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UPDATED MARINE IMPACT ASSESSMENT FOR THE PART 2 AMENDMENT APPLICATION AT THE WEST POINT FISH MEAL PROCESSING PLANT



2026

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UPDATED MARINE IMPACT ASSESSMENT FOR THE PART 2 AMENDMENT APPLICATION AT THE WEST POINT FISH MEAL PROCESSING PLANT 2026

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EXECUTIVE SUMMARY

Introduction

PHS Consulting are the lead Environmental Assessment Practitioners (EAP) for a Part 2 Amendment Application on behalf of West Point Fish Meal Processing Plant (WPP) on ERF 1097, St Helena Bay. This Part 2 Amendment Application is motivated by a number of requirements, but of relevance to this assessment is to combine the two Discharge Pipelines (Outfall A & B) into one combined outfall. Anchor Environmental Consultants (Pty) Ltd (Anchor) has undertaken a number of studies for the various Environmental Authorisation (EA) and EA amendment applications for the WPP operations, including expansion activities and the inclusion of a reverse osmosis (RO) desalination plant. This study is a marine impact assessment with a focus on the Part 2 Amendment Application activities of relevance (in this case, a combined outfall). It includes an updated description of the affected environment and an overview of relevant existing near field dispersion models to demonstrate rates of initial dilution of updated effluent profile in the receiving environment. It also provides a description and assessment of all potential impacts associated with the intake of water and discharge of effluent to the marine environment in St Helena Bay, along with proposed mitigation and monitoring measures.

Affected Environment

St Helena Bay is situated on the west coast of South Africa. The bay extends from Dwarskersbos in the north, past the Shelley Point Peninsula, to Cape St Martin in the west, and encompasses 18 smaller bays and the Berg River Estuary. The system is positioned in the southern section of the Benguela Current System, downstream of the Cape Columbine upwelling cell, and is characterised by the wind-driven upwelling of cold, nutrient rich water. St Helena Bay is a highly productive marine environment and relatively sheltered from southerly and south westerly swells. Due to this enrichment and retention, St Helena Bay is a particularly productive system that supports a high biomass of marine biota and several important fisheries.

The highly productive, sheltered environment of the bay is also conducive to incidences of harmful algal blooms and regular episodes of oxygen depletion in the coastal waters, which have in the past led to major mortality events of organisms such as rock lobsters and fish. Low oxygen events that have led to stranding and mortality of marine biota have been documented at least once or twice per decade since the 1960s (these natural events were occasionally documented prior to this, but the published record is only considered consistent post 1960). While St Helena Bay is host to seasonal hypoxia events, and rare anoxia events, these are not persistent, and should not be considered the “norm” for the system, because St Helena Bay still supports abundant and diverse benthic and pelagic marine life.

St Helena Bay is positioned in the Southern Benguela ecoregion. Wind-driven coastal upwelling is the predominant physical driver that shapes the high levels of biological productivity in the southern Benguela, providing nutrients for primary producers, and food for diverse fauna, such as pelagic (pilchards, anchovy) and demersal (hakes, kingklip) fish stocks, near shore fisheries (linefish, rock lobster), mammals (seals and whales) and seabirds (penguins, gannets, cormorants etc.). There are three broad marine habitats around the area of interest, and these include sand and rocky shores, kelp forest and the water column or pelagic habitat. Much of the coastal area around the WPP area is sandy shores (e.g. Southern Benguela Intermediate or Reflective Sandy Shore), or rocky shores (Cape Sheltered Rocky Shore), with kelp forests in the nearshore.

Much of St Helena Bay is classified as Vulnerable by the National Biodiversity Assessment, and this Vulnerable habitat extends northwards until 10 km north of Lambert's Bay. Currently Rocher Pan Marine Protected Area constitutes the only MPA within St Helena Bay, although the bay does include a West Coast Rock Lobster sanctuary in which no harvesting of this resource may occur.

St Helena Bay is falls within the Cape Canyon and Associated Islands, Bays and Lagoon Ecologically or Biologically Significant Marine Area (EBSA), which extends from Sixteen Mile Beach MPA in the south to about 10 km south of Lamberts Bay in the north This area was identified as a priority area through a national plan to identify areas for offshore protection and by a systematic biodiversity plan for the west coast, and was identified as an important area for pelagic ecosystems and species. The majority of St Helena Bay is an Ecological Support Area, with a slightly smaller area covered by a Critical Biodiversity Area (CBA) Restore site, and a few small areas designated as CBA Natural.

Dispersion modelling

WPP is investigating the implications of combining the Outfall A and Outfall B effluents (a combined outfall) to improve dilution prior to discharge. WPP is currently exploring potential options through a draft Water Management Plan (WMP), which aims to implement mitigation measures to address concerning parameters. Model simulations were undertaken following updated engineering design specifications, based on a maximum combined design flow rate of 1500 m^3/hr (0.42 m^3/s). To investigate the water quality impacts the effluent may have on the receiving environment, four scenarios were modelled to represent the combined outfall, ranging from the "worst case" effluent to "treated" effluent. Simulations were run using a conservative tracer to determine the optimum outfall configuration to maximise dilution potential.

Pollutant levels at the edge of the Recommended Mixing Zone (RMZ) are expected to comply with published Water Quality Guidelines (WQGs) which in turn are determined by the various beneficial users of the receiving environment. Near field modelling was performed using the Cornell Mixing Zone expert system (CorMix) to predict the geometry and dilution characteristics within the RMZ (100 m) for a range of discharge scenarios and to determine compliance with regional WQGs.

Single outfall model results indicate that discharging at a pipe end diameter of 495 mm results in a discharge velocity slightly above 2 m/s. The outfall diameter needs to be increased to 515 mm to maintain a velocity of 2 m/s. Discharging within 100 m of the shore results in bank attachment some 350 m downstream of the discharge. This is considered to be unacceptable from a marine ecological perspective — discharging at 500 m offshore ensures no bank attachment occurs and is the environmentally preferable option.

Near field results for all scenarios indicate that the untreated discharge via a single outfall 500 m from shore in 7.2 m of water does not meet the legislated WQG for ammonia-N and TSS at the 100 m RMZ for any of the pipe end diameters under consideration. The proposed 'semi-treated' (Scenario 3) and 'treated' (Scenario 4) effluent profiles significantly reduce the ammonia-N and TSS end of pipe concentrations. Under Scenario 4 in particular, the predicted ammonia-N concentration exceeds the threshold by 0.01 mg/L, while TSS exceeds the threshold by 0.5 mg/L. Given the conservative modelling approach, this may indeed be compliant in situ. It is critical therefore that environmental monitoring be undertaken to validate this result.

Impact assessment

A summary of potential impacts is provided in Table 1 below.

Table 1. Summary of potential impacts.

Phase	Impact identified	Significance before mitigation	Significance with mitigation
Construction	Impact 1: Disturbance of intertidal and subtidal habitat	VERY LOW	INSIGNIFICANT
	Impact 2: Disturbance of pelagic habitat.	INSIGNIFICANT	n/a
	Impact 3: Litter pollution.	LOW	VERY LOW
	Impact 4: Hazardous substance spills.	LOW	VERY LOW
	Impact 5: Increased noise and vibration.	VERY LOW	INSIGNIFICANT
Operation	Impact 6: Disturbance marine life due to the intake of seawater	LOW	VERY LOW
	Impact 7: Changes in salinity	VERY LOW	n/a
	Impact 8: Elevated nutrient levels	HIGH	LOW
	Impact 9: Increased suspended solid concentrations.	HIGH	LOW
	Impact 10: Changes in temperature.	VERY LOW	INSIGNIFICANT
	Impact 11: Sediment scouring and shifts in sediment movement patterns	LOW	VERY LOW
	Impact 12: The impacts of discharged co-pollutants on marine biota	LOW	VERY LOW
	Cumulative impacts	MEDIUM	LOW

The primary cumulative impacts for this development are related to other discharges of nitrogenous waste (i.e., nutrients) into the same receiving environment i.e. from other fish factory farm discharges and Wastewater Treatment Works (WWTWs). The cumulative nutrient loading of the southern, sheltered portion of St Helena Bay due to long-term fish factory discharges is ongoing, and detailed in the 2023 State of St Helana Bay report. These impacts must be managed through onshore treatment across all factories as a whole, and should include the improvement of effluent quality as well as improvement of record keeping and monitoring to inform management actions and monitor success of interventions. It is strongly recommended that any effluent improvement strategy be undertaken in incremental stages, with more frequent and reliable monitoring data used to assess management outcomes of the specific intervention and inform the next stages.

Monitoring recommendations

The end of pipe concentrations published in the permit conditions must be met to ensure compliance at the edge of the RMZ. Compliance monitoring of the effluent before discharge should therefore be performed to minimise environmental impacts. If discharged effluent

exceeds the end of pipe values at any time, the operation will be in violation of the CWDP and the cause of poor effluent quality must be identified, reported and rectified immediately.

A continuous in situ monitoring program should be implemented to validate the dispersion modelling and assess compliance with WQGs. A data logging instrument capable of measuring conductivity, temperature and depth (CTD) should be moored at the 100 m RMZ for a period of at least one year. Additional quarterly monitoring should be conducted at the sites (including adequate control sites) for temperature, TSS, dissolved oxygen, salinity, ammonia and pH at the edge of the RMZ.

It is recommended that rocky intertidal and subtidal communities be monitored. Biological indicators such as species abundance, biomass and diversity provide a direct measure of the state of the ecosystem in space and time and tend to be directly affected by pollution/disturbance. It is recommended that a minimum of three sites be monitored in the vicinity of each outfall, with three control sites. Monitoring should be aligned to the State of St Helena Bay monitoring program methodology so that any changes detected can be assessed in the context of larger scale trends in the Bay.

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GLOSSARY

Amphipods: Crustaceans with no carapace and a laterally compressed body.

Anaerobic: Relating to or requiring an absence of free oxygen.

Anoxic: An absence of oxygen (<0.5 mg/L dissolved oxygen).

Anthropogenic: Environmental pollution originating from human activity

Benthic: Pertaining to the environment inhabited by organisms living on or in the ocean bottom

Biocide: A chemical substance or microorganism intended to destroy, deter, render harmless, or exert a controlling effect on any harmful organism.

Biodiversity: The variety of plant and animal life in a particular habitat.

Biological monitoring survey: A scientific study of organisms to assess the condition of an ecological resource, involving the collection and analysis of animal and/or plant samples which serve as indicators to the health/recovery of an affected system.

Biomass: The mass of living biological organisms in a given area or ecosystem.

Bioregion: A region defined by characteristics of the natural environment rather than by man-made divisions.

Biota: Living organisms within a habitat or region

Bivalves: A class of marine and freshwater molluscs that have laterally compressed bodies enclosed by a shell consisting of two hinged parts. Includes oysters, mussels, and scallops.

Chart datum: Chart Datum is level on the shore corresponding with the Lowest Astronomical Tide (LAT) as from 1 January 2003.

Construction phase: The stage of project development comprising site preparation as well as all construction activities associated with the development.

Copepod: A group of small crustaceans found in the sea and nearly every freshwater habitat. Some species are planktonic (drifting in the water column), while some are benthic (living on the ocean floor).

Crustacea/n: Generally, differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws.

Cumulative impacts: Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.

Dinoflagellate: A large and diverse group of unicellular protists, most of which are marine, and that can either be free-living in the plankton, or benthic.

Endemicity /endemism: A species unique to a defined geographic location. Organisms that are indigenous to an area are not endemic if they are found elsewhere.

Environment: The external circumstances, conditions and objects that affect the existence of an individual, organism, or group. These circumstances include biophysical, social, economic, historical, and cultural aspects.

Environmental Authorisation: Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.

Environmental Impact Assessment: A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.

Far-field: The region of the receiving water where buoyant spreading motions and passive diffusion control the trajectory and dilution of the effluent discharge plume.

Faunal community: A naturally occurring group of native animals that interact in a unique habitat.

Filter feeding: A sub-group of suspension feeding animals that feed by straining suspended matter and food particles from water, typically by passing the water over a specialized filtering structure.

Hypoxic: Very low oxygen (<2 mg/L dissolved oxygen).

Impact: A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.

Intertidal zone: The section of the marine environment that lies exposed at low tide and submerged at high tide.

Invertebrate: An animal without a backbone (e.g. a starfish, crab, or worm)

LC50 values: The lethal concentration required to kill 50% of the population.

Lowest Observed Effective Concentration: The lowest tested concentration at which the substance is observed to have a statistically significant effect on reproduction and parent mortality when compared with the control, within a stated exposure period.

Macrofauna: Animals larger than 0.5 mm.

Mitigation measures: Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage.

Mixing zone: An administrative construct which defines a limited area or volume of the receiving water where the initial dilution of a discharge is allowed to occur, until the water quality standards are met. In practice, it may occur within the near field or far field of a hydrodynamic mixing process and therefore depends on source, ambient, and regulatory constraints.

Mollusc/a: Invertebrate with a soft unsegmented body and often a shell, secreted by the mantle.

Near-field: The region of a receiving water where the initial jet characteristic of momentum flux, buoyancy flux and outfall geometry influence the jet trajectory and mixing of an effluent discharge.

Nearshore: Zone extending seawards of Chart Datum to a point where the seabed is less than 10 m depth at Chart Datum, or the distance offshore from Chart Datum is less than 500 m, whichever is greater.

No Observed Effect Concentration: The concentration in an environmental compartment (water, soil, etc.) which below an unacceptable effect is unlikely to be observed. It is typically obtained from chronic aquatic toxicity studies.

Offshore: The area seaward of the nearshore environment boundary.

Operational phase: The stage of the works following the Construction Phase, during which the development will function or be used as anticipated in the Environmental Authorisation.

Pelagic: Within the water column.

Phytoplankton: Ocean dwelling microalgae that contain chlorophyll and require sunlight in order to live and **grow.**

Polychaete/a: Segmented worms with many bristles (i.e. bristle worms).

Primary production: The process of assimilation and fixation of inorganic carbon and other inorganic nutrients into organic matter by autotrophs such as phytoplankton.

PSU: Ocean salinity is generally defined as the salt concentration in sea water. It is measured in unit of PSU (Practical Salinity Unit), which is a unit based on the properties of sea water conductivity. It is equivalent to per thousand or (o/00) or to g/kg.

Recommended Mixing Zone (RMZ): An administrative construct which defines a limited area or volume of the receiving water where the initial dilution of a discharge is allowed to occur, until the water quality standards are met. In practice, it may occur within the near field or far field of a hydrodynamic mixing process and therefore depends on source, ambient, and regulatory constraints. The following recommendations have been tabled for South Africa (Anchor Environmental Consultants 2015): 300 m in an offshore environment, 100 m in a nearshore open coast environment, 30 m in sheltered coastal environments and special management areas, 0 m for outfalls in established or proposed MPAs, the surf zone and estuaries

Semi-diurnal tides: When there are two high tides and two low tides within a day that are about the same height,

Species: A category of biological classification ranking immediately below the genus, grouping related organisms. A species is identified by a two part name; the name of the genus followed by a Latin or Latinised un-capitalised noun.

Species richness: The number of different species represented in an ecological community. It is simply a count of species and does not take into account the abundance of species.

Stratification: The separation of water in layers based on a specific quantity, such as temperature or salinity.

Subtidal: The marine habitat that lies below the level of mean low water for spring tides.

Thermocline: An abrupt temperature gradient in a body of water such as the ocean, marked by a layer above and below which the water is at different temperatures.

Total Residual Chlorine: The sum of free chlorine and combined chlorine.

Total Suspended Solids: A measure of the mass per unit volume of TSS in the water column.

Turbidity: A measure of light conditions in the water column.

Uniform Effluent Standard (UES) approach: Fixed maximum concentrations or loads are applicable for contaminants in wastewater discharges for all users or outfalls, irrespective of where they are located.

Upwelling: An oceanographic phenomenon that involves wind-driven motion of dense, cooler, and usually nutrient-rich water from deep water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water.

Upwelling cells: Areas of intense upwelling.

Water Quality Guidelines: Target values for a range of contaminants that must be met in the receiving environment.

Water quality-based effluent limits approach: Site-specific effluent limits that are calculated based on the Water Quality Guidelines (or standards) of a given water body, the effluent volume and concentration, as well as the site-specific assimilative capacity of the receiving environment.

Wind forcing: The movement of surface waters and the resulting transfer of energy to deeper waters by the predominant wind (i.e. a strong easterly wind will result in an eastward flowing surface current).

ABBREVIATIONS AND ACRONYMS

Anchor	Anchor Environmental Consultants (Pty) Ltd
CSIR	Council for Scientific and Industrial Research
CTD	Conductivity, temperature, depth
CWDP	Coastal Water Discharge Permit
DO	Dissolved Oxygen
EA	Environmental Authorisation
ICMA	Integrated Coastal Management Act (No. 24 of 2008) as amended
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (No. 107 of 1998) as amended)
NH_3	Ammonia
NH_4^+	Ammonium ion. A positively charged polyatomic ion. It is formed by the protonation of ammonia
NWA	National Water Act (No. 36 of 1998)
PSU	Practical Salinity Unit
RMZ	Recommended Mixing Zone
RO	Reverse Osmosis
RWQ	Receiving Water Quality
TOC	Total Organic Carbon
TON	Total Organic Nitrogen
TSS	Total Suspended Solids
UES	Uniform Effluent Standard
WQBEL	Water quality-based effluent limits
WQG	Water Quality Guidelines
WWTW	Wastewater Treatment Works
MP	Wate Management Plan

1 INTRODUCTION

1.1 BACKGROUND

PHS Consulting are the lead Environmental Assessment Practitioners (EAP) for a Part 2 Amendment Application on behalf of West Point Fish Meal Processing Plant on ERF 1097, St Helena Bay (Figure 1.1). This Part 2 Amendment Application is motivated by:

- The need to increase the number of reservoirs on site used to store municipal water to better mitigate and manage demand.
- The need to introduce cold storage facilities on site to maintain the cold chain because of the inclusion of additional fish material (off-cuts and trimmings) from white fish (demersal fish) processing facilities (frozen or fresh) into the existing process facility (as per the Part 1 Amendment Application dated 8 July 2025).
- To combine the two Discharge Pipelines (Outfall A & B) into one outfall (Outfall B only).



Figure 1.1. West Point Processors fish factory plant location within St Helena Bay (Google Earth, 2021).

Anchor Environmental Consultants (Pty) Ltd (Anchor) has undertaken a number of studies for the various Environmental Authorisation (EA) and EA amendment applications, including proposed expansion activities and the inclusion of a reverse osmosis (RO) desalination plant (Wright et al. 2021, 2023, Wright & Hutchings 2022, Wright 2023). In line with permitting requirements, these previous assessments have included dispersion modelling studies to assess potential for dilution and dispersion of the effluent from the fish processing plant, as well as marine specialist assessments on likely impacts on the marine environment.

1.2 TERMS OF REFERENCE

The Terms of Reference for this study include the following:

- Provide an updated description of the affected environment to contextualise the proposed development and potential impacts;
- Provide a summary of the relevant existing near field dispersion models to demonstrate rates of initial dilution of updated effluent profile in the receiving environment;
- Using the outputs from the model and available information on the nature of the marine environment at the discharge site, provide a description and assessment of all potential impacts associated with the intake of water from and discharge of desalination effluent to the marine environment in St Helena Bay;
- Provide recommendations on measures to be adopted/implemented that will mitigate negative impacts on the ecology and other beneficial uses of the environment; and,
- Provide recommendations on minimum monitoring requirements based on the assessed impacts of the discharge on the marine environment.

1.3 ASSUMPTIONS AND LIMITATIONS

- The effluent profiles previously modelled for both Outfall A and Outfall B options and the combined option (volume, salinity, temperature *inter alia* as well as the outfall design) in 2023 (Wright 2023, Wright et al. 2023) to inform the update of this study remain the same.
- This study is based on details provided by the client as they pertain to planned infrastructure design and, effluent profile sites etc.
- The accuracy and confidence of this study is dependent on the data available for the marine and coastal environments of the west coast and St Helena Bay.
- This assessment is entirely desktop-based, and no new in situ data was made available for this assessment.

2 DESCRIPTION OF RECEIVING ENVIRONMENT

2.1 SPATIAL CONTEXT

St Helena Bay is situated on the west coast of South Africa and extends from Dwarskersbos in the north, past the Shelley Point peninsula, to Cape St Martin in the west. The area encompasses 18 smaller bays, including Britannia Bay, Stompneus Bay, Sandy Bay and West Point (Figure 2.1). St Helena Bay and the Berg River Estuary provide a large proportion of the sheltered habitat along the otherwise very exposed west coast of South Africa. There are only four other large estuarine systems which provide sheltered habitat for birds along the West Coast — the Orange, Olifants and Diep River estuaries and Langebaan Lagoon. While South Africa's coastline has numerous estuaries (about 290), the west coast has few very large sheltered coastal habitats.

