succession ecology

West Beach Dune Stabilisation Management Plan

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1.0 INTRODUCTION

1.1 Background

Adelaide's metropolitan beaches and associated dune systems have been recognised as an important part of the coastal landscape (DEH, 2005). They provide a highly valued recreational facility for Adelaide's residents and visitors, as well as essential protection of adjacent infrastructure (public and private) from ocean inundation and storm surges. Adelaide's coastal flora and fauna also utilise these areas as an important habitat resource.

Sandy coastlines are extremely dynamic, with cyclic patterns of sand accretion (build-up) and erosion. In a natural system where there is a balance between accretion and erosion, sandy coastlines are able to persist, although they will change form and dimensions within natural cycles. The Adelaide coast is characterised by a south to north littoral drift system and there is effectively little to no sediment supply, so over time the beaches experience a net loss of sand as sediment moves northwards. In addition, the urban and infrastructure development that has occurred along the Adelaide coastline has greatly modified natural processes (Figure 1). Intervention is now required to keep sand along the metropolitan beaches and within the narrow strip of remnant dunes that remain.

Figure 1: Comparison of sand resources along West Beach in 1968 and 2014. Source: Coastal Protection Board, via InDaily, 10 Jul 2019.

Sand replenishment strategies were introduced to Adelaide's metropolitan beaches in the 1970's and have evolved over time in response to ever-changing natural processes and the introduction of built structures along the shoreline. In 2005 a broad management change was enacted with the establishment of seven management 'cells' along the coastline (DEH, 2005). This has enabled sections of the coastline to receive targeted management actions in line with the landforms, built structures and coastal processes that influence its beach and dunes. This dune restoration project includes dunes within Cell 3, West Beach (Figure 2).

The West Beach management cell extends from the Adelaide Shores Boat Haven (West Beach Boat Ramp) to the River Torrens Outlet. Cell 3 has been subject to significant, ongoing beach erosion and dune destabilisation in recent decades. In response to this, the State Government is currently enacting a sand

replenishment plan for the West Beach cell that is expected to rebuild the beach and maintain sand volumes, providing a store of dune sands over time. This is occurring as part of the (former) government's *Securing the Future of our Coastline* project.

