other organs of state (this report), with responses to all comments received from all I&AP's in an update of Comments and Response Report (CRR), Version 03.	January 2017.
• Focus group meetings.	13 to 22 February 2017.
• Discussions and liaison with I&APs, stakeholders and competent authority.	Ongoing. 13 to 22 February 2017.
• Presenting the results of the EIA phase to DEDEAT.	13 to 22 February 2017.
• Updating the CRR with new comments received during review of draft EIR (CRR Version 04).	February 2017.
• Submission of final EIR to the DEA, with CRR Version 04 appended.	March 2017.

12.5 EIA Phase

The EIA phase was conducted in accordance with the plan of the study for EIA that was developed during the scoping phase. The following tasks were included in the plan of study (*left column*). The EAP endeavoured to address all these items but slight deviations were necessary in some instances. These are highlighted below (*right column*). None of the deviations are regarded as significant and should not affect the DEA's decision-making process. The EIR contains comprehensive and adequate information to inform decision-making.

Plan of Study for EIA task	EAP's evaluation and comment regarding how each task was addressed in the EIR
Surface Water	
ISSUES AND POTENTIAL IMPACTS	
Rainwater harvesting and storage of water.	Yes. Adequate for decision-making.
Changes to runoff patterns.	Yes. Adequate for decision-making.
Storm water management.	Yes. Adequate for decision-making.
Erosion.	Yes. Adequate for decision-making.

Contamination of storm water.	Yes. Adequate for decision-making.
Storm water releases and permits for storm water releases to the sea.	Yes. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	Yes. Adequate for decision-making.
Assess impacts on dune slacks due to changes in surface water runoff.	Yes. Adequate for decision-making.
Consider storm water management on and around ADZ structure and infrastructure.	Yes. Adequate for decision-making.
Rainwater harvesting.	Yes. Adequate for decision-making.
Storm water management on and around ADZ structure and infrastructure.	Yes. Adequate for decision-making.
Storm water treatment	Yes. Adequate for decision-making.
Monitoring requirements.	Yes. Adequate for decision-making.
Recommendations regarding storm water management and erosion control to be incorporated into the EMPr.	Yes. Adequate for decision-making.
EMP and design guidelines for individual investors to adhere to.	Yes. Adequate for decision-making.
Determine need for permits for storm water releases to the sea.	Yes. Adequate for decision-making.
CDC's existing storm water management plan.	Yes. Adequate for decision-making.
Groundwater	
ISSUES AND POTENTIAL IMPACTS:	
Seepage / leakages and contamination from tanks, ponds, lagoons, reservoirs, waste water treatment, effluent pipelines, etc.	Yes. Adequate for decision-making.
Viability of groundwater abstraction to reduce dependency on municipal water supply.	Aquifer potential discussed in the EIR. Each developer wanting to develop a borehole will have to assess the feasibility of their boreholes. Information in EIR adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Likelihood of seepage / leakages and contamination from tanks, ponds, lagoons, reservoirs, waste water treatment, effluent pipelines, etc.	Yes. Adequate for decision-making.
Specify design criteria for ADZ investors.	Yes. Adequate for decision-making.
Recommendations for monitoring.	Yes. Adequate for decision-making.
Risk assessment and emergency procedures.	Yes. Adequate for decision-making.
Potential for groundwater abstraction.	Aquifer potential discussed in the EIR. Each developer wanting to develop a borehole will have to assess the feasibility of their boreholes. Information in EIR adequate for decision-making.
EMP and design guidelines for individual investors to adhere to.	Yes. Adequate for decision-making.
Water Supply	
ISSUES AND POTENTIAL IMPACTS:	
Restrictions to development (water quality and temperature, red tide).	Conceptually since restrictions would depend on the specific species and aquaculture methods used.
Fresh water supply options, limitations and risks.	Options are discussed. Risks could only be discussed conceptually. Addressed in design criteria and conditions for development.
Potential for linkages with other developments.	Yes. Adequate for decision-making.
Cost implications.	Costs of desalination provided. Real cost implications on individual developers cannot be defined since the desalination plant will deliver water into the IDZ's and NMB Metro's overall water supply and not specifically to the ADZ.
Competition for access to water.	Various water supply options discussed Adequate for decision-making.
Dependency on CDC marine pipeline (different for continuous flow and recirculated systems).	Yes. Interim water supply measures provided. Also addressed in design criteria and conditions for development. Adequate for decision-making.