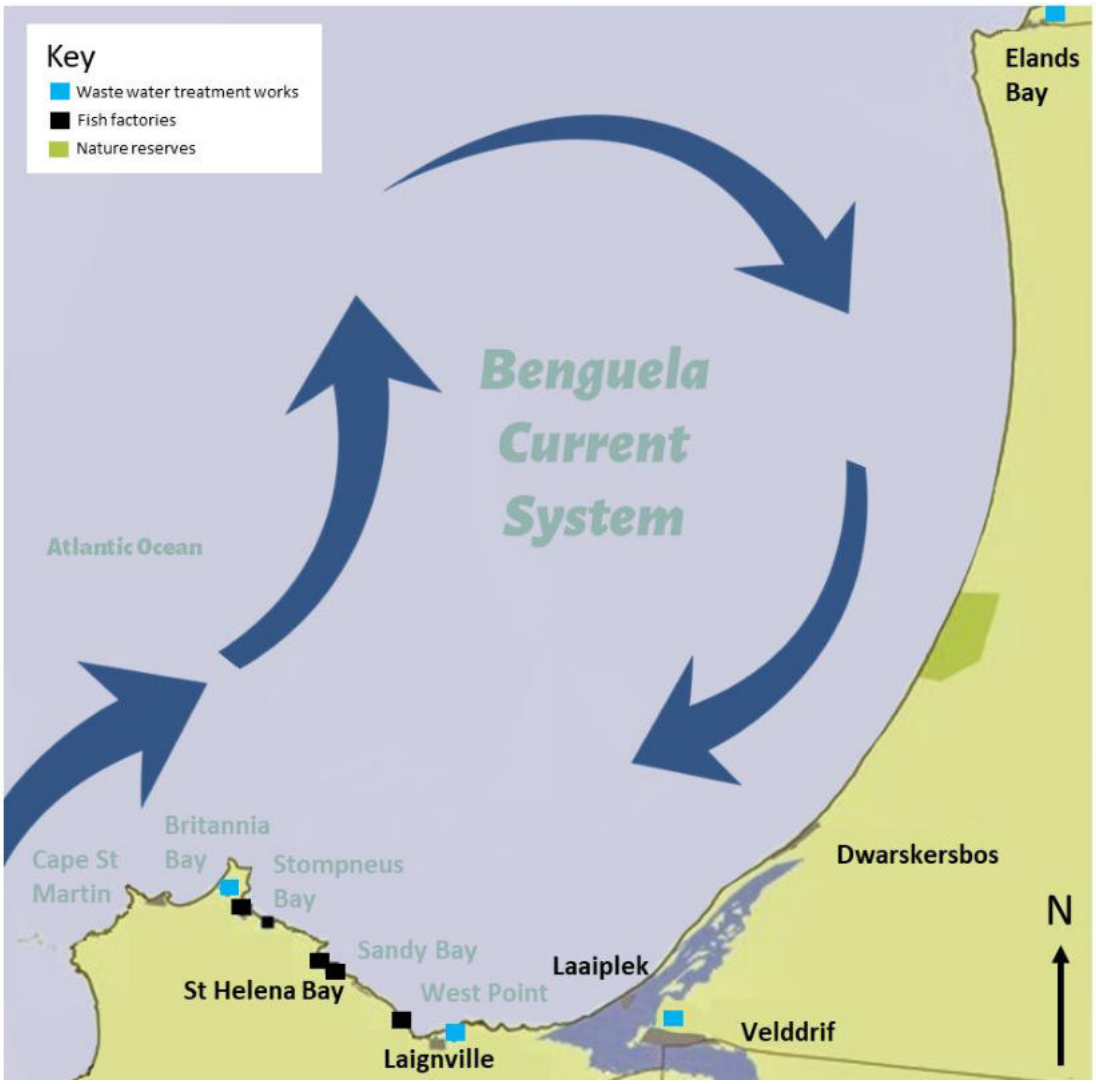


Figure 2.1. Regional map of St Helena Bay and current movement within the system. The Berg River Estuary mouth meets the sea at Laaiplek (Clark et al. 2023).

2.2 OCEANOGRAPHY

The Benguela system dominates the oceanography of South Africa's Western Cape coast with the system influenced predominantly by the wind-driven upwelling of deep nutrient rich water close to the coast (Figure 2.2). Wind is the primary driver of life in the system, strongly influencing both water temperature and inorganic nutrient levels, and in turn, primary production. The prevailing south-easterly winds displace surface water offshore during the summer, and cause cold, nutrient rich water to rise from deeper water masses to replace this surface water. These upwelling events are the trigger for minimum temperatures and maximum nutrient levels (Branch & Griffiths 1988, Branch & Branch 2018). The area of interest in this study falls to the north of the Namaqua upwelling cell (Shannon & Nelson 1996). Projected climate change impacts on the southern Benguela system for the end of the 21st century (based on the RCP8.5 emissions scenario) predict a strengthening of coastal parallel wind speeds over the ocean, which results in increased upwelling and corresponding decrease in water temperatures (as cooler water is brough to the surface) (Lima et al. 2019).

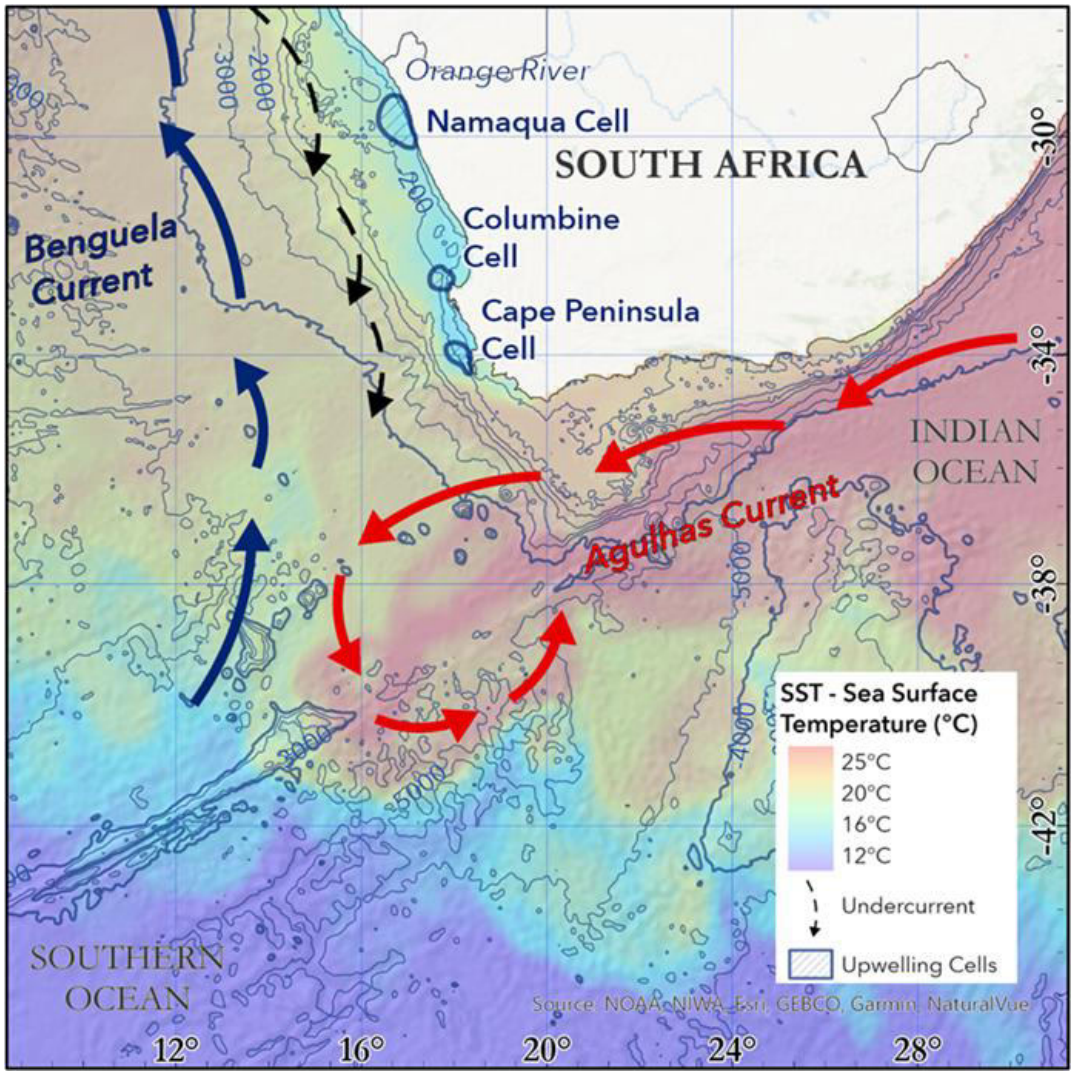


Figure 2.2. Major current streams around South Africa. The warm Agulhas Current flows down the east coast, and cold upwelling cells can be observed along the west coast, inshore of the north-flowing Benguela Current.

The oceanic primary producers, phytoplankton, bloom when upwelled inorganic nutrients become available for photosynthesis in the presence of sunlight. These are consumed by zooplankton, which are in turn consumed by small pelagic fish species, such as anchovy and sardine. The Benguela is one of the world's most productive systems, supporting rich fishing grounds and attracting large colonies of sea birds and seals (Branch & Branch 1981).

More locally, the study site is subject to semi-diurnal tides, with each successive high (and low) tide separated by 12 hours. Each high tide occurs approximately 25 minutes later every day, which is due to the 28-day rotational cycle of the moon around the earth. Spring tides occur once a fortnight during full and new moons. Tidal activity greatly influences the biological cycles (feeding, breeding and movement) of intertidal marine organisms, and influences when people visit the coastline to partake in various activities (e.g., relax, bathe, harvest marine resources).

2.3 WATER QUALITY

On the West Coast, warm oceanic water is typically more saline and nutrient-deficient than cool upwelled water that usually occurs below the thermocline (a clear boundary layer separating warm and cool water). During summer months, when wind driven coastal upwelling within the Benguela region brings cooler South Atlantic central water to the surface, salinities are usually lower than during the winter months, when the upwelling front breaks down and South Atlantic surface waters move against the coast. Under summer conditions, when the water column is stratified, surface salinities may be slightly elevated due to evaporation (Clark et al. 2023). Salinity values for inshore water along the West Coast typically vary between 34.6 and 34.9 (Hutchings et al. 2009). Transect studies at Elands Bay show that mean monthly salinities are higher in the surface layers at offshore stations during spring and summer, while salinities during autumn and winter were slightly lower (Lamont et al. 2015) (Figure 2.3). At nearshore stations, a contrasting pattern emerged, with higher salinities in autumn and winter, with lower values during spring and summer (Lamont et al. 2015).

As with the salinity data, surface temperatures in the St Helena Bay system (transect line shown in Figure 2.3), tend to be lower during spring and summer in the nearshore, and higher in autumn and winter (Lamont et al. 2015). Generally, rising temperatures are associated with southward currents and decreasing temperatures with northward currents (Fawcett et al. 2008). There are large temperature variations in the surface waters of the area, ranging between 9.71-21.3°C, while the temperatures range between 6.32°C-13.18°C in the bottom waters (Lamont et al. 2015).

Within-month Sea Surface Temperature variability is small in winter, but increases during the upwelling season in summer as a response to repeated shifts between upwelling events and periods of relaxation (Demarcq et al. 2003, Lamont et al. 2015). A thermocline is often present in the nearshore area in summer at 15-25 m (Hutchings et al. 1991, Wright et al. 2021). Water column stratification is particularly prevalent in the late upwelling season. This stratification may persist for several days, interspersed with periods where the water column is cool and well mixed. During winter conditions, the water column is well mixed, and temperatures are significantly less variable (Fawcett et al. 2008, Lamont et al. 2015).

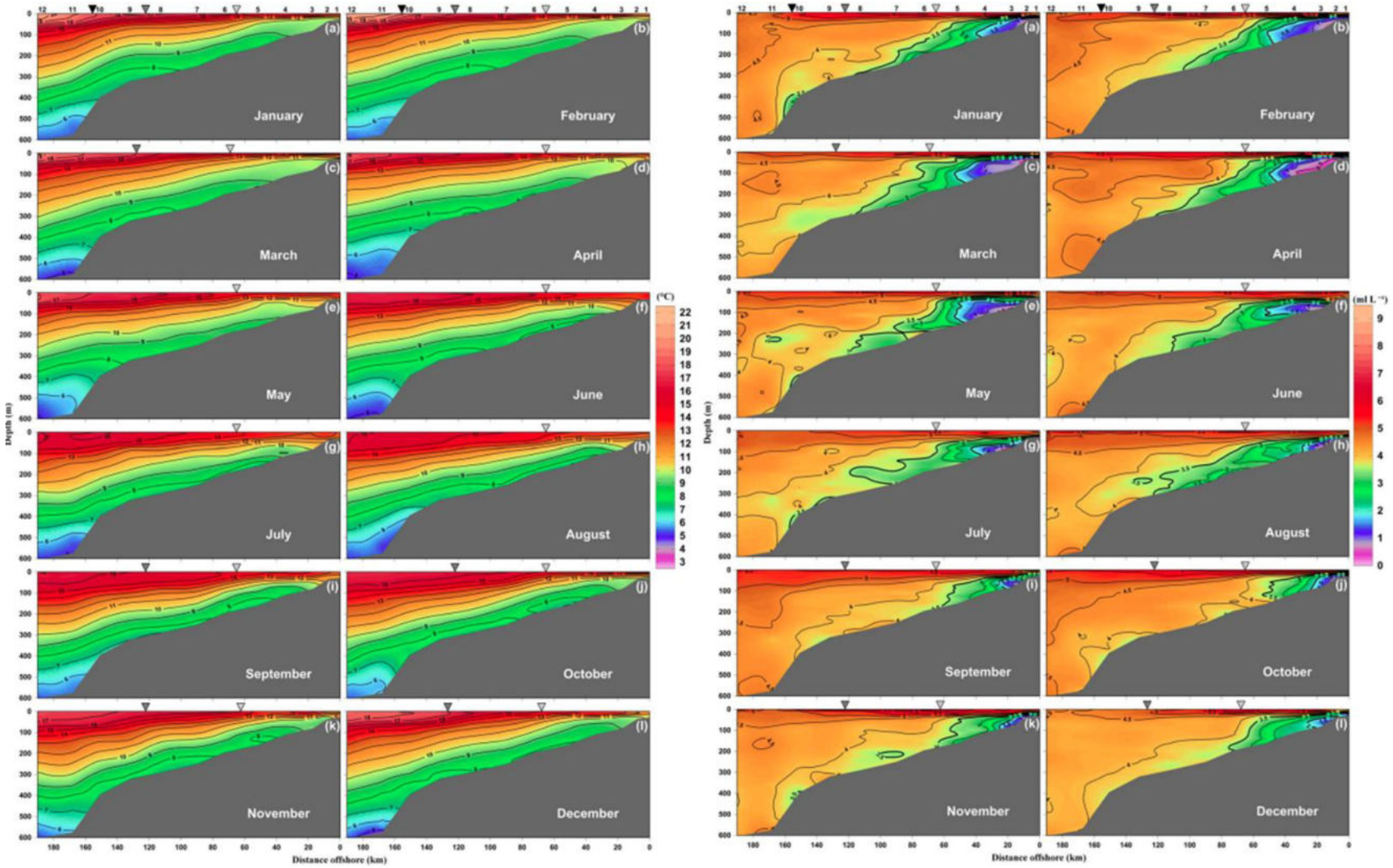


Figure 2.3. (Left) Vertical distribution of conservative temperature (°C) and (right) dissolved oxygen (mL/Ll) measured monthly along the St Helana transect (Lamont et al. 2015).

Dissolved oxygen (DO) is an essential requirement for most heterotrophic marine life. Its natural levels in seawater are largely governed by local temperature and salinity regimes, as well as organic content. Coastal upwelling regions are frequently exposed to hypoxic conditions (i.e., DO levels of <2 ml O_2/l) owing to extremely high primary production (e.g., phytoplankton blooms and red tides) and subsequent oxidative degeneration of organic matter. Further anaerobic degradation of organic matter by sulphate-reducing bacteria may additionally result in the production of hydrogen sulphide, which is detrimental to marine organisms (Brüchert et al. 2003). Along the southern African west coast, low-oxygen waters are a feature of the Benguela system. Two local zones for formation of oxygen-deficient water along the west coast have been identified — one in the vicinity of the Orange River mouth and the other in St Helena Bay (Pitcher & Probyn 2017, Pitcher et al. 2022, Carlson et al. 2025). This persistent "seasonal hypoxia" (Kemp et al. 2009) is considered a consequence of local drawdown, where oxygen depletion is confined to the bottom layer of the water column (Pitcher & Probyn 2017, Pitcher et al. 2022, Carlson et al. 2025). This is driven by strong stratification of the water column in summer that impedes the downward mixing of oxygen from the surface layers, in addition to high upwelling driven algal production in surface waters, and settlement of that algal production to the benthos as organic matter (Pitcher & Probyn 2017, Pitcher et al. 2022, Carlson et al. 2025).

This results in harmful algal blooms (HABs) and episodes of oxygen depletion in the shallow nearshore waters ("episodic anoxia") (Kemp et al. 2009). This episodic anoxia follows the decay of high biomass dinoflagellate blooms and leading to major mortality events for organisms such as rock lobsters and fish (Pitcher & Probyn 2017, Carlson et al. 2025). Periods of stratification and poleward advection of warm water, especially following wind relaxation, create favourable conditions for HABs (Fawcett et al. 2008). These algal blooms have significant and wide-ranging impacts on the marine ecosystem, causing large-scale fish and shellfish kills, either through direct toxicity, oxygen depletion (hypoxia), or the production of harmful compounds like reactive oxygen species. Such events can alter community structure, reduce species richness, and disrupt the balance of marine ecosystems (Pitcher & Louw 2021).

Many fish and marine organisms can detect, and actively avoid hypoxia (e.g., rock lobster 'walk-outs') and the stranding and mortality of marine biota have been documented in St Helena Bay at least once or twice per decade since the 1960s (Cockcroft & Van Zyl 2018) (Figure 2.4). There has been a notable increase in the number and severity of low oxygen induced events in the 1990s (five recorded), three over 2000-2010 and three post 2010 (March 2012, an extended event during February-March 2015, and March 2022) (Cockcroft & Van Zyl 2018). While St Helena Bay is host to seasonal hypoxia events, and rare anoxia events, these are not persistent, and should not be considered the "norm" for the system, because the bay still supports abundant and diverse benthic and pelagic marine life.

Sustained, localised hypoxic (<2 mg/L DO) and anoxic (<0.5 mg/L DO) conditions have been recorded around the fish factory outfalls in St Helena Bay, including at the West Point outfalls. At this site, Lwandle (2018) reported that the water column was hypoxic 300 m from the outfall, with almost all these sites were anoxic below 2 m depth (Table 2-1). The lowest DO values reached 0.02 mg/L at sites ~100 m to the southwest of the discharge (Lwandle 2018). In general, DO levels increased further away from the outfall, but at almost all sites, even those ~1.5 km from the outfall, DO levels were lower than the

"ambient" control site situated ~5 km away (Table 2-1). Indeed, of the 30 sites measured (including those 1.5 km away), 93% were lower than the "ambient" control site (Lwandle 2018).



Figure 2.4. Mortality of bivalves, rock lobster and fish associated with a low oxygen event in St Helena Bay (near Dwarskersbos) in 2015. Photo credit: S.J. Lamberth.

Table 2-1. Mean dissolved oxygen levels, temperatures and turbidity values measured through the water column for sites at varying distances from the WestPoint outfalls (distances are approximate) as measured in June 2018. Values within the "mixing zone" are shown in blue (adapted from Lwandle 2018).

Site	Approximate distance from outfall (m)	Dissolved Oxygen (mg/L)	Temperature (°C)	Turbidity (NTU)
3	100	0.22	15.31	70.15
4	100	0.02	15.02	21.34
5	150	0.02	15.00	19.72
10	150	0.76	15.02	11.88
1	250	1.82	15.04	7.42
2	250	1.30	15.11	8.85
6	250	0.04	15.09	18.62
7	250	0.39	15.05	14.81
13	250	4.33	15.16	5.04
20	500	2.84	15.05	9.92
19	900	2.65	15.07	9.37
27	1 000	3.24	14.89	9.88
28	1 000	2.77	14.81	15.53
26	1 300	3.35	14.93	10.48

Site	Approximate distance from outfall (m)	Dissolved Oxygen (mg/L)	Temperature (°C)	Turbidity (NTU)
29	1 300	2.66	14.84	16.15
25	1 500	3.91	14.97	5.98
30	1 500	2.60	14.84	34.82
Ambient	5 000	3.58	14.84	3.13

2.4 SEDIMENT QUALITY

Sediment quality is a measure of the extent to which the nature of benthic sediments (particle size composition, organic content and contaminant concentrations) has been altered from its natural state. This is important as it influences the types and numbers of organisms inhabiting the sediments and is, in turn, strongly affected by the extent of water movement (wave action and current speeds), mechanical disturbance (e.g. dredging) and quality of the overlying water. Sediment parameters respond quickly to changes in the environment but are able to integrate changes over short periods of time (weeks to months) and are thus good indicators or short to very short-term changes in environmental health.

The particle size composition of the sediments is strongly influenced by wave energy and circulation patterns in the Bay. Coarser or heavier sand and gravel particles are typically found in areas with high wave energy and strong currents as the movement of water in these areas suspends fine particles (mud and silt) and flushes them out of these areas. Disturbances to wave action and current patterns, which reduce the movement of water, can result in the deposition of mud in areas where sediments were previously much coarser. The quantity and distribution of different sediment grain particle sizes (gravel, sand and mud) influences biological communities and the extent of contaminant loading that may occur.

Contaminants such as metals and organic toxic pollutants are predominantly associated with fine sediment particles (mud and silt). This is partially because fine grained particles have a relatively larger surface area for pollutants to adsorb and bind to and may be indicative of the presence of clay minerals which have naturally higher trace metal concentrations. Higher proportions of mud, relative to sand or gravel, can thus lead to high organic loading and trace metal contamination. Disturbance to the sediment (e.g. dredging) can lead to re-suspension of the mud component from underlying sediments, along with the associated organic pollutants and metals. It may take several months or years following a dredging event before the mud component that has settled on surface layers is scoured out of the Bay by prevailing wave and tidal action.