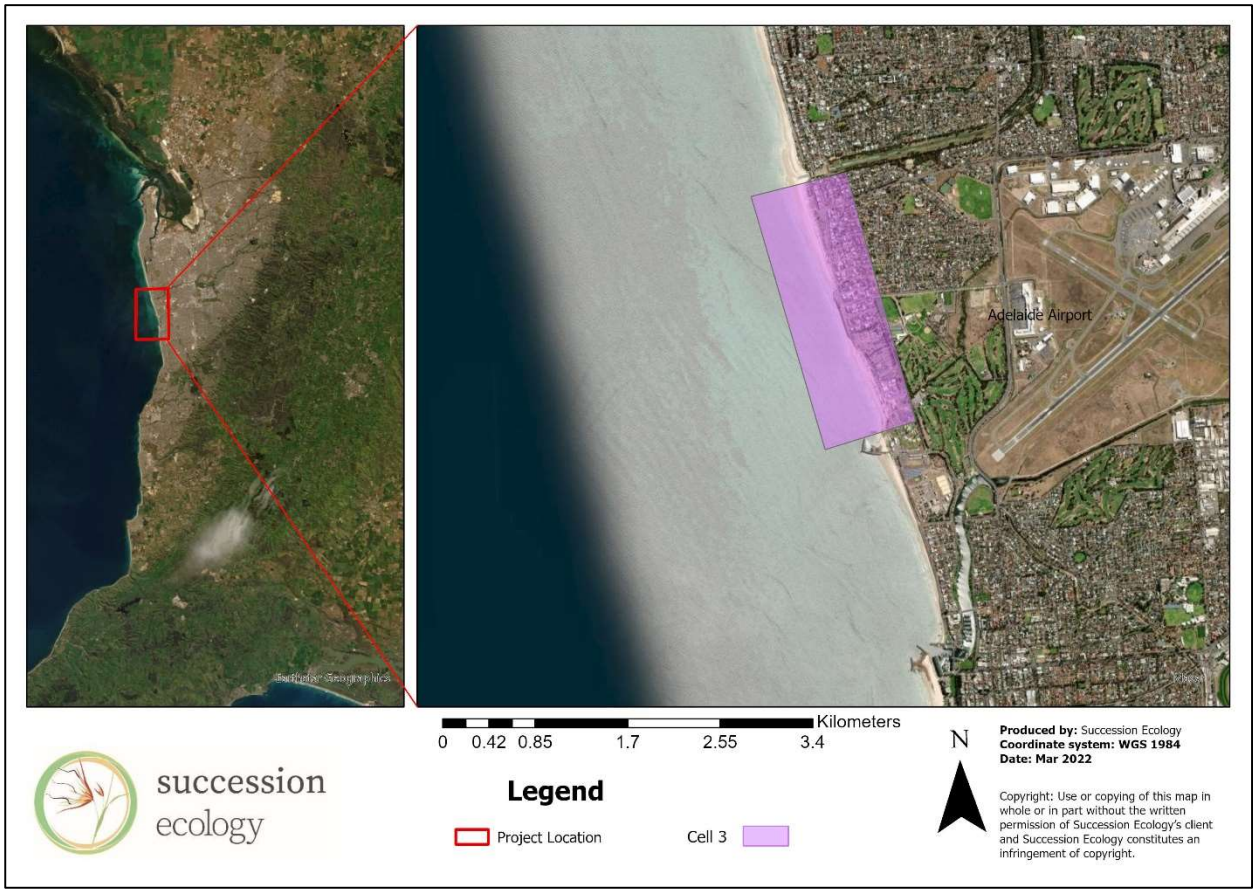


Figure 2: Project location at West Beach (Cell 3), South Australia.

1.2 Proponent

The West Beach Cell is under the co-operative management of a number of parties, including the City of Charles Sturt, the City of West Torrens, the Department for Environment and Water and the Coast Protection Board. There has also been some local community support provided by the West Beach and Henley Beach South working group.

The Department for Environment and Water (DEW) is currently taking the lead on the West Beach dune replenishment and stabilisation project and have engaged Succession Ecology to assist in the management of dunes within the West Beach management cell.

All works are supported by the (former) State Government's *Securing the Future of our Coastline* project.

1.3 Project Objectives

Tasks assigned to Succession Ecology include:

1. Development and implementation of a plan to stabilise the key erosion points within the Rockingham St and Hamra Ave dunes (refer Succession Ecology, 2022).

2. Development and implementation of a long-term management plan for sections of the dune system within the West Beach management cell.

Task (1) has commenced, with the Interim Measures report completed (Succession Ecology, 2022), and on-ground works in progress. These works aim to stabilise key erosion points within the Rockingham St (referred to here as SVRD4) and Hamra Ave (referred to here as WBPD1) dunes.

Task (2) is the subject of this report. This Management Plan provides recommendations for the long-term stabilisation of a number of sections within the West Beach cell, in particular the whole of the West Beach Parks dunes (WBPD), and dunes adjacent Seaview Road (Seaview Rd Dunes; SVRD) from Rockingham St to Burbridge Rd (Figure 3).

