DRAFT BASIC ASSESSMENT REPORT FOR THE PROPOSED UPGRADE OF STORM WATER AND ENVIRONMENTAL SYSTEMS IN THE PORT OF SALDANHA WITHIN SALDANHA BAY LOCAL MUNICIPALITY IN THE WESTERN CAPE PROVINCE

Anchor Environmental Consulting Report No, 1769/5

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EXECUTIVE SUMMARY

Project description

Transnet SOC Limited (Transnet) South Africa is to upgrade the stormwater management system at the Port of Saldanha with the view to prevent future uncontrolled discharges into the marine environment and the municipal sewage system. This requires that all surface water runoff from contaminated areas within the Port is contained and iron ore dust and other pollutants are removed either by settlement of sediments and/or treatment to bring the effluent pollutants concentrations to within allowable concentrations before the effluent is released into the Bay. Surfaces, channels, ponds, berms and infiltration trenches need to be installed and/or altered for this purpose. Nsovo Environmental Consulting ('Nsovo') has contracted Anchor Environmental Consultants (Pty) Ltd ('Anchor') to compile a terrestrial and marine biodiversity impact assessment report that describes the affected environment within the study area and assesses potential impacts of the project on affected environment. For the marine biodiversity component, this report draws on the findings of the "State of the Bay" monitoring work that has been conducted by Anchor Environmental on behalf of the Saldanha Bay Water Quality Trust since 2006. The terrestrial component draws on available information pertinent to the study area and observations made during a site visit in August 2017. While the Saldanha Port Stormwater Master Plan (Hatch 2013) outlines five distinct catchments, this report focuses on the environment and impacts of proposed work within Catchments 3 and 4, as these are the only two catchments affected by the proposed activity. If the scope of work is expanded to include other catchments, another impact assessment is required.

Description of the affected environment

Saldanha Bay is located approximately 100 km north of Cape Town on the West Coast. The Port is located on the northern shore of Saldanha Bay. The area along the northern coast of the Bay is characterised by a gently undulating coastal plain with sandy soil and sparse vegetation typical of the West Coast. Low hills are located to the north and west surrounding the Bay, with Malgaskop at 173 m above mean sea level to the west, Karringberg at 175 m above mean sea level to the east and Potsberg on the Langebaan Peninsula at 192.8 m above mean sea level to the south. Granite outcrops frequent this coastal area and surrounding environment.

Saldanha Bay lies within the Fynbos biome, which makes up a large proportion of the Cape Floristic Region (CFR). The CFR is internationally recognised as an area with extraordinarily high biodiversity and endemism. It is home to over 9000 vascular plant species, of which 69 percent are endemic. This highly diverse floral kingdom provides a diversity of different habitat types and abundant food resources, which in turn support diverse insect, mammal, bird and reptile communities. At least 70% of all the plant species in the Cape region do not occur elsewhere, and many have a very small range (these are known as narrow endemics). Habitat fragmentation is one of the most serious threats to the survival of such range restricted species and is brought about by agricultural practices, urbanisation, industrialisation and the spread of invasive plants.

The naturally occurring vegetation types i.e. the vegetation that would have historically covered the study area (Catchments 3 and 4) include Saldanha Flats Strandveld and Langebaan Dune Strandveld. The Saldanha Flats Strandveld vegetation type is listed as Endangered based on the latest available information and extends into the northern parts of the study site. A large part of the study area is artificial land (i.e. iron ore and Small Craft Harbour jetties) that remain highly disturbed and vegetation has not successfully established in these areas. Much of the affected area is of little conservation value.

The Saldanha Bay-Langebaan Lagoon system consists of a deep, protected bay, connected to a tidally driven lagoon. This report briefly describes the regional oceanography, biogeography and ecology of the system.

Saldanha Bay falls within the Southern Benguela ecoregion, one of four inshore ecoregions identified in the 2011 National Biodiversity Assessment (NBA). The large tidal Langebaan Lagoon is a unique habitat type as it is the only Lagoon habitat type recognised in the 2011 NBA. Due to ground water input, Langebaan Lagoon shares some characteristics with estuaries. Sun warming of nutrient rich waters creates a unique, productive and sheltered habitat which provides refuge for marine species more usually associated with estuaries in the Agulhas inshore ecozone. Intertidally, the Saldanha Bay-Langebaan Lagoon system consists of both rocky shores and sandy beaches, which support fauna and flora typical of the cold west coast. Sandy shores within Big Bay are predominantly exposed to high degrees of wave action and tend to support a lower diversity and biomass of organisms than the sheltered shores within the Lagoon. The Lagoon is dominated by intertidal mud- and sand-flats and also supports saltmarsh habitat. Subtidally, the nutrient rich waters of the system support an abundant and diverse benthic macrofaunal community on soft sediment habitats. Approximately 80 macrofaunal species are regularly found within the system with abundance in Small Bay and Big Bay averaging around 1 500 individuals.m^{-2} and biomass around 1 000 g.m^{-2}.

At least 30 non-indigenous marine species are currently known from the Saldanha Bay-Langebaan Lagoon system. Many of these alien species are considered invasive, including the Mediterranean mussel *Mytilus galloprovincialis*, the European green crab *Carcinus maenas* and the barnacle *Balanus glandula*.

Saldanha Bay is South Africa's largest and deepest natural port and as a result has undergone extensive harbour development. Major developments within the Bay include the construction of the Marcus Island causeway and the Iron Ore Terminal (IOT), the construction of three small craft harbours, the establishment of mariculture farms and several fish processing factories, and the development of artisanal fisheries, while extensive industrial and residential developments have become established around the periphery of the Bay. The lagoon provides excellent conditions for water sport and fishing enthusiasts and tourism that is largely dependent on marine and coastal activities have become an important income generator.

Saldanha Bay is the only natural sheltered embayment in South Africa and as a result it is regarded as an ideal area for mariculture. Mariculture operations situated within Saldanha Bay are dominated by mussel and oyster farming, and in 2015 experimental sea cage farming with Atlantic salmon was trialled. In 2013, the mussel sub-sector based in Saldanha Bay contributed 37% to the total mariculture production and is currently the second highest contributor to the overall mariculture productivity in the country. Western Cape oyster farms produce approximately 70% of the 277 tons produced nationally and four of the six oyster farms in the Western Cape are situated within Saldanha Bay.

Potential impacts

Impacts on the affected environment are considered for the 'No Go' scenario as well as those that might arise during construction and operational phases for the proposed upgrade of stormwater and environmental systems. To reduce negative impacts, precautions referred to as 'mitigation measures' are set and attainable mitigation actions are recommended.

Potential impacts on terrestrial biodiversity that may arise from the redesign and development of the stormwater management system of the Port of Saldanha during the construction phase include:

- Rehabilitation of erosion-prone areas (positive); and
- Diversion of contaminated stormwater away from remaining natural areas (positive).

The proposed upgrade of stormwater and environmental management system has positive long-term impacts on terrestrial biodiversity. The ecological condition of the remaining natural areas of the site is more likely to become degraded and transformed under the 'No Go' scenario.

Potential impacts on marine biodiversity that may arise from the upgrades during the construction phase include ecological effects due to the:

- Temporary loss of artificial concrete habitat;
- Possibility of increased noise and vibration;
- Mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the Bay;
- Generation and disposal of waste; and
- Possibility of spillage of hazardous substances.

Potential operational impacts may include:

- The containment of contaminated stormwater run-off into the marine system, halting a known source of anthropogenic pollutants that are evident at the MPT in particular (where elevated concentrations of trace metals have been detected in marine sediments).

The status of the assessed impacts before and after implementing mitigation measures are summarised below.

Phase	Impact identified: terrestrial environemnt	Status	Significance before mitigation	Significance after mitigation
Operational	Impact 1: Rehabilitation of erosion-prone areas by repairing erosion runnels and re-vegetating where possible.	+'ve	HIGH	n/a
	Impact 2: Diversion of contaminated stormwater away from remaining natural areas.	+'ve	HIGH	n/a
No-go option	'No Go' option: Ecological effects due to the loss of intact habitat as a result of uncontrolled stormwater runoff.	-'ve	HIGH	

Phase	Impact identified: marine environment	Status	Significance before mitigation	Significance after mitigation
Construction	Impact 1: Ecological effects due to the temporary loss of artificial concrete habitat.	-'ve	VERY LOW	n/a
	Impact 2: Noise and vibrations caused by construction related activities.	-'ve	VERY LOW	INSIGNIFICANT
	Impact 3a: Ecological effects on the marine system through the disturbance of marine sediments	-'ve	INSIGNIFICANT	n/a
	Impact 3b: Ecological effects on the marine system through the runoff of contaminated terrestrial sediments during construction.	-'ve	LOW	INSIGNIFICANT
	Impact 4: Waste generation and disposal during construction.	-'ve	MEDIUM	LOW
	Impact 5: The effect of the spillage of hazardous substances on marine biota.	-'ve	LOW	VERY LOW
Operational	Impact 6: Ecological effects of the containment of contaminated stormwater run-off into the marine system.	+'ve	HIGH	n/a
No-go option	'No Go' option: Ecological effects due to the loss of intact habitat as a result of uncontrolled stormwater runoff.	-'ve	HIGH	

Recommended mitigation measures

Mitigation measures for the terrestrial environment include:

- Use species that are specific to the original vegetation type of the affected area for the re-vegetation of erosion runnels.

Mitigation measures for the marine environment include:

- Subject mobile equipment, vehicles and power generation equipment to noise tests at commencement and periodically throughout the construction phase;
- Ensure that stringent waste management practices are in place at all times;
- Maintain high safety standards and employ "good housekeeping" on site. This should incorporate plans for emergencies;
- Use bunding where possible to contain terrestrial sediment run-off into the marine system, and use drip trays and bunding where hydrocarbon (i.e. construction vehicle fuel) losses are likely to occur;
- Collect and dispose of polluted soil at appropriate bio-remediation sites;
- Minimise run-off as much as possible i.e. Ensure that construction does not coincide with heavy rainfall, cover disturbed sediment etc.;
- 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;
- Vehicle maintenance or refuelling on the construction site is only permitted in dedicated areas with appropriate controls; and,
- Accidental diesel and hydrocarbon spills must be cleaned up accordingly.

Current monitoring programs, specifically the annual State of the Bay monitoring commissioned by the Saldanha Water Quality Trust, should be sufficient to detect negative impacts on the marine environment resulting from the proposed development.

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GLOSSARY

Amphipod	Crustaceans with no carapace and a laterally compressed body
Anaerobic bacteria	Organisms that do not require oxygen to function
Anomura	Decapod crustaceans, including hermit crabs
Anthropogenic	Environmental pollution originating from human activity
Apparent oxygen utilization	A measure of the potential available oxygen in the water that has been used by biological processes
Benthic	Pertaining to the environment inhabited by organisms living on or in the ocean bottom
Biodiversity hot spot	A biogeographic region with significant levels of biodiversity that is under threat from humans
Biota	Living organisms within a habitat or region
Bivalves (Bivalvia)	An aquatic mollusc which has a laterally compressed body enclosed within a hinged shell, such as oysters and mussels
Brachyura	Decapod crustaceans including some species of crabs
Buffer zone	Area designated for environmental protection
Cetaceans	An order of aquatic mammals including whales, dolphins and porpoises
Cnidarian (Cnidaria)	Coelenterate characterized by specialized stinging structures in the tentacles surrounding the mouth (e.g. jellyfish, sea anemone, coral)
Copepod (Copepoda)	Small crustaceans
Coriolis force	The rotational force of the earth which causes objects in the southern hemisphere to spin anticlockwise.
Crustacean (Crustacea)	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.
Cumacean (Cumacea)	Small marine crustaceans called hooded shrimp
CTD	An instrument that is lowered into the water to record profiles for conductivity, temperature and depth
Decapod (Decapoda)	Crustacean with ten legs (e.g. crabs, lobsters, prawns)
Echiurid (Echiuridea)	A group of marine worms distinguished by a non-retractile proboscis overlying the mouth
Echinoderm (Echinodermata)	Marine invertebrates with fivefold radial symmetry, a calcareous skeleton and tube feet (e.g. starfishes, sea urchins, sea cucumbers)
Effects range low (ERL)/effects range median (ERM)	Measures of toxicity in marine sediment. They are derived from biological toxicity assays and synoptic sampling.
Elasmobranchs	Sharks, skates and rays
Front-end loading	Also referred to as pre-project planning (PPP), feasibility analysis, conceptual planning, programming/schematic design and early project planning. It is the process for conceptual development of projects in processing industries. This involves developing sufficient strategic information with which owners can address risk and make decisions to commit resources in order to maximize the potential for success.
Gastropod (Gastropoda)	Molluscs (e.g. snails and slugs)
Ichthyofauna	Fish of a particular region
Inert	Unreactive or non-threatening
Invertebrate	An animal without a backbone (e.g. a starfish, crab, or worm)
Isopod (Isopoda)	Crustaceans typically flattened from top to bottom