Aquaculture product quality control important but aquaculture water quality requirements for the development not clearly defined.	Yes. Adequate for decision-making.
Water quality impacts from Port activities such as dredging, sand movement, etc.	For consideration in marine pipeline EIA.
Marine inlet to take cognisance of foreign matter that could block the pipeline, especially near harbour.	For consideration in marine pipeline EIA.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Comment on the availability of water for the development.	Yes. Adequate for decision-making.
Evaluation of alternative water supply options.	Yes. Adequate for decision-making.
Impact of water supply options.	Impacts of desalination plant discussed in detail. Rainwater harvesting impacts discussed. Adequate for decision-making.
Water quality requirements and feasibility of supplying sea water from Algoa Bay, close to port activities and urban development.	For consideration in the marine pipeline EIA.
Linkage with CDC marine pipeline.	Yes. Adequate for decision-making.
Identify project components that can function independently from marine pipeline to avoid unnecessary restrictions and delays to development should there be a delay in the development of the marine pipeline.	Yes. Adequate for decision-making.
Bio-Security and Biodiversity	
ISSUES AND POTENTIAL IMPACTS:	
Spread of diseases.	Yes. Adequate for decision-making.
Genetic contamination.	Yes. Adequate for decision-making.
Biodiversity risks.	Yes. Adequate for decision-making.
SPECIALIST STUDY:	
A bio-security and biodiversity assessment will be undertaken to: Review available information relevant to the operations and species selected.	Yes. Adequate for decision-making.
Assess the risk of spread of marine animal diseases and genetic contamination from culture to wild populations.	Yes. Adequate for decision-making.
Undertake a bio-security and biodiversity risk assessment of the proposed activities.	Yes. Adequate for decision-making.
Assess risks assessed against the following criteria: Temporal Scale. Spatial Scale. Risk or likelihood. Degree of confidence or certainty. Severity or benefits.	Yes. Adequate for decision-making.
Assess potential implications on the impact of the proposed activity on the environment.	Yes. Adequate for decision-making.
Recommendations and mitigation measures for all identified risks and alternatives suggested where possible.	Yes. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA	
Incorporate specialist recommendations in to project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
EMP and design guidelines for individual investors to adhere to.	Yes. Adequate for decision-making.
Abalone Farmers Association of South Africa have all subscribed to a Biosecurity standard for producers, processors, and harvesters of abalone in South Africa drafted by Amanzi Biosecurity; which is available to all members of the association – EMPr to incorporate this.	Yes. The report makes reference to various aquaculture sector standards and guidelines. Adequate for decision-making.
Solid Waste and Waste Water	
DATA AVAILABILITY	
Case study information and examples of effluent and waste water treatment options considered by prospective ADZ investors.	Yes. Adequate for decision-making.
EMP and design guidelines for individual investors to adhere to.	Yes. Adequate for decision-making.
ISSUES AND POTENTIAL IMPACTS	
Odours.	Yes. Adequate for decision-making.
Pollution potential.	Yes. Adequate for decision-making.
Pests and vectors.	Yes. Adequate for decision-making.
Sediment and sludge.	Yes. Adequate for decision-making.
Treatment technologies - all treatment options cannot be defined for an ADZ.	Addressed through design criteria and identification of technologies typically used in the industry. Adequate for decision-making.
EIA approval cannot be based on specific technologies.	
Water quality at outlet from facility.	These quality objectives will be defined by the CDC coastal waters discharge permit conditions and the municipal sewer system
Need to define quality objectives (marine pipeline requirements / municipal or CDC waste water treatment plant requirements).	

	permits requirements and bylaws. This EIA cannot be prescriptive on these objectives. Each operator in the ADZ will be required to meet the effluent requirements as dictated by the CDC coastal waters discharge permit conditions and/or the municipal sewer system permit and bylaws. Information in EIR adequate for decision-making.
South African Abalone farms typically do not treat their diluted effluent.	Yes. Adequate for decision-making.
SPECIALIST STUDY:	
Waste management specialist input to:	The initial intention was for an aquaculture industry specialist to provide as assessment of waste management options make recommendations. This would have been feasible if the assessment was for focused on a specific aquaculture project, but since the ADZ is for a wide-spectrum of possible aquaculture designs and systems as well as for desalination, it was more appropriate to consult with various people with a diverse background working with different aquaculture designs and systems. Ethical Exchange compiled the information based on consultation with various aquaculture industry specialists and an extensive literature review of international research on the topic of waste management in the aquaculture sector. See Appendix G7. Information provided adequate for decision-making.
Identify and conceptually quantify waste streams.	
Solid waste.	
Blood water.	
Sea water waste water.	
Domestic sewage.	
Determine effluent flows.	
Identify quality and treatment options.	
Identify measures for odour control.	Yes – air quality assessment. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Potential for foul odours.	Yes – air quality assessment. Adequate for decision-making.
Pollution potential.	Yes. Adequate for decision-making.
Water quality management considerations.	Yes - Appendix G7. Adequate for decision-making.
Bio-remedial standards.	Bio remedial options are proposed. Adequate for decision-making.
Receiving environment requirements (marine pipeline requirements / municipal or CDC waste water treatment plant requirements).	These quality objectives will be defined by the CDC coastal waters discharge permit conditions and the municipal sewer system permits requirements and bylaws. This EIA cannot be prescriptive on these objectives. Each operator in the ADZ will be required to meet the effluent requirements as dictated by the CDC coastal waters discharge permit conditions and/or the municipal sewer system permit and bylaws. Yes. Adequate for decision-making.
Specify objectives and standards for ADZ investors.	Addressed on EIA level. The EMPr provides a framework for the detailed plans and procedures that each investor in the ADZ will have to put in place. Adequate for decision-making.
Specify design criteria for ADZ investors.	
Recommendations for monitoring.	
Risk assessment and emergency procedures.	
EMP and design guidelines for individual investors to adhere to.	
Incorporation of industrial ecology into the development.	Yes. Options for future linkages and synergies between developments in the IDZ and broader NMB Metro are discussed in the EIR. Adequate for decision-making.