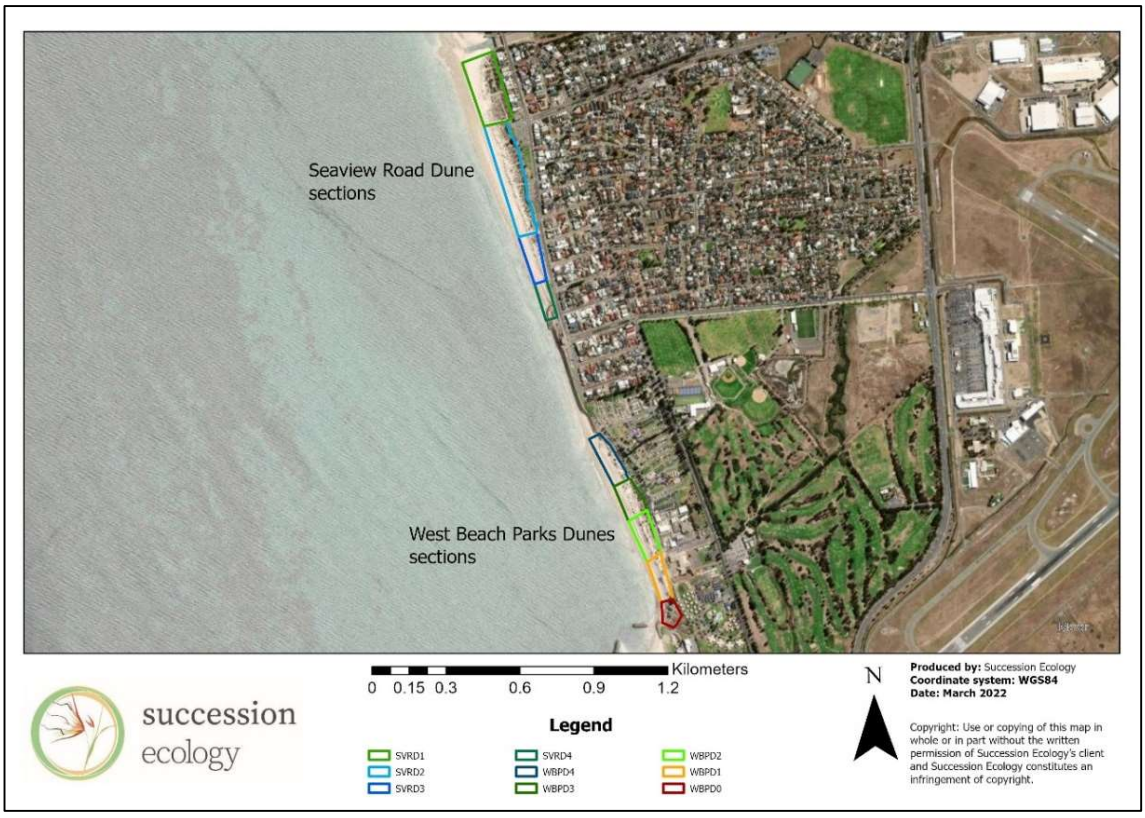


Figure 3: West Beach Cell 3 management sections.

1.4 Structure

This Management Plan includes the following:

- Introduction
- Discussion on key coastal process
- Dune stabilisation methodology descriptions
- Project area descriptions and proposed management actions
- Summary of recommendations

To ensure the effectiveness of management measures across the dune system the West Beach Cell has been divided into sub-sections based on like conditions, and management recommendations are presented for each sub-section.

2.0 COASTAL PROCESSES

2.1 Dune Formation Processes

Dune systems have complex structures and are extremely dynamic, determined by interactions among prevailing winds, sediment supply, wave action, and the broader geomorphology of the area. A typical, natural dune structure is shown in Figure 4. Dunes are predominantly influenced by wave action which both delivers and erodes sand, depending on conditions, wind-blown (aeolian) sand transport and salt spray. The seaward portion of a dune system typically comprises an incipient (newly forming) dune, a foredune (older, more established dune) and hind dunes of various types. The incipient foredune and established foredune can be periodically impacted by wave action and high seas. The hind dunes are normally the most stable dunes in the system except where significant coastal erosion is occurring. Seaward slopes on foredunes and incipient dunes are referred to as 'stoss' slopes.

