DRAFT

Dune Maintenance and Management Plan – Gouritz

CES

ENVIRONMENTAL AND SOCIAL ADVISORY SERVICES

DUNE MAINTENANCE AND MANAGEMENT PLAN - GOURITZ

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

CES	Coastal and Environmental Services
CSIR	Council for Scientific and Industrial Research
DEA&DP	Department of Environmental Affairs and Development Planning
DEM	Digital Elevation Model
DMMP	Dune Maintenance and Management Plan
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GIS	Geographic Information Systems
GN	Government Notice
GPS	Global Positioning System
HWM	High Water Mark
IFC	International Finance Corporation
MMP	Maintenance Management Plan
MSL	mean sea level
NEMA	National Environmental Management Act
PV	Photovoltaic
RAP	Resettlement Action Plan
SAGC	South African Geomatics Council
SAGI	South African Geomatics Institute
SANBI	South African National Biodiversity Institute
SA VEG MAP	South African Vegetation Map
SLR	Sea Level Rise
UAV	Unmanned Aerial Vehicle

PROJECT TEAM

Dr A.M (Ted) Avis (*Coastal Dune Specialist and Report Writer*)

Ted Avis is a leading expert in the field of Environmental Impact Assessments, having project-managed numerous large-scale ESIAs to international standards, especially those of the International Finance Corporation (IFC). From 1997 to 2005 Ted acted was principle environmental consultant to Corridor Sands Limitada, managing all environment aspects of the US$1,2billion Corridor Sands Project, including five ESIA's, associated ESMPs, and the RAP. He has managed ESIA studies and related environmental assessments of similar scope in Kenya, Madagascar, Egypt, Malawi, Zambia and South Africa. Ted also has experience in large scale Strategic Environmental Assessments in southern Africa, and has been engaged by the IFC on a number of projects.

Between 1994 and 1996 Ted was instrumental in establishing the Environmental Science Department at Rhodes University, whilst a Senior lecturer in Botany at that time. This resulted from his experience running honours modules in EIA practice and environmental management, as well as the applied research he undertook in these disciplines. He was an Honorary Visiting Fellow in the Department of Environmental Sciences at Rhodes between 1998 and 2003. He was one of the first certified Environmental Assessment Practitioner in South Africa, gaining certification in April 2002. He has delivered papers and published in the field of EIA, Strategic Environmental Assessment and Integrated Coastal Zone Management, and has been a principal of CES since its inception in 1990, and Managing Director since 1998.

Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled "Coastal Dune Ecology and Management in the Eastern Cape". Ted is a Certified Environmental Assessment Practitioner (since 2002) and a professional member of the South African Council for Natural Scientific Professionals (since 1993).

Summary of specific experience in coastal management, including plan and programme development:

- 1990 to 1997. Lecturing and research experience in coastal dune ecology at Rhodes University
- Between 1985 and 1999 - Delivered papers and published in the field of Integrated Coastal Zone Management.
- 1994 - PhD thesis entitled "Coastal Dune Ecology and Management in the Eastern Cape".
- 2010 - Presented a 5-day short course on Tools of Sustainable Coastal Zone Management (Namibia).
- Four two-day short courses presented on the Integrated Coastal Zone Management Act to various Government and NGO stakeholders.
- 2004 to 2005 – Developed the Integrated Coastal Zone Management Plan for the Buffalo City Municipality, Eastern Cape South Africa, including numerous Management Plans for estuaries, beaches etc.
- 2002 to 2004 - The development of the Eastern Cape Coastal Management Plan, adopted as policy by the Eastern Cape Government.
- 2017 to 2019 - Western Cape State of Coast report prepared for Dept. of Environmental Affairs & Development Planning (2017 – current).

- 2018 to 2019 – Update of the Coastal Management Plan for West Coast District Municipality and Five Local Municipalities

Ms Tarryn Martin *(Botanical Specialist and Report Review)*

Tarryn holds a BSc (Botany and Zoology), a BSc (Hons) in African Vertebrate Biodiversity and an MSc with distinction in Botany from Rhodes University. Tarryn's Master's thesis examined the impact of fire on the recovery of C3 and C4 Panicoid and non-Panicoid grasses within the context of climate change for which she won the Junior Captain Scott-Medal (Plant Science) for producing the top MSc of 2010 from the South African Academy of Science and Art as well as an Award for Outstanding Academic Achievement in Range and Forage Science from the Grassland Society of Southern Africa.

Tarryn specializes in conducting vegetation assessments in Africa, specifically southern Africa and has worked in the following countries: Mozambique, Zambia, Lesotho and South Africa. She has also recently undertaken work in Cameroon. The types of projects she has worked on include mines (graphite, oil and heavy minerals), solar PV facilities and windfarms (including powerlines), bulk transportation of water and the construction of dams. A number of these projects have been to IFC standards and in addition to a botanical baseline and impact assessment, have included further reporting such as habitat assessments to determine if the site is a trigger for critical habitat, the drafting of site-specific biodiversity management plans and alien invasive species management plans and, recently, an ecosystem services assessment.

Mr Michael Johnson *(GIS Specialist)*

Michael holds a BSc in Geoinformatics, a BSc (Hons) cum laude in Geoinformatics and an MSc in Geoinformatics from Stellenbosch University. Michael's Master's thesis examined the use of Remote Sensing and computer vision technologies for the extraction of near-shore ocean wave characteristic parameters. For the duration of his Master's, he was based at the CSIR in Stellenbosch. During this time, in addition to his Master's studies, he conducted work in collaboration with the CSIR Coastal Systems Research Group and provided GIS and Remote Sensing tutoring and technical assistance to the junior staff and fellow students. Michael graduated in March 2018 and has been working for CES since. Since joining CES, Michael has been involved in a number of projects where his GIS and Remote Sensing skills have been utilised. These include, but are not limited to, landcover mapping for the King Cetswayo District Municipality Environmental Management Framework, the use of remote sensing to map invasive alien plant species for the Buffalo City Invasive Alien Species Management Plan and multiple Visual Impact Assessments. Michael is registered with the South African Geomatics Council as a Candidate Geomatics Practitioner: GISc Professional (CGPrGISc 0299).

Mr Nico van Schalkwyk *(Drone Pilot)*

Nico is an experienced surveyor with excellent skills and competencies related to geospatial solutions. During his 22 years with the Global Geomatics he has worked in many different roles on projects ranging from small cadastral to large pipeline and railway projects. He has worked in many African countries, often in very remote areas and is able to work independently and is solutions orientated.

Nico is competent in all the latest survey technologies and is continuously upgrading his knowledge and skills. His vast experience in all the different survey methodologies makes him a versatile surveyor who can provide clients with high quality, effective and efficient solutions.

- SAGC – Geomatics Candidate CGP ES0504
- SAGI - S631

Thamsanqa Dyantyi (*Surveyor*)

Thamsanqa is an experienced surveyor with excellent skills and competencies related to geospatial solutions. During his 10 years at Global Geomatics the company he has worked in many different roles on projects ranging from small cadastral to large solar plant projects. He is able to work independently and is solutions orientated.

Thamsanqa is competent in all the latest survey technologies and is continuously upgrading his knowledge and skills. His vast experience in all the different survey methodologies makes him a versatile surveyor who can provide clients with high quality, effective and efficient solutions.

EXECUTIVE SUMMARY

Introduction

The stretch of frontal dune system has been artificially changed as it provides access to the only Blue Flag Beach in the vicinity of Gouritz.

The parking area at the bottom of Voortrekker Street, at south-western edge of the Gouritz beach, is located close to the High Water Mark (HWM). Although the southern half of the parking area is protected by a rocky shore and boulders, the vegetated edge is subject to erosion from wave attack and storm surges. It is expected that this situation will worsen over time as a result of climate change and sea-level rise.

To the north-west of the formal parking area there is a second smaller parking area and ablution facilities. Access is gained from either River Street or Kus Road. The 200m long dune system between these two parking areas has low vegetation cover, blowout dunes and active sand movement. Loss of vegetation cover is mainly due to recreational impacts and effects of trampling on the vegetation. The continuous human impact therefore supports the need to maintain the system in a holistic manner which prescribes to relevant statutes.

Approach

The vegetation at Gouritz was sampled along equal interval transects. Transects ran perpendicular to shoreline, and the following sampling took place:

- 7 transects were sampled along the 200m site.
- At each transect the species composition and vegetation cover (estimated visually) of each species was determined.
- A drone and topographical survey was undertaken to capture high resolution aerial imagery and to calculate a Digital Elevation Model (DEM) for the project area.
- Using the drone aerial survey, results were extrapolated to prepare accurate vegetation and elevation maps of the site.

Conclusions and Recommendations

Based on the field survey, as well as the high-resolution drone aerial imagery and digital elevation model of the project area, the following conclusions were drawn.