Historical grain size data shows substantial fluctuations in sediment compositions, linked to varying sediment inputs and mobilisation due to riverine inflows and storm/ weather events. These changes are covered extensively in other reports (Biccard et al. 2020b, Clark et al. 2023). During a 2020 survey for example, the mud component at many sites was notably reduced when compared to 2018. Surveys in both 2020 and 2023 showed that most sites were composed predominantly of sand, with the greatest number of sites falling within the “muddy sand” category, although mud does form the dominant constituent of some samples (Biccard et al. 2020b, Clark et al. 2023). The highest proportion of mud is located in the vicinity of the St Helena Bay Wastewater Treatment Works (WWTW) and St Helena Bay Harbour in the vicinity of two fish processing factories

(Figure 2.5). The elevated proportions of mud in these areas likely occurs as result of inputs of fine particulate matter from the WWTW and these fish factories, coupled with natural seabed topography and/or fine circulation patterns promoting accumulation at these points (Biccard et al. 2020b, Clark et al. 2023).

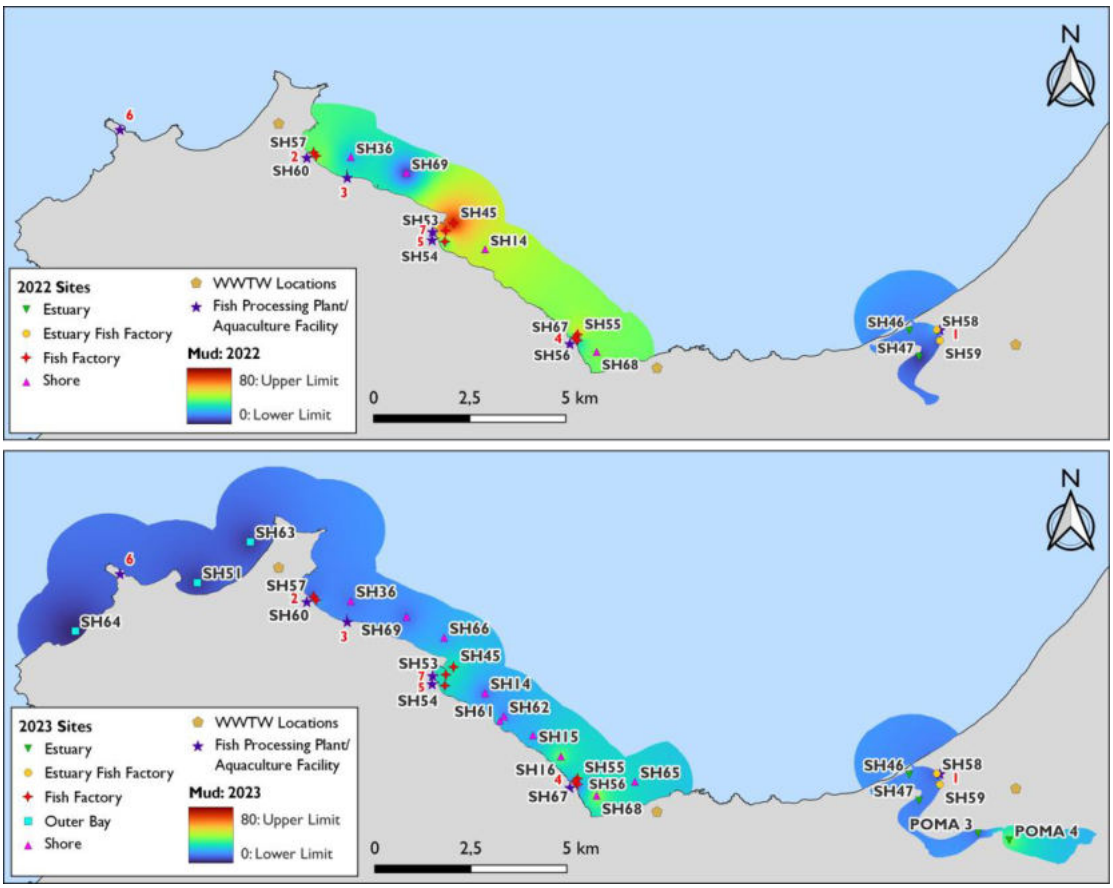


Figure 2.5. Spatial interpolation of the mud fraction recorded at each of the St Helena Bay monitoring sites sampled in 2022 and 2023. Red colours = higher mud fraction while green and blue colours = lower (Clark et al. 2023).

The dominant sources of organic matter in St Helena Bay includes natural sources such as phytoplankton production at sea and associated detritus, terrestrial nutrients carried by the Berg River and anthropogenic sources (such as fish factory waste discharged into the Bay, and the leaking of sewage from septic tanks and conservancy tanks). Measures of nutrient input, namely Total Organic Carbon (TOC) and Total Organic Nitrogen (TON), showed similar distribution and accumulation trends as sediment particle size. These organic components have typically been typically elevated in the vicinity of the St Helena Bay harbour FFPs, indicating a high output from these processing plants and retention within the harbour. While it is noted that the overall concentrations of TOC (and to a lesser extent, TON) saw notable decreases from 2020 to 2022, both TOC and TON were again found to be higher at sites sampled close to the fish factories compared to other areas in the Bay and estuary (Clark et al. 2023). The increases in average nutrients near the fish factories indicate that much of these nutrients accumulated relatively recently before the sampling event (in the period following the flushing events which likely flushed much of the fine material and organics from the bay). This, therefore, may indicate that

the rate of nutrient enrichment (both artificial and natural) may be higher than what the results at first indicate (Clark et al. 2023).

2.5 REGIONAL BIOGEOGRAPHY

Most of marine biogeographic 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. Therefore, according to new nomenclature, St Helena Bay is positioned in the Southern Benguela ecoregion (Sink et al. 2012) (Figure 2.6).

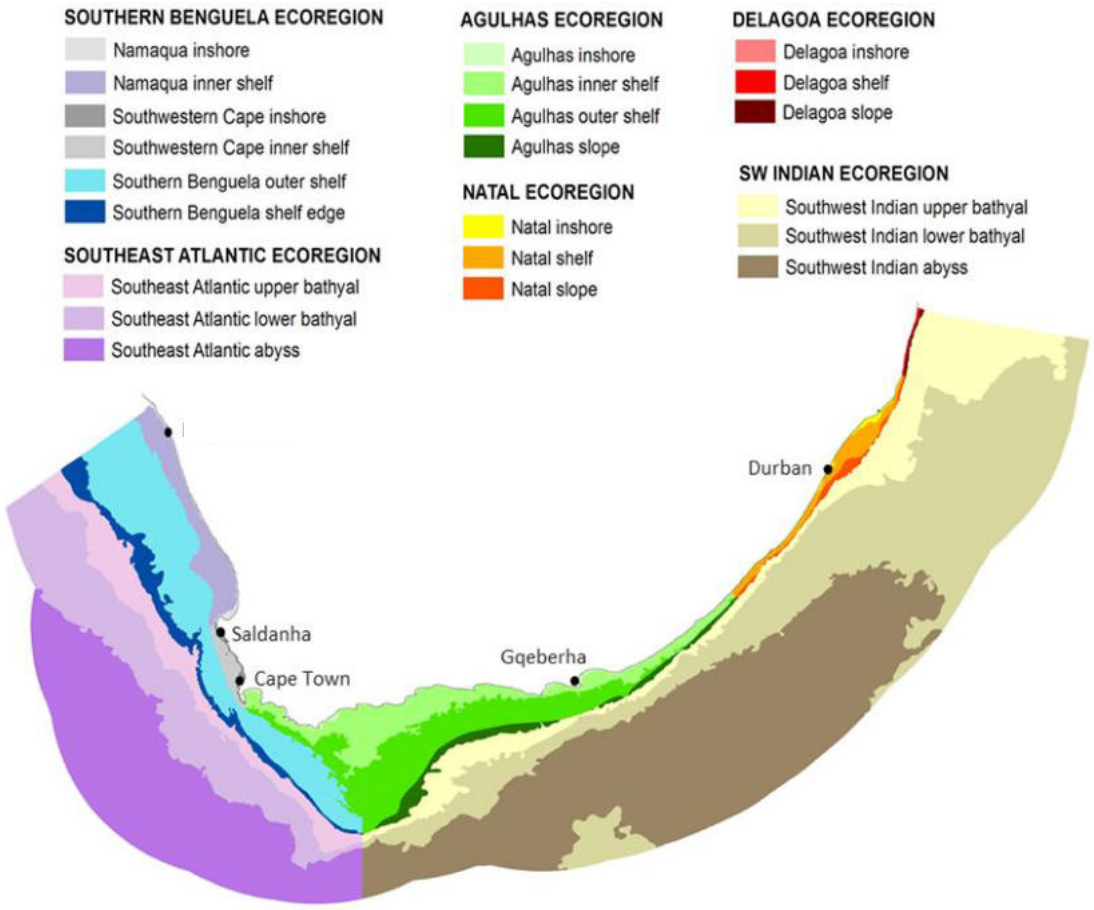


Figure 2.6. Six marine ecoregions with 22 ecozones incorporating biogeographic and depth divisions in the South African marine environment as defined by (Sink et al. 2012).

2.6 HABITATS AND ECOSYSTEM TYPES

2.6.1 OVERVIEW

Wind-driven coastal upwelling is the predominant physical driver that shapes the high levels of biological productivity in the southern Benguela, providing nutrients for primary producers, and food for diverse fauna, such as pelagic (pilchards, anchovy) and demersal (hakes, kingklip) fish stocks, near shore fisheries (linefish, rock lobster), mammals (seals and whales) and seabirds (penguins, gannets, cormorants etc.).

There are three broad marine habitats around the area of interest, and these include sand and rocky shores, kelp forest and the water column or pelagic habitat. Much of the coastal area around the WPP area is sandy shores (e.g. Southern Benguela Intermediate or Reflective Sandy Shore), or rocky shores (Cape Sheltered Rocky Shore), with kelp forests in the nearshore (Figure 2.7).



Figure 2.7. Ecosystem types for the St Helena Bay area and surrounds (data from NBA 2018).

Table 2-2. Major ecosystem types of the area of interest. A description of each ecosystem type is also provided, along with the Protection Level for each type (Sink et al. 2025).

Ecosystem type	Description	Protection Level
Cape Kelp Forest	Kelp forest in the Cape ecoregion as mapped from Sentinel 2 satellite imagery. Extends from Cape Point to south of Doringbaai. Total national area of 9.78 km^2. Vulnerable habitat type.	Poorly Protected
Cape Mixed Shore	A shore with both rocky and sandy habitat in the Cape subregion of the Southern Benguela ecoregion. Total national area of 33.73 km^2. Endangered habitat type.	Poorly Protected
Cape Sheltered Rocky Shore	Rocky shore exposed to low wave intensity in the Cape subregion of the Southern Benguela ecoregion. Total national area of 1.48 km^2. Endangered habitat type.	Poorly Protected
Southern Benguela Intermediate Sandy Shore	Beach with medium grain size and moderate slope in the in the Southern Benguela ecoregion. Often with cusps on the shore and sandbars and rips in the surf. Total national area of 32.34 km^2. Near Threatened habitat type.	Poorly Protected
Southern Benguela Reflective Sandy Shore	Steep sloped, coarse-grained sandy shore with a narrow surf zone within the Southern Benguela ecoregion. Total national area of 10.54 km^2. Endangered habitat type.	Poorly Protected
St. Helena Bay	St Helena Bay in the Cape ecoregion, extending from the back of the surf zone to outer edge of embayment (approximately -50 m). This bay is characterised by lower oxygen than other bays. Total national area of 980.82 km^2. Endangered habitat type.	Not Protected

The communities within these habitats are generally ubiquitous throughout the southern African West Coast region. They consist of many hundreds of species, often displaying considerable temporal and spatial variability. The biological communities 'typical' of each of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species.

2.6.1 SUBTIDAL SANDY BENTHIC HABITAT

Fauna and flora that inhabit the surfaces of subtidal sand are called benthic epifauna, while those that burrow or dig into the soft sediments are called benthic infauna (Castro & Huber 1997). The distribution of infauna and the depth at which organisms can live in the substrate is largely dependent on sediment particle size. More porous, larger grained substrates allow for greater water circulation through the sediment, thereby replenishing the oxygen that is used up during the decomposition processes. Much of the benthic infauna on the west coast of South Africa are deposit feeders (e.g. worms), which either ingest sediments and extract organic matter trapped between the grains, or actively collect organic matter and detritus (Castro & Huber 1997). Suspension feeders eat drifting detritus and plankton from the water column (e.g. seapens and some species of crabs), while filter feeders actively pump and filter water to extract suspended particles (e.g. bivalves and some species of amphipods and polychaetes). Predators in soft bottom habitats either burrow through sediments or catch their prey on the surface (Castro & Huber 1997). Most bottom-dwelling fish in soft bottom habitats are predators that scoop up prey (e.g. rays and skates), while flat fish (e.g. monk fish and sole) lie camouflaged on the bottom. Predators such as crabs, hermit crabs, lobsters and

octopuses, which inhabit rocky areas, may move to sandy benthos to feed (Castro & Huber 1997). Similarly, reef-associated fish also rely on sandy substrate for food.

Benthic monitoring surveys in St Helena Bay have revealed that macrofaunal communities are mostly dominated by predatory and detritivorous polychaetes and filter feeding bivalves (Figure 2.8). The presence of Malacostraca (mostly composed of amphipods and isopods) across the bay and the seapen *Virgularia schultzei* at the outer bay sites, suggests that the Bay as a whole has a fairly low level of contamination as these taxa do not tolerate pollutants well (Clark et al. 2023). Furthermore, the persistence of filter feeders in the Bay suggests that sediment and benthic macrofaunal communities in the broader Bay have remained stable and in a fairly good state of health.

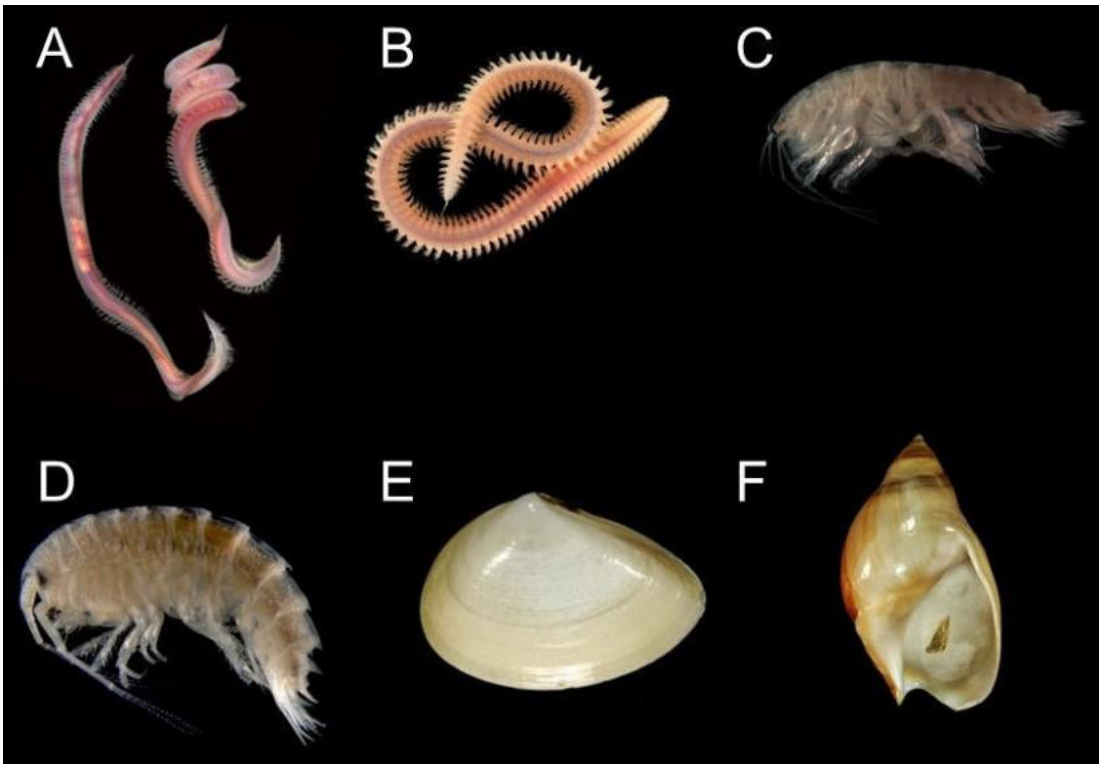


Figure 2.8. Selection of subtidal macrofauna species collected the general area of interest. A) glycerine worm *Glycera tridactyla* (Paul Sterry, Nature Photographers), B) polychaete *Nephtys hombergii* (Fredrik Pleijel), C) amphipod *Ampelisca brevicornis* (Hans Hillewaert), D) amphipod *Nototropis guttatus* (Hans Hillewaert), E) trilateral tellin *Homalina trilatera* (Joop Trausel & Frans Slieker), F) fat plough shell *Bullia laevissima* (Joop Trausel & Frans Slieker).

However, at most sampling sites located in close proximity to fish factories, reduced indices of benthic macrofaunal diversity, particularly abundance and biomass, were noted (Clark et al. 2023) (Figure 2.9). This is attributable to the poor sediment quality in the area surrounding the fish factories, where high organic loading from fish processing factory effluent has resulted in localised eutrophication of the benthos, and a toxic low-oxygen environment. In order to ensure continued improvement in the health of the marine environment, it is recommended that every effort is made to improve compliance with the effluent quality limits as specified in CWDPs and that other mitigation is implemented as required to achieve compliance with the revised marine environmental water quality standards. Clark et al. (2023) do note that the results of the study indicate

that mitigation measures implemented by one of the small pelagic processing factories to improve their waste-water effluent quality has improved the health of the benthos in at least one part of the Bay.

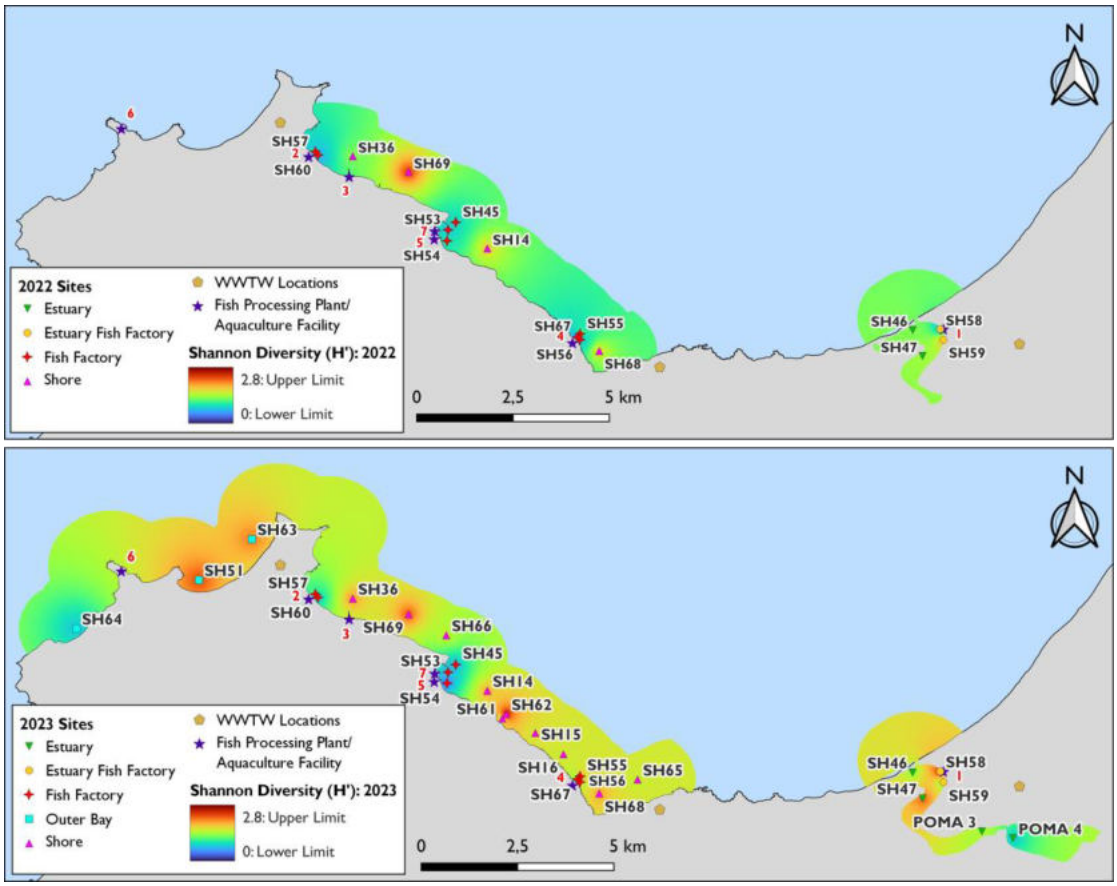


Figure 2.9. Variation in the diversity of the benthic macrofauna in St Helena Bay as indicated by the 2020 survey results (H' = 0 indicates low diversity, H' = 2.27 indicates high diversity) (Clark et al. 2023).

