



# Environmental Management Programme

## Proposed Development of the Granger Bay Precinct and Reclamation of Land at the V&A Waterfront in Cape Town, Western Cape

PREPARED IN COMPLIANCE WITH THE REQUIREMENTS  
OF THE EIA REGULATIONS, GN 326 OF 2017 AND THE  
NATIONAL ENVIRONMENTAL MANAGEMENT ACT, ACT  
NO. 107 OF 1998

DEA&DP REF NO. 16/3/3/2/A7/4/3051/25

**VERSION: DRAFT FOR PUBLIC COMMENT**

**DATE: MARCH 2026**

**APPLICANT**

V&A Waterfront Holdings



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# REPORT DETAILS

## PROPOSED DEVELOPMENT OF THE GRANGER BAY PRECINCT AND RECLAMATION OF LAND AT THE V&A WATERFRONT IN CAPE TOWN, WESTERN CAPE: ENVIRONMENTAL MANAGEMENT PROGRAMME

### APPLICANT

#### V&A Waterfront Holdings

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### Report purpose

This Environmental Management Programme is prepared as part of a Scoping and Environmental Impact Assessment in terms of the Environmental Impact Assessment Regulations, 2014 (as amended). It prescribes control methods to mitigate and manage negative environmental impacts and enhance positive impacts associated with the construction and operation of the development and provides a programme for monitoring the performance of personnel in applying such methods.

### DOCUMENT CONTROL

Date	Version
18 March 2026	Draft

### DECLARATION OF EAP'S INDEPENDENCE

I, Jeremy Rose, appointed by the V&A Waterfront Holdings as Environmental Assessment Practitioner for the Environmental Management Programme, hereby declare that the information provided in this report and supporting documentation is complete and correct to the best of my knowledge; that other than fair remuneration for work performed in terms of this application I have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; that I have disclosed, to the Applicant, the specialist(s), the Competent Authority and registered interested and affected parties all material information that have or may have the potential to influence the decision of the Competent Authority; that I have ensured that information in respect of the application was distributed or was made available to registered interested and affected parties and that participation will be facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments; and that I am aware that a false declaration is an offence in terms of Regulation 48 of the NEMA EIA Regulations.



**Jeremy Themba Rose** BSc (Hons), Reg. E.A.P. 2019/1116, Pr.Sci.Nat. 120148, IAIAsa member 5781

Infinity Environmental (Pty) Ltd: Director & Principal EAP

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## EMPR OVERVIEW

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# 1 INTRODUCTION

## 1.1 Project Background

V&A Waterfront Holdings (Pty) Ltd. proposes to develop the Granger Bay Precinct of the Victoria & Alfred Waterfront for a new mixed-use residential and commercial development, west of Beach Road and north of Granger Bay Boulevard in Cape Town. The proposal includes the reclamation of land from the sea, protected by new coastal defence structures, including two new breakwaters forming a sheltered bay. The proposal would provide for public access along this section of shoreline west of the V&A Waterfront, extending the existing public promenade.

## 1.2 Project Description

### 1.2.1 Proposed reclamation of land and new coastal protection structures

The proposed development involves the reclamation of approximately 3.2 hectares of land from Table Bay to accommodate new coastal public amenities and new mixed-use development.\* This reclamation will be protected by a new permanent rock revetment and two ('east' and 'west') breakwaters forming a new protected bay approximately three hectares in extent. The west breakwater will extend approximately 90 metres into Table Bay, and the east breakwater approximately 140 metres. A revetment along the new shoreline connecting the two breakwaters will be approximately 540 metres long. New public amenities will include the new bay, providing sheltered waters for boating, kayaking, and swimming. Land-based amenities will include a coastal public walkway, a slipway, a fixed quayside, a landscaped promenade, tidal pools, pedestrian paths and open areas. The proposed revetment and breakwater will be constructed in phases over approximately 3 years.

### 1.2.2 Mixed-use development

New mixed-use development is proposed on the portion of the site currently located within 100m of the highwater mark, which will accommodate residential, hotel, leisure, and commercial uses, with residential accommodation options such as hotels, serviced apartments, and private apartments. The orientation and massing of buildings will respond to the coastal setting and maximise outward views of the ocean. Approximately 78 000 m<sup>2</sup> of bulk will be allocated from the existing development rights permitted within the V&A Waterfront. Development rights are already in place for a portion of the Granger Bay precinct not included in this Scoping and EIA.

### 1.2.3 Public space

New public amenities will include the new bay, providing sheltered waters for boating, kayaking, and swimming. Land-based amenities will include a coastal public walkway, a slipway, a fixed quayside, a landscaped promenade, tidal pools, pedestrian paths, and open areas. This will be accessible to the public in the same way that the other public areas in the Waterfront are open to the public.

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\* As measured from the current highwater mark of the sea; if measured from the existing cadastral boundary, a total of 3.8 hectares of new land is proposed to be reclaimed, but this includes areas of existing coastal protection infrastructure.

### 1.2.4 Slipway and Boat Launching Area

A new public slipway is part of the amenities to be provided; due to the importance of this slipway and the fact that continuous utilisation is required throughout construction, it is a specific focus of the EMPr.

#### Location

The proposed slipway will be located at the northeastern end of a new road, establishing a direct vehicular connection from Beach Road to the launching facility. Trailer and vehicular parking will be accommodated on-site within the parking area of a new building adjacent to the slipway, ensuring convenient and efficient access between parking and the launch zone.

#### Parking

Designated trailer and vehicle bays within the podium parking area will optimise spatial efficiency while also providing parking for visitors and other users. In addition, a parallel stacking lane along the approach road to the slipway will accommodate vehicles queuing to launch watercraft without disrupting primary circulation routes. Overflow parking can be located on Beach Road as is the current practice.

#### Non-Motorised vessels

Non-motorised vessels, including kayaks and stand-up paddle boards, will be accommodated at a separate launch area, either from an area separate to the slipway or a floating jetty with integrated access steps to ensure ease of use. This separation will reduce congestion at the main slipway and enhance safety and user experience for non-motorised vessel operators. Some storage for kayaks and other non-motorised craft will be provided within the podiums of buildings., positioned in close proximity to the dedicated non-motorised launch area.

#### Design Informants

The design informants that have determined the location and configuration of the proposed slipway in Granger Bay are based on the principles of providing the existing slipway user groups with an accessible, launching facility that will, in future, be located in a coastal environment favourable for various leisure craft and recreational use of the ocean. It is envisaged that the slipway and the surrounding area will support and encourage small-scale maritime activity, innovation, and the place identity of the V&A Waterfront. To further activate the precinct, ground-floor podium spaces near the slipway are intended to accommodate ocean-related businesses and enterprises, contributing to a vibrant and integrated waterfront environment.

### 1.2.5 Transport and services

The Granger Bay development will be supported by various transport modes, including MyCiTi, Park & Ride, and micro-mobility services, with enhanced integration between these modes. No major access road or external road network upgrades are required to support the proposed development. Wastewater management, potable water supply, solid waste removal and disposal, and electricity supply will be accommodated within the existing infrastructure capacity.

## 1.3 Project Implementation and EMPr structure

Coastal protection infrastructure and land reclamation is programmed to be completed prior to any mixed-development development being constructed. Furthermore, while coastal infrastructure will be phased over a period of around 2.5 years, it is not known at the time of writing this EMPr precisely

when the mixed-use aspect of the development will commence, nor how this will be phased. With this in mind, the EMPr has been structured in a way that allows for different aspects of the development to be managed and monitored as and when they become applicable during the project's implementation phase.

**Aspects:** Two distinct activities are proposed and have informed the structure of this EMPr as detailed in **Figure 2-1**: Activities **above the current highwater mark (HWM)** and activities **below the current highwater mark**. Activities above the HWM largely focus on the construction of the mixed-use component of the project and other activities landward of the HWM, whereas activities below the HWM includes the land reclamation, construction of the revetments and other activities seaward of the HWM.

**Implementation phase:** The **stage** of the project life cycle, which, by necessity, will be different for different aspects of the project. That is, it is necessary for activities seaward of the HWM to be in the post-construction phase before activities landward of the HWM can be in the construction phase.

Thus, the mitigation measures have been structured in a way that allows for specific aspects of the environmental management programme to be applicable only at the relevant phase of implementation and ensure clarity of responsibilities and ease of auditing.

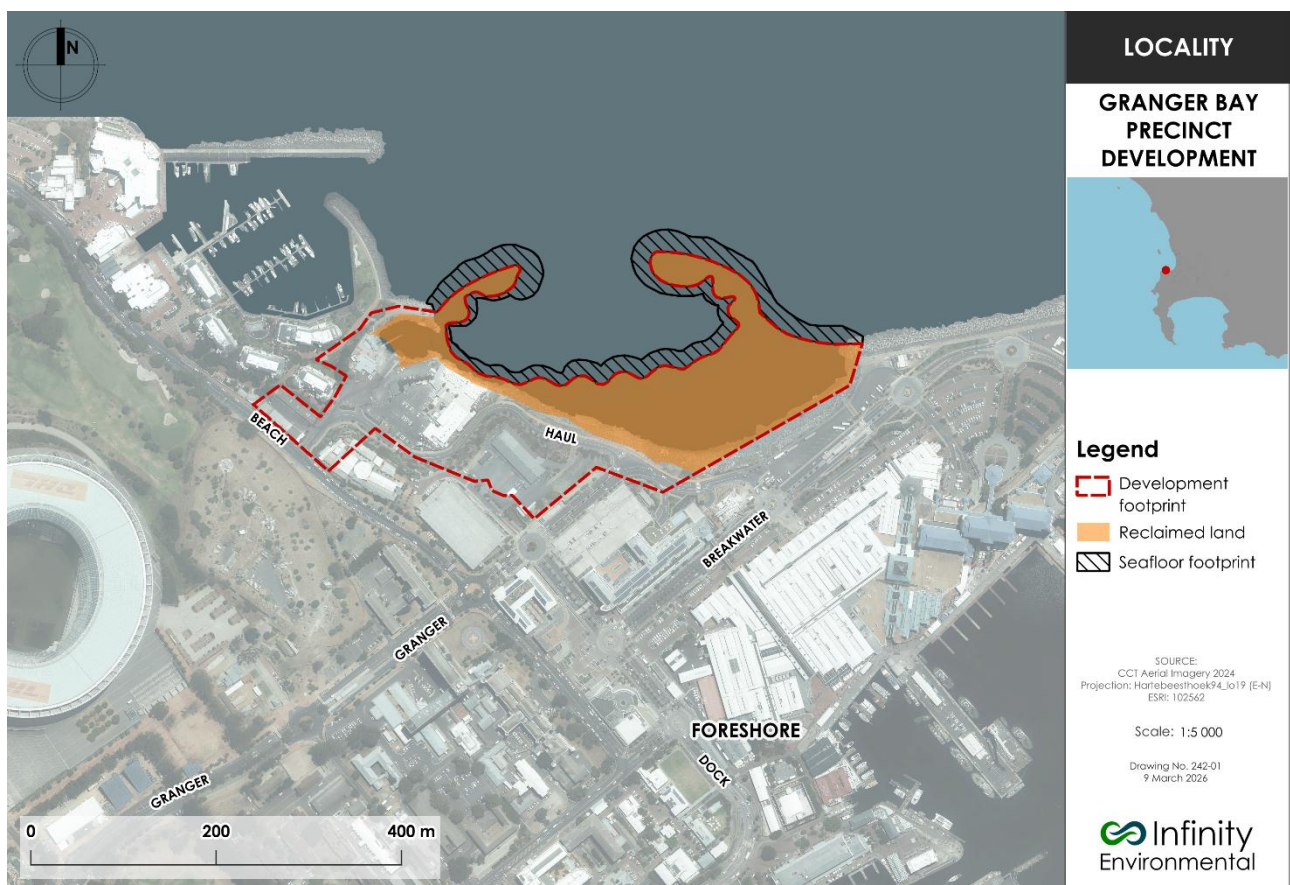


Figure 1-1: Locality map of the site and proposed land reclamation area

## 1.4 Environmental Sensitivities

### 1.4.1 Marine biodiversity

Construction will result in the direct loss of artificial rocky shore habitat, specifically that of the Granger Bay dolosse, and adjacent subtidal sandy and reef habitat (NBA 2018 Cape Mixed Shore ecosystem). Soft sediment habitats will be lost, and pelagic open water habitat will be disturbed by the development during both construction and operation.

Specific marine ecosystems are not mapped Figure 1-2 as the entire development footprint falls within marine ecosystems. It is accepted that the loss of habitat cannot be avoided within the development footprint. Mitigation measures to manage the impact of activities associated with the development is included in this EMPr.

### 1.4.2 Heritage resources

Heritage resources make up the rest of the sensitivities for the site. None of these sensitivities constitute No-Go areas, but they have either been considered as design informants where specific avoidance or compliance is necessary; or where impacts on resources are unavoidable, mitigation measures have been included to minimise and manage the negative impacts of the proposed development on these resources.

#### 1.4.2.1 Visual sensitivities

The Arc of Fire: the historic arc of fire from a gun emplacement at Fort Wynyard, where no buildings may exceed a height of 21.5m in the arc, and buildings of 10 and 16 floors are acceptable outside of the arc (Figure 1-3) is a heritage sensitivity that has informed the design of the proposed development in regard to heights and massing.

**Water's edge view:** the 30-metre-wide view corridor from the main gun emplacements to the coastline needs to be kept open to ensure a visual linkage between Table Bay and Fort Wynyard.

#### 1.4.2.2 Archaeological sensitivities

Pre-colonial archaeological material could survive under the later landfill along the former coastline within the Granger Bay Land Reclamation project site. Given the rarity of such survivals of pre-colonial material in the developed urban context of this part of the city, the archaeological significance and value of any such sites or materials is likely to be high. There is also potential to find pre-colonial archaeological sites and artefacts, and to recover paleoenvironmental data from submerged, seabed contexts within Table Bay. Consideration should be given to the possibility that at least some shipwrecked vessels are located within the project area, making their exact location unknown. It is possible that unmarked burials could be present in the same areas of the site that may be archaeologically sensitive.

#### 1.4.2.3 Social sensitivity

Many of the fishermen who use the slipway belong to communities who were forcibly removed from Cape Town (District 6, Sea Point) during the Apartheid years and have a long-standing tradition of using the facility to launch their boats. Access to the slipway is regarded as being of high significance to these fishermen (IIIC heritage grading). A new slipway is planned to be constructed to replace the existing slipway (mapped in Figure 1-3), but the transition between the operation of the current and the new slipway needs to be carefully managed, and access for vessels to the ocean needs to be maintained.



Figure 1-2: Proposed development superimposed on terrestrial and marine sensitivities (Arrows indicate the direction of the sensitivity)



Figure 1-3: Combined map indicating sensitivities, development footprint and construction area.

## 1.5 Impacts assessed during the EIA

**This EMPr gives effect to the mitigation measures prescribed in the environmental impact assessment.**

Based on the specialist studies, the following potential direct impacts, as indicated in Table 2 have been identified. Appropriate management and mitigation measures are included within the EMPr (where required) as per the recommendations made in the specialist studies to ensure the potential impacts are adequately mitigated and managed during all phases of the project.

It should be noted that other impacts for which specialist studies were not undertaken but where mitigation or management actions may be required, are also included in the EMPr.

### 1.5.1 Construction Phase Impacts

**Table 1-1. Key impacts and mitigation measures assessed in the EIA**

Impact Description	Key Mitigation Summary	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
<b>Marine Ecosystem Impacts</b>				
Disturbance of intertidal and subtidal artificial habitat: rocky habitat (dolosse revetment removal and replacement)	Limit duration; constrain spatial extent	<b>Very Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
Disturbance of intertidal and subtidal artificial habitat: sediment habitats (reclamation footprint)	Careful placement and stabilisation of reclaimed material; silt curtains around active reclamation; constrain disturbance area	<b>Very Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
Impacts of construction on West Coast Rock Lobster ( <i>Jasus lalandii</i> ) — habitat loss and displacement	Limit extent of construction disturbance	<b>Low, Negative</b>	<b>Low, Negative</b>	Neutral
Disturbance to pelagic open water habitats (fish, invertebrates) from construction turbidity and vessel activity	Silt curtains; careful material handling; limit turbidity-generating activities to daytime; stabilise disturbed areas immediately; no concrete wash or hydrocarbons to marine environment	<b>Very Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
Effects of construction waste generation and disposal on marine ecosystems	Appropriate waste handling protocols	<b>Medium, Negative</b>	<b>Very Low, Negative</b>	Neutral
Effects of construction related pollution on marine ecosystems (oils, fuels, cement)	Spill prevention plan; bunded fuel storage; no leaking vehicles; immediate	<b>Low, Negative</b>	<b>Very Low, Negative</b>	Neutral

Impact Description	Key Mitigation Summary	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
	containment and reporting of any spill; dedicated spill kits on-site; sediment management			
Construction noise and vibration impacts on marine organisms (invertebrates, fish, birds) - including potential piling	Periodic maintenance checks of equipment	<b>Very Low, Negative</b>	<b>Insignificant, Negative</b>	Neutral
Impacts on marine mammals (Heaviside's dolphins, Cape fur seals) - vessel disturbance and noise	Speed limit for vessels, marine mammal observer protocol	<b>Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
Noise and vibration impacts of the reclamation and in-water marine construction	Soft-start piling protocol; restrict piling to weekday daytime; Marine mammal observer; Underwater Noise Management Plan	<b>Medium to High, Negative</b>	<b>Low to Medium, Negative</b>	Neutral
<b>Climate Change Hazards</b>				
High wind speeds and associated storm surge delays construction and/or damages equipment.	None required due to the low significance of the impact.	<b>Very Low, Negative</b>		N/A
High shear stress impacts the settling of sand, concrete, etc. used for construction, delaying completion.	None required due to the low significance of the impact.	<b>Low, Negative</b>		N/A
<b>Archaeology</b>				
Disturbance or destruction of pre-colonial terrestrial archaeological material (middens, LSA sites) within reclamation footprint	Archaeological monitoring during coastal construction; suitably qualified archaeologist on-site; discovery protocol (cease works, report to HWC)	<b>Medium, Negative</b>	<b>Low, Negative</b>	Neutral
Impact on maritime archaeology (shipwrecks) within reclamation and breakwater footprint	Geophysical survey (sidescan sonar, multibeam bathymetry, sub-bottom profiler) prior to construction;	<b>High, Negative</b>	<b>Low, Negative</b>	Neutral

Impact Description	Key Mitigation Summary	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
	archaeologist review; redesign around confirmed wreck sites.			
<b>Visual and sense of place impacts</b>				
Temporary visual disturbance from construction site hoardings, cranes, and stockpiles	Manage stockpiles, waste management, site camp screening; no unnecessary night-time lighting.	<b>Medium - High, Negative</b>	<b>Medium, Negative</b>	Neutral
<b>Heritage impacts</b>				
Disruption of access to the slipway	Slipway access maintained throughout; advance notices for closures	<b>Medium, Negative</b>	<b>Low Negative</b>	Neutral
Disruption of pedestrian access to the shoreline	Phase activities to maximise access to existing boardwalks	<b>Medium, negative</b>	<b>Medium, Negative</b>	Neutral
<b>Traffic impacts</b>				
Increased traffic volumes from rock haulage (≈35 loaded trucks/day over 2 years) on Helen Suzman Blvd, Buitengracht, and Granger Bay Boulevard	Traffic Management Plan; designated haul route; no peak-hour haulage; coordination with CCT Urban Mobility	<b>High, negative</b>	<b>Low, negative</b>	Neutral
Pavement wear and dust on haul route from heavy vehicle movements	Pre-construction road condition survey; contractor responsible for repair; tarpaulin covers on loads	<b>High, negative</b>	<b>Low, negative</b>	Neutral
Construction worker and public safety risk on haul route and site access points	Traffic marshals; hoarding; pedestrian alternatives; flaggers at site crossings	<b>Medium, negative</b>	<b>Very low, negative</b>	Neutral
Temporary road closures, lane restrictions, and diversions	Advance public notice; flagpersons and barriers; signalled detours; early liaison with MyCiti	<b>Medium, negative</b>	<b>Very low, negative</b>	Neutral
<b>Construction Nuisance Impacts (Noise, Dust, and Visual)</b>				
Noise and vibration - general land-side construction (demolition, earthworks, structural works)	PN 200 working hours; electric tools preferred; generator enclosures	<b>Medium, Negative</b>	<b>Low - medium, Negative</b>	Neutral

Impact Description	Key Mitigation Summary	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
Fugitive dust - construction activities (all aspects): rock haulage, stockpiling, end-tipping and demolition, earthworks, concrete cutting	Tarpaulin covers on all loads; wheel wash; twice-daily haul road watering; wind-break fencing on stockpiles; activity suspension when wind >15 m/s; wet-cutting for concrete demolition	<b>Low - Medium, Negative</b>	<b>Low, Negative</b>	Neutral
<b>Socio-economic impacts</b>				
Temporary stimulation of production and GDP (R24.2 billion total production; R8.8 billion GDP contribution) from construction expenditure across construction, supply, and service industries	Procurement of local goods and services; BBBEE-compliant contractor conditions; reporting of economic contribution	<b>Medium - High, Positive</b>	<b>Medium - High, positive</b>	Neutral
Temporary positive impact on employment (≈26,929 direct, indirect, and induced jobs during construction)	Local employment targets; skills development programme; BBBEE requirements in contractor conditions	<b>Medium - High, Positive</b>	<b>High, Positive</b>	Neutral
Temporary positive impact on household income (approximately R4 billion distributed across industries)	Prioritisation of local labour and construction companies	<b>Medium, Positive</b>	<b>Medium - High, Positive</b>	Neutral
Temporary negative impact on traffic congestion along Helen Suzman Blvd and Buitengracht from construction haulage	Traffic Management Plan; peak-hour haulage exclusion; coordination with CoCT Urban Mobility and MyCiTi	<b>Medium - High, Negative</b>	<b>Medium, Negative</b>	Neutral
Nuisance caused by construction activities and resultant impact on neighbours and visitors – noise, dust and visual intrusion	Compliance with regulations, regular maintenance of site camp	<b>Medium, Negative</b>	<b>Low, Negative</b>	Neutral
Temporary displacement of marine wildlife-based tourism (kayaking, SUP operators) due to construction noise and vessel activity in Granger Bay	Limit construction noise; maintain access routes where possible, early engagement	<b>Medium, Negative</b>	<b>Low, Negative</b>	Neutral
Temporary disruption to economic activity of informal traders and small businesses	Maintain access routes where possible; early engagement with affected operators;	<b>Medium, Negative</b>	<b>Low, Negative</b>	Neutral