- The dune slope below the formal parking area has eroded due to wave attack, and slope re-enforcement, adding additional sand and revegetating is required.
- The integrity of the foredune system north-east of the parking area has been compromised, and it has disaggregated into hummock dunes. It is not linear or intact for most of its length.
- However, no recontouring or physical changes to the dune system are required as cover is still good enough for the system to be regarded as stable.
- Active revegetation, including brushwood packing and wind net establishment is required.
- Areas behind the foredune require interplanting with woody vegetation.
- For most of the site seeding and planting pioneer species along the foredune ridge. and interplanting dune shrub species is required to ensure the system remains stable.

- An irrigation system should be installed along the frontal dune ridge, as active revegetation and management of this area is required, due to the impacts from trampling.
- At both parking areas access to the beach must be improved, and elevated boardwalks are recommended.
- The grassed parking area needs to be paved with grass blocks and planted with *Sporobolus virginicus*.

1 INTRODUCTION

1.1 STUDY AREA AND LOCATION

The project area is located at Gouritz, in the Hessequa Local Municipality in the Western Cape Province of South Africa. The site is located adjacent to the parking area at the south-western edge of the Gouritz beach, approximately 850m from the mouth of the Gouritz River.

This is the main recreational beach at Gouritz and is 175m at its widest point. It is backed by a well vegetated stable dune system of between 60m to 150m wide, with low foredune ridge of between 20m and 50m wide that is partially vegetated with pioneer species such as *Tetragonia decumbens, Sporobolus viginicius* and *Elymus distichum*.

The dune system is functionally stable, but unfortunately a large amount of the vegetation is dominated by the invasive alien species, *Acacia cyclops*. Although this area falls outside the project area covered by this Dune Maintenance and Management Plan (DMMP), it is recommended that the alien species be cleared, and the cleared areas packed with brushwood and planted with indigenous woody dune species. Suitable species are presented in Table 5.1. In addition, the gravel access road to the north of the project site should have an access control boom installed, to prevent unauthorised vehicles driving onto the beach.

Figure 1.1: Location of the project area.

1.2 PROBLEM STATEMENT

The parking area at the bottom of Voortrekker Street has been located too close to the High Water Mark (HWM). There is a very narrow strip (6m) of vegetation in front of the parking area which is above the HWM. Although the southern half of the parking area is more stable due to the rocky shore and boulders (Plate 1.1), the vegetated edge is subject to erosion from wave attack and storm surges (Plate 1.2). This situation will worsen over time as a result of climate change and sea-level rise.

To the north-west of the formal parking area there is a second smaller parking area and ablution facilities. Access is gained from either River Street or Kus Road. The 200m long dune system between these two parking areas has low vegetation cover, blowout dunes and active sand movement. Loss of vegetation cover is mainly due to recreational impacts and effects of trampling on the vegetation. Improved access control is required.

Figure 1.2: High resolution aerial imagery of the project area.

Plate 1.1: Narrow vegetated dune slope and boulder beach in front of the parking area. Edge of boulders define the HWM.

Plate 1.2: The narrow vegetated slope is subject to erosion from wave attack, and disturbance due to trampling.

1.3 PROVINCIAL REQUIREMENTS FOR AN MMP

The Department of Environmental Affairs and Development Planning (DEA&DP) produced an information document for the development of maintenance management plans for water courses (DEA&DP, 2017). In the absence of a specific guideline document, this report has been used to sure that the content of this DMMP is aligned to DEA&DP requirements.

The MMP must be submitted with a signed declaration for the MMP to be adopted in terms of the National Environmental Management Act. It must provide a strategic overview of the need for its development, and how the plan aims to contribute to sustainable practices and reducing and/or mitigating the need for maintenance. Details on the responsible party who will implement the MMP must also be included.

In section for the document provides further details on the expectations of a thorough team engagement for this MMP engagement with the following authorities was undertaken:

- Department of Environmental Affairs and Development Planning
- Hessequa local municipality

Details of the interaction with the authorities must be provided, and comments received must be submitted and referenced within the MMP. Interested in affected parties must be notified that an MMP is to be prepared, and afforded an opportunity to comment on the document.

In terms of the actual maintenance plan method statements providing a step-by-step plan must be included for the various activities that will be required. Time period should be provided within which the maintenance actions need to be implemented, and an indication as to whether certain maintenance actions will be repeated must be given.

1.4 SCOPE OF THE MMP

This Dune Maintenance and Management Plan (DMMP) has been prepared in order to facilitate the ongoing management and maintenance of the dune areas in front of the two parking areas at Gouritz, which are subject to recreational impacts. The location of the sites covered by the DMMP are presented in Section 1.1.

The report has been prepared in order to cover activities that are required to improve the management, use and ecological integrity of the frontal dune systems, in order to ensure that the ecological function of these systems is maintained. This is essential given the current loss of vegetation in certain areas due to ongoing recreational impacts on the dune system, the impacts of natural erosion events and the threat to built infrastructure. The importance of maintaining a natural coastal defence, especially in light of sea level rise and related storm surges, and increased frequency of the erosion events, is likely to require that the following activities take place, as and when necessary (City of Cape Town, 2017):

- Mechanical movement of sand that may have accumulated on, against or near coastal infrastructure.
- Bulk movement of sand to repair blow-outs and reshape compromised dune profiles.
- “Topping”, reshaping and re-vegetating dunes that have grown too tall, or which have a very irregular topography due to erosion and blow-out development.
- Clearing access paths from sand build-up and re-distribution of the sand on the beach, dunes or intertidal areas.

- Reconstructing primary and hummock dunes that might have eroded as a result of extreme storm events.
- Returning clean sand that might have accumulated on roads and other built infrastructure to suitable areas on the beach or dunes.
- Planting vegetation and installing irrigation systems as part of dune rehabilitation projects.
- The stabilisation of sand with brushwood, netting, Kelp or mulch.
- Installation of post and rail fencing and barriers to prevent public from walking over sensitive dune systems.
- Installing wooden or Pollywood raised boardwalks and walkways to improve access control.
- Removal or repair of irrigation systems as and when required.
- Maintaining and repairing storm-water outlets along beaches in dune systems.
- Installing refuse bins, benches, signage, fencing and bollards as and when required, and
- Removal of broken benches, fencing, signage, bollards, rubble and poles.

1.5 LISTED ACTIVITIES COVERED IN THE MMP

This report has been produced in accordance with the National Environmental Management Act, 1988 (NEMA Act No. 107 of 1998), as amended and the Environmental Impact Regulations of 2014.

The following listed activities contained in NEMA 107 of 1998, as defined in Government Notice (GN) No. R 327, R. 325 and R. 324 of 4 December 2014 (as amended in 2017) are likely to be trigged, and this DMMP applies for authorisation to undertake the below activities:

1. **Activity 18 of GN No. R. 327** – the planting of vegetation or placing of any material on dunes or exposed sand surfaces of more than 10 m² within the littoral active zone, for the purpose of preventing the free movement of sand, erosion or accretion, excluding where –
    i. The planting of vegetation or placement of material relates to restoration and maintenance of indigenous coastal vegetation undertaken in accordance with a maintenance management plan, or
    ii. Such planting of vegetation or placing of material will occur behind a development setback.

2. **Activity 19A of GN No. R. 327** – the infilling or depositing of any material of more than 5 m³ into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 m³ from –
    i. The seashore;
    ii. The littoral active zone, an estuary or a distance of 100 m inland of the high-water mark of the sea or an estuary, which ever distance is the greater; or
    iii. The sea;-
    But excluding where such infilling, depositing, dredging, excavation, removal or moving-
        f. Will occur behind a development setback.

g. Is for maintenance purposes undertaken in accordance with a maintenance management plan; or
h. Falls within the ambit of activity 21 in this notice, in which case that activity applies.

3. **Activity 14 (xi) of GN No. R. 324** – the development of boardwalks exceeding 10 m² in size in the (i) Western Cape (i) outside and urban area; or in (ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans.

The DMMP also covers the following activity, in accordance with the **Integrated Coastal Management Act (Act 36 of 2014)** - **Section 15: measures affecting erosion and accretion** – Subsection (2): "no person may construct, maintain, or extend any structure, or take other measures on coastal public property to prevent or promote erosion or accretion of the seashore except as provided for in this Act, the National Environmental Management Act or any other specific environmental management Act".

It also covers regulations relating to the control of the use of vehicles in the coastal area known as the **off-road vehicle regulations**. Section 3(1)(d) make provision for permissible activities which include "the use of a vehicle by any employee or agent of an organ of state acting in the course and scope of their employment of mandate, or by any person contracted by an organ of state, for the purposes of performing the public duties of that organ of state mandated by law".

1.6 Assumptions and Limitations

This report is based on the information available at the time of the compilation and as such, the following assumptions and limitations are implicit:

- This report is based on best available information gained from the sire surveys and desktop research
- No historical quantitative data on changes to the dune system were available.
- That the "edge of vegetation line" approach used is accurate enough to use as a surrogate for estimating longer term dune movement.