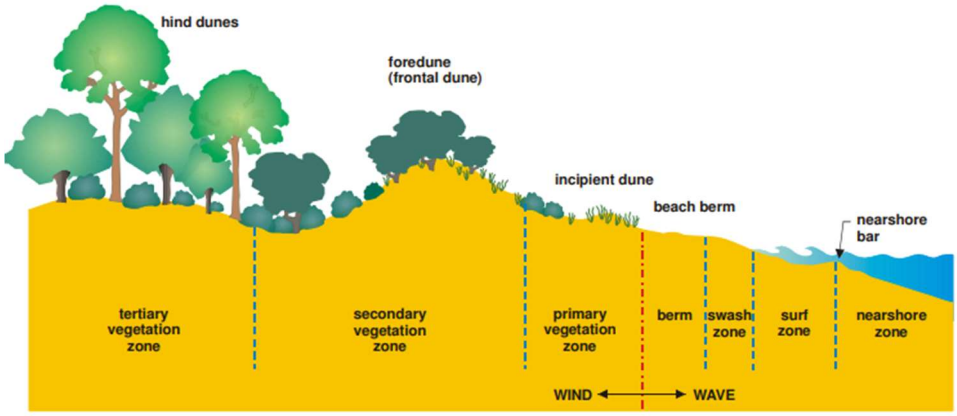


Figure 4: Typical features of a dynamic beach and dune system. Source: DLWC, 2001.

The changes seen on beaches and within dune systems are cyclic. Storm waves remove sand from the beach and dunes and form storm bars in the nearshore (on Adelaide coastlines these build during summer months; DEH, 2005), whilst calmer conditions allow the deposition of these sands back onto beaches, where wind can then blow the dried sands into the dune system (DLWC, 2001; Figure 5).

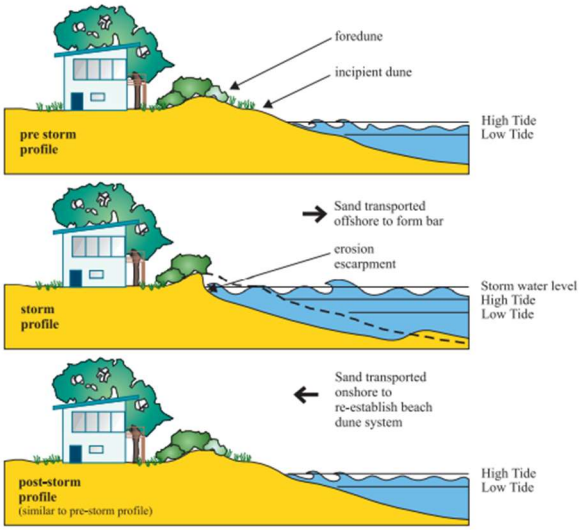


Figure 5: The cycle of beach erosion during storm events and accretion during calm conditions. Source: DLWC, 2001.

Along the coastlines of metropolitan Adelaide, including West Beach, the natural cycles of erosion and accretion (build up) of sands in the dune systems have been interrupted by built structures along shorelines (such as marinas and seawalls) and housing development which covers the vast majority of hind dunes along the coast. Further, the degradation of near-shore seagrass beds over time has lowered the seabed, increasing the velocity and size of waves when they reach the beaches and changed the angle at which waves are hitting the shoreline (DEH, 2005). These factors combine to present a situation where natural processes are significantly disrupted or altered and the erosion of certain sections of beach out-weight the accretion. This has led to net erosion and beach recession in these areas. As such, intervention (such as dune stabilisation and sand replenishment) to counter this effect is required to maintain a stable beach and dune system on Adelaide's metropolitan coastline.

2.2 Dune Stabilisation

Sands within dune systems are inherently unstable. They are usually nutrient poor, highly mobile when not stabilised and have poor water-holding capacity (high porosity). This is particularly true of the foredunes. Hind dunes tend to be more complex, containing more developed soils and increased vegetation stability, with little to no interaction with waves (DLWC, 2005; Figure 6). Unstable sands quickly become mobile, with wind-blown sand causing significant nuisance and damage to adjacent property and infrastructure (Figure 7). The maintenance of a protective cover of native coastal vegetation is required to stabilise dune sands and dune structure. Root systems and low-lying vegetative matter trap and hold the sand and moisture, and also support soil development (Page and Thorpe, 2010).