2.6.2 INTERTIDAL SANDY HABITATS

The West Coast from St Helena Bay to the mouth of the Olifants River is predominantly sandy (Bally 1987). In the study area of interest, there small shallow bays with coarse, reflective sandy beach shores, interspersed with rocky shore headlands and sub tidal reefs. The benthic biota of soft bottom substrates constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into megafauna (animals >10 mm), macrofauna (>1 mm) and meiofauna (<1 mm). The macrofauna beach species recorded from the Lamberts Bay area are ubiquitous throughout the biogeographic province, and no rare or endangered species are known (Bally 1987). Therefore, the general scheme proposed by Branch & Griffiths (1988) is used below, supplemented by data from various publications on West Coast sandy beach biota (Bally 1987, Brown et al. 1989, Soares et al. 1996, 1997, Nel 2001, Soares 2003, Branch 2005).

Sandy beaches are one of the most dynamic coastal environments. The composition of their faunal communities is largely dependent on the interaction of wave energy, beach

slope and sand particle size, referred to as beach morphodynamics. The supralittoral zone is situated above the high-water spring tide level and receives water input only from large waves at spring high tides or through sea spray. This zone is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, often associated with and feeding on kelp deposited near or on the drift line. On the West Coast, terrestrial species of the supralittoral include a diverse array of beetles and arachnids and some oligochaetes, while semi-terrestrial fauna include the isopod *Tylos granulatus*, and amphipods of the genus *Talorchestia*. The intertidal zone, also termed the mid-littoral zone, has a vertical range of about 2 m, and on the West Coast is characterised by the cirolanid isopods *Excirolana latipes*, *Eurydice kensleyi*, and *Excirolana natalensis*, the polychaetes *Scolelepis (Scolelepis) squamata*, *Orbinia angrapequensis*, *Nepthys hombergii* and *Scoletoma tetraura*, and amphipods of the families Haustoridae and Phoxocephalidae. In some areas, juvenile and adult white mussels *Donax serra* may also be present in considerable numbers. For example, standing stocks of *D. serra* of 76 and 218 g/m^2 were recorded for intertidal beaches at Rocherpan (~60 km south of Lamberts Bay) and Strandfontein (~50 km north of Lamberts Bay) respectively (Soares et al. 1997). Predators in soft bottom habitats may burrow through sediments to get to their prey or catch it on the surface (Castro & Huber 1997). Predators such as crabs, hermit crabs, lobsters and octopuses, which inhabit rocky areas, may move to sandy benthos to feed (Castro & Huber 1997). Most bottom-dwelling fish in soft bottom habitats are predators. Rays and skates scoop up clams, crabs and other infauna and epifauna, while flat fishes, such as flounders and soles, lie camouflaged or covered on the bottom and forage for a wide variety of prey.

2.6.3 INTERTIDAL ROCKY HABITATS

Rocky shore communities are ubiquitous within a biogeographical zone and tend to vary in response to wave exposure (Stephenson & Stephenson 1972). Typically, the intertidal area of rocky shores can be divided into different zones according to height on the shore. Each zone is distinguishable by its different biological communities, which is largely a result of the different exposure times to air. Roughly, the shore can be divided into a high, mid and low-shore zone. Besides the varying levels of air exposure, the degree of wave force reaching the shore is the most influential factor controlling the structure of rocky intertidal communities (McQuaid et al. 1985, Little et al. 2009). This effect of wave action is particularly important on the low shore. Generally, biomass is greater on exposed shores, which are dominated by filter-feeders. Sheltered shores support lower biomass, and algae form a large portion of this biomass (McQuaid & Branch 1984, McQuaid et al. 1985).

The typical high shore of the Cape Rocky Shore habitat type is usually dominated by few, small, desiccation resistant species of fauna and little to no algae species. Much of this high shore area is barren rock, with biotic cover was dominated by the southern periwinkle *Afrolittorina knysnaensis*. Other high shore species included *Burnupena papyracea*, *Scutellastra granularis* and/or diatoms. The mid shore is typically also dominated by barren rock but is also host to filter feeding species such as the *Mytilus galloprovincialis* and a range of seawards, including corticated (folious) seaweeds and ephemerals (fast growing and recruiting seaweed species) such as *Ulva* spp. and *Porphyra capensis*. The low shore tends to be dominated by encrusting algae and corticated algae species, filter feeders and corticated algae (Figure 2.10).

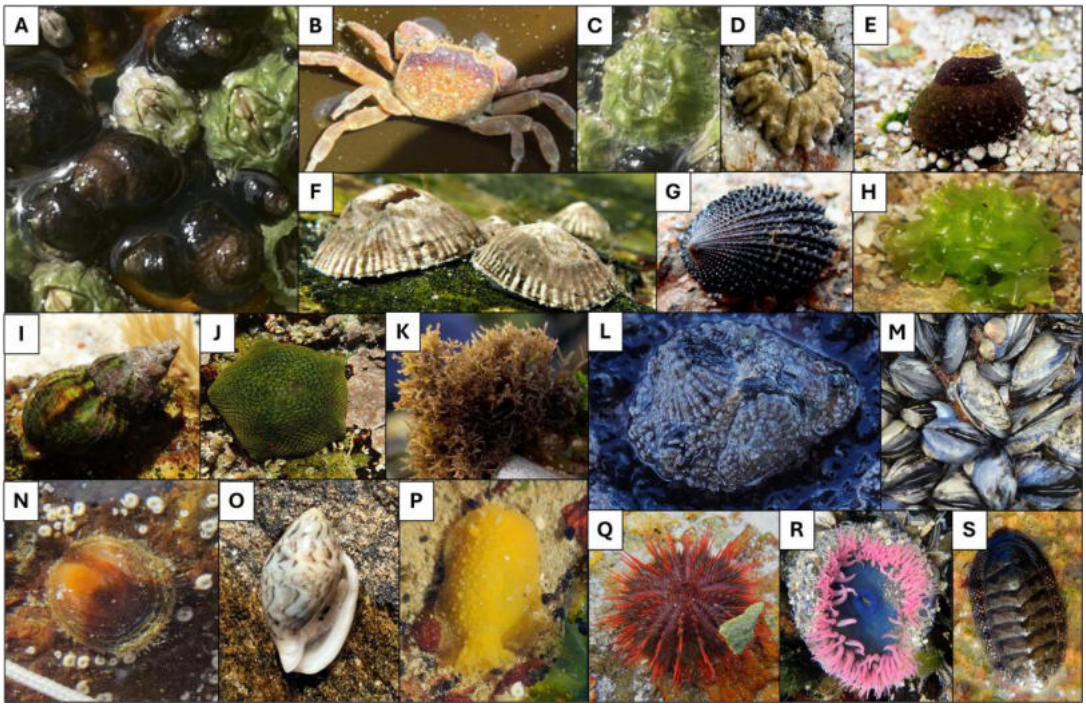


Figure 2.10. Examples of species commonly found on the Cape rocky shores . High shore: A) the southern periwinkle, B) shore crab, C) alien acorn barnacle, D) toothed barnacle, E) pink-lipped topshell, F) Cape false-limpet, G) broad rayed-limpet, H) sea lettuce. Mid shore: I) Burnupena whelk, J) dwarf cushion-star, K) spiky turf weed, L) pear limpet, M) mytilid mussels. Low shore: N) alien disc lamp shell, O) pinch-lipped marginella, P) warty sea slug, Q) Cape sea urchin, R) sandy anemone, S) brooding chiton. (Clark et al. 2025).

2.6.4 PELAGIC HABITATS

This habitat type constitutes the largest of all habitats and is loosely defined as the water column of the open ocean, which can be further divided into regions by depth. In contrast to demersal and benthic biota that are associated with the seabed, pelagic species live and feed in the open water column. Pelagic communities are largely defined by the physical properties of the water column. Main physical drivers include temperature, turbidity, dissolved oxygen, nutrient levels and light. These parameters vary with depth and play a large role in shaping the structure of pelagic communities. The major oceanic currents on the east and west coast of South Africa differ in terms of these parameters, and as such, harbour different pelagic communities.

The **phytoplankton** in the region includes diatoms, dinoflagellates, coccolithophorids and microflagellates. Maximum diatom concentrations are found in the upper 10 m and thereafter decrease with increasing depth. Common and widely distributed diatom species include *Asterionella glacialis*, *Leptocylindrus danicus*, *Coscinodiscus trioculatus, Skeletonema costatum, Thalassionema nitzschioides* and several *Navicula*, *Nitzschia* and *Thalassiosira* species. The most common member of the microflagelattes is a species of *Pyramimonas*. Dinoflagellates are represented by several members of the genus *Gyrodinium, Ceratium, Protoperidilium* amongst others. Also present in the area are toxic dinoflagellate species such as *Alexandrium catenella* and various members of the genus *Dinophysis,* which can cause mass mortalities of fish, shellfish, marine mammals, seabirds and other animals (Pitcher & Calder 2000).

Zooplankton are characterised by pelagic crustaceans (e.g., copepods, cumaceans, hyperiid amphipods, chaetognaths, mysids, euphausiids), invertebrate larvae (e.g., bivalve, polychaete, etc.), pelagic cnidarians, and ichthyoplankton. Ichthyoplankton constitutes the eggs and larvae of fish. Long-term changes in the southern Benguela include a significant increase in zooplankton over the past five decades, with a decline since 1995 linked to a concomitant increase in pelagic fish biomass as the main predators on zooplankton (Hutchings et al. 2006).

Small pelagic fish species that occur in the area include the sardine *Sardinops sagax*, anchovy *Engraulis capensis*, juvenile Cape horse mackerel *Trachurus capensis*, and round herring *Etrumeus whiteheadi*. Although these species generally occur within the 200 m contour, they may often be found very close inshore (Pecquerie et al. 2004). **Demersal fish** include deep water hake *Merluccius paradoxus*, shallow water hake *M. capensis* and kingklip *Genypterus capensis*. St Joseph shark *Callorhinchus capensis* are found in shallow inshore waters. Species such as white stumpnose *Rhabdosargus globiceps*, white steenbras *Lithognathus lithognathus*, silver kob *Argyrosomus inodorus,* galjoen *Dichistius capensis* and elf *Pomatomus saltatrix* are also common (Biccard et al. 2020a).

The greater St Helena Bay region is considered an important nursery area for some fish including sardine, anchovy, round herring and snoek (Griffiths 2002). The surf-zone and outer turbulent zone habitats of sandy beaches are considered to be important nursery habitats for marine fishes (Modde 1980, Lasiak 1981, Kinoshitsa & Fujita 1988, Clark et al. 1994). However, the composition and abundance of the individual assemblages seems to be heavily dependent on wave exposure (Blaber & Blaber 1980, Potter et al. 1990, Clark 1997a b). Surf-zone fish communities off the South African West Coast have relatively high biomass, but low species diversity. Typical surf-zone fish include harders *Chelon richardsonii*, white stumpnose *R. globiceps*, Cape sole *Heteromycteris capensis*, Cape gurnard *Chelidonichthys capensis*, False Bay klipfish *Clinus latipennis*, sandsharks *Acroteriobatus annulatus*, eagle ray *Myliobatis aquila*, and smooth-hound shark *Mustelus mustelus* (Clark 1997b).

2.7 SPATIAL CONSTRAINTS

2.7.1 ECOSYSTEM THREAT STATUS

The Ecosystem Threat Status developed by the South African National Biodiversity Institute (SANBI) is an indicator of how threatened ecosystems are, specifically the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function, or composition (Harris et al. 2018). Ecosystem types are categorised as “Critically Endangered”, “Endangered”, “Vulnerable”, “Near Threatened” or “Least Concern”, based on the proportion of the original extent of each ecosystem type that remains in good ecological condition relative to a series of biodiversity thresholds (Sink et al. 2019). Much of St Helena Bay is classified as Vulnerable (Figure 2.11). This Vulnerable habitat extends northwards until 10 km north of Lambert’s Bay.

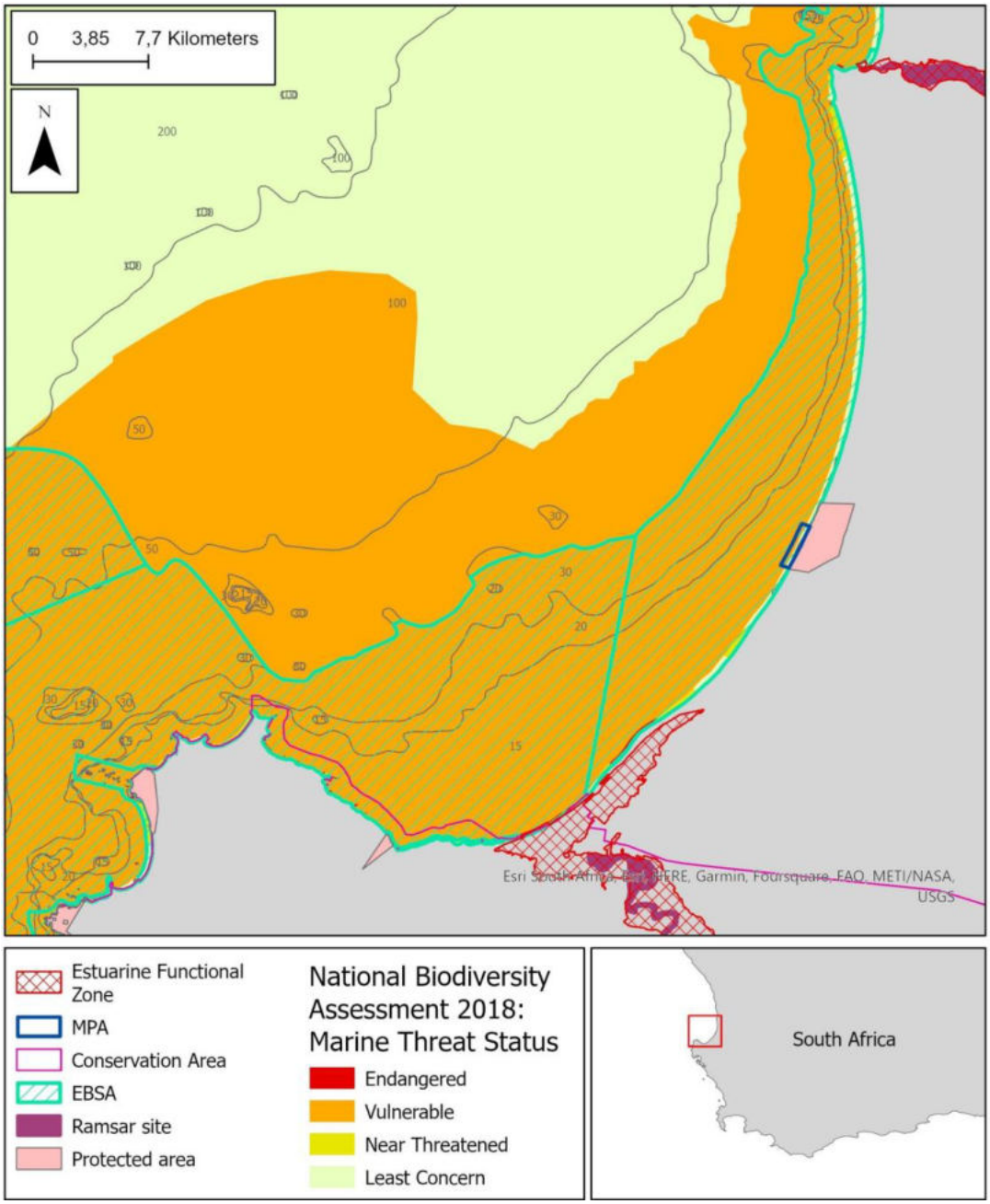


Figure 2.11. Ecosystem types categorised as "Critically Endangered", "Endangered", "Vulnerable", "Near Threatened" or "Least Concern" as per the NBA (2018). Marine Protected Areas are shown in blue, Estuarine Functional Zones in red, Ramsar sites in purple and Ecologically or Biologically Significant Marine Areas (EBSAs) in green.

2.7.2 Marine Protected Areas and Sanctuaries

The implementation of Marine Protected Areas (MPAs) in South Africa is enabled through the National Environmental Management: Protected Areas Act 2003 which provides the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes. Two pieces of Legislation most commonly used in the management of MPA's is the National Environmental Management: Protected Areas Act and the MLRA. South Africa now has 41 MPAs in the marine environment around its mainland as well as the very large MPA surrounding the Prince Edward Islands that covers more than 30% of the Southern Ocean territory (Mann-

Lang et al. 2021). Currently Rocher Pan Marine Protected Area constitutes the only MPA within St Helena Bay (Figure 2.11).

St Helena Bay includes a West Coast Rock Lobster sanctuary in which no harvesting of this resource may occur. In Section 47 of the Regulations in terms of the MLRA (1998), "*no person shall, in any manner or for any purpose, engage in fishing, collecting or disturbing west coast rock lobster within…the area within six nautical miles seaward of the high-water mark on the coast between, as western limit, a straight line drawn through beacons marked S.H.B.W.1 and S.H.B.2, respectively, and situated on Stompneus Point, and, as eastern limit, a straight line drawn through a beacon marked S.H.B.E. and a beacon marked D.R., both situated on the remaining extent of Wilde Varkens Valley A, due south of "Doctor's Reef"; and the area within three nautical miles seaward of the high-water mark between, as western limit, a line (315º true bearing) drawn through two beacons marked S.H.B.W.2 and S.H.B.3, respectively, and situated on Shell Bay Point, and as eastern limit, a straight line drawn through beacons marked S.H.B.W.1 and S.H.B.2, respectively, and situated on Stompneus Point*." These closed areas are illustrated in Figure 2.12.

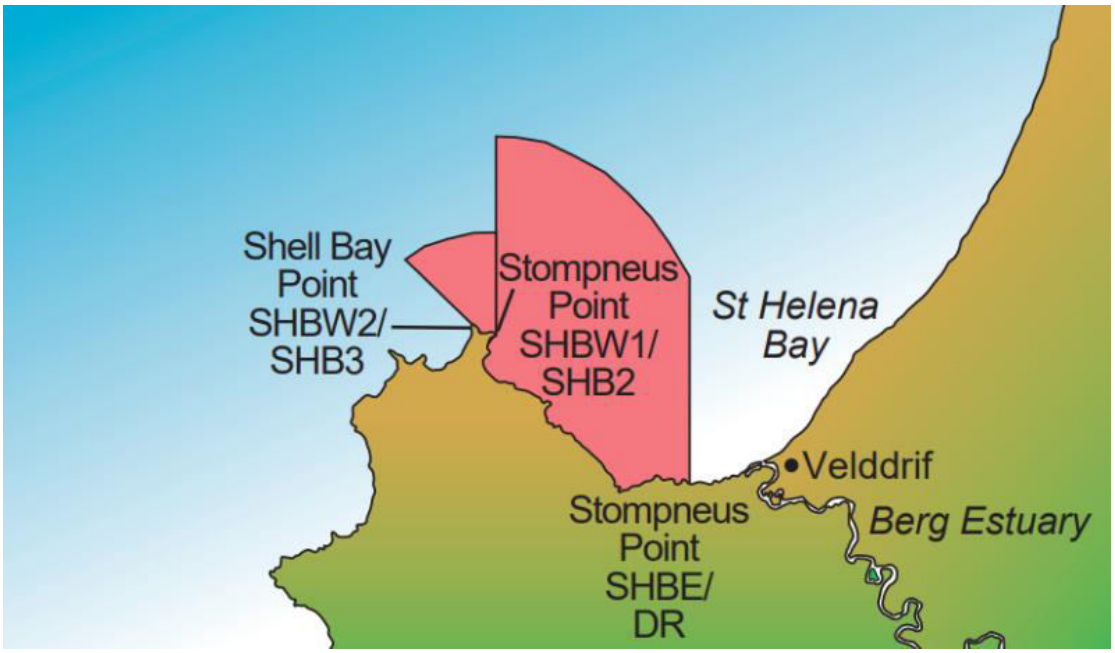


Figure 2.12. Areas Closed to Rock Lobster Fishing (in red) in St Helena Bay. Source: (DAFF 2018).

2.7.3 Ecologically or Biologically Significant Marine Areas

Ecologically or Biologically Significant Marine Areas (EBSAs) are defined by the Convention on Biological Diversity (CBD) as "geographically or oceanographically discrete areas that provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the [EBSA] criteria".

The EBSA that covers the whole of St Helena Bay is the Cape Canyon and Associated Islands, Bays and Lagoon EBSA that is bounded along the shore from the Sixteen Mile Beach MPA in the south to about 10 km south of Lamberts Bay in the north (see Figure 2.13). This area was identified as a priority area through a national plan to identify areas

for offshore protection and by a systematic biodiversity plan for the west coast (Sink et al. 2011, Majiedt et al. 2013). It was also identified as an important area for pelagic ecosystems and species (Grantham et al. 2011).

2.7.4 Critical Biodiversity Areas

A Critical Biodiversity Area (CBA) assessment presents a spatial plan for the natural environment, designed to inform planning and decision-making in support of sustainable development (Harris et al. 2022), and CBA maps are developed using the principles of systematic biodiversity planning. These maps comprise three categories of biodiversity priority areas, namely Protected Areas, CBAs, and Ecological Support Areas (ESAs), which are jointly important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning and connectivity of the landscape or seascape as a whole.