2 APPROACH

2.1 VEGETATION ASSESSMENT

The vegetation at Gouritz was sampled along equal interval transects that were defined using ArcGIS prior to the site visit, to ensure objectivity (Figure 2.1). Transects ran perpendicular to shoreline, and the following sampling took place:

- 7 transects, numbered 25 to 31 were sampled along the 200m site.
- At each transect the species composition and vegetation cover (estimated visually) of each species was determined.
- A drone and topographical survey was undertaken to capture high resolution aerial imagery and to calculate a Digital Elevation Model (DEM) for the project area.
- Using the drone aerial survey, results were extrapolated to prepare an accurate vegetation map of the site.
- Accurate GPS readings were taken at the start and end points of the transects.

Figure 2.1: Transects used for vegetation assessment.

In addition to obtaining an accurate vegetation map, the edge of the vegetation line was also determined over time. Barwell & Associates (2015) have shown that the “edge-of-vegetation” line is relatively easy to observe on aerial images and remote sensing images as the boundary between the dark area (vegetation) and light area (beach) is distinct. It is a useful means of tracking beach stability over time (Figure 2.2).

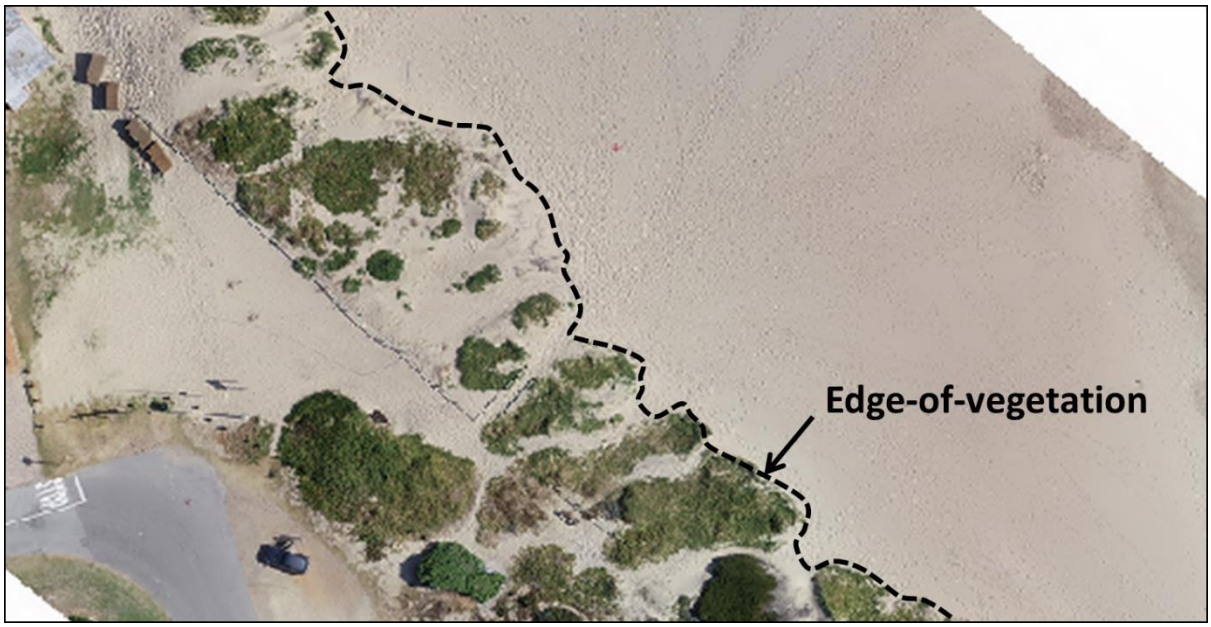

Figure 2.2: Defining the "Edge-of-vegetation" line

2.2 Topographical Assessment

A UAV (Drone) topographic and detail survey was conducted and the pictometry method was used to generate contours for each site. Where vegetation was too dense a conventional GPS survey method was used to fill in the missing information. The GPS was also used to capture detail such as fences and road/tar edge.

The survey included the following:

- A drone survey to capture aerial imagery of each site;
- Calculation and capture of cadastral data;
- In fill survey of basic detail (i.e. fences, roads and Services); and
- Processing of data, generation of elevation contours and completion of final drawings.

This was then used to create a detailed topographical map and DEM that was used as a key data source for the project.

3 CLIMATE, CLIMATE CHANGE AND SEA LEVEL RISE

3.1 GENERAL CLIMATE

Gouritz is classified as having a cold semi-arid climate. Average daily temperatures range from 24°C in February to 17.8°C in July. The coldest night time temperatures are recorded during the month of August when temperatures drop to a low of 7.1°C. Gouritz normally receives about 226mm of rain per annum, with rainfall patterns more akin to subtropical climates, with dry summers, relatively wet winters, and even wetter springs and autumns. (SA Explorer, 2017) (Figure 3.1).

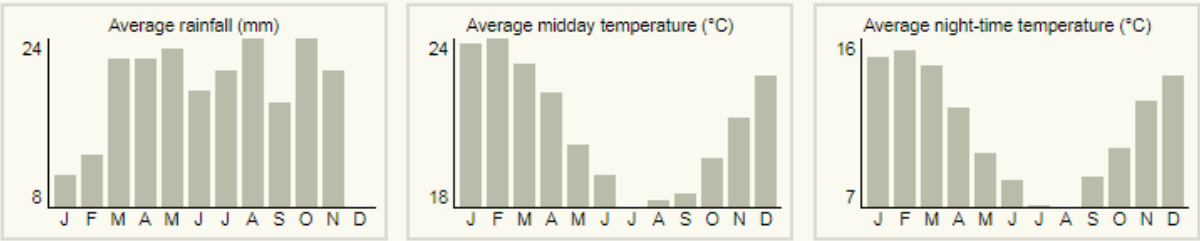

Figure 3.1: Graphs (from left to right) showing the average monthly rainfall; average monthly midday temperature; and average monthly night-time temperatures for Gouritz (SA Explorer, 2017).

Along South Africa's southern coast, westerly to south-westerly winds occur throughout the year. The main seasonal difference occurs during the spring and summer months, when there is a high frequency of easterly winds. Along the south coast there is also a slight sea breeze throughout the year with a moderate to strong north-west land breeze component. The windiest time of the year is from midwinter to spring (Tinley, 1985).

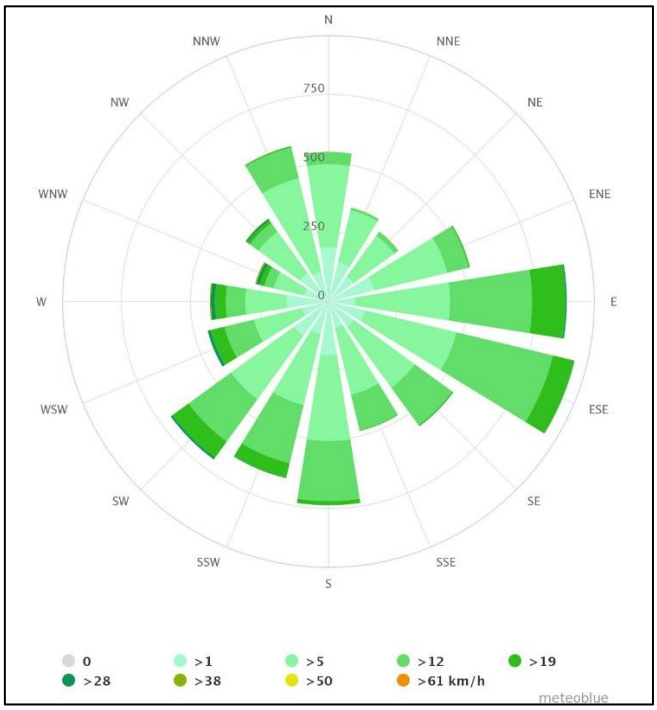

Figure 3.2: Windrose for Gouritz (Meteoblue, 2020)

3.2 Climate Change and Sea Level Rise

Climate variability and change is becoming an increasing threat to both natural and man-made assets along the coastline and coastal management needs to more carefully consider the effects of this. The main pressures on the coast as a result of climate change are sea level rise together with increasing storm frequencies, intensities and storm surge events. Infrastructure located in low lying coastal areas are particularly vulnerable to damage and destruction during extreme natural events that have become more frequent and intense due to climate change.

The following climate change related impacts are relevant to the study area:

- Changes in sea level;
- Occurrence of severe storms;
- Extreme sea levels, and
- Wind and waves;

In particular, the first two will have a significant effect on foredune integrity, and are discussed further below.