Lipophilic	Mix more easily with oil than water
Macrofauna	Animals larger than 0.5 mm
Meiofauna (meiobenthos)	Small benthic invertebrates that are larger than microfauna but smaller than macrofauna
Mollusc (Mollusca)	Invertebrate with a soft unsegmented body and often a shell, secreted by the mantle
Nematode (Nematoda)	Small, unsegmented roundworms with an outer layer of cuticle
Nemertine (Nemertea)	Small, unsegmented ribbon worms with an eversible proboscis
Ophiuroid (Ophiuroidea)	Echinoderms with distinct scales on arms and disc (i.e. brittle stars)
Pelagic	Within the water column
Phytoplankton	Ocean dwelling microalgae that contain chlorophyll and require sunlight in order to live and grow.
Pinniped	Fur seals, sea lions and walruses.
Polychaete (Polychaeta)	Segmented worms with many bristles (i.e. bristle worms)
Ramsar Site	A wetland site recognised as being of international importance under the Ramsar Convention, which is an intergovernmental environmental treaty established in 1971 by UNESCO.
Recommended Mixing Zone	Region of receiving water where DAFF (1995) guidelines are expected to be met.
Recruitment overfishing	Removing a large proportion of adult fish resulting in the number and size of mature fish (spawning biomass) not having the reproductive capacity to replenish the population.
Sessile	Anchored in one place
Spatangoida	Echinoderms with the mouth an anus on different ends (i.e. heart urchins)
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.
Surficial sediments	Calculated conservatively as the upper 20 cm of sediment for the purposes of offshore disposal.
Thermal stratification	Temperature layers within a body of water caused by separation of water with different densities

LIST OF ABBREVIATIONS

ACC	Arctic Circumpolar Current
Anchor	Anchor Environmental Consultants
AOU	Apparent oxygen utilization
CBA	Critical Biodiversity Area
CSIR	Council for Scientific and Industrial Research
BCS	Benguela Current System
BWS	Ballast Water and Sediments
DBT	Dry Bulk Terminal
DEA	Department of Environmental Affairs
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
EMZ	Environmental Management Zone
ERL	Effects Range Low
ERM	Effects Range Median
FEPA	Freshwater Ecosystem Priority Areas
FEL	Front-End Loading
FPSO	Floating Production Storage and Offloading
GMQ	General Maintenance Quay
HAT	Highest Astronomical Tide
HDPE	High-Density Polyethylene
IBAs	Important Bird Areas
ICMA	Integrated Coastal Management Act
IDZ	Industrial Development Zone
IOT	Iron Ore Terminal
IUCN	International Union for Conservation of Nature
LBT	Liquid Bulk Terminal
MPA	Marine Protected Area
MPT	Multi-Purpose Terminal
MSL	Mean Sea Level
NAL	National Action List
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (No. 107 of 1998)
NOAA	National Oceanic and Atmospheric Administration
NPA	National Ports Authority
PAH	Poly-aromatic hydrocarbon
RMZ	Recommended Mixing Zone
RoD	Record of Decision
SAC	South Atlantic Circulation
SAR	Situation Assessment Report

SBM	Saldanha Bay Municipality
SSP	Saldanha Stormwater Project
SQG	Sediment Quality Guidelines
SWC	South-Western Cape
SWMP	Stormwater Master Plan
TNPA	Transnet National Ports Authority
TOC	Total Organic Carbon
TON	Total Organic Nitrogen
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
VRF	Vessel Repair Facility
WQG	Water Quality Guidelines
ZAA	ZAA Engineering Projects and Naval Architects

1 INTRODUCTION

1.1 Background

Stormwater runoff, which occurs when rain flows over impervious surfaces into waterways, is one of the major non-point sources of pollution in Saldanha Bay (CSIR 2002). Sealed surfaces such as driveways, streets and pavements prevent rainwater from soaking into the ground and the runoff typically flows directly into rivers, estuaries or coastal waters. Stormwater running over these surfaces accumulates debris and chemical contaminants, which then enters water bodies untreated and may eventually lead to environmental degradation. Contaminants that are commonly introduced into coastal areas via stormwater runoff include metals (Lead and Zinc in particular), fertilizers, hydrocarbons (oil and petrol from motor vehicles), debris (especially plastics), bacteria and pathogens and hazardous household wastes such as insecticides, pesticides and solvents (EPA 2003).

Historically, stormwater from the Port of Saldanha and ore terminal was allowed to overflow into the Bay, but most of this is now diverted to stormwater evaporation ponds and any material settling in these ponds is either screened for export or disposed of at appropriate facilities. Ongoing development and expansion of the Saldanha Port is associated with the alteration of runoff patterns over time and increased runoff volumes. The stormwater run-off generated contains high levels of both suspended iron ore dust (which in and of itself is not a significant concern in the already iron-rich Benguela system), but also other hazardous operation-derived contaminants such as hydrocarbons, heavy metals and cleaning agents. Stormwater management is therefore an important component of environmental management in the Saldanha Bay Municipality (SBM).

In 2012, Hatch Africa (referred to as Hatch Goba) was appointed to revise, update and replace the 2003 Stormwater Master Plan (SWMP)[1]. The need for this update was a result of various further phases of development at the Port of Saldanha (Hatch Africa 2014). The revised SWMP found that the existing stormwater management infrastructure of certain areas in the Port is inadequate for 1:50 year flood conditions. The National Ports Authority (NPA) of South Africa is to upgrade the management system at the Port of Saldanha with the view to prevent future uncontrolled discharges into the marine environment and the municipal sewage system. The Saldanha Port Stormwater Master Plan (Hatch 2013) outlines five distinct catchments – however, this report will focus on the environment and impacts of work within Catchments 3 and 4. If the scope of work is expanded to include other catchments, another impact assessment is required.

In accordance with the requirements of the EIA Regulations, Transnet SOC Limited (Transnet) requires approval from the Competent Authorities (Department of Environmental Affairs and Department of Water and Sanitation) prior to commencement of the proposed project. Nsovo Environmental Consulting ('Nsovo') have requested assistance from Anchor Environmental Consultants (Pty) Ltd ('Anchor') with a marine and terrestrial biodiversity study as part of the EIA.

[1] The SWMP should be read in conjunction with the Port of Saldanha Stormwater Master Plan 2012 (H340361-0000-10-236-0001) and the Stormwater Treatment on the Iron Ore Jetty Report (H340361-1360-00-236-0002).

1.2 Terms of Reference

The marine and terrestrial specialist Terms of References for this project includes:

- Preparation of a baseline description of the affected environment highlighting any sensitive and/or significant terrestrial and marine habitats that might be affected by the proposed changes to the design of the stormwater management system for Catchments 2 and 3;
- The identification and assessment of all potential impacts to the terrestrial and marine environment associated with the proposed changes to the design of the stormwater management system within Catchments 2 and 3; and
- The identification of measures required to mitigate negative impacts associated with the development and/or enhance positive aspects within Catchments 2 and 3.

The marine component of this report draws heavily on the findings of the "State of the Bay" monitoring work that has been conducted by Anchor Environmental on behalf of the Saldanha Bay Water Quality Trust since 2006 (Anchor 2016, 2015, 2014, 2012a, 2011), while the terrestrial component draws on available information pertinent to the study area and observations made during a site visit in August 2017.

2 DESCRIPTION OF THE PROPOSED ACTIVITY

The Port of Saldanha is the largest iron ore handling port in South Africa. The iron ore is transported to the port by rail from Sishen in the Northern Cape, at the port the iron ore is stockpiled prior to loading onto bulk iron ore carriers for export. The port also serves base metal mines, an adjacent heavy minerals smelter as well as the crude oil storage facility near the port. Saldanha Bay has long been recognised as a strategically important industrial centre in the Western Cape. This provided a strong foundation for the establishment of an Industrial Development Zone (IDZ) in October 2013.

Transnet is to upgrade the stormwater management system at the Port of Saldanha with the view to prevent future uncontrolled discharges into the marine environment and the municipal sewage system. This requires that all surface water runoff from contaminated areas within the Port are contained and iron ore dust and other pollutants are removed either by settlement of sediments and/or treatment to bring the effluent pollutants concentrations to within allowable concentrations before the effluent enters the Bay. Surfaces, channels, ponds, berms and infiltration trenches need to be installed and/or altered for this purpose. The following description of the proposed development and study site was extracted from the Saldanha Port Stormwater Master Plan (Transnet 2018).

While the Saldanha Port Stormwater Master Plan (Hatch 2013) outlines five distinct catchments, this report will focus on the environment and impacts of upgrades to the stormwater system within Catchments 3 and 4 (see Figure 2.1 and Figure 2.2).

The proposed development entails the upgrade of the existing stormwater infrastructure in both operational and non-operational Transnet areas in the Port of Saldanha. The Study Area spans five distinct catchments, including (1) the Small Craft Harbour, (2) the Port Industrial Area, (3) the Service Corridor, (4) the Stockyard and (5) the Dune Area to the east of the service corridor (Figure 2.1). These five catchments are discussed in more detail below to provide context to potential impacts on terrestrial biodiversity as a result of site-specific activities.

The current stormwater management infrastructure will be upgraded by:

- Providing additional storage volume by creating additional stormwater retention ponds;
- Expanding and reshaping of existing stormwater retention ponds;
- Formalising natural depressions to increase storage volume in areas where storage capacity is insufficient;
- Providing new stormwater infiltration trenches (South African Sustainable Drainage Systems (SuDS) Guidelines);
- Repairing erosion runnels and re-instate vegetation where possible;
- Re-shaping hardened surfaces (e.g. gravel, asphalt compacted sediment) to optimise and control drainage towards stormwater retention ponds;
- Retrofitting existing outlet manholes with grit/oil separator where required (i.e. runoff contains contaminants); and
- Building berms to prevent runoff from entering into natural areas.

Maintenance activities during the operational phase include:

- Cleaning of all stormwater inlets, manholes and pipes;
- Removal of dust and caked material from retention ponds, infiltration trenches and channels; and
- Repairing of stormwater pipes and infrastructure when required.

Figure 2.1 **Map of the study site, showing five catchment areas including (1) the Small Craft Harbour, (2) the Port Industrial Area, (3) the Service Corridor, (4) the Stockyard and (5) the Dune Area to the east of the service corridor.**

Figure 2.2 **Map of the study site, showing the Pond numbers for Catchment 3 (yellow pins) and Catchment 4 (blue pins) (Google Earth 2018).**

2.1 Catchment 3

This long and narrow catchment is divided into eight sub-catchments and consists of the Causeway, Ore/Oil Jetty, Multi-Purpose Terminal, Maintenance Terminal and Rail Corridor (Figure 2.1). Ponds 1, 2, 3, 11, 12, 13 and 14 are included in Catchment 3 (Figure 2.2). Proposed upgrades to the infrastructure in this catchment that could potentially have site-specific impacts (positive and negative) on terrestrial biodiversity include:

(1) Re-vegetation of bare soil to prevent erosion (positive impact provided that indigenous vegetation is used).

(2) Re-shaping and deepening of existing depressions along the service corridor, which requires removal of vegetation. Note, however, that these depressions are already disturbed or have been created on artificial substrate (iron ore jetty).

(3) Sub-catchment 3D: This site has no formal stormwater drainage infrastructure at present and stormwater is allowed to run off into the dune area and into the Bay. Upgrades must prevent any stormwater discharge from the disturbed areas entering the undisturbed area, which include:

   a. Re-shaping the fill area to create terraces for filling of material in a controlled manner;
   b. Creating shallow depressions on each terrace to allow stormwater to pond and evaporate/infiltrate;
   c. Creating a protective earth berm along the toe of the backfill in the disturbed areas to prevent stormwater entering the dune area;
   d. Removing existing railway sleepers from the backfill area embankment and dispose or store elsewhere;
   e. Providing for overflow stormwater from the hard standing gravel area; and
   f. Constructing a new stormwater detention/evaporation pond of proposed capacity.

2.2 Catchment 4

Catchment 4 is further divided into three smaller sub-catchments. This catchment consists primarily of the Iron Ore Stockyard and the Administration Complex (Ponds 4, 5 6, 7, 8, 9 and 10 – see Figure 2.2). All activities within the stockyard are controlled from Control Tower which forms part of the administration complex which houses a number of workshops, stores and office buildings. The proposed upgrades include the expansion of existing ponds and re-shaping of surfaces. The substrate of this catchment is artificial and due to constant disturbance of the site, no vegetation has established. These activities will therefore have no impact on terrestrial biodiversity.

3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

Saldanha Bay is located approximately 100 km north of Cape Town on the West Coast. The Port is located on the northern shore of Saldanha Bay. The area along the northern coast of the Bay is characterised by a gently undulating coastal plain with sandy soil and sparse vegetation typical of the West Coast. Low hills are located to the north and west surrounding the Bay with Malgaskop at 173 m above mean sea level located to the west, Karringberg at 175 m above mean sea level located to the east and Potsberg on the Langebaan Peninsula at 192.8 m above mean sea level located to the south. Granite outcrops frequent this coastal area and surrounding environment. Catchments 3 and 4 are the only catchments affected by this project, and therefore are the only catchments under consideration in this report.