Impact Description	Key Mitigation Summary	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
operating in and around Granger Bay during reclamation	advance notice of access restrictions			
Temporary disruption to recreational use	Manage access; proactive communication with users of the bay; avoid peak boating seasons	<b>Medium, Negative</b>	<b>Low, Negative</b>	Neutral

### 1.5.2 Post-Construction Phase Impacts

Table 1-2. Key impacts and mitigation measures assessed in the EIA

Impact Description	Key Mitigation	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
<b>Coastal Dynamics</b>				
Short-wave reflections into Table Bay from the eastern breakwater face, affecting surf conditions and small craft operations	Breakwater geometry optimised through wave modelling to minimise offshore reflection energy; monitoring programme	<b>Low, Negative</b>	<b>Low, Negative</b>	Neutral
Longshore sediment transport - no significant change anticipated	None required	<b>Insignificant, Negative</b>	<b>Insignificant, Negative</b>	Neutral
Short-wave reflections towards the Granger Bay Marina from the inner breakwater faces, affecting berthing conditions	None required	<b>Low, Negative</b>	<b>Low, Negative</b>	Neutral
Long-wave reflections towards the Granger Bay Marina – low-probability possibility of resonance	Should accentuated long wave action present in the Granger Bay Marina, wave mitigation measures should be investigated and implemented.	<b>Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
Short and long wave reflections onto the Granger Bay Marina breakwater	Monitoring and rehabilitation of the breakwater, when necessary	<b>Very Low, Negative</b>	<b>Very Low, Negative</b>	Neutral

Impact Description	Key Mitigation	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
Impacts on small craft operations - wave conditions in new bay	User awareness programmes	<b>Very Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
<b>Marine Ecology</b>				
Permanent change in habitat and ecosystem function - replacement of natural rocky shore and soft sediment with reclaimed land and artificial hard substrate	Management of potential pollution sources	<b>Low, Negative</b>	<b>Very Low, Negative</b>	Neutral
Long-term loss of rocky shore habitat replaced by artificial hard substrate (dolosse) - opportunity for artificial reef recolonisation	None practically possible	<b>Low, Negative</b>		Neutral
Long-term impacts on West Coast Rock Lobster – creation of additional habitat (albeit artificial)	None required	<b>Low, Positive</b>		Neutral
Increased vessel traffic in operational marina and bay - fuel spill risk, underwater noise, propeller strike risk for marine fauna	Speed limits within bay; no-idling zones; spill response kits at marina; no-wake zones near tidal pools; stringent pollution prevention protocols	<b>Medium, Negative</b>	<b>Very Low, Negative</b>	Neutral
Disturbance to marine mammals	None practically possible. Marine mammal response unpredictable to some extent.	<b>Low, Negative*</b>		Neutral
		<i>*Significance ratings presented here have the higher confidence rating.</i>		
<b>Climate Change</b>				
Proposed development prevents high wind speeds and associated storm surge in the area damaging established infrastructure.	None required	<b>Medium, Positive</b>		Negative
Proposed development reduces the risk of coastal flooding	None required	<b>Medium, Positive</b>		Negative

Impact Description	Key Mitigation	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
Proposed development reduces the risk of coastal erosion	None required	<b>Medium, Positive</b>		Negative
Increased potential for groundwater intrusion – affecting the entire region**	Where feasible, rainwater storage for the extended dry period; greywater recycling,	<b>Low, Negative</b>	<b>Low, Positive</b>	Low, Negative
Reduce water availability for the development due to increased drought periods**	Where feasible, rainwater storage for the extended dry period; greywater recycling; consideration of alternative water sources should this risk be realised	<b>Low, Negative</b>	<b>Low, Negative</b>	Neutral
Increased potential for fires starting and spreading to Granger Bay**	None required	<b>Very Low, Negative</b>		Neutral
Chemical erosion resulting from increased temperatures and reduced ocean pH**	None required	<b>Low, Negative</b>		Neutral
<i>**Climate change related risks to the development, rather than impacts posed by the development.</i>				
Visual and Sense of Place				
Change in visual character and sense of place – buildings generally setback to provide views. Uncertainty on final designs.	Building forms and finishes to be finalised in detailed design; appropriate landscaping measures to soften hard infrastructure	<b>High, Negative</b>	<b>Medium, Negative</b>	Low, Negative (status quo retained)
Visual intrusion – Certain packages need to be carefully planned to minimise obstruction on existing view lines	Views down Granger Bay Blvd to Table Bay to be retained; careful articulation of buildings in packages 1 and 2	<b>Medium - High, negative</b>	<b>Medium, negative</b>	Low, Negative (status quo retained)
Light pollution from operational security and amenity lighting affecting the promenade, tidal pools, and marine environment	Downward-directed and shielded luminaires only; low-level path lighting; no lighting into marine water above minimum safe navigation standard	<b>Medium, Negative</b>	<b>Low, Negative</b>	Low, Negative (status quo retained)
Transport impacts				

Impact Description	Key Mitigation	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
Increased traffic volumes on Beach Road and Granger Bay Boulevard and Dock Road	<p><i>Only relevant to any portion of the proposed development which does not utilise pre-existing development rights held by the V&amp;AW, therefore not applicable at this stage.</i></p> <p>Granger Bay Blvd extension as a dual carriageway; internal road geometry to City guidelines; promote NMT</p>	<b>High, Negative</b>	<b>Low, Negative</b>	Neutral
Impact on intersection performance and capacity		<b>High, Negative</b>	<b>Low, Negative</b>	Neutral
Access safety and local circulation		<b>Medium, Negative</b>	<b>Very Low, Negative</b>	Neutral
Non-Motorised and Public Transport Facility Provision		<b>Medium, Negative</b>	<b>Very Low, Negative</b>	Neutral
<b>Socio-economic impacts</b>				
Sustained positive impact on production and GDP – increase total production by ≈R691.8 million and contribute ≈R322.3 million to GDP annually.	Local procurement; SMME development	<b>Medium, Positive</b>	<b>High, Positive</b>	Neutral
Sustained positive impact on employment - approximately 822 direct, indirect, and induced jobs during construction	Local employment preference; BBBEE compliance	<b>Low-Medium, Positive</b>	<b>High, Positive</b>	Neutral
Sustained positive impact on household income from permanent operational employment	Local labour preference	<b>Medium, Positive</b>	<b>Medium - High, Positive</b>	Neutral
Sustained increase in government revenue through rates, taxes, and harbour permits	N/A - inherent benefit; no mitigation required	<b>Medium, Positive</b>	<b>Medium, Positive</b>	Neutral
Sustained positive impact on tourism and the visitor economy - new coastal destination reinforcing Cape Town's tourism competitiveness	Public access to promenade maintained at no charge; tourism signage and wayfinding; accessible design throughout	<b>Medium-High, Positive</b>	<b>High, Positive</b>	Neutral

Impact Description	Key Mitigation	Preferred Alternative		No-Go Alternative
		Pre-Mitigation	Post-Mitigation	
Enhanced coastal public access through a minimum 9m wide and 750m long promenade, tidal pools, sea park, and public quayside - equitable access to coastal public property	Ensure public right of way maintained in perpetuity; universally accessible design; no barriers to public beach or promenade, noting that control measures will be put in place on extremely busy days, where crowds on the breakwaters may be a safety hazard.	<b>Medium-High, Positive</b>	<b>High, Positive</b>	Neutral
Increased access to marine infrastructure for recreational boating, tourism operators, and small marine enterprises	Inclusive slipway access; berthing fee structure established in conjunction with user groups; slipway accessible throughout construction and operations	<b>Medium-High, Positive</b>	<b>High, Positive</b>	Neutral
Enhanced physical and visual access to the coastline benefiting diverse user groups including persons with disabilities	Universal access design; level pathways; accessible ablution facilities; tactile paving and signage at key nodes	<b>Medium-High, Positive</b>	<b>High, Positive</b>	Neutral
Long-term integration of reclaimed land into the urban environment - improved land use efficiency and coastal amenity	Mixed-use zoning with active ground floor uses; publicly accessible coastal edge; no private enclosure of coastal public property	<b>Medium-High, Positive</b>	<b>High, Positive</b>	Neutral
<b>Heritage Impacts</b>				
Visual, physical or design implied constraints on pedestrian access to coastline	Designs make provision for coastal public walkways and coastal public space	<b>High, Negative</b>	<b>Low – Medium, Negative</b>	<b>Low, Negative</b>

# 2 APPROACH AND STRUCTURE

## 2.1 Structure of the EMPr

As described in detail in Section 1.3, the EMPr is structured as a set of nested environmental management plans, as shown in

Figure 2-1. Some mitigation measures are specific to certain aspects of the activity (e.g., marine mammal monitoring during marine construction and reclamation), whereas others are applicable to all aspects of the activity (e.g., containment and proper handling of hazardous materials). To avoid duplication, these mitigation measures have been categorised according to their applicability in different tables. Aspects of these will be supplemented by more detailed levels of planning as and when the proposed development is implemented, as indicated.

There may be some overlap between the phases. A decommissioning phase is not included, as it is not anticipated that the proposed infrastructure will be decommissioned.

IMPLEMENTATION PHASE (SECTIONS)			
	SECTION 4: PRE-PLANNING & DESIGN PHASE	SECTION 5: CONSTRUCTION PHASE	SECTION 6: POST- CONSTRUCTION
ASPECT OF ACTIVITY (TABLES)	<b>TABLE 1:</b> All aspects / General requirements  Table 4-1: PLANNING AND PRE- CONSTRUCTION: ALL ASPECTS	Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS	Table 6-1: POST- CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS
<b>TABLE 2:</b> Aspects or infrastructure <u>above</u> the HWM	Table 4-2: PLANNING AND PRE- CONSTRUCTION: ASPECTS <u>ABOVE</u> THE HIGH-WATER MARK	Table 5-2: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS <u>ABOVE</u> THE HIGH-WATER MARK	Table 6-2: POST- CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS <u>ABOVE</u> THE HIGH-WATER MARK
<b>TABLE 3:</b> Aspects or infrastructure <u>below</u> the HWM	Table 4-3: PLANNING AND PRE- CONSTRUCTION: ASPECTS <u>BELOW</u> THE HIGH-WATER MARK	Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS <u>BELOW</u> THE HIGH-WATER MARK	Table 6-3: POST- CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS <u>BELOW</u> THE HIGH-WATER MARK

Figure 2-1. Schematic of EMPr content and structure

The table below lists the method statements required to be compiled as part of the implementation of the project. These method statements may be prepared subsequent to environmental authorisation. All method statements required for the construction phase of all aspects must be approved by the Engineer.

**Table 2-1: Method Statements Required**

Method Statement / Management Plan	Relevant Implementation Phase		
	Pre-construction & Planning	Construction	Post-Construction
Lighting Plan	✓		
Construction Phasing Plan	✓		
Construction Management Plan for the New Bay and Slipway	✓		
Landscape Plan(s)	✓		
Demarcation of Working & No-Go Areas		✓	
Construction Liaison Committee		✓	
Construction Access and Traffic Management Plan	✓ (high level)	✓ (detailed)	
Spill Prevention, Containment and Response Plan		✓	
Waste Management Plan		✓	
Dust Management Plan		✓	
Site Camp Establishment Method Statement (locational & visual)		✓	
Management of Ocean Access (public, vessels, crafts) & phasing thereof		✓	
Archaeological Monitoring Plan		✓	
Baseline Water Quality Monitoring Programme		✓	
Underwater Noise Management Plan		✓	
Marine Mammal Monitoring Plan		✓	
Vessel Management Plan		✓	
Operational Management Plan for the New Bay and Slipway			✓

## 2.2 Legislative compliance

A key objective of the EMPr is to satisfy the requirements of Appendix 4 of the amended NEMA EIA Regulations published in Government Notice No. R 326 of 7 April 2017. These regulations prescribe the content of the EMPr and specify the type of supporting information that must accompany the submission of the report to the competent authority. An overview of where the requirements are addressed in this EMPr is presented in Table 2-2 overleaf.

**Table 2-2: Compliance with EIA Appendix 4 Requirements**

Appendix 4 of EIA Regulations	
1. An EMPr must include- (a) details of- (i) the EAP who prepared the EMPr; and (ii) the expertise of that EAP to prepare an EMPr, including a curriculum vitae;	Appendix 1 of EMPr

Appendix 4 of EIA Regulations	
(b) a detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description;	Section 1.2 and Section 1.3
c) a map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that should be avoided, including buffers;	Figure 1-3
(d) a description of the impact management outcomes, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development including— (i) planning and design; (ii) pre-construction activities; (iii) construction activities; (iv) rehabilitation of the environment after construction and where applicable post closure; and (v) where relevant, operation activities;	All tables in Sections 4, 5 and 6 – 2 <sup>nd</sup> column.
e) a description of proposed impact management actions, identifying the manner in which the impact management outcomes contemplated in paragraph (d) will be achieved, and must, where applicable, include actions to (i) avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation; (ii) comply with any prescribed environmental management standards or practices; (iii) comply with any applicable provisions of the Act regarding closure, where applicable; and (iv) comply with any provisions of the Act regarding financial provision for rehabilitation, where applicable;	All tables in Sections 4, 5 and 6 – 3 <sup>rd</sup> column.
(f) the method of monitoring the implementation of the impact management actions contemplated in paragraph (f);	All tables in Sections 4, 5 and 6 – 4 <sup>th</sup> column.
g) the frequency of monitoring the implementation of the impact management actions contemplated in paragraph (f);	All tables in Sections 4, 5 and 6 – 5 <sup>th</sup> column.
(h) an indication of the persons who will be responsible for the implementation of the impact management actions;	All tables in Sections 4, 5 and 6 – 6 <sup>th</sup> column.
(i) the time periods within which the impact management actions contemplated in paragraph (f) must be implemented;	All tables in Sections 4, 5 and 6 – 5 <sup>th</sup> column.
j) the mechanism for monitoring compliance with the impact management actions contemplated in paragraph (f);	All tables in Sections 4, 5 and 6 – 4 <sup>th</sup> column.
(k) a program for reporting on compliance, taking into account the requirements as prescribed by the Regulations;	Sections 4, 5 and 6.
l) an environmental awareness plan describing the manner in which— (i) the applicant intends to inform his or her employees of any environmental risk which may result from their work; and (ii) risks must be dealt with in order to avoid pollution or the degradation of the environment; and	Section 7
m) any specific information that may be required by the competent authority	Not applicable

## 2.3 Content of the EMPr

The EMPr includes the findings and recommendations of the EIA Process and specialist studies and/or compliance statements. The EMPr may be updated with additional information or actions during the design, construction, and post-construction phases if applicable. A standardised approach is followed, in which outcomes are set, followed by management actions aimed at achieving the objectives. Management actions are accompanied by monitoring requirements, responsibilities, and targets where applicable. A tabular format is used for ease of reference.

Key terms used in the EMPr include:

- **Impact:** The potential positive or negative impact of the development that needs to be enhanced, mitigated or eliminated (as appropriate) to a desired state
- **Outcomes (objectives):** The desired state after mitigation or management
- **Management Actions:** The actions needed to achieve the objectives of enhancing, mitigating or eliminating impacts; taking into consideration factors such as responsibility, methods, frequency, resources required and prioritisation.
- **Monitoring:** The key monitoring actions required to check whether the outcomes are being achieved, taking into consideration methodology, frequency and responsibility.

## 2.4 Overarching objective

The overarching objective, from which the detail contained in this EMPr flows, is **to construct and operate the project in a manner that -**

- **Reduces** the risk of pollution or damage to ground or surface water, ecosystems, soils and air.
- **Minimises** nuisance and disruption to people residing in, working in or moving through the area.
- **Adheres** to all relevant environmental legislation.

## 2.5 Amendment of this EMPr

- Amendments shall be made as and when required to keep this EMPr up to date, and to provide for adaptive management in support of the management outcomes set out in the approved EMPr and the EIA.
- The EMPr may be amended due to:
  - Legislative changes;
  - Changes to the roles and organisational structure set out in chapter 3;
  - Amendments to the environmental authorisation;
  - Audits of the EMPr carried out in terms of the EIA Regulations;
  - Based on the annual reviews as set out below; or
  - Whenever deemed necessary by the competent authority.
- Amendments will be numbered sequentially (e.g. Amendment 001, Amendment 002, Amendment 003 etc.). The status of a particular page shall be reflected in the appropriate space of each page. Each amendment shall also have an effective date (the date on which the amendment was made).
- Amendments to the impact management **actions** may be effected immediately by the authorisation holder and must be reflected in the next environmental audit report submitted to the competent authority in terms of regulation 34 of the EIA Regulations. The record of

revisions must be updated accordingly, and the revision number and status of a particular page shall be reflected in the appropriate space of each page.

- Amendments to the impact management **outcomes** stipulated in this EMPr are subject to an application for amendment to the competent authority, which must be submitted for approval by the authorisation holder and may require public participation. Such an amendment shall only become effective once approved by the competent authority.

## 2.6 Review of this EMPr

- The EMPr should be reviewed if and when deemed necessary.
- The Authorisation Holder will keep a record of all dates of review, even if review did not necessitate an amendment to the EMPr.
- The review may take the form of an internal audit or may form part of the external audit conducted in terms of regulation 34 of the EIA Regulations.
- The main aims of a review of the EMPr for purposes of a revision will, among other things, be to determine the following:
  - Ability of the EMPr to sufficiently provide for the avoidance, management and mitigation of environmental impacts associated with the undertaking of the activity on an ongoing basis
  - Conformity and adherence to the minimum legislative requirements;
  - Simplicity and clarity of the content and text; or
  - The incorporation of practical experience gained during implementation.

## 2.7 Authors of the EMPr

This EMPr has been compiled by the Environmental Assessment Practitioner (EAP) based on best practice environmental management requirements. Details of the EAP who prepared the EMPr are as follows:

**Table 2-3: Authors of the EMPr**

Authors	Qualification	Professional registrations	Years of experience	Relevant expertise
<b>Jeremy Rose</b>	B.Sc. (Hons) Environmental and Geographical Science	Registered E.A.P. Pr.Sci.Nat.	12+	More than 75 EIAs or EMPrs – Refer to Appendix A.
<b>Kaylyn Heinrich</b>	B.Sc. (Hons) Environmental and Geographical Science	Candidate E.A.P Member of IAIAAsa	3+	

Jeremy Rose has 12 years' experience in the field of environmental management and impact assessment and has managed multiple EIAs and Basic Assessments in South Africa. He holds an Honours degree in Environmental and Geographical Science and is an Environmental Assessment Practitioner duly registered with the Environmental Assessment Practitioners Association of South Africa and a professional natural scientist in the field of Environmental Science with the South African Council for Natural Scientific Professions. Kaylyn Heinrich is a registered Candidate E.A.P.

## 3 PROJECT ROLES AND STRUCTURE

The general roles to be defined are those of the:

- Authorisation holder
- Environmental Control Officer
- Contractor (Principal Contractor / Project Manager); and
- Environmental Auditor

The specific titles referred to may vary, but the intent of this section is to broadly define expectations and responsibilities for key role players in the implementation of the EMPr.

### 3.1 Authorisation Holder

The holder of the Environmental Authorisation, should it be issued, will be responsible for ensuring that the conditions of such authorisation are fully adhered to. It is expected that the authorisation holder will appoint the Environmental Control Officer and Contractor (or Contractors) during the implementation phase. The responsibility for the implementation of this EMPr lies with the Authorisation Holder. Commonly, responsibilities borne by the Authorisation Holder are delegated to a project manager.

Key responsibilities include ensuring that:

- An ECO is timeously appointed, and remains employed for the duration of the construction phase.
- The ECO is provided with the necessary information in order to adequately undertake their responsibilities.
- This EMPr is included in the contractual agreements with all contractors and subcontractors,
- Method Statements requested by the ECO are provided timeously.
- Corrective action is implemented as required; and
- Appropriate records and information regarding compliance with the EMPr requirements are maintained and made available to the ECO.

### 3.2 Environmental Control Officer

An independent Environmental Control Officer (ECO) must be appointed for the duration of the implementation phase of the development to ensure compliance with the EMPr and conditions of the EA. The ECO's role also includes monitoring compliance with other environmental legislation, the monitoring of environmental impacts, and the keeping of accurate records.

The ECO shall update the EMPr when necessary and shall compile a monitoring checklist or protocol based on the EMPr. The ECO's role includes the following aspects:

- Periodic environmental audits during the implementation phase of the proposed project to monitor and record environmental impacts and nonconformances, and to monitor site activities to ensure adherence to the specifications contained in the EMPr, using a monitoring checklist.
- Maintain a record of site visits and audits, a copy of the environmental authorisation (should it be granted) and other permits and licenses, a register of non-conformances, and a copy of previous environmental audits.

- Prior to commencement, the ECO must meet on site with the Contractor representative to confirm designated development and no-go areas and to confirm the method statements required.
- Request, review and approve Method Statements from the contractor and sub-contractors prior to the commencement of the activities concerned.
- Ensure that the contractors and sub-contractors and their employees have received the appropriate environmental awareness training.
- Meet with the contractors to discuss the implementation of this document.
- Identify appropriate corrective measures if transgressions occur.
- Keep a register of monitoring activities and results
- Assist in finding environmentally acceptable solutions to implementation problems.
- Identify and make amendments to the EMPr where appropriate.
- Conduct an environmental inspection on completion of the implementation period and prepare a close-out report.

*It is important to note that the weekly monitoring of construction activities below the HWM will be significantly more onerous than the monitoring of construction activities above the HWM. Monitoring of the activities below the HWM require an ECO with the relevant expertise and experience to implement the specialised management actions.*

### 3.3 Contractor

The role of the contractor is as follows:

- The Contractor shall ensure that all employees, contractors and sub-contractors are made aware of the EMPr and their responsibilities.
- Prior to commencement, the Contractor must meet on site with the ECO representative to confirm designated development and no-go areas and to confirm the method statements required.
- Liaise with the ECO and Authorisation Holder (or representative) and ensure that works on site are conducted in an environmentally sensitive manner in accordance with this EMPr.
- Maintain on site a copy of this EMPr and all environmental authorisations and licenses pertinent to the development on site.
- Ensure that all appointed contractors and sub-contractors repair, at their own cost, any environmental damage because of a contravention of the specifications contained in the EMPr, to the satisfaction of the Project Owner's ECO.
- Ensure that all employees (permanent and temporary) and all sub-contractors that work on the site for longer than two days, receive environmental awareness training within one week of being on site.
- Designate an Environmental Officer (or employ a designated suitably qualified individual to fulfil the role of an Environmental Officer) to monitor and report on the daily activities on-site during the implementation period. The Contractor and individual contractors may designate Environmental Officers to liaise with the ECO on environmental matters.