Changes in sea level pose a significant risk to coastal systems and coastal development. It can lead to beach and dune erosion resulting in shoreline retreat, as well as salt water intrusion into freshwater coastal aquifers, negatively affecting the quality of water used for human consumption and irrigation (Nicholls, 2010). Over the 20th century, mean sea-level has risen an average of 0.17 metres (0.12 metres – 0.22 metres) (Mather et al. 2009). In South Africa, the first detailed analysis of all tide gauge sites along the southern African coastline was conducted in 2009. The analysis shows that over the past 50 years, sea level rise (SLR) along the southern African coastline has not been constant, varying between 0.42 mm/year (West Coast) to 3.55 mm/year (East Coast) (with a rise of 1.57 mm/year along the southwestern and southern Cape coastline) (Mather et al. 2009). This equates to a mid-scenario for SLR due to climate change of 1m by 2100, and 0,35m by 2050 (CSIR, 2014). Along the coastline around Pringle Bay, and assuming a planning horizon of 2050, the extreme future scenario for a coastal low pressure system occurring during spring high tide could resulting in flooding levels of about 1,84m above mean sea level (MSL) (Barwell, 2015). In the absence of site specific data, a similar event in Stillbaai needs to be catered for. The 1,84m refers to the still-water level. The dune system must also be able to withstand the additional effects of wave setup and wave run-up. (Wave setup is the effect of water build-up against the shore due to waves breaking and wave run-up is the rush of water in the swash zone up the beach slope of the still water level). This can add an additional 4,3m to the still water level, meaning that the foredune height needs to be at least 6m above MSL to accommodate the compounding effects of SLR.

Changes in sea levels negatively affect coastal ecosystems indirectly by altering the saline gradient in estuaries, flooding low lying areas such as dune slacks, inducing changes to parameters such as available light, salinity, and temperature, and ultimately altering species composition.

Severe storms, such as tropical cyclones and extratropical cyclones, can result in storm surges that affect coastal areas. The severity of the storms depends on the storm's projected path, the regional bathymetry, near shore hydrodynamics and the contribution from waves

(Wong, et. al. 2014). On short time scales (order of hours to days), tides and weather contribute to a sudden rise in sea level. This is because variations in wind and atmospheric pressure can raise sea levels by up to forty centimetres, and during extreme storms waves can increase sea level by several metres. These variations are more significant due to climate change. With a rise in sea-level and increase in frequency and intensity of sea storms, accompanied by an increase in wave heights, the coastline is expected to experience a greater risk of damage by storm surge; increased exposure to more intense and more frequent extreme events; increased flooding, with greater extent and frequency, and ultimately more frequent destruction of foredunes, coastal property and infrastructure (Goschen, 2011).

Coastal erosion, including the removal of dunes and subsequent under-scouring of foundations are important consequences. Areas located closer to river mouths are more susceptible, due to the possibility of higher water levels in the estuary, and foredune wash-away due to the river mouth changing direction.

4 PHYSICAL DESCRIPTION OF THE DUNE SYSTEM

4.1 TOPOGRAPHY

The parking lot in the south of the project area is located close to the HWM. There is a very narrow strip (6m) of vegetation to the west of the parking lot. In this area, the elevation rises quickly to approximately 5.5m above MSL. The area to the east of the parking lot has relatively uniform topography with a steep slope, which exceeds 30˚, immediately adjacent to the parking lot.

To the north-west of the parking lot, the dune system has been disturbed which has resulted in low vegetation cover, blowout dunes and active sand movement. As can be seen in Figures 4.1 and 4.2, the linear foredune system has been compromised as a result of wind erosion in areas where vegetation cover has been lost. This results in the development of hummock dunes that allow wind to blow between the hummocks, resulting in further erosion. The elevation in parts of this area exceeds 6.5m above MSL, however, between these high elevation areas, there are lower elevation blowout areas. This results in variable slopes along the foredune system, as seen in Figure 4.2.

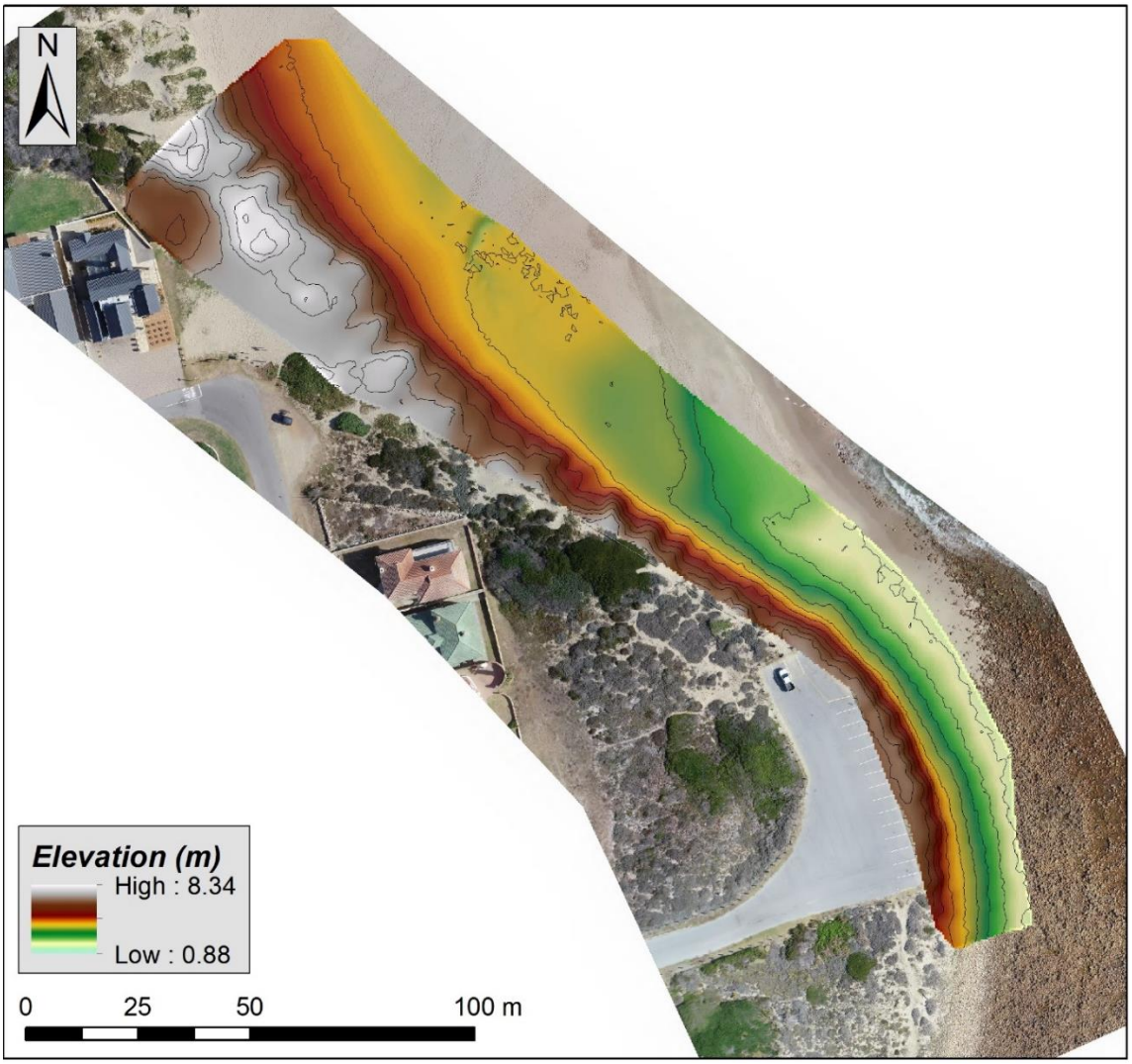

Figure 4.1: Digital Elevation Model for the project area.