3.1 Terrestrial Environment

Saldanha Bay lies within the Fynbos biome, which makes up a large proportion of the Cape Floristic Region (CFR). The CFR is internationally recognised as an area with extraordinarily high biodiversity and endemism. It is home to over 9000 vascular plant species, of which 69 percent are endemic. This highly diverse floral kingdom provides a diversity of different habitat types and abundant food resources, which in turn support diverse insect, mammal, bird and reptile communities. At least 70% of all the plant species in the Cape region do not occur elsewhere, and many have a very small range (these are known as narrow endemics). Habitat fragmentation is one of the most serious threats to the survival of such range restricted species and is brought about by agricultural practices, urbanisation, industrialisation and the spread of invasive plants. The latest data from the Red Data Book listing process undertaken for South Africa is that 67% of the rare or threatened plant species in the country occur only in the southwestern Cape, and these total over 1800 species (Raimondo *et al.* 2009). The study area is part of the greater West Coast region, and lies within what has been termed the Saldanha Peninsula. This bioregion has a fairly distinct flora, and a particularly high number of locally and regionally endemic plant species, as well as plant Species of Conservation Concern (Helme & Koopman, 2007).

3.1.1 Vegetation, conservation status and biodiversity plans

Historically, dense forests of large Milkwood trees used to exist at Noordhoek, Olifantsbos, Macassar and Gordons Bay (Rebelo *et al.* 2006; Mucina & Rutherford 2006). Native Cape Strandveld species (see Figure 3.1) include shrubs such as *Chrysanthemoides monilifera*, *Olea exasperata*, *Metalasia muricata*, *Roepera flexuosum*, *Rhus laevigata* and *Rhus glauca*; succulents, including sour figs (*Carpobrotus acinaciformis* and *Carpobrotus edulis*) and *Mesembryanthemum* species; Restios; herbs such as geraniums and a great variety of daisies (*Senecio elegans*, *Senecio burchellii* and *Dimorphotheca pluvialis* as well as endemic plant species such as *Lampranthus tenuifolius*).

Figure 3.1 Examples of Cape Strandveld vegetation including flowering geophytes (left), the Cape Camphor tree (*Tarchonanthus camphoratus*) (middle) and the endemic *Lampranthus tenuifolius*.

The Vegetation Map of South Africa, Lesotho and Swaziland (SANBI 2012) shows the original distribution of southern African vegetation types. The naturally occurring vegetation types (i.e. the vegetation that would have historically covered the area) in the study area (Catchments 3 and 4) include the Saldanha Flats Strandveld and Langebaan Dune Strandveld (Figure 3.2).

The Saldanha Flats Strandveld vegetation type is listed as Endangered and extends into the northern parts of Catchment 3 of the study site (Figure 3.3). However, there is hardly vegetation here and the the catchment is on a reclaimed land. Proposed activities in the northern part of the Service Corridor (Catchment 3) include re-vegetation of bare soil to prevent erosion, which could have a localised positive impact on the endangered vegetation type provided that indigenous vegetation is used. This part of the study site is already highly disturbed and mainly consists of train tracks and adjacent service access roads. Saldanha Flats Strandveld is typically composed of areas of tall, evergreen shrubs, with great numbers of bulbs, grasses, succulents and annual flowers growing in between.

Langebaan Dune Strandveld comprises of slightly undulating old coastal dune systems and stabilised inland duneveld supporting closed, with evergreen, up to 2 m tall, sclerophyllous shrubland with prominent annual herbaceous flora occurring in gaps (and forming spectacular displays, especially after good rain in late winter). This vegetation type is listed as Least Threatened (Figure 3.3).

The study area falls within the planning domain of the Western Cape Biodiversity Spatial Plan (WCBSP) for Saldanha Bay (CapeNature 2017). A large part of the study area (Catchments 3 and 4) is artificial land (iron ore and Small Craft Harbour jetties) and therefore not of conservation value.

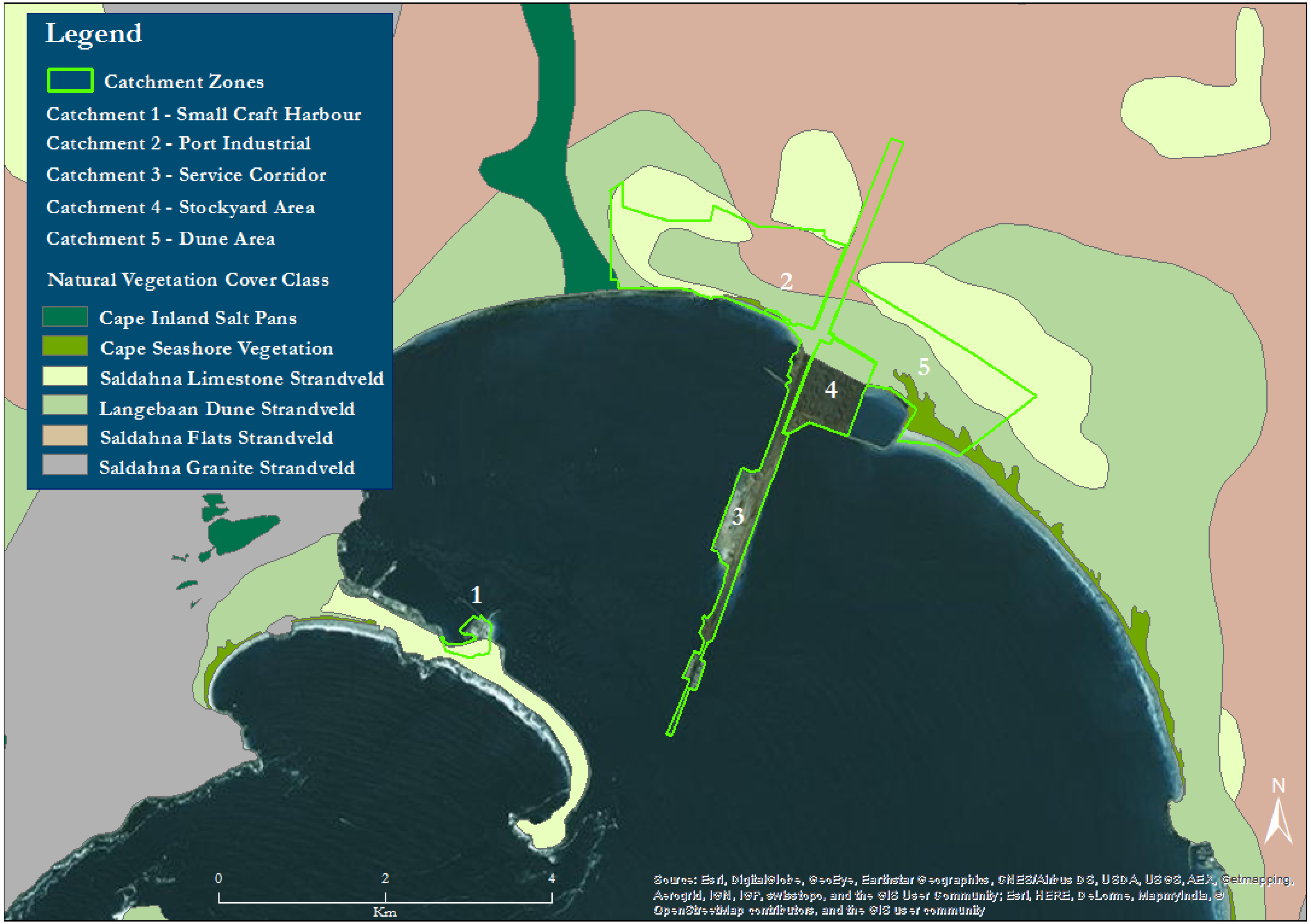

Figure 3.2 **The National Vegetation Map 2012 for Saldanha Bay. The map shows that natural vegetation types occurring in the study area include the Cape Seashore Vegetation, Langebaan Dune Strandveld, Saldanha Limestone Strandveld, Saldanha Flats Strandveld, and a very small area of Cape Inland Salt Pans (Source: SANBI 2012).**

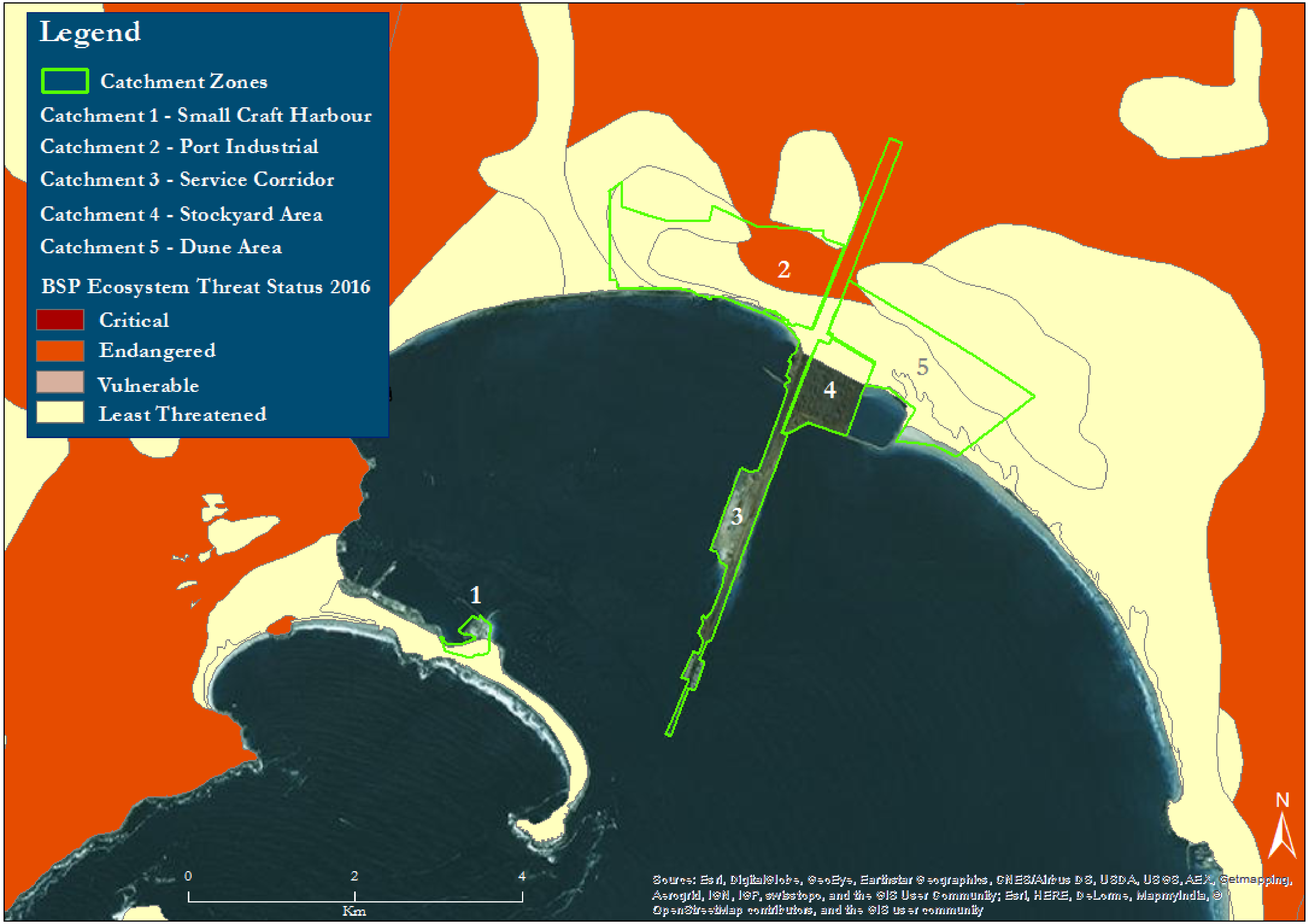

Figure 3.3 The Threat Status of vegetation types occurring in Saldanha Bay. The map shows that Catchment 2, 3 and 5 are situated within the original extent of the Endangered Saldanha Flats Strandveld vegetation type (Source: CapeNature 2016).

3.2 Marine Environment

The Saldanha Bay - Langebaan Lagoon system is a deep, protected bay connected to a tidally driven lagoon. This report briefly describes the regional oceanography, biogeography and ecology of the Saldanha Bay-Langebaan Lagoon system and provides a detailed description of the water quality, sediments and ecology of the areas directly adjacent to the proposed activity.

The Port of Saldanha is situated approximately 120 km north of Cape Town on the west coast of South Africa, and is the largest Iron Ore Terminal in South Africa (Hatch Africa 2014). The construction of the Iron Ore Terminal and the Marcus Island Causeway in the early 1970s divided Saldanha Bay into Small Bay, Big Bay and North Bay (Figure 3.4). The jetty also serves base metal mines, an adjacent heavy minerals smelter as well as the crude oil storage facility near the port (Hatch Africa 2014). Saldanha Bay is still directly linked to the tidal Langebaan Lagoon, which is situated within the West Coast National Park (Figure 3.4). The Bay and Lagoon are considered to be valuable biodiversity “hot spots” and a number of Marine Protected Areas (MPAs) have been proclaimed in and around the Bay (Figure 3.4). Langebaan Lagoon, along with Schaapen, Marcus, Malgas, Jutten and Vondelig Islands, were declared a Ramsar Site in 1988. Despite these existing impacts and pressures, Saldanha Bay should not be regarded solely as an industrial port - the area still provides valuable goods and services to the Saldanha Bay - Langebaan Lagoon system as a whole and is essential for the healthy functioning of the Bay.