### 3.4 Environmental Auditor

An independent Environmental Auditor must be appointed for the duration of the implementation phase of the development responsible for assessing the ECO's and subsequently the Contractor's compliance with environmental regulations, policies, and standards as stipulated in the EMPr and ECO Reports.

The Environmental Auditor's role includes the following aspects:

- Periodic environmental audits (biannual) to perform comprehensive audits to evaluate the environmental performance of an organization. This includes site inspections, reviewing documentation (i.e) EMPr, ECO Reports and other documentation contained in the Contractor's file.
- Conducting follow-up audits to ensure that corrective actions have been implemented and to verify ongoing compliance.
- Preparing detailed audit reports that summarize findings, including areas of compliance and non-compliance, and providing actionable recommendations for improvement.

## 4 PLANNING AND PRE-CONSTRUCTION ACTIVITIES

The outcomes, management measures, and monitoring requirements detailed in this section are applicable only to the pre-construction phase of the proposed development, defined as including the phase of the development before which land clearing, bulk earthworks, the installation of civil services, and the construction of new structures other than those related to the management of the conservation area on the site.

**Table 4-1: PLANNING AND PRE-CONSTRUCTION: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions		Monitoring Actions	
			Method	Frequency	Responsibility
<b>4.1 Compliance with legislative and other requirements</b>	Construction is conducted in compliance with all relevant legislation and is not in conflict with existing approvals and authorisations.	<b>4.1.1 Confirm prior to commencement of construction that the following requirements in terms of other legislation, as identified in the EIA, have been addressed</b>	Confirm approvals or amendments have been issued.	Prior to first construction contract or where approvals are relevant only to certain precincts on the site, prior to construction in such precincts.	Authorisation holder
<b>4.2 Establishing working and no-go areas</b>	Construction activities will be restricted to within the designated areas and any environmentally sensitive areas (no-go areas) will be protected from disturbance.	<b>4.2.1 Demarcation of working areas and no-go areas under the guidance of the ECO.</b>	A method statement for the demarcation of no-go and working areas to be compiled and approved prior to work taking place.	Prior to commencement of construction activities.	Engineer, contractor and ECO.
<b>4.3 Noise and vibration impacts of the reclamation and in-water marine construction.</b>	Adequate planning for, and notification of disturbance from noise and vibration resulting from the reclamation and in-water marine construction is provided to adjacent landowners and tenants.  A communication process and structure are established to handle noise and vibration related complaints prior to	<b>4.3.1 The Contractor shall establish a dedicated Construction Liaison Committee (CLC) comprising representatives of adjacent landowners and the V&amp;A Waterfront. The CLC shall meet quarterly and shall receive advance notice of particularly noisy activities such as impact piling, mass rock placement events, compaction operations as well as any restrictions on access to the slipway.</b>	Confirm a Construction Liaison Committee Agreement is in place, and members have been appointed.	Prior to commencement of construction activities.	Authorisation holder, Contractor and ECO.

Table 4-1: PLANNING AND PRE-CONSTRUCTION: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions		Monitoring Actions	
			Method	Frequency	Responsibility
	construction activities commencing,				
<b>4.4 Disruption of ocean economy</b>	<p>Plans are in place for the decommissioning of the existing slipway and the construction of the new slipway, to ensure that the transition entails as little disruption to existing operations as is possible.</p> <p>The slipway operator and relevant local authorities have been consulted in the development of the Construction Traffic and Access Management Plan.</p> <p>Disruption to economic activity and informal trading during land reclamation activities are managed through consultation with affected stakeholders.</p>	<p><b>4.4.1 Prepare a Construction Traffic and Access Management Plan prior to construction commencement that identifies all phases of work likely to affect slipway access, anticipated duration of any restrictions or closures, and proposed alternative arrangements.</b></p> <p><b>4.4.2 Engage with the slipway operator and relevant local authority before construction commences to agree on acceptable working hours and minimum access requirements that must be maintained throughout construction.</b></p> <p><b>4.4.3 Engage affected operators (commercial, institutional) early to identify and address disruption concerns.</b></p>	Confirm a Construction Traffic and Access Management Plan has been compiled to the satisfaction of the local authority.	Prior to commencement of construction activities.	Authorisation holder, Contractor and ECO.
<b>4.5 Traffic Management Plan</b>	The Construction Traffic and Access Management Plan include the relevant information stipulated by the Traffic Specialist.	<p><b>4.5.1 In addition to identifying impacts to the existing slipway operations, the Traffic and Access Management Plan should include:</b></p> <ul style="list-style-type: none"> <li>» <b>Early liaison with MyCiti operations to phase any temporary stop or route restrictions and obtain route deviations.</b></li> <li>» <b>Stakeholder notifications and information boards within the Waterfront precinct.</b></li> </ul>	Confirm that a Construction Traffic and Access Management Plan has been compiled to the satisfaction of the relevant local authorities.	Prior to commencement of construction activities.	Authorisation holder, Contractor and ECO.

**Table 4-1: PLANNING AND PRE-CONSTRUCTION: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions		Monitoring Actions	
			Method	Frequency	Responsibility
		» All other required information as per the South African Road Traffic Signs Manual (SARTSM).			
<b>4.6 Temporary economic boost from construction activities.</b>	Conditions are included in contractual documents to prioritise the local economy.	<p><b>4.6.1 The developer should encourage the contractor to increase the local procurement practices and promote the employment of people from local communities, as far as feasible, to maximise the benefits to the local economies;</b></p> <p><b>4.6.2 The developer should engage with local authorities and business organisations to investigate the possibility of procuring construction materials, goods and products from local suppliers where feasible.</b></p> <p><b>4.6.3 Where feasible, efforts should be made to employ locally to create maximum benefits to the communities.</b></p> <p><b>4.6.4 Sub-contract to local construction companies particularly SMMEs and BBBEE compliant enterprises where possible.</b></p> <p><b>4.6.5 Where possible, local labour should be considered for employment to increase the positive impact on the local economy.</b></p> <p><b>4.6.6 Employ labour-intensive methods in construction where feasible.</b></p> <p><b>4.6.7 Sub-contract to local construction companies first where possible to do so.</b></p>	Conditions are included in contract documentation, where relevant.	Prior to commencement of construction activities.	Authorisation holder.
<b>4.7 Change in visual character and impact on scenic resources</b>	Design elements must take into consideration public interfaces, landscaping requirements and requirements from	<p><b>4.7.1 The visual intrusion of vehicular roads and parking areas between buildings must be minimised.</b></p> <p><b>4.7.2 Garages on the ground floor, which create 'dead' building frontages, are to be avoided.</b></p>	Precinct Plan and relevant SDPs have been approved by the City of Cape Town.	Prior to commencement of construction activities.	Authorisation holder and Contractor

**Table 4-1: PLANNING AND PRE-CONSTRUCTION: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Method	Monitoring Actions Frequency	Responsibility
	<p>previously authorised permits and approvals.</p>	<p><b>4.7.3 Appropriate landscaping measures:</b></p> <ul style="list-style-type: none"> <li>» The Guidelines for Landscaping provided in the V&amp;A Urban Design Guideline Document must be followed.</li> <li>» The Development Control Document addresses human-scaled outdoor spaces and routes, with climatic wind shelter and shade, and opportunities for sitting, particularly along the proposed coastal promenade. These must be implemented via an approved landscape plan as part of the SDP approval for these parcels.</li> <li>» Similarly, figures indicate the special treatment of the proposed coastal protection works to ameliorate the visual effect of engineered structures, which can appear visually severe. The engineered straight lines are replaced by way of curved edges, vertical and horizontal undulations, pathways at various levels, landscaping and access to the water's edge with a variety of water activities. These concepts must be implemented.</li> <li>» The design must be subject to an approved landscape plan prepared by a professionally registered landscape architect, as part of the SDP submission stage.</li> <li>» Street furniture, lighting and signage must be designed as part of an integral system and avoid unnecessary visual clutter in the coastal landscape setting.</li> <li>» Rock revetments are visually preferable to 'dolos'. This should be used on visible revetment areas.</li> </ul> <p><b>4.7.4 Further visual review: Given the current lack of detailed architectural and landscaping</b></p>			

Table 4-1: PLANNING AND PRE-CONSTRUCTION: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions		Monitoring Actions	
			Method	Frequency	Responsibility
		information relating to the proposed project at the time of writing the VIA, it is essential that further visual reviews of the proposals take place at the Site Development Plan stages. These plans must give an indication of architectural and landscape proposals for the development.			
<b>4.8 Potential effect of lighting related to sense of place</b>	Light pollution from all sources is minimised as far as possible and aligns with relevant policy and best practice.	<p><b>4.8.1 Light pollution from outdoor or security lighting must be avoided, and high mast lighting prohibited. Street lights must be fitted with reflectors to avoid light spillage, and low-level lights provided for pedestrian areas. The design must be subject to an approved lighting plan by a professional lighting engineer.</b></p> <p><b>4.8.2 Street furniture, lighting and signage must be designed as part of an integral system and avoid unnecessary visual clutter in the coastal landscape setting.</b></p>	Precinct Plan and relevant SDPs have been approved by the City of Cape Town.	Prior to commencement of construction activities.	Authorisation holder and Contractor
<b>4.9 Pedestrian access to the coastline</b>	Ensure that the development facilitates public access to the coastline.	<p><b>4.9.1 Implement designs as per the Urban Design Guidelines and Phase 2 Development Controls dated September 2025 (or as updated), specifically allowing for the continuous coastal walkway along the shoreline.</b></p> <p><b>4.9.2 Make appropriately sensitive provision for the management of building height, massing and edges in relation to the public realm.</b></p>	Confirm designs have been approved by the relevant City Departments.	Prior to commencement of construction activities.	Authorisation holder and ECO.

**Table 4-2: PLANNING AND PRE-CONSTRUCTION: ASPECTS ABOVE THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>4.10 Compliance with legislative and other requirements</b>	Construction is conducted in compliance with all relevant legislation and is not in conflict with existing approvals and authorisations.	<b>4.10.1 Confirm prior to commencement of construction that the following requirements in terms of other legislation, as identified in the EIA, have been addressed:</b>	Confirm approvals or amendments have been issued.	Prior to first construction contract or where approvals are relevant only to certain precincts on the site, prior to construction in such precincts.	Authorisation holder
<b>4.11 Establishing working and no-go areas</b>	Construction activities will be restricted to within the designated areas & environmentally sensitive areas (no-go areas) will be protected from disturbance.	<b>4.11.1 Demarcation of working areas must be as per Figure 1-3, with no development outside the development footprint.</b>	A method statement for the demarcation of no-go and working areas to be compiled and approved prior to work taking place.	Prior to commencement of construction activities.	Engineer, contractor and ECO.
<b>4.12 Change to Sense of Place, Visual Character and View corridors</b>	Building heights and massing do not compromise existing views of Table Bay.  Existing heritage and view controls are complied with.	<p><b>4.12.1 Implement building heights and massing for land-based development as per the Granger Bay Phase 2 Development Controls document dated September 2025.</b></p> <p><b>4.12.2 Adherence to height limits (21.5m MSL in Arc of Fire)</b></p> <p><b>4.12.3 The proposed buildings in Packages 1 and 2, situated north and north east of The Water Club's Dover Apartment building, should be articulated such that they allow views toward Table Bay and Table Mountain.</b></p> <p><b>4.12.4 The buildings in Packages 13 and 14 should be such that they allow views of Table Bay at the end of Granger Bay Boulevard.</b></p> <p><b>4.12.5 Designs of building forms and finishes finalized and approved.</b></p>	Confirm the following designs have been approved by the City of Cape Town: <ul style="list-style-type: none"> <li>» Packages 1 and 2;</li> <li>» Packages 13 and 14;</li> <li>» Architectural designs of all packages.</li> </ul>	Prior to commencement of construction activities.	Authorisation holder and ECO.
<b>4.13 Reduced water availability</b>	Increased drought risk has been considered and sustainable building	<b>4.13.1 Rainwater storage should be investigated and implemented where possible.</b>	Confirm that sustainability considerations regarding	At building-plan approval stage.	Authorisation holder

**Table 4-2: PLANNING AND PRE-CONSTRUCTION: ASPECTS ABOVE THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
	practices have been implemented where feasible.	<p><b>4.13.2 Greywater recycling programmes should be investigated and implemented where possible.</b></p> <p><b>4.13.3 Consideration of alternative water sources should there be a drought period.</b></p>	water-saving initiatives have been explored and implemented where feasible.		

**Table 4-3: PLANNING AND PRE-CONSTRUCTION: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>4.14 Permit for the translocation of West Coast rock lobster</b>	Translocation of West Coast Rock lobsters must be approved prior to the activity being undertaken.	<b>4.14.1 Acquire a permit in terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) if West Coast rock lobsters are to be translocated as part of the construction phase.</b>	In accordance with permit conditions.	Prior to translocation of lobster individuals.	Authorisation holder and ECO.
<b>4.15 Change in marine habitat and system function</b>	The development must be designed in such a way that resultant modelled wave dynamics are not detrimental to the marine environment.	<b>4.15.1 The project design must account for potential changes in hydrodynamic function and ensure that resultant local changes in hydrodynamics do not cause significant, ongoing scour of the seabed.</b>	At the time of writing this EIA and EMP, the PRDW Wave and Hydrodynamic Modelling Study Report (2025) confirms that no significant changes to hydrodynamics or scour is expected from the development area. It is the opinion of the EAP that this mitigation measure has been complied with.		
<b>4.16 Access to the ocean and other facilities</b>	Ensuring that minimal public disruption to ocean access and ablution facilities.	<b>4.16.1 The contractor must follow a construction phasing plan that ensures ocean access is always possible.</b> <b>4.16.2 Schedule construction outside peak boating seasons as far as possible.</b> <b>4.16.3 Communicate construction schedule in advance to affected stakeholders.</b>	Check that a phasing plan is in place prior to the commencement of construction activities and that it provides for uninterrupted access to a launch site.	Prior to commencement of construction.	to Authorisation Holder and ECO
<b>4.17 Management of the slipway and bay area</b>	<p>A management plan for the new bay and slipway is established prior to construction of the coastal infrastructure commencing.</p> <p>The management plan has been developed after consultation with the relevant authorities.</p>	<b>4.17.1 Engagements must, at a minimum, be held with the following authorities to inform the management of the new bay area:</b> » Transnet National Ports Authority » DFFE: Oceans & Coasts <b>4.17.2 Management plans for the bay and new slipway have been approved by the relevant authorities.</b>	Confirm that management plans for the slipway and new bay have been confirmed. Confirm that the relevant authorities have been consulted and agreed to a management plan. Written evidence must be provided in this regard (meeting minutes, email communication, etc.)	Prior to commencement of construction.	to Authorisation holder and ECO.

Table 4-3: PLANNING AND PRE-CONSTRUCTION: ASPECTS BELOW THE HIGH-WATER MARK

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>4.18 Impact on maritime archaeology (shipwrecks)</b>	<p>Maritime archaeological finds are proactively identified prior to coastal construction commencing.</p> <p>Any identified maritime archaeological remains are reported to a suitably qualified archaeologist immediately for guidance on next steps.</p>	<b>4.18.1 A geophysical survey of the seabed, (sidescan sonar, multibeam bathymetry and magnetometry), is conducted in the project area prior to any land reclamation activities, to confirm whether there are shipwreck or other heritage sites present. The results of the geophysical survey should be reviewed by a suitably qualified archaeologist.</b>	Check that a geophysical survey of the seabed has been conducted.	Prior to commencement of construction.	Authorisation holder and ECO.

## 5 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

The outcomes, management measures, and monitoring requirements detailed in this section are applicable to the construction phase of the proposed activity.

**Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>5.1 Interruption of access to the slipway and associated impacts on public use and recreational boating activities during construction.</b>	<p>Public access to and use of the slipway is continued throughout the construction period.</p> <p>Slipway access at the new slipway is possible with full equivalent functionality before closure of the existing slipway.</p> <p>Any planned closure or restriction of the existing slipway access is communicated to affected users in advance with sufficient notice. Alternative access arrangements are in place for the duration of any necessary closure.</p>	<b>5.1.1 Prepare a Construction Traffic and Access Management Plan prior to construction commencement that identifies all phases of work likely to affect slipway access, anticipated duration of any restrictions or closures, and proposed alternative arrangements.</b>	ECO site inspections to confirm that access management measures are in place and that any active restrictions are consistent with the approved Construction Traffic and Access Management Plan.	Weekly	ECO
		<b>5.1.2 Engage with the slipway operator and relevant local authority before construction commences to agree on minimum access requirements that must be maintained throughout construction.</b>	Functionality of new slipway prior to existing slipway closure	Once-off joint inspection before any closure is implemented	ECO and Employer's Agent
		<b>5.1.3 Complete construction, commissioning, and testing of the new slipway to a standard of full equivalent functionality (including launch and retrieval capability, approach, and lighting) and confirm this with a joint inspection before any restriction or closure of the existing slipway is implemented.</b>	Complaints and grievance register	Reviewed at each site meeting	
		<b>5.1.4 Provide reasonable advance public notice of any planned slipway closures or restrictions through appropriate channels (signage at the slipway, notice to local boating clubs and harbour users, and municipal or harbour authority communication channels) before any restriction takes effect.</b>	<b>Thresholds of concern:</b> <ul style="list-style-type: none"> <li>Closure or restriction of the existing slipway before the new slipway has been confirmed as</li> </ul>		
		<b>5.1.5 Minimise the footprint and duration of any construction exclusion zone affecting the slipway approach, launch area, or</b>			

Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>associated parking and rigging areas; remove temporary obstructions at the end of each working day where practicable.</p> <p><b>5.1.6 Ensure construction signage and barriers at the slipway are clearly marked, well-lit, and do not create safety hazards for members of the public navigating around the works area.</b></p> <p><b>5.1.7 Maintain a complaints and grievance register for slipway users and respond to complaints relating to access disruption within 2 working days.</b></p> <p><b>5.1.8 Maintain temporary access routes and berthing.</b></p>	<p>fully operational following joint inspection.</p> <ul style="list-style-type: none"> <li>Any unplanned slipway closure not communicated to users at least 5 working days in advance.</li> </ul> <p>Any complaint relating to access disruption not resolved within 2 working days</p>		
<b>5.2 Spills of hydrocarbons, chemicals, or other hazardous substances during construction, and associated impacts on water quality, marine life, and habitat</b>	<p>The marine environment, intertidal zone, and seabed within and adjacent to the works area are not contaminated by hydrocarbons or hazardous substances attributable to construction activities.</p> <p>Any spill that occurs is contained, recovered, and remediated before it causes a measurable impact on water quality, marine fauna, or benthic</p>	<p><b>5.2.1 Prepare and implement a Method Statement for Spill Prevention, Containment, and Response as before any construction commences. The SPCR must identify all hazardous substances on site, specify containment measures, define roles and responsibilities, and set out step-by-step spill response procedures.</b></p> <p><b>5.2.2 Ensure all refuelling of plant and equipment takes place on shore or on a designated bunded vessel or platform, never directly over open water. Where floating plant must be refuelled at sea, use drip trays, absorbent matting, and a standby spill kit.</b></p>	<p><b>General</b></p> <p>Regular ECO site inspections of fuel and chemical storage areas, vessels, and in-water plant, with observations and any non-conformances recorded in the site environmental register.</p> <p><b>Hazardous substance storage and plant condition</b></p> <p>Visual inspection of bunded storage areas for leaks, containment</p>	<p>Twice weekly during in-water construction</p> <p>Weekly and after significant rainfall</p>	<p>ECO</p> <p>ECO Contractor or</p>

**Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
	<p>habitat outside the immediate spill location.</p> <p>Water quality parameters, including hydrocarbon concentrations, dissolved oxygen, and pH, return to baseline conditions within an acceptable period following any spill incident.</p> <p>No mortality or sub-lethal harm to listed threatened or protected species, fish, invertebrates, or other marine fauna is attributable to a hydrocarbon or chemical spill from construction activities.</p> <p>No persistent or visible hydrocarbon sheen, slick, or chemical contamination is present in the works area or surrounding marine environment at the conclusion of construction.</p>	<p><b>5.2.3 Maintain a spill kit at all work locations at all times. Kits must be appropriate for hydrocarbon spills (absorbent booms, pads, and pillows) and inspected and restocked monthly.</b></p> <p><b>5.2.4 Store all fuels, lubricants, hydraulic fluids, and chemicals on shore within bunded storage areas with a containment capacity of 110% of the largest single container, positioned away from stormwater drains and the shoreline.</b></p> <p><b>5.2.5 Inspect all marine plant and equipment — including vessels, dredges, pumps, and hydraulic systems — for leaks or defects before mobilisation and at the start of each working day. Remove any plant found to be leaking from service until repaired.</b></p> <p><b>5.2.6 Maintain an up-to-date register of all hazardous substances on site, including Material Safety Data Sheets (MSDS), quantities stored, and storage locations. Make this register available to the ECO and emergency responders.</b></p> <p><b>5.2.7 Ensure all construction personnel receive spill awareness and response training before commencing work, including recognition of a spill, immediate containment actions, and reporting procedures.</b></p> <p><b>5.2.8 Report any spill reaching the marine environment immediately to the ECO, and notify DFFE and DEA&amp;DP in accordance with Section 30 of NEMA and any applicable conditions of the environmental authorisation. Record all</b></p>	<p>integrity, and correct storage. Visual inspection of all marine plant and equipment for fuel, hydraulic fluid, or chemical leaks.</p> <p><b>Water quality: hydrocarbon and chemical indicators</b></p> <p>In the event of a suspected or confirmed spill, collect water samples at the spill location, 50 m downcurrent, and at the reference monitoring station for laboratory analysis of Total Petroleum Hydrocarbons (TPH) and relevant chemical parameters. Compare against baseline and applicable water quality guidelines (e.g. SANS or DWAF guidelines for marine receiving environments).</p> <p><b>Thresholds of concern:</b></p> <ul style="list-style-type: none"> <li>Any visible hydrocarbon sheen on the water surface constitutes an immediate response trigger</li> </ul>	<p>Immediately following any spill event; again at 24 hours and 7 days post-spill</p> <p>Monthly</p>	<p>ECO or appointed water quality contractor</p> <p>ECO or Contractor</p>

Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>spill incidents in the site environmental register.</p> <p><b>Additional Adaptive Management Actions required only where a spill incident occurs, to be implemented as and when required under the guidance of the ECO:</b></p> <p>5.2.9 Deploy containment booms immediately upon detection of any hydrocarbon sheen or spill in the water to prevent spread, followed by recovery using absorbent materials or mechanical skimming appropriate to the scale of the spill.</p> <p>5.2.10 Engage a specialist oil spill response contractor if the volume or extent of a spill exceeds the capacity of the on-site spill kit or cannot be contained within one hour of detection.</p> <p>5.2.11 Conduct post-spill water quality and marine fauna surveys at the affected location and a reference site following any significant spill, to assess impact and inform the need for further remediation.</p> <p>5.2.12 Conduct a root cause analysis following any spill incident and revise the Method Statement and relevant operational procedures to prevent recurrence before resuming affected activities.</p>	<ul style="list-style-type: none"> <li>TPH &gt;0.01 mg/L at the 50 m downcurrent monitoring point</li> </ul> <p><b>Spill kit and response equipment</b> Physical inspection of all on-site spill kits to confirm contents are complete, dry, and within service life</p>		
<b>5.3 Waste generation and disposal</b>	<p>Manage waste in accordance with legislation and best practice methods.</p> <p>Minimise the production of general waste.</p>	<p>5.3.1 Contractor is to prepare and implement a waste management plan for the construction phase.</p> <p>5.3.2 A method statement for the management of waste should be prepared by the contractor for review by the ECO and approval by the engineer.</p>	<p>Waste removal and disposal to be monitored. Monitor via site audits and record noncompliance and incidents.</p>	Weekly	Contractor and ECO

**Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
	Prevent pollution or contamination due to improper waste handling or storage on site.	<p><b>5.3.3 All debris is to be cleared from road surface at minimum daily, particularly during the rainy season</b></p> <p><b>5.3.4 Food waste must be stored in bins or skips that are covered and cannot be accessed by flies or rodents.</b></p> <p><b>5.3.5 Waste should be separated into hazardous, general, and recyclable waste streams, with clearly designated bins and skips for each waste type.</b></p> <p><b>5.3.6 Hazardous wastes, including materials contaminated with oils and hydrocarbons, must be removed from site by a suitably licensed contractor and manifests provided.</b></p> <p><b>5.3.7 Other non-hazardous solid waste (e.g., refuse) to be disposed of at a licensed landfill.</b></p> <p><b>5.3.8 A suitable waste contractor must be appointed to collect waste from site on a regular basis for correct disposal. Proof of disposal (waybills or waste disposal slips) must be retained and kept on file for auditing purposes.</b></p> <p><b>5.3.9 If the volumes of waste stored exceed 80m<sup>3</sup> for hazardous waste and/or 100m<sup>3</sup> for general waste the National Environmental Management: Waste Act (NEM:WA) National Norms and Standards for the Storage of Waste in terms of Government Notice (GN) No. 926 of 29 November 2013 must be adhered to.</b></p> <p><b>5.3.10 All rubble and waste are to be removed from site regularly and completely removed from site at the end of the construction phase.</b></p>	Monitor waste disposal slips and waybills via site audits and record non-compliance and incidents.		

Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>5.3.11 Designate a waste management area, which should be an area of hardstanding with a roof and sides or consist of separate bins and skips.</p> <p>5.3.12 Litter and construction waste should be collected on site by the end of each day and stored in bins, skips, or other suitable storage area.</p> <p>5.3.13 Suitable handling and disposal protocols must be clearly explained, and sign boarded.</p> <p>5.3.14 Waste disposal at licensed landfill sites by qualified contractors is mandatory, with proof of disposal submitted to the appointed Environmental Officer. Waste management certification must be obtained, and detailed records of all stored and disposed waste, including quantity, nature, and fate, must be maintained for auditing purposes.</p> <p>5.3.15 Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area. Enforcement of facility usage and cleanliness is crucial.</p> <p>5.3.16 Intentional disposal of any substance into the environment is strictly prohibited, while accidental spillage must be prevented, contained and reported immediately.</p>			
<b>5.4 Noise and vibration</b>	<p>Avoid unnecessary noise generation.</p> <p>Avoid causing a nuisance to adjacent landowners.</p>	<b>5.4.1 The Construction Liaison Committee (CLC) shall meet monthly and shall receive reasonable advance notice of particularly noisy activities such as impact piling, mass rock placement events, and compaction operations.</b>	<p>Monitor activities and record and report non-compliance with the management actions.</p> <p>Maintain complaints register on site. If two or</p>	Ongoing throughout construction	Contractor and ECO.

Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p><b>5.4.2</b> The Construction Liaison Committee (CLC) shall receive monthly construction noise update reports, including upcoming noisy activity schedules as well as any required slipway access restriction.</p> <p><b>5.4.3</b> A publicly accessible construction noise complaints register shall be maintained by the ECO. All complaints shall be logged, investigated, and responded to within 48 hours. Adaptive management actions shall be implemented in response to valid complaints.</p> <p><b>5.4.4</b> A dedicated construction hotline number shall be prominently displayed on site hoardings and on the V&amp;A Waterfront and project website.</p> <p><b>5.4.5</b> Noise emissions from mobile and fixed equipment should be subject to periodic checks as part of regular maintenance programmes to allow for detection of any unacceptable increases in noise.</p>	more noise complaints are received, the Contractor must indicate whether the noise generated on site exceeds thresholds outlined in the Western Cape Noise Control Regulations.		
<b>5.5 Dust impacts from construction activities</b>	Prevent the introduction and spread of dust from construction activities.	<p><b>5.5.1</b> A method statement detailed dust management actions must be prepared by the contractor and submitted to the ECO for review and Engineer to approve.</p> <p><b>5.5.2</b> Dust suppression using a water bowser shall be implemented at all exposed surfaces during dry, windy conditions.</p> <p><b>5.5.3</b> All site vehicles shall observe a speed limit of 20 km/h on site access tracks and internal haul roads to minimise re-suspension of surface fines.</p> <p><b>5.5.4</b> A construction complaints hotline shall be maintained. All dust-related complaints shall be logged, investigated, and responded to within 48 hours.</p>	<p>Review dust management prior to construction commencing</p> <p>Check that minimal and defined routes are used for access and that unauthorised vehicle access is prevented.</p> <p>Monitor activities and record and report non-compliance.</p>	<p>Once-off</p> <p>During site inspections</p> <p>During site inspections</p>	<p>ECO and Engineer,</p> <p>ECO and Contractor</p> <p>ECO and Contractor</p>

Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>5.5.5 All haul trucks transporting fill material shall be covered with tarpaulins or tailgate covers before leaving the loading area and throughout transit along the haul route. Uncovered loads are prohibited.</p> <p>5.5.6 The haul road within the site boundary and Granger Bay Boulevard adjacent to the site shall be swept and/or watered as required during active haulage periods.</p> <p>5.5.7 Stockpiles of fine-grained materials (sand, crusher dust, topsoil) shall be covered with geotextile sheeting when not in active use. Cement shall be stored in sealed silos or closed bulk bags only. The stockpile layout shall be approved by the ECO before site establishment. All active stockpiles exceeding 1 m in height shall be enclosed by wind-break fencing (minimum 1.8 m height, 50% porosity) on the upwind sides.</p> <p>5.5.8 End-tipping operations shall use controlled drop heights to suppress dust at the point of impact.</p> <p>5.5.9 Haul vehicles shall be maintained to prevent spillage on public roads. Any spillage on public roads shall be cleared within one hour. Vehicles shall not be overloaded beyond manufacturer specifications.</p> <p>5.5.10 All concrete demolition and saw-cutting operations shall use wet-cutting techniques (water suppression on cutting blade and drill) to prevent generation of airborne dust.</p> <p>5.5.11 All skip bins and rubble skips shall be covered when filled.</p>			

Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>5.5.12 Workers involved in demolition and concrete cutting shall be provided with appropriate respiratory protective equipment in accordance with the Construction Regulations, 2014.</p> <p>5.5.13 Construction access tracks and internal haul routes shall be water-suppressed or treated with dust binders to minimise re-suspension of surface fines.</p>			
5.6 Visual impacts of construction activities	Minimise visual disturbance from construction activities.	<p>5.6.1 A method statement site camp establishment and locational and visual management measures for review by the ECO and approval by the Engineer.</p> <p>5.6.2 Manage stockpile and laydown areas for cleanliness and appearance.</p> <p>5.6.3 Roof and screen waste areas.</p> <p>5.6.4 Avoid unnecessary signage or advertisement on site.</p> <p>5.6.5 Restrict the activities and movement of construction workers and vehicles to the immediate construction site as much as possible;</p> <p>5.6.6 Ensure that rubble, litter and disused construction materials are managed and removed regularly;</p> <p>5.6.7 Locate site camps and laydown areas away from visually sensitive receptors such as residences.</p> <p>5.6.8 Screen site camps and laydown areas with shade cloth or similar, where possible and appropriate.</p> <p>5.6.9 Regularly clean and maintain the construction site to prevent the accumulation of dust.</p> <p>5.6.10 Limit construction footprint to minimum area required.</p>	<p>Review method statement for site camp establishment for locational and visual management measures.</p> <p>Monitor by visual inspections.</p>	<p>Immediately prior to construction</p> <p>Weekly</p>	<p>ECO</p> <p>ECO and Contractor</p>

**Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<b>5.6.11 Manage site lighting and only implement the minimum required.</b>			
<b>5.7 Disruption of ocean-going and pedestrian access to the coastline</b>	Access to the ocean for recreational activities or crafts / vessels is not impeded unless required, and sufficient notice is given to the public prior to any closures or restrictions.	<b>5.7.1 Complete construction, commissioning, and testing of the new slipway to a standard of full equivalent functionality (including launch and retrieval capability, approach, lighting, and associated facilities) and confirm this with a joint inspection before any restriction or closure of the existing slipway is implemented.</b>	A joint inspection of the new slipway with the slipway operator and relevant local authorities must take place.	Once-off prior to new slipway operation and existing slipway decommissioning.	ECO, Engineer, Contractor.
		<b>5.7.2 Provide advance public notice of any planned slipway closures or restrictions through appropriate channels (signage at the slipway, notice to local boating clubs and harbour users, and municipal or harbour authority communication channels) at least 5 working days before any restriction takes effect.</b>	Confirm proof of timeous public communications / notifications is provided.	As and when required.	ECO
		<b>5.7.3 Minimise the footprint and duration of any construction exclusion zone affecting the slipway approach, launch area, or associated parking and rigging areas; remove temporary obstructions at the end of each working day where practicable.</b>	A method statement must be compiled detailing the management of ocean access to the public (including pedestrians, vessels and recreational crafts) during construction. This must include detail on how activities are to be phased.	Once-off prior to the slipway and coastal promenade being closed off to the public.	Authorisation holder, Engineer, ECO and Contractor.
		<b>5.7.4 Phase construction activities so that the existing boardwalks and walkways are only closed off when and where needed for construction activities.</b>			
		<b>5.7.5 The coastal public walkway / sea park area should be prioritised for completion as soon as the coastal protection infrastructure is completed.</b>			
		<b>5.7.6 Ensure construction signage and barriers at the slipway are clearly marked, well-lit,</b>			

**Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>and do not create safety hazards for members of the public navigating around the works area.</p> <p><b>5.7.7 Maintain a complaints and grievance register for slipway users and respond to complaints relating to access disruption within 2 working days.</b></p>	Maintain complaints register on site.		
<b>5.8 Increase in traffic volume due to construction activities.</b>	Increase in traffic is managed in accordance with the relevant regulations.	<p><b>5.8.1 Off-peak scheduling of heavy-vehicle movements.</b></p> <p><b>5.8.2 Advance public notice of road, lane or shoulder closures, with on-site flagmen, barriers and signage compliant with Southern African Road Traffic Signs Manual (SARTSM).</b></p> <p><b>5.8.3 Implement well-marked detours and providing real-time traffic updates to inform motorists of alternative routes and expected delays.</b></p> <p><b>5.8.4 Site traffic-management plan with qualified marshals.</b></p> <p><b>5.8.5 Early liaison with MyCiti operations to phase any temporary stop or route restrictions and obtain route deviations.</b></p> <p><b>5.8.6 Wheel-wash bays and routine road-sweeping to prevent debris spillage.</b></p> <p><b>5.8.7 Condition checks of Granger Bay Boulevard and adjacent intersections along well-used haul routes.</b></p> <p><b>5.8.8 Stakeholder notifications and information boards within the Waterfront precinct.</b></p> <p><b>5.8.9 Night works or off-peak works wherever feasible, in consultation with the CLC. All relevant approvals must be in place prior to any night works commencing.</b></p> <p><b>5.8.10 Maintain temporary access routes, where possible. Provision should be made for</b></p>	<p>Confirm the Construction Traffic and Access Management Plan is implemented.</p> <p>Monitor activities and record and report non-compliance.</p>	Ongoing throughout construction.	Contractor and ECO.

**Table 5-1: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		alternative access routes and alternative parking areas, where feasible. 5.8.11 Engage affected operators early to identify and address disruption concerns to traffic flow and parking.			

**Table 5-2: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS ABOVE THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>5.9 Noise and vibration impacts of general land-side construction</b>	Avoid unnecessary noise generation.  Avoid causing a nuisance to adjacent landowners.	<p><b>5.9.1 All construction plant shall be equipped with manufacturer-fitted or retrofit silencers and exhaust mufflers. Equipment shall be maintained in good working order and shall be subject to noise compliance checks at commissioning and at monthly intervals.</b></p> <p><b>5.9.2 Site generators shall be fitted with acoustic enclosures reducing generator noise to a maximum of 70 dB(A) at 7 m. Generators shall be positioned as far as practicable from sensitive receptors.</b></p> <p><b>5.9.3 Demolition activities using hydraulic breakers shall be phased and limited to maximum two-hour continuous sessions, with breaks of at least 30 minutes, to avoid prolonged noise exposure to adjacent receptors.</b></p> <p><b>5.9.4 Materials delivery scheduling shall be managed to prevent concentration of heavy vehicle movements during early morning and late afternoon periods.</b></p> <p><b>5.9.5 A dedicated site marshal shall direct and manage delivery vehicles to prevent congestion and unnecessary idling on Granger Bay Boulevard and adjacent roads.</b></p> <p><b>5.9.6 All haul vehicles operating on the site shall observe a speed limit of 20 km/h to reduce tyre and engine noise.</b></p>	<p>Monitor activities and record and report non-compliance with the management actions</p> <p>Maintain complaints register on site. If two or more noise complaints are received, the Contractor must indicate whether the noise generated on site exceeds thresholds outlined in the Western Cape Noise Control Regulations.</p>	Ongoing throughout construction.	ECO and contractor.
<b>5.10 Damage to, or destruction of archaeological sites and/or artefacts</b>	Avoid impacts to archaeological finds during earthworks or excavations.	<p><b>5.10.1 Where new development or earthworks which have the potential to reach the depth of the former, historical land surface are undertaken in the areas indicated in Figure 1-3, the work is to be monitored by a suitably qualified archaeological specialist.</b></p> <p><b>5.10.2 The archaeological specialist is to provide training on how to recognise archaeological</b></p>	Archaeological monitoring visits must be undertaken by the appointed archaeologist.	Weekly	ECO and Contractor.

**Table 5-2: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS ABOVE THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>site and finds and the appropriate response. Signage with this information must also be clearly displayed.</p> <p>5.10.3 Should pre-colonial archaeological material be encountered, this must be reported immediately to the appointed archaeologist, who will need to assess the situation.</p> <p>5.10.4 In the event of the discovery of human remains, work in the affected area must cease immediately, the find must be made secure but left in situ, and HWC and an archaeologist must be informed so that the find can be assessed and arrangements can be made for its mitigation.</p>	Monitor activities and record and report non-compliance with the management actions	Ongoing throughout construction.	ECO and Contractor.

**Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>5.11 Sedimentation, siltation and water quality impacts caused by in-water construction, and associated impacts on marine life, habitat and water quality</b>	<p>Turbidity levels in the marine environment adjacent to and downstream of construction activities remain within acceptable thresholds and do not cause a measurable decline in water quality.</p> <p>Sensitive marine habitats outside the approved project footprint are not permanently smothered, destabilised, or lost as a result of sediment deposition attributable to construction activities.</p> <p>Benthic community composition and diversity in reference areas outside the immediate construction footprint are not significantly altered during or after construction.</p> <p>Marine fauna, including fish,</p>	<p><b>5.11.1 Establish a baseline survey covering water quality (turbidity, TSS, dissolved oxygen, salinity, pH) at a minimum of one impact site and one reference site before any in-water works commence. This establishes the baseline against which impact management outcomes are assessed.</b></p> <p><b>5.11.2 Conduct post-construction marine surveys mirroring the baseline surveys of benthic habitat mapping and community assessments conducted as part of the MIA, at the same impact and reference sites, at intervals of three months, twelve months, and twenty-four months following completion of in-water works, to assess recovery trajectories.</b></p> <p><b>5.11.3 Ensure that rock placement for the outer edge of the new revetments and infrastructure meets the specifications set out in Appendix B, with clean, graded rock and sand containing no fine sediments.</b></p> <p><b>5.11.4 Delineate and physically mark no-go zones around the works area using buoys or GPS-referenced exclusion boundaries.</b></p> <p><b>5.11.5 Install silt curtains (turbidity barriers) of appropriate type and depth (permeable or impermeable depending on tidal regime and current velocity) at the perimeter of all in-water work zones prior to commencement of filling or other sediment-disturbing activities.</b></p> <p><b>5.11.6 Maintain and inspect silt curtains daily for damage, displacement, or bypass, particularly following storm events or strong tidal currents. Repair or reposition immediately where integrity is compromised.</b></p>	<p><b>General</b> Weekly ECO site inspections of in-water works and record observations, trigger level readings, and any non-conformances in the site environmental register.</p> <p><b>Water Quality</b> Monitor DO, pH, salinity, temperature, and turbidity in water column using a calibrated probe. Monitor at an upcurrent reference site, edge of work zone, and 50m / 200m downcurrent of the works area.</p> <p>Turbidity trigger levels:</p> <ul style="list-style-type: none"> <li>Intermediate: &gt;50 NTU above background at 200 m</li> <li>Major: &gt;100 NTU above background at 200 m.</li> </ul> <p>Other thresholds of concern:</p> <ul style="list-style-type: none"> <li>DO &lt;6 mg/L</li> <li>pH outside 7.8–8.3.</li> </ul> <p><b>Silt curtain integrity</b></p>	<p>Monitor with continuous real-time logging or twice-weekly sampling.</p>	<p>ECO</p> <p>ECO or appointed water quality contractor</p>

**Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
	<p>invertebrates, and any listed threatened or protected species, are not subject to chronic or acute impacts from suspended sediment.</p> <p>Sediment dispersion does not encroach outside the works areas without triggering a management response.</p> <p>Water quality parameters — including turbidity, total suspended solids (TSS), dissolved oxygen, and light attenuation — return to baseline conditions within 12 hours following the cessation of in-water works in any given construction phase.</p> <p>No irreversible loss of reef or hard substrate habitat occurs outside the works area.</p>	<p><b>5.11.7 Ensure all in-water plant and equipment is inspected for fuel and hydraulic fluid leaks before mobilisation to prevent compounding water quality impacts.</b></p> <p><b><u>Additional Adaptive Management Actions required only where there is a measurable and significant negative impact, to be implemented as and when required under the guidance of the ECO:</u></b></p> <p><b>5.11.8 If monitoring records turbidity exceeding the Intermediate trigger level, immediately reduce the rate or intensity of in-water activities and assess whether the exceedance is attributable to construction. If turbidity exceeds the Major trigger level, suspend all in-water works and implement the STMP emergency response procedure until turbidity returns to below the Intermediate level.</b></p> <p><b>5.11.9 Restrict in-water construction activities to low-energy tidal windows where practicable (slack water periods) to minimise sediment transport distance and plume spread.</b></p> <p><b>5.11.10 Implement progressive construction sequencing to minimise the simultaneous exposure of disturbed sediment areas; complete and stabilise one work zone before opening the next where operationally feasible.</b></p> <p><b>5.11.11 Implement habitat rehabilitation measures in any areas where residual sediment deposition on sensitive habitat is confirmed by post-construction monitoring, in consultation with the relevant authority. This may include mechanical removal of deposited sediment.</b></p> <p><b>5.11.12 Stabilise all reclaimed surfaces and batters as rapidly as possible using appropriate</b></p>	<p>Visual inspection and physical check for any visible breach, displacement, or significant sediment bypass</p> <p><b>Plume extent</b> Photographic record of plume extent using drone photography</p>	<p>Daily during in-water works; post-storm</p> <p>Weekly during active filling</p>	<p>ECO or Contractor</p>

**Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		geotextile, rock armour, or revegetation to prevent ongoing terrestrial runoff and erosion from contributing secondary siltation loads to the marine environment.			
<b>5.12 Marine habitat loss and disturbance</b>	<p>Mortalities of West Coast rock lobster are avoided as far as possible.</p> <p>Duration and extent of construction activities below the HWM is minimised.</p> <p>All staff are provided environmental awareness training specifically on marine ecosystems.</p>	<p><b>5.12.1 Implement phased removal of West Coast rock lobsters, and potential translocation of individuals from high-density zones.</b></p> <p><b>5.12.2 Limit duration of construction activities in the coastal zone.</b></p> <p><b>5.12.3 Constrain spatial extent of impacts to the minimum required.</b></p> <p><b>5.12.4 Inform and train all staff about sensitive marine species and the responsible disposal of construction waste. This training must be integrated into toolbox talks or onsite awareness sessions to ensure that waste management practices are understood and followed diligently. Additionally, contractors must prepare a method statement outlining specific waste management procedures, which must be approved by the resident engineer before construction activities commence.</b></p>	<p>Conditions of the permit for the removal of West Coast rock lobster are complied with.</p> <p>Monitor activities and record and report non-compliance with the management actions</p>	<p>As and when required</p> <p>Weekly</p>	<p>ECO</p> <p>ECO</p>
<b>5.13 Noise and vibrations</b>	<p>Avoid unnecessary noise generation</p> <p>Avoid causing a nuisance to adjacent landowners</p>	<p><b>5.13.1 Where rock placement / breakwater construction is planned - aim to work from the ocean space backwards towards shore to create a physical barrier to sound in the initial stages of work, then all other fill work will be effectively 'on land'.</b></p> <p><b>5.13.2 Before engaging in any rock dumping or similar actions where material is dumped directly into the ocean, ensure that no baleen whales are within ~500 m of the impact site (in the absence of direct measures of sound levels and hearing thresholds, 500 m is widely used as a typical distance for safe avoidance</b></p>	<p>Monitor activities and record and report non-compliance with the management actions.</p> <p>Maintain complaints register on site. If two or more noise complaints are received, the Contractor must indicate whether the noise generated on site exceeds thresholds</p>	<p>Ongoing throughout construction</p>	<p>ECO and contractor</p>

**Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>of noise impacts). As far as possible, ensure no dolphins are within 500 m of the impact site. A dedicated marine mammal observer should be used for these phases of work.</p> <p>5.13.3 Ensure all machinery is in good working order to reduce in in-air noise levels and transmission into the marine environment.</p> <p>5.13.4 All marine and reclamation construction activities, including rock placement, compaction, and haul truck deliveries, shall be restricted to permitted working hours as prescribed by PN 200 of 2013: Monday to Friday 07:00–18:00 and Saturday 07:00–14:00 unless written exemption is granted by the local authority and prior notification is given to affected stakeholders.</p> <p>5.13.5 Impact piling activities (if required) shall be restricted to 08:00-17:00 on weekdays only.</p> <p>5.13.6 All diesel-powered construction plant and vehicles shall be maintained in accordance with manufacturer specifications and fitted with effective silencers or mufflers. Plant emitting noise above 85 dB(A) at 7 m shall not be used unless no quieter alternative is available.</p> <p>5.13.7 Where practicable, hydraulic breakers shall be fitted with hydraulic silencing attachments. Rock placement shall use low-drop techniques (reduced fall heights for rock placement from cranes and excavators) to limit impulsive noise from large armour rock deployment.</p> <p>5.13.8 Where marine piling is required, a soft-start procedure (ramping up hammer energy progressively over a minimum of 20 minutes) shall be implemented at the commencement of each piling session to allow mobile marine</p>	outlined in the Western Cape Noise Control Regulations.		

**Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<p>fauna to move away from the noise source before full impact energy is applied.</p> <p><b>5.13.9</b> A qualified Marine Mammal Observer shall be stationed during all impact piling sessions (if required) to monitor for the presence of cetaceans and Cape fur seals within a defined exclusion radius of 500 m. Piling shall not commence if cetaceans are observed within the exclusion zone.</p> <p><b>5.13.10</b> An Underwater Noise Management Plan (UNMP) shall be prepared by a qualified acoustics specialist prior to commencement of any marine piling operations, incorporating exclusion zones, soft-start procedures, monitoring requirements, and mitigation trigger levels. The UNMP shall be submitted to SANParks and DFFE (Oceans &amp; Coasts Branch) for approval prior to implementation.</p> <p><b>5.13.11</b> Marine vessels used for construction support shall be fitted with engine silencers and vibration-dampening mountings where practicable. Engine idling of marine plant for extended periods while not operating shall be prohibited.</p>			
<b>5.14 Impacts of increased vessel presence on marine mammals</b>	Disturbance to marine life from construction vessels is minimised.	<p><b>5.14.1</b> Vessels used must be driven in a slow and responsible manner, keep gear changes and acceleration to a minimum to minimise rapid changes in noise levels.</p> <p><b>5.14.2</b> A lookout must be kept for dolphins and whales at all times and groups should be avoided where possible.</p> <p><b>5.14.3</b> If any impacts are observed (vessel strike, entanglement, strong avoidance responses) these should be reported to the relevant environmental authority as soon as possible (e.g. DFFE).</p>	<p>A method statement must be compiled detailing the management of vessels during construction.</p> <p>Confirm the Marine Mammal Monitoring Plan as outlined in Section 8 is implemented by a suitably qualified person.</p>	<p>Once-off prior to any coastal construction taking place that required vessels.</p> <p>Ongoing throughout construction.</p>	<p>Contractor and ECO.</p> <p>ECO</p>

**Table 5-3: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
		<b>5.14.4 Implement the Marine Mammal Monitoring Plan as outlined in Section 8.</b>			
<b>5.15 Traffic Impacts from land reclamation and marine infrastructure</b>	<p>Traffic impact from the transportation of quarried material is minimised.</p> <p>Noise from vehicles transporting quarried material is minimised.</p>	<p><b>5.15.1 Rock placement activities shall not commence before 07:30 daily. Peak-hour deliveries (07:00–08:30 and 16:30–18:00) shall be minimised to reduce traffic noise on the haul route.</b></p> <p><b>5.15.2 Haul trucks shall use only the designated haul route (Granger Bay Boulevard, Helen Suzman Blvd, Buitengracht / M62 to N1 / N7) as prescribed in the Traffic Management Plan. Deviation from the designated route is prohibited.</b></p> <p><b>5.15.3 Haul trucks shall not idle unnecessarily at loading or offloading areas. Truck engines shall be switched off during extended waits.</b></p> <p><b>5.15.4 A maximum truck speed of 20 km/h shall be enforced within the site boundary and 30 km/h on the designated haul road adjacent to the OPBC and public areas.</b></p>	<p>Confirm the Construction Traffic and Access Management Plan is implemented.</p> <p>Monitor activities and record and report non-compliance.</p>	<p>Ongoing throughout construction.</p> <p>Weekly</p>	<p>Contractor and ECO.</p> <p>ECO</p>
<b>5.16 Impact on maritime archaeology (shipwrecks)</b>	Avoid impacts to maritime archaeology during land reclamation and coastal construction.	<b>5.16.1 If a wrecks or wrecks are present in the area SAHRA must be notified immediately, and the site/material must be assessed by a suitably qualified archaeologist, after which a decision can be made about the need for any mitigation measures, which may include site recording, sampling/excavation, and potentially removal and recovery.</b>	<p>Survey as specified prior to commencement.</p> <p>Chance-find procedure with reporting to SAHRA.</p>	<p>One-off</p> <p>Ongoing throughout construction.</p>	<p>Archaeologist.</p> <p>ECO and Contractor.</p>

## 6 POST-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

**Table 6-1: POST-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ALL ASPECTS**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>6.1 Management of the new bay and slipway</b>	<p>The new bay and slipway are managed in a way that allows public access.</p> <p>Users are made aware of the circulation in the bay and possible navigation difficulty.</p>	<p><b>6.1.1 Users made aware of the possible effects that they may encounter, such as appropriate signage near the slipway.</b></p> <p><b>6.1.2 Promote inclusive access to berthing and marine infrastructure.</b></p> <p><b>6.1.3 Enable safe public use.</b></p> <p><b>6.1.4 Brochures or digital awareness material (including QR codes) must be provided to promote compliance with MPA rules.</b></p> <p><b>6.1.5 Develop safe, well-maintained coastal access infrastructure, including accessible pathways, sufficient lighting, safety measures, and the promotion of public use of open spaces.</b></p>	<p>Confirm management of the new bay and slipway has been approved by relevant authorities and is implemented.</p> <p>Should issues arise, ensure that these are handled through the appropriate channels, through consultation with relevant stakeholders and authorities.</p>	In perpetuity	Authorisation holder.
<b>6.2 Stormwater system management</b>	Sources of pollutants within the development area are managed.	<p><b>6.2.1 The development will increase impervious surfaces and stormwater flows into Table Bay. Both the Marine and Oceanography studies identify pollution risks, including litter and sediment transport. To mitigate these risks, the following requirements apply:</b></p> <p>» <b>Litter traps and gross pollutant traps must be installed on all stormwater outlets draining into Table Bay from the development area.</b></p>	Confirm litter and gross pollutant traps are installed on stormwater outlets.	Once-off, once stormwater infrastructure upgrades are completed.	Contractor and ECO.

**Table 6-2: POST-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS ABOVE THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
None – all relevant aspects addressed in <b>Table 6-1</b> above.					

**Table 6-3: POST-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions	Monitoring Actions		
			Method	Frequency	Responsibility
<b>6.3 Monitor coastal water quality for compatibility with recreational use</b>	Water quality monitoring sufficient to inform decisions on recreational water use	<p><b>6.3.1 Monitor water quality within the new bay in line with South African Water Quality Guidelines for Recreational Water Use (DEA 2012 or relevant update / revision).</b></p> <p><b>6.3.2 Report regularly on results, either via the City of Cape Town's coastal water quality reporting system or a dedicated webpage.</b></p> <p><b>6.3.3 Implement advisories for recreational users if data over time indicate trends or patterns of reduced safety for recreational use.</b></p> <p><b>6.3.4 Implement closures to full-contact recreation when required by episodic spill or overflow events, or other contributors to impaired water quality.</b></p>	Collect seawater samples as described in ISO 19458 and SANS 5667 – using a new or sterilised bottle opened underwater at a water depth of not less than 0.5m and not less than 10cm below the surface, behind a broken wave. Store samples on ice with a temperature logger until analysed within no more than 24 hours (12 preferred) at a laboratory accredited for enumeration of enterococci in seawater. Maintain chain of custody documentation and cold-chain records. Calculate Hazen percentile and report on the Health Risk Category in line with the DEA 2012 guidelines and City of Cape Town standardised procedures.	Weekly sampling Monthly or semi-annual reporting	Authorisation Holder

**Table 6-3: POST-CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN: ASPECTS BELOW THE HIGH-WATER MARK**

Environmental aspect or impact	Impact Management Outcomes	Impact Management Actions		Monitoring Actions	
			Method	Frequency	Responsibility
<b>6.4 Monitor stormwater quality for compliance with national limits</b>	Effective monitoring programme is implemented for stormwater discharges to the coastal environment	<b>6.4.1 Monitor stormwater discharges in line with the ICMA General Discharge Authorisation or applicable Coastal Waters Discharge Permit, for at least the following parameters:</b> <ul style="list-style-type: none"> <li>» Ammonia (ionised and un-ionised) as N</li> <li>» Nitrate as N</li> <li>» Soap, oil or grease</li> <li>» Total suspended solids</li> <li>» Chemical oxygen demand</li> <li>» Dissolved oxygen</li> <li>» pH</li> <li>» Temperature</li> <li>» Salinity</li> </ul>	Collect stormwater samples from each stormwater outfall as described in SANS 5667 and analyse at an accredited laboratory or in situ using a calibrated instrument as applicable. Report to DFFE on compliance with the Special limits set out in GN 2290 of 2022 or revision thereof.	Quarterly for first year Biannually thereafter	Authorisation Holder
<b>6.5 Disturbance to marine habitat and system function</b>	Operation of the bay and associated uses are managed so that potential pollution of the bay area is avoided as far as possible.	<b>6.5.1 Ensure potential pollution sources (including bilge water and greywater etc.) associated with the development are managed to avoid pollution which may further degrade these habitats.</b> <p><b>6.5.2 Follow local legislation and international best-practice guidelines for bilge and greywater discharge, with clear signage and training for all vessel users.</b></p> <p><b>6.5.3 Conduct regular environmental awareness campaigns for vessel operators, and implement a system for reporting marine mammal sightings and pollution events.</b></p> <p><b>6.5.4 Designate speed-restricted areas within the new bay to reduce underwater noise and minimise the risk of vessel strikes on marine fauna.</b></p> <p><b>6.5.5 Additional measures include public education signage, responsible wildlife viewing guidelines, and coordination with local operators to minimise disturbance.</b></p>	Implement management actions.	In perpetuity	Authorisation holder

## 7 ENVIRONMENTAL AWARENESS TRAINING PLAN

This section outlines the training by which the authorisation holder (via its appointed contractor during the construction phase) will inform its employees of environmental risks and the manner in which risks must be dealt with to avoid pollution or degradation of the environment. It may be adapted as needed to suit the circumstances in which it is implemented.

Course	Required attendees	Presented by	Course content	Timing	Records to be kept
<b>Construction phase Environmental Awareness Training for manager</b>	<ul style="list-style-type: none"> <li>Project Manager appointed by the authorisation holder</li> <li>Principal contractor's contract manager, site agents, and assistant site agents (as applicable)</li> <li>Contractor's designated environmental officer or SHE representative</li> </ul>	ECO	<ul style="list-style-type: none"> <li>Overview of environmental authorisations and permits granted</li> <li>Basic environmental law</li> <li>Roles of the ECO, authorisation holder, project manager, and contractor</li> <li>Purpose and content of method statements</li> <li>Site sensitivities</li> <li>Management actions and measures for the construction phase as detailed in this EMPr</li> <li>Record keeping requirements</li> <li>Emergency procedures</li> <li>Reporting and compliance monitoring</li> </ul>	Prior to commencement of construction	<ul style="list-style-type: none"> <li>Declaration of adherence to Construction phase EMPr, signed by Contractor's representative</li> <li>Register of attendance</li> </ul>
<b>Environmental Awareness Training for site personnel</b>	<ul style="list-style-type: none"> <li>All site staff and personnel, including temporary staff and visitors to site</li> <li>Maximum of 20 attendees at any one session</li> </ul>	Contractor's designated environmental officer	Environmental do's and don'ts, including: <ul style="list-style-type: none"> <li>Access to work areas, location and identification of no-go areas</li> <li>Managing animals found on site</li> <li>Smoking and fires</li> <li>Storing and handling fuels and oils</li> <li>Storing and handling chemicals</li> <li>Management of cement, cement bags, slurry, and wash water</li> <li>Dust and noise</li> </ul>	Before any staff member begins work on site	<ul style="list-style-type: none"> <li>Register of attendance, identifying all attendees by name and ID number, the topics covered, the presenter, and the date and time.</li> </ul>

Course	Required attendees	Presented by	Course content	Timing	Records to be kept
			<ul style="list-style-type: none"> <li>• Water wastage</li> <li>• Waste management and litter, especially near the ocean.</li> <li>• Waste site management</li> <li>• Ablution facilities</li> <li>• Plant and machinery maintenance and load management</li> <li>• Accident and incident reporting</li> <li>• Identifying sensitive marine species and appropriate responses</li> <li>• Managing of rock placement in the ocean</li> <li>• Spill response in the ocean</li> <li>• Identifying archaeological material and reporting procedure</li> </ul>		

## 8 MARINE MAMMAL MONITORING PLAN

### 8.1 Introduction

The proposed development will include the reclamation of a portion of Table Bay. Increased vessels, noise, turbidity and pollution during construction may have an impact on marine mammals residing in and around Granger Bay.

### 8.2 Objectives

To undertake a Before-After Control-Impact type study of the impacts of the land-reclamation project on the resident Heaviside's dolphins and other species in the area through Marine top predator baseline boat and visual surveys and Cetacean Ecology baseline passive acoustic monitoring.



**Figure 8-1: Suggested deployment plan for long-term acoustic monitoring of dolphins and whales in Granger Bay and Three Anchor Bay area (Blue-dots: Known locations of Heaviside's dolphins, Red dots: proposed location of hydrophones and Red circles: 200m effective detection radius and 500m maximum detection radius for Heaviside dolphins.**

Task	Monitoring Actions	Method	Output
	Method	Frequency	
8.1 Marine top predator boat and visual surveys	8.1.1 Survey impact and surrounding areas to collect data on cetacean, seal, sunfish, and bird species.	Four surveys monthly during in-water construction, commencing at least one month prior to commencement of works	Bi-Monthly report focused on maps of new and total-updated dataset showing species spatial distribution patterns, hotspots, overlap with shipping in a larger spatial area.  Summary statistics and figures showing diurnal and monthly sighting rates—identification of high-risk areas/periods.
	8.1.2 Acoustic recordings of species in situ and environment to confirm passive acoustic monitoring species and detection range on PAM equipment.	10-15 samples minimum  Four surveys monthly during in-water construction commencing at least one month prior to commencement of works	
	8.1.3 Photographic identification of encountered Heaviside's dolphins. Granger Bay is the effective southernmost limit of the range of this endemic species and is thought to host a resident population. Photo-ID will allow the identification of individuals and confirm numbers, residency and change over time.	Four surveys monthly during in-water construction commencing at least one month prior to commencement of works	
8.2 Cetacean Ecology baseline passive acoustic monitoring	8.2.1 Dolphin monitoring (Heaviside's focus) passive acoustic monitoring for dolphin presence. Location: an array of 4x CPOD Click detecting hydrophones placed across the high-density use area and construction impact site before/ during/ after deployment. Array placement will enable measurement of (potential) changes in habitat use during the construction period.	Continuous monitoring during in-water construction commencing at least one month prior to commencement of works	Bi-Monthly: Focused report providing tabular and visual summaries of temporal presence of animals (whales and dolphins by species, fish sounds by type), anthropogenic sounds and long-term sound scape metrics
	8.2.2 Whale and soundscape monitoring (10% subsampled) passive acoustic monitoring for whales, fish, dolphin ID, human noise and ocean soundscape. Subsampled to 1 min every 10 min (10%).		

## 9 LIST OF APPENDICES

Appendix No.	Contents	Revision date	Revised by	Effective Date
1	E.A.P. Curriculum Vitae	19 March 2026	J ROSE	19 March 2026
2	PRDW's Generic Rock Specification	2019	PRDW	19 March 2026

## JEREMY ROSE

### Environmental Scientist

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#### Professional Registrations

EAPASA: Reg. E.A.P.  
 2019/1116

SACNASP Pr.Sci.Nat.  
 120148

IAIASa 5781

#### Years' experience

Twelve

#### Education and Certifications

- B.Sc. Hons  
 Environmental and  
 Geographical Science
- B.Sc. Environmental  
 and Geographical  
 Science & Biochemistry
- Remote Pilot

#### Date of Birth

7 December 1991

#### Nationality

South African

#### Languages

English  
 Afrikaans  
 isiXhosa

Environmental scientist, stakeholder engagement and policy professional. Experienced in leading and participating in multi-disciplinary specialist teams for environmental monitoring, resource management, policy development, and strategic planning projects in the public and private sectors.

Principal consultant at Infinity Environmental, responsible for project management and business development including consulting services associated with:

- Advising public and private-sector clients on environmental feasibility, legislation, and risks
- Managing Environmental Impact Assessment (EIA) and Basic Assessment processes for environmental authorisation
- Development of environmental policy and strategic and spatial planning instruments
- Geographic information systems (GIS), including spatial data management, digitisation and analysis, and production of static and web-based drawings and maps
- Planning for construction- and operation-phase environmental management, including preparation of site-specific environmental management programmes (EMPr)
- Management of permitting and licensing processes for air emissions, water uses, waste management, and mining
- Monitoring and auditing of environmental compliance as an Environmental Control Officer (ECO) or independent auditor
- Management of multidisciplinary teams for complex remediation and rehabilitation projects
- Lifecycle environmental compliance, including the management of decommissioning and contaminated land processes
- Public participation and stakeholder engagement, including planning and facilitation of consultation
- Drone-based aerial imaging and data capturing as a certified and licensed remote pilot.