Terrestrial Ecological Assessment	
POTENTIAL IMPACTS:	
Spread of alien species.	Yes. Adequate for decision-making.
Removal of protected species.	Yes. Adequate for decision-making.
Ecological corridors.	Yes. Adequate for decision-making.
Habitat loss.	Yes. Adequate for decision-making.
Impact on critical biodiversity areas.	Yes. Adequate for decision-making.
Alien vegetation management.	Yes. Adequate for decision-making.
Fresh water abstraction for development and subsequent impacts on Coega River.	Yes. Adequate for decision-making.
SPECIALIST STUDY:	
A terrestrial ecological assessment will be undertaken to: Review existing data.	Yes. Adequate for decision-making.
Supplement data where required based on vegetation sampling.	Survey conducted. Information adequate for decision-making.
Threatened, endemic or rare species, with an indication of the relative functionality and conservation importance of the specific community in the area under investigation will be identified.	Yes. Adequate for decision-making.
Identify extent of invasive or exotic species present on the site.	Yes. Adequate for decision-making.
Determine functional and conservation importance of vegetation communities.	Yes. Adequate for decision-making.
Assess impacts.	Yes. Adequate for decision-making.
Recommendations for project design, construction, and operation.	Yes. Adequate for decision-making.
Identify monitoring requirements.	Yes. Adequate for decision-making.
Identify need for permits for the removal of protected species.	Yes. Adequate for decision-making.
Criteria for defining plants of special concern.	Yes. Adequate for decision-making.
Identification of threatened ecosystems.	Yes. Adequate for decision-making.
Listing of protected species, based on up to date legislation.	Yes. Adequate for decision-making.
Listing of alien species, based on up to date legislation.	Yes. Adequate for decision-making.
Listing of rare and endangered species, based on up to date guidelines / red lists.	Yes. Adequate for decision-making.
Discuss applicable legislation, including protected species and alien species.	Yes. Adequate for decision-making.
Rehabilitation potential and criteria.	General rehabilitation potential discussed, but exact criteria for rehabilitation will depend on the final ADZ layout plan and individual farm site development plans. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Incorporate specialist recommendations into project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Confirmation of permits for search and rescue.	Yes. Adequate for decision-making.
Search and rescue.	Requirements for search and rescue written into EMPr. Adequate for decision-making.
Dune Ecology	
ISSUES AND POTENTIAL IMPACTS:	
Sand movement.	Yes. Specialist considered all these matters and recommended mitigation measures as required. Adequate for decision-making.
Ecological corridors.	
Habitat loss.	
Impact on critical biodiversity areas.	
Wind erosion.	
Dunes are very sensitive.	
Impacts on maintenance costs due to sand movement.	
Sandblasting effect on infrastructure.	
Consult with SANParks, NMMU, Bayworld and other institutions involved in research.	All consulted. DEIR will be made available.
SPECIALIST STUDY:	
A dune ecological assessment study will be undertaken to: Assess the present state and importance of the dune areas.	Adequate for decision-making.