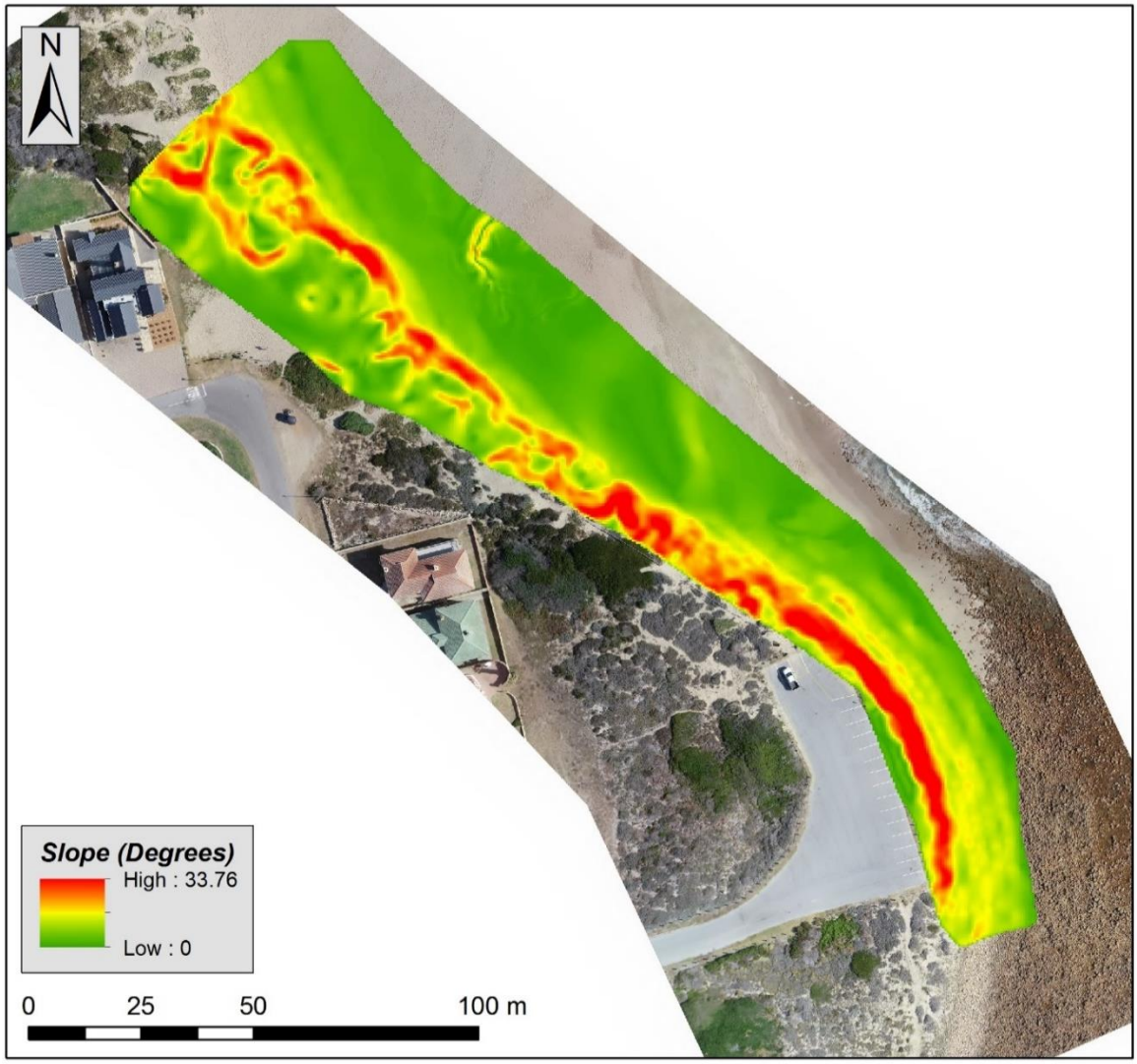

Figure 4.2: Slope of the dunes within the project area.

4.2 EDGE-OF-VEGETATION

Based on analysis of aerial imagery over the last 16 years, the edge of vegetation line has remained relatively stable. However, it is evident that there has been a reduction in vegetation cover at existing beach access points. This includes the area just north of the formal parking lot and the dunes to the east of the smaller parking lot and ablution facilities (Figure 4.3).

01/09/2004	06/08/2011
	
15/04/2012	05/02/20013
	
21/01/2014	16/01/2016
	
03/02/2017	13/01/2019
	

Figure 4.3: Historical Edge-of-Vegetation.

5 VEGETATION OF THE DUNE SYSTEM

5.1 GENERAL DESCRIPTION OF THE VEGETATION

The South African Vegetation Map (SA VEGMAP) of 2018 is an important resource for biodiversity monitoring and conservation management in South Africa. Under the custodianship of the South African National Biodiversity Institute (SANBI) the SA VEGMAP, (2018) was updated in order to 'provide floristically based vegetation units of South Africa, Lesotho and Swaziland at a greater level of detail than had been available before'. The map provides a detailed description of each of South Africa's unique vegetation types along with a comprehensive list of the important species associated with each, including endemic and biologically important species. According to the SA Veg Map (2018), the following vegetation type is found within the dune system of the project area:

Cape Seashore Vegetation

Cape Seashore Vegetation typically occurs on recently deposited coastal sandy sediments forming dunes and beaches, along the Eastern and Western Cape Provinces of South Africa. It stretches along the temperate coasts of the Atlantic and Indian Ocean, from Olifants River mouth to Cape Agulhas in the south west and from Cape Agulhas to East London in the south. This vegetation type is characteristic of beaches, coastal dunes, dune slacks and coastal cliffs. It ranges from open grassy and herbaceous vegetation to dwarf-shrubby vegetation, often dominated by a single pioneer species. The age of the substrate and natural disturbance regime (moving dunes), coupled with the distance from the upper tidal mark and the exposure of the dune slope (leeward verses seaward), influences the composition of the plant communities present (Muncina *et al*., 2006).

Cape Seashore Vegetation is classified as **Least Concern**, with a conservation target of 20%. Almost half of the area is statutorily conserved in formal protected areas, including national parks and Nature Reserves, while a considerable portion is protected in a number of private conservation areas. Only 1.7% of this vegetation type has been transformed, mainly as a consequence of urban development (Mucina *et al*., 2006).

Further inland the vegetation becomes more woody and is dominated by small bush clumps in a mosaic of low asteraceous fynbos, and is classified as Hartenbos Dune Thicket.

5.2 VEGETATION COMPOSITION AND COVER

The vegetation in front of the parking area (Transects 30 and 31) differs slightly from the rest of the vegetation. Dominant species are *Tetragonia decumbens* and *Atriplex semibaccata*, with *Sporobolus virginicus* occurring on lower slopes close to the rocky area. A number of other species, some associated with salt marsh vegetation (such as *Chenolia diffusa*) as well as Pelargonium sp, *Helichrysum* sp. and Artctotis sp are found in lower numbers (Plate 5.1).

Plate 5.1: Typical vegetation in front of the parking area. In the foreground is *Atriplex semibaccata*, and the low growing grass species at the edge of the boulders is *Sporobolus virginicus*.

The vegetation at transect 29 differs from the more typical foredune vegetation from transect 28 onward as there is an expansive area of *Atriplex semibaccata* from 15m inland to the houses.

The foredunes above the HWM are dominated by *Tetragonia decumbens,* which covers approximately 25% of the area. However, the absence of the grass *Elymis distichum,* which is abundant on foredunes further west is notable.

From the sparsely vegetated foredune the pioneer species become interspersed with woody pioneer shrubs, and the most distinctive species are *Chrysanthemoides monolifera* and

Atriplex semibaccata. However, there are also extensive stands of the invasive Rooikrans found on the dunes, from 25 inland.

Overall species cover is less than 25% along most of the dune, and the foredune system this is regarded as disturbed, mainly due to recreational pressures.

Based on the high resolution drone aerial cover, it has been possible to produce a very detailed map of the area (Figure 5.1). The following plant communities have been identified and mapped:

i. **Sporobolus, Atriplex Tetragonia grass forb mix.** This vegetation is restricted to the area in front of the parking lot and extending a few metres east it is distinctly dominated by *Atriplex semibaccata,* but there are a number of succulents species and smaller herbaceous species which are able to withstand the effects of salt spray, as the edge of the vegetation is close to the HWM (Plate 5.1 and 5.2).
ii. ***Tetragonia Atriplex foredune***. A short stretch of fortune from the parking lot almost to transect 27 is dominated by *Tetragonia decumbens* and *Atriplex semibaccata,* and differs from the rest of the foredune due to the presence of the latter. Vegetation is generally low (<50%) due to the loss of vegetation from trampling (Plate 5.3).
iii. ***Atriplex shrubland.*** The area in the land of the parking area is distinctly dominated by *Atriplex semibaccata* and patches of other woody vegetation, especially *Chrysanthemoides monolifera.* A few trees were also noted, including the White Milkwood, *Sideroxylon inerme.* This community generally falls outside the study area.
iv. ***Tetragonia foredune***. These foredunes are distinctly dominated by *Tetragonia decumbens,* which can achieve an aerial cover well in excess of 60% on certain hummock dunes. Densities are too low to form a continuous dune ridge (Plate 5.4). Other species present include *Sporobolus virginicus. Atriplex semibaccata* and *Chrysanthemoides monolifera.*
v. ***Sporobolus virginicus grassland and parking****.* The informal parking area behind concept six has been planted with Sporobolus, but cover is very low as the species is unable to tolerate vehicle movements and trampling (Plate 5.5).
vi. *Acacia cyclops.* There are three stands of the invasive Rooikrans at transects 25 and 28, as well as one smaller stand between transects 27 and 28. However, further to the north-east the dune behind the main beach is completely dominated by this invasive species (Figure 5.1; Plate 5.6).