SELECTED PROJECT EXPERIENCE

DATE

CLIENT

**INTEGRATED ENVIRONMENTAL MANAGEMENT**

Basic Assessment for the dredging of Milnerton Lagoon	2025-2026	City of Cape Town
Scoping and Environmental Impact Assessment for the realignment of Protea Road in Klapmuts	2025-2026	Heineken Beverages
Scoping and Environmental Impact Assessment for the proposed land reclamation and Development of the Granger Bay Precinct at the V&A Waterfront in Cape Town	2025-2026	V&A Waterfront
Section 24G application for rectification of unlawful development commencement on a residential property in Misty Cliffs, Cape Town	2025-2026	Private
Environmental feasibility assessment for the extension of the St James Coastal Walkway to Fish Hoek	2025	PRDW
Stakeholder engagement and Basic Assessment for Three Anchor Bay Erf 2187, Green Point	2025-2026	City of Cape Town
Environmental Impact Assessment for the proposed Mowbray Golf Course Redevelopment project	2025-2026	City of Cape Town
Water Use Licence applications for coastal groundwater use for dune rehabilitation at Table View	2023	City of Cape Town
Environmental impact assessment and stakeholder engagement process for redevelopment of the Strand Street Quarry national heritage site	2023-2025	City of Cape Town
Basic Assessment for a new operations centre for Biodiversity Management at the Westlake Conservation Centre	2025	City of Cape Town
Basic Assessment for the expansion of the Kuils River Cemetery	2024	City of Cape Town
Basic Assessment for the expansion of the Rusthof Cemetery, Strand	2024	City of Cape Town
Basic Assessment for the proposed Vaalfontein Cemetery	2024-2025	City of Cape Town
Basic Assessment for the proposed Tafelsig Cemetery	2024-2025	City of Cape Town
Section 24G Application for unlawful vegetation clearing in Scarborough Cape Town	2025	Private
Water Use Licence applications for coastal groundwater use for dune rehabilitation at Fish Hoek	2023	City of Cape Town
Water Use Licence applications for coastal groundwater use for dune rehabilitation at Fleur Park	2023	City of Cape Town
Renewal of the atmospheric emissions licence for the Cape Town International Airport	2025	Airports Company South Africa
Basic Assessment for the realignment of Protea Road in Klapmuts	2025	Heineken
Basic Assessment for the upgrading of the N1 / R44 interchange in Klapmuts	2025	Heineken
Basic Assessment for the modification of the Zeekoevlei Weir in the False Bay Nature Reserve	2024	City of Cape Town
Basic Assessment for a proposed residential development in Bishopscourt	2022-present	Private

**SELECTED PROJECT EXPERIENCE**

	<b>DATE</b>	<b>CLIENT</b>
Basic Assessment for a proposed residential development and river rehabilitation in Bellville	2023-2024	City of Cape Town
Basic Assessment for proposed infrastructure upgrades on Porter Estate	2023-2025	WCG
Basic Assessment for proposed dredging remediation of the Zeekoevlei	2023	City of Cape Town
Basic Assessment for the upgrading of the M3 highway in Cape Town	2021-2023	City of Cape Town
Basic Assessment and amendments of a water use licence and environmental authorisation for an industrial facility in Springs, Ekurhuleni	2021-2022	Distell
Basic Assessment for a new bulk sewer in Montague Gardens, Cape Town	2021-22	City of Cape Town
Section 24G application to rectify historical unlawful cultivation and construction of dams on a farm in the Western Cape	2021	Private
Basic Assessment for a proposed high-density social housing and mixed-use development in Salt River, Cape Town	2020-2021	City of Cape Town
Basic Assessment for the proposed expansion of an industrial development	2020-21	Bowler Plastics
Basic Assessment for the proposed expansion of a municipal cemetery in Struisbaai	2020-21	Cape Agulhas Municipality
Basic Assessment for the proposed expansion of a municipal resort in Struisbaai	2020-21	Cape Agulhas Municipality
Scoping and EIA for an urban development framework on the 500-ha Swartklip site, Khayelitsha, Cape Town	2020-2023	Airports Company SA
Water Use Licence Application for a pharmaceutical production facility in Atlantis, Cape Town	2019-20	Canopy Growth
Basic Assessment for in-fill housing developments in Bonteheuwel	2018-19	City of Cape Town
Scoping and environmental impact assessment for a 200-hectare agro-industrial and mixed-use development in Klapmuts North	2017-18	Distell
Environmental Impact Assessments (Basic Assessments) for two proposed Integrated Rapid Transit Phase 2A West Trunk Routes in Cape Town	2016	City of Cape Town/SMEC
Environmental Impact Assessment (Basic Assessment) for a proposed filling station in Bellville, Cape Town	2016	City of Cape Town
Environmental Impact Assessment and Water Use Authorisation for the proposed upgrading of the Elizabeth Park and Elsieskraal River, Bellville	2016	City of Cape Town
Amendment to the Environmental Authorisation for a fishmeal processing plant in Saldanha Bay	2014	Sea Harvest
Environmental assessment of proposed maintenance dredging within the Mitchell Channel log handling facility on the Fraser River, Vancouver, Canada	2015	Fraser River Pile & Dredge
Environmental Impact Assessment for the proposed extension of the Vygekraal Cemetery in Rylands, Cape Town	2014	Private
Basic Assessment and Atmospheric Emissions Licence application for the proposed additional jet fuel tank, Cape Town International Airport	2013-14	Airports Company SA

SELECTED PROJECT EXPERIENCE

DATE

CLIENT

**WATER QUALITY MONITORING AND REMEDIATION PLANNING**

Annual report on the Mitchell's Plain WWTW coastal water quality programme for 2024-2025	2026	City of Cape Town
Implementation of coastal and nearshore water quality and environmental monitoring for the coastal outfalls and wastewater treatment works in Cape Town	2024-2026	City of Cape Town
Data management, analysis and display for the City of Cape Town's Know Your Coast Report 2025	2025	City of Cape Town
Data analysis and assessment for the City of Cape Town's Inland Water Quality Report 2023-2024	2025	City of Cape Town
Development of a monitoring programme for Cape Town's coastal waters with a focus on long-term environmental change and priority contaminants	2025	City of Cape Town
Rehabilitation Plan for the Theo Marais Canal in Montague Gardens	2025	City of Cape Town
Annual report on the marine outfall environmental monitoring programme for 2024-2025, including water quality, sediment quality, ecological effects, bioaccumulation, and microplastics impacts	2025	City of Cape Town
Receiving Environment Monitoring Programme and Marine Impact Assessment for the Simon's Town Wastewater Treatment Works	2025	City of Cape Town
Receiving Environment Monitoring Programme and Marine Impact Assessment for the Oudekraal Wastewater Treatment Works	2025	City of Cape Town
Receiving Environment Monitoring Programme and Marine Impact Assessment for the Miller's Point Wastewater Treatment Works	2025	City of Cape Town
Receiving Environment Monitoring Programme and Marine Impact Assessment for the Llandudno Wastewater Treatment Works	2025	City of Cape Town
Receiving Environment Monitoring Programme and Marine Impact Assessment for the Mitchell's Plain Wastewater Treatment Works	2025	City of Cape Town
Pollution monitoring in the Milnerton Lagoon in response to sewage spill events	2024-2025	City of Cape Town
Real-time monitoring of oxygen levels in the Milnerton Lagoon for tracking of aeration success	2024	City of Cape Town
Receiving Environment Monitoring Programme for the marine sewage outfalls at Green Point, Camps Bay, and Hout Bay	2024	City of Cape Town
Remediation Planning for the Milnerton Lagoon, including hydrodynamic modelling and ecological assessments of dredging options	2023	City of Cape Town
Remediation Planning for the Zandvlei recreational waterbody, including hydrodynamic modelling and ecological assessments of dredging options	2022	City of Cape Town
Remediation Planning for the Rietvlei recreational waterbody, including hydrodynamic modelling and ecological assessments of dredging options	2022	City of Cape Town
Rehabilitation Plan for sewage spill events in the False Bay Nature Reserve	2022	City of Cape Town
Management options advisory for the Lourens River Protected Natural Environment	2021	City of Cape Town
Review of the Diep River Estuarine Management Plan	2021	City of Cape Town

**SELECTED PROJECT EXPERIENCE**

**DATE**

**CLIENT**

Field sampling programme for marine water quality monitoring following a pollution incident in Howe Sound estuary, Canada. Preparation of a long-term Ecological Receptor Monitoring Plan for the estuary.

2016

Private

Review of the Zandvlei Estuarine Management Plan and Situation Assessment

2022-2023

City of Cape Town

Pollution tracking and water quality assessment for the Diep River and Potsdam WWTW for a remediation plan for the Milnerton Lagoon

2022-2023

City of Cape Town

**CONSERVATION PLANNING AND INVASIVE SPECIES MANAGEMENT**

Conservation Development Framework for the Macassar Conservation Area

2025

City of Cape Town

Report on the condition, importance, and threats to wetlands in Cape Town, with a focus on seasonal wetlands

2024-2025

City of Cape Town

Municipal Invasive Species Monitoring, Control and Eradication Plan for the Bergrivier Local Municipality

2019

Bergrivier Municipality

Conservation Area Management Plan including rehabilitation planning, fire management planning, and invasive species management for a 200-ha property in Klapmuts

2019-2020

Distell

Preparation of a Municipal Invasive Species Monitoring, Control and Eradication Plan for the Garden Route District Municipality

2019

Garden Route District Municipality

Preparation of an Invasive Species Control Plan in terms of the NEMBA AIS Regulations for a private landowner, Hoekwil

2017

Private

Monitoring of implementation of a control plan for the invasive alien Japanese knotweed along a river corridor in West Vancouver, Canada

2015

Private

Environmental offset rehabilitation planning for a residential development on Glenlyon Creek in North Vancouver, Canada

2015

Private

Implementation of the invasive alien Guttural Toad eradication project in Cape Town

2013

City of Cape Town

**STRATEGIC AND POLICY PROJECTS**

Local Spatial Development Framework for the Dwars River Valley in Stellenbosch

2026

Stellenbosch Municipality

Groundwater Management Policy development for the City of Cape Town

2025

City of Cape Town

Sustainability assessment of the coastal dune rehabilitation projects at Hout Bay, Table View, Fish Hoek, Gordons Bay, and Glencairn in Cape Town

2024-2025

City of Cape Town

Facilitation of an international expert workshop to assess the causes and contributors of aggression in Cape Fur Seals and the implications and management of the rabies outbreak

2024

City of Cape Town

Environmental aspects of a policy for small-scale wind generation in the City of Cape Town

2022

City of Cape Town

Heritage and stakeholder engagement for the Langa Living Streets public places programme

2025

City of Cape Town

**SELECTED PROJECT EXPERIENCE**

**DATE**

**CLIENT**

Geographic information systems services and mapping for a risk and wildfire plan for the Robben Island World Heritage Site	2023	Western Cape Government
Environmental feasibility assessment for the Potsdam Sustainability Campus in Killarney Gardens, Cape Town	2022	City of Cape Town
Heritage study of the Philippi, Nyanga East and Crossroads area in Cape Town	2021	City of Cape Town
Heritage study of the Bellville CBD in Cape Town	2021	City of Cape Town
Environmental feasibility and project management for a housing programme in the Philippi Opportunity Area in Cape Town	2021	City of Cape Town
Environmental and stakeholder engagement component of a masterplan for the Foreshore precinct in Cape Town	2021	City of Cape Town
Environmental aspects of a local area spatial development framework for the Adam Tas Corridor in Stellenbosch	2021	Stellenbosch Municipality
Environmental and GIS component of a precinct plan for the Robertson-Nkqubela precinct	2020	Langeberg Municipality
Development of a GIS-based online web mapping tool for the display of risk and disaster management data for the Witzenberg Municipality	2020	Santam / Vulcan Wildfire
Environmental and GIS component of the review of the Witzenberg Spatial Development Framework, 2019-2024	2019	Witzenberg Municipality
Environmental component of the Stellenbosch Municipal Spatial Development Framework, 2018-2023	2018	Stellenbosch Municipality
Environmental, GIS and stakeholder engagement components of the Paarl CBD Local Spatial Development Framework	2017	Drakenstein Municipality
Environmental and GIS components of the Cape Agulhas Municipality Spatial Development Framework 2017-2022.	2017	Cape Agulhas Municipality
Environmental status quo investigation for the draft Urban Design Framework for Masiphumelele	2016	City of Cape Town / AECOM
Environmental feasibility assessments of 31 sites for human settlements masterplanning and land disposal	2013-2014	WCG / AECOM
Environmental Feasibility for housing developments in Sir Lowry's Pass Village	2013-2014	City of Cape Town / AECOM

**CONSTRUCTION MANAGEMENT, MONITORING AND AUDITING**

Environmental Control Officer services for the dredging of Zeekoevlei	2025-2026	City of Cape Town
Environmental Control Officer services for the Zeekoevlei Weir upgrade	2026	City of Cape Town
Environmental Control Officer services for a new warehouse and distribution centre in Stikland Industria	2025	Zenprop
Environmental Control Officer services for the replacement of a scour chamber on the bulk water pipeline at Meerlust	2025	City of Cape Town

**SELECTED PROJECT EXPERIENCE**

**DATE**

**CLIENT**

Environmental Control Officer services for the new sludge handling facility at the Wildevoelwei wastewater treatment works, Cape Town	2025	City of Cape Town
Environmental Control Officer services for the rehabilitation of Jakes Gerwel Drive in Cape Town	2021	City of Cape Town
Environmental Control Officer services for an industrial development in Philippi	2021	Bowler Plastics
Independent environmental compliance audit of construction and operation of the Touwsrivier CPV 1 Concentrated Photovoltaic solar plant	2020	CPV 1
ECO services for the construction of a new parking area at the University of Cape Town	2020	University of Cape Town
ECO services for the construction of a pedestrian bridge over the N2 at De Beers Ave, Somerset West	2019-2021	Western Cape Government
ECO services for sewerage infrastructure upgrades in Gordon's Bay, Cape Town	2018-2020	City of Cape Town / Delta
ECO services for infrastructure developments for the new administration building, Kirstenbosch National Botanical Garden	2018-2020	SANBI/Aurecon
ECO services for the upgrading of Sir Lowry's Pass Road and Old Sir Lowry's Pass Road, Cape Town	2017-2021	City of Cape Town / SMEC
ECO services for the replacement of culverts beneath the R44 near Somerset West	2016	Western Cape Government
ECO services for the upgrade of the N1 between Platteklouf and R300	2016-2017	Western Cape Government
ECO services for upgrades to the water distribution system at Klaver Valley, Simonstown, Cape Town	2016-2017	Department of Public Works
Environmental construction monitoring for the widening of the Braid Street Bridge over the Fraser River, Burnaby, BC, Canada	2015-2016	Metro Vancouver
Environmental construction monitoring for the construction of the Glenlyon Business Park, Burnaby, BC, Canada	2015-2016	Private developer
Environmental construction monitoring for the construction of the New Haven commercial development, Burnaby, BC, Canada	2015-2016	Private developer
Environmental construction monitoring for the construction of the RedBrick residential development, Burnaby, BC, Canada	2015-2016	Private developer
Environmental construction monitoring for the construction of the Philip Avenue road-over-rail overpass, North Vancouver, Canada	2015-2016	District of North Vancouver
Environmental construction monitoring for the soil contamination remediation works and construction of a quay at Lonsdale Quay, North Vancouver, Canada	2015-2016	City of North Vancouver
Environmental construction monitoring for road widening at 160 <sup>th</sup> Street, Surrey, Canada.	2016	City of Surrey
Environmental construction monitoring for upgrades to various culverts, drainage channels, and stormwater infrastructure in Surrey, Canada.	2015-2016	City of Surrey
ECO services for the upgrading of the Stellenbosch Arterial Road, Cape Town	2014	Western Cape Government
ECO services for emergency works on the Franschoek Pass	2014	Western Cape Government
ECO services for the upgrade of Philippi Rail Station	2014	PRASA

### SELECTED PROJECT EXPERIENCE

### DATE CLIENT

ECO services for the construction of a Shared Services Office Building in Khayelitsha, for the Western Cape Department of Transport and Public Works and the Western Cape Department of Health.

2014

Western Cape Government

Environmental monitoring for various private residential developments in Squamish, Coquitlam, and Burnaby, Canada.

2015-2016

Private

ECO services for the construction of the Southbreak / Dune Crest residential developments in Muizenberg

2013-2017

Private

ECO services for the construction of the Joe Slovo Phase 3 housing development in Langa

2013-2014

City of Cape Town

ECO services for the construction of the Nuutgevonden residential development in Stellenbosch

2014

Private

**TECHNICAL SPECIFICATIONS**

**GENERIC SPECIFICATIONS**

**ROCK FOR RUBBLE MOUND STRUCTURES**



**PRESTEDGE RETIEF DRESNER WIJNBERG (PTY) LTD**  
**CONSULTING PORT, COASTAL AND ENVIRONMENTAL ENGINEERS**

<b>Generic Specifications: Rock for Rubble Mound Structures</b>					
<b>Revision</b>	<b>Date</b>	<b>Author</b>	<b>Checked</b>	<b>Status</b>	<b>Approved</b>
00	24 April 2013	CWK/MWS	RS/SRP	Draft for approval	AHH
01	6 March 2014	FMG	RS	For use	
02	6 August 2019	GMH	AHH	For use	

**Keywords:** Marine Works, Specifications, Rock, Rubble mound

**TECHNICAL SPECIFICATIONS**  
**GENERIC SPECIFICATIONS**  
**ROCK FOR RUBBLE MOUND STRUCTURES**

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**TRACK OF CHANGES**

<b>Revision</b>	<b>Description of changes</b>
01	<ul style="list-style-type: none"><li>- New definitions.</li><li>- Simplification of sampling and testing procedures.</li><li>- Differentiation of requirements for light and heavy armour.</li><li>- Method statements and Quality Control Plans added as requirements.</li><li>- Precedence of concrete armour license holder's own specification.</li></ul>
02	<ul style="list-style-type: none"><li>- New definitions.</li><li>- Revised and clarified wording.</li><li>- Revised rock sourcing specifications.</li></ul>

## 1. SCOPE

This specification provides definitions and requirements for the production, testing, transport, placement and survey of rock materials for use in the construction of marine rubble mound structures. These structures may include but are not limited to breakwaters, causeways, revetments, scour protection and groynes.

## 2. DEFINITIONS

For the purposes of this specification the following definitions will apply:

Armourstone/ Armour rock: Coarse aggregate used in hydraulic structures for protection against waves or currents.

Class limits: The size (or weight) defined for each rock grading together with the allowable percentage of a sample that can lie beyond that limit, as follows:

- Extreme Lower Limit (ELL)
- Nominal Lower Limit (NLL)
- Nominal Upper Limit (NUL)
- Extreme Upper Limit (EUL)

Coarse grading rock: A grading which is determined with the aid of sieve sizes.

Effective mean weight  $W_{em}$ : The arithmetic average weight of all blocks in a sample excluding any rock fragments.

Grading: Rock distribution which is graded by sieve sizes or by weight of individual rocks.

GVM: Gross vehicle mass.

Heavy grading rock: A rock grading which is determined by weight for rocks of mean weight of at least 300 kg.

Light grading rock: A rock grading which is determined by weight or size of rock for mean weights less than 300 kg per rock unit.

Load of rock: The quantity of rock per unit of transport.

Mean layer thickness: The ratio of the area under the mean actual profile and the length of the survey profile (Figure 6-1: (b)).

Nominal layer thickness  $t$ : Assumed layer thickness used to prepare design drawings and for the estimation of bulk volume of armourstone.

Nominal rock diameter  $D_n$ : The nominal rock diameter,  $D_n$ , shall be calculated as the cube root of the volume of the rock. The volume shall be calculated by dividing the mass of the rock by the saturated surface dry density. Where a numbered subscript is given to  $D_n$ , this refers to the percentage by weight of rocks in the grading having a smaller nominal rock diameter.

Rock: Broken natural rock sourced from a quarry.

**Rock fragment:** A piece of rock in a grading with lesser weight or size than the extreme lower class limit (ELL) for that particular grading class.

**Rock Placement:** This is categorized as follows (CIRIA, CUR, CETMEF, 2007):

- **Random placement** is without control of individual rock orientation with void porosities typically up to 2 per cent higher than standard placement.
- **Standard placement** is where minimum orientation control is applied so that the block attitude is effectively governed by its orientation in the stockpile before lifting. However, a minimum of three points of contact within the layer being placed should be ensured. This will require some re-orientation of individual rocks.
- **Dense placement** involves the rotation of armour rocks until the orientation achieved is expected to give the maximum number of point contacts and minimum voids. Individual stones are removed and replaced if necessary.
- **Specific placement** is used when in addition to placement procedures, stone shape constraints are also specified.

### 3. MATERIALS

Full quality control of rock as referred to in Section 7 is carried out at the site of the quarry. However, further visual inspections must be carried by the Contractor on a regular basis during delivery of rock to the workface or to stockpile, as the case may be. These inspections must include at least the following:

- Verification of origin of the material (agreed section/face of the quarry); indicators are petrography, colour, and grain size.
- Mass distribution to be carried out by a trained inspector. In case of doubt, the Engineer may require an additional mass distribution test to be carried out. This will involve the weighing and plotting of the weight distribution of an agreed sample as per Section 7.2.3.2.
- Inspect cracks.
- Check on cleanliness, absence of soil or quarry dust.

#### 3.1 Standard Rock Gradings

Rock gradings are divided into:

- Heavy gradings for larger sizes appropriate for armour layers – normally handled individually.
- Light gradings appropriate for armour layers, under layers and filter layers – produced in bulk, usually by crusher opening and grid bar separations.

- Coarse gradings often used for filter layers of such a size that all pieces can be processed by production screens with square openings (i.e. typically less than 200 mm).

Standard gradings according to EN 13383 are specified in

**Table 3-1: Heavy, Light and Coarse Standard Grading Requirements (BS EN 13383-1, 2002)**

Heavy	Class designation	ELL	NLL	NUL	EUL	W <sub>em</sub> [kg]	
	Passing Requirements [kg]	<5% [kg]	<10% [kg]	>70% [kg]	>97% [kg]	Lower limit	Upper limit
	10 000 – 15 000	6 500	10 000	15 000	22 500	12 000	13 000
	6 000 – 10 000	4 000	6 000	10 000	15 000	7 500	8 500
	3 000 – 6 000	2 000	3 000	6 000	9 000	4 200	4 800
	1 000 – 3 000	700	1 000	3 000	4 500	1 700	2 100
	300 - 1 000	200	300	1 000	1 500	540	690

Light	Class designation	ELL	NLL	NUL	EUL	W <sub>em</sub> [kg]	
	Passing Requirements [kg]	<2% [kg]	<10% [kg]	>70% [kg]	>97% [kg]	Lower limit	Upper limit
	60 – 300	30	60	300	450	130	190
	10 – 60	2	10	60	120	20	35
	40 – 200	15	40	200	300	80	120
	5 – 40	1.5	5	40	80	10	20
	15 – 300*	3	15	300	450	45	135

Coarse	Class designation	ELL	NLL	NUL	EUL	< 50 %
	Passing Requirements [mm]	<5% [mm]	<15% [mm]	>90% [mm]	>98% [mm]	[mm]
	45/125	22.4	45	125	180	63
	63/180	31.5	63	180	250	90
	90/250	45	90	250	360	125
	45/180**	22.4	45	180	250	63
	90/180***	45	90***	180***	250	NA

Notes: \* = wide light grading, \*\* = wide coarse grading, \*\*\* = gabion grading, NLL = 20 %, and NUL = 80 %.

### 3.2 Shape: Length-to-thickness ratio

Heavy gradings must not contain more than 5 percent of rocks with length to thickness ratio (LT) greater than 3. Light gradings must not contain more than 20 percent of rocks with length to thickness ratio (LT) greater than 3.

### 3.3 Rock Quality Requirements

#### 3.3.1 General

All samples for rock quality tests must be taken in accordance with Section 7.2.

#### 3.3.2 Density

The average particle density of armourstone (excluding fragments) must be at least 2 600 kg/m<sup>3</sup>, with 90 percent of the rocks having a density of at least 2 500 kg/m<sup>3</sup>.

#### 3.3.3 Water Absorption

The average water absorption of rock must be less than 2% and the water absorption of nine of the individual rocks less than 2.5% (CIRIA, CUR, CETMEF, 2007).

#### 3.3.4 Resistance to Breakage

The mean compressive strength of 9 specimens out of 10 must be higher than 80 MPa. No more than 2 specimens out of 10 may be lower than 60 MPa (CIRIA, CUR, CETMEF, 2007).

#### 3.3.5 Resistance to Impact and Mineral Fabric Breakage

The average Point Load Index in the planar direction of the most pronounced layering if any visible anisotropy exists must be at least 4.0 MPa (CIRIA, CUR, CETMEF, 2007). The average minus one standard deviation must be at least 3.0 MPa.

#### 3.3.6 Block Integrity

Armourstone pieces must be free from visually observable cracks, veins, fissures, shale layers, stylolite seams, laminations, foliation planes, cleavage planes, unit contacts or other such flaws which could lead to breakage during loading, unloading or placing (BS EN 13383-1, 2002).

The block integrity must be tested by means of a destructive test, the drop breakage test. The drop test breakage index calculated based on appropriate sampling and testing as described in Section 7.9 must be less than 5%.

### 3.4 Impurities

Rock must not contain visually observable or chemically detectable impurities or foreign matters in such quantities that these are damaging for the constructive application of the rock or for the environment in which the rock is applied.

