MARINE IMPACT ASSESSMENT FOR THE ESTABLISHMENT OF AN AQUACULTURE DEVELOPMENT ZONE IN AMATIKULU, KWAZULU-NATAL

Anchor Environmental Consultants Report No. 1825/1

MARINE IMPACT ASSESSMENT FOR THE ESTABLISHMENT OF AN AQUACULTURE DEVELOPMENT ZONE IN AMATIKULU ESTUARY, KWA-ZULU NATAL

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EXECUTIVE SUMMARY

NuLeaf Planning & Environmental commissioned Anchor Environmental Consultants (Pty) Ltd to conduct a desktop marine specialist study to assess likely impacts associated with the establishment and operation of an Aquaculture Development Zone (ADZ) at Amatikulu in KwaZulu-Natal (KZN) Province. Species to be farmed include dusky kob, barramundi, scallops, sea cucumbers, marine and freshwater ornamental fish and ornamental plants, tilapia, catfish and Nile crocodile. The ADZ requires application for environmental authorisation (EIA), and a Coastal Waters Discharge Permit (CWDP), both of which will require assessment of potential impacts on the marine environment.

Affected environment

The proposed Amatikulu ADZ is located at 29°04'S; 31°38'E, 105 km north of Durban and 56 km south of Richard's Bay. The western boundary Agulhas current is the dominant oceanographic feature in this area. Core current speeds exceed 2 $m.s^{-1}$ and the current flows close inshore along much of the KZN coast as the continental shelf is narrow. Aside from the Agulhas Current, the dominant physical forcing affecting the Amatikulu coast is strong wave action, coupled with high volumes of sediment transported via longshore drift from the Thukela River to the south. The salinity of KZN shelf water is 35-35.5 PSU, and temperatures usually vary between a winter minimum of 21^{o}C and a summer maximum of 28^{o}C.

From a biogreographic perspective, the Amatikulu area falls within the Natal Bioregion, one of five inshore bioregions located around the coast of South Africa. Marine and coastal habitats present in the study area include estuarine habitat (the Amatikulu estuary) and sandy beach and coastal dune habitat. Potential impacts to the Amatikulu estuary are a subject of a separate study and are not considered in this report. Intertidal sandy beaches are dynamic environments, and the faunal community composition is largely dependent on the interaction of wave energy, beach slope and sand particle size. Three beach types are recognised: dissipative, intermediate and reflective. Dissipative beaches are wide and flat with fine sands. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches and are coarse grained (>500 µm sand) with narrow, steep intertidal beach faces. The relative absence of a surf-zone causes the waves to break directly on the shore causing a high turnover of sand and resulting in depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a variable species composition. The profile of beach at Amatikulu area is steep and narrow, and thus characteristic of an intermediate/reflective beach type. Data from beaches at Tinley Manor, a short distance to the south, indicate that oorganisms that are likely to be present in the study area include aquatic scavengers, aquatic particle feeders, air breathing scavengers, meiofauna (smaller than 1 mm in size), and higher predators, all in low numbers. Above the high water mark, the shore has been colonised by dune vegetation. This type of vegetation is adapted to survive the harsh salt spray, wind and unstable sediment conditions of the coastal zone. Their resilience allows for vegetated dunes to serve as a protective barrier from coastal exposure. Plant species recorded on the dunes at Tinley Manor is characteristic of KwaZulu-Natal coastal dunes and is likely to be similar at Amatikulu. It comprises of small fragmented patches of dense coastal forest on the back dune, beach morning glory *Ipomoea pes-caprae* and the treasure flower *Gazania rigens* at the bottom of the front dune, and dune koko tree *Maytenus procumbens* and coastal red-milkwood *Mimusops* *caffra* on the back dune. No red listed species were recorded at Tinley Manor to the south, but it is not clear whether this also applies to the Amatikulu site.

The study area was assessed using the ecosystem threat status tool according to the National Biodiversity Assessment (NBA) (Sink *et al.* 2012). The marine classification extends a few hundred metres inland to provide a buffer zone for the marine environment. The ecosystem threat status rates the system's ability to provide ecosystem services. Ecosystem types are categorised as 'critically endangered', 'endangered', 'vulnerable' or 'least threatened', based on the proportion of each ecosystem type that remains in good ecological condition (Driver *et al*. 2012). The majority of the Amatikulu area is listed as 'vulnerable', while the mouth of the Amatikulu estuary is classified as 'least threatened'.

Legal status of the affected environment

The Amatikulu ADZ is located directly adjacent to the newly proposed uThukela Banks Marine Protected Area, while intake and outfall pipeline for the proposed ADZ are located within the boundaries of the MPA. The Minister of Environmental Affairs published for public comment a notice (Notice no. R108) declaring her intention to establish the uThukela Banks Marine Protected Area (TBMPA) under section 22A of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) (NEMBA: PAA) on 3 February 2016, along with a second notice (Notice no. 103) outlining draft regulations for the management of this MPA (Government Gazette No. 39646). The proposed Marine Protected Area (MPA) consists of an inshore and offshore area. The inshore area consists of two Inshore Restricted zones and the remainder is an Inshore Controlled Zone. The intake and outfall pipeline for the proposed Amatikulu ADZ development fall within the uThukela Banks Inshore Restricted Zone 1 (TIRZ1). This comprises the inshore portion of the uThukela Banks Marine Protected Area and is defined as the section between the following two co-ordinates (I1) 29° 26.928' S, 31° 36.945' E and (I2) 29° 13.472' S, 31° 31.062' E running from the high water mark to the two meter depth contour.

The NEMBA: PAA does not specifically exclude construction of intake or outfall pipelines in MPAs generally or intake or discharge of waste water into the MPAs, nor are any of these activities specifically excluded under GN 103 or 108 (Draft Regulations for the Establishment and Management of the uThukela Banks Marine Protected Area). However, all of these activities are likely to be considered unlawful under the Marine Living Resources Act No. 18 of 1998 (MLRA) when the MPA is formally established. The MLRA states that in Chapter 4 (Marine Protected Areas):

(2) No person shall in any marine protected area, without permission in terms of subsection (3)—

> *(c) dredge, extract sand or gravel, discharge or deposit waste or any other polluting matter, or in any way disturb, alter or destroy the natural environment;*
>
> *(d) construct or erect any building or other structure on or over any land or water within such a marine protected area; or*
>
> *(e) carry on any activity which may adversely impact on the ecosystems of that area.*

In particular, Section 5 of the MLRA states that:

1. *Restriction of Activities*
   No person may undertake any activity listed in section 48A(1) of the Act in the Marine Protected Area unless authorised in terms of these regulations.

The boundaries of the proposed uThukela Banks MPA extend up to the High Water Mark and at least 10 km to the north and around 18 km to the south of the ADZ. This is considered a potential fatal flaw in respect of the establishment of the ADZ, and particularly the construction of intake or outfall pipelines, seawater intake, and wastewater discharge for the ADZ, unless authorisation for these activities can be secured in terms of the MLRA.

Potential impacts

The assessment of these impacts before and after recommended mitigation is summarised in the Table below. Impacts expected in the decommissioning phase are dealt with in the construction phase.

A total of nine potential environmental impacts were assessed for this report, ranging from habitat loss to operational effects. Of these, five were flagged as fatal flaws inherent in the construction and operation of the proposed development. It may, however, be possible to secure an exemption from the prescripts of the MLRA for these impacts, such that these operational fatal flaws can be reclassified with appropriate mitigation. This would require that numerical modelling be undertaken to inform optimal design of the outfall and to confirm that impacts of waste water discharge remain low (insignificant).

Summary of impacts identified, and significance before and after mitigation

Phase	Impact	Consequence	Probability	Significance	Status	Confidence
Construction	Impact 1: Permanent loss and/or modification of habitat and temporary disturbance of coastal marine fauna and flora during construction.	FATAL FLAW			-'ve	High
	Impact 2: Permanent loss or alteration of subtidal soft sediment habitat.				-ve	High
					-ve	High
	Impact 3: Permanent loss or alteration of coastal dune habitat.	Medium	Probable	**MEDIUM**	-ve	High
	With mitigation	Low	Possible	**LOW**	-ve	High
	Impact 4: The effect of increased noise and vibration from construction.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 5: Waste generation and disposal during construction.	High	Possible	**MEDIUM**	-ve	High
	With mitigation	Medium	Improbable	**LOW**	-ve	High
	Impact 6: The effect of the spillage of hazardous substances.	Medium	Possible	**LOW**	-ve	Medium
	With mitigation	Low	Improbable	**VERY LOW**	-ve	Medium
Operation	Impact 7: Impacts on water quality and physiological functioning due to discharge.	FATAL FLAW			-'ve	High
	With mitigation	Medium	Possible	**LOW**	-ve	Medium
	Impact 8: Disturbance and/or mortality of marine life due to the intake of seawater	FATAL FLAW			-'ve	High
	With mitigation	Medium	Possible	**LOW**	-ve	Low
	Impact 9: Sediment scouring and shifts in sediment movement patterns.	FATAL FLAW			-'ve	High
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Low

TABLE OF CONTENTS

GLOSSARY

Alien species	**Species that become established in areas outside their natural, native range.**
Amphipod/a	Crustaceans with no carapace and a laterally compressed body
Anaerobic bacteria	Unicellular organisms that do not require oxygen to function
Annelid/a	Segmented worms including earthworms, leeches, and a large number of mostly marine worms known as polychaetes.
Anthropogenic	Environmental pollution originating from human activity
Arthropod/a	An arthropod is an invertebrate animal with an exoskeleton, a segmented body and jointed appendages. Arthropods form the phylum Arthropoda, which includes crustaceans.
Ascidian	Primitive chordates resembling sac-like marine filter feeders, also known as sea squirts.
Avifauna	The birdlife of a particular region or habitat.
Baseline	Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.
Benthic	Pertaining to the environment inhabited by organisms living on or in the ocean bottom
Biodiversity	The variety of plant and animal life in a particular habitat.
Biological monitoring survey	A scientific study of organisms to assess the condition of an ecological resource, involving the collection and analysis of animal and/or plant samples which serve as indicators to the health/recovery of an affected system.
Biota	Living organisms within a habitat or region
Biomass	The mass of living biological organisms in a given area or ecosystem.
Bioregion	A region defined by characteristics of the natural environment rather than by man-made divisions.
Chart datum	Chart Datum is level on the shore corresponding with the Lowest Astronomical Tide (LAT) as from 1 January 2003.
Copepod	A group of small crustaceans found in the sea and nearly every freshwater habitat. Some species are planktonic (drifting in the water column), while some are benthic (living on the ocean floor).
Construction phase	The stage of project development comprising site preparation as well as all construction activities associated with the development.
Crinoid	Feather stars belong to the phylum Echinodermata. As juveniles, they are attached to the sea bottom by a stalk with root-like branches. In the adult stage, they break away from the stalk and move about freely.
Coralline	Corallines are red algae in the order Corallinales. They are characterized by a thallus that is hardened by calcareous deposits contained within the cell walls.
Coriolis force	An effect whereby a mass moving in a rotating system experiences a force (the Coriolis force) acting perpendicular to the direction of motion and to the axis of rotation. On the earth, the effect tends to deflect moving objects to the right in the northern hemisphere and to the left in the southern and is important in the formation of cyclonic weather systems.
Crustacea/n	Generally differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws.