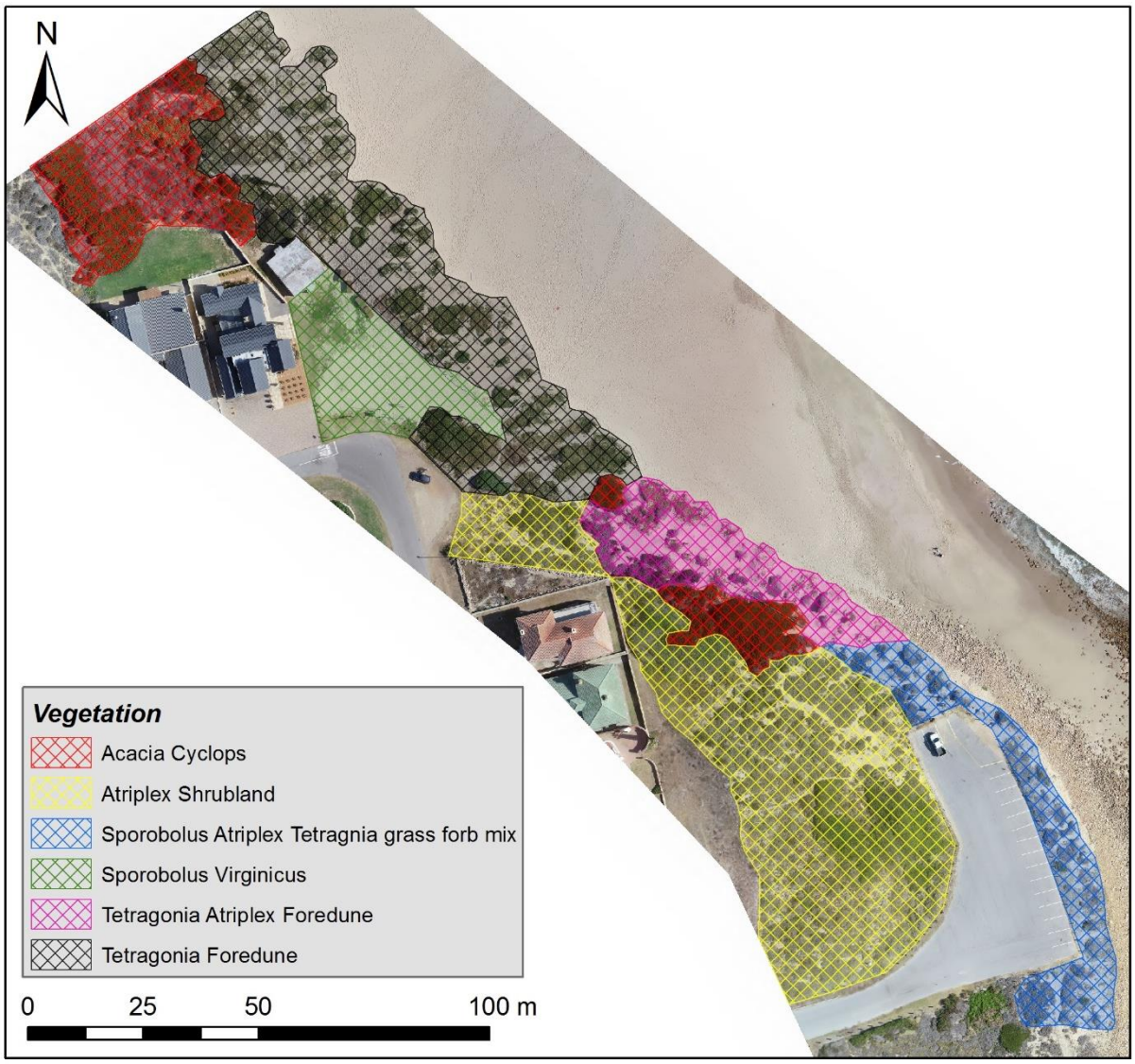

Figure 5.1: Vegetation recorded on site

Plate 5.2: A *Sporobolus, Atriplex Tetragonia* grass forb mix dominates the eroded foredune ridge next to the parking area. Dominant species here *Tetragonia decumbens* (Foreground) and *Sporobolus virginicus* (background). Note erosion and Gabions placed to prevent further erosion but now dislodged from the slope.

Plate 5.3: Atriplex Tetragonia dominated foredune habitat.

Plate 5.4: *Tetragonia* foredune. Note small blowouts and hummock dunes. The shrub in the middle foreground is *Chrysanthemoides monolifera*

Plate 5.5: Tetragonia decumbens foredune in the foreground, and *Sporobolus virginicus* parking area in the background.

Plate 5.6: *Acacia cyclops* appears as dense stands. The shrub is low and sprawling as it has been severely wind pruned.

5.3 DUNE STABILITY AND INTEGRITY

The dune slope below the parking area at Gouritz's is not stable. It is subject to wave attack during spring high tides, and this results in erosion at the base of the slope. Eventually the under-cutting results in the dine slumping (Plate 5.7). Attempts to stabilize the area using gabions has been partly successful, but ongoing maintenance is required (Plate 5.8).

Plate 5.7: The dune slope below the parking area is severely eroded due mainly to wave attack but also recreational impacts (trampling).

The dune system beyond the parking area is also unstable. There is no linear foredune system due to wind erosion in areas where vegetation cover has been lost. This results in the development of hummock dunes that allow wind to blow between the hummocks, resulting in further erosion. Loss of vegetation is primarily due to human trampling, indicating that improved access control is required.

The grassy parking area at the corner of River Street and Kus Road has very low vegetation cover, and access from here to the beach is not well controlled. The grass cover (*Sporobolus virginicus)* cannot withstand the effects of vehicle traffic on the soft sand, and hence the surface is unstable.

Plate 5.8: Gabions have been used to reinforce the slope but sand has eroded in front of them, and the undercutting eventually results in their collapse.

Plate 5.9: Unstable and sandy parking area at River street.

6 MANAGEMENT & MAINTENANCE PLAN FOR GOURITZ

6.1 REFORMING (REBUILDING & SHAPING) DUNES

The reconstruction of dunes is sometimes necessary when the shape, size or topography has changed as a result of wind erosion and wave attack. This is the situation for the foredune ridge between transects 25 to 29, so ideally the dune system should be re-profiled with earthmoving equipment, but this will result in the loss of vegetation cover. Although the linear foredune ridge has been compromised, vegetation cover is still good (Plate 6.1). Therefore, it is recommended that the sand trapping techniques of installing wind-nets and spreading brushwood over the sand, followed by active revegetation be done instead. In this way the existing vegetation cover is not lost, and the approach will be more cost effective.

Plate 6.1: The vegetation along the foredune ridge has been impact from trampling, resulting in the loss of a linear ridge. However, cover is still relatively good and thus no re-contouring is recommended.

6.2 DUNE STABILIZATION

The following interventions are required:

- **Wind-nets in blowouts:** dune forming fences must mainly used on smaller isolated blowouts which are still surrounded by functional dunes and vegetation. They have the advantage of preventing people from walking through the blowouts, which is important since they are usually caused by trampling followed by natural wind erosion. The establishment of very short wind-nets at specific locations where erosion has taken place is required. These wind-nets should be constructed towards the back of the small blow-out dunes to trap wind-blown sand, and as it accumulates to fence height, a new wind-net fence must be placed approximately 15 to 20m in front of the wind-net, towards the mouth of the blowout. Once sand has accumulated to the required height behind the first wind-net, the area must be covered with brushwood or mulch and revegetated. Vegetation will become established as the sand surface is now stable. The wind-nets should ideally be constructed of natural materials such as branches obtained from alien invasive removal programs (with the seeds removed). If this is not possible then wind-nets can be constructed from porous materials such as shade cloth can be used (Plate 6.2). Wooden slats laced together, as well as hessian may also be used in addition to shade cloth.
- **Mulch/woodchips:** In areas where exposure to the wind is less, surface stability can be achieved by using mulch. It assists with retention of soil moisture, and provides protection for seedlings. Suitable materials include grass cuttings, wood chips, leaves and straw. Chipped waste can be considered as long as the material is not contaminated with the seeds of alien vegetation. Note that mulching is not effective on areas exposed to strong wind.
- **Brush matting:** This involves placing a layer of branches over the sand surface. As wind passes over the brush, velocities are reduced and this allows the sand surface to remain stable, and sand movement is reduced. Wind blowing sand drops through the brush to settle underneath (Plate 5.3). This is labour-intensive as it involves the cutting, transporting and spreading of brush, but funds could be obtained from the Extended Public Works Program. It is restricted to areas where brush is readily available, and brush could be obtained from the areas being cleared of Rooikrans, provided those branches are sterile (do not do not carry and seed). Using brush has the following advantages (City of Cape Town, 2017):
    - Dune vegetation establishes well and grows easily through brush matting. The sand trapping qualities of brush matting are useful for burying seed that can be planted over the brushed area. It is incorporated into the soil profile as windblown sand is trapped and deposited on top of the seeds;
    - Brush matting withstands strong winds while keeping the sand surface stable;
    - With competent supervision, the brush can be obtained and spread by relatively unskilled staff;
    - Seed or seedlings can be planted and fertilizer applied either before or after the brush is laid. Brush matting provides shelter for the developing seedlings; and
    - As the brush eventually decays it adds organic matter to the sand, improving its nutrient status and moisture-holding capacity.