Big Bay forms the centre of the Saldanha-Langebaan system and is the least developed and impacted part of Saldanha Bay, with the major Port development and industrial activity concentrated in Small Bay. Major impacts in Big Bay include the construction of the iron ore terminal, the current High-Density Polyethylene (HDPE) pipeline and associated infrastructure, and the establishment of mariculture activities. These developments have had some impacts on the circulation patterns but the water quality, sediments and ecology of Big Bay remain largely intact (Laird & Clark 2016, Hutchings and Clark 2016). Dredging and underwater blasting associated with port development had significant short term impacts on biota close to the ore jetty, but these appear to have recovered well (Laird & Clark 2016, Hutchings & Clark 2016). Mariculture activity in Big Bay started with mussel (*Mytilus galloprovincialis* and *Choromytilus meridionalis*) rafts that were deployed around the turn of the century but sea conditions proved too exposed and now Pacific oyster (*Crassostrea gigas*) culture is carried out on long lines in a demarcated area in the centre of Big Bay.

Anthropogenic pollutants and wastes find their way into the Bay from a range of activities and developments within Small Bay. Sources include dredging and port expansion, port activities, shipping, ballast water discharges, oil spills, municipal sewage, household discharges, discharges from fish processing factories (Anderson, Smit & Levitt 1999), biological waste associated with mariculture (Boyd & Heasman 1998), and stormwater runoff. These pressures have collectively resulted in changes in the physical environment including water quality and sediment characteristics (Jackson & McGibbon 1991, Monteiro *et al*. 2000, Weeks *et al*. 1991) and biological communities (Anchor 2006, Kruger *et al*. 2005, Robinson *et al*. 2007).

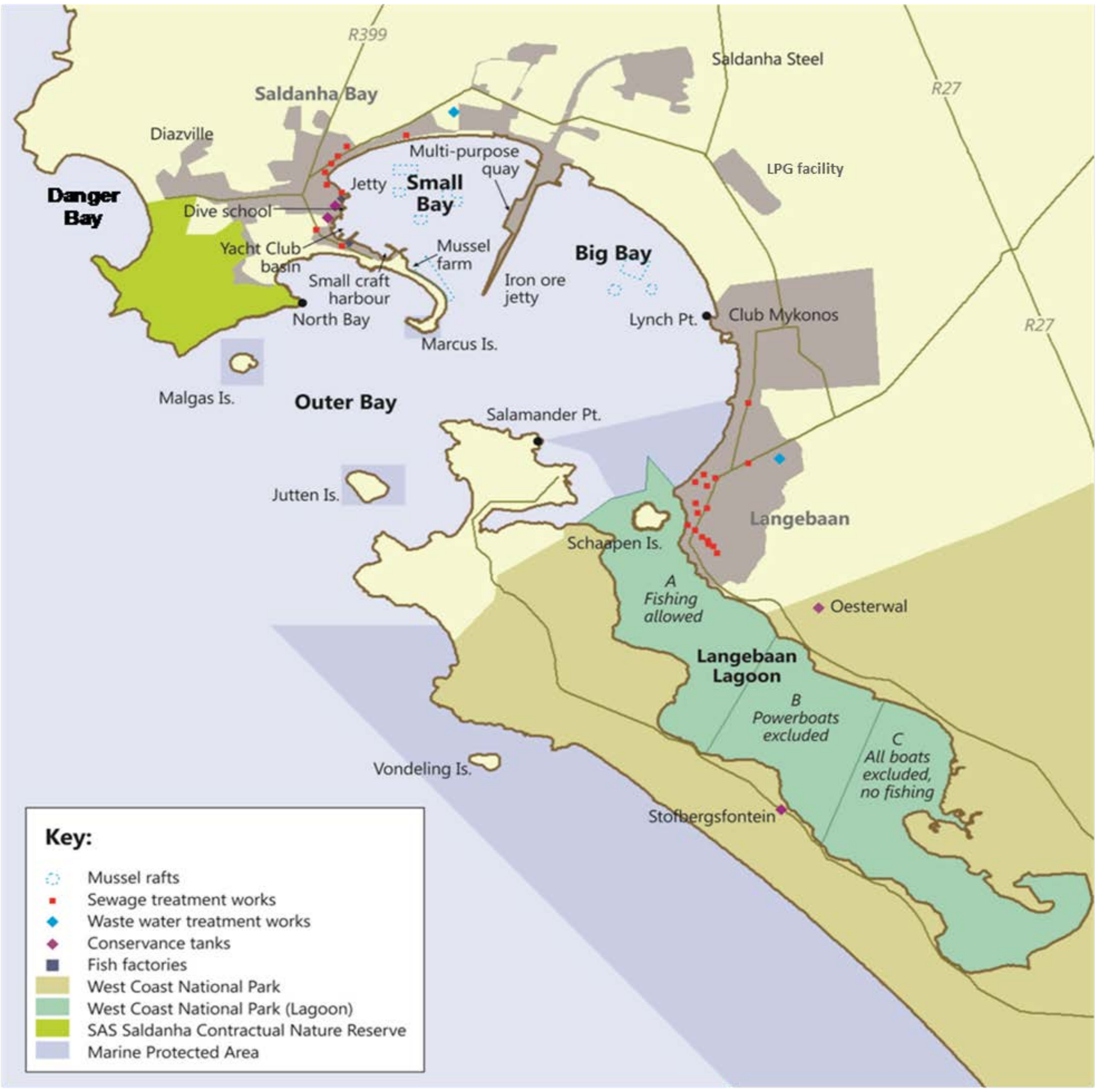

Figure 3.4 **Regional map of Saldanha Bay and Langebaan Lagoon with conservation areas shaded dark green and dark blue (Anchor 2017).**

3.2.1 Regional oceanography

The physical oceanography of an area, particularly water temperature, nutrients, oxygen levels, and wave exposure are the principal driving forces that shape the marine communities. The marine ecosystems off the south west coast of Africa are influenced by the Benguela Current System (BCS), which extends along the eastern edge of the southern Atlantic Ocean between Cape Agulhas in South Africa, and Southern Angola (Figure 3.5). The BCS is one of four major eastern-boundary current systems which is characterised by the wind-driven upwelling of cold, nutrient rich water (Shannon and O'Toole 1998). Phytoplankton bloom when the nutrients reach the surface waters where plenty of light is available for photosynthesis. The phytoplankton is preyed upon by zooplankton, which is in turn eaten by filter feeding fish such as anchovy or sardine. This makes the west coast one of the richest fishing grounds in the world and attracts large colonies of birds, cetaceans and seals (Branch 1981). The water temperature and nutrient levels are strongly influenced by wind, with minimum temperatures and maximum nutrient levels occurring in conjunction with upwelling events (Branch and Griffiths 1988).

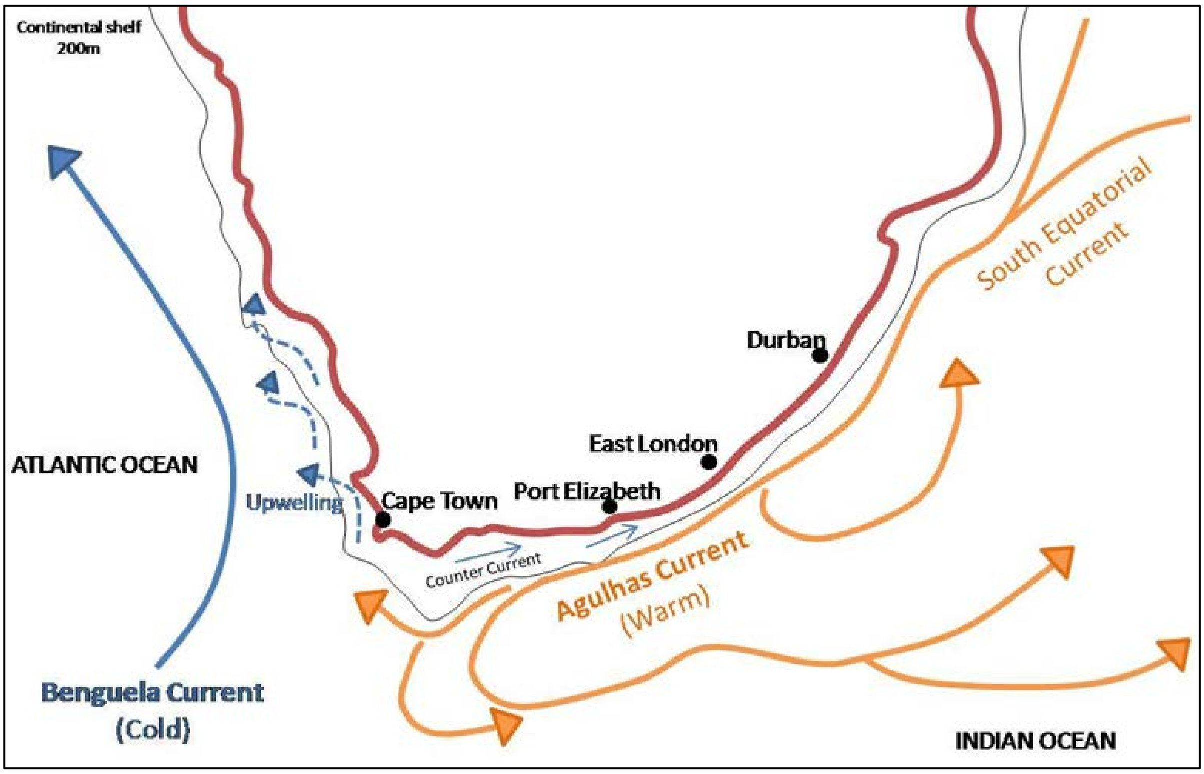

Figure 3.5 Major current streams around South Africa (Anchor 2015).

3.2.2 Local oceanography

3.2.2.1 Tides, currents and temperature

The West Coast is subject to semi-diurnal tides, with each successive high (and low) tide separated by 12 hours. Tidal variation on the West Coast usually ranges between 0.28 m (relative to chart datum) at mean low water springs and 1.91 m at mean high water springs, with the highest and lowest astronomical tide being 2.25 m and 0.056 m respectively. During summer conditions from

November to February, prevailing south-southwest (SSW) winds cause regional scale upwelling (Weeks *et al.* 1991a&b, Monteiro & Largier 1999). In the winter from May to August, winds are gentle and blow predominantly from the north-northeast (NNE) (CSIR 2015).

Current strengths within Big Bay are moderate (10-20 $cm.s^{-1}$) and current direction within the main channels is dependent on the tidal state. Circulation patterns in Big Bay changed subtly with the construction of the ore jetty in 1975 with enhanced south-westerly currents occurring along the ore jetty (Weeks *et al.* 1991a). Construction of the ore jetty provided some protection from waves along the northern shore of Big Bay, resulting in a shore sheltered and semi-sheltered area (Hutchings & Clark 2016). Harbour construction has constrained water circulation within Small Bay, enhancing the general clockwise pattern and increasing current speeds along the boundaries, particularly the south-westward current flow along the iron ore/oil terminal (Weeks *et al.* 1991a). Small Bay is very sheltered from offshore swell (PRDW 2012).

3.2.2.2 Sediments

Sediments within Big Bay are mostly sandy (> 95% on average in 2016 samples) with a small (on average < 3%) mud fraction (Anchor 2015) (Figure 3.6). The highest mud fraction in sediments occurred in the vicinity of the ore jetty and towards the centre of the Bay. Organic matter and contaminants such as metals and organic toxic pollutants are predominantly associated with fine sediment particles such as mud. This is due to the fact that fine grained particles have a relatively larger surface area for the absorption and binding of pollutants.

Saldanha Bay has fairly turbid water, due to both organic and inorganic particulates suspended in the water column (van Ballegooyen *et al.* 2012). Turbidity, particularly in Big Bay, generally peaks under strong wind and wave conditions (Hutchings & Clark 2016). Phytoplankton blooms and shipping movements have also been observed to cause significant increases in turbidity in the Bay. Average levels of Total Suspended Solids (TSS) in the Bay are in the order of 4.08 mg/l (± 2.69 mg/l SD) and peak at around 15.33 mg/l (Carter and Coles 1998), and variations in turbidity caused by these different driving forces are clearly demonstrated in Google Earth images (van Ballegooyen *et al.* 2012).

The most likely sources of organic matter in Big Bay are from phytoplankton production at sea and the associated detritus that forms from the decay thereof. Both Total Organic Carbon (TOC) and Total Organic Nitrogen (TON) levels were elevated across the entrance of Big Bay in the 2015 samples (Figure 3.6), which may reflect summer upwelling events. TOC and TON accumulates in the same areas as mud as most organic particulate matter is of a similar particle size range and density to that of mud particles (size <60 µm) and settle out of the water column together with the mud. Sites at the entrance of Big Bay displayed the highest percentage of mud in Big Bay (6.5%) during 2015 sampling and it is not surprizing that the TOC and TON concentrations in sediments were elevated in this area. Elsewhere in Big Bay, TOC and TON levels were low relative to Small Bay.