Cumulative impacts	Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.
Diatom	A major group of algae that makes up the most common type of phytoplankton. Most are unicellular but they can group together to form colonies.
Dinoflagellate	A large and diverse group of unicellular protists, most of which are marine, and that can either be free-living in the plankton, or benthic.
Echinoderm/ata	Marine invertebrates with fivefold radial symmetry, a calcareous skeleton and tube feet (e.g. starfishes, sea urchins, sea cucumbers)
Echiuroids	Spoon worms
Estuary	An estuary is defined in terms of the National Environmental Management: Integrated Coastal Management Act (ICMA) and the NEMA 2014 EIA Regulations as "a body of surface water— a) that is permanently or periodically open to the sea; b) in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the body of surface water is open to the sea; or c) in respect of which the salinity is higher than fresh water as a result of the influence of the sea, and where there is a salinity gradient between the tidal reach and the mouth of the body of surface water.''
Estuarine Functional Zone	Used to delineate the functional zone of an estuary to include functional areas of estuarine habitat (e.g. sand and mudflats, rock and plant communities and flood plain areas) as well as the open water area of the estuarine system.
Elasmobranchs	Sharks, skates and rays
Encrusting algae	A type of coralline algae that grows in low carpets on rocky shores.
Endemicity /endemism	A species unique to a defined geographic location. Organisms that are indigenous to an area are not endemic if they are found elsewhere.
Environment	The external circumstances, conditions and objects that affect the existence of an individual, organism or group. These circumstances include biophysical, social, economic, historical and cultural aspects.
Environmental Authorisation	Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.
Environmental Impact Assessment	A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.
Environmental Management Programme	A description of the means (the environmental specification) to achieve environmental objectives and targets during all stages of a specific proposed activity.
Epibiotic	An organism that lives on the surface of another living organism without causing harm to its host.
Epiphyte	An organism that grows on the surface of a plant.
Far field	The region of the receiving water where buoyant spreading motions and passive diffusion control the trajectory and dilution of the effluent discharge plume.
Faunal community	A naturally occurring group of native animals that interact in a unique habitat.
Gastropod/a	Molluscs (e.g. snails and slugs)
Harmful Algal Blooms	HABs (or 'red tides') occur when colonies of algae proliferate under favourable conditions. They may result in toxic or harmful effects on people, fish, shellfish, marine mammals and birds.
High shore	The section of the intertidal zone reaching from the extreme high water spring tide to the mean high water neap tide.

Hydroid	Colonial coelenterates (i.e. jellyfish, corals, sea anemones) having a polyp rather than a free-swimming form as the dominant stage of their life cycle.
Ichthyoplankton	The eggs and larvae of fish, which are usually found in the sunlit zone of the water column (epipelagic/photic zone).
Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.
Important Bird and Biodiversity Area (IBA)	An area identified using an internationally agreed set of criteria as being globally important for the conservation of bird populations. The program was developed and sites are identified by BirdLife International. Currently there are over 12 000 IBAs worldwide.
Inert	Unreactive or non-threatening
Intertidal zone	The section of the marine environment that lies exposed at low tide and submerged at high tide.
Infauna	The assemblage of organisms inhabiting the seafloor.
Invasive species	Alien species capable of spreading beyond the initial introduction area and have the potential to cause significant harm to the environment, economy or society.
Invertebrate	An animal without a backbone (e.g. a starfish, crab, or worm)
Low shore	The section of the intertidal zone reaching from the mean low water neap tide to the extreme low water spring tide.
Macrocrustacea	Crustaceans (lobsters, crayfish, shrimp, krill, and barnacles etc.) that are visible to the naked eye.
Macrofauna	Animals larger than 0.5 mm.
Macroscopic	Visible to the naked eye.
Meiofauna (meiobenthos)	Small benthic invertebrates that are larger than microfauna but smaller than macrofauna.
Microscopic	So small as to be visible only with a microscope.
Microtidal	A term applied to coastal areas in which the tidal range is less than 2 m.
Mitigation measures	Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage.
Mixing zone	An administrative construct which defines a limited area or volume of the receiving water where the initial dilution of a discharge is allowed to occur, until the water quality standards are met. In practice, it may occur within the near field or farfield of a hydrodynamic mixing process and therefore depends on source, ambient, and regulatory constraints.
Mollusc/a	Invertebrate with a soft unsegmented body and often a shell, secreted by the mantle.
Near field	The region of a receiving water where the initial jet characteristic of momentum flux, buoyancy flux and outfall geometry influence the jet trajectory and mixing of an effluent discharge.
Nearshore	Zone extending seawards of Chart Datum to a point where the seabed is less than 10 m depth at Chart Datum, or the distance offshore from Chart Datum is less than 500 m, whichever is greater.
Negative buoyancy	The measure of the tendency of an effluent discharge to sink in a receiving water body.
No-take zone	A type of MPA where no fishing is allowed
Offshore	The area seaward of the nearshore environment boundary.
Operational phase	The stage of the works following the Construction Phase, during which the

	development will function or be used as anticipated in the Environmental Authorisation.
Ophiurida	An order of echinoderms known as the brittle stars.
Pelagic	Within the water column.
Phytoplankton	Ocean dwelling microalgae that contain chlorophyll and require sunlight in order to live and grow.
Polychaete (Polychaeta)	Segmented worms with many bristles (i.e. bristle worms).
Population fragmentation	A form of population segregation often caused by habitat fragmentation and may lead to a decrease in genetic variability.
Red tide	See 'Harmful Algal Blooms'.
River-Estuary-Interface	The interface between fresh and saline water. This zone normally occurs at a salinity of between 10-15 ppt, and is considered ecologically productive.
Rotifer	Small zooplankton that occur in freshwater, brackish, and marine environments and feed on microalgae.
Semi-diurnal tides	When there are two high tides and two low tides within a day that are about the same height,
Site fidelity	A species with high site fidelity is likely to occupy a single home range, with limited movement beyond the boundaries of that site. Birds returning to the same location to breed, year after year also have high site fidelity.
Scoping	A procedure to consult with stakeholders to determine issues and concerns and for determining the extent of and approach to an EIA and EMP (one of the phases in an EIA and EMP). This process results in the development of a scope of work for the EIA, EMP and specialist studies.
Specialist study	A study into a particular aspect of the environment, undertaken by an expert in that discipline.
Species	A category of biological classification ranking immediately below the genus, grouping related organisms. A species is identified by a two part name; the name of the genus followed by a Latin or Latinised un-capitalised noun.
Species richness	The number of different species represented in an ecological community. It is simply a count of species and does not take into account the abundance of species.
Stakeholders	All parties affected by and/or able to influence a project, often those in a position of authority and/or representing others.
Subtidal	The marine habitat that lies below the level of mean low water for spring tides.
Supratidal	The area above the spring high tide mark that is not submerged by seawater. Seawater penetrates these elevated areas only at high tide during storms.
Surficial sediments	Calculated conservatively as the upper 20 cm of sediment for the purposes of offshore disposal.
Surf zone	Zone extending seawards of the high water mark to a point where the largest waves begin to break, off any section of coast defined as "sandy coast" or "mixed coast" on the National Coastline Layer, available from the South African National Biodiversity Institute's BGIS website (http://bgis.sanbi.org).
Trophodynamics	The dynamics of nutrition and metabolism.
Wind forcing	The movement of surface waters and the resulting transfer of energy to deeper waters by the predominant wind (i.e. a strong easterly wind will result in an eastward flowing surface current).

LIST OF ABBREVIATIONS

ADZ	Aquaculture Development Zone
Anchor	Anchor Environmental Consultants
BACI	Before-After/Control-Impact
BCS	Benguela Current System
BMSL	Below Mean Sea Level
CDOM	Coloured dissolved organic matter
CSIR	Council for Scientific and Industrial Research
CTD	Conductivity, temperature, depth
CWDP	Coastal Water Discharge Permit
DEA: O&C	Department of Environmental Affairs: Oceans and Coasts
DEAT	Department of Environmental Affairs and Tourism
DWA	Department of Water Affairs
EA	Environmental Authorisation
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
GA	General Authorisation
GDA	General Discharge Authorisation
HABs	Harmful Algal Blooms
IBA	Important Bird and Biodiversity Area
ICMA	Integrated Coastal Management Act (No. 24 of 2008)
IEM	Integrated Environmental Management
IUCN	International Union for Conservation of Nature
KZN	Kwa-Zulu Natal
MIA	Marine Impact Assessment
MPA	Marine Protected Area
MSL	Mean Sea Level
NBA	National Biodiversity Assessment
NAL	National Action List
NEMA	National Environmental Management Act (No. 107 of 1998, as amended)
NWA	National Water Act (No. 36 of 1998)
PSU	Measure of ocean salinity (Practical SalinityUnit), based on the properties of sea water conductivity.
REI	River-Estuary-Interface
RWQ	Receiving Water Quality
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WML	Waste Management Licence
WQG	Water Quality Guidelines
WUA	Water Use Authorisation
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 Background

NuLeaf Planning & Environmental commissioned Anchor Environmental Consultants (Pty) Ltd to conduct a desktop marine specialist study to assess likely impacts associated with the establishment and operation of an Aquaculture Development Zone (ADZ) at Amatikulu in KwaZulu-Natal (KZN) Province (Figure 1). Species to be farmed include dusky kob, barramundi, scallops, sea cucumbers, marine and freshwater ornamental fish and ornamental plants, tilapia, catfish and Nile crocodile. The ADZ requires application for environmental authorisation (EIA), and a Coastal Waters Discharge Permit (CWDP), both of which will require assessment of potential impacts on the marine environment.

An ADZ is a designated area selected for its suitability for a specific aquaculture sector. The aim of ADZ development is to provide opportunities for existing aquaculture operations to expand and new ones to be established, providing economic benefits to the local community through job creation and regional economic diversification. ADZs are intended to boost investor confidence by providing 'investment ready' platforms with strategic environmental approvals and management policies already in place, allowing commercial aquaculture operations to be set up without the need for lengthy, complex and expensive approval processes. It is anticipated that an ADZ will create incentives for industry growth, provide marine aquaculture services and enhance consumer confidence.

1.2 Terms of Reference

The terms of reference for this marine specialist impact report included:

2. A description of the species and habitats present in the coastal zone in the vicinity of the outfall;
3. An assessment physical and chemical dynamics of the system, as well as their importance and sensitivity;
4. Identification of potential impacts associated with construction and operation of the proposed ADZ on the environment including discharge of nutrient rich effluent into the sea; and,
5. Identification of appropriate risk and impact mitigation measures.

Impacts to the marine environment were assessed at a desktop level only supplemented with a site visit. Wastewater from the ADZ is set to be discharged to sea directly opposite the ADZ site (Figure 1) but no numerical modelling was conducted to assess dilution and dispersion of this effluent. Potential impacts to the Amatikulu estuary are a subject of a separate study and are not considered in this report.