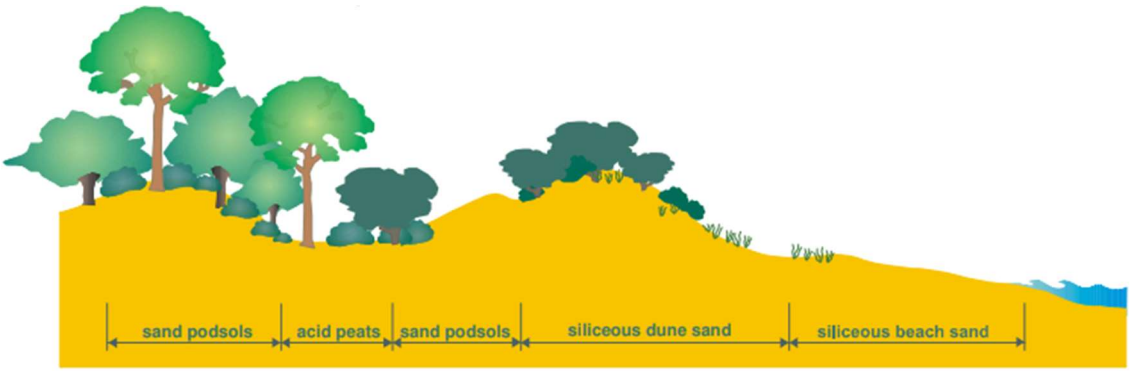


Figure 6: Coastal dune structure with increasing soil development and vegetation stability with distance from ocean. Source: DLWC, 2001.

Figure 7: Mobile sands severely impacting a property at North Beach, Wallaroo, SA.

The vegetation structure within dune systems can be considered to occur in three distinct zones. The Primary zone occurs on the seaward parts of the system amongst the incipient dune and seaward slope of the foredune. This zone can support species such as grasses and creepers. The Secondary zone occurs on the foredune crest and landward slope and can support low to medium shrubs. The foredune is an elevated feature that provides wind deflection near the shoreline. The Tertiary zone occurs amongst the hind dunes and supports taller shrubs and trees. These provide further protection from the wind for successive inland vegetation (Figure 8).

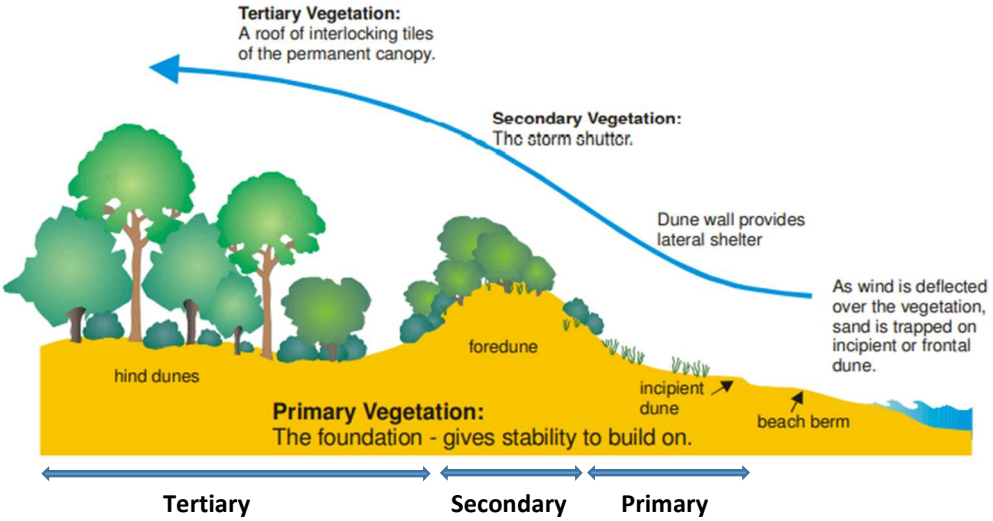


Figure 8: Vegetation zones and the protection provided within a dune system. Source: DLWC, 2001.