## 4. **EQUIPMENT**

### 4.1 General

Suitable equipment must be provided for the accurate control of placing the rock in the structure and for surveying the seabed and the profiles of the sub-components of the structure to prove compliance with the relevant tolerances.

Spillage of materials, generation of dust, and contamination of public roads with mud or stone fragments from the site must be controlled. The Contractor is responsible for cleaning the haul route of any material spilt from his vehicles.

Audible reversing warning signals must be provided for all transport vehicles exceeding 3 ton GVM. All equipment must comply with the applicable safety, environmental and legal requirements.

### 4.2 Safety

The Contractor is responsible for preventing public access to the site of the works at all times.

Construction equipment must be operated by personnel who are suitably trained, licensed and qualified to operate the particular item of equipment.

Stockpiles of rock and stacking areas for concrete armour units must be monitored and controlled by an experienced supervisor to ensure that they present no danger to personnel working in the vicinity.

#### 4.3 Lifting Machinery

All cranes and gantries together with all slings, ropes and hooks, to be used on the site of the works must be tested and certified as required by legislation.

Breakwater construction cranes must be equipped with load measuring devices, and means to monitor the location of the crane hook in three degrees of freedom whether in air or underwater.

#### 4.4 Nuisance and Environmental Control

The contractor must comply with the environmental controls specified in the environmental specifications

### 5. **CONSTRUCTION**

#### 5.1 Method Statements

The Contractor must before work commences submit for the Engineer's acceptance method statements describing its proposed method of construction. Each method statement must be revised and resubmitted for acceptance every time the Contractor wishes to change its method of construction. The Contractor must ensure that the works are constructed in accordance with the latest method statement.

The method statements must include details regarding the following:

- Health, Safety and Environmental risk assessment
- Index of Quality Control Plans including pro forma inspection and test plans
- Survey methods and frequency
- Transportation of rock
- Handling and stockpiling of rock
- Setting out
- Rock placement methods, equipment, production rates, traffic management
- Access control
- Storm management

## 5.2 Quality Control General Requirements

The Contractor must ensure that the production of materials and construction of the structure is included in its project quality plan.

The Contractor must before work commences submit for the Engineer's acceptance an index of Quality Control Plan's (QCP's) which it intends implementing to ensure compliance with this specification as well as an index of supporting documentation (data packs) to prove compliance.

The QCP's must identify all inspections, test and other verification requirements to meet the specifications.

The Engineer will indicate to the Contractor which additional quality control interventions he requires. The QCP's must take account of the required interventions and include these in the QCP.

The contractor must provide to the Engineer all facilities reasonably required for carrying out quality verification activities in a safe and timely manner, including any on-site inspections and audits of the Contractor's records.

## 5.3 Source of Rock

The rock must be sourced from suitable quarries or from alternative sources if applicable according to the specifications.

The Contractor must before haulage of rock commences submit for the Engineer's acceptance test results demonstrating that the rock intended for use in the works complies with the specifications.

## 5.4 Transportation, Handling and Stockpiling

### 5.4.1 Transportation

The Contractor must before work commences submit for the Engineer's acceptance a method statement describing its proposed method for the transportation of rock.

The method statement must be revised and resubmitted for acceptance every time the Contractor wishes to change its method the transportation of rock. The Contractor must ensure that the transportation of rock is performed in accordance with the latest accepted method statement.

The method statement must include details regarding the following:

- Transportation plan describing the transport from the quarry to the site of the Works, including details of signage, flagmen, dust control, noise control and dealing with spillage and mud contamination on roads.
- Control of rock leaving the quarry area, ensuring that only rock that has been subjected to quality control inspections and tests can leave the quarry.

It is the responsibility of the Contractor to obtain the necessary permits to perform the quarrying and transport operations as required by legislation, and to perform these operations in compliance with all statutory requirements.

Rock must be transported to the site of the permanent works approved routes only. The Contractor must:

- Obtain the acceptance of the Engineer and the approval of the appropriate Authorities before using public roads.
- Avoid damage to public or private roads and repair any damage that does occur due to the transport of rock.
- Prior to the start of the works make a photographic record of the state of the public and/or private road will be used for transporting rock.
- Trucks used to transport rock must be of a type specifically constructed for hauling rock and must have tail boards or scow-ends. When transporting heavy armour stone adequate chains and slings must be used and verified before the truck leaves the quarry to ensure optimum security. No other mode of rock transportation may be used unless first accepted by the Engineer and approved by the relevant Authorities.
- If sea transportation is used, ensure all barges are seaworthy and have the necessary safety certificates and insurance issued by the relevant Authorities. Permission for safe mooring of sea transport vessels must be obtained from the relevant Authorities. The Contractor must have an emergency procedure in place should there be an imminent threat of sea and wind conditions beyond the safe mooring design conditions.

#### 5.4.2 Handling and Stockpiling

A stockpile plan must be drawn up which is commensurate with the overall project planning, giving due regard to the quarry output capacity and production lead-in time.

Stockpiles on site must be sized, taking into considerations the type of grading, access, weight limitations, manoeuvring and handling requirements (tipping or tipping and stacking) and risk of cross contamination (no overlaps of grades). If possible, a one-way rotation system must be instituted for controlling traffic. The stockpile area should be checked for existing services to avoid risk of damage. The Contractor must prevent unauthorized pedestrian access, keep stockpile areas well-lit during night operation, maintain equipment in adequate working condition, and keep suitable backup equipment nearby.

The Contractor must before work commences submit for the Engineer's acceptance a method statement describing its proposed method for the stockpiling of rock at or near the site of the Works. The method statement must be revised and resubmitted for acceptance every time the Contractor wishes to change its method for stockpiling of rock. Stockpiling of rock must be performed in accordance with the latest accepted method statement.

The method statement must include details regarding the following:

- Layout plan for stockpiles
- Control to avoid cross contamination of rock of different grades
- Access control
- Lighting at night
- Dust and noise control
- Health, Safety and Environmental risk assessment if not included in a separate Health and Safety Specification.

On-site stockpiles must be managed in a manner that ensures that:

- Contamination by fines and other non-conforming material is avoided,
- Safe access is available for handling, inspection and sampling of rock during all weather conditions,
- Cross contamination by different grades of rock is avoided,
- Pedestrian access is controlled and safe, and
- Adequate lighting is provided at night.

## 5.5 Placing of Rock to Specified Profiles

### 5.5.1 General

Before commencement of the construction work the Contractor shall submit to the Engineer for his acceptance full details of his proposed method of forming the works to the profiles indicated on the drawings (to be prepared after the pre-construction survey).

The sequential placing of layers of different rock grades (i.e. core, armour toe, underlayer and lee armour) must proceed as defined fronts in only one grade of material at each front location. At each location, placing of material for the next front is only permitted after acceptance by the Engineer of the previous front.

Rock that will be placed in the Works in bulk must be transported and handled in such a manner as to minimise segregation of the rock.

For work above low-tide level, fine material on the surface and between already placed stones must be removed before placing the next layer of stone to ensure sound bearing and interlock between stones.

### 5.5.2 Temporary Haul Roads

Any temporary haul road or track to be created within or on the rubble mound structure, must be constructed of free-draining local material if available and suitable for this purpose, or of other free-draining material accepted by the Engineer. Such material must be removed before placing subsequent layers. The haul road material must be sufficiently removed to expose between one third and one half of the depth of the upper layer of stones of the permanent works upon which the haul road material is placed, when measured from the highest points. Any rocks laid to facilitate haul road construction that do not comply with the specified requirements must be removed and replaced as necessary.

### 5.5.3 Underlayer and Core

Underlayer and core material must be placed according to random placement as defined under Section 2.

Placing of core and underlayer material (including scour protection material, where provided) must comply with the following requirements:

- Core material must be placed to the position, slopes and tolerances indicated on the drawings and this specification. Placement must be in accordance with the method and sequence of construction accepted by the Engineer.
- Underlayer and core material must be placed carefully to achieve a dense underlayer or core, avoid damage to the surface below or to the geotextile if used, and to achieve an even distribution of stone sizes without concentration of smaller stones. Underlayer and core material must not be compacted.
- Where concrete armour units are used, the licence holder's own specification takes precedence over this specification with regard to the underlayer and toe protection.

Tipping of stones for underlayer from vehicle, or bulldozing or dumping from hoppers or barges into final position, is not permitted without the prior acceptance of the Engineer. Such acceptance will only be considered after carrying out placing trials which demonstrate the proposed method.

Placing light grading stones for underlayer with a side stone dumping vessel-split hopper or a flat top barge- is permitted provided that the position of the vessel and the rate of dumping can be controlled in such a way that the materials are placed according to the required lines and levels.

#### 5.5.4 Cover Layer Armourstone

Armourstone must be placed as specified in the (project specific) particular specifications and drawings, and to the requirements specified below. In case of conflict the particular specifications and drawings take precedence.

Armourstone must be placed to achieve a dense, fully interlocked armoured slope so that each armour stone is securely held in place by its neighbours. Placing must commence at the toe and proceed upwards towards the crest.

Armourstone must be lowered into place individually and in such a way that they obtain their stability from interlocking and frictional resistance..

The rocks must be deposited carefully to minimise disturbance of any already-placed rock and to avoid damage to geotextiles and any existing structures. The rocks must be placed to achieve an even distribution of stone size without concentrations of smaller stones.

If light grading armourstone is permitted to be placed in bulk, it must be deposited carefully to minimise disturbance to any already-placed rock and to avoid damage to any existing structures.

Unless otherwise stated, the surface of the armoured slope must present an angular uneven face to the water to achieve the desired energy dissipation of waves. Pieces of armourstone smaller than the equivalent of the ELL value of the grading must not be used to fill interstices, or to prop larger stones in order to achieve the required profile.

Pieces of armourstone broken during handling or placing must be removed immediately at the Contractor's expense. Subject to the Engineer's approval, broken pieces of armourstone may be included in lighter gradings.

Any void below the finished profile level in excess of the  $0.75D_{n50}$  size of the armour rock, must be filled with an appropriate rock or rocks. Determination of the acceptability of any void is by means of a test sphere of diameter  $0.75D_{n50}$ .

#### 5.6 Protection of Placed Materials

Each placed layer must be protected by the subsequent layer (as indicated on the drawings) as soon as possible after placement in order to minimise damage due to currents or due to waves in the event of

storms during the construction period. Placing of materials must be one continuous operation, to ensure that none of the underlying layers are left unprotected over a distance greater or for duration greater than that proposed by the Contractor and accepted by the Engineer. If the operation has to be interrupted, temporary protection of the underlying layers must be provided with the same material as to be used for the final construction.

#### 5.7 Disturbance to Previously Placed Materials

Material eroded by wave action or other cause must be made good before placing the appropriate protective layer. However, in respect of core material, if accepted in writing by the Engineer, the core may be built up to the dimensions shown on the drawings with the material specified for the next layer overlying the core and in accordance with the method for this overlying layer at no additional cost to the Employer.

Notwithstanding the above, the Contractor must take all reasonable care to avoid disturbing a previously placed layer due to dropping or other potentially disturbing placing methods.

#### 5.8 Precautions

##### 5.8.1 Safety

Over and above the general safety requirements as specified elsewhere, the Contractor's safety management plan must take cognisance of the following specific risks:

- The Contractor is at all times responsible for preventing public access to the site of the Works.
- Construction and equipment must be operated only by personnel who are suitably trained, licensed and qualified for the particular item of equipment.
- Stockpiles of rock must each be monitored and controlled by an experienced supervisor to ensure that they present no danger to personnel working in the vicinity.
- Storm management plan (storm warnings, securing of equipment, evacuation of personnel).
- Emergency sea rescue plan.
- Working over water.
- Falling from heights and falling objects.
- Personnel safety and risk of damage to the Works due to wave overtopping.
- Communication breakdown between diver and crane operator, could lead to injury to divers.

The Contractor is responsible to implement all required safety measures.

### 5.8.2 Storm Water and Groundwater

For the duration of the contract, the Contractor must provide and maintain suitable flood control structures to protect the site from storm damage and protection from potential flooding.

### 5.8.3 Nuisance and Environmental Control

The Contractor must comply with all environmental control requirements specified or required by legislation.

## 6. TOLERANCES

### 6.1 Tolerances in Rock Grading

The system for defining heavy, light and coarse gradings requirements is based on setting limit values with an associated percentage passing by mass. A set of nominal limits corresponds to the target size of the armourstone. A set of extreme limits corresponds to tolerances. The standard grading requirements and associated passing values are summarised in

For heavy gradings the associated limits are:

- ELL (Extreme Lower Limit) – the mass below which no more than 5 per cent passing by mass is permitted.
- NLL (Nominal Lower Limit) – the mass below which no more than 10 per cent passing by mass is permitted.
- NUL (Nominal Upper Limit) – the mass below which no less than 70 per cent passing by mass is permitted.
- EUL (Extreme Upper Limit) – the mass below which no less than 97 per cent passing by mass is permitted.

### 6.2 Tolerances on Placed Rock Levels

#### 6.2.1 Cover Layer Armourstone

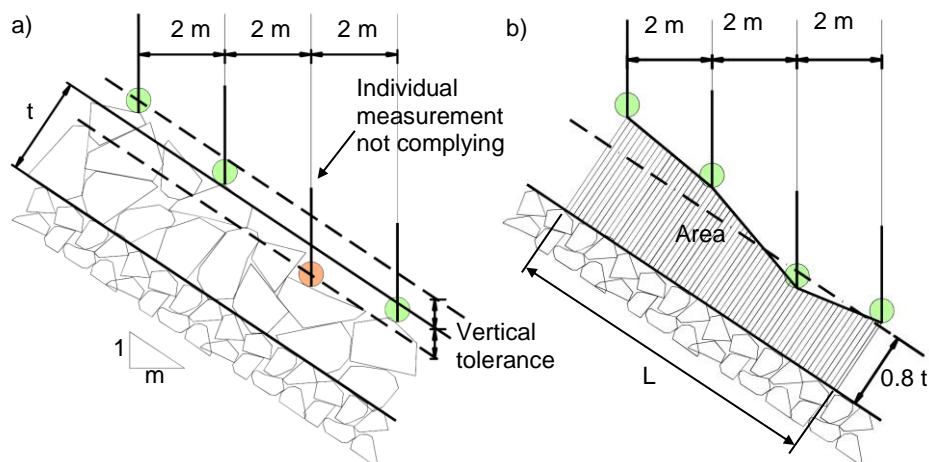
Rock material must be placed to levels, dimensions and slopes shown on the drawings and, when the surface profile is measured using the specified techniques, must comply with the vertical placing tolerances in accordance with as illustrated in Figure 6-1 (a).

**Table 6-1: Vertical Placing Tolerances for Placing Rock in Armour Layers.  
(CIRIA, CUR, CETMEF, 2007)**

Maximum allowable deviations based on individual measurements [m]		
Dry, i.e. above low water, placed using land-based plant	Below low water placed using land based plant	Below low water, placed by waterborne equipment
±0.3 D <sub>n50</sub>	±0.5 D <sub>n50</sub>	±0.8 D <sub>n50</sub>

Notwithstanding the tolerances of Table 6-1, the following criteria apply to the armourstone cover layer:

- The mean layer thickness,  $t_{mean}$ , must not be less than the nominal layer thickness ( $t$ ) on two consecutive surveyed profiles. The mean layer thickness is calculated as the ratio of the area under the surveyed profile and the length of the survey ( $L$ ) as shown in Figure 6-1: (b).
- Notwithstanding any accumulation of positive tolerances on underlying layers, the mean layer thickness must not be less than 80 percent of the nominal layer thickness ( $t$ ), as shown in the drawings. In Figure 6-1 (b), this implies that  $t_{mean}$  must be larger or equal to  $0.8 t$ . Where an accumulation of positive tolerances arises and is acceptable to the Engineer, the position of the design profiles will need to be adjusted to suit.



**Figure 6-1: a) Individual measurements and vertical tolerances, b) parameters to calculate the mean layer thickness  $t_{mean} = Area/L$ .**

The Contractor must remove rock outside the specified profiles irrespective of whether the excess is due to faulty placing or due to displacement of the rock by sea action.

### 6.2.2 Underlayer and Core

Rock material for under layers and core must be placed to levels, dimensions and slopes shown on the drawings and, when the surface profile is measured using the specified techniques, must comply with the following vertical tolerances:

The vertical placing tolerance of individually-placed under layers consisting of heavy grading is the same as the tolerance for placing rock in armour layers given in Section 6.2.1.

The vertical tolerance of under layers and core consisting of bulk placed quarried rock must be in accordance with Table 6-2: .

**Table 6-2: Vertical Placing Tolerances for Bulk-Placed Material in Underlayers and Core.**  
(CIRIA, CUR, CETMEF, 2007)

Placement method	Coarse gradings and core	Light gradings (NUL < 300 kg)	Heavy gradings (NUL > 300 kg)
Placed with land-based plant above low water	+0.1 m to -0.1 m	+0.2 m to -0.2 m	+0.4 m to -0.2 m
Placed with land-based plant up to 5 m below water	+0.15 m to -0.15 m	+0.5 m to -0.3 m	+0.8 m to -0.3 m
Placed with land-based plant between 5 m and 15 m below water	+0.2 m to -0.2 m	+0.5 m to -0.3 m	+1.2 m to -0.4 m
Placed with land-based plant below -15 m	+0.2 m to -0.2 m	+0.5 m to -0.3 m	+1.5 m to -0.5 m
Placed with water-borne plant below low water	+0.2 m to -0.2 m	+1.0 D <sub>n50</sub> to -1.0 D <sub>n50</sub>	+1.0 D <sub>n50</sub> to -1.0 D <sub>n50</sub>

## 7. TESTING

### 7.1 Inspection

The requirements of Section 3.3 apply to inspections at or near the site. For inspections carried out at the quarry, the interpretation of inspection results must take into account the possible influence of storage, loading, transporting and unloading on the quality requirements.

### 7.2 Sampling

#### 7.2.1 General

The samples of the grading of rock to be inspected must be taken at random and must be representative. The sampling, transport and transfer of the samples must be carried out in a careful manner so that breakage is limited to a minimum.

The pieces of one rock which, according to observation, were broken during sampling, will be considered to comprise one rock at the inspection.

## 7.2.2 Homogeneity of the Batch

When, on the basis of visual judgement of the quarried rock batch to be inspected, non-homogeneity or possible non-homogeneity of the batch is evident with regard to one or more of the relevant qualities, that batch must be divided into parts considered to be homogeneous. Sampling for those qualities must then be carried out separately on the parts.

When one of the parts does not satisfy the requirements, the whole batch of quarried rock is considered non-compliant.

If separation of the divided part(s), which does (do) not satisfy the requirements, is possible without difficulty, it can be agreed to regard the remaining part of the batch as a separate batch.

## 7.2.3 Size and Composition of Samples

### 7.2.3.1 Samples for Determining Particle Distribution

For the determination of the particle distribution of a coarse-graded quarry rock, at least six sub-samples must be taken if the sampling takes place from a stockpile or a ship's load. In all other cases the number of sub-samples must be at least three.

The numerical value of the weight X in kilograms of each sub-sample must be at least equal to the numerical value Y of the upper limit (NUL) in millimetres of the designation of the grading concerned if that upper limit is less than or equal to 100 mm. The numerical value of the weight of each sub-sample X in kilograms must be at least twice the numerical value Y of the upper limit in millimetres of the grading designation if the upper limit is greater than 100 mm. A summary of the minimum sample mass required are shown in Table 7-1.

**Table 7-1: Sample mass for determining particle distribution**

Numerical value Y of the Nominal Upper limit (NUL)	Sample mass X [kg]
Y (NUL) < 100	X = Y
Y (NUL) > 100	X = 2 Y

### 7.2.3.2 Samples for Determining Weight Distribution

For the determination of the weight distribution, the number of pieces of armourstone required in the sample is as shown in Table 7-2: .

**Table 7-2: Number of pieces of armourstone in test portion for determination of mass distribution**

Grading	Minimum number of pieces of armourstone heavier than fragments
Heavy grading 10 t – 15 t	25
Heavy grading 6 t – 10 t	30
Heavy grading 3t – 6 t	60
Heavy grading 1t – 3 t	90
Heavy grading 300 kg – 1000 kg	140
Light grading	200

#### 7.2.3.3 Samples for Determining Shape

Same sample and armourstone pieces as used for grading.

#### 7.2.3.4 Samples for Determining Mass Density and Water Absorption

The sample must contain at least 10 specimens of mass from 150 g to 450 g from different armourstones. If mass density is expected to be lower than 2.3 t/m<sup>3</sup>, 40 pieces are required.

#### 7.2.3.5 Samples for Determining Compressive Strength

The sample must contain at least 10 drilled cores of 50 mm (or 70 mm if UCS is expected to be less than 40 MPa).

### 7.2.4 Sampling Methods

#### 7.2.4.1 General

The Contractor must ensure that during sampling the degree of filling of the grab or other extraction equipment does not adversely affect the representativeness of the sample taken.

#### 7.2.4.2 Sampling from a Belt Conveyor

Prior to sampling material on the belt conveyor, let the belt transport for a period sufficient to ensure that deviations from the composition of the material possibly present due to the starting up of the installation will not be shown in the sample. For sampling from a belt conveyor a sample of a sufficient

quantity of material should be taken by catching it from the end of the belt or by stopping the belt and then taking material from the belt. Catch the material from the end of the belt in a manner to ensure that, from the cross-section of the material flow, material is taken from each point for equal periods of time.

Take the required number of sub-samples at approximately equal intervals along the whole batch.

#### 7.2.4.3 Sampling from a Silo

When sampling from a silo, take a sample by catching a sufficient quantity of material discharging from the silo. When sampling from a silo, account must be taken of the fact that particle size reduction and segregation can occur due to the methods of filling and extraction from the silo. Take the required number of sub-samples at approximately equal intervals from the whole batch to be sampled.

If during the sampling, segregation is observed, the number of samples must be adjusted accordingly.

#### 7.2.4.4 Sampling from a Stockpile

When sampling from a segregated stockpile, take a sample of sufficient quantity from the material which is being taken from the stockpile. Take, for this purpose, the contents of one or more loads of a wheel loader, lorry or any other transport or transfer method employed.