There are two categories of CBA, namely 'CBA Natural' areas and 'CBA Restore' areas. CBA Natural sites have natural/near-natural ecological condition, with the management objective of maintaining the sites in that natural/near-natural state; and CBA Restore sites have moderately modified or poorer ecological condition, with the management objective to improve ecological condition and, in the long term, restore these sites to a natural/near-natural state, or as close to that state as possible. As a minimum in CBA Restore sites, further deterioration in ecological condition must be avoided, and options for future restoration must be maintained. The ESAs include all portions of EBSAs that are not already within MPAs or CBAs, and a 5 km buffer area around all MPAs (where these areas are not already CBAs or ESAs). Within ESAs, negative impacts of human activities on key biodiversity features are managed and minimised to maintain the features in at least a functional, semi-natural state and/or to allow the area to improve in ecological condition. The majority of St Helena Bay is an Ecological Support Area, with a slightly smaller area covered by a CBA Restore site (Figure 2.13). There are a few small areas designated as CBA Natural (Figure 2.13).

Some caution should be taken when interpreting the CBA maps. Given the scale of the national assessments, the pressure datasets are mapped and analysed at a scale and resolution entirely appropriate for the realm, but not for the very narrow shore and backshore which are barely even visible when viewed on a national map (Harris et al. 2022). Indeed, the authors of the CBA assessment identify the resolution of the datasets and analyses are probably too coarse for accurate assessment at high resolution such as being used in this current screening report. The CBA assessment should still be used to inform Marine Spatial Planning but, to improve the accuracy of current CBA Natural delineations within the area under consideration here, it is strongly recommended that a specialist site visit and a marine ecological assessment be undertaken to confirm the status of the CBA Natural areas.

2.7.5 Ramsar Sites

The Ramsar Convention on Wetlands of International Importance is an international treaty for the conservation and sustainable use of wetlands. As a signatory to the Ramsar Convention, South Africa is committed to working towards the wise use of all wetlands through effective land use planning and the development of appropriate policies and legislation, management actions, and public education to protect selected natural

purifiers of water resources. In February 2022 the Berg Estuary was declared as a Ramsar Site under the Convention on Wetlands of International Importance, as a wetland recognised both nationally and internationally as a site of ecological importance, becoming South Africa's 28th Ramsar site (see Figure 2.11) (Ramsar 2022). The system also forms part of the biodiversity priority core set on both a national and regional level.

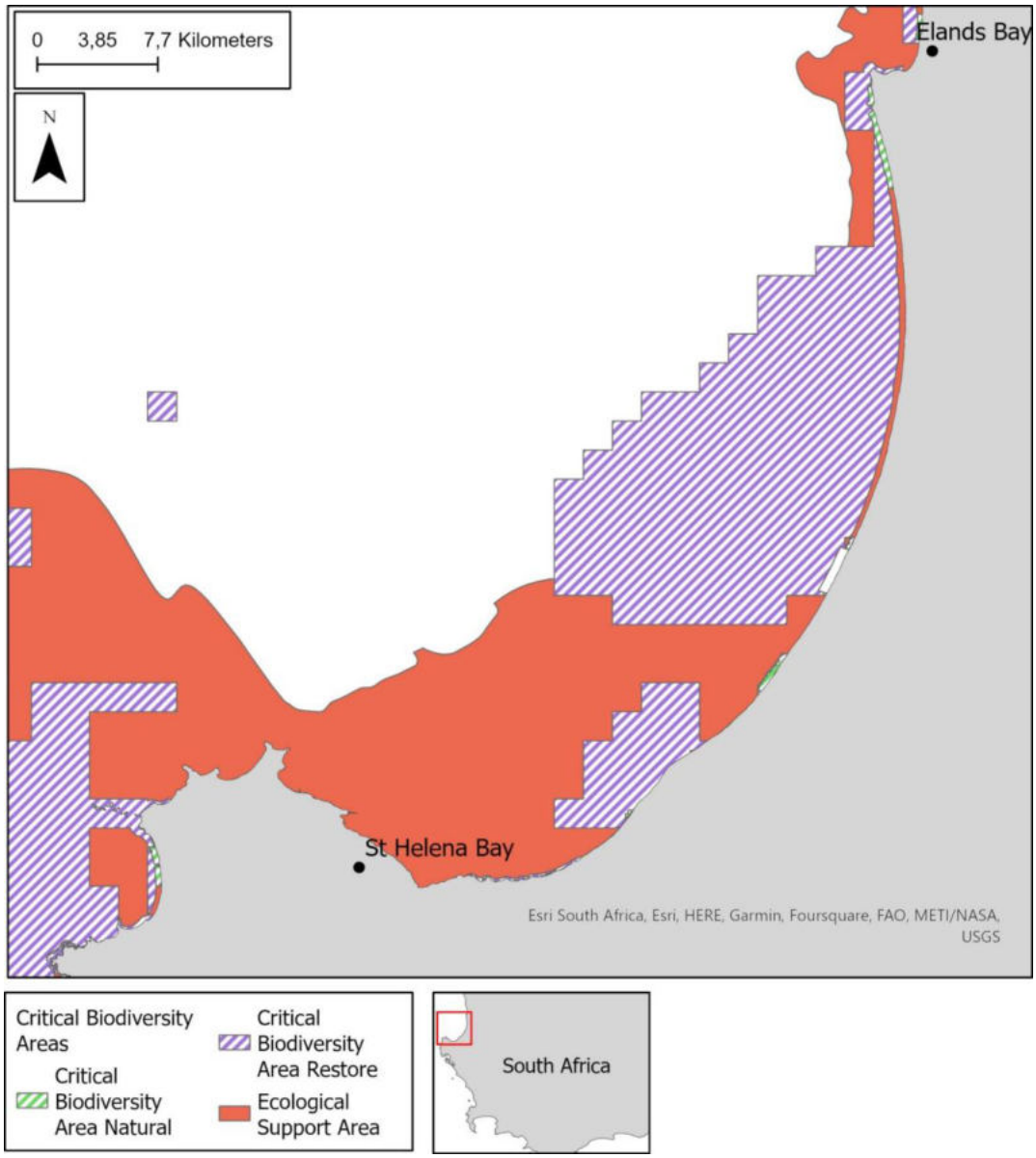


Figure 2.13: Critical Biodiversity Areas present around St Helena Bay. Source: Harris *et al*. (2022).

3 LEGISLATIVE CONTEXT

3.1 POLLUTION CONTROL IN SOUTH AFRICA

The National Environmental Management: Integrated Coastal Management Act 24 of 2008 (ICMA) is the primary environmental legislation responsible for the integration and coordination of various coastal and marine management efforts. This integrated coastal management addresses the governance of human activities affecting the sustainable use of goods and services generated by coastal and marine ecosystems.

Chapter 8 of ICMA controls marine and coastal pollution. Section 69(1) provides that no person may discharge effluent originating from a land source into coastal waters without a coastal waters discharge permit or a general authorisation in terms of ICMA. When considering an application for a coastal waters discharge permit the Minister must take into consideration the likely impact and cumulative effects of the discharge on the coastal environment. Any discharges of effluent must be compliant with waste standards or water management practices prescribed under ICMA and section 29 of the NWA.

Moreover section 58(1) of ICMA places the duty of care requirement, as prescribed in section 28 of NEMA, explicitly on any person who produced or discharged a substance which caused, is causing or is likely to cause, an adverse effect on the coastal environment.

3.2 WATER QUALITY GUIDELINES

Contemporary coastal water management strategies worldwide aim to maintain or achieve receiving water quality that supports all designated uses of a water body. These uses typically include aquaculture, recreation, industry, and the protection of biodiversity and ecosystem functioning. This goal-oriented approach, known as the Receiving Water Quality framework, emerged from the recognition that enforcing end of pipe effluent limits without considering the assimilative capacity and ecological requirements of the receiving environment can result in water bodies becoming only marginally suitable for their intended uses (Anchor 2015). Under this framework, many countries have developed Water Quality Guidelines (WQGs) that specify target contaminant levels to be met within the receiving environment. In most cases, these WQGs are legally binding and must be adhered to by all users and discharge points. While the value of the framework is widely acknowledged, its implementation varies significantly between countries.

Countries use a range of legal instruments to maintain or achieve WQGs in receiving environments. These include setting contaminant limits, banning or restricting specific discharges in designated areas, and offering financial incentives to reduce pollution at the source through cleaner treatment technologies. However, the most effective method for ensuring effluent compliance with WQGs or standards is the establishment of site-specific effluent limits. These limits are calculated based on the WQGs of the receiving water body, the effluent's volume and concentration, and the assimilative capacity of the environment. This method, known as the water quality-based effluent limits approach (Anchor 2015), acknowledges that effluent is diluted upon entering the receiving water.

To account for this, a Recommended Mixing Zone (RMZ) is typically defined—a limited area extending from the outfall where contaminant concentrations may temporarily exceed WQGs. Although the RMZ should ideally vary according to the sensitivity and ecological importance of the receiving environment and the outfall's location, it is commonly set at approximately 100 meters from the discharge point in marine systems.

The water quality-based effluent limits approach contrasts with the Uniform Effluent Standard approach, which applies fixed maximum concentrations or loads for all discharges, regardless of their location (Anchor 2015). South Africa has adopted the Receiving Water Quality framework to manage water quality in both inland and marine environments, employing both the water quality-based effluent limit approach and the Uniform Effluent Standard approach. As part of this framework, Receiving Water Quality guidelines have been published for various beneficial uses. For inland waters, these include human consumption, aquaculture, irrigation, recreation, industrial use, and biodiversity protection.

Water quality guidelines for physico-chemical properties of seawater are contained in the 1995, 2018 and 2022 South African Water Quality Guidelines for Coastal Marine Waters (DWAF 1995a c, DEA 2018, DFFE 2022b) (Table 3-1). The 2022 guidelines sought to improve South Africa's guidelines for physico-chemical properties with regards to (1) the level of protection awarded to the designated uses (previous WQG regulations lacked a definition for the term 'ambient conditions') and (2) the practicality for implementation. These regulations specifically adopt a site-specific, "reference system" approach, defining 'ambient condition' "*as the natural range of conditions at a particular site (seasonal and/or event driven)*" (DFFE 2022b) (Table 3-1).

Table 3-1. Water quality guidelines for physico-chemical properties of seawater as contained in the 1995, 2018 and 2022 South African Water Quality Guidelines for Coastal Marine Waters (DWAF 1995a, DEA 2018, DFFE 2022b).

Parameter	WQGs (1995)	WQGs (2018)	WQGs (2022)
Temperature	The maximum acceptable variation in ambient temperature is + or - 1°C.	Derived from a reference system (data set) for locality; range defined by the 20th and 80th percentiles of the seasonal and/or event-driven distributions for the receiving system. Test data: median value.	
Salinity	The target range for the South African coastal zone is 33-36 ppt.	Derived from a reference system (data set) for locality; range defined by the 20th and 80th percentiles of the seasonal and/or event-driven distributions for the receiving system, depending upon whether low salinity or high salinity effects are being considered. Test data: median concentration.	Human activities should not cause the salinity (expressed as, parts per thousand) of marine and estuarine waters to fluctuate by more than 10% of the natural level expected at that time and depth.
pH	The target range for the South African coastal zone is 7.3-8.2	Derived from a reference system (data set) for locality; range defined by the 20th and 80th percentiles of the seasonal and/or event-driven distributions for the receiving system. pH changes of more than 0.5 pH units from the seasonal maximum or minimum defined by the reference systems should be fully investigated. Test data: median concentration for the period.	

Parameter	WQGs (1995)	WQGs (2018)	WQGs (2022)
Suspended solids	The concentration of suspended solids should not be increased by more than 10% of the ambient concentration.	Derived from a reference system (data set) for locality; should not exceed the 80th percentile of the seasonal and/or event-driven distributions for the receiving system. Test data: median concentration. Additionally, the natural euphotic depth (Z) should not be permitted to change by more than 10%.	
Colour/Turbidity/ Clarity	Turbidity and colour acting singly or in combination should not reduce the depth of the euphotic zone by more than 10 % of background levels measured at a comparable control site. The colour (substances in solution) of water should not exceed background levels by more than 35 Hazen units.	Derived from a reference system (data set) for locality; should not exceed the 80th percentile of the seasonal and/or event-driven distributions for the receiving system. Test data: median concentration. Additionally, the natural euphotic depth (Z) should not be permitted to change by more than 10%.	
Dissolved oxygen	For the south and east coasts, the dissolved oxygen should not fall below 5 mg/L (99% of the time) and below 6 mg/L (95% of the time). For the west coast, the dissolved oxygen should not fall below 10% of the established natural variation.	Derived from a reference system (data set) for discharge locality; and should not drop below the 20th%ile of the seasonal and/or event-driven distributions in question. Where possible, values should be obtained during low flow and high temperature periods when DO concentrations are likely to be lowest. Test data: Median DO concentration for the period, calculated using the lowest diurnal DO concentrations.	Derived from a reference system (data set) for discharge locality and time of day (separate diurnal and nocturnal oxygen ranges should be determined); should not drop below the 20th%ile of the seasonal and/or event-driven distributions in question. Where possible, values should be obtained during low flow and high temperature periods when DO concentrations are likely to be lowest. Test data: median concentration.
Dissolved nutrients (mg/L): Phosphates (PO_4^-P), Nitrogen (NO_2^-, NO_3 and NH_3)	Should not cause excessive algal growth and the loads should not exceed the levels which are introduced by natural processes such as upwelling.	Should not result in chlorophyll a, turbidity and/or dissolved oxygen levels that are outside the recommended WQG range. Alternatively, derived from a reference system (data set) for locality; should not exceed the 80th percentile of reference. Where insufficient/no reference data exists, single guideline values derived from available data based on professional judgement, as an interim measure.	
Ammonium (NH_3) and ammonia (NH_3 + NH_4^+)	0.02 mg N as NH_3 0.60 mg N as NH_3 + NH_4^+	Should not result in chlorophyll a, turbidity and/or dissolved oxygen levels that are outside the recommended WQG range. Alternatively, derived from a reference system (data set) for locality; should not exceed the 80th percentile of reference. Where insufficient/no reference data exists, single guideline values derived from available data based on professional judgement, as an interim measure. As total recoverable ammonia nitrogen (µg/L) (Chronic): 600	
Toxic inorganics	As total recoverable x (µg/L) (Chronic):	As total recoverable x (µg/L) (Chronic):	As total recoverable x (µg/L) (Chronic):
	As 12	As 8	As 8
	Cd 4	Cd 0.12	Cd 0.12
	Cr 8	Cr 2	Cr 2 (Cr6+)
	Cu 5	Cu 3	Cu 3
	Pb 12	Pb 2	Pb 2
	Hg 0.30	Hg 0.016	Hg 0.016

Parameter	WQGs (1995)		WQGs (2018)		WQGs (2022)	
	Ni	25	Ni	5	Ni	5
	Zn	25	Zn	20	Zn	20

3.3 COASTAL WATERS DISCHARGE PERMITS

The National Environmental Management: Integrated Coastal Management Act 24 of 2008 (ICMA) is the primary environmental legislation responsible for the integration and coordination of various coastal and marine management efforts. This integrated coastal management addresses the governance of human activities affecting the sustainable use of goods and services generated by coastal and marine ecosystems.

Chapter 8 of ICMA controls marine and coastal pollution. In terms of Section 69 of ICMA, no person is permitted to discharge effluent originating from a source on land into coastal waters except in terms of a General Discharge Authorisation or a Coastal Waters Discharge Permit (CWDP). New operators wishing to discharge effluent to coastal waters are required to apply for a CWDP before commencing and are also required to comply with the applicable WQGs. Applications for CWDP are expected to include data on contaminant levels in the effluent to be discharged, as well as results of dilution and dispersion model studies. These models are required to simulate the worst-case scenario and indicate maximum expected levels for the same contaminants at the edge of the Recommended Mixing Zone (RMZ). These levels are expected to comply with published guideline levels as defined by other existing, or potential, beneficial uses of the receiving environment.

When considering an application for a CWDP, the Minister must take into consideration the likely impact and cumulative effects of the discharge on the coastal environment. Any discharges of effluent must be compliant with waste standards or water management practices prescribed under ICMA and section 29 of the National Water Act of 1998 (as amended). Moreover section 58(1) of ICMA places the duty of care requirement, as prescribed in section 28 of the National Environmental Management Act (No. 107 of 1998) as amended, explicitly on any person who produced or discharged a substance which caused, is causing or is likely to cause, an adverse effect on the coastal environment.

In 2019, Coastal Waters Discharge Permit Regulations were published to provide an administrative framework to implement Section 69(3) of the ICMA and stipulate timeframes, renewal application processes, applicable fees and information to be submitted as part of an application for a CWDP.

3.4 SIZE OF THE RECOMMENDED MIXING ZONE

The radius of the RMZ was determined according to the 'Assessment Framework for Effluent Discharged from Land Based Sources' (Anchor 2015). An RMZ of 100 m was used for the nearshore open coast environment (<10 m water depth or <500 m from shore, whichever the most conservative).

4 DISPERSION MODELLING RESULTS

4.1 INTRODUCTION

Near-field dispersion modelling was performed using the Cornell Mixing Zone expert system software (CorMix) (v12.0GTS) to assess dilution and dispersion of the effluent from the West Point fish meal processing plant in St Helena Bay for a range of discharge options. These discharge options were chosen to limit ecological impacts of the effluent discharge, while taking engineering and cost limitations into account.

Near-field models are designed to resolve initial dilution processes that occur in the immediate area around the discharge. The main objective of this modelling study was therefore to determine key near-field design parameters to achieve a sufficient level of initial dilution in accordance with regulatory requirements.

This section outlines the Plant Operations and estimated effluent profile (Section 4.3.2); and provides a summary of recommendations for outfall design and location so as to promote dilution from existing modelling work (Wright et al. 2021, 2023, Wright & Hutchings 2022, Wright 2023).

4.2 ASSUMPTIONS

The primary emphasis of CorMix lies in predicting geometry and dilution characteristics within the initial RMZ of a discharge with a view to achieve compliance with regional water quality guidelines. The system is, however, also able to make predictions regarding discharge plume behaviour over larger distances. CorMix classifies discharge flows according to generic qualitative descriptions (Doneker & Jirka 1990, 2002). Based on these flow classifications, CorMix can identify solutions which are included in the resulting model analysis. In addition, the system can predict quantitative aspects of the hydrodynamic mixing processes such as dilution ratio and plume trajectory. CorMix is considered by its authors to be applicable in more than 80% of cases except for highly complex discharge geometries or regions prone to non-uniform flow leading to local recirculation (Doneker & Jirka 1990, 2002).

While CorMix is applicable to a wide array of applications, ranging from dams and rivers to estuaries and open coastlines, the model requires the receiving water body to be highly simplified or ‘schematized’ (Doneker & Jirka 1990, 2002). Any area which may be non-uniform must be depicted as a relatively simple, uniform, rectangular channel within the model. A channel is typically assumed to comprise two boundaries representative of a river, canal or estuary. In coastal applications the schematization is considered to be unbounded. This is achieved by placing the discharge near one boundary (typically a shoreline), while the second boundary is assumed to be far beyond the reach of any impacts.

Another major assumption of CorMix is that of a steady state. As such, all parameterisations (e.g., receiving water body width, depth, ambient current, temperature and stratification) are held constant during any simulation. In applications where ambient currents are strongly impacted by tidal fluctuations (e.g., estuaries or

lagoons), quasi-steady analyses are recommended. These involve quantifying the interplay between variation in sea level height and ambient velocity during tidal cycles.

4.3 METHODS

4.3.1 AMBIENT CONDITIONS

As per Section 3, the WQBEL approach to discharges into the marine environment determines site-specific effluent limits that are calculated based on the WQGs (or standards) of a given water body, the effluent volume and concentration, as well as the site-specific assimilative capacity of the receiving environment. As such, it is of crucial importance to include accurate data on background/ambient parameters of the system into which the discharge is proposed. Water current data (speed and direction), temperature, salinity, bathymetry, and background constituents are discussed below. These parameters are used to determine which environmental conditions are used in the dispersion model. When selecting environmental conditions to simulate, it is considered best practise to consider worst-case scenarios i.e., the environmental conditions that lead to the poorest outcomes from a water quality and environmental perspective. It is also imperative to cover a range of environmental conditions that are expected to occur at the discharge site.

Tides in St Helena Bay are typical of the South African West Coast, and almost identical to those of Saldanha Bay (Lwandle 2018). The tides are semi-diurnal (high tide occurs twice a day) with a mean range of 1.51 m and 0.57 m for spring and neap tide respectively (Figure 4.1).

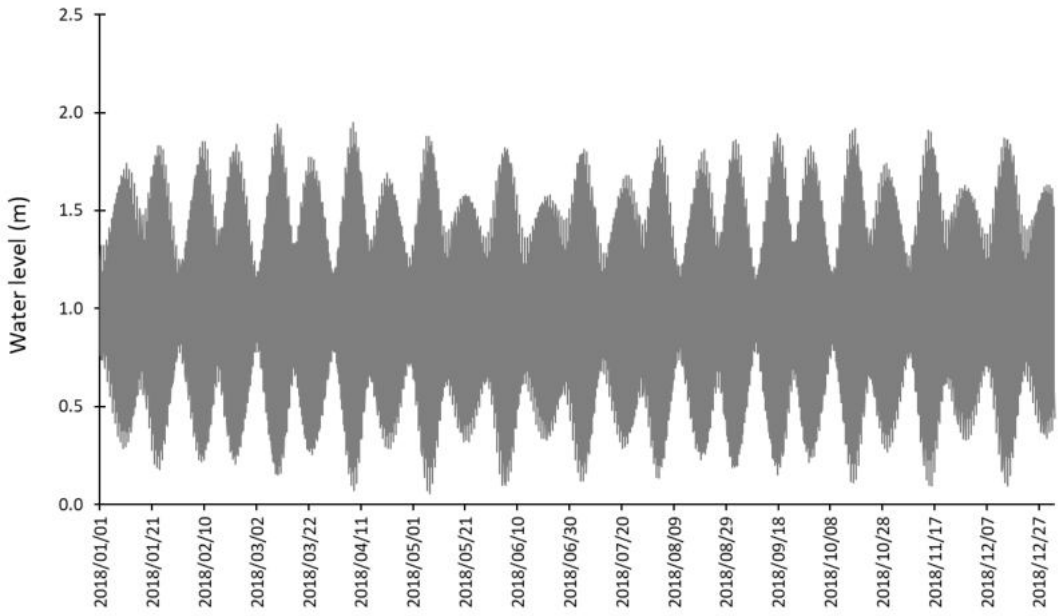


Figure 4.1. Hourly water level measurements for Saldanha Bay (i.e., tidal range) for the year 2018 (data from the South African Navy Hydrographic Office).