In areas of the Bay where muddy sediments tend to accumulate, trace metals and other contaminants often exceed acceptable threshold levels. This may be due to naturally-occurring high levels of the contaminants in the environment (e.g. in the case of cadmium[2]), or due to impacts of human activities (e.g. lead, copper[3], manganese and nickel associated with ore exports). While such trace metals are generally biologically inactive when buried in the sediment, they can become toxic to the environment when re-suspended as a result of mechanical disturbance. On average, the concentrations of all metals were highest in Small Bay, lower in Big Bay and below detection limits in Langebaan Lagoon. Following the major dredging event in 1999, Cadmium concentrations in certain areas in Small Bay exceeded internationally accepted safety levels, while concentrations of other trace metals (e.g. lead, copper and nickel) approached threshold levels. Subsequent to this time, there have been a number of smaller spikes in trace metal levels, mostly as a result of dredging operations. Currently, trace metal levels are mostly well within safety thresholds with the exceptions of a few sites in Small Bay where thresholds were exceeded in 2015 and 2016. Key areas of concern regarding trace metal pollution within Small Bay include the Yacht Club Basin where cadmium and copper exceeded recommended thresholds two years in a row and enrichment factors (EF) continue to be high, as well as adjacent to the Multi-purpose terminal where levels of cadmium and lead dropped just below internationally accepted guidelines, but still have extremely high enrichment factors for all trace metals measured. Recent increases in the concentration of manganese around the ore terminal are also a little concerning.

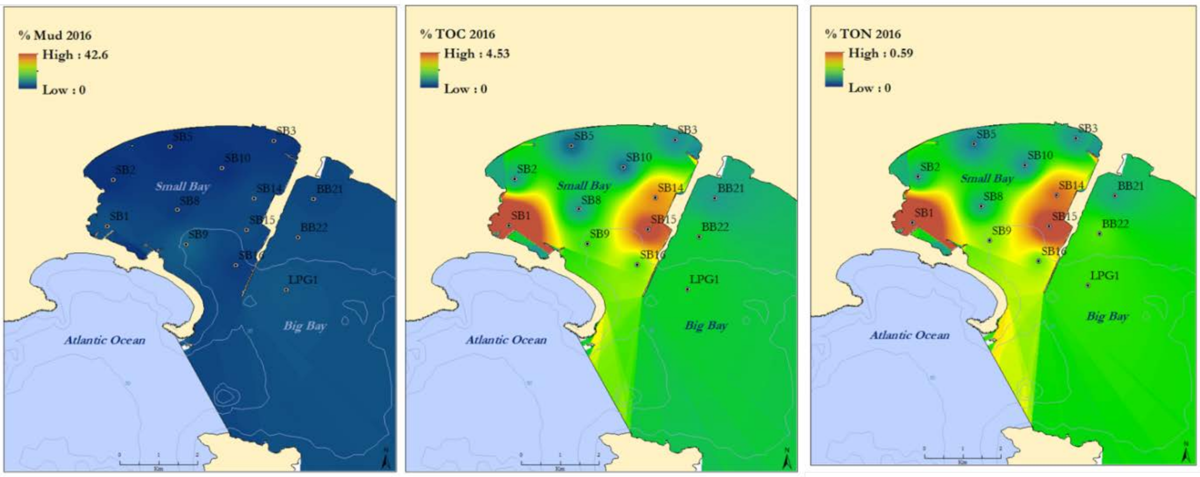

Figure 3.6 Distribution of the percentage mud in sediments, total organic carbon (TOC) and total organic nitrogen (TON) in Saldanha Bay (Anchor 2016).

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[2] Cadmium (Cd) is a trace metal used in electroplating, in pigment for paints, in dyes and in photographical process. Likely sources of Cd in the marine environment include emissions from industrial combustion process, metallurgical industries, motor vehicle emissions and waste streams such as stormwater drains (OSPAR 2010). As Cd is prone to bioaccumulation and becomes toxic at elevated concentrations, its effect on the marine environment and on human consumers can be significant (OSPAR 2010). Although Cd may be naturally elevated at sites along the west coast due to high Cd concentrations in terrestrial sediments, the spatial pattern in Saldanha Bay indicates that elevated values are likely a result of activities related to shipping and boating.

[3] Copper (Cu) concentrations were also high along the Multi-Purpose Terminal (MPT) and near the yacht club. This suggests that there may be a source of copper pollution affecting most of the Small Bay region. Cu is used as a biocide in antifouling products as it is very effective for killing marine organisms that attach themselves to the surfaces of boats and ships. Anti-fouling paints release Cu into the sea and can make a significant contribution to Cu concentrations in the marine environment (Clark 1986). The areas with elevated normalized Cu values also correspond with those with high levels of boat traffic. It is thus likely that anti-fouling paints used on boats may have been contributing Cu to the system.

3.2.3 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, Saldanha Bay falls within the Southern Benguela ecoregion, which is nested within the Southern Benguela Ecoregion (Figure 3.7). At a finer spatial scale, the Saldanha-Langebaan Lagoon system falls within the South Western Cape inshore ecozone (Cape point to Cape Columbine) (Figure 3.7). This ecozone is a transition zone between the cooler Namaqua, and warmer Agulhas inshore ecozones, and shares components of the biota from both neighbouring ecozones.

For most groups, marine species diversity decreases from east to west, whilst biomass increases. The presence of the large tidal Langebaan Lagoon, however, creates a unique habitat type, the only lagoon habitat type recognised in the 2011 National Biodiversity Assessment (NBA) (Sink *et al.* 2012). Sun-warming of nutrient rich waters creates a unique, productive and sheltered habitat and potential refuge for marine species more usually associated with estuaries, or marine habitats in the Agulhas inshore ecozone. Although Langebaan Lagoon may be unique in South Africa, comparable systems do exist elsewhere in southern Africa such as Sandwich harbour in Namibia and Baía dos Tigres in Angola.

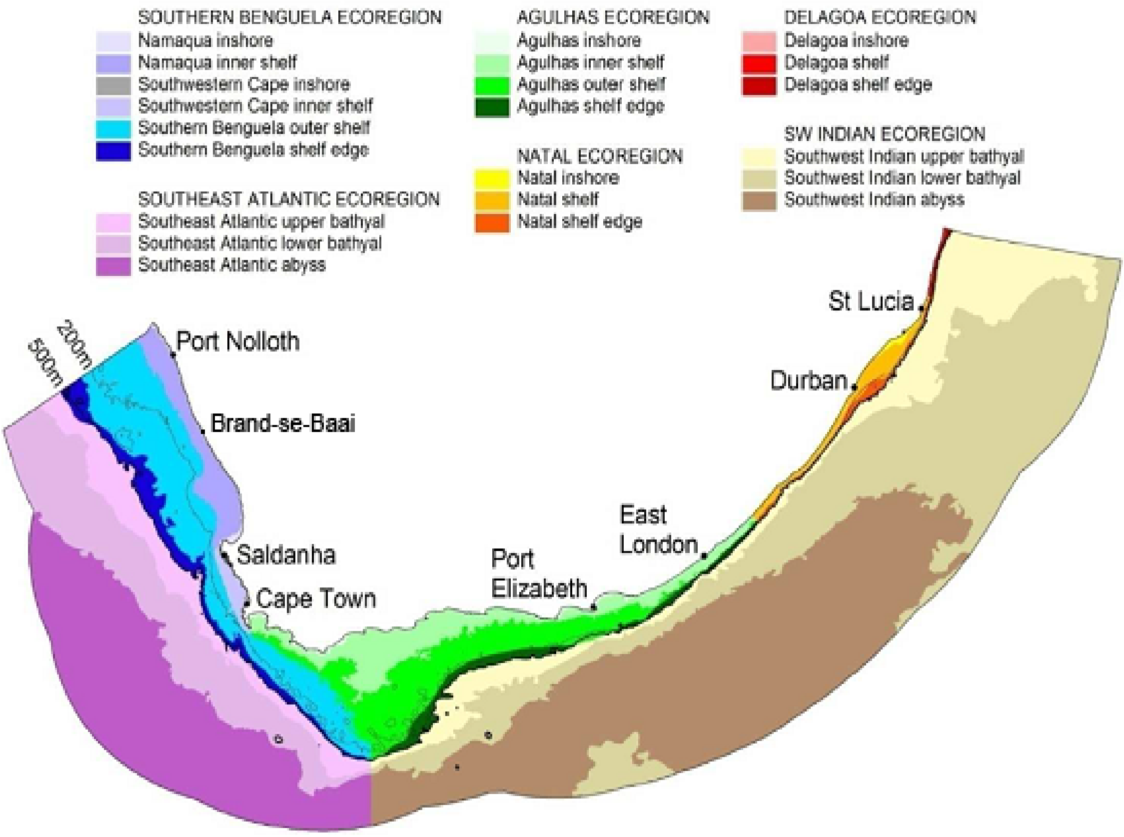

Figure 3.7 **Six marine ecoregions with 22 ecozones incorporating biogeographic and depth divisions in the South African marine environment as defined by Sink *et al.* (2012).**

3.2.4 Ecology

3.2.4.1 Rocky shores and sandy beaches

The Saldanha Bay-Langebaan Lagoon system has both rocky shores and sandy beaches, which support fauna and flora typical of the cold west coast. Exposed and semi-exposed rocky shores tend to be dominated by the alien mussel *Mytilus galloprovincialis* and the alien barnacle *Balanus glandula* (Robinson *et al.* 2007), while algae are more prolific on sheltered shores (Figure 3.8). Sandy shores within Big Bay are predominantly exposed to high degrees of wave action and tend to support a lower diversity and biomass of organisms than the sheltered shores within the Lagoon. The Lagoon is dominated by intertidal mud and sand-flats but also supports saltmarsh habitat (Summers 1977). Although the system is entirely marine, estuarine species such as the common sandprawn (*Callichirus kraussi*) and the estuarine mudprawn (*Upogebia africana*) occur. Beds of the sea grass *Zostera capensis* are distributed intermittently over the sand flats, and provide habitat for the rare limpet *Siphonaria compressa* (Angel *et al.* 2006).

Figure 3.8 Typical high, mid and low rocky shore sites in Saldanha Bay (from left to right). The mid-shore is dominated by the alien mussel *Mytilus galloprovincialis* (Anchor 2015).

3.2.4.2 Benthic macrofauna

Subtidally, the nutrient rich waters of the Saldanha Bay - Langebaan Lagoon system support an abundant and diverse benthic macrofaunal community on soft sediment habitats (Figure 3.9). Benthic macrofauna play an important role in the bioturbation of sediments. These organisms assist in promoting the exchange of oxygen and nutrients by enhancing sediment porosity. Macrofaunal communities also provide an important food source for numerous fish, bird and invertebrate species. Biological indicators, such as species abundance, biomass and diversity, provide a direct measure of the state of the ecosystem in space and time. Benthic macrofauna are the biotic component most frequently monitored to detect changes in the health of a marine environment as they are short lived and their community composition responds rapidly to environmental change (Warwick 1993). They also tend to be directly affected by pollution, are easy to sample quantitatively (Warwick 1993), and are scientifically well-studied compared to other sediment-dwelling components.