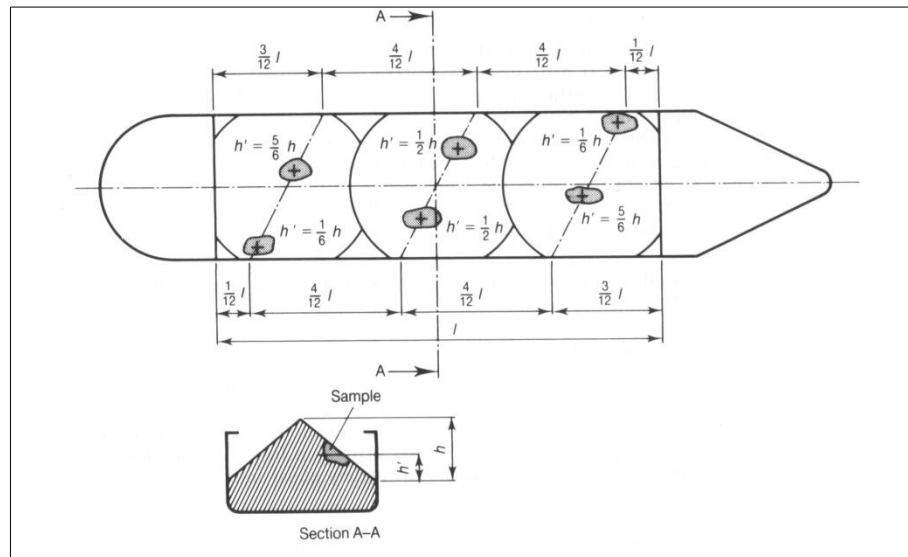
Simulate the removal of material from the segregated stockpile if, at the instance of sampling, no material is undergoing routine removal. Before taking the sample, make several extractions of material from the stockpile so as not to distort the sample contents with segregation effects associated with initiation of stockpile extraction.

When sampling from a non-segregated stockpile, take a sample as indicated for a segregated stockpile or take a sufficient quantity of material from a random location which is easily reached with the equipment available.

#### 7.2.4.5 Sampling from Floating Equipment

For sampling prior to the unloading of the segregated load, take adequate quantities of material from the locations shown in Figure 7-1 at the surface of the load, with the aid of the unloading equipment. For the sampling of a non-segregated load the samples must be taken as indicated for a segregated load or by taking an adequate quantity of material at random or evenly distributed locations on the surface of the load, with the aid of the unloading equipment.

When sampling during the unloading, take for each sample an adequate quantity of material with the aid of the unloading equipment. Take the required number of sub-samples at approximately equal intervals from the whole of the load to be sampled.



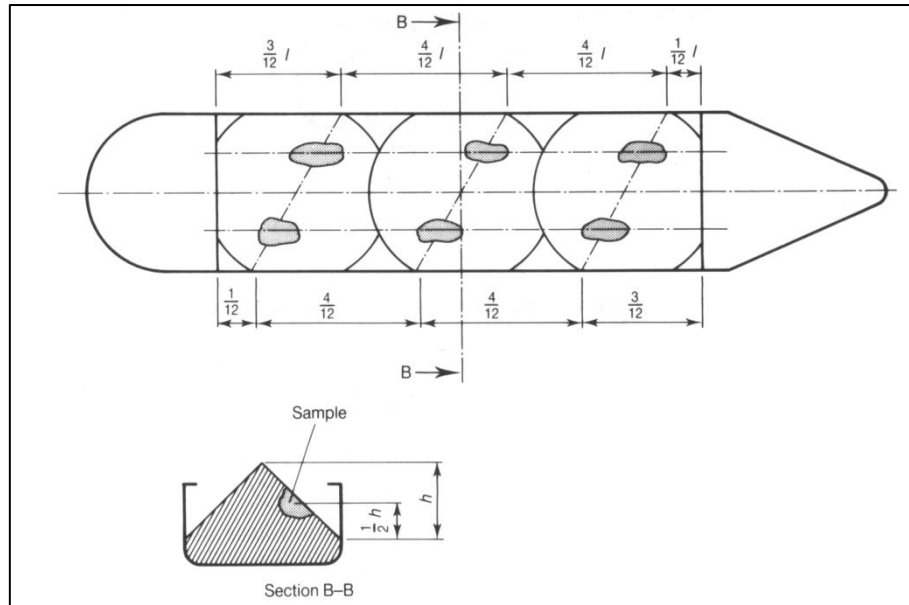
**Figure 7-1: Sampling Locations in the Load on Floating Equipment**

#### 7.2.4.6 Sampling from Wheeled Transport

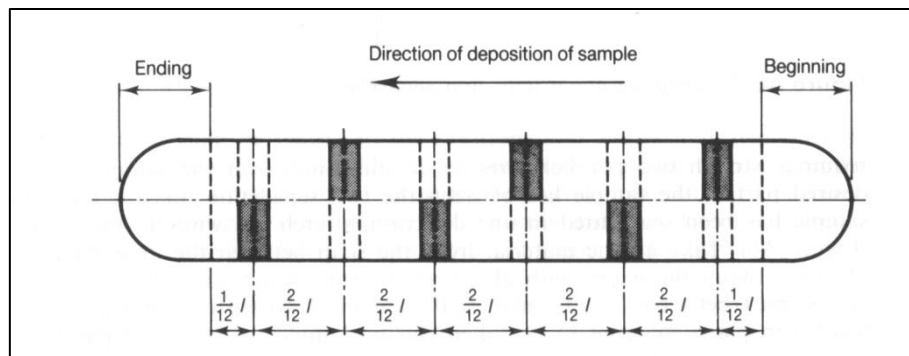
For the sampling of a load of rock, let the load be tipped out partially or completely in a manner which produces an evenly distributed long pile. Take the required number of sub-samples from across that pile by removing at random or at equally distributed locations an adequate quantity of material, while avoiding the possible segregated material at the start and finish of the pile. Take the material in long strips over the full width of the pile or in equal numbers of half strips from the left – and right-hand side of the centre line of the pile.

#### 7.2.4.7 Splitting of Samples of Light and Fine Gradings

If the collected sample to be inspected for compliance with the rock quality requirements of Section 3.3 is too large, reduce the size of the sample according to one of the methods described below.



**Figure 7-2: Sampling Locations in a Non-Segregated Load on Floating Equipment.**

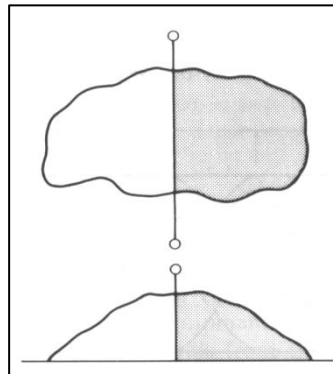


**Figure 7-3: Sampling Locations in a Spread Dumped Load.**

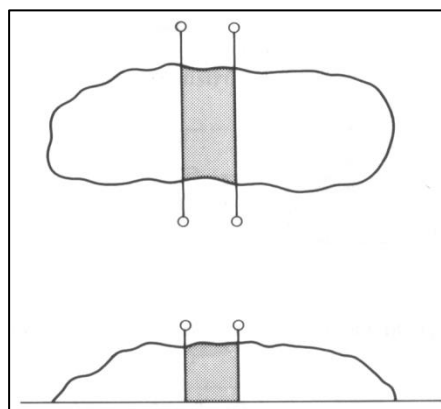
When depositing a sample, take into account the splitting to be carried out by spreading the sample appropriately. Dump the sample to be deposited and to be split into one or more buckets in a manner which limits segregation as far as possible. When dumping material from a wheel loader bucket, catch all the material from an imagined cross-sectional width of the bucket content in the sample bucket(s). The diameter of the (sample) buckets must be twice the sieve dimensions of the largest piece of rock. If so desired dump the sample, which is to be deposited and to be split, over one or two vertically set plates, which will create separation planes as shown in Figure 7-4 and Figure 7-5. Proceed further in accordance with the work methods presented in the following description, utilising wires representing the imaginary vertical separation surfaces. Stretch a wire as a separation line over the sample already deposited to indicate the desired demarcation into two approximately equal parts. Where segregation has taken place in one direction of the deposited sample, place the wire in the same direction. Remove all material where all pieces of rock or the majority are placed to one side of the imagined vertical plane projected by the wire (Figure 7-4).

When, for division of the deposited sample, less than half of the total sample is required, stretch two parallel wires as dividing lines over the sample, so that the desired part of the sample lies between the two separation lines (Figure 7-5). If the complete sample has been segregated in one direction, stretch the wires in the same direction. Take all the material from the strip between the imaginary two vertical planes between the wires, with all pieces of rock which are completely or for the largest part between the two planes. If so desired, where no segregation of material has taken place, material to be taken can be limited to half the separated strip.

Take a sample, which consists of a not too large number of rocks, by a random collection of the necessary number of rocks. Take the rock pieces at random by choosing them blindfolded by lottery numbers or by selecting rocks at pre-determined but irregular intervals.



**Figure 7-4: Halving a Sample by means of a Separation Plane.**



**Figure 7-5: Dividing a Sample with Two Separation Planes.**

#### 7.2.4.8 Transport and Identification of the Samples

For the transport of a sample, precautions must be taken to ensure that no material is broken or lost and that the sample is not contaminated. A sample must be accompanied by a certificate drawn up by the person responsible for taking the sample. The certificate must include the following information:

- a) A reference to this specification
- b) The name of the producer and location of the quarry or other source where the broken rock is produced
- c) The description and class designation of the grading
- d) The number of rock pieces (or weight for coarse grading) in the sample
- e) Details about location and method of sampling, including the date when the sampling took place
- f) The name of the sample taker

### 7.3 Test Frequency

Quality control must take place during production of the rock and should routinely be performed by the producer. Part of the quality control consists of ensuring that the rock is coming from the areas designated in the extraction plan as suitable for rock. Significant variation within the rock source should be detected by quality control that focuses on petrography, density, porosity and discontinuity content. The production method should also be considered to determine the optimum quality control, e.g. quality control of gradings should be more frequent for eye-selected than for mechanically produced rock. The frequency of testing should be selected to be representative of homogeneous batches of production. It should be selected by considering the potential range of variability of the properties. Guidance on the frequency of testing armour stone properties during deliveries is given in Table 7-3: . Unless specified differently in the (project specific) particular specifications or drawings the frequencies stated in Table 7.3 must be used.

**Table 7-3: Guidance on Frequency of Testing Rock Properties during Deliveries**

Property considered	Frequency for mechanically sorted armourstone	Frequency for individually selected armourstone
Size – coarse gradings	Every 3000 – 5000 t	N/A
Mass – light gradings	Every 3000 – 5000 t	N/A
Mass- heavy gradings	Every 3000 – 5000 t	Every 1500 – 2500 tonnes
Core material – mass	Every 10 000 – 25 000 t	N/A
Shape – coarse and light gradings	As for size/mass grading testing (see above), but take into account the type of use, i.e. armour or under layer	
Shape – heavy gradings	Visual inspection of 50 per cent of the stones	

Property considered	Frequency for mechanically sorted armourstone	Frequency for individually selected armourstone
Block integrity	Drop test at least every 20 000 t. Visual inspection of all stones for heavy grading; further quality control may be required for borderline blocks or poor integrity.	
Rock density, water absorption, durability, strength (using point load at the quarry)	Adapt based on known variability of the source and the risk of further weathering: at least every 20 000 t	

Note: N/A = not applicable

#### 7.4 Determination of the Weight Distribution of Quarried Rock

##### 7.4.1 Equipment and Other Aids

- a) Weighing equipment, accurate to 2% of the NLL
- b) Lifting equipment and lifting aids for pieces that cannot be moved manually

##### 7.4.2 Weighing

Weigh each piece of armourstone heavier than the ELL separately ( $W_i$ ), and all pieces lighter than the ELL (the rock fragments) together ( $W_s$ ). Record the total weights falling in each weight fraction together with the total number of rocks ( $n$ ), heavier than the ELL.

##### 7.4.3 Calculation

Calculate the total weight  $\sum W_i$ , of pieces equal to or heavier than the ELL.

To obtain the cumulative curve where  $W_y$  is the weight for which the fraction  $y$  is lighter, calculate the successive points on the curve at weight intervals given in Table 7-4: .

**Table 7-4: Weight Intervals for the Cumulative Weight Plot**

NLL of grading class [kg]	Weight interval [kg]
10-60	5
60-300	25
300-1000	50
1000-3000	200
3000 or greater	500

To obtain only those values of  $y$  for which a requirement has been set, i.e. the fractions corresponding to  $W_y$  at the ELL, NLL, NUL and EUL, calculate the total weight  $W_n$ , for  $W_y$  corresponding to each of the four class limits, with the formula:

$$y = \frac{W_n}{W_s + \sum W_i} \times 100 \text{ [%]}$$

where

- $W_n$  = the total weight of rocks lighter than  $W_y$  [kg]  
 $\sum W_i$  = the total weight of all pieces heavier than the ELL [kg]  
 $W_s$  = the total weight of pieces lighter than the ELL [kg]

Calculate the effective mean weight,  $W_{em}$ , to the nearest kilogram, using the formula:

$$W_{em} = \frac{\sum W_i}{n} \text{ [kg]}$$

where:

- $W_{em}$  = the effective mean weight of the rock sample which equals the average weight of rocks heavier than the ELL,  
 $n$  = the number of rocks heavier than the ELL.

#### 7.4.4 Report

The following data must be included in the report:

- a) The measured cumulative percentage by weight passing the ELL, NLL, NUL and EUL holes
- b) The average weight of pieces not passing the L hole
- c) The rock density tested according to Section 7.6
- d) A reference to this specification
- e) A description of the sample; including its weight
- f) The source of the sample
- g) The date of the inspection

### 7.5 Determination of Length-to-Thickness Ratio

#### 7.5.1 Subject and Area of Applicability

The test method applies to light and heavy gradings that are placed in less than three layers, and it requires LT to be estimated visually and measured only on borderline blocks.

#### 7.5.2 Sample for Analysis

Same sample and pieces as used to determine the grading.

### 7.5.3 Equipment and Other Aids

- Witness stones for visual comparison
- A calliper and a trained controller

### 7.5.4 Execution

The length to thickness ratio (LT) is defined as the maximum length,  $\ell$  [m], divided by the minimum distance,  $d$  [m], between parallel lines through which the particle can just pass.

Measure the length of each rock as the maximum distance between two points on the rock,  $\ell$  [m].

Measure the thickness of each rock,  $d$  [m], defined as the minimum distance between two parallel straight lines through which the rock can just pass. Calculate LT and determine the number of rocks ( $n_{LT}$ ) with LT greater than 3. Count the total number of rocks in the sample,  $n$ .

### 7.5.5 Calculations

Calculate the number percent of rocks with length-to-thickness ratio (LT) greater than 3 using the formula:

$$C_{LT} = \frac{n_{LT}}{n} * 100[\%]$$

### 7.5.6 Report

The report must provide the following data:

- a) The measured number per cent of rocks with length-to-thickness ratio greater than 3 ( $C_{LT}$ )
- b) A reference to this specification
- c) A description of the sample, including the weight and the number of rocks
- d) The source of the sample
- e) The date of the test

## 7.6 Determination of Rock Density and Water Absorption

### 7.6.1 Subject and area of application

This method applies to all rock samples. Density and water absorption are determined simultaneously.

### 7.6.2 Sample for Analysis

Sample 10 representative pieces of mass from 150 g to 450 g. If mass density is expected to be lower than 2.3 t/m<sup>3</sup> then 40 pieces must be analysed.

### 7.6.3 Equipment and other aids

- a) Drying oven or other appropriate, adjustable to (110±5) °C
- b) Weighing scales, accurate to 0.05 % of the rock weight, suitable for weighing in air and under water
- c) Water-bath, filled with tap water at room temperature and suitable for weighing rocks under water
- d) Thermometers, suitable for recording temperature in the water bath, accurate to 1 °C
- e) Moist chamois leather

### 7.6.4 Execution

Remove all loose parts and brush the rock clean with water. Measure the water temperature in the water-bath to 1 °C accuracy. Keep the rock submerged in the tap water at room temperature for at least 5 min and then weigh it submerged ( $m_1$ ) with an accuracy of 0.05 percent of the rock's weight.

Take the rock out of the bath, dry it with the moist chamois leather to the point that no shiny-wet surface remains and then weigh the rock ( $m_2$ ) again with 0.05 percent accuracy.

Dry the rock in the oven to a constant (steady) weight, which is reached when two consecutive weightings with a 24-hour interval show less than 0.05 percent loss of total weight.

Weigh the rock again after cooling to room temperature ( $m_3$ ) with 0.05 percent accuracy.

### 7.6.5 Calculation

Calculate the density of the rock rounded to the nearest unit with the formula:

$$\rho_r = \frac{m_3}{m_2 - m_1} \rho \text{ [kg/m}^3\text{]}$$

Calculate the Water Absorption (WA) with the formula:

$$WA = \frac{m_2 - m_3}{m_3} * 100[\%]$$

Where

$\rho_r$  = the density of the particle, [g/ml] or [kg/m<sup>3</sup>]

$\rho$  = water density [g/ml] at the test temperature of the water-bath

$m_1$  = apparent weight of the rock submerged [g]

$m_2$  = weight of saturated-surface dry sample [g]

$m_3$  = weight of oven-dry sample [g]

#### 7.6.6 Report

The report must supply the following data:

- a) The density of the sample
- b) The Water Absorption (WA) of the sample
- c) Reference to this specification
- d) A description, including the weight of the rock and of the part of the rock that is used
- e) Source of the rock
- f) Date of testing

#### 7.7 Determination of Resistance to Breakage

##### 7.7.1 Sample for Analysis

Ten specimens must be prepared from different pieces of armourstone.

##### 7.7.2 Method

The determination of the resistance to breakage (compressive strength) of armourstone (excluding fragments) must be done in accordance to BS EN 1926.

#### 7.8 Determination of Resistance to Impact and Mineral Fabric Breakage

##### 7.8.1 Sample for Analysis

Twelve specimens must be prepared from different pieces of armourstone randomly selected.

##### 7.8.2 Method

The average Point Load Index is determined in accordance with ISRM 1985 "Suggested Methods for Determining Point Load Strength".

The average and standard deviation are calculated from at least 10 valid results after the largest and smallest valid test results have been excluded from the calculation.

## 7.9 Determination of Block Integrity

### 7.9.1 Subject and Area of Application

This destructive method is used to determine the percentage of rock loss in a standard drop test (DT). This method applies to heavy gradings.

### 7.9.2 Sample for Analysis

The sample must contain at least 50 blocks taken at random from ELL-EUL weight of the grading class being tested.

### 7.9.3 Equipment and Other Aids

- a) Suitable hydraulic grab (e.g. orange-peel type).
- b) Weighing equipment, accurate to within 2 percent of the lightest piece to be weighed.
- c) Bed of rocks of same grading as the sample to be tested.
- d) Sufficient volume of crushed rock aggregate to give a 0.5 m thick layer covering an area to support the bed of rocks.

### 7.9.4 Execution

Determine the individual weights of the rock sample prior to the test in accordance with Section 7.4. Prepare a bed of rocks of armourstone of similar size by laying them out in a single compact layer on a  $0.5 \pm 0.05$  m thick layer of crushed rock aggregates. Subject each block in the test sample, in turn, to a drop onto the bed of rocks from a fall height of  $3 \text{ m} \pm 0.1 \text{ m}$ . Record the result of each drop, such record to include the number and type of visible flaws in blocks and the number and type of blocks resulting.

Remove the block, or broken parts thereof, from the bed of rocks. Set aside all resulting pieces whose weight is greater than the ELL weight, or whose weight is assessed to be close to the ELL weight, for further weightings. Clear all rock fragments from the bed of rocks, leaving clean surfaces prior to dropping the next block in the test sample.

Individually weigh each rock piece in the test sample heavier than the ELL on completion of drop testing accurate to within 2% of the NLL weight. Record the total weights in each weight fraction.

### 7.9.5 Calculation

Calculate the cumulative weight distribution curves for the sample prior to drop testing and after drop testing for all pieces heavier than the ELL and calculate the median sample weight before testing ( $W_{50i}$ ) and the median sample mass of pieces above ELL after testing ( $W_{50f}$ ), all in accordance with Section 7.4.3.

Calculate the Drop Test breakage index,  $I_d$ , as

$$I_d = \frac{W_{50i} - W_{50f}}{W_{50i}} * 100[\%]$$

### 7.9.6 Report

The following data must be included in the report:

- a) The Drop Test breakage index;
- b) A reference to this specification;
- c) A description of the sample, including its weight;
- d) The source of the sample;
- e) The date of the testing.

If agreed beforehand, the cumulative weight distributions before and after testing must be provided and it is recommended that this be on a single graph.

## 8. SURVEY TECHNIQUES

### 8.1 General Requirements

Profiles of rubble mound structures must be plotted at a scale of 1:100, unless agreed otherwise, and provided to the Engineer in digital CAD format.

Survey points must be recorded with a horizontal accuracy of 500 mm and a vertical accuracy of 100 mm. This tolerance applies to the bottom of the survey staff or probe and any inclination of the staff or probe must be accurately accounted for in the survey method.

### 8.2 Survey of Rock Layers

Measurements must be carried out using a probe connected to a rigid stem with a rigid connection between stem and special spherical end of diameter  $0.5 D_{n50}$ , unless for reasons such as health and safety an alternative method is deemed necessary e.g. for certain gradings of heavy armourstone. If

the Contractor intends to use an alternative method to the spherical foot probe, the alternative method for obtaining individual armourstone surface heights across the profile must be submitted to the Engineer for acceptance.

For land-based survey, measurements must be carried out at intervals not exceeding 2 metres (measured horizontally) along the measurement profile, and not exceeding 1 metre at the toe and at benches.

Measurement profiles must be at intervals not exceeding 10 m, but must be more frequent as directed by the Engineer where the profile is changing rapidly or on tight-radius curves. Roundheads must be surveyed by radial profiles at not more than 15 degree intervals.

The Contractor must provide and maintain chainage markers at each measurement interval. Chainage markers must be visible from both the land and seaward side of the structure. Surveyed sections must extend to a distance of 5 m beyond the as-constructed toe and 2 m for the other edges. No layer may be covered by a subsequent layer until the profile of the former layer has been accepted by the Engineer.

The Contractor must perform a post storm re-survey of the rock layers in areas where in the opinion of the Engineer storm damage may have occurred, before covering with a subsequent layer.

**9. REFERENCES**

BS EN 13383-1. (2002). Armourstone - Part 1: Specifications. BSI.

BS EN 1926. (2007). Natural stone test methods. Determination of uniaxial compressive strength. BSI.

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