Most of the swell energy in the Atlantic basin along the West Coast of South Africa is generated from extra-tropical storms between latitudes 40° and 70°, and as a result, the predominant swell direction is from the south-west, varying between south-south-west and west-south-west (Figure 4.2). The West Point factory is located in the southwestern corner of St Helena Bay and is well protected against the dominant offshore wave conditions (Figure 4.3). As such, the existing far field model undertaken by PRDW (2018) for the West Point outfall excluded the effects of waves, noting that the "worst-case dispersion will occur under calm wave conditions".

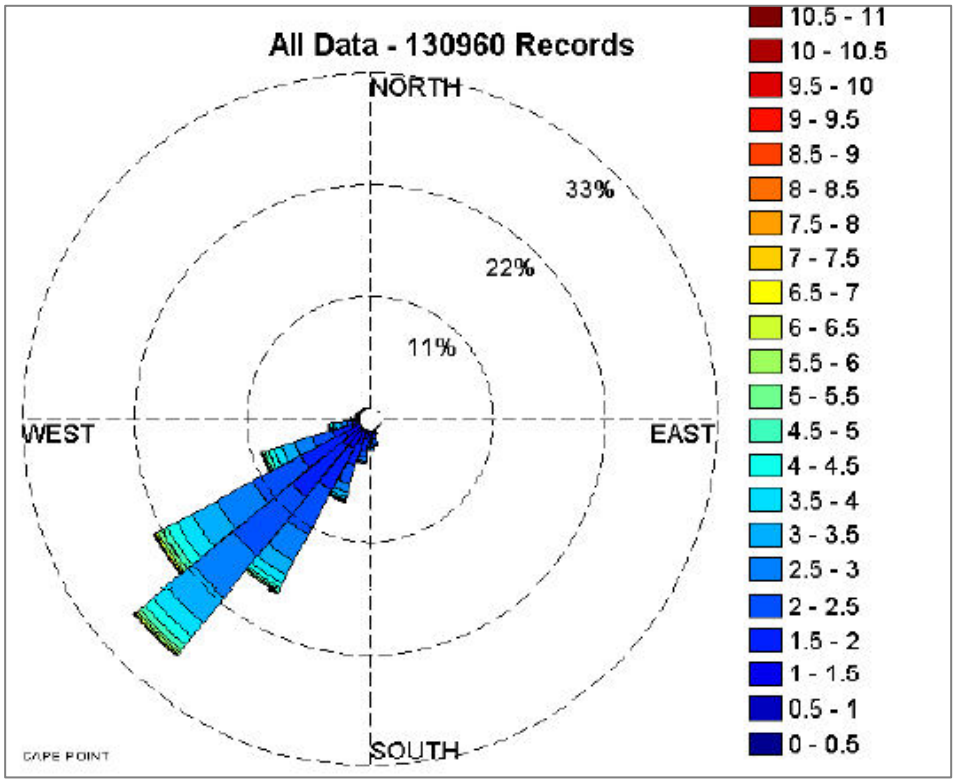


Figure 4.2. Slangkop wave rose for significant wave height (Hmo) and direction (CSIR 2014).

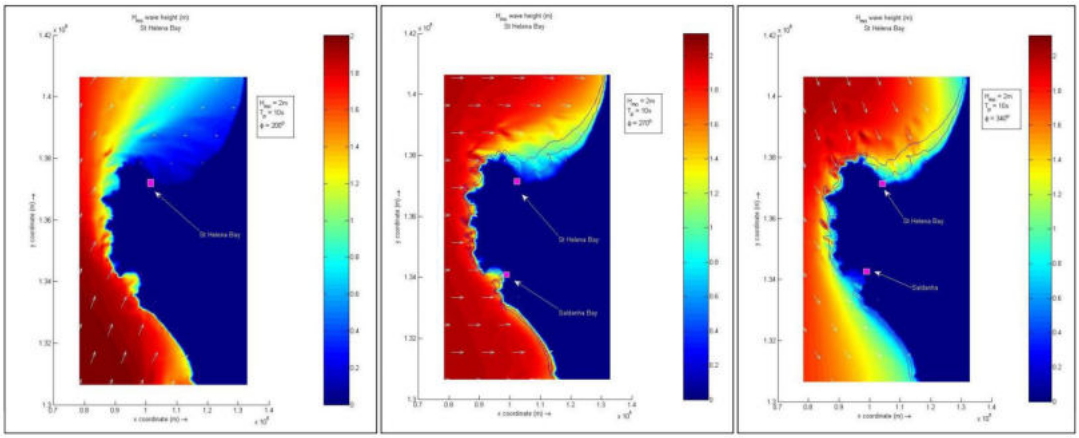


Figure 4.3. SWAN modelled wave simulations for a 2 m significant wave height and 12 s conditions approaching from south-south-westerly, westerly, and north-north-westerly directions (CSIR 2014).

The current regime in St Helena Bay is predominantly influenced by the Benguela Current (Wright et al. 2023) which drives a clockwise circulation within the larger Bay (Figure 2.1). Current speeds within the bay tend to be very low because of the sheltered nature of the system: CSIR (2014) report current velocities of between 0.1–0.3 m/s along the coast, values that are replicated by in situ current data for St Helena Bay at a site at 10 m depth at Dwarskersbos where an Acoustic Doppler Current Profiler (ADCP) was deployed. This deployment from 3 April to 13 May 2017 provided six weeks of recent data in this area. Current velocities recorded at the deployment site over the sampling period were low, with almost 60% of the measured current velocities less than 10 cm/second (Figure 4 4).

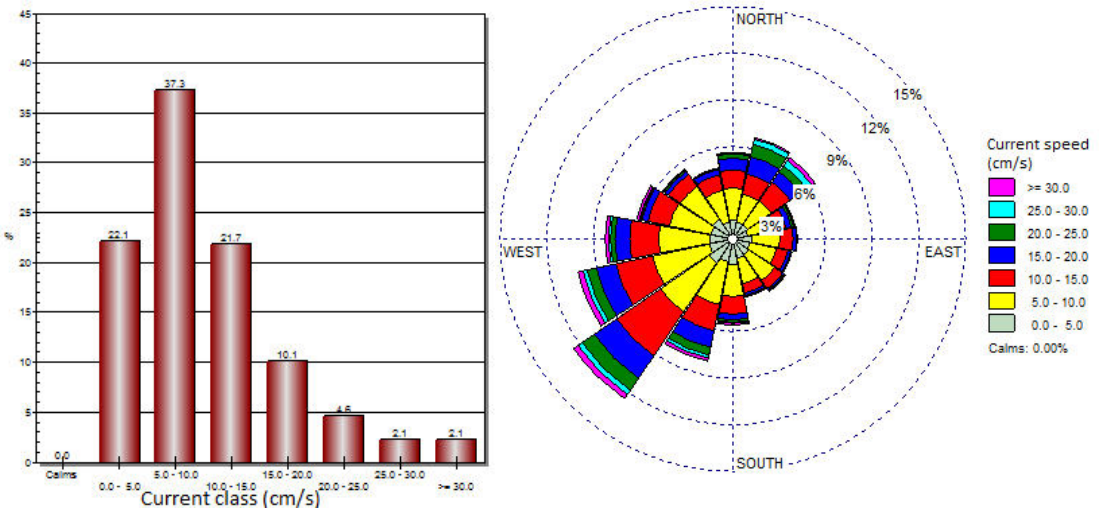


Figure 4.4. Frequency, current direction, and strength at -5 m water depth offshore of Dwarskersbos (Laird & Clark 2015). Note that, by convention, wind roses depict the direction that a wind is blowing from, whilst current roses show the direction to which a current is flowing.

Given that PRDW (2018) assessed that 'worst-case dispersion will occur under calm wave conditions', a similar approach was followed here: a worst-case scenario of current speed of 0.03 m/s was used in this near field model. The primary concern for the dispersion of the effluent is the southward moving and entrapment in the sheltered corner to the southeast of the West Point discharge. Therefore, the worst-case scenario is a current flowing to the southeast towards the corner of Slippers Bay.

The previous dispersion model (PRDW 2018) reported that the extent of the plume is primarily determined by wind-driven surface currents. As such, the wind speed and direction are important parameters to be included in this near field model set up. The winds data for the St Helena Bay region is strongly seasonal: strong south easterly winds dominate in summer, and to a lesser degree in spring and autumn (Figure 4.5). An increase in the frequency of north-westerly wind occurs during spring and winter months, which can be attributed to the passage of cold front systems during this period (CSIR 2014) (Figure 4.5). This previous dispersion model assessed that periods of calm represent the "worst-case" dispersion scenario.

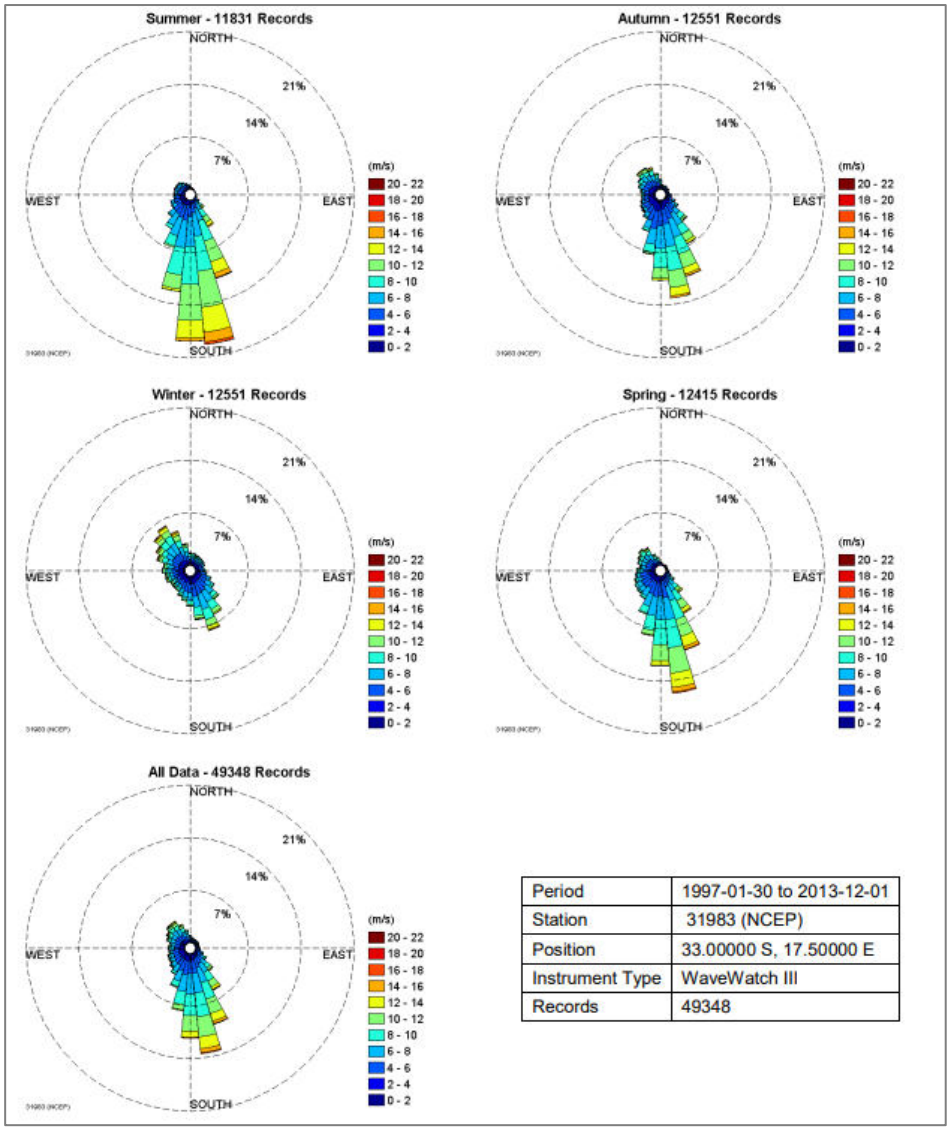


Figure 4.5. The offshore wind climate for St Helena Bay as based on the NOAA/NCEP hindcast data. The grid-point is located approximately 35 km offshore (CSIR 2014).

The general bathymetry of St Helena Bay is presented in Figure 4.6, while bathymetry adjacent to the proposed discharge site is shown in Figure 4.7. The bathymetry slopes gently out to sea, especially in the centre from the Berg River mouth. Indeed, while the 30 m depth contour is reached 1 km from shore at the northern part of the bay (Elandsbaai) and 3 km from the southern edge of the bay (Shelly Point), the 30 m depth contour is about 16 km from the Berg River Estuary mouth (CSIR 2014). The water depth around the West Point plant is very shallow — 10 m depth is achieved to the north at ~2.7 km from the shore, while at 500 m from the shore, the water depth reaches only ~5 m (Figure 4.7).

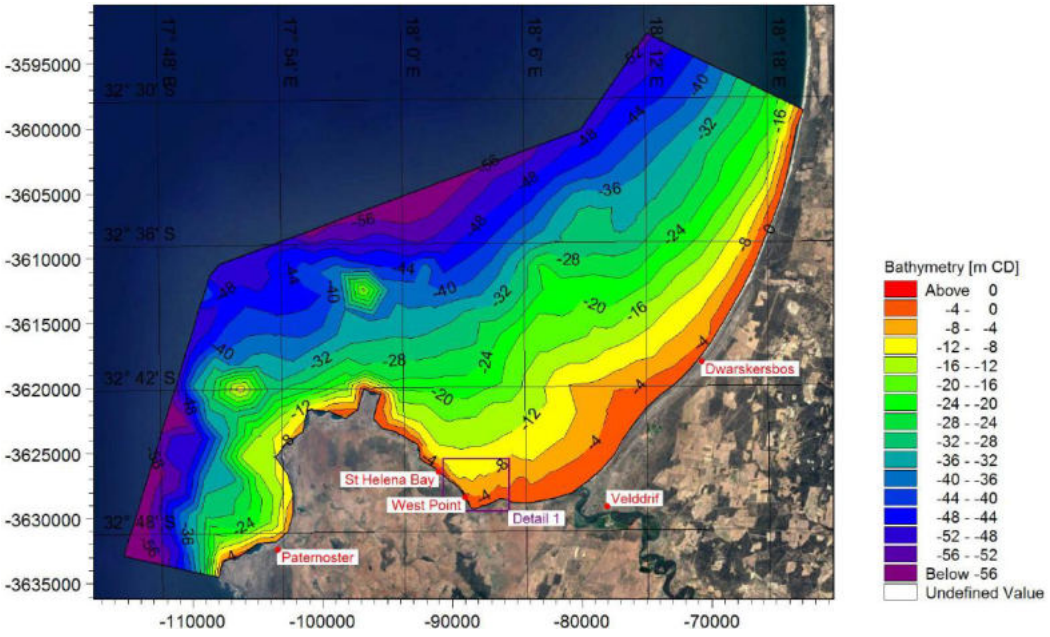


Figure 4.6. General bathymetry of St Helena Bay (Lwandle 2018).

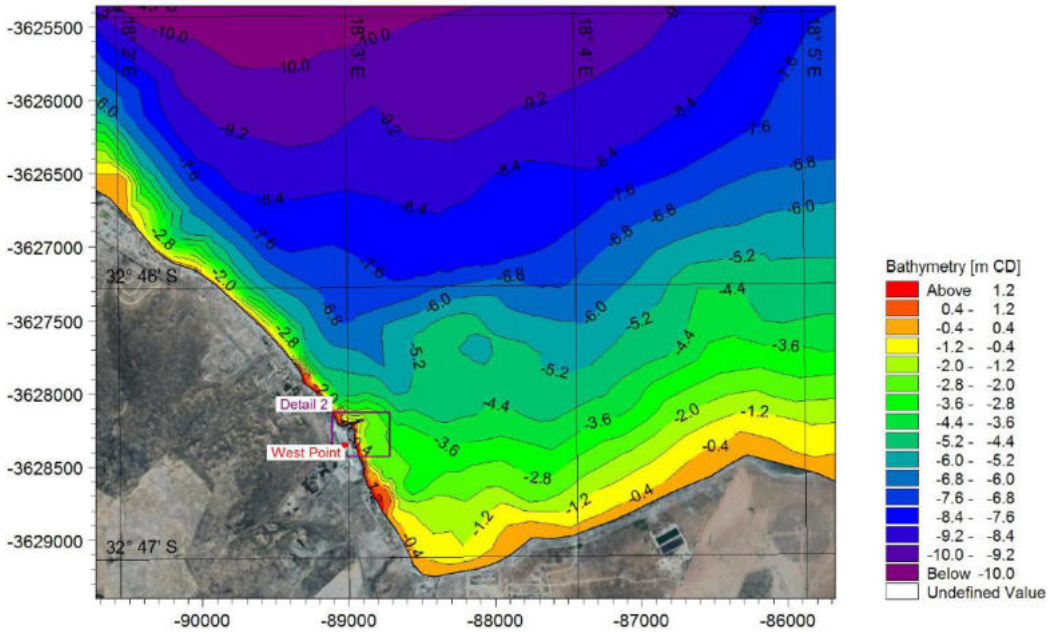


Figure 4.7. Bathymetry in the vicinity of the West Point outfalls (Lwandle 2018).

4.3.2 PLANT OPERATION

The West Point fish meal processing plant currently discharges effluent through two separate surf zone outfalls, namely Outfall A and Outfall B (Figure 4.8). Outfall A (32°46'34.94"S; 18° 3'1.72"E) discharges cooling effluent at approximately mean high water. This thermally elevated effluent is collected from the condensation and chemical scrubbers. Outfall B (32°46'30.64"S; 18° 2'58.85"E) discharges fish processing effluent at approximately mean high water. Sea water and fresh water are used to transport fish onto the cutting tables within the factory as well as for the cleaning of equipment after production. The effluent passes through a rotatory screen filter of 5 micron to remove

solids from the effluent. The remaining effluent is thereafter discharged into the coastal waters via an open channel. Solids are removed to a fish meal processing plant situated on site.



Figure 4.8. The current status quo, with the West Point Processors fish factory effluent discharged into the nearshore on 2019/02/17. The current location of the abstraction (intake) point is indicated, as are the two West Point outfalls. Outfall A discharges thermally elevated effluent, and Outfall B discharges fish processing effluent.

The dispersion modelling results presented in previous Marine Impact Assessment studies (Wright et al. 2021, 2023, Wright & Hutchings 2022, Wright 2023) noted that onshore treatment would be required to improve effluent quality to ensure compliance with WQG limits in the receiving environment. While the studies recommended that a subtidal discharge away from the shore to reduce the likelihood of plume attachment to the bank in order to facilitate mixing, results showed that the shallow bathymetry and retentive nature of St Helena Bay limits the improvement dilution normally associated with a longer offshore pipeline (Wright et al. 2021, Wright & Hutchings 2022). The combining of Outfall A and Outfall B has also been investigated as an alternative to improve compliance (Wright 2023, Wright et al. 2023), and the set up for this option is presented below.

4.3.3 MODELLING SCENARIOS

WPP is investigating the implications of combining the Outfall A and Outfall B effluents (discharged via Outfall B) to improve dilution prior to discharge. WPP is currently exploring potential options through a draft Water Management Plan (WMP), which aims to implement mitigation measures to address concerning parameters. Model simulations were undertaken following updated engineering design specifications, based on a maximum combined design flow rate of 1500 m^3/hr (0.42 m^3/s) (Wright 2023). To investigate the water quality impacts the effluent may have on the receiving environment,

four scenarios were modelled to represent the combine outfall, ranging from the "worst case" effluent to "treated" effluent (Table 4-1). Simulations were run using a conservative tracer to determine the optimum outfall configuration to maximise dilution potential.

Table 4-1. Combined Outfall effluent treatment scenarios (average).

Parameter	Treatment scenario			
	Scenario 1: Worst Case	Scenario 2: 2022 Average	Scenario 3: Semi Treated	Scenario 4: Treated
Without RO plant operation				
NH_3 (mg/L)	97	24	7.5	3.7
COD (mg/L)	6 219	1 613	194	19
FOG (mg/L)	155	68	33	3.7
TSS (mg/L)	1 944	544	272	39
Turbidity NTU	389	194	97	23
Salinity (ppt)	36.9	33.1	33.1	33.1
With RO plant operation				
NH_3 (mg/L)	92	23	7.4	3.7
COD (mg/L)	5 899	1 530	184	18
FOG (mg/L)	147	65	31	3.7
TSS (mg/L)	1 848	521	263	41
Turbidity NTU	369	184	92	22
Salinity (ppt)	36.5	32.8	32.8	32.8

Simulations were run using a conservative tracer to determine the optimum outfall configuration to maximise dilution potential (Table 4-2). It must be noted that these depths and pipeline lengths are not to engineering specification; appropriately qualified marine engineers will need to be consulted to determine the routing. The pipeline route was estimated based on the information provided by the client. The ideal discharge site is as far away from the shore as possible (to prevent attachment of the plume to the bank), and as deep as possible (to allow time for the effluent to diffuse).