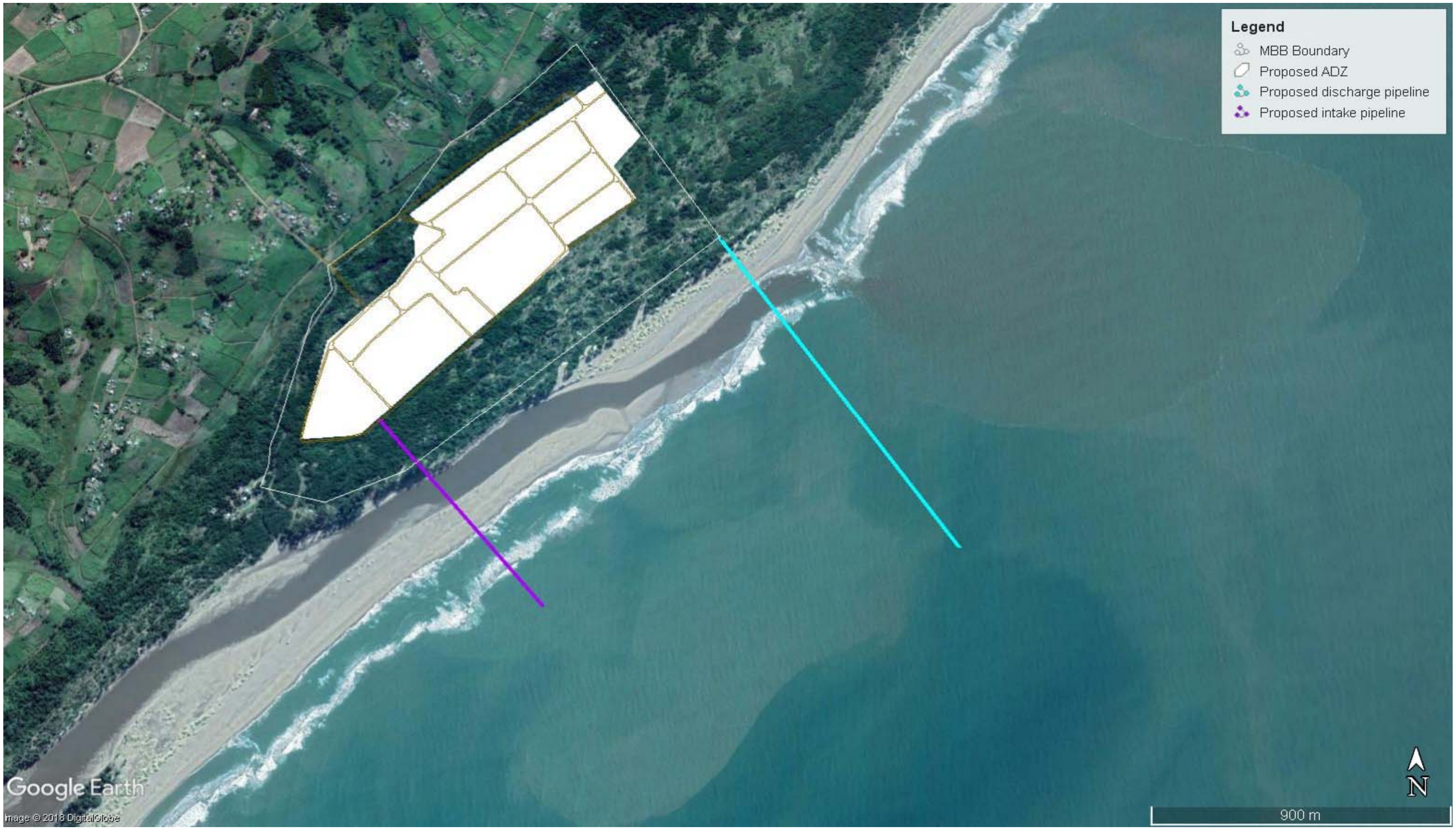

Figure 1 **Location of the proposed Amatikulu Aquaculture Development Zone (ADZ) (Google Earth 2018).**

2 OVERVIEW OF THE AFFECTED ENVIRONMENT

The Amatikulu study area is located at 29°04'S; 31°38'E, 105 km north of Durban and 56 km south of Richard's Bay.

2.1 Oceanography and ecology

The western boundary Agulhas current is the dominant oceanographic feature of the South African east coast (Figure 2). Core current speeds exceed 2 $m.s^{-1}$ and the current flows close inshore along much of the KZN coast as the continental shelf is narrow. This results in high current velocities and warm temperatures along much of the KZN coast. Near-shore currents are, however, variable and are thought to be associated with offshore movement of the Agulhas current due to the infrequent passage (~5 times per year) of the well documented Natal Pulse, a solitary meander of the Agulhas Current that originates near St Lucia and grows in amplitude as it travels south (Roberts *et al.* 2010). The salinity of KZN shelf water is 35-35.5 PSU, and temperatures usually vary between a winter minimum of 21°C and a summer maximum of 28°C (Pearce 1978).

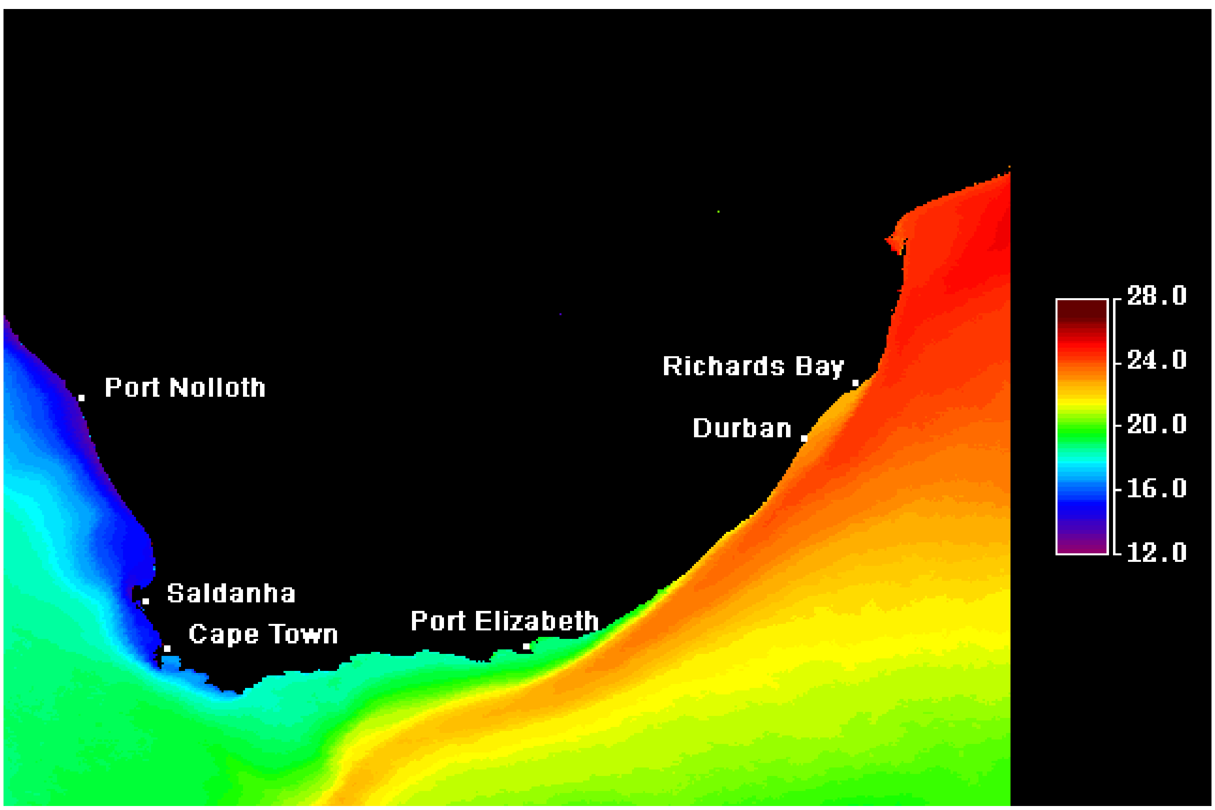

Figure 2 **Average sea surface temperature (°C) showing the warm-water Agulhas Current moving south westerly along the coast (AquaMODIS 4km-resolution, nine-year time composite image).**

The Natal Bight, a widening of the shelf from just north of Richards Bay to Durban is an area with a considerably gentler shelf slope than the rest of the Kwa-Zulu Natal (KZN) coast (Lutjeharms *et al.* 1989). The Bight originates near St Lucia where the 50 m depth contour is about 5 km offshore, and widens progressively southwards to Richards Bay (50 m depth contour is 10-16 km offshore) (CSIR 2014). South of Durban the continental shelf is narrow and the 50 m depth contour is found just 2 km off the Bluff. Topographically induced upwelling occurs on the KZN Bight via several mechanisms including cyclonic eddys, shelf edge upwelling or divergence driven upwelling on a current meander (Coetzee *et al.* 2010). This upwelling brings nutrient rich bottom water onto the KZN bight and results in increased productivity. For example phytoplankton and zooplankton biomass is frequently greater on the Bight than along other parts of the KZN shelf (Figure 3). Some authors have considered the Bight a semi-enclosed system with the Agulhas current forming a barrier to exchange with open ocean biota (Lutjeharms & Roberts 1988). This enrichment and retention on the KZN Bight makes this area an important regional feeding, spawning and nursery ground for many marine species including commercially important fishery species such as sardines and prawns (Freon *et al.* 2010, Everett 2014).

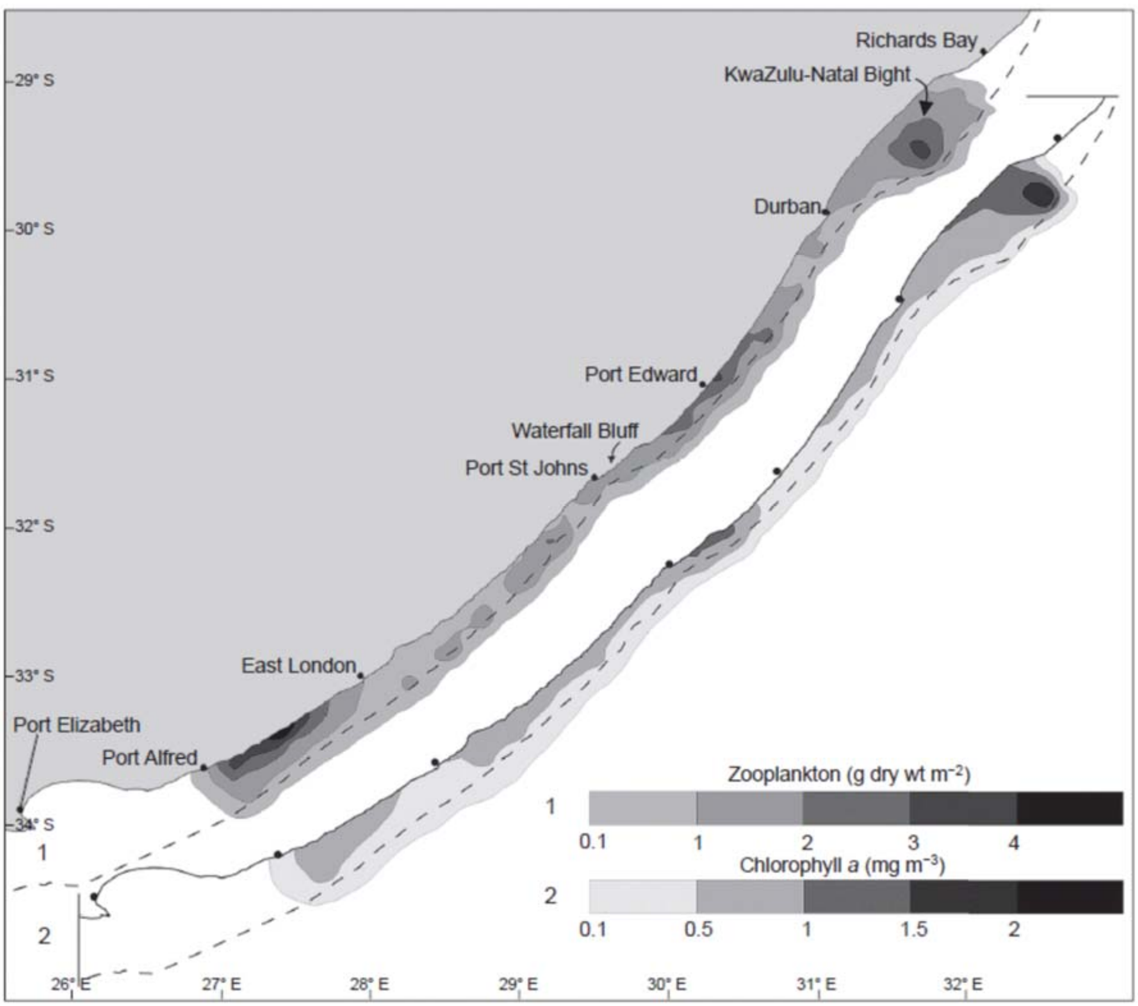

Figure 3. **Interpolated maximum concentrations of chlorophyll a and mesozooplankton biomass along the KZN coast showing enrichment on the KZN Bight (Coetzee *et al.* 2010, reproduced with permission from NISC).**

The dominant physical forcing affecting the Amatikulu estuary and surrounding coast is strong wave action, coupled with high volumes of sediment transported via longshore drift from the Thukela River to the south (Le Vieux 2010).