- **Irrigation:** Irrigation is required to assist with the watering of plants in the early stages of their establishment, so they can evade moisture stress during their establishment period. It greatly increases the survival rate of planted seedlings. Typically, irrigation will be required during the hot and dry summer months, and for the first two years only. Portable irrigation systems, such as draglines, could be used. The following guidelines are provided:
    - During periods of drought use of water for irrigation must be limited.
    - If possible use non-potable water for irrigation.
    - Insure the correct amount of water is provided. Besides being wasteful, excessive irrigation results in root rot, and root growing too close to the surface, resulting in plants being drought intolerant.
    - Irrigation let's take place at weekly intervals that reduce water loss ideally in the early mornings or late afternoons.
    - The irrigation system must be designed to ensure that all plants receive 100% irrigation coverage.
    - Weeds and alien vegetation should be removed on ongoing basis.
    - The irrigation system must be checked frequently to identify leaks.

Plate 6.2: Bare sand and blowouts require wind-nets be established at 10m intervals prior to brushwood packing and planting, as done at Hout Bay, Cape Town (Photo R Rose).

Plate 6.3: Brushwood is very suitable to place over there sand behind the foredune ridge prior to planting, as has been done at Lappiesbaai.

6.3 DUNE RE-VEGETATING

The most effective long-term method of dune stabilisation is through the planting of vegetation. It is the least expensive and most durable cover lens and blends into the natural setting. It is generally self-maintaining as coastal vegetation is adaptive to the harsh conditions it is exposed to, and plays a very important role in binding the sand, thus creating dune systems. Ultimately a self-sustaining ecosystem, with minimal maintenance requirements is created, and this should be the goal (Plate 6.4).

Establishing vegetation can be achieved by using nursery-raised seedlings, in-situ cuttings and seeding the area with indigenous species. Established plants from the area which might have been rescued during at the operations can also be relocated and used. The following conditions are applicable when using vegetation to stabilise the dune system:

- Planting must only occur once the dune has been profiled and/or the sand surface has been stabilised.
- Locally indigenous species must be used. Recommended species are provided in Table 6.1.
- When using seed it is advised that a seed mulch be used, whereby the seed is mixed with straw or grass and broadcast across the site. This must only be done once the area has been packed with brushwood and the sand service is stable.
- Successional processes should be mimicked, meaning that pioneer species are planted close to the high-water mark, and then as one moves further inland pioneer woody species are planted, and later more climax shrubs and small trees.

- Because the combination of high temperature, low soil moisture and strong winds are the major causes of poor establishment of dune vegetation, the timing of planting is critically important. In the Western Cape planting must take place in the growing season, which is generally between May and August.
- If required mulch or fertiliser should be added improve the chances of survival. As mentioned above irrigation systems will improve plant survival, but even if an irrigation system is installed it is recommended that planting occurs between May and August.
- Improved survival rates are achieved if hardy indigenous dune plants are used. These can be raised in nurseries and when ready planted on the dunes. As it is difficult to obtain dune plants from commercial nurseries it might be necessary to establish a small nursery to propagate the species.
- In bare and open areas set-back from the HWM, where dune scrub is found, woody vegetation must be planted. However, to ensure their survival it will be necessary to use fertiliser or compost in order to increase the nutrient level for these later successional species.
- Organic matter generated by garden refuge may be used as compost.
- Care must be taken when using fertiliser products near sensitive areas such as wetlands, to avoid contamination of these areas.
- Organic fertilisers should be used in preference to inorganic fertilisers.
- Fertilizer must not be used to establish vegetation on undisturbed coastal dunes.
- The addition of fertiliser after the initial planting is not required and must not be applied.
- It is preferable to apply fertilizer during favourable weather and not when heavy rainfall is anticipated, as the nitrogen and phosphate can leach out the soil and contaminate adjacent areas. The fertilizer is also leeched out the root zone of these young plants.

Plate 6.4: The area in front of the parking at lot at Lappiebaai has been successfully re-vegetated after the dune was recontoured, packed with brushwood and planted. The site was irrigated, and this played an important role in its successful revegetation.

Table 6.1: Suitable species to use for dune revegetation.

Species	Common name	Picture	Moisture require-ments	Means of planting	Months to be collected	Habitat	Notes
GRASSES							
Ammophila arenaria	Marram grass		H	P	-	Foredunes, immediately above HWM	Excellent species to create small dune systems and trap advancing sand. Able to grow in mobile sands and build frontal dune system. Will die out once sand become stabilised.
Ehrharta villosa	Pipegras		L	P, S	Oct-Dec	Foredunes; areas with mobile sand. Blowouts.	Good in mobile sands. Indigenous equivalent to Marram grass but not as aggressive. More common in the Eastern Cape. In the Western Cape *Elymus distichus* seems to occupy its niche more effectively, but the species is still suitable. Will die out once sand become stabilised.
Elymus distichus	Sea wheat		L	S	Sep-Nov	Foredunes; areas with mobile sand. Blowouts.	As above, but in addition this species is very common in the study site. It appears to be one of the most aggressive pioneers, and is able to colonise disturbed areas. It is therefore highly suitable to use for revegetation.

Species	Common name	Picture	Moisture require-ments	Means of planting	Months to be collected	Habitat	Notes
Sporobolus virginicus	Dune kweek		M	P	-	Areas of mobile sand. Not restricted to foredunes.	A low growing sprawling grass similar to kweek. More suitable in rear dune areas, lower lying areas. Suitable to use in parking areas provided it is irrigated. Can tolerate tramping and vehicle movements better than most species. Fairly easily propagated by planting runners.
HERBACEOUS SPECIES							
Arctotheca populifolia	Dune pumpkin		L	P, S	Jan-Dec	Incipient foredunes and hummock dunes	In areas close to the high-water mark. This plant is able to tolerate severe salt spray and sand movement, and is able to establish incipient foredunes immediately above the high-water mark. It can also be used as a pioneer in open sandy areas within existing vegetation, but will die out once sand become stabilised.
Felicia aethiopica	Blue daisy		M	P		Foredunes and rear dunes	Useful groundcover in fairly stable areas. Not necessarily suitable on for foredunes. Useful ground cover towards the rear of the dunes. Suitable to be planted between date woody shrubs as ground cover.
Gazania rigens var. uniflora	Daisy		M	P,S		Foredunes and rear dunes	Good in foredune areas, but plant behind the *Arctotheca* zone and in slightly more stable sands. Suitable to plant together with *Elymus distichus* and *Ehrharta villosa.*

Species	Common name	Picture	Moisture require-ments	Means of planting	Months to be collected	Habitat	Notes
Senecio elegans	Dune Senecio		L	S	Sep-Jan	Foredunes and rear dunes	As above, But also suitable in the rear dunes and as an alternative to *Felicia aethiopica*. Bi-annual plant
SUCCULENTS							
Carpobrotus edulis	Hottentot fig		L	P, S		Foredunes and rear dunes	A very good, hardy pioneer groundcover plant that is suitable on foredunes and rear dunes alike. Easily propagated from cuttings.
Tetragonia decumbens or Tetragonia sp.	Klappiesbrak		L	P	-	Foredunes and rear dunes	A very good, hardy pioneer plant that is also suitable on foredunes and rear dunes alike. It can be propagated from cuttings. It dominates the foredune in the study area and is regarded as one of the most suitable species to use
SHRUBS							
Chrysanthemoides monolifera	Bitou		L	P, S	Jun-Jul	Rear dunes	Excellent shrub that grows well from seed and spreads rapidly in open areas. Grows extensively in the study area.

Species	Common name	Picture	Moisture require-ments	Means of planting	Months to be collected	Habitat	Notes
Myrica cordifolia	Waxberry		L	P,S	-	Rear dunes	Shrub that can be germinated from seed, but is slow growing. The horizontal stems grow along the surface of the dunes.
Rhus crenata	Dune crowberry		L	P	-	Rear dunes	Shrub that can be germinated from cutting. The horizontal stems grow along the surface of the dunes, and the shrub is very effective at covering large areas. Grows extensively in the study area.
Passerina rigida	Dune-string		L	S	Dec	Rear dunes	Very good in open areas and is a pioneer dune forest species, but seeds are slow to germinate.