Using past aerial photographs, assess and estimate the mobility of the dunes.	Adequate for decision-making.
Propose mechanisms to stabilise any of these coastal features to protect the proposed development and maintain coastal dune ecological processes.	Stabilisation was not recommended.
Identify and rank important habitat areas (based on the species compositions of the vegetation analysis, topography and dune areas) in terms of their significance based on the Ecological Sensitivity and Conservation Importance.	Adequate for decision-making.
Develop a sensitivity and habitat map (including buffer zones if applicable).	Various maps show sensitive areas. Adequate for decision-making.
Assess impacts.	Adequate for decision-making.
Recommend and mitigation measures with proposed buffers.	Adequate for decision-making.
Determine monitoring requirements.	Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Incorporate specialist recommendations into project design criteria and the EMPr for the development.	Adequate for decision-making.
Avi-Faunal Ecological Assessment	
DATA AVAILABILITY:	
Data from avi-fauna specialists that have researched / monitored the study area	Adequate for decision-making.
ISSUES AND POTENTIAL IMPACTS:	
Impact on Damara Tern.	Adequate for decision-making.
Impact on flight paths.	Adequate for decision-making.
Birds attracted to potential source of food and water.	Adequate for decision-making.
Consider the impacts of noise on birds.	Adequate for decision-making.
SAPAB2 data to be consulted.	Adequate for decision-making.
SPECIALIST STUDY:	
The ecological specialist will: Review available data.	Adequate for decision-making.
Integrate data collected as part of the CDC Bird Monitoring Programme.	Adequate for decision-making.
Conduct a site survey and sampling.	Site visit conducted. Adequate for decision-making.
Develop a list of species observed and expected to occur. Reference will be made to the occurrence of Red Data species.	Adequate for decision-making.
Identify known bird flight pathways.	Bird flightpaths considered. Adequate for decision-making.
Define populations of sensitive or endangered species and providing suitable mitigation measures with regard the potential disturbance.	Adequate for decision-making.
Consult with individuals with specific knowledge of the bird populations in the area, i.e. Dr Paul Martin.	Adequate for decision-making.
Assess impacts.	Adequate for decision-making.
Make recommendations for project design, construction, and operation	Adequate for decision-making.
Define monitoring requirements	Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Incorporate specialist recommendations in to project design criteria and the EMPr for the development.	Adequate for decision-making.
Marine Ecology	
ISSUES AND POTENTIAL IMPACTS:	
Impacts on the coastal environment.	Adequate for decision-making.
ADZ EIA focusses on impacts from land based activities.	Marine environment considered. Separate EIA for marine pipelines.
Main impacts of ADZ covered in CDC Marine Pipeline Servitude EIA.	
Linkage with CDC Marine Pipeline Servitude EIA.	
Specific issues such as Penguins and Bull Sharks largely covered in CDC Marine Pipeline EIA.	
Impacts associated with sourcing of fish feed.	Adequate for decision-making.
Impacts on MPA, Algoa Bay Islands and their fauna and algae.	Adequate for decision-making.
Impacts on birds nesting on the nearby islands, including dust during construction.	Adequate for decision-making.
Consult with stakeholders such as NMMU, Bayworld, SANParks, and tourism charters.	All consulted. DEIR will be made available.

SPECIALIST STUDY:	
A marine ecological assessment will be undertaken to: Assess the potential impacts on the marine environment due to the presence of the aquaculture development zone along the coastline.	Yes. Adequate for decision-making.
Recommend and mitigation measures with proposed buffers.	Yes. Adequate for decision-making.
Determine monitoring requirements.	Yes. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Incorporate specialist recommendations in to project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Socio-Economic Aspects	
DATA AVAILABILITY:	
Previous assessment conducted for Coega IDZ.	-
Previous assessment conducted for SeaArk prawn farm.	-
ISSUES AND POTENTIAL IMPACTS:	
CDC employment figures questioned and to be verified.	Yes. Adequate for decision-making.
Employment.	Yes. Adequate for decision-making.
Economic growth.	Yes. Adequate for decision-making.
Market barriers.	Yes. Adequate for decision-making.
Failure of previous aquaculture initiatives.	Reasons discussed in report.
Sustainability of developments, impacts if ADZ fail.	Decommissioning discussed. Adequate for decision-making.
SMME / local business opportunities and training.	Yes. Adequate for decision-making.
SPECIALIST STUDY:	
A socio-economic specialist assessment will be undertaken to: Assess socio-economic impacts of the proposed development (including impacts in the areas of skills transfer and economic contribution).	Yes. Adequate for decision-making.
Rate socio-economic impacts, with and without mitigation, in terms of consequence and significance with reference to criteria.	Yes. Adequate for decision-making.
Recommend mitigation measures, where appropriate, for project design, construction, and operation.	Yes. Adequate for decision-making.
Comment on environmental externalities and costs.	Aquaculture life cycle matters discussed in the report. Not possible to define costs. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Incorporate specialist recommendations in to project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Air Quality	
POTENTIAL IMPACTS:	
Odours.	Yes. Adequate for decision-making.
Impacts from other industries on the ADZ.	Yes. Adequate for decision-making.
ADZ imposing restrictions to future developments in the IDZ, to be considered in future project EIA's and AEL's	Yes. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Odour management covered under solid waste and waste water management (above).	Assessed by air quality specialist. Adequate for decision-making.
CDC air quality modelling data	Used by air quality specialist. Adequate for decision-making.
Impacts from other industries	Yes. Adequate for decision-making.
Incorporate recommendations for odour management into project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Heritage Resources	
DATA AVAILABILITY	
Previous assessment conducted for Coega IDZ and Zone 10.	-
No further specialist assessment required.	-