2.2 Biogeography

Numerous attempts have been made to understand and map marine biogeographic patterns around the coast of South Africa with the most recent being Sink *et al.* (2012). Most of the studies recognised three coastal regions; a cool temperate west coast, a warm temperate south coast and a subtropical east coast region; however, Sink *et al.* (2012) defined several new ecoregions that are now in use. According to these divisions, the Amatikulu area falls within the Natal Bioregion, one of five inshore bioregions located around the coast of South (Figure 4). Numerous works particularly focused on rocky shores have refined the latitudinal boundaries of the Natal Bioregion and it is accepted to extend from the Mbashe River in the Eastern Cape northwards to St Lucia (Stephenson & Stephenson 1972, Brown & Jarman 1978, Bustamante 1994, Bustamante & Branch 1996, Sink 2001, Bolton *et al.* 2004, Sink *et al*. 2005, Spalding *et al.* 2007). Subtidal biogeographic patterns also show congruency with intertidal patterns (Lawrence 2005, Evans 2005, Porter *et al.* 2009, Porter *et al.* 2013).

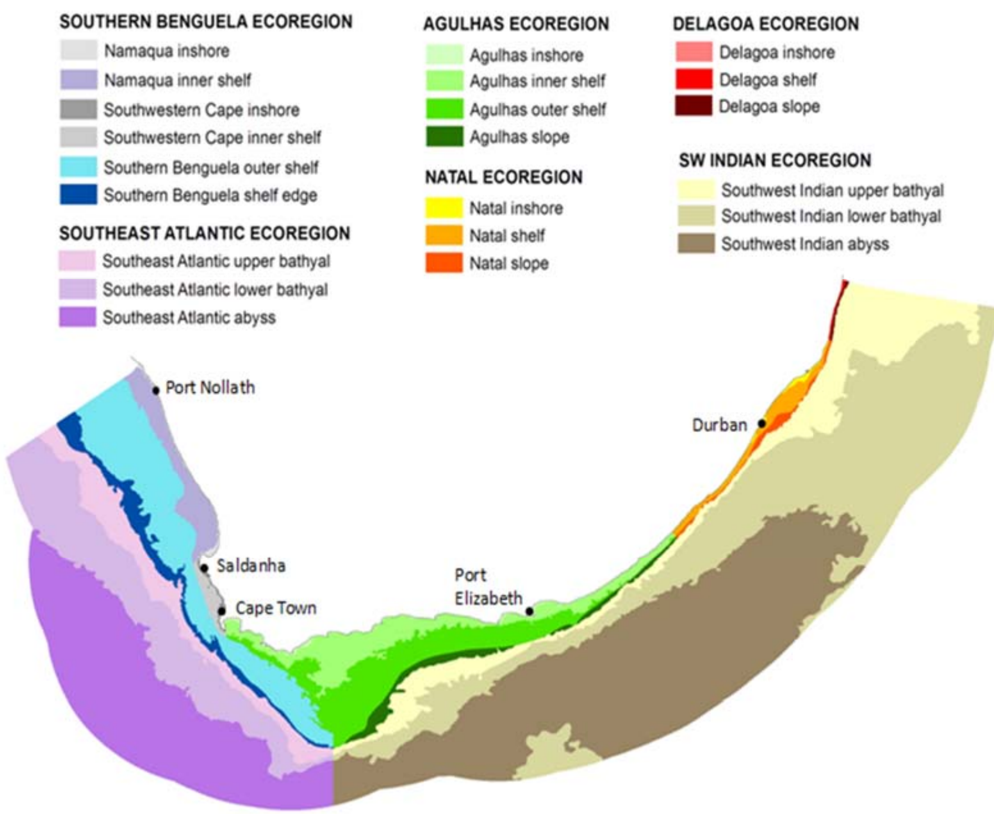

Figure 4. Inshore and offshore ecoregions in South Africa as defined by Sink *et al.* (2012).

2.3 Ecology

Marine and coastal habitats present in the study area include estuarine habitat (the Amatikulu estuary) and sandy beach and coastal dune habitat. Potential impacts to the Amatikulu estuary are a subject of a separate study and are not considered in this report.

2.3.1 Sandy beaches

Intertidal sandy beaches are dynamic environments, and the faunal community composition is largely dependent on the interaction of wave energy, beach slope and sand particle size. Beaches typically comprise three functional zones, namely the surf zone (sublittoral fringe), the beach (intertidal and backshore zones) and the upper drift line (supralittoral zone). Sandy beaches have no hard substratum onto which animals and plants can attach, thus sessile species are virtually absent (Castro & Huber 1997). Five groups of organisms are typically found on sandy beaches: aquatic scavengers, aquatic particle feeders, air breathing scavengers, meiofauna (smaller than 1 mm in size), and higher predators (Branch & Branch 1981). Fauna and flora that inhabit the surfaces of subtidal sand are called benthic epifauna, while those that burrow or dig into the soft sediments are called benthic infauna. Soft-bottom subtidal communities are typically dominated by benthic infauna, with some epifauna present. The distribution of infauna and the depth at which organisms can live in the substrate is largely dependent on sediment particle size. More porous, larger grained substrates allow greater water circulation through the sediment, thereby replenishing the oxygen which is used up during the decomposition processes.

Aquatic scavengers feed on dead or dying animals that wash up on the beach and their activity is largely regulated by tides. The majority of these species migrate up and down the beach with each tidal cycle, such that they remain in the surf zone and can escape avian and terrestrial predators. Sand hoppers are important for the breakdown of washed up seaweed and plant matter, and are also a major food source for sanderlings and other birds. Air breathing scavengers live high on the shore and feed on washed up seaweed, as well as dead and decaying animal matter. These species complete their life cycles out of water, emerging from the sand during low tide when there is less risk of being washed away. They are almost strictly nocturnal to avoid desiccation and predation.

Much of the benthic infauna are deposit feeders, which either ingest sediments and extract organic matter trapped between the grains or actively collect organic matter and detritus (Castro & Huber 1997). Suspension feeders eat drifting detritus and plankton from the water column (Castro & Huber 1997). Some suspension feeders are filter feeders which actively pump and filter water to obtain suspended particles. These include clams as well as species of amphipods and polychaetes. Other suspension feeders lift arms, tubes, branches or polyps vertically into the water column to catch suspended particles. Meiofauna (organisms < 1mm in size) are by far the most abundant of the animals found on sandy beaches, as their small size enables them to live between sand grains. The two most common groups are nematode worms and harpacticoid copepods. Meiofauna play an important role in breaking down organic matter that is then colonised by bacteria.

Predators in soft bottom habitats may either burrow through sediments to get to their prey, or catch organisms on the surface (Castro & Huber 1997). Predators such as crabs, hermit crabs, lobsters and octopuses, which inhabit rocky areas, may move to sandy benthos to feed (Castro & Huber 1997).

Most bottom-dwelling fish in soft bottom habitats are predators. Rays and skates scoop up clams, crabs and other infauna and epifauna, while flat fishes, such as flounders and soles, lie camouflaged on the bottom and forage for a wide variety of prey. Other higher predators that feed on sandy beach organisms include birds such as swift tern (*Sterna bergii*) (Branch & Branch 1981).

There are three beach types: dissipative, intermediate and reflective. Dissipative beaches are wide and flat with fine sands. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches and are coarse grained (>500 µm sand) with narrow, steep intertidal beach faces. The relative absence of a surf-zone causes the waves to break directly on the shore causing a high turnover of sand and resulting in depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a variable species composition. Overall, relatively few macrofauna species occur on sandy beaches due to their unstable and harsh nature, but those that do occur are hardy and well adapted to life in these environments.

No data are available on the communities inhabitation the shore at the Amatikulu site, but observations made during a site visit conducted for this study indicate that conditions are very similar to those found at Tinley Manor, approximately 60 km to the south, which have been subject to detailed study by Harmer & Clark (2017).

Harmer & Clark (2017) showed that the profile of beaches at Tinley Manor and Amatikulu are generally fairly steep and narrow, characteristic of an intermediate/reflective beach type (see Figure 5, Figure 6). Six dune vegetation and sandy beach were sampled along the length of the shore between Christmas Rock and the Umhlali River mouth during the latter study, with a view to capturing local scale variability in the habitats and biota in the area (Figure 7). For the beach surveys, beach profiles were measure using the Emery method, at each site. Sandy beach macrofauna were also collected by excavating and sieving (through a 1 mm mesh bag) a known volume of sand (0.023 m^3) collected from three different levels on the beach (high, mid, low) at each of stations across the shore. All fauna extracted from the samples were identified to the lowest possible taxonomic level, counted and weighed. Sediment samples were collected at each station for grain size and total organic carbon (TOC) analysis. Dune vegetation was surveyed at a series of 20 m x 20 m plots along the shoreline at the top of the beach. Percentage cover of dominant plant species was recorded and assigned to abundance categories as follows:

- Very abundant: >75%
- Abundant: 50%
- Common: <25%
- Rare: <5%

Figure 5 Northwards facing beach profile at Tinley Manor.

Figure 6. Shore at Amatikulu. The water body in the foreground is the Amatikulu estuary.

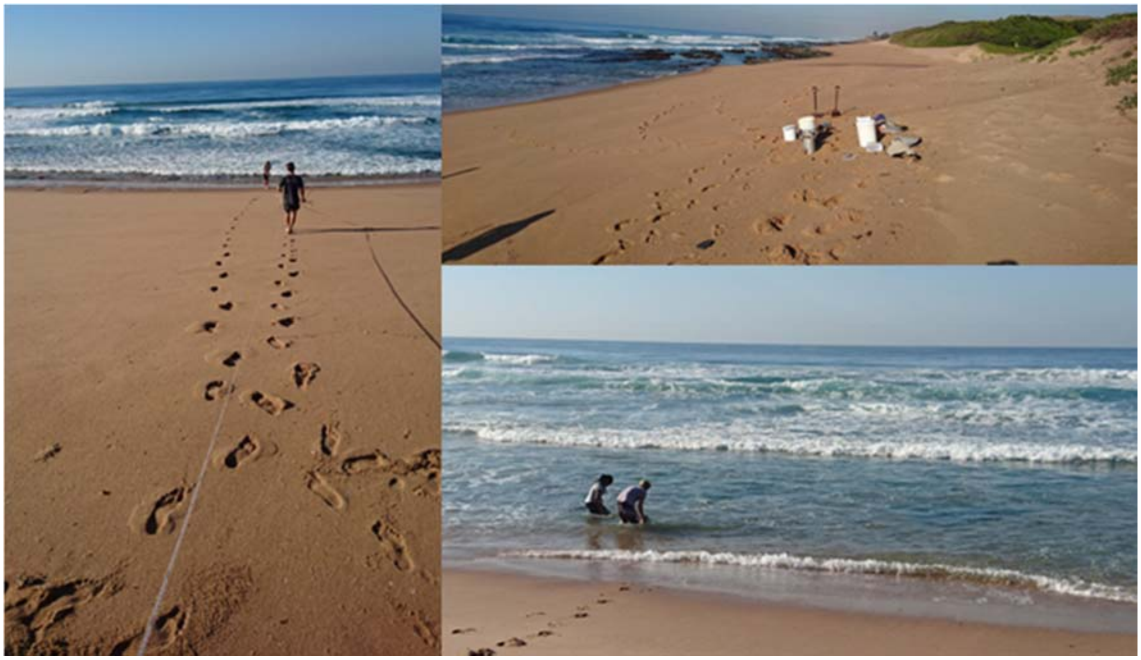

Figure 7 **Beach sampling (from Harmer & Clark 2017): measuring beach profile (left), macrofauna sampling equipment (top right), extracting macrofauna (bottom right).**

Harmer & Clark (2017) found very little difference in sediment characteristics between sampling stations at Tinley Manor. Sediments were comprised of predominantly sandy sediments (particle size ranging between 63 µm and 2000 µm). The sediment type was classified as coarse sand (Table 1). TOC levels in sediments were expectedly low and varied little between stations, ranging from 0.71 – 0.99 %.