Table 4-2. Modelled outfall configuration.

Scenario	Distance offshore (m)	Depth (m)	Pipe end diameter (mm)
Combined (flow rate 0.42 m^3/s)	100	5.6	495
			500
			515
	500	7.2	495
			500
			515

The effluent density changes as the salinity changes. Therefore, a single pipe discharge point and a multiport diffusor were modelled separately to investigate which outfall design provides the better dilutions for both effluent types. Both effluent densities are

less than that of seawater and so the discharge point was placed 0.2 m above the ocean floor, discharging upwards at 45°. This increases the time to diffuse before the effluent reaches the surface and avoids the scouring of sediment around the outfall. This sediment scouring can become a serious design issue for poorly designed pipe ends discharging into shallow receiving water bodies.

4.3.4 RMZ WATER QUALITY LIMITS

Fish processing plants generally discharge effluent with high nutrient loads. As such, the effluent discharge of fish processing plants into St Helena Bay is of environmental concern due to the increased organic loading this effluent introduces to the water column and sediments (Biccard et al. 2020b, Clark et al. 2023). The shore discharge by West Point Processors is no exception to this (see Figure 4.8). High levels of nutrients and/or organic matter can cause eutrophication of coastal waters, resulting the proliferation of algae, red tide blooms, and deoxygenation of the water, which may result in hypoxic water and black tides. In shallow systems, excessive macroalgal growth can result in anoxic conditions within the water column, especially during periods of warm water temperatures and during the night when photosynthesis cannot occur. This is when dissolved oxygen (DO) reaches a minimum and may result in the death of aerobic benthic organisms and, in severe cases, fish kills (Nixon & Fulweiler 2009a). Further anaerobic degradation of organic matter by sulphate-reducing bacteria may additionally result in the production of hydrogen sulphide, which is highly toxic to marine organisms (Brüchert et al. 2003). Environmental monitoring of the West Point outfalls has indeed detected depressed DO levels in the water column, and anoxic sediment conditions near the discharge sites (Lwandle 2018). The sediment anoxia is attributed to “the bacterial breakdown of organic matter within the plume, evident by the sulphurous black sediment identified just offshore of the discharge” (Lwandle 2018). While coastal upwelling regions, including the Southern Benguela, are frequently exposed to hypoxic (low dissolved oxygen) conditions owing to extremely high primary production and subsequent oxidative degeneration of organic matter, measures must be taken to reduce any further anthropogenic depletion of oxygen in coastal waters.

Environmental monitoring of the West Point outfalls has also shown depressed pH levels near the discharge points of up to 1 pH unit (Lwandle 2018). This translates to a ten-fold increase in acidity. Many marine organisms, particularly those with carbonate shells or “skeletons” such as foraminifera and corals are susceptible to acidic conditions (low pH) (Charrieau et al. 2018).

While Lwandle (2018) states that the “substantial periods of no discharge that should allow flushing and regeneration”, this is not borne out by the continued evidence of significant environmental degradation at the outfall sites over multiple years of monitoring. Sediment health has not improved over time, because there is a mismatch between the time required for regeneration, and the frequency of the impact. The impacts of the discharge when it does occur, even intermittently, is of such extensive impact that there is no “regeneration” in periods of no discharge.

Given the potential environmental impacts of fish processing plants discharge, the pipe end constituents of concern are therefore nutrients (including ammonia, and nitrogen) and indicators of nutrient pollution (such as low oxygen levels), as well as total suspended solids (TSS) and turbidity.

- High levels of suspended solids are characteristic of fish processing plant effluent. Elevated levels of TSS have been known to cause growth deficiencies in marine organisms and in some cases lead to mortalities should smothering of benthic habitats occur. High TSS levels also increase turbidity and decrease light penetration which impacts negatively on primary productivity, respiration and feeding in many marine species. Turbidity and total suspended solids are both important measures of water quality and there is usually a strong relationship between these two parameters.

- Ammonia (NH_3) is one of the principal nutrients required for primary production in nearshore marine environments. Ammonia is highly soluble in water and its speciation is affected by a wide variety of environmental parameters (CCME 2010). In seawater, ammonia exists in an equilibrium with ammonium (NH_4^+) (which is formed by the protonation of ammonia) where the relative concentration of each and depends largely on the pH and temperature of the water body, and to a lesser extent on the salinity (Körner et al. 2001). In a waste stream, ammonium ions exist in equilibrium with ammonia. As ammonia is uncharged and lipid soluble, it is acutely toxic to marine organisms at low concentrations. In vertebrates, ammonia can cause convulsions, coma and death. This has been attributed to elevated NH_4^+ displacing potassium ions (K^+) and depolarizes neurons, causing activation of NMDA type glutamate receptor, which leads to an influx of excessive calcium (Ca^{2+}) and subsequent cell death in the central nervous system, while the hydrated ammonium ion is non-toxic and a nutrient to primary producers (Randall & Tsui 2002). The concentration of ammonium/ammonia in seawater exhibits considerable spatial and temporal variations, which can be attributed to the complex processes that determine its fate in the marine environment. In oxygenated unpolluted seawater samples, Total Ammonia Nitrogen (TAN) rarely exceeds 70 µg/L, while in deep anoxic stagnant water ammonium concentrations can be as high as 2 100 µg/L (Grasshoff et al. 1976). Levels of ammonia in estuaries can also reach very high levels due to natural- and anthropogenically- linked contributions from the catchment (>1 mg/L) especially in systems that receive large volumes of organically rich water such as Waste-Water Treatment Works effluent (DFFE 2022a). One of the most serious consequences of nutrient over-enrichment to marine ecosystems is the decreased level of DO within the water column (Nixon & Fulweiler 2009b). In shallow systems, excessive macroalgal growth can result in anoxic conditions within the water column, especially during periods of warm water temperatures and during the night when photosynthesis cannot occur. This is when dissolved oxygen reaches a minimum and may result in the death of aerobic benthic organisms and, in severe cases, fish kills (Nixon & Fulweiler 2009b).

As such, the 100 m RMZ temperature limit was set at 15.84 °C, based on data presented in other reports (Wright et al. 2021, 2023, Wright & Hutchings 2022) (Table 4-3). Given that only TSS data was available for the final effluent, the turbidity limit of 3.44 NTU (based on data presented in Wright et al. (2021) and Wright & Hutchings (2022) was converted to a TSS RMZ limit of 11.78 mg/L (Table 4-3). The ammonia water quality guideline limit of 0.60 mg/L N as NH_3^+ NH_4^+ was used in this study (Table 4-3).

Table 4-3. Water quality limits at the edge of the 100 m RMZ

Parameter	Unit	Limit	Source
Temperature	°C	15.84	DWAF (1995b)
Salinity	PSU	33-36	DWAF (1995b)
Total Suspended Solids	mg/L	11.78	DWAF (1995b)
Ammonia nitrogen ($NH_3 + NH_4^+$) [a]	mg/L	0.60	DWAF (1995b)

a. Modelled as a conservative parameter, assuming equilibrium of non-ionized ammonia (NH_3) and ammonium ion (NH_4^+).

4.4 RESULTS

For modelling purposes, all values entered the model were compared to ambient by subtracting the quantity of the naturally occurring constituent in the receiving environment from that in the effluent.

A sensitivity analysis was conducted to determine the optimum outfall configuration to maximise dilution potential. For modelling purposes, all values entered the model were compared to ambient by subtracting the quantity of the naturally occurring constituent in the receiving environment from that in the effluent. Details on outfall configurations are provided in Wright et al. (2023). Results for a single outfall configuration and diffuser outfall configuration are presented in Table 4-4 and Table 4-5.

Table 4-4 Single outfall configuration results.

Scenario	Distance offshore (m)	Depth (m)	Pipe end diameter (mm)	Average dilution potential at the 100 m RMZ	Maximum discharge velocity (m/s)	Bank contact (m)
Combined (flow rate 0.42 m^3/s)	100	5.6	495	20.3	2.17	364
			500	20.1	2.12	357
			515	19.5	2.00	363
	500	7.2	495	25.7	2.17	n/a
			500	25.5	2.12	
			515	24.8	2.00	

Table 4-5 Diffuser outfall configuration simulation results.

Scenario	Distance offshore (m)	Depth (m)	Pipe end diameter (mm)	Average dilution potential at the 100 m RMZ	Maximum discharge velocity (m/s)
Combined (flow rate 0.42 m^3/s)	500	7.2	300	26.2	1.97

Single outfall model results (Table 4-4) indicate that discharging at a pipe end diameter of 495 mm results in a discharge velocity slightly above 2 m/s. The outfall diameter needs to be increased to 515 mm to maintain a velocity of 2 m/s. There is a reduction in dilution potential with larger pipe end diameters: dilution potential is reduced by some 4% when moving from a 495 mm pipe end diameter to a 515 mm diameter. Discharging within 100

m of the shore results in bank attachment some 350 m downstream of the discharge. This is considered to be unacceptable from a marine ecological perspective — discharging at 500 m offshore ensures no bank attachment occurs and is the environmentally preferable option. Only the outfalls placed at 500 m from shore are modelled in further assessments.

Using the dilution values for each of the outfall pipe end diameters (Table 4-4 and Table 4-5), and the average end of pipe concentrations for each of the treatment scenarios defined in Wright et al (2023), compliance with legislated Water Quality Guidelines (WQGs) in the marine environment for ammonia-N and TSS at the 100 m mixing zone were assessed (Table 4-6 and Table 4-7). Near field results for all scenarios indicate that the discharge via a single outfall 500 m from shore in 7.2 m of water does not meet the legislated WQG for ammonia-N and TSS at the 100 m RMZ, once ambient concentrations are considered for any of the pipe end diameters under consideration (Table 4-6). Near field results indicate that the discharge via an offshore diffuser with three ports of 300 mm diameter does not meet the legislated WQG for ammonia-N at the 100 m RMZ, but that these WQGs are met for TSS under Treatment Scenarios 3 and 4 (Table 4-7).

Table 4-6 Predicted constituent concentrations of effluent at the edge of the 100 m Recommended Mixing Zone (RMZ) for a flow rate of 1 500 m^3/hour for a single outfall. These values consider ambient concentrations. Values that do not comply with water quality standards are highlighted in red. End of pipe concentrations represent the average value across all the flow rates assessed in Wright et al (2023) for each Treatment Scenario.

Flow rate 0.42 m^3/s			**Treatment Scenario**			
Pipe end diameter 0.495 mm			**1**	**2**	**3**	**4**
Ammonia-N	Concentration at pipe end	mg/l	92.17	22.86	7.37	3.69
	Limit at edge of RMZ		0.20			
	Concentration at edge of 100 m RMZ		3.66	0.96	0.36	0.21
TSS	Concentration at pipe end	mg/l	1848.00	520.77	262.70	41.50
	Limit at edge of RMZ		11.80			
	Concentration at edge of 100 m RMZ		82.62	30.97	20.93	12.32
Pipe end diameter 0.500 mm			**1**	**2**	**3**	**4**
Ammonia-N	Concentration at pipe end	mg/l	92.17	22.86	7.37	3.69
	Limit at edge of RMZ		0.20			
	Concentration at edge of 100 m RMZ		3.68	0.97	0.36	0.21
TSS	Concentration at pipe end	mg/l	1848.00	520.77	262.70	41.50
	Limit at edge of RMZ		11.80			
	Concentration at edge of 100 m RMZ		83.18	31.13	21.01	12.34
Pipe end diameter 0.515 mm			**1**	**2**	**3**	**4**
Ammonia-N	Concentration at pipe end	mg/l	92.17	22.86	7.37	3.69
	Limit at edge of RMZ		0.20			
	Concentration at edge of 100 m RMZ		3.79	0.99	0.37	0.22
TSS	Concentration at pipe end	mg/l	1848.00	520.77	262.70	41.50
	Limit at edge of RMZ		11.80			
	Concentration at edge of 100 m RMZ		85.23	31.71	21.30	12.38

Table 4-7 Predicted constituent concentrations of effluent at the edge of the 100 m Recommended Mixing Zone (RMZ) for a flow rate of 1 500 m^3/hour for a diffuser. These values consider ambient concentrations. Values that do not comply with water quality standards are highlighted in red. End of pipe concentrations represent the average value across all the flow rates assessed in Wright et al (2023) for each Treatment Scenario.

Flow rate 0.42 m^3/s			**Treatment Scenario**			
Pipe end diameter 0.300 mm			**1**	**2**	**3**	**4**
Ammonia-N	Concentration at pipe end	mg/l	92.17	22.86	7.37	3.69
	Limit at edge of RMZ		0.20			
	Concentration at edge of 100 m RMZ		3.59	0.94	0.35	0.21
TSS	Concentration at pipe end	mg/l	1848.00	520.77	262.70	41.50
	Limit at edge of RMZ		11.80			
	Concentration at edge of 100 m RMZ		70.60	19.95	10.10	1.65

5 IMPACT ASSESSMENT

5.1 OVERVIEW

Identified potential impacts of the proposed expansion activities of the West Point fish meal processing plant, St Helena Bay, were assessed as part of this study. Construction phase impacts are expected to be localised and of temporary duration, while operating phase impacts are of a longer duration.

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). 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 the engineering design.

Both 'worst case' impacts and cumulative impacts are assessed in this report. Negative impacts associated with the construction and operation of the proposed expansion of the West Point fish meal processing plant fall into two main categories:

- Construction impacts, including loss of habitat, disturbance to and/or mortality of marine life due to construction activities associated with installation of the intake and discharge pipelines.
- Operational impacts, including disturbance to and/or mortality of marine life due to the intake of seawater and discharge of effluent into the marine environment.

Each of these impacts is likely to affect marine habitats and associated biota in different ways and at varying intensities depending on the nature of the affected habitat and the sensitivity of the biota. In assessing potential impacts on the marine biota in the vicinity of proposed construction and maintenance operations, consideration was given to the current state of the marine environment. Results of each assessment for the construction, operational and decommissioning phases are presented below in Table 5-1 to Table 5-8, and cumulative impacts are presented Table 5-9. A summary is provided in in Table 5-10.

5.2 CONSTRUCTION PHASE

Construction of the proposed intake and outfall pipelines will involve heavy vehicle traffic on the intertidal and the utilisation of machinery for laying the infrastructure over the intertidal and subtidal sandy and rocky substrate. Five potential impacts associated with intake and outfall pipeline construction were identified and addressed below. These include the loss of biota and habitat, barotrauma, noise and disturbance of biota, reduced water quality and litter and pollution. These impacts have been assessed in a previous marine impact assessment for the proposed expansion of the plant (Wright et

al. 2021) and these construction phase impacts will not be reassessed here. Instead, a summary of these construction impacts is presented in Table 5.1 below.

Table 5-1. Construction phase impact assessment summary (see Wright et al. 2021).

	Impact identified	Severity	Probability	Significance	Status	Confidence
Construction Phase (offshore Outfall B)	Impact 1: Disturbance of intertidal and subtidal habitat.	Very Low	Probable	**VERY LOW**	-ve	High
	With mitigation	Very Low	Possible	**INSIGNIFICANT**	-ve	High
	Impact 2: Disturbance of pelagic habitat.	Very Low	Possible	**INSIGNIFICANT**	-ve	High
	Impact 3: Litter pollution.	Low	Probable	**LOW**	-ve	High
	With mitigation	Low	Possible	**VERY LOW**	-ve	High
	Impact 4: Hazardous substance spills.	Medium	Possible	**LOW**	-ve	Medium
	With mitigation	Low	Improbable	**VERY LOW**	-ve	Medium
	Impact 5: Increased noise and vibration.	Very Low	Definite	**VERY LOW**	-ve	Medium
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium

Likewise, mitigation for the construction phase impacts is detailed in Wright et al. (2021), and include the following:

- Limit duration of construction activities in the coastal zone and marine environment.
- Keep construction equipment within the developmental footprint, and do not disturb sediment outside this area.
- Constrain spatial extent of impacts to the minimum required.
- Rehabilitation of the disturbed area must be conducted immediately following construction by removing all artificial materials not related to the permanent fixture of the pipeline.
- Inform all staff about sensitive marine habitats.
- Intentional disposal of any substance into the environment is strictly prohibited, while accidental spillage must be prevented, contained, and reported immediately.
- A rigorous environmental management and control plan must be implemented (including procedures for remediation).
- All fuel and oil are to be stored with adequate spill protection.
- No leaking vehicles are permitted on site, and appropriate spill kits are to be maintained on site for the duration of construction/decommissioning activities.
- All hazardous substances must be accompanied by a permit, a hazard report sheet, and may only be handled by suitably trained operators.
- Subject mobile equipment, vehicles, and power generation equipment to noise tests at commencement and periodically throughout the construction phase.
- Reduce, reuse, recycle.

- Suitable waste handling and disposal protocols must be clearly explained, and sign boarded.

5.3 OPERATIONAL IMPACTS

The primary operational phase impacts are effluent discharge and seawater intake. Physico-chemical attributes of the effluent mean that it could impact negatively on the marine ecology and on marine users depending on the effluent concentrations and levels of dilution achieved in the receiving environment. Assessment of these impacts was based on the dispersion modelling results presented in Section 4.4.

5.3.1 DISTURBANCE AND/OR MORTALITY OF MARINE LIFE DUE TO THE INTAKE OF SEAWATER

The impacts of seawater abstraction on marine life can include entrainment and impingement. Entrainment occurs when organisms pass through intake structures and into the processing equipment (Barnthouse 2013). Impingement occurs when larger marine organisms are trapped against intake screens by the velocity of the water flow (Bamber & Seaby 2004).

While the significance of both impingement and entrainment is related to the location of an intake, impingement is primarily a function of intake velocity, and entrainment depends largely on the overall volume of water drawn into plant. Intake structures should be positioned away from sensitive environments or areas with high species diversity or abundance, like rocky reefs, and should not draw in water from the upper one metre of the water column, as planktonic organisms tend to concentrate in this zone. The intake should also avoid the bottom one metre of the water column to minimise intake of suspended sediment. Impingement and entrainment can be mitigated through optimal designs to open water intakes. The horizontal extraction of water should aid in reducing fish entrainment as fish have been shown to avoid rapid changes in horizontal flow (Roberts 2015). There is a broadly accepted rule that water extraction velocities should not exceed 0.15 m/s to minimize debris and marine life impingement (Roberts 2015). Intake velocities can be reduced to the requisite 0.15 m/s through the use of footer values — these increase the area of intake, resulting in a decrease in intake velocity to safe levels. The impacts are expected to last for the duration that the plant is on operation for the lifetime of the plant. Predicted impacts are rated as of Low significance before mitigation and Very Low following mitigation (Table 5-2). The impacts are expected to last for the duration that the plant is on operation for the lifetime of the plant.

Table 5-2. Impact 6: Disturbance and/or mortality of marine life due to the intake of seawater via pipeline.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Long Term 3	Low 5	Definite	**LOW**	-ve	Medium
Essential mitigation measures: • Intake velocities should be kept below 0.15 m/s to ensure that fish and other mobile organisms can escape the intake current. Intake velocities can be reduced to the requisite 0.15 m/s through the use of footer values. • Intake structures should be positioned away from sensitive environments or areas with high species diversity or abundance, like rocky reefs, and should not draw in water from the upper meter of the water column.								

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
• Intake structures should ensure the horizontal intake of water. This can be achieved through use of footer valves.								
With mitigation	Local 1	Low 1	Long Term 3	Low 5	Possible	**VERY LOW**	-ve	Medium

5.3.2 IMPACTS OF CHANGES IN SALINITY

Marine organisms have variable tolerance levels to changes in salinity, which is related to their ability to regulate the osmotic balance of their individual cells and organs to maintain positive turgor pressure. Aquatic organisms are commonly classified in relation to their range of tolerance as stenohaline (able to adapt to only a narrow range of salinities) or euryhaline (able to adapt to a wide salinity range), with most organisms falling into the first category. The South African WQG (DWAF 1995a) set an upper target value for salinity of 36 PSU. At levels exceeding 40 PSU, significant negative effects are expected, including possible disruptions to the recruitment of molluscan bivalves (e.g., mussels, oysters and clams), crustaceans, and possibly fish (McClurg 1974, King 1977, McLusky 1981, Kungvankij & Chua 1986, Kungvankij et al. 1986, Latorre 2005)

The combine outfall salinity is anticipated to be 36.9 ppt, and has been shown by previous assessments to meet the legislated WQG at the 100 m RMZ (Wright et al. 2023). The impacts of elevated salinity are therefore deemed as of Very Low significance (Table 5-3).

Table 5-3. Impact 7: Changes in salinity.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Combined Outfall Without mitigation	Local 1	Low 1	Long Term 3	Low 5	Improbable	**VERY LOW**	-ve	High
Essential mitigation measures: • Effluent must be discharged via the pipeline configuration modelled here (see Section 4.3).								

5.3.3 IMPACTS OF ELEVATED NUTRIENTS

Increased nutrient levels in receiving waters can encourage plant growth, which may lead to algal blooms and local eutrophication. Prolific seaweed growth on intertidal rocky shores and foul-smelling subtidal sediments are often indications of enrichment. There are three forms of nitrogen that are commonly measured in water bodies: ammonia, nitrates and nitrites. Total Kjeldahl nitrogen (TKN) is the sum of organically bound nutrients, while total nitrogen is the sum of inorganic and organic nutrients. Organic nutrients include nitrogen, ammonia (NH_3) and ammonium (NH_4+), while inorganic nutrients include nitrates (NO_3) and nitrite (NO_2). Organic nutrients need to be broken down into inorganic nutrients before being absorbed by organisms; therefore, inorganic nutrients can be described as being readily available sources of energy.