ISSUES AND POTENTIAL IMPACTS:	
Destruction of heritage resources – Hougham farmstead, outbuildings and cemetery within ADZ footprint.	Yes. Adequate for decision-making.
Clarify if there is a need for further surveys.	ECPHRA consulted but they could not give feedback to date due to internal operational matters. The DEIR will be submitted to them and consultation will continue.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Clarify if there is a need for further surveys – consult with specialists that worked in the area previously.	As above but unlikely, as discussed in the Heritage Section.
Management measures for Hougham farmstead, outbuildings and cemetery.	Criteria listed. Actual management measures to be developed by the CDC outside the scope of this EIA. Adequate for decision-making.
Incorporate specialist recommendations from previous studies and SAHRA recommendations into project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Soils	
DATA AVAILABILITY	
Sufficient information is available about soils.	-
POTENTIAL IMPACTS:	
Erosion of sensitive dunes.	Yes. Adequate for decision-making.
Soil movement and sandblasting effect on infrastructure.	Yes. Adequate for decision-making.
Balance of construction cut and fill.	Yes. Adequate for decision-making.
Recycling of cut material.	Yes. Adequate for decision-making.
Management of excess material.	Yes. Adequate for decision-making.
Source of fill material.	Yes. Adequate for decision-making.
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Incorporate specialist recommendations from previous studies into project design criteria and the EMPr for the development.	Yes. Adequate for decision-making.
Traffic	
Traffic considerations addressed as part of CDC master planning.	-
Access road to Zone 10 approved as part of 2006 Coega IDZ rezoning EIA.	-
Noise	
No significant impacts expected.	-
Noise management is addressed in CDC EMPr and environmental guidelines.	Yes. Adequate for decision-making.
Relevant noise standards (SANS 10103) would apply as for any agricultural or industrial development.	Yes. Adequate for decision-making.
Land Use	
Issues and Potential Impacts to be considered in the EIA	Yes. Adequate for decision-making.
Mining footprint and timeframes, impacts from mining.	Yes. Adequate for decision-making.
Old abalone farm and prawn pilot farm facility (demolition / use / legal status).	Legal matters separate to this EIA.
Old abalone farm located outside CDC defined ADZ.	Yes. Adequate for decision-making.
Impacts associated with existing plans and land uses.	Yes. Adequate for decision-making.
Consultation with stakeholders regarding abalone farm and prawn pilot farm facility.	Yes. Contractual arrangements outside the scope of this EIA. Adequate for decision-making.
Climate	
ISSUES AND POTENTIAL IMPACTS	
Climate change impacts.	Yes. Adequate for decision-making.
Greenhouse gas emissions.	Yes. Based on industry case studies and a comparison between aquaculture and other animal protein agricultural products. Adequate for decision-making.

GENERAL ASPECTS TO BE ADDRESSED IN THE EIA:	
Available applicable emission factors will be used to compile an initial calculation of Scope 1 GHG's.	Energy use provided. GHG can therefore be calculated based on a specific farms' production capacity and Eskom's known emission factors.
Available documentation regarding climate change in the NMB Municipality to be sourced for consideration in the EIA.	Yes. Adequate for decision-making.
Environmental Health	
ISSUES AND POTENTIAL IMPACTS	Addressed in biosecurity risk section. This has to be managed in accordance with established and approved CDC management practices. A reference to that provided in the EMPr. Adequate for decision-making.
Rodent control.	
Disease control.	
GENERAL ASPECTS TO BE ADDRESSED IN THE EIA	
EMP to address rodent control measures.	
Specific Project Design Detail	
ISSUES AND POTENTIAL IMPACTS	
Lack of specific project detail.	Proactive design criteria provided. Adequate for decision-making.
Development guidelines / criteria.	Yes. Adequate for decision-making.
EMP for individual developers to adhere to.	Yes. Adequate for decision-making.
Monitoring and operational control.	General monitoring requirements provided, but detailed monitoring programme will need to be developed once the coastal water discharge permits conditions are known. Each aquaculture farm to develop a specific monitoring programme based on their various DAFF permits. Adequate for decision-making.
Identification of project design information gaps and confirmation of process to address information gaps, i.e. specific technologies used for water and waste treatment, and identification of assessments required to fill information gaps.	Proactive design criteria provided. Adequate for decision-making.
Confirm need for risk assessments for alien invasive species to be cultivated.	Yes. Adequate for decision-making.
Address issue regarding the lack of information on specific technologies (aquaculture, processing, water treatment and waste water treatment).	Proactive design criteria provided. Adequate for decision-making.
Consult with aquaculture operators and research institutions.	Yes. Adequate for decision-making.

12.6 Deviations from Plan of Study for EIA

As highlighted above. None of the deviations are regarded as significant and should not affect the DEA's decision-making process.

12.7 Coega OSMP Requirements

The Revision 1 of the OSMP provides the following principles and management recommendations that will need to be followed for development within this coastal cluster area between the Port of Ngqura and the CBA-IDZ defined in Zone 10.

OSMP Principles and Management Recommendations	Comment / Reference to Section where addressed in EIR
• Any development activities within this dune area will be subject to approval from the relevant environmental authorities.	The coastal section of the proposed ADZ is located within the OSMP coastal cluster for development. The impacts of the ADZ are assessed in this EIR and mitigation measures incorporated into the EMPr. The EIR will be submitted to DEA, as competent authority, for approval.
• Should any development require the permanent stabilisation/removal of the mobile dune fields within the region, then the regional effects of the stabilisation of the mobile dunes will need to be determined in the EIA for the	Specialist Study Appendix F2 Dune Geomorphology Specialist Assessment for the Coega IDZ, Dr Werner Kurt Illenberger (Illenberger, 2016).