Table 1 **Summary of beach and sediment characteristics as per Harmer & Clark (2017).**

Summary Table	
Beach type	Intermediate/Reflective
Exposure	Very exposed
Average width of beach (m)	30
Average particle size (µm)	589.3
Sediment type	Coarse sand
Average TOC (%)	0.87

A total of 55 macrofaunal organisms were collected in their surveys, with 12 species identified.

Table 2 Macrofauna species recorded from sandy beach samples collected by Harmer & Clark (2017).

Phylum	Taxa	Species
Annelida	Polychaeta	Dorvillea sp
		Glycera sp.
		Pisione africana
		Pisionidens indica
		Scolelepis squamata
Crustacea	Isopoda	Dentonidae sp.
		Excirolana natalensis
	Copoepod	Copepod
	Mysid	Gastrosaccus sp.
Chaetognatha	Chaetognatha	Chaetognath sp.
Nemertea	Nemertea	Nemertea
Insecta	Insecta	Carabidae larva

Marked differences were evident in community structure between the high, mid and low shore stations. Both abundance and biomass was low on the high shore for all stations (average = 2.18 indiv.m^2; 1.01 g.m^2). Mean abundance was highest in the low shore (average = 87.29 indiv.m^2), while mean biomass was greatest in the mid shore (average = 1.04 g.m^2) (Figure 8). Polychaeta dominated the taxonomic composition of the low shore macrofaunal communities, while Isopoda dominated the mid shore. The main contributor to mean biomass for both the mid- and low-shore communities was Polychaeta. Isopoda followed in the mid shore and Mysids on the low shore. Species richness was correspondingly low on the high shore.

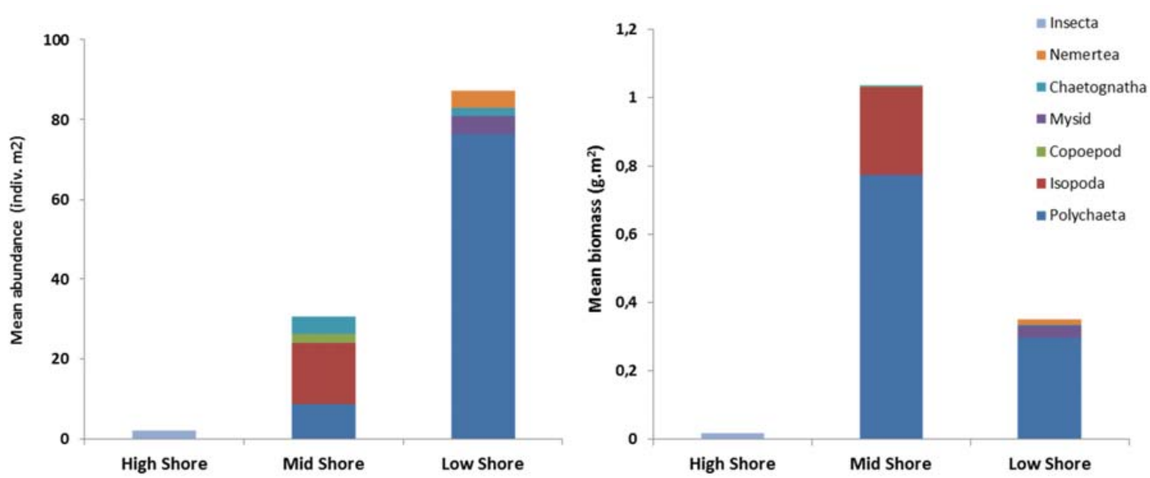

Figure 8 Mean macrofauna abundance and biomass as per Harmer & Clark (2017).

2.3.2 Dune vegetation

Harmer & Clark (2017) also surveyed dune vegetation in the Amatikulu area (Figure 9). Dune vegetation is adapted to survive the harsh salt spray, wind and unstable sediment conditions of the coastal zone. Their resilience allows for vegetated dunes to serve as a protective barrier from coastal exposure. Plant species recorded on the dunes at each sampling station are presented in (Table 3). Dune vegetation recorded a Tinley Manor is considered characteristic of KwaZulu-Natal coastal dunes. Dune vegetation was fragmented with small patches of dense coastal forest on the back dune. Beach morning glory *Ipomoea pes-caprae* and the treasure flower *Gazania rigens* was predominantly found at the bottom of the front dune, while the dune koko tree *Maytenus procumbens* and coastal red-milkwood *Mimusops caffra* characterised the back dune (Figure 10).

Harmer & Clark (2017) identified no red listed species at the Tinlet Manor site, but it is not clear whether this also applies to the Amatikulu site as well or not.

Figure 9 **Dune vegetation in the Amatikulu area (Harmer & Clark 2017).**

Table 3 **Dube vegetation species recorded in the Amatikulu area (from Harmer & Clark 2017).**

Family	Species
Acanthaceae	*Barleria obtuse*
Aizoaceae	*Carpobrotus dimidiatus*
	Tetragonia sp.
Araceae	*Colocasia sp. (Amadumbe)*
	Monstera deliciosa
Arecaceae	*Phoenix reclinata*
Asparag-aceae	*Chlorophytum bowkeri*
	Dracaena aletriformis
Asteraceae	*Brachylaena discolor*
	Chrysanthemoides monilifera
	Dimorphotheca fruticosa
	Gazania rigens
Celastraceae	*Maytenus procumbens*
Commelin-aceae	*Cyanotis sp*
Convolvul-aceae	*Ipomoea pes-caprae*
	Ipomoea sp.
Fabaceae	*Canavalia rosea*

Family	Species
Lecythid-aceae	*Barringtonia racemosa*
Pandan-aceae	*Pandanus sp*
Sapotaceae	*Mimusops caffra*
Strelitzi-aceae	*Strelitzia Nicolai*
Xanthorrhoeaceae	*Aloe thraskii*

Figure 10 **Flora observed on the vegetated dune with in the development area. Front dune (Top left), Back dune costal forest (top right), Treasure flower - *Gazania rigens* (middle left), Dune Koko Tree - *Maytenus procumbens* (middle right), Beach morning glory - *Ipomoea pes-caprae* (bottom left) and Coastal red-milkwood - *Mimusops caffra* (bottom right) (from Harmer & Clark 2017).**

2.4 Sensitivity and significance

The beaches in the Amatikulu area are typically depauperate of fauna, due to physical environmental factors and the associated morphodynamic state of the beach. In sandy beach environments, the physical characteristics of a beach such as wave energy, beach slope and sediment grain size, all play an important role in determining macrofaunal community composition. The reflective, coarse grained and relatively steep beaches of the area are generally characterised by relatively low richness, abundance and biomass of fauna (Harmer & Clark 2017).

The dune vegetation in the Amatikulu area is characteristic of coastal dunes found in Kwa-Zulu Natal. Such vegetated dunes are, however, considered to be an uncommon habitat due to considerable loss considerable of the habitat through urbanisation. Current factors threatening costal dune habitats in KZN include urban development, recreational pressure, pollution and alien species. Their protection is important as they serve as a protective barrier from coastal exposure; they reduce beach erosion; and provide a habitat for numerous endemic terrestrial fauna. Although the vegetated dunes throughout the development area are fragmented, they offer important environmental services and are ecologically significant to the area.

The study area was assessed using the ecosystem threat status tool according to the National Biodiversity Assessment (NBA) (Sink *et al.* 2012). The marine classification extends a few hundred metres inland to provide a buffer zone for the marine environment. The ecosystem threat status rates the system's ability to provide ecosystem services. Ecosystem types are categorised as 'critically endangered', 'endangered', 'vulnerable' or 'least threatened', based on the proportion of each ecosystem type that remains in good ecological condition (Driver *et al*. 2012). The majority of the Amatikulu area is listed as 'vulnerable', while the mouth of the estuary is classified as 'least threatened' (Figure 11). Figure 11 also shows the delineation of the Amatikulu Nature Reserve (Protected Area) and estuary.

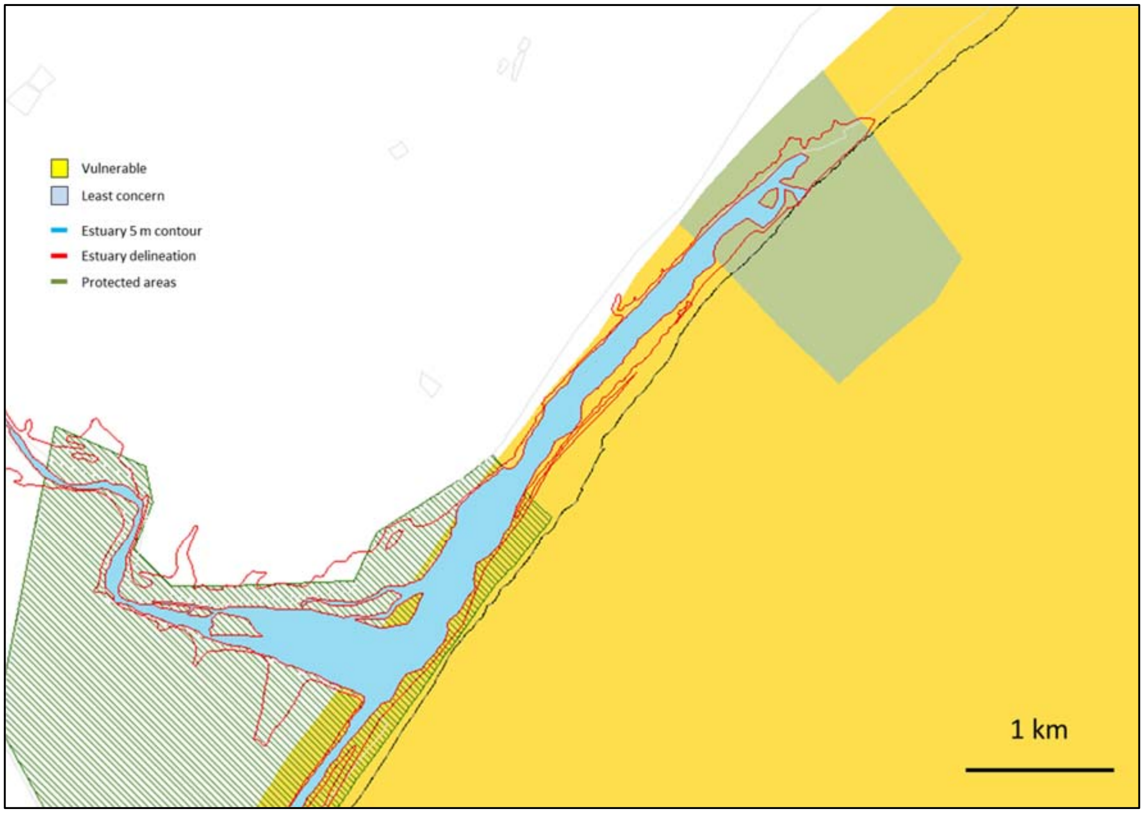

Figure 11 **The ecosystem threat status of Amatikulu area according to data from the National Biodiversity Assessment (Sink *et al.* 2012).**

2.5 Legal status of the affected environment

The Amatikulu ADZ is located directly adjacent to the newly proposed uThukela Banks Marine Protected Area, while intake and outfall pipeline for the proposed ADZ are located within the boundaries of the MPA. The Minister of Environmental Affairs published for public comment a notice (Notice no. R108) declaring her intention to establish the uThukela Banks Marine Protected Area (TBMPA) under section 22A of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) (NEMBA: PAA) on 3 February 2016, along with a second notice (Notice no. 103) outlining draft regulations for the management of this MPA (Government Gazette No. 39646). The proposed Marine Protected Area (MPA) consists of an inshore and offshore area (Figure 12). The inshore area consists of two Inshore Restricted zones and the remainder is an Inshore Controlled Zone. The intake and outfall pipeline for the proposed Amatikulu ADZ development fall within the uThukela Banks Inshore Restricted Zone 1 (TIRZ1). This comprises the inshore portion of the uThukela Banks Marine Protected Area and is defined as the section between the following two co-ordinates (I1) 29° 26.928' S, 31° 36.945' E and (I2) 29° 13.472' S, 31° 31.062' E running from the high water mark to the two meter depth contour.