6.4 SPECIFIC RECOMMENDATIONS FOR THE GOURITZ DUNES

The following rehabilitation activities are required, and the location of where these activities need to take place is presented in Figure 6.1.

i. ***Slope re-enforcement, sand placement and revegetation*** – the slope below the formal parking area has been subject to erosion from wave attack, and subsequent wind erosion (Plates 5.7 and 5.8). Sand will need to be brought in to fill the voids, and to establish a gentler slope that would be easier to revegetated. The slope should have a maximum slope angle of 18°. Thereafter the slope should be covered with mulch or brushwood, planted and the covered with Geojute matting. Geojute is commonly used as a biodegradable surface stabiliser or for pre-vegetated slopes. The product is manufactured from woven jute fibre to form a mesh of approximately 10mm x 10mm, which is staked at 1m² intervals. The jute will eventually degrade into an organic mulch after about two years, by which time the planted vegetation will have become established (see http://www.geotextilesafrica.co.za/erosion-Geojute-data.html). Alternatively, gabions could be constructed, but if required then engineering input is essential. Suitable species to plant include the grasses *Sporobolus virginicus* and *Elymus distichum*, and the herbs *Tetragonia decumbens* and *Gazania rigens var. uniflora,* as well as *Carpobrotus edulis.*

ii. ***Establish wind nets, pack with brushwood and plant pioneer species*** – in the entire foredune system from the parking lot to the end of the study vegetation cover has been reduced significantly and there are two distinct blowouts. Active rehabilitation is required in these blowouts. Wind net need to be constructed at 10 to 15m intervals, the areas between the wind nets must be covered with brushwood, and then seedlings of pioneer species (see Table 6.1), especially *Tetragonia decumbens* need to be planted. The area should also be seeded with *Elymus distichum* seed collected from adjacent areas.

iii. ***Plant pioneer shrubs and prevent access*** – there are areas within the rear dune, close to the informal parking area that are not entirely stable, but the sand surface is stable enough to directly plant woody shrub species grown in a nursery. These plants should be large enough to have been planted up into 10kg bags. This is required to improve vegetation cover and diversity. Must be planted at a density or 16 per 100m^2 or 1600 plants per hectare. Suitable species are presented in Table 6.1. Access to these areas needs to be regulated, through the establishment of fences (see Figure 6.1)

iv. ***Clear Acacia, pack with brushwood and plant pioneer species –*** there are two areas that are covered with Acacia which need to be cleared. The cleared area must be packed with brushwood from the cleared Acacia, provided it has no seed, and then planted with suitable pioneer species. This could include a mixture of herbs and shrubs listed in Table 6.1.

v. ***Establish boardwalks and pathways*** – disturbance to the dune system has largely resulted from human trampling, with multiple access points from the two parking areas to the beach. Improved access requires the establishment of two pathways. At both parking areas an elevated boardwalk constructed of Pollywood will be required. On level areas a pathway can be established by packing the area with woodchips and defining the edges with wooden poles. The elevated wooden boardwalk will require stairs down to the HWM.

vi. ***Pave parking area 2 with interlocking pavers*** – It will not be possible to establish an effective grass sward at the grassed parking area due to the impact of vehicles on the soft sand. The area should be paved with permeable grass block pavers. A suitable paver would be the 400mm x 400mm grass block paver available from Pavement Materials Group (see https://www.pavementmaterials.co.za/?. This is a cheaper option than cobble paving, and allows water to percolate thus preventing erosion. Once paved it must be planted with runners of *Sporobolus virginicus*.

vii. ***Establish an irrigation system*** – to improve the success of vegetation establishment and rehabilitation an irrigation system should be established, only along the foredune ridge and parking area.

viii. ***Establish a lifeguard facility***: This MMP also covers activities associated with the establishment of a lifeguard facility, which will be a small (approximately 15m^2) elevated wooden “Wendy house”. It is suggested that this be located just above the highwater mark where Seesig Road extends into the frontal dune system, to allow access for emergency vehicles. It is further suggested that an acces control structure (boom) be installed just below the intersection of Seesig Road and River Street, to avoid illegal ORV access to the beach and river mouth.

Figure 6.1: Rehabilitation activities required.

7 CONCLUSIONS

The following main conclusions are drawn:

- The dune slope below the formal parking area has eroded due to wave attack, and slope re-enforcement, adding additional sand and revegetating is required.
- The integrity of the foredune system north-east of the parking area has been compromised, and it has disaggregated into hummock dunes. It is not linear or intact for most of its length.
- However, no recontouring or physical changes to the dune system are required as cover is still good enough for the system to be regarded as stable.
- Active revegetation, including brushwood packing and wind net establishment is required.
- Areas behind the foredune require interplanting with woody vegetation.
- For most of the site seeding and planting pioneer species along the foredune ridge, and interplanting dune shrub species is required to ensure the system remains stable.
- An irrigation system should be installed along the frontal dune ridge, as active revegetation and management of this area is required, due to the impacts from trampling
- At both parking areas access to the beach must be improved, and elevated boardwalks are recommended.
- The grassed parking area needs to be paved with grass blocks and planted with *Sporobolus virginicus*.

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8 APPENDIX A

Simplified list of suitable species with photographs

Common name	Picture	Habitat	Notes
Marram grass		Foredunes, immediately above HWM	Excellent species to create small dune systems and trap advancing sand. Able to grow in mobile sands and build frontal dune system. Will die out once sand become stabilised.
Pipegras		Foredunes; areas with mobile sand. Blowouts.	Good in mobile sands. Indigenous equivalent to Marram grass but not as aggressive. More common in the Eastern Cape. In the Western Cape *Elymus distichus* seems to occupy its niche more effectively, but the species is still suitable. Will die out once sand become stabilised.

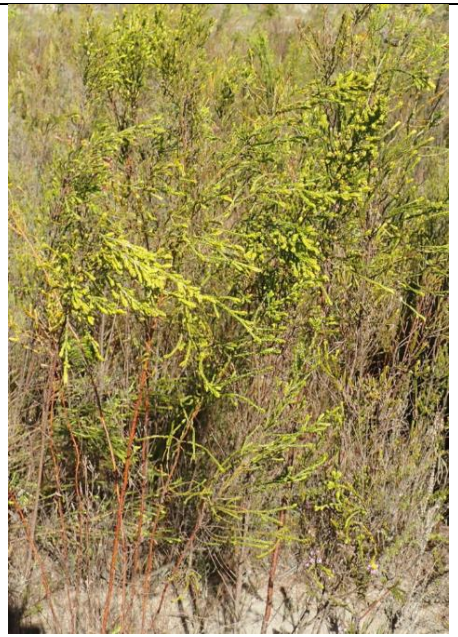
Common name	Picture	Habitat	Notes
Sea wheat		Foredunes; areas with mobile sand. Blowouts.	As above, but in addition this species is very common in the study site. It appears to be one of the most aggressive pioneers, and is able to colonise disturbed areas. It is therefore highly suitable to use for revegetation.
Dune kweek		Areas of mobile sand. Not restricted to foredunes.	A low growing sprawling grass similar to kweek. More suitable in rear dune areas, lower lying areas. Suitable to use in parking areas provided it is irrigated. Can tolerate tramping and vehicle movements better than most species. Fairly easily propagated by planting runners.

Common name	Picture	Habitat	Notes
Dune pumpkin		Incipient foredunes and hummock dunes	In areas close to the high-water mark. This plant is able to tolerate severe salt spray and sand movement, and is able to establish incipient foredunes immediately above the high-water mark. It can also be used as a pioneer in open sandy areas within existing vegetation, but will die out once sand become stabilised.
Blue daisy		Foredunes and rear dunes	Useful groundcover in fairly stable areas. Not necessarily suitable on for foredunes. Useful ground cover towards the rear of the dunes. Suitable to be planted between date woody shrubs as ground cover.

Common name	Picture	Habitat	Notes
Daisy		Foredunes and rear dunes	Good in foredune areas, but plant behind the *Arctotheca* zone and in slightly more stable sands. Suitable to plant together with *Elymus distichus* and *Ehrharta villosa.*
Dune Senecio		Foredunes and rear dunes	As above, But also suitable in the rear dunes and as an alternative to *Felicia aethiopica*. Bi-annual plant

Common name	Picture	Habitat	Notes
Hottentot fig		Foredunes and rear dunes	A very good, hardy pioneer groundcover plant that is suitable on foredunes and rear dunes alike. Easily propagated from cuttings.
Klappiesbrak		Foredunes and rear dunes	A very good, hardy pioneer plant that is also suitable on foredunes and rear dunes alike. It can be propagated from cuttings. It dominates the foredune in the study area and is regarded as one of the most suitable species to use

Common name	Picture	Habitat	Notes
Bitou		Rear dunes	Excellent shrub that grows well from seed and spreads rapidly in open areas. Grows extensively in the study area.
Waxberry		Rear dunes	Shrub that can be germinated from seed, but is slow growing. The horizontal stems grow along the surface of the dunes.

Common name	Picture	Habitat	Notes
Dune crowberry		Rear dunes	Shrub that can be germinated from cutting. The horizontal stems grow along the surface of the dunes, and the shrub is very effective at covering large areas. Grows extensively in the study area.
Dune-string		Rear dunes	Very good in open areas and is a pioneer dune forest species, but seeds are slow to germinate.