OSMP Principles and Management Recommendations	Comment / Reference to Section where addressed in EIR
proposed development. This must include an assessment of the potential impacts on the sand budget for this coastline, inclusive of potential impacts on the marine ecosystems, as well as any possible effects this would have on the Port of Ngqura.	<u>EIR Report Sections</u> *Baseline* Section 6.7 Coastal Dunes and Littoral Active Zone and the first part of Section 7.5. Section 2.3.2 Mining (Geological Resources). *Impact Assessment and Recommendations* Section Section 7.5 (last part). <u>Summary of Results</u> *Impacts on dunes in the ADZ* The dunes in the ADZ are highly impacted due to previous attempt to stabilise the dunes, sand built up behind, alien wattle infestations, and sand mining. Dr Illenberger concluded that the dunes in the ADZ do not affect the coastal sand budget and have no effect on the harbour, and that not much is to be gained from an attempt to conserve the highly disturbed and impacted mobile dunes within the ADZ footprint. The best option is to mine the sand as it is a valuable resource, and then develop the ADZ structures and infrastructure on the underlying calcrete surface. The nuisance value of loose sand will thereby be removed, as will possible problems with wind-blown sand; like sand-blasting. *Impact on regional sediment dynamics* In his previous studies, Dr Illenberger concluded that the dunes are partly accretionary, i.e. sand that blows onto the dune fields by the dominant south-westerly wind accumulates vertically as well as transgressing landward and that mining of the dune field in the Coega/Hougham Park area would have no effect on the regional coastal sediment dynamics, because this dune field acts as a sand sink with respect to sand moving along the coast (Illenberger, 1994; 2007 in 2016). In his latest assessment, Dr Illenberger concluded that the dunes in the ADZ do not affect the coastal sand budget and have no effect on the harbour. From a physical and sedimentary perspective, Dr Illenberger did not identify any sensitivities to development of the ADZ as proposed.
• A 100 m wide band of mobile dunes, landward from the high water mark, will need to be vegetated with indigenous dune vegetation typical of Algoa Dune Thicket to establish a stable, vegetated primary dune, should it be demonstrated in the bullet point above that this will not negatively affect the sand budget. Once well established (and the level of vegetation cover in this new primary dune will need to be quantitatively assessed to determine what level of cover is acceptable before it can be regarded as stable) the alien vegetation between the new primary dune and the developable portions of the area can be removed, and this area either re-vegetated or utilized for development.	A 100 m wide band of mobile dunes: Dr Illenberger is advising against the establishment of a 100 m wide band of vegetation based on the fact that the wind energy is too high for the establishment of an indigenous vegetated dune system – that is why the natural state of the dunes is mobile. The Damara Terns use bare mobile dunes as their breeding sites.

OSMP Principles and Management Recommendations	Comment / Reference to Section where addressed in EIR
• As far as possible, ecological corridors should be provided between developments within this area • The width and location of the ecological corridors should be determined during the EIA for the proposed development.	Ecological corridors are part and parcel of the design criteria for the ADZ as discussed throughout the EIR and summarised in Section 0 and Section 7.11. However, specific distances could not be recommended in all instances, mainly due to the fact that: biosecurity buffers will only be determined during design of the individual developments; and ecological buffers in the coastal zone need to be specifically designed around the small pockets of remaining intact indigenous vegetation – a fixed buffer zone will defeat the purpose.
• Fencing should allow free movement of animals.	The ecological specialist study assessed the impact on the migration of animals and recommended fencing should allow for the passage of small and medium sized mammals and all forms of mesh fencing should be avoided. The fence design should also allow for migration of tortoises, and thus tortoise holes must be provided. Furthermore, it is suggested that mountable kerbing be used, which allows for the movement of animals across any roads, especially the smaller species of rodent, tortoises, snakes and lizards. These recommendations were incorporated into the EMPr.
• Development in the area shall be in strict accordance with the recommendations contained in the OSMP and according to any Environmental Authorisations issued for developments within these coastal areas.	The OSMP requirements were considered in the development of the plan of study for EIA, in the specialist assessments and during the development of mitigation measures and the EMPr.
• All developments will have to comply with all national and provincial legislation.	This applies by implication to any development in the ADZ, the broader IDZ and South Africa.