The NEMBA: PAA does not specifically exclude construction of intake or outfall pipelines in MPAs generally or intake or discharge of waste water into the MPAs, nor are any of these activities specifically excluded under GN 103 or 108 (Draft Regulations for the Establishment and Management of the uThukela Banks Marine Protected Area). However, all of these activities are likely to be considered unlawful under the Marine Living Resources Act No. 18 of 1998 (MLRA) when the MPA is formally established. The MLRA states that in Chapter 4 (Marine Protected Areas):

(2) No person shall in any marine protected area, without permission in terms of subsection (3)—

(c) dredge, extract sand or gravel, discharge or deposit waste or any other polluting matter, or in any way disturb, alter or destroy the natural environment;

(d) construct or erect any building or other structure on or over any land or water within such a marine protected area; or

(e) carry on any activity which may adversely impact on the ecosystems of that area.

In particular, Section 5 of the MLRA states that:

1. *Restriction of Activities*
   No person may undertake any activity listed in section 48A(1) of the Act in the Marine Protected Area unless authorised in terms of these regulations.

The boundaries of the proposed uThukela Banks MPA extend up to the High Water Mark and at least 10 km to the north and around 18 km to the south of the ADZ. This is considered a potential fatal flaw in respect of the establishment of the ADZ, and particularly the construction of intake or outfall pipelines, seawater intake, and wastewater discharge for the ADZ, unless authorisation for these activities can be secured in terms of the MLRA.

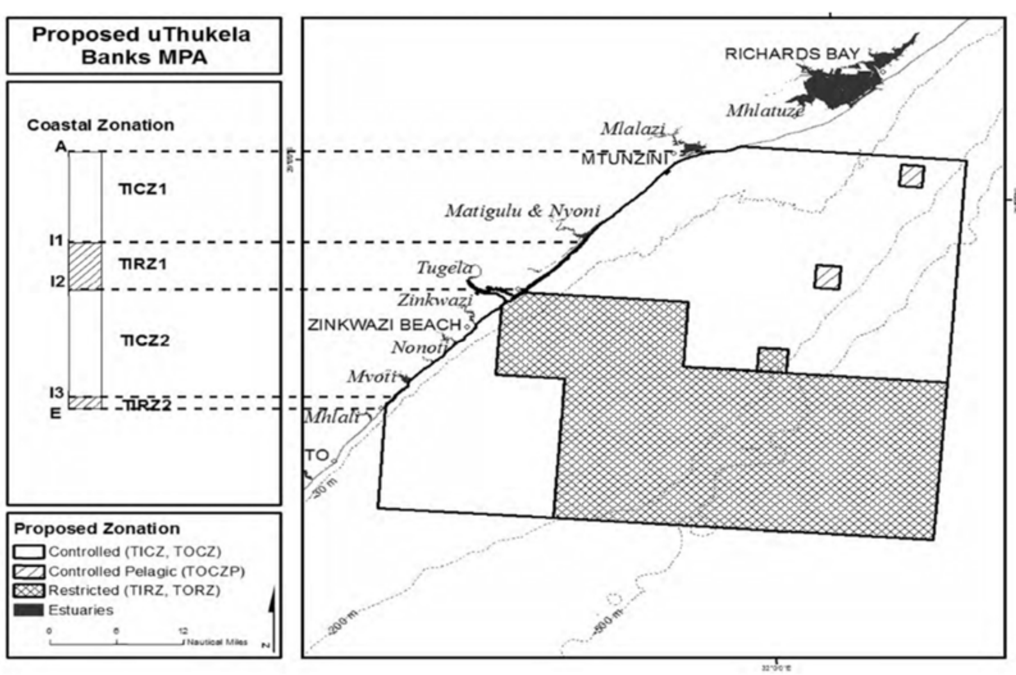

Figure 12 **Proposed uThukela Banks Marine Protected Area inshore zonation (Government Gazette, 3 February 2018).**

3 ASSESSMENT OF POTENTIAL IMPACTS

All potential impacts on the marine ecology of Amatikulu as a result of the proposed development were evaluated as part of this study. Both construction and operating phase impacts are expected to be localised, and construction phase impacts are expected to be of temporary duration.

In the marine/estuarine environment a disturbance can be relatively short-lived (e.g. accidental spill which is diluted in the water column below threshold limits within hours) but the effect of such a disturbance may have a much longer lifetime (e.g. attachment of pollutants to sediment which may be disturbed frequently). The assessment and rating procedure described in Appendix 1 (as per the specialist terms of reference) addresses the effects and consequences (i.e. the impact) on the environment rather than the cause or initial disturbance alone. To reduce negative impacts, precautions referred to as 'mitigation measures' are set and attainable mitigation actions are recommended. In this report, the 'construction footprint' is defined as the total area of new infrastructure as determined by design engineers.

Results of each assessment are presented in Table 4 to Table 12 and are summarised in Table 13.

3.1 Construction Phase

These potential impacts relate to the construction and installation of the onshore and subtidal sections of the seawater intake and effluent discharge pipelines (i.e. disturbance, waste, noise and vibration, and turbidity). Impacts associated with the location of onshore ADZ and the associated land-based pipelines are not deemed to be of relevance to the marine environment, and must be addressed by terrestrial specialist studies.

Potential impacts that may arise from the laying of new pipelines during the construction phase include ecological effects due to the:

- permanent loss and/or modification of sandy beach, coastal dune and unconsolidated subtidal habitats, and the disturbance or mortality of associated biota at, and immediately adjacent to, the development site resulting from installation of project infrastructure (pipelines, roads, paths and breakwaters etc.); and,
- temporary disturbance of coastal marine fauna and flora during construction due to noise, turbidity and the presence of construction crews and equipment on the site during construction.

3.1.1 Permanent loss and/or modification of habitat and temporary disturbance of coastal marine fauna and flora during construction

Construction of intake and discharge pipeline infrastructure at Amatikulu sandy beach will involve the disturbance to and/or mortality of subtidal benthic and pelagic fauna, flora and habitats. This is considered a fatal flaw, given that the marine system where construction is proposed is within a proposed Marine Protected Area (see Section 2.5) (Table 5).

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The Marine Living Resources Act No. 18 of 1998 states that in Chapter 4 (Marine Protected Areas):

> (2) No person shall in any marine protected area, without permission in terms of subsection (3)—
>
> (c) dredge, extract sand or gravel, discharge or deposit waste or any other polluting matter, or in any way disturb, alter or destroy the natural environment;
>
> (d) construct or erect any building or other structure on or over any land or water within such a marine protected area; or
>
> (e) carry on any activity which may adversely impact on the ecosystems of that area.

Table 4. **Impact 1: Permanent loss and/or modification of habitat and temporary disturbance of coastal marine fauna and flora during construction.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	**FATAL FLAW**						-'ve	High

Outside of an MPA, this impact would have been considered to be 'local' and of 'low intensity' and easily mitigated. However, given that the boundaries of the proposed uThukela Banks MPA extend up to the High Water Mark and at least 10 km to the north and around 18 km to the south of the ADZ it will not be practically possible to mitigate these impacts through an alternative pipeline routing.

3.1.2 Permanent loss or alteration of subtidal soft sediment habitat

Construction of pipeline infrastructure across the Amatikulu sandy beach will involve some traffic on the beach by heavy vehicles and machinery, and as such will result in the loss of sandy habitat habitat within the construction footprint, and will likely cause mortality of resident infauna. The pipeline itself will result in the loss of a very small area of sandy beach habitat.

Sandy beaches are inherently highly dynamic systems. Construction activities will be localised and confined to within a few hundred metres of the construction footprint. The pipelines will likely be covered with sand (either through natural deposition or beach nourishment). Any birds feeding and/or roosting in the area will be disturbed and displaced for the duration of construction activities but are expected to return on completion of pipeline placement. The relatively small footprint and temporary nature of construction activities will result in the impact being felt over a very limited spatial scale and will not noticeably influence the ecology of the beach in question. Recovery of sandy beach assemblages will occur primarily through immigration from adjacent areas.

Under normal circumstances, the impact would have been considered to be 'local' and of 'low intensity' and easily mitigated. However, given that the boundaries of the proposed uThukela Banks MPA extend up to the High Water Mark and at least 10 km to the north and around 18 km to the south of the ADZ it will not be practically possible to mitigate these impacts through an alternative pipeline routing. Impact on intertidal communities are therefore considered a fatal flaw (Table 5).

Table 5 **Impact 2: Permanent loss or alteration of subtidal soft sediment habitat.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	FATAL FLAW						-ve	High

3.1.3 Permanent loss or alteration of coastal dune habitat

Impacts on dune vegetation and fauna are likely to be much lower than for marine species with complete mortality only occurring in the areas within the actual development footprint (i.e. in the paths of any roads, parking areas, paths, tanks, etc.) and correspondingly lower levels of mortality and disturbance occurring in the surround areas. Again, despite the destructive nature of this 'permanent' disturbance, the impact is considered to be 'local' and of 'low intensity'. As long as construction equipment is kept within the developmental footprint and the sediment outside this area is not disturbed, the significance of this impact is expected to be 'low' after mitigation (Table 6).

Table 6 **Impact 3: Permanent loss or alteration of coastal dune habitat.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Permanent 3	Medium 6	Probable	**MEDIUM**	-ve	High
Recommended mitigation measures: • Limit duration of construction activities in the coastal zone. • Constrain spatial extent of impacts to the minimum required and to areas that are already disturbed through cultivation. • Inform all staff about sensitive marine habitats.								
With mitigation	Local 1	Low 1	Permanent 3	Low 5	Probable	**LOW**	-ve	High

3.1.4 Noise and vibration management during construction

During construction operations, noise may have an impact on marine organisms in the surrounding area. Noise may be generated by construction activities (e.g. earthmoving vehicles, service vehicles, heavy machinery, generators etc.). Marine invertebrates have been shown to be relatively insensitive to low frequency sound, whilst fish appear to be able to tolerate moderate sound levels (Keevin & Hempen 1997). Foraging seabirds and cetaceans are expected to avoid the sound source should it reach levels sufficient to cause discomfort. Due to the existence of similar habitats in the surrounding area, it is not expected that avifauna will be excluded from feeding on a particular food source/utilising a particular habitat as a roosting site. The impact of noise and vibration on the marine environment is considered to be 'insignificant' (Table 7).

Table 7 **Impact 4: The effect of increased noise and vibration from construction.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Low 1	Low 1	Short -term 1	Very Low 3	Improbable	INSIGNIFICANT	-ve	Medium
Recommended mitigation measures: • Not considered necessary due to low impact rating.								