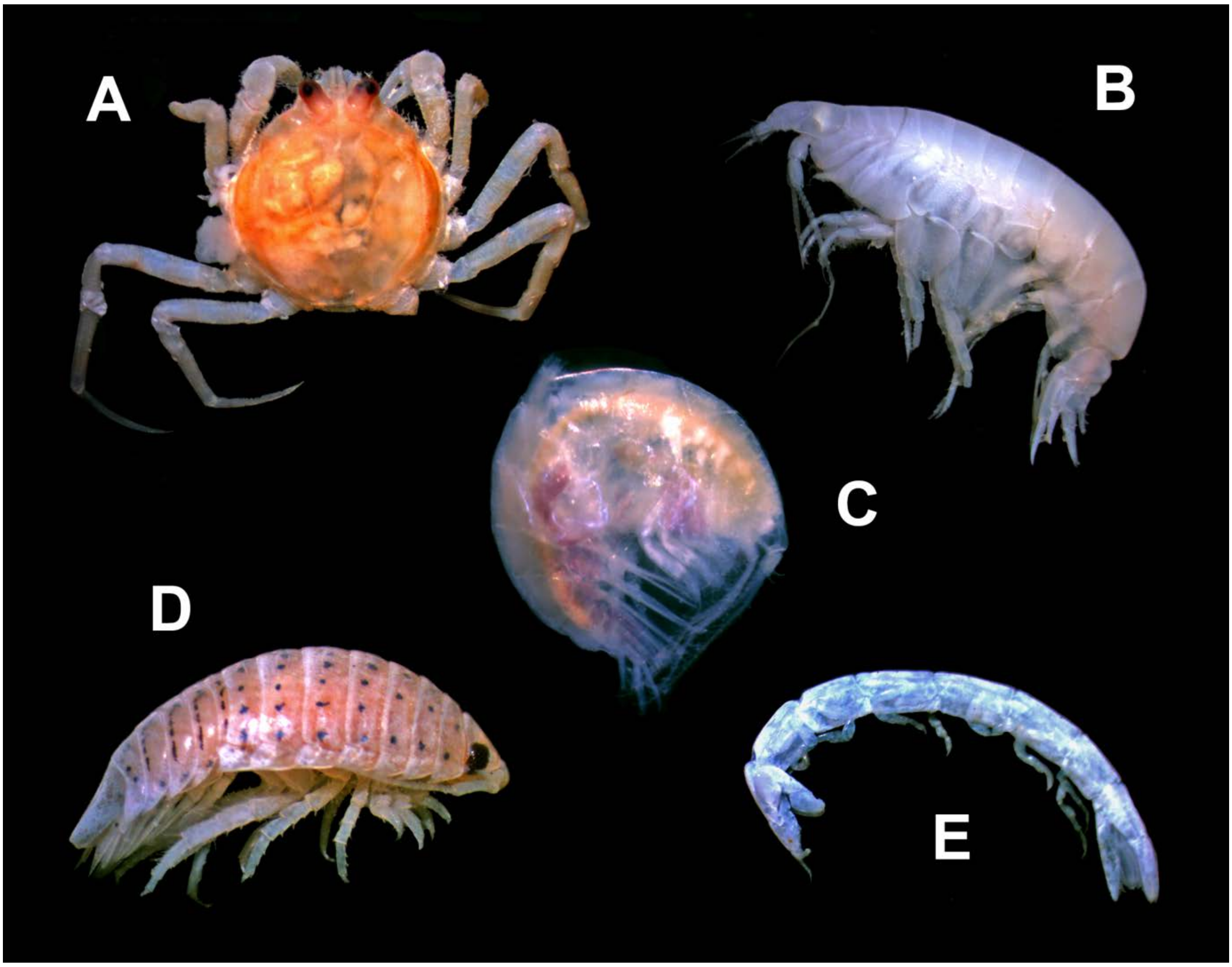

Figure 3.9 **Benthic macrofauna species frequently found in Saldanha Bay include: A – *Hymenosoma obiculare* (crown crab); B – *Socarnes septimus* (amphipod); C – *Ampelisca palmata* (amphipod); *Eurydice longicornis* (isopod); E – *Centrathura caeca* (isopod).**

Studies conducted by Anchor from 2008 to 2017 provide recent and comparable data on the benthic macrofaunal community composition, abundance and biomass throughout the Saldanha-Langebaan system. Approximately 200 benthic macrofauna species are regularly found within the system, with infaunal abundance averaging around 2 000 individuals/m^2 and biomass around 650 g/m^2. Average infaunal biomass within Langebaan Lagoon was found to be lower at around 300 g/m^2. Monitoring of benthic macrofaunal communities over time has revealed a relatively stable situation in most parts of Saldanha Bay and Langebaan Lagoon with the exception of 2008, when a dramatic shift in benthic community composition occurred at all sites. Extensive dredging activities undertaken during 2007 and early 2008 appear to have had bay-wide impacts on the macrobenthic community structure, resulting in a temporary loss of less tolerant species and a shift in community composition to one dominated by more tolerant species (Anchor 2015b). This shift involved a decrease in the abundance and biomass of filter feeders and an increase in shorter lived, opportunistic detritivores. Filter feeding species are typically more sensitive to changes in water quality than detritivores or scavengers and are the most dominant functional group in Saldanha Bay.

The community composition in Big Bay is generally more similar to that of Small Bay than to Langebaan Lagoon (Anchor 2017). Hardier filter feeders such as the prawn *Upogebia capensis* are abundant in both Big Bay and Small Bay, but the more sensitive filter feeders such as the amphipods *Ampelisca spinimana* and *A. anomala*, the mollusc *Macoma odinaria* and the polychaete *Sabellides luderitzi* are notably more abundant in Big Bay than Small Bay. Similarly, the sea pen *Virgularia schultzei*, widely regarded as a sensitive species is found only in Big Bay (Anchor 2017). This species was reportedly very abundant in Saldanha Bay prior to port development but is now completely absent from Small Bay and is rare in Big Bay (Anchor 2017).

Spatial variation in species diversity (represented by the Shannon Weiner Index, H') is presented in Figure 3.10. Of the sites within Saldanha Bay, those around the ore terminal, in the yacht basin and at the Liquid Petroleum Gas site in Big Bay displayed low levels of diversity. This is corresponds with results from earlier surveys and is most likely attributable to the high levels of anthropogenic disturbance (mainly dredging) and the presence of elevated levels of contaminants (trace metals, organic material, etc.) in the fine sediment (mud) collected at these sites. It is well known that high levels of disturbance associated with pollution can allow a small number of opportunistic, short-lived or r-selected species to colonize the affected area and prevent a more diverse community comprising longer living k-strategist species from becoming established.

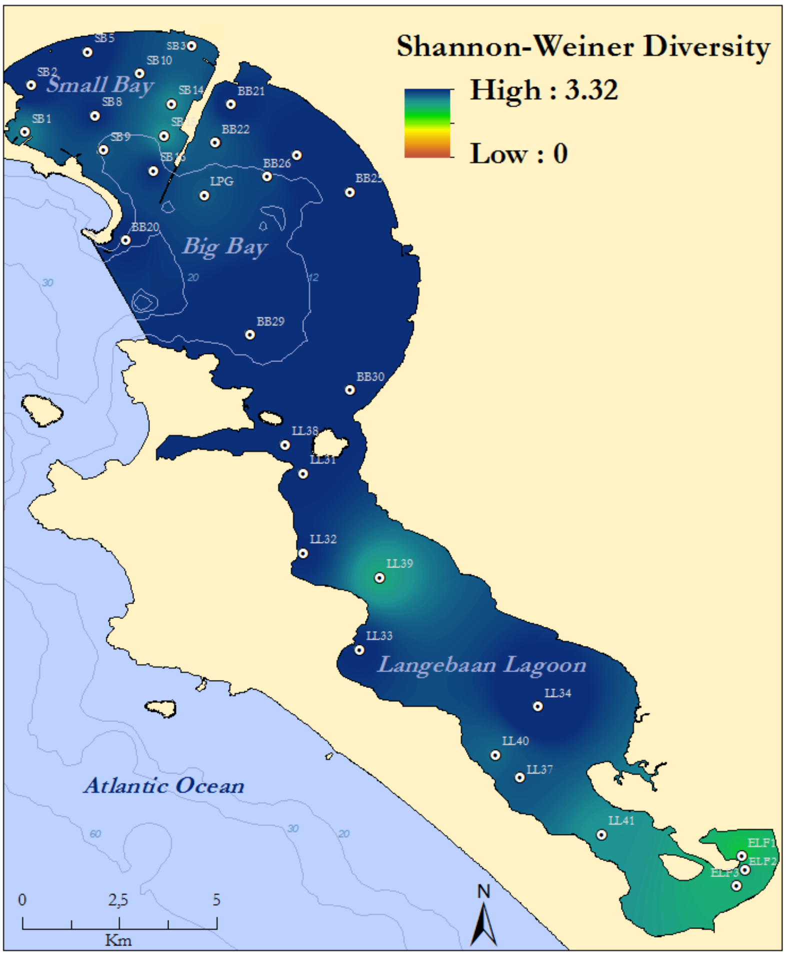

Figure 3.10 **Variation in the diversity of the benthic macrofauna in Saldanha Bay and Langebaan Lagoon as indicated by the 2017 survey results (H' = 0 indicates low diversity, H' = 3.32 indicates high diversity) (Anchor 2017).**

3.2.4.3 Alien and invasive species

At least 28 confirmed marine alien species have been recorded from Saldanha Bay and/or Alien species are plants, animals and microorganisms that are transported beyond their natural range and become established in a new area. They are sometimes called exotic, introduced, non-native or non-indigenous species but are not necessarily invasive. Invasive species are introduced species that have a tendency to spread to a degree believed to cause damage to the environment, to the economy or to human health. At least 92 marine alien species have been recorded from South African waters, 70 of which are thought to occur along the west coast of South Africa, and 28 of which have been confirmed from Saldanha Bay and/or Langebaan Lagoon (Anchor 2017). An additional 39 species are currently regarded as cryptogenic, which means they are of unknown origin but are likely introduced to South Africa. Of these, five species have already been identified from Saldanha Bay.

Most of the introduced species in South Africa have been found in sheltered areas such as harbours, and are believed to have been introduced through ballast water discharge or hull fouling. As ballast water tends to be loaded in sheltered harbours, the species that are transported originate from these habitats and have trouble adapting to South Africa's exposed coast. This might explain the low number of introduced species that have established along the coast in comparison to the high number found in sheltered bays or harbours (Griffiths *et al.* 2008).

Invasive species include the Mediterranean mussel (*Mytilus galloprovincialis*), the European green crab (*Carcinus maenas*) (Griffiths *et al.* 1992, Robinson *et al.* 2005), the acorn barnacle *Balanus glandula* (Laird & Griffiths 2008), and the Pacific South American mussel (*Semimytilus algosus*) (de Greef *et al.* 2013). Data from the State of the Bay surveys suggest that *Mytilus* occurs mainly on exposed rocky shores in Saldanha Bay (i.e. North Bay, Iron Ore Terminal (IOT), Marcus Island and Lynch Point) and is present in low numbers at the more sheltered sites (Dive School, Jetty and Schaapen Island East and West). Populations grew fairly rapidly in the period 2005 until 2012/2013 at most exposed sites, after which populations stabilized. This mussel is by far the most dominant faunal species on the rocky shore and covers 100% of the available space across substantial portions of the shore at some sites. It reaches its highest densities low on the shore in areas exposed to high wave action.

Surveys in Saldanha Bay have not found any live specimens of the European green crab to date, but a single dead specimen was picked up by Robinson *et al.* (2004) in Small Bay at the Small Craft Harbour. Abundance of the acorn barnacle was very high when it was first detected in 2010 but has been declining at most sites except at the IOT. The Pacific South American mussel is usually present only on wave exposed shores, although in Saldanha Bay it has been observed on the ropes at mussel farms.

3.2.4.4 Fish

The sheltered, nutrient rich and sun warmed waters of the Saldanha Bay-Langebaan Lagoon system provide a refuge from the cold, rough seas of the adjacent coast and constitute an important nursery area for the juveniles of many fish species that are integral to ecosystem functioning (Figure 3.11). Certain areas within Langebaan Lagoon have therefore been closed to fishing. There is considerable life history and tagging evidence that populations of key fishery species, namely hound sharks, white stumpnose, steentjies and elf, are resident within the Saldanha Bay-Langebaan Lagoon system and comprise semi-isolated, largely self-recruiting populations (Kerwath *et al.* 2009, Tunley *et al.* 2009, Attwood *et al.* 2010, Hedger *et al.* 2010, da Silva *et al.* 2013). .

Monitoring of fish populations in Saldanha Bay was initiated by means of experimental seine-netting in 1986. Surveys undertaken in 2011 recorded good recruitment of harders (*Liza richardsonii*), white stumpnose (*Rhabdosargus globiceps*), gobies (*Caffrogobius* sp.) and silversides (*Atherina breviceps*) in Big Bay (Anchor 2012a). In Small Bay, however, where commercially important species such as white stumpnose have traditionally been most abundant, there were clear signs of decline (Anchor 2012a).

Figure 3.11 Important angling and food fish caught in Saldanha Bay and Langebaan Lagoon include: Elf (*Pomatomus saltatrix*) (top left), southern mullet (*Liza richardsonii*) (top right), white stumpnose (*Rhabdosargus globiceps*) (bottom left) and yellowtail (*Seriola lalandi*) (bottom right).

3.2.4.5 Birds

Thousands of migratory waders visit Langebaan Lagoon during the austral summer, making it the most important ‘wintering’ area for these birds in South Africa (Underhill 1987). Since Langebaan Lagoon regularly supports over 20 000 waders it is recognised as an internationally important site under the Ramsar Convention on Wetlands of International Importance, to which South Africa is a signatory.

Saldanha Bay, Langebaan Lagoon and the associated islands provide important shelter, feeding and breeding habitat for at least 53 species of seabirds, 11 of which are known to breed on the islands of Malgas, Marcus, Jutten, Schaapen and Vondeling (Anchor 2017). These islands support important breeding colonies of African penguin (*Spheniscus demersus*), Cape gannet (*Morus capensis*), Cape cormorants (*Phalacrocorax capensis*), bank cormorants (*Phalacrocorax neglectus*), white-breasted cormorants (*Phalacrocorax carbo lucidus*), crowned cormorants (*Phalacrocorax africanus*), kelp gulls (*Larus dominicanus*), Hartlaub's gulls (*Larus hartlaubii*) and swift terns (*Sterna bergii*) (Anchor 2006). The African penguin, Hartlaub's gull, Cape bank cormorant and Crowned cormorant are endemic to the Benguela region. The rocky shore environment supports the endemic African black oystercatcher (*Haematopus moquini*), a population which is successfully recovering from low numbers; while the tidal flats of the Lagoon support large numbers of migrant waders during the summer months (Summers 1977). The IUCN lists African penguins, Cape cormorants, Cape gannets and Bank cormorants as endangered (IUCN 2017); crowned cormorants as near threatened (IUCN 2017) and oyster catchers as least threatened (IUCN 2017). The majority of these species are piscivorous and depend largely on a healthy population of fish for sustenance.