12.7.1 Review of the Draft EIR

Public Notice of the Draft Environmental Impact Report Review Process

A notice was sent to Interested and Affected Parties (I&APs) that the DEIR for the Coega Land-Based Aquaculture Development Zone (ADZ) is available for comment for a 30 day review period from 3 February 2017 to 6 March 2017 at the following locations:

Electronic Documents

1. Internet site: www.ethicx.co.za.	Electronic version of the full report (Volume 1 and 2; main report and appendices) available for download as individual files. Due to size of files, medium resolution maps and diagrams are used in the reports. Separate high resolution files are available as individual downloads for selected maps and diagrams.
2. For collection from CDC Head Office or Ethical Exchange offices upon request. *Direct request to Wim Schroeder or Mari Wolmarans on 041 823 9010 or adz@ethicx.co.za.*	Electronic version of full report (Volume 1 and 2; main report and appendices) on CD for collection by I&APs. *The full report and all maps and diagrams are high resolution and optimal for viewing details on maps and diagrams.*

3. Request documents via email, from adz@ethicx.co.za.	Medium resolution electronic files of the main report and selected individual report annexures will be emailed on request (please note that there are limitations due to file size via email). *For high resolution maps please refer options 1 and 2 above.*

Printed Documents

4. CDC Head Office. Coega Business Centre, Corner Alcyon Road and Zibuko Street, Zone 1, Coega IDZ, Port Elizabeth. *Ask for report at CDC reception.*	1 printed copy of full report (Volume 1 and 2; main report and appendices) for review on location. Please note: documents not to be removed from the building. Selected A3-sized maps and diagrams are inserted in Section 14 of the report but all maps and diagrams in the report are optimally viewed in electronic form. Separate higher resolution files are available as individual download or on CD, *as per options 1 and 2 above.*

12.7.2 Authority Comment and Review

The draft EIR (January 2017) was issued to the competent authority and the organs of state listed below, for a 30 day review period from 3 February 2017 to 6 March 2017.

Competent Authority	Printed Copy	Electronic CD	Delivered
Department of Environmental Affairs Att: Bathandwa Ncube Legal, Authorizations, Compliance and Enforcement Integrated Environmental Authorizations: IPS & S24G Pretoria	1	1	Courier 3/2/2017

Provincial Department (Copy to Provincial Department)	Printed Copy	Electronic CD	Delivered
Department of Economic Development Environmental Affairs and Tourism (DEDEAT) Att: Leon Els Regional Director of the Sarah Baartman Region.	1	1	Deliver 3/2/2017

Coega IDZ Environmental Liaison Committee (ELC) Members	Printed Copy	Electronic CD	Delivered
Department of Environmental Affairs (Coega IDZ ELC Member) Att: Mrs Masina Litsoane AND Wayne Hector	1	2	Courier 3/2/2017
Department of Environmental Affairs Oceans and Coast (Coega IDZ ELC Member) Att: Nitasha Baijnath-Pillay AND Reuben Molale	1	2	Courier 3/2/2017
Department of Economic Development Environmental Affairs and Tourism (DEDEAT) Att: Jeff Govender Andries Struwig	1	2	Deliver 3/2/2017
Department of Economic Development Environmental Affairs and Tourism (DEDEAT) Bisho Att: Lyndon Mardon	1	1	Courier 3/2/2017

Coega IDZ Environmental Liaison Committee (ELC) Members	Printed Copy	Electronic CD	Delivered
Transnet National Ports Authority (Coega IDZ ELC Member) Att: Nomkhitha Kwinana Renee de Klerk	1	2	Deliver 6/2/2017
Department of Water and Sanitation (Coega IDZ ELC Member) Att: David Bligh Tel: 041-5010737		1	Deliver 3/2/2017
NMB Municipality Environmental Manager (Coega IDZ ELC Member) Att: Joram Mkosana	1	1	Deliver 3/2/2017
NMB Municipality Air Pollution & Noise Control (Coega IDZ ELC Member) Att: Joannie Black	1	1	Deliver 3/2/2017

Other Organs of State	Printed Copy	Electronic Copy CD	Delivered
Department of Water and Sanitation Att: The Director-General Ms Margaret-Anne Diedricks		1	Courier 3/2/2017
Department of Rural Development and Agrarian Reform (Bisho) Attention: Head of Department Lumkile Ngada - SUPERINTENDENT GENERAL		1	Courier 3/2/2017
Department of Agriculture Forestry and Fisheries Att: Office of the Director-General Mr KCM Mannya, Acting Director General		1	Courier 3/2/2017
Department of Sport, Recreation, Arts and Culture Att: Head of Department Mr Sodo and Mr Kobese		1	Courier 3/2/2017
Eastern Cape Provincial Heritage Resources Agency Requested no hard copy, undertook to download electronic copy from website			Notified via eMail 3/2/2017

Proof of delivery of notices and reports as well as communication and comments received during the review period are provided in Appendix D and have been incorporated into the Comments and Response Report (Appendix E).

Focus Meetings

A public meeting was held during the scoping phase of the study. For the EIA phase, focus meetings were planned to discuss key issues and concerns. IAPs were provided with the opportunity to indicate if they wanted to attend a focus meeting around their specific issue or concern, but no IAPs wanted to attend a meeting. Glendore Sands indicated that they were keen to meet with the CDC to discuss potential planning synergies –mining of sand dunes in the ADZ footprint to prepare the areas covered with dunes for future development. This is a planning meeting and not directly related to the Coega ADZ EIA Process. The CDC will arrange a meeting between their planning department and Glendore representatives.