3.1.5 Waste generation and disposal

South Africa has laws against littering, both on land and in the coastal zone, but unfortunately these laws are seldom rigorously enforced. Objects which are particularly detrimental to aquatic fauna include plastic bags and bottles, pieces of rope and small plastic particles. Large numbers of aquatic organisms are killed or injured daily by becoming entangled in debris or as a result of the ingestion of small plastic particles (Gregory 2009, Wright *et al*. 2013). If allowed to enter the ocean, solid waste may be transported by currents for long distances out to sea and around the coast. Thus, unlike fuel or sewage contamination, the extent of the damage caused by solid waste is potentially large. The impact of floating or submerged solid materials on aquatic life (especially birds and fish) can be lethal and can affect rare and endangered species.

The problem of litter entering the aquatic environment has escalated dramatically in recent decades, with an ever-increasing proportion of litter consisting of non-biodegradable plastic materials. In order to reduce this, all domestic and general waste generated must be disposed of responsibly. All reasonable measures must be implemented to ensure there is no littering and that construction waste is adequately managed. Staff must be regularly reminded about the detrimental impacts of pollution on aquatic species and suitable handling and disposal protocols must be clearly explained and sign boarded. The 'reduce, reuse, recycle' policy must be implemented. This impact is rated as 'medium' without mitigation and is reduced to 'low' by implementing the actions outlined in Table 8.

Table 8 **Impact 5: Waste generation and disposal during construction.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	International 3	Low 1	Long-term 3	High 7	Possible	**MEDIUM**	-ve	High
Essential mitigation: • Inform all staff about sensitive marine species and the responsible disposal of construction waste. • Suitable handling and disposal protocols must be clearly explained and sign boarded. • Reduce, reuse, recycle.								
With mitigation	International 3	Low 1	Medium-term 3	Medium 7	Improbable	**LOW**	-ve	High

3.1.6 Hazardous substance spills

The risk of spillage of a variety of hazardous substances may occur during the use of heavy machinery, construction vehicles and construction vessels. Hydrocarbons are toxic to aquatic organisms and precautions must be taken to prevent them from contaminating the environment. This impact can be mitigated successfully if authorities implement a rigorous environmental management and control plan to limit ecological risks from accidents. Intentional disposal of any substance into the aquatic environment is strictly prohibited, while accidental spillage must be prevented, contained and reported immediately. After mitigation, the impact of accidental spillage is considered to be 'very low' (Table 9).

Table 9 **Impact 6: The effect of the spillage of hazardous substances.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Medium-term 2	Medium 6	Possible	**LOW**	-ve	Medium
Essential mitigation measures: • Intentional disposal of any substance into the environment is strictly prohibited, while accidental spillage must be prevented, contained and reported immediately. • Implementation of a rigorous environmental management and control plan (including procedures for remediation). • All fuel and oil is to be stored with adequate spill protection. • No leaking vehicles are permitted on site. • All hazardous substances must be accompanied by a permit, a hazard report sheet, and a first aid treatment protocol and may only be handled by suitably trained operators.								
With mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Improbable	**VERY LOW**	-ve	Medium

3.2 Operation Phase

Operational phase impacts include:

- Impacts on water quality and physiological functioning due to ADZ effluent discharge;
- Mortality of marine organisms due to entrainment and impingement; and
- Sediment scouring and shifts in sediment movement patterns.

3.2.1 Impacts on water quality and physiological functioning due to discharge

Aquaculture derived effluent has the potential to be a significant source of enhanced nutrient supply that may stimulate algal blooms in disturbed environments, potentially resulting in eutrophication and oxygen depletion in the area of discharge (Masterson *et al*. 2008).

However, the marine system off Amatikulu is a Gazetted Marine Protected Area (see Section 2.5). Therefore, discharge of ADZ effluent via the proposed outfall pipeline contravenes the Marine Living Resources Act No. 18 of 1998 states that in Chapter 4 (Marine Protected Areas), and is thus considered a fatal flaw (Table 10):

> *(2) No person shall in any marine protected area, without permission in terms of subsection (3)—*
>
> *(c) dredge, extract sand or gravel, discharge or deposit waste or any other polluting matter, or in any way disturb, alter or destroy the natural environment;*
>
> *(d) construct or erect any building or other structure on or over any land or water within such a marine protected area; or*
>
> *(e) carry on any activity which may adversely impact on the ecosystems of that area.*

However, should efforts be undertaken to successfully ensure that effluent **at pipe end** meets DWAF (1995) Water Quality Guidelines (WQG) for coastal marine waters, and a comprehensive monitoring program implemented, the impact will be considered to be of low significance (Table 10).

Table 10 **Impact 7: Impacts on water quality and physiological functioning due to discharge.**

<table>
<tr><th></th><th>Extent</th><th>Intensity</th><th>Duration</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>Status</th><th>Confidence</th></tr>
<tr><td>Without mitigation</td><td colspan="6">FATAL FLAW</td><td>-'ve</td><td>High</td></tr>
<tr><td colspan="9">• Fatal flaw
Essential mitigation measures:
• Ensure that effluent at pipe end meets DWAF (1995) Water Quality Guidelines (WQG) for coastal marine waters.
• Implement a comprehensive monitoring program.</td></tr>
<tr><td>With mitigation</td><td>Local
1</td><td>Medium
2</td><td>Long-term
3</td><td>Medium
6</td><td>Possible</td><td>LOW</td><td>-ve</td><td>Medium</td></tr>
</table>

3.2.2 Mortality of marine organisms due to impingement and entrainment in the seawater intake

Intake of water directly from the ocean usually results in loss of marine species as a result of impingement and entrainment. Impingement refers to injury or mortality of organisms that collide with and are trapped by intake screens, while entrainment refers to organisms that slip through the screens and are taken into the plant with the abstracted water. If screens are in place, entrained material is likely to include smaller organisms such as holoplanktonic organisms (i.e. permanent members of the plankton - copepods, diatoms and bacteria) and meroplanktonic organisms (i.e. temporary members of the plankton - juvenile shrimps and the planktonic eggs and larvae of invertebrates and fish).

Entrained organisms are killed or injured when water is forced against intake screens and/or filters. While some studies estimated a 100% mortality rate of entrained organisms in power plant cooling systems (California Coastal Commission 2004), a study by Bamber and Seaby (2004) demonstrated mortalities ranging from 10 to 20%. It is likely that mortality rates in an aquaculture facility are likely to be similar to those experienced in cooling. While the significance of both impingement and entrainment is related to the location of an intake, impingement is primarily a function of intake velocity, and entrainment depends largely on the overall volume of water drawn into the ADZ. Impingement can be mitigated through structural or operational designs including abstracting seawater at reduced flow rates, the use of velocity caps to angle flow, and the instalment of intake screens. Intake rates should be kept below 0.15 m/s to allow fish and other organisms to escape the intake current. This can be achieved through calculating optimal pumping rates and through intake design. Alternatively, concrete velocity caps can be used to change the predominant intake flow from vertical to horizontal, thereby significantly reducing impacts on fish, which are better able to detect a horizontal rather than a vertical change in water velocity. The abovementioned options require little ongoing maintenance once installed.

Further mitigation options involve the installation of screens that are specifically sized to prevent fish from entering the system, while still allowing adequate water flow. Travelling screens installed at the landward end of a pipeline intake enable fish to be transported out of an intake system, through a fish return system, and back to the ocean (California Coastal Commission 2004). The downside is that these systems involve ongoing maintenance and personnel for operation.

Abstracting water directly from the sea via a pipeline means that the seawater will not be filtered through sediment and may still contain high numbers of marine biota that will be trapped within the plant and foul equipment. In addition, the greater proportion of particles in the water will require the injection of more chemicals and biocides in pre-treatment, resulting in increases in backwash volumes, costs and environmental contamination. Under normal circumstances, the impact from this source would be considered to be of Medium significance but could be easily mitigated. However, , owing to the fact that the marine environment off the Amatikulu site is likely to be declared as an MPA in the near future, any disturbance of marine life must be considered a fatal flaw in this study.

Table 11. Impact 8: Disturbance and/or mortality of marine life due to the intake of seawater.

<table>
<tr><th></th><th>Extent</th><th>Intensity</th><th>Duration</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>Status</th><th>Confidence</th></tr>
<tr><td>Without mitigation</td><td colspan="6"></td><td>-ve</td><td>Medium</td></tr>
<tr><td colspan="9">• <u>Fatal flaw</u>
<u>Essential mitigation:</u>
• Intake velocities should be kept below 0.15 m.s^{-1} to ensure that fish and other organisms can escape the intake current.
• Velocity caps can be used to change the predominant intake flow from vertical to horizontal, thereby significantly reducing impingement of fish.
<u>Best practice mitigation:</u>
• Travelling screens can be installed at the landward end of a pipeline intake to enable fish to be transported out of the system.</td></tr>
<tr><td>With mitigation</td><td>Local
1</td><td>Low
1</td><td>Long-term
3</td><td>Low
5</td><td>Definite</td><td>LOW</td><td>-ve</td><td>Medium</td></tr>
</table>

3.2.3 Sediment scouring and shifts in sediment movement patterns

Scouring of sediment around the discharge outlet can become a serious design issue for poorly designed pipe ends discharging into receiving water bodies (Carter & van Ballegooyen 1998). Given that the marine system off Amatikulu is likely to be Gazetted as a Marine Protected Area (see Section 2.5), this impact contravenes the Marine Living Resources Act (No. 18 of 1998) and is thus considered a fatal flaw (Table 12). Chapter 4 of the Act states that:

> *(2) No person shall in any marine protected area, without permission in terms of subsection (3)—*
>
> > *(c) dredge, extract sand or gravel, discharge or deposit waste or any other polluting matter, or in any way disturb, alter or destroy the natural environment;*

Table 12 <u>Impact 9</u>: Sediment scouring and shifts in sediment movement patterns.

<table>
<tr><th></th><th>Extent</th><th>Intensity</th><th>Duration</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>Status</th><th>Confidence</th></tr>
<tr><td>Without mitigation</td><td colspan="6">FATAL FLAW</td><td>-‘ve</td><td>High</td></tr>
<tr><td colspan="9">• Fatal flaw
<u>Essential mitigation measures:</u>
• Undertake dispersion modelling of effluent to optimise outfall design.</td></tr>
<tr><td>With mitigation</td><td>Low
1</td><td>Low
1</td><td>Short - term
1</td><td>Very Low
3</td><td>Improbable</td><td>INSIGNIFICANT</td><td>-ve</td><td>Low</td></tr>
</table>

3.3 Decommissioning Phase

No decommissioning procedures or restoration plans have been compiled at this stage, although impacts are expected to be similar (certainly not more than) those assessed during the construction phase. The potential impacts during the de-commissioning phase are expected to be minimal in comparison to those occurring during the operational phase, and no key issues related to the marine environment have been identified at this stage. The same mitigation procedures as those explained in the construction phase should be adhered to in the decommissioning phase in order to mitigate for any of the impacts listed above.

3.4 Cumulative Impacts

Anthropogenic activities can result in numerous and complex effects on the natural environment. While many of these are direct and immediate, the environmental effects of individual activities or projects can interact with each other in time and space to cause incremental or aggregate effects. Impacts from unrelated activities may accumulate or interact to cause additional effects that may not be apparent when assessing the activities individually. Cumulative effects are defined as the total impact that a series of developments, either present, past or future, will have on the environment within a specific region over a particular period of time (DEAT IEM Guideline 7, Cumulative effects assessment 2004). Provided that the mitigation procedures listed in this report are implemented, it is unlikely that the cumulative impacts will be significant or will endure beyond the short to medium-term.

Table 13 summarises the impacts that may be experienced during construction and operation before and after mitigation.