Populations of two cormorant species, namely Bank cormorants and Cape cormorants, that utilise islands within the Saldanha Bay region for shelter and breeding, have decreased since early to mid-1990. In the past this has been attributed to the construction of the causeway linking Marcus Island to the mainland, and to increased human disturbance. However, given that the populations of several other seabirds that breed on these islands have not decreased over this period, it appears that declines in local availability of their principal prey species, (rock lobster and sardines), as well as egg and chick predation by pelicans and gulls may be the principal drivers.

The Cape gannet population on Malgas Island has also undergone a severe decline due mainly to predation by Cape fur seals and more recently by Great white pelicans. Predation by seals was responsible for a 25% reduction in the size of the colony at Malgas Island, between 2001 and 2006 (Anchor 2017). Management measures have been put in place, through selective culling of seals, which has improved conditions for the gannets at Malgas Island. The African penguin populations are also under considerable pressure, partially due to causes unrelated to conditions on the island such as the eastward shift of the sardines, one of their main prey species. However, because populations are so depressed, conditions at the islands in Saldanha have now become an additional factor in driving current population decreases.

3.2.4.6 Seafarm Dam

An artificial rocky breakwater encloses a 25 hectare, coffer dam (also known as the "Seafarm Dam", or the "Oyster Dam") at the base of the IOT jetty that was created during the existing oil pipeline construction. The average depth of seawater in the dam is approximately 4 m and it is connected to the sea via a pipe that allows for limited tidal fluctuation (about 10 cm). This dam has been intensively used for shellfish mariculture since 1984, first Mediterranean black mussels *Mytilus galloprovincialis* and later (since the early 1990s), Pacific oysters *Crassostrea gigas*. Several studies investigated the physical and biological conditions within the Oyster dam in relation to the mariculture operations taking place. These studies found the biophysical environment within the Oyster Dam to be distinct from the surrounding Big Bay marine environment, a difference which is largely attributable to the limited exchange of water through the pipe (Brown *et al*. 1983). Reduced oxygen and nitrate concentrations and elevated temperature, ammonia and phosphate levels in the Dam led to the development of faunal and floral communities in the Dam that were distinct from that in the Bay. The Dam typically contains dinoflagellate phytoplankton, rotifers, sea hares, cultured black mussels and oysters (Brown *et al*. 1983). Blood worm *Arenicola loveni* are reportedly abundant in the shallow sandy areas of the Dam, whilst fish species include most of those found within the surrounding bay. The Oyster Dam was a popular bait collecting and shore angling site for several years during the 1990s, but public access has since been closed. A phytoplankton species, *Aureococcus anophagefferens,* that was previously only known from coastal embayments along the north-eastern USA coast was first recorded in the Oyster dam in 1997, throughout Saldanha Bay and Langebaan Lagoon in 1998, and again in the Oyster dam in 1999 (Probyn *et al*. 2001, 2010). This recurrence of "brown tide" had significant negative impacts on the growth of cultured oysters and threatened the economic viability of the mariculture operation that ceased production in the early 2000s. Oysters still occur in the Dam but infilling to increase the area available for iron ore stockpiling commenced between 2006-and 2009, and complete infilling of the Oyster Dam is planned (PRDW 2010). The sandy shore adjacent to the Oyster Dam at the proposed landfall of the subsea pipeline is the most sheltered part of the Big Bay shoreline. No data exists on the sandy beach macrofauna inhabiting this beach but the biota is likely to be similar to that found on sandy shores in Small Bay with comparable levels of wave exposure. This sheltered beach is used as a roosting site by gulls, common terns, white breasted cormorants and Cape cormorants.

4 ASSESSMENT OF IMPACTS

The impact assessment is a measure of the impacts likely to occur on the affected environment. In the case of the terrestrial environment, impacts on the vegetation, biodiversity, ecological processes, important species and habitats are assessed. In the marine 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).

Impacts on the affected environment are considered for the 'No Go' scenario as well as impacts occurring in the construction and operational phases. The assessment and rating procedure described in Appendix 1 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, as well as the existing ponds as they will be cleaned. Results of each assessment are presented in Table 4-1 to Table 4-10 and are summarised in Table 5-1 and Table 5-2.

4.1 Terrestrial Environment

4.1.1 Construction Phase

Potential impacts on terrestrial biodiversity that may arise from the redesign and development of the stormwater management system of the Port of Saldanha during the construction phase includes the rehabilitation of erosion-prone areas. While loss of vegetation (including intact vegetation) and the loss of ecological processes associated with the loss of intact vegetation, ecologically important species and species of conservation concern would be expected of such a development, all activities associated with this development are in disturbed areas on reclaimed land where no intact vegetation currently exists. Therefore, these potential impacts are not assessed here.

4.1.1.1 Rehabilitation of erosion-prone areas

Erosion runnels will be repaired and re-vegetated where possible. Provided that vegetation appropriate to the vegetation type found in the area is used for rehabilitation, the impact to terrestrial biodiversity will be highly positive (Table 4-1)

Table 4-1 Impact 1: Rehabilitation of erosion-prone areas.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Long-term 3	High 7	Definite	**HIGH**	+ve	High
Recommended mitigation measures: • No mitigation measures are available to enhance the positive impact.								

4.1.2 Operational Phase

Operational phase activities involve the diversion of stormwater by the new infrastructure and maintenance activities of the stormwater infrastructure. Upgrades to the stormwater system will in some instances divert contaminated water away from the remaining natural areas, which constitutes a positive impact on terrestrial biodiversity that has been given a 'high' significance rating (Table 4-2).

Table 4-2 **Impact 2: Diversion of contaminated stormwater away from remaining natural areas.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Long-term 3	High 7	Definite	**HIGH**	+ve	High
Recommended mitigation measures: • No mitigation measures are available to enhance the positive impact.								

4.1.3 'No Go' option

The 'No Go' scenario takes into consideration the impact associated with the no development option. It is a prediction of the future state of the affected area in the event of no development taking place based on the current and/or anticipated future land use. Upgrading the current stormwater management system certainly has positive impacts on terrestrial biodiversity (as assessed above) (Table 4-3).

Table 4-3 **'No Go' option: Ecological effects due to the loss of intact habitat as a result of uncontrolled stormwater runoff.**

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Local 1	High 3	Long-term 3	High 7	Definite	**HIGH**	-ve	High

4.2 Marine Environment

In assessing potential impacts on the marine biota in the vicinity of proposed construction and maintenance operations, consideration is given to the fact that these areas are already subject to disturbance from maintenance dredging and propeller wash, and sediments have been affected by pollutants due to industry, port activities, shipping, ballast water discharges, oil spills, sewage, household discharges, discharges from fish processing factories, biological waste associated with mariculture, and stormwater runoff. In addition, Small Bay has undergone extensive harbour development and has been subjected to dredging and marine blasting activities. Each of these impacts is likely to affect the associated biota in different ways and at varying intensities depending on the nature of the affected habitat and the sensitivity of the biota. The degree of each impact depends on the construction methods used.

Preliminary identification of potential impacts of the proposed expansion of the existing Crude Oil Jetty and the construction of a new pipeline system on the marine environment was undertaken during the scoping study in August 2017. These included construction phase impacts that are expected to be localised and of temporary duration, while operating phase impacts are of a longer duration.

The construction related impacts are similar in nature to those expected with the decommissioning phase (should the stormwater management system be removed).

4.2.1 Construction phase

Potential negative impacts on the marine environment that may arise from the redesign and development of the stormwater management system of the Saldanha iron ore terminal during the construction phase include ecological effects due to the:

- Temporary loss of artificial concrete habitat;
- Possibility of increased noise and vibration;
- Mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the Bay;
- Generation and disposal of waste; and
- Possibility of spillage of hazardous substances.

4.2.1.1 Temporary loss of intertidal and subtidal artificial concrete habitat

An artificial intertidal zone exists on quay structures at the IOT. These are colonised by a number of intertidal invertebrate fauna and flora (e.g. mussels, barnacles, crabs, sea lettuce), which characterise much of the intertidal habitat in Small Bay (*pers. obs*. during previous port surveys). Although existing intertidal and subtidal habitat may be altered, similar habitat will exist after construction. Since this disturbance will not result in a net loss of habitat and since the existing habitat is artificial, the significance of this impact is rated as 'very low' and no mitigation is required (Table 4-4).

Table 4-4 **Impact 1: Ecological effects due to the temporary loss of artificial concrete habitat.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Medium-term 2	Very low 4	Definite	**VERY LOW**	-ve	High
Mitigation measures: • Not considered necessary due to very low significance.								

4.2.1.2 Increased noise and vibration

During construction operations, noise may have an impact on marine organisms in the Port. Noise may be generated by construction activities (e.g. earthmoving vehicles, service vehicles, vessels, cranes, heavy machinery, generators, chopping, drilling, grinding 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 within the Bay, it is not expected that avifauna will be excluded from feeding on a particular food source.

As a precautionary measure, mobile equipment, vehicles and power generation equipment should be subject to noise tests which are measured against manufacturer specifications to confirm compliance before deployment on site. Noise emissions from mobile and fixed equipment should be subject to periodic checks as part of regular maintenance programmes to allow for detection of any unacceptable increases in noise. After mitigation is considered, the impact of noise and vibration on the marine environment is considered to be 'insignificant' (Table 4-5).

Table 4-5 **Impact 2: Noise and vibrations caused by construction related activities.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Definite	**VERY LOW**	-ve	Medium
Recommended mitigation measures: • Subject mobile equipment, vehicles and power generation equipment to noise tests at commencement and periodically throughout the construction phase.								
With mitigation	Low 1	Low 1	Short -term 1	Very Low 3	Improbable	**INSIGNIFICANT**	-ve	Medium

4.2.1.3 Mobilisation/runoff of contaminants in marine and terrestrial sediment

Cadmium concentrations within marine sediments around the MPT were found to be above the Effect Range Low (ERL) (refer to Section 3.2.2.2) indicating that disturbance of the sediment in these areas may result in mobilisation of these pollutants that are potentially toxic to sensitive marine species (NOAA 1999). Cadmium is a trace metal used in electroplating, paints and dyes and likely sources of Cd in this area include the adjacent metallurgical industry and hull paint scrapings from vessels (OSPAR 2010). This substance is toxic and prone to bioaccumulation, which is a concern for both the marine environment and shellfish grown for human consumption (OSPAR 2010). Lead concentrations have been flagged as high (above the ERL of 46.7 mg/kg, see Section 3.2.2.2) at the MPT on a number of occasions over the past eight years, likely due to industrial and shipping activities at the MPT (Anchor 2015).

There are no available resources on the contamination of the terrestrial sediments on the IOT. However, it is assumed that contaminants such as hydrocarbons and heavy metals present in the marine sediments are also likely contaminants of terrestrial sediments. Construction activities may result in the mobilisation of these sediments, which if not contained may run into the marine system. Terrestrial sediment run-off into the marine system has a variety of negative impacts, including increased turbidity (which may impair prey capture in piscivorous fish that rely on visual prey detection methods, and a decrease in autotrophic microphytobenthos and phytoplankton production due to reduced light penetration) and the smothering of benthic marine organisms. A further impact is the input of terrestrial derived pollutants into the marine system, which of particular concern in areas of heavy industrial use such as the Saldanha Bay IOT.

Although toxic trace metals can be lethal, undissolved trace metals remain attached to sediment which settles out of the water column after sediment disturbance. As toxicity tests were not performed to determine what proportion of these trace metals are likely to become bioavailable during dredging, this assessment assumes that 100% of the trace metals in the sediments is biologically available. However, while the risk of introducing high concentrations of toxins such as lead and cadmium into the water column adjacent to sensitive areas (e.g. surf zone nursery areas) may be substantial, this impact is rated as 'insignificant' as no direct disturbance of the marine sediments is planned (Table 4-6a). However, the runoff of terrestrial sediments as a result of construction activities (earth moving etc.) has a 'medium' impact rating that is reduced to 'low' with appropriate mitigation measures (Table 4-6b).

Table 4-6 **Impact 3a: Ecological effects on the marine system through the disturbance of marine sediments.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Short-term 1	Very Low 3	Improbable	**INSIGNIFICANT**	-ve	Medium

Mitigation measures:

- Not considered necessary due to very low significance.

Impact 3b: Ecological effects on the marine system through the runoff of contaminated terrestrial sediments during construction.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Low 1	Medium 2	Medium-term 2	Low 5	Probable	**LOW**	-ve	Medium
Essential mitigation measures: • Use bunding where possible. • Collect and dispose of polluted soil at appropriate waste facilities. • Minimise run-off as much as possible i.e. ensure that construction does not coincide with heavy rainfall, cover disturbed sediment etc. • Dust suppression techniques to be used on all dust generating surfaces. Screening measures to be placed adjacent to roads. Handling of soils is not to be conducted during high winds (25km/h). While there is no intention to stockpile inside the Port, soil stockpiles are to be covered to prevent dust generation. The speed of construction vehicles to be restricted within the construction area or near stockpiles. Trucks transporting any form of soil or waste should be covered.								
With mitigation	Local 1	Low 1	Short-term 1	Very Low 2	Possible	**INSIGNIFICANT**	-ve	Medium

4.2.1.4 Solid waste

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 marine fauna include plastic bags and bottles, pieces of rope and small plastic particles. Large numbers of marine organisms are killed or injured daily by becoming entangled in debris or as a result of the ingestion of small plastic particles (Wallace 1985, 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 marine life (especially seabirds, cetaceans and fish) can be lethal and can affect rare and endangered species.