12.8 Gaps and Limitations

Since no engineering designs have been completed for each development component, the technical parameters of each component were determined based on industry norms. A conceptual site layout plan has been developed by the CDC but detailed planning of the area still needs to be completed. Although this is a limitation for the EIA

process, it has its benefits since it provided an opportunity for the various specialists and the EAP to put forward design criteria to guide the design of the development – making the EIA proactive rather than reactive.

Specific gaps and limitations for each of specialist assessments are discussed in the various specialist reports and are clearly summarised in Section 7 under the various chapter headings.

The EAP is of the opinion that there are no gaps and limitations to prevent the DEA's decision-making process.

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14 Selected Foldout Maps (Printed Report)

Printed Report

Maps in this report are optimally viewed in electronic format. A selection of maps printed at A3 size is included in printed report for information purposes. All maps in the report are available on CD or can be electronically downloaded from www.ethicx.co.za.

Electronic Report

This section will be blank if report is viewed electronically. Maps for electronic report on CD are provided as separate individual files.

15 List of Appendices

Appended to Volume 1: Environmental Impact Report, Appendix A, B & C

Appendix A: Details of Activities Requiring Authorisation, Licensing or Permitting

A1 Activities triggered by GNR 983, 984 and 985 in terms of the NEMA (Environmental Authorisation)
A2 Activities triggered by GNR 921, in terms of the NEM:WA (Waste Management Licence)
A3 Water uses in terms of Section 21 of the NWA (Water Authorisation and Registration)
A4 Activities triggered by GNR 893 in terms of the NEM:AQA (Air Emission Licence)
A5 Activities in the Public Coastal Property (triggering a Coastal Lease)

Appendix B: Environmental Management Programme

Appendix C: Comments and Response Report

(Version 1 in DSR, Version 2 in FSR, Version 3 in DEIR, Version 4 in FEIR)

Volume 2: Public Participation Documentation

Appendix D: Record of Public Participation

D1 List of I&APs
D2 Notices sent to I&APs
D3 Registration of I&APs
D4 Communication during DSR phase
D5 DSR review and public meeting notices
D6 Adverts and Site Poster
D7 Communication regarding first DSR (issued Oct 2015)
D8 Communication regarding revised DSR (issued May 2016)
D9 Communication regarding FSR
D10 Communication after completion of FSR review period
D11 Communication during DEIR review
D12 Communication after FEIR submission (not applicable)

(Written submissions and comments, questions asked and issued raised have been summarised in Appendix B: Comments and Response Report)

Appendix E: Competent Authority (DEA) Requirements

Appendix F: Minutes of Meetings and Presentations

F1 ELC Meeting 1 (19 February 2015)
- Presentation
- List of ELC Members as at February 2015
- *Discussions in Comments and Response Report (refer Appendix C)*

F2 Pre-Application Meeting (16 April 2015)
- Minutes of Meeting
- CDC Presentations at Meeting
- *Discussions in Comments and Response Report (refer Appendix C)*

F3 Public Meeting (16 November 2015)
- Presentations by CDC
- Presentation by EAP
- Meeting attendance list
- *Discussions in Comments and Response Report (refer Appendix C)*

F4 ELC Meeting 2 (19 November 2015) (relevant section of meeting minutes available on request)
- Presentation
- List of ELC Members as at February 2016
- *Discussions in Comments and Response Report (refer Appendix C)*

F5 Meeting with DEDEAT (14 December 2015)
Meeting notes
Discussions in Comments and Response Report (refer Appendix C)

F6 ELC Meeting 3 (17 November 2016)
Presentation
(relevant section of meeting minutes available on request)

F7 DEA Site Inspection (23 November 2016)
Presentation (as per ELC Meeting 3)

F8 Record of Meetings during Review of Draft EIR (January to March 2017)
To be inserted in FEIR

Volume 3: Specialist Report and Study Team Information

Appendix G: Specialist Reports

G1 Social Impact Assessment for the Coega ADZ, by Dr Anton de Wit (De Wit, 2016b)

G2 Dune Geomorphology Specialist Assessment for the Coega IDZ, Dr Werner Kurt Illenberger (Illenberger, 2016)

G3 Ecological (Terrestrial and Aquatic) Specialist Assessment, by Sherman Colloty & Associates (SC&A, 2016)

G4 Marine Specialist Assessment for the Coega ADZ, by Dr Russell Chalmers (Chalmers, 2016)

G5 Biosecurity and Biodiversity Risk Assessment for the Coega ADZ, by Timothy Guy Paulet (Paulet, 2016)

G6 Air Quality Assessment for the Coega ADZ, by Chris Albertyn, LAQS

G7 Waste Management Options in the Aquaculture Sector, compiled by Ethical Exchange

Appendix H: Study Team Details