Nitrogen is an essential nutrient for plants and animals; however, an excess amount of nitrogen may lead to low levels of dissolved oxygen in the water (anoxia) and may negatively affecting organisms within the marine environment. For example, a surplus of ammonia and organic nitrogen in a body of water can result in eutrophication and lead to

prolific algal growth. Sources of nitrogen include WWTWs, runoff from fertilized lawns and croplands, failing septic tank systems, and input from processing factories, aquaculture facilities and industrial discharges. Thus, ammonia and the associated ions are required parameters for regulatory reporting at many treatment plants to assist in the monitoring of operations and effluent quality. Ammonia is highly toxic to most organisms and even low levels can cause toxicity issues for animals. Increased concentrations of nitrate (>30 mg/L) can have serious impacts on aquatic organisms as it inhibits growth of some organisms and promotes that in others and can cause a number of stresses on aquatic life. Increased phosphates can also lead to enrichment and potentially eutrophication, which will result in significant changes to species composition and species diversity in the affected area. Increased levels of nitrates and phosphate can result in an increased abundance of certain algal species and may facilitate the generation of harmful algal blooms.

The dispersion modelling results presented in Section 4.4 show that a combined discharge via a single outfall or diffuser located 500 m from shore in 7.2 m of water does not meet the legislated WQG for ammonia-N under Scenario 1 or 2 (Table 4-6). This impact is therefore rated as of High significance prior to the implementation of mitigation measures (Table 5-4). Indeed, the only way for ammonia-N WQGs to be met at the 100 m mixing zone is to treat the effluent onshore and reduce the overall loading entering the system. The draft WMP is exploring mitigation measures to address concerning parameters such as ammonia-N. The proposed 'semi-treated' (Scenario 3) and 'treated' (Scenario 4) effluent profiles significantly reduce the ammonia-N end of pipe concentrations: for Scenario 4, the predicted ammonia-N concentration exceeds the threshold by 0.01 mg/L — given the conservative modelling approach, this may indeed be compliant in situ. It is critical that environmental monitoring be undertaken to validate this result. As such, the proposed 'treated' effluent profiles are assessed as of Low significance (Table 5-4).

Table 5-4. Impact 8: Elevated nutrient levels from the Combined Outfall.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Scenario 1&2 Without mitigation	Local 1	High 3	Long Term 3	High 7	Definite	**HIGH**	-ve	High
Essential mitigation measures: • Implement the proposed WMP. Discharge must meet the Scenario 4 effluent quality (Table 4-1). • Effluent must be discharged via the pipeline configuration modelled here (i.e., at 7.2 m depth, 500 m offshore). • Monitoring of end of pipe concentrations must be conducted and operations adjusted should adverse effects be detected by the monitoring program. • Ecological and water quality monitoring must be conducted in the vicinity of the outfall, to detect potential changes in subtidal community structure as a result of the discharge.								
Scenario 4 With mitigation	Local 1	Medium 2	Long Term 3	Medium 6	Possible	**LOW**	-ve	High

5.3.4 IMPACTS OF ELEVATED SUSPENDED SOLIDS

High levels of suspended solids have been shown to cause growth deficiencies in marine organisms and in some cases lead to mortalities should smothering of benthic habitats.

High TSS levels also increase turbidity and decrease light penetration which can impact on primary production, respiration and feeding in marine species (such as plankton and small pelagic fish species).

The dispersion modelling results presented in Section 4.4 show that a combined discharge via a single outfall or diffuser located 500 m from shore in 7.2 m of water does not meet the legislated WQG for TSS under Scenario 1 or 2 (Table 4-6). This impact is therefore rated as of High significance prior to the implementation of mitigation measures (Table 5-4). Indeed, the only way for TSS WQGs to be met at the 100 m mixing zone is to treat the effluent onshore and reduce the overall loading entering the system. The draft WMP is exploring mitigation measures to address concerning parameters such as TSS. The proposed 'semi-treated' (Scenario 3) and 'treated' (Scenario 4) effluent profiles significantly reduce the TSS end of pipe concentrations: for Scenario 4, the predicted TSS concentration exceeds the threshold by ~0.5 mg/L — given the conservative modelling approach, this may indeed be compliant in situ. It is critical that environmental monitoring be undertaken to validate this result. As such, the proposed 'treated' effluent profiles are assessed as of Low significance (Table 5-4).

Table 5-5. Impact 9: Increased suspended solid concentrations from the Combined Outfall.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Scenario 1&2 Without mitigation	Local 1	High 3	Long Term 3	High 7	Definite	**HIGH**	-ve	High
Essential mitigation measures: • Implement the proposed WMP. Discharge must meet the Scenario 4 effluent quality (Table 4-1). • Effluent must be discharged via the pipeline configuration modelled here (i.e., at 7.2 m depth, 500 m offshore). • Monitoring of end of pipe concentrations must be conducted and operations adjusted should adverse effects be detected by the monitoring program. • Ecological and water quality monitoring must be conducted in the vicinity of the outfall, to detect potential changes in subtidal community structure as a result of the discharge.								
Scenario 4 With mitigation	Local 1	Medium 2	Long Term 3	Medium 6	Possible	**LOW**	-ve	High

5.3.5 IMPACTS OF POTENTIAL CHANGES IN TEMPERATURE

An increase in water temperature can have a substantial impact on aquatic organisms and ecosystems, with the effects influencing the physiology of the biota (e.g. growth and metabolism, reproduction timing and success, mobility and migration patterns, and production); and/or ecosystem functioning (e.g. through altered oxygen solubility) (Bamber 1995). For thermal barriers to be effective in limiting or altering migration paths of marine organisms, they need to be persistent over time and cover a large cross-sectional area of the water body (Van Ballegooyen et al. 2005). Internationally, a number of studies have investigated the effects of heated effluent from coastal power stations on the open coast. These concluded that at elevated temperatures of less than 5°C above ambient seawater temperature resulted in little or no effects on species abundance and distribution patterns (Van Ballegooyen et al. 2005). However, some adverse effects were observed in the development of eggs and larvae (Cook 1978, Sandström et al. 1997, Lukšiene et al. 2000), alterations in the photosynthesis behaviour of algal assemblages

(Martínez-Arroyo et al. 2000), decreases in the duration of larval development (e.g. barnacle larvae, (Thiyagarajan et al. 2003), suppressed growth in the post larvae of the spiny lobster *Panulirus argus* (Lellis & Russell 1990), and increased photosynthetic and biological community metabolism rates (Parsons et al. 1977).

The impacts of increased temperature have been reviewed in a number of studies along the West Coast of South Africa, most of which focused on adverse effects experienced in southern African West Coast intertidal (e.g., the white mussel *Donax serra*) or rocky bottom species (e.g., abalone Haliotis midae, kelp Laminaria pallida, mytilid mussels, Cape rock lobster *Jasus lalandii*). In West Coast fish, reported effects of thermal pollution include an increase in biomass of shallow water hake Merluccius capensis and West Coast sole *Austroglossus microlepis* at 18°C, but no influence on chub-mackerel *Scomber japonicus* at temperatures less than 17.5°C (Macpherson & Gordoa 1992, Villacastin-Herrero et al. 1992). In addition, 18°C was found to be the lower lethal limit reported for larvae and eggs of galjoen *Dichistius capensis* (Van Der Lingen 1994). On the West Coast rocky shore, increased mean temperatures may also lead to *Mytilus galloprovincialis* outcompeting *Choromytilus meridionalis* as the juveniles of the former species grow faster in temperatures between 17 and 22°C (van Erkom Schurink & Griffiths 1993).

As such, changes in water temperature can have a substantial impact on marine species and ecosystems, with the effects either influencing the physiology of the biota (e.g. growth and metabolism, reproduction timing and success, mobility and migration patterns and production); and/or influencing ecosystem functioning (e.g. through altered oxygen solubility). This includes impacts on plankton and the pelagic food web. South African WQGs (DWAF 1995b) recommend that the maximum acceptable variation in ambient temperature should not exceed 1°C at the edge of the RMZ (Table 3-1). This is a conservative value considering the limited effects of thermal plumes on benthic assemblages reported for a change in temperature of 5°C or less (Van Ballegooyen et al. 2005).

Wright et al. (2021) showed that shore discharge did not promote adequate dispersion of elevated thermally elevated effluent so that WQG were met at the 100 m RMZ, but that these limits were met when the outfalls discharge below the water surface. As such, the impact of the combine outfall is likely to be of Low significance prior to mitigation (Table 5-6).

Table 5-6. Impact 10: Changes in temperature.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Long Term 3	Very Low 4	Probable	**VERY LOW**	-ve	High
Essential mitigation measures: • Effluent must be discharged via the pipeline configuration modelled here (i.e., at 7.2 depth, 500 m offshore). • Monitoring of end of pipe concentrations must be conducted and operations adjusted should adverse effects be detected by the monitoring program. • Ecological and water quality monitoring must be conducted in the vicinity of the outfall, to detect potential changes in subtidal community structure as a result of the discharge.								

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
With mitigation	Local 1	Low 1	Long Term 3	Very Low 4	Possible	**INSIGNIFICANT**	-ve	High

5.3.6 IMPACTS ON SEDIMENTS

Scouring of sediment around the discharge outlet can become a serious design issue for poorly designed pipe ends discharging into shallow receiving water bodies. However, this is not anticipated to be a problem for the West Point discharge as long as the outfall is angled towards the water surface to enable water to jet upwards into the water column (as per the design as recommended in Section 4.3.2, which was selected to maximise dilution potential while simultaneously minimising erosion of the sandy seabed) (Table 5.7).

Table 5-7. Impact 11: Sediment scouring and shifts in sediment movement patterns.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Long Term 3	Medium 6	Possible	**LOW**	-ve	Medium
Essential mitigation measures: • The diffuser must be angled towards the water surface to enable water to jet upwards into the water column (as per Section 4.3.2).								
With mitigation	Local 1	Low 1	Long Term 3	Low 5	Possible	**VERY LOW**	-ve	Medium

5.3.7 IMPACTS OF DISCHARGED CO-POLLUTANTS ON MARINE BIOTA

Anti-scalants, biocides, mineral acids, halogenated by-products, and heavy metals are routinely added to the brine discharges of many RO plants. The co-pollutants often include heavy metals, anti-scalants, biocides and cleaning in place (CIP) effluents. The potential effects of these co-pollutants were assessed in a previous marine impact assessment for the proposed RO plant (Wright & Hutchings 2022) and will not be reassessed here. Instead, a summary of this impact is presented in Table 5-8 below.

Table 5-8. Impact 12: The impacts of discharged co-pollutants on marine biota.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Medium Term 2	Low 5	Definite	**LOW**	-ve	Medium
Essential mitigation measures: • Aeration of the effluent prior to discharge must be undertaken should oxygen levels drop below 5 mg/L 90% of the time. • Strong acidic and alkaline solutions must be neutralised. • Construction and operation must occur in line with the results of the relevant dispersion modelling study to ensure that the effluent plume does not exceed that modelled, specifically with regards to depth of discharge, process with the brine discharge to allow for maximum dilution before release into the environment. • Monitoring of end of pipe concentrations must be conducted and adjust dosing levels should adverse effects be detected by the monitoring program.								

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
With mitigation	Local 1	Low 1	Medium Term 2	Very Low 4	Possible	VERY LOW	-ve	Medium

5.4 DECOMMISSIONING PHASE

No decommissioning procedures or restoration plans have been compiled at this stage, although impacts are expected to be similar to but of lessor magnitude than those assessed during the construction phase. The potential impacts during the de-commissioning phase are expected to be minimal in comparison to those occurring during the operational phase, and no key issues related to the marine environment have been identified at this stage. The same mitigation procedures as those explained in the construction phase should be adhered to in the decommissioning phase in order to mitigate for any of the impacts listed above.

5.5 CUMULATIVE IMPACTS

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

The primary cumulative impacts for this development are related to other discharges of nitrogenous waste (i.e., nutrients) into the same receiving environment i.e. from other fish factory farm discharges and Wastewater Treatment Works (WWTWs). The cumulative nutrient loading of the southern, sheltered portion of St Helena Bay due to long-term fish factory discharges is ongoing, and detailed in the 2023 State of St Helana Bay report (Clark et al. 2023). As many of these fish processing factories discharge their effluent close to shore, it is considered highly unlikely that the required dilutions will be achieved at the edge of the RMZ under the current CWDP limits (Clark et al. 2023).

Critically, efforts to improve effluent quality through onshore treatment must be encouraged, but is not unique to WPP — instead, a number of onshore effluent improvement options should be implemented at across all factories as a whole and should include the improvement of effluent quality as well as improvement of record keeping and monitoring to inform management actions and monitor success of interventions. It is noted that the effluent quality problem of the St Helena Bay fish processing factories is not unique to South Africa, and management interventions to improve effluent quality over time should be encouraged. It is strongly recommended that any effluent improvement strategy be undertaken in incremental stages, with more frequent and reliable monitoring data used to assess management outcomes of the specific intervention and inform the next stages.

The cumulative impacts are assessed in Table 5-9.

Table 5-9. Cumulative impacts.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Long Term 3	Medium 6	Probable	**MEDIUM**	-ve	High
Essential mitigation measures: • Effluent must be discharged via the pipeline configuration modelled here (i.e., at 7.25 m depth, 500 m from shore). • Effluent should be treated prior to discharge (through filtration/membrane technology etc.). Discharge must meet the Scenario 4 effluent quality (Table 4-1). • Monitoring of end of pipe concentrations must be conducted and operations adjusted should adverse effects be detected by the monitoring program. • Ecological and water quality monitoring must be conducted in the vicinity of the outfall, to detect potential changes in subtidal community structure as a result of the discharge.								
With mitigation	Local 1	Medium 2	Long Term 3	Medium 6	Possible	**LOW**	-ve	High

5.6 SUMMARY OF POTENTIAL IMPACTS

The impacts that may be experienced during construction and operation before and after mitigation are summarised in Table 5.10.

Table 5-10. Summary of potential impacts as a result of construction and operation of the proposed facilities.

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Construction	Impact 1: Disturbance of intertidal and subtidal habitat	Very Low	Probable	**VERY LOW**	-ve	High
	With mitigation	Very Low	Possible	**INSIGNIFICANT**	-ve	High
	Impact 2: Disturbance of pelagic habitat.	Very Low	Possible	**INSIGNIFICANT**	-ve	High
	Impact 3: Litter pollution.	Low	Probable	**LOW**	-ve	High
	With mitigation	Low	Possible	**VERY LOW**	-ve	High
	Impact 4: Hazardous substance spills.	Medium	Possible	**LOW**	-ve	Medium
	With mitigation	Low	Improbable	**VERY LOW**	-ve	Medium
	Impact 5: Increased noise and vibration.	Very Low	Definite	**VERY LOW**	-ve	Medium
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
Operation	Impact 6: Disturbance marine life due to the intake of seawater	Low	Definite	**LOW**	-ve	Medium
	With mitigation	Low	Possible	**VERY LOW**	-ve	Medium
	Impact 7: Changes in salinity	Low	Improbable	**VERY LOW**	-ve	High

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Operation (cont).	Impact 8: Elevated nutrient levels (Scenario 1&2)	High	Definite	HIGH	-ve	High
	With mitigation (Scenario 3&4)	Medium	Possible	LOW	-ve	High
	Impact 9: Increased suspended solid concentrations (Scenario 1&2)	High	Definite	HIGH	-ve	High
	With mitigation (Scenario 4)	Medium	Possible	LOW	-ve	High
	Impact 10: Changes in temperature.	Very Low	Probable	VERY LOW	-ve	High
	With mitigation	Very Low	Possible	INSIGNIFICANT	-ve	High
	Impact 11: Sediment scouring and shifts in sediment movement patterns	Medium	Possible	LOW	-ve	Medium
	With mitigation	Low	Possible	VERY LOW	-ve	Medium
	Impact 12: The impacts of discharged co-pollutants on marine biota	Low	Definite	LOW	-ve	Medium
	With mitigation	Very Low	Possible	VERY LOW	-ve	Medium

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Cumulative Impacts	Cumulative impacts	Medium	Probable	MEDIUM	-ve	High
	With mitigation	Low	Probable	LOW	-ve	High

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 DISPERSION MODELLING

Pollutant levels at the edge of the Recommended Mixing Zone (RMZ) are expected to comply with published Water Quality Guidelines (WQGs) which in turn are determined by the various beneficial users of the receiving environment. Near field modelling was performed using the Cornell Mixing Zone expert system (CorMix) to predict the geometry and dilution characteristics within the RMZ (100 m) for a range of discharge scenarios and to determine compliance with regional WQGs.

WPP is investigating the implications of combining the Outfall A and Outfall B effluents to improve dilution prior to discharge. A conservative tracer was modelled to determine the optimum outfall configuration to maximise dilution potential. Single outfall model results (Table 4-4) indicate that discharging at a pipe end diameter of 495 mm results in a discharge velocity slightly above 2 m/s. The outfall diameter needs to be increased to 515 mm to maintain a velocity of 2 m/s. Discharging within 100 m of the shore results in bank attachment some 350 m downstream of the discharge. This is considered to be unacceptable from a marine ecological perspective — discharging at 500 m offshore ensures no bank attachment occurs and is the environmentally preferable option.

Near field results for all scenarios indicate that the discharge via a single outfall 500 m from shore in 7.2 m of water does not meet the legislated WQG for ammonia-N and TSS at the 100 m RMZ for any of the pipe end diameters under consideration. The proposed 'semi-treated' (Scenario 3) and 'treated' (Scenario 4) effluent profiles significantly reduce the ammonia-N and TSS end of pipe concentration. Under Scenario 4, the predicted ammonia-N concentration exceeds the threshold by 0.01 mg/L, while TSS exceeds the threshold by 0.5 mg/L. Given the conservative modelling approach, this may indeed be compliant in situ. It is critical therefore that environmental monitoring be undertaken to validate this result.

6.2 IMPACT ASSESSMENT

A total of eleven potential environmental impacts were assessed operation for this report, both construction impacts (loss of habitat, disturbance to and/or mortality of marine life due to construction activities associated with installation of the intake and discharge pipelines) and operational impacts (disturbance to and/or mortality of marine life due to the intake of seawater and discharge of effluent into the marine environment).

Of these identified impacts, one was rated as Insignificant' and do not require mitigation, five were rated as of Very Low significance before mitigation (rated Very Low or Insignificant after mitigation). Five impacts were rated as of Low significance and are reduced to Very Low significance with mitigation). Two impacts were rated as of High significance, with implementation of mitigation measures expected to reduce this rating to Low significance (Table 5-10).

The primary cumulative impacts for this development are related to other discharges of nitrogenous waste (i.e., nutrients) into the same receiving environment i.e. from other fish factory farm discharges and WWTWs. The cumulative nutrient loading of the southern,

sheltered portion of St Helena Bay due to long-term fish factory discharges is ongoing, and detailed in the 2023 State of St Helana Bay report (Clark et al. 2023). These impacts must be managed through onshore treatment across all factories as a whole, and should include the improvement of effluent quality as well as improvement of record keeping and monitoring to inform management actions and monitor success of interventions. It is strongly recommended that any effluent improvement strategy be undertaken in incremental stages, with more frequent and reliable monitoring data used to assess management outcomes of the specific intervention and inform the next stages.

6.3 MONITORING

On receipt of a Coastal Waters Discharge Permit (CWDP), the end of pipe concentrations published in the permit conditions must be met to ensure compliance at the edge of the Recommended Mixing Zone (RMZ). Compliance monitoring of the effluent before discharge should be performed to minimise environmental impacts. If discharged effluent exceeds the end of pipe values at any time, the operation will be in violation of the CWDP and the cause of poor effluent quality must be identified, reported and rectified immediately.

A continuous in situ monitoring program should be implemented to validate the dispersion modelling and assess compliance with WQGs. A data logging instrument capable of measuring conductivity, temperature and depth (CTD) should be moored at the 100 m RMZ for a period of at least one year. Additional quarterly monitoring should be conducted at the sites (including adequate control sites) for temperature, TSS, dissolved oxygen, salinity, ammonia and pH at the edge of the RMZ.

It is recommended that rocky intertidal and subtidal communities be monitored. Biological indicators such as species abundance, biomass and diversity provide a direct measure of the state of the ecosystem in space and time and tend to be directly affected by pollution/disturbance. It is recommended that a minimum of three sites be monitored in the vicinity of each outfall, with three control sites. Monitoring should be aligned to the State of St Helena Bay monitoring program methodology so that any changes detected can be assessed in the context of larger scale trends in the Bay.

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8 APPENDIX I

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.

- **INSIGNIFICANT**: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity.
- **VERY LOW**: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.
- **LOW**: the potential impact may not have any meaningful influence on the decision regarding the proposed activity.
- **MEDIUM**: the potential impact should influence the decision regarding the proposed activity.
- **HIGH**: the potential impact will affect a decision regarding the proposed activity.
- **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 • Xxxx • 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:

Phase	Impact identified	Severity	Probability	Significance	Status	Confidence
xxxxxx	Impact 1: xxx	Medium	Improbable	**LOW**	–ve	High
	With mitigation	Low	Improbable	**VERY LOW**		High
	Impact 1: xxx	Very Low	Definite	**VERY LOW**	–ve	Medium
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	–ve	Medium

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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