The problem of litter entering the marine 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 marine 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 4-7.

Table 4-7 **Impact 4: 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 measures: • 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

4.2.1.5 Hazardous substances

The risk of spillage of a variety of hazardous substances may occur during the use of heavy machinery, construction vehicles and construction vessels. For example, spillage may occur as a result of fuel leaks, refuelling, or collision. Hydrocarbons are toxic to aquatic organisms and precautions must be taken to prevent them from contaminating the marine environment. This impact can be mitigated successfully if authorities implement a rigorous environmental management and control plan to limit ecological risks from accidents. All fuel and oil must be stored with adequate spill protection and no leaking vehicles should be permitted on site. Intentional disposal of any substance into the marine 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 4-8).

Table 4-8 **Impact 5: The effect of the spillage of hazardous substances on marine biota.**

	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: • Ensure that stringent waste management practices are in place at all times. • Maintain high safety standards and employ "good housekeeping" on the construction site. This should incorporate plans for emergencies. • Vehicle maintenance or refuelling on the construction site is only permitted in dedicated areas with appropriate controls • Use drip trays and bunding where losses are likely to occur. • Accidental diesel and hydrocarbon spills must be cleaned up accordingly.								

• Collect and dispose of polluted soil at appropriate waste facilities.								
With mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Improbable	**VERY LOW**	-ve	Medium

4.2.2 Operational phase

Potential operational impacts that may arise from the redesign and development of the stormwater management system of the Saldanha iron ore terminal include:

- The containment of contaminated stormwater run-off into the marine system, halting a known source of anthropogenic pollutants that are evident at the MPT in particular (where elevated concentrations of trace metals have been detected in marine sediments).

4.2.2.1 Ecological effects of the containment of contaminated stormwater run-off

Trace/heavy metals are often regarded as pollutants of aquatic ecosystems. However, they are naturally occurring elements, some of which (e.g. copper and zinc) are required by organisms in considerable quantities (Phillips 1980). Aquatic organisms accumulate essential trace metals that occur naturally in water as a result of, for example, geological weathering. All of these metals, however, have the potential to be toxic to living organisms at elevated concentrations (Rainbow 1995). Human activities greatly increase the rates of mobilization of trace metals from the earth's crusts and this can lead to increases in their bioavailability in coastal waters via natural runoff and pipeline discharges (Phillips 1995). Dissolved metal concentrations in water are typically low (presenting analytical problems), have high temporal and spatial variability (e.g. with tides, rainfall events etc.) and most importantly reflect the total metal concentration rather than the portion that is available for uptake by aquatic organisms (Rainbow 1995).

There is an increasing global trend to monitor the long-term effects of water quality by assessing impacts on specific marine species or species assemblages. Mussels and oysters (i.e. filter feeding organisms) are considered to be good indicator species for the purpose of monitoring water quality as they tend to accumulate trace metals, hydrocarbons and pesticides in their flesh. Mussels are sessile organisms (anchored in one place for their entire life) and will be affected by both short-term and long-term trends in water quality. Monitoring the contaminant levels in mussels can therefore provide an early warning of poor water quality and dramatic changes in contaminant levels in the water column.

In 1985 the MCM initiated the Mussel Watch Programme whereby mussels (either brown mussels *Perna perna* or Mediterranean mussels *Mytilus galloprovincialis*) were collected every six months (Apr/May and October) from 26 coastal sites. Mussels were collected periodically from five stations in Saldanha Bay. According to DEA, challenges in processing the mussel samples have resulted in data from the Saldanha Bay Mussel Watch Programme only being available between 1997-2001 and 2005-2007. No new data have been received since 2007 despite the fact that the programme was due to resume in late 2014. In the interim, Anchor Environmental Consultants continued the programme by collecting mussel samples from the same five sites annually during the field surveys from 2014 to 2016. The mussel samples were analysed for the metals lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu), iron (Fe), manganese (Mn) and mercury (Hg) in 2016.

Data from the Mussel Watch Programme and from the annual State of the Bay monitoring (Anchor 2016) are discussed below:

- **zinc** concentrations at the Iron Ore Jetty by Anchor (2016) were higher than the 150 ppm regulatory limit listed by Canada[4] (Fish Products Standard Method Manual, Fisheries & Oceans, Canada of 1995);
- **manganese** concentrations were also elevated at the Iron Ore Terminal (Anchor 2006), and have been attributed to, "the increase of manganese export volume from 1 231 thousand tons in 2014 to 2 090 thousand tons in 2015" (Anchor 2016) i.e. directly related to land-based pollutant sources;
- Anchor (2016) data showed that concentrations of **lead** at the Portnet site (situated at the base of the Iron Ore Terminal on the Small Bay side) were consistently above the regulatory limit for foodstuffs, with values averaging 119 ppm from 1970 - 2016 (Anchor 2016). Compared to the limit of 0.5 ppm, lead concentrations were found to be extremely high. The high levels of lead are almost certainly linked to the export of lead ore from the multipurpose quay, which is situated in close proximity to the Portnet site (Anchor 2016);
- in 2016 **iron** concentrations had increased from 2015 values at all sites sampled (Anchor 2016). Iron concentrations were highest at Saldanha Bay North, a site on the opposite side of Small Bay to the Iron Ore Terminal (Anchor 2016)[5]. As Iron ore is processed in Saldanha Bay on a large scale and iron ore residue is apparent on all structures in the vicinity of the Saldanha Steel processing plant, Anchor (2016) recommends that the concentration of iron in the flesh of bivalves continue to be monitored to flag any sharp increases over time;
- **cadmium** concentrations frequently exceeded the regulatory limit of 3 ppm at all sites within the Bay, The concentration of cadmium in mussels tissue collected at all sites in 2016 averaged 5.3 ppm, which is high relative to the safe limit of 3 ppm. In addition, sediments from sites located alongside the Ore Jetty and in the vicinity of the yacht club within Small Bay displayed elevated Cd concentrations.

The high concentrations of trace metals along the shore points to the need for management interventions to address this issue, as consumption of contaminated shellfish poses a very serious health risk. Therefore, the identified marine impacts of the operational phase of the proposed development are generally positive due to the anticipated improvements in the quality of stormwater discharged (i.e. should result in a net improvement of the current state of the system). The significance of this positive impact is rated as 'high' (Table 4-9).

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[4] There is no maximum legal limit prescribed for zinc concentrations in shellfish for human consumption in South Africa (Regulation R.500 of 2004 published under the Foodstuffs, Cosmetics and Disinfectants Act, Act 54 of 1972).

[5] As there are no official limits outlined for the safe concentration of iron present in foodstuffs, it is not possible to comment on the suitability of these mussels for consumption based on this trace metal (Anchor 2016).

Table 4-9 **Impact 6: Ecological effects of the containment of contaminated stormwater run-off into the marine system.**

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Local 1	High 3	Long-term 3	High 7	Definite	**HIGH**	+ve	High

Mitigation measures:

- Not necessary due to positive status.

4.2.3 'No Go' option

The 'No Go' scenario takes into consideration the impact associated with the no development option. It is a prediction of the future state of the affected area in the event of no development taking place based on the current and/or anticipated future land use. Upgrading the current stormwater management system certainly has positive impacts on the marine system (as assessed above). The ecological condition of the site is more likely to become more degraded and transformed under the 'No Go' scenario (Table 4-10).

Table 4-10 **'No Go' option: Ecological effects due to the loss of intact habitat as a result of uncontrolled stormwater runoff.**

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Local 1	High 3	Long-term 3	High 7	Definite	**HIGH**	-ve	High

5 SUMMARY OF POTENTIAL IMPACTS

Table 5-1 Summary of potential impacts on terrestrial biodiversity as a result of construction and operation of the proposed development.

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Operational	Impact 1: Rehabilitation of erosion-prone areas:	High	Definite	**HIGH**	+ve	High
	Impact 2: Diversion of contaminated stormwater away from remaining natural areas.	High	Definite	**HIGH**	+ve	High
'No Go'	'No Go' Option:	High	Definite	**HIGH**	-ve	High

Table 5-2 Summary of potential impacts on marine environment as a result of construction and operation of the proposed development.

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Construction	Impact 1: Ecological effects due to the temporary loss of artificial concrete habitat.	Very low	Definite	**VERY LOW**	-ve	High
	Impact 2: Noise and vibrations caused by construction related activities.	Very Low	Definite	**VERY LOW**	-ve	Medium
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**		
	Impact 3: Ecological effects on the marine system through:					
	(a) the disturbance of marine sediments during construction	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	(b) the runoff of contaminated terrestrial sediments during construction.	Low	Probable	**LOW**	-ve	Medium
	(b) With mitigation	Very Low	Possible	**INSIGNIFICANT**	-ve	Medium
	Impact 4: Waste generation and disposal during construction.	High	Possible	**MEDIUM**	-ve	High
	With mitigation	Medium	Improbable	**LOW**	-ve	High
	Impact 5: The effect of the spillage of hazardous substances on marine biota.	Medium	Possible	**LOW**	-ve	Medium
	With mitigation	Low	Improbable	**VERY LOW**	-ve	Medium
Operation	Impact 6: Ecological effects of the containment of contaminated stormwater run-off into the marine system.	High	Definite	**HIGH**	+ve	High
'No Go'	'No Go' Option:	High	Definite	**HIGH**	-ve	High

6 CONCLUSIONS AND RECOMMENDATIONS

The Port of Saldanha is a major industrial port which is of high economic value, while the surrounding area is of recreational and ecological importance. To date, development within the Port and the greater Saldanha Bay area has significantly altered the environment (terrestrial and marine environments alike) impacting negatively on ecosystem health.

There are a number of impacts that have been identified that are likely to result from construction activities, but there are effective mitigation options available to address these impacts. It is anticipated that there will be a net positive impact on the marine environment throughout the operational phase. No fatal flaws in the design, construction or operation of the proposed development have been identified. Based on the impacts assessed in this report, it is recommended that the proposed development proceed with the implementation of environmentally responsible practices as outlined in the mitigation measures. Without a formal assessment of the impacts, no dredging is permitted for this proposed development whatsoever. Such measures should contribute towards the existing monitoring programme in Saldanha Bay and Langebaan Lagoon to enable the detection of probable negative effects of development on the marine environment.

Three different impacts on terrestrial biodiversity were assessed in this study (Table 5-1). All impacts were rated as highly positive. The upgrading of the stormwater system within Catchments 3 and 4 was found to have a highly positive impact (Table 5-1).

Mitigation measures for the terrestrial environment include:

- Use species that are specific to the original vegetation type of the affected area for the re-vegetation of erosion runnels.

A total of six marine environmental impacts were assessed in this study, ranging from habitat loss to operational effects (see Table 5-2). Of these, three were of 'very low' to 'insignificant' significance and do not require mitigation. Two impacts were rated as 'low', one as 'medium' and one as 'high'. However, the 'high' significance impact had a positive status. No negative status impact was rated as 'high'. Implementation of mitigation measures is expected to reduce these ratings to 'low', 'very low' and 'insignificant' significance (Table 5-2). Mitigation measures, both best practise and essential, include the following:

- Subject mobile equipment, vehicles and power generation equipment to noise tests at commencement and periodically throughout the construction phase;
- Ensure that stringent waste management practices are in place at all times;
- Maintain high safety standards and employ "good housekeeping" on site. This should incorporate plans for emergencies;
- Use bunding where possible to contain terrestrial sediment run-off into the marine system, and use drip trays and bunding where hydrocarbon (i.e. Construction vehicle fuel) losses are likely to occur;
- Collect and dispose of polluted soil at appropriate bio-remediation sites;
- Minimise run-off as much as possible i.e. Ensure that construction does not coincide with heavy rainfall, cover disturbed sediment etc.;

- 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;
- Vehicle maintenance or refuelling on the construction site is only permitted in dedicated areas with appropriate controls; and,
- Accidental diesel and hydrocarbon spills must be cleaned up accordingly.

Intertidal and subtidal concrete habitat will be affected by the development, although this is an artificial habitat which is relatively common in Saldanha Bay, and removal or alteration of which habitat types is likely to be of 'very low' consequence. The proposed developments are unlikely to significantly alter hydrodynamics and sediment movement within the Bay, given that the proposed development will occur within an existing developmental footprint.

Current monitoring programs, specifically the annual State of the Bay monitoring commissioned by the Saldanha Water Quality Trust, should be sufficient to detect negative impacts on the marine environment resulting from the proposed development.

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8 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
Impact 1: XXXX	Medium	Improbable	LOW	–ve	High
With Mitigation	Low	Improbable	VERY LOW		High
Impact 2: 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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