Table 13 **Summary of potential impacts as a result of construction and operation of the proposed facilities.**

Phase	Impact	Consequence	Probability	Significance	Status	Confidence
Construction	Impact 1: Permanent loss and/or modification of habitat and temporary disturbance of coastal marine fauna and flora during construction.	FATAL FLAW			-'ve	High
	Impact 2: Permanent loss or alteration of subtidal soft sediment habitat.				-ve	High
					-ve	High
	Impact 3: Permanent loss or alteration of coastal dune habitat.	Medium	Probable	**MEDIUM**	-ve	High
	With mitigation	Low	Possible	**LOW**	-ve	High
	Impact 4: The effect of increased noise and vibration from construction.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 5: Waste generation and disposal during construction.	High	Possible	**MEDIUM**	-ve	High
	With mitigation	Medium	Improbable	**LOW**	-ve	High
	Impact 6: The effect of the spillage of hazardous substances.	Medium	Possible	**LOW**	-ve	Medium
	With mitigation	Low	Improbable	**VERY LOW**	-ve	Medium
Operation	Impact 7: Impacts on water quality and physiological functioning due to discharge.	FATAL FLAW			-'ve	High
	With mitigation	Medium	Possible	**LOW**	-ve	Medium
	Impact 8: Disturbance and/or mortality of marine life due to the intake of seawater	FATAL FLAW			-'ve	High
	With mitigation	Medium	Possible	**LOW**	-ve	Low
	Impact 9: Sediment scouring and shifts in sediment movement patterns.	FATAL FLAW			-'ve	High
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Low

4 CONCLUSIONS

A total of nine potential environmental impacts were assessed for this report, ranging from habitat loss to operational effects (see Table 13). Of these, five were flagged as fatal flaws inherent in the construction and operation of the proposed development. It may, however, be possible to secure an exemption from the prescripts of the MLRA for these impacts, such that these operational fatal flaws can be reclassified with appropriate mitigation. This would require that numerical modelling be undertaken to inform optimal design of the outfall and to confirm that impacts of waste water discharge remain low (insignificant).

5 REFERENCES

Bolton, J.J., Leliaert, F., De Clerk, O., Anderson, R., Stegenga, H., Engledow, H.E. Coppejans. 2004. Where is the western limit of the tropical Indian Ocean seaweed flora? An analysis of intertidal seaweed biogeography on the east coast of South Africa. *Marine Biology* 144: 51-59.

Branch, G.M. and Branch, M. 1981. *The living shores of Southern Africa*. Struik Publishers.

Brown, A.C. & Jarman, N. 1978. *Coastal marine habitats*. In: Werger, M.J.A. (Ed.). Biogeography and ecology of southern Africa. *Monographiae Biologicae* 31: 1239-1277.

Bustamante, R.H. 1994. *Patterns and causes of intertidal community structure around the coast of southern Africa*. PhD thesis. University of Cape Town.

Bustamante, R.H. & Branch, G.M. 1996. Large scale patterns and trophic structure of southern African rocky shores: the roles of geographic variation and wave exposure. *Journal of Biogeography* 23: 339-351.

Castro, P. & Huber, M.E. 1997. *Marine Biology*. WCB/McGraw-Hill, New York.

Coetzee J.C., Merkle D., Hutchings L., van der Lingen C.D., van den Berg M., Durholtz M.D. 2010. The 2005 KwaZulu-Natal sardine run survey sheds new light on the ecology of small pelagic fish off the east coast of South Africa. *African Journal of Marine Science* 32: 337–360

Cooper, J.A.G. 2001. Geomorphological variability among microtidal estuaries from the wave-dominated South African coast. *Geomorphology* 40: 99–122.

Council for Scientific and Industrial Research (CSIR). 2014. *Environmental studies in the Richards Bay offshore outfalls region*. Report No. 25. Surveys made in 2012 and 2013. CSIR Report CSIR/NRE/ECOS/ER/2014/0005/C.

Evans, A. 2005. *An investigation into the ecology and biogeography of subtidal seaweed communities of KwaZulu-Natal*. MSc thesis, University of Cape Town.

Everett B.I (Ed). 2014. *Marine and estuarine fisheries along the Kwazulu-Natal Coast: an inventory and brief description*. Oceanographic research Institute special Publication No. 11.

Fréon P., Coetzee J.C., van der Lingen C.D., Connell A.D., O'Donoghue S.H., Roberts M.J., Demarcq H., Attwood C.G., Lamberth S.J., Hutchings L. 2010. A review and tests of hypotheses about causes of the KwaZulu-Natal sardine run. *African Journal of Marine Science* 32: 449–479.

Gregory M.R. 2009. Environmental implications of plastic debris in marine settings—entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. *Philosophical Transactions of the Royal Society* 364(1526): 2013–2025.

Harmer R. & Clark B.M, 2017. *Marine ecology impact assessment for a proposed beach enhancement initiative at Tinley Manor*. Report prepared by Anchor Environmental Consultants for Tongaat Hulett Developments. Report 1719/2. 59 pp.

Keevin T.M. and Hempen G.L. 1997. *The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts*. SEDAR31-RD44. 100 pp.

Lawrence, C. 2005. *Biodiversity survey towards conservation of subtidal reef habitats in KwaZulu-Natal: Biogeography and depths patterns*. MSc thesis. University of Cape Town.

Le Vieux, A. 2010. *Sediment dynamics of the Amatikulu Estuary, Central KwaZulu-Natal Coast, South Africa*. MSc. Thesis, University of Kwa-Zulu Natal. 157 pp.

Lutjeharms J.R.E, Gründlingh M.L., Carter R.A. 1989. Topographically induced upwelling in the Natal Bight. *South African Journal of Science* 85: 310-316.

Lutjeharms J.R.E. and Roberts H.R. 1988. The Agulhas Pulse: an extreme transient on the Agulhas Current. *Journal of Geophysical Research* 93: 631-45

Pearce A.F. 1978. Seasonal variations of temperature and salinity on the northern Natal continental shelf. *South African Geography Journal* 60: 135-143.

Porter, S.N., Branch, G.M. & Sink, K.J. 2013. Biogeographic patterns on shallow subtidal reefs in the western Indian Ocean. *Marine Biology* 160: 1271-1283.

Porter, S.N. 2009. *Biogeography and potential factors regulating shallow subtidal reef communities in the western Indian Ocean*. PhD Thesis, University of Cape Town.

Roberts, M.J., van der Lingen, C.D., Whittle, C., van den Berg, M. 2010. Shelf currents, lee-trapped and transient eddies on the inshore boundary of the Agulhas Current, South Africa: their relevance to the KwaZulu-Natal sardine run. *African Journal of Marine Science* 32(2): 423-447.

Sink K., Holness S., Harris L., Majiedt P., Atkinson L., Robinson T., Kirkman S., Hutchings L., Leslie R., Lamberth S., Kerwath S., von der Heyden S., Lombard A., Attwood C., Branch G., Fairweather T., Taljaard S., Weerts S., Cowley P., Awad A., Halpern B., Grantham H., Wolf T. 2012. *National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine and Coastal Component*. South African National Biodiversity Institute, Pretoria. 32pp.

Sink, K.J., Branch, G.M., Harris, J.M. 2005. Biogeographic patterns in rocky intertidal communities in KwaZulu-Natal, South Africa. *African Journal of Marine Science* 27: 81-96.

Sink, K.J. 2001. *A hierarchical analysis of abiotic determinants and harvesting impacts in the rocky intertidal communities of KwaZulu-Natal*. PhD thesis. University of Cape Town.

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdnana, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A. & Robertson, J. 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience* 57: 573-583.

Stephenson, T.A. & Stephenson, A. 1972. *Life between tidemarks on rocky shores*. Freeman, San Francisco, USA

Wright S.L., Thompson R.C., Galloway T.S. 2013. The physical impacts of microplastics on marine organisms: a review. *Environmental Pollution* 178: 483e492.

6 APPENDIX 1

Impact Assessment Methodology

The significance of all potential impacts that would result from the proposed project is determined in order to assist decision-makers. The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The significance of each identified impact was thus rated according to the methodology set out below:

Step 1 – Determine the consequence rating for the impact by determining the score for each of the three criteria (A-C) listed below and then adding them. The rationale for assigning a specific rating, and comments on the degree to which the impact may cause irreplaceable loss of resources and be irreversible, must be included in the narrative accompanying the impact rating:

Rating	Definition of Rating	Score
A. *Extent – the area over which the impact will be experienced.*		
Local	Confined to project or study area or part thereof (e.g. limits of the concession area)	1
Regional	The region (e.g. the whole of Namaqualand coast)	2
(Inter) national	Significantly beyond Saldanha Bay and adjacent land areas	3
B. *Intensity – the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources.*		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. *Duration – the time frame for which the impact will be experienced and its reversibility.*		
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years (state whether impact is irreversible)	3

The combined score of these three criteria corresponds to a Consequence Rating, as follows:

Combined Score (A+B+C)	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Example 1:

Extent	Intensity	Duration	Consequence
Regional 2	Medium 2	Long-term 3	High 7

Step 2 – Assess the probability of the impact occurring according to the following definitions:

Probability – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Example 2:

Extent	Intensity	Duration	Consequence	Probability
Regional 2	Medium 2	Long-term 3	High 7	Probable

Step 3 – Determine the overall significance of the impact as a combination of the consequence and probability ratings, as set out below:

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	**INSIGNIFICANT**	**INSIGNIFICANT**	**VERY LOW**	**VERY LOW**
	Low	**VERY LOW**	**VERY LOW**	**LOW**	**LOW**
	Medium	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**
	High	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**
	Very High	**HIGH**	**HIGH**	**VERY HIGH**	**VERY HIGH**

Example 3:

Extent	Intensity	Duration	Consequence	Probability	Significance
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH

Step 4 – Note the status of the impact (i.e. will the effect of the impact be negative or positive?)

Example 4:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve

Step 5 – State the level of confidence in the assessment of the impact (high, medium or low).

Impacts are also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below. Depending on the data available, a higher level of confidence may be attached to the assessment of some impacts than others. For example, if the assessment is based on extrapolated data, this may reduce the confidence level to low, noting that further ground-truthing is required to improve this.

Confidence rating	
Status of impact	+ ve (beneficial) or – ve (cost)
Confidence of assessment	Low, Medium or High

Example 5:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve	High

The significance rating of impacts is considered by decision-makers, as shown below. Note, this method does not apply to minor impacts which can be logically grouped into a single assessment.

1. INSIGNIFICANT: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity.
2. VERY LOW: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.
3. LOW: the potential impact may not have any meaningful influence on the decision regarding the proposed activity.
4. MEDIUM: the potential impact should influence the decision regarding the proposed activity.
5. HIGH: the potential impact will affect a decision regarding the proposed activity.
6. VERY HIGH: The proposed activity should only be approved under special circumstances.

Step 6 – Identify and describe practical mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of the impact. Mitigation and optimisation measures must be described as either:

1. Essential: must be implemented and are non-negotiable; and

2. Best Practice: must be shown to have been considered and sound reasons provided by the proponent if not implemented.

Essential mitigation and optimisation measures must be inserted into the completed impact assessment table. The impact should be re-assessed with mitigation, by following Steps 1-5 again to demonstrate how the extent, intensity, duration and/or probability change after implementation of the proposed mitigation measures.

Example 6:

	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional **2**	Medium **2**	Long-term **3**	High **7**	Probable	HIGH	– ve	High
Essential mitigation measures: xxxxx xxxxx								
With mitigation	Local **1**	Low **1**	Long-term **3**	Low **5**	Improbable	VERY LOW	– ve	High

Step 7 – Prepare a summary table of all impact significance ratings as follows:

Impact	Consequence	Probability	Significance	Status	Confidence
<u>Impact 1</u>: XXXX	Medium	Improbable	LOW	–ve	High
With Mitigation	Low	Improbable	VERY LOW		High
<u>Impact 2:</u> XXXX	Very Low	Definite	VERY LOW	–ve	Medium
With Mitigation:	Not applicable				

Indicate whether the proposed development alternatives are environmentally suitable or unsuitable in terms of the respective impacts assessed by the relevant specialist and the environmentally preferred alternative.

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