When working to stabilise or build dune systems it is important to mimic the natural vegetation structure (DLWC, 2001). Native flora species are the most suitable for dune stabilisation and formation as they can withstand harsh coastal conditions and are adapted to poor nutrient soils. Exotic species have been used in the past, however they can be very detrimental to dune formation and long-term stabilisation, as well as undermine the habitat value of the dune system. For example, introduced sea wheat grass has been used in the past in an attempt to stabilise dunes in Australia, however this species tends to form steeper dunes, which can cause the wind to eddy and remove sand (DLWC, 2001; DEH, 2005). It also extends further out onto the backshore than do native species, reducing nesting habitat for shorebirds such as plovers. In contrast, a native coastal spinifex is a coloniser of the foredune forming a wide, stable, flat foredune (DLWC, 2001).

The stabilisation of a foredune system can be enhanced by the presence of incipient dunes. These dunes form seaward of the foredune, from wind-blown sand (Page and Thorpe, 2010). They can build over time and become vegetated with primary zone vegetation. Incipient dunes can help in the protection of the foredune by taking the brunt of wave action, preventing scarping of the foredune during storm events.

2.3 Beach Replenishment

The Adelaide coastline has undergone significant modification over the past 80 years. Because of the urban development of the hind dunes and the numerous structures built along the coastline (such as marinas, seawalls and boat ramps), the patterns of erosion and accretion of sands within Adelaide's beaches have been highly modified.

Sand naturally trends northwards along Adelaide's coastline, being deposited along beaches as it drifts, with little sand lost to the open ocean (DHI, 2018). However, at West Beach there has been a net loss of sands from the beach for many years. This is due to the limited natural sand supply available from southern beaches, and the development of the Glenelg Marina and the West Beach Boat Ramp (at the southern end of the West Beach cell), which intercept the northward movement of sands and prevent deposition at West Beach (DHI, 2018). To maintain sandy beaches within West Beach (and many other sections of the Adelaide coastline) and protect adjacent property, the State Government has undertaken a sand nourishment program along the Adelaide metropolitan coastline. These works commenced in the 1970's and will need to continue into the future in order to maintain Adelaide's very important beach resource.

In 2012 a sand pumping system was developed, diverting deposited sands from Henley South to the southern part of the West Beach management cell. The (former) State Government's current *Securing the Future of our Coastline* project aimed to extend the sand pumping system, increasing the sand replenishment at West Beach and creating a number of new replenishment locations en-route to Semaphore. This aimed to ensure that the ongoing replenishment of sands at key beaches to balance the net erosion that has been recorded. Such replenishment will help to maintain the critical dune system that borders these beaches. The first phase of sand replenishment has been completed, with the introduction of around 200,000 cubic metres of quarry sands to West Beach. Construction of the new sand pumping system is now subject to a review under the newly elected State Government.

2.4 Climate Drivers

Adelaide's metropolitan coastline is subject to the effects of a number of climate drivers, including the Indian Ocean Dipole (IOD), the El Niño-Southern Oscillation (ENSO), sea level rise and prevailing wind and wave action, which all impact coastal processes and dune stability.

2.4.1 IOD and ENSO

The IOD is a phenomenon caused by the difference in sea surface temperatures between two areas in the Indian Ocean. The IOD can significantly influence the climate of southern Australia, with a negative IOD event causing increased rainfall and storm events and a positive IOD causing reduced rainfall (Figure 9). An IOD event typically runs from May to October in a year that it occurs, and the IOD index can fluctuate from negative to positive to neutral, year to year (Figure 10).

Adelaide's coastline can also be affected by the ENSO, another climate driver this time originating in the Pacific Ocean (Figure 11). The effects of ENSO on South Australia's coasts can be amplified when an El Niña event (i.e., wetter than average rainfall) is coupled with a negative IOD event. For example, the winter and spring seasons of 2021 experienced a Negative IOD event coupled with a minor El Niña event, which brought a number of storm events to South Australian coasts.

The Australian Bureau of Meteorology (BOM) presents a number of global models on the IOD and ENSO, which can be viewed to predict the possible effects of these climate drivers in any given season. Use of these models can assist with the ongoing planning and management Adelaide's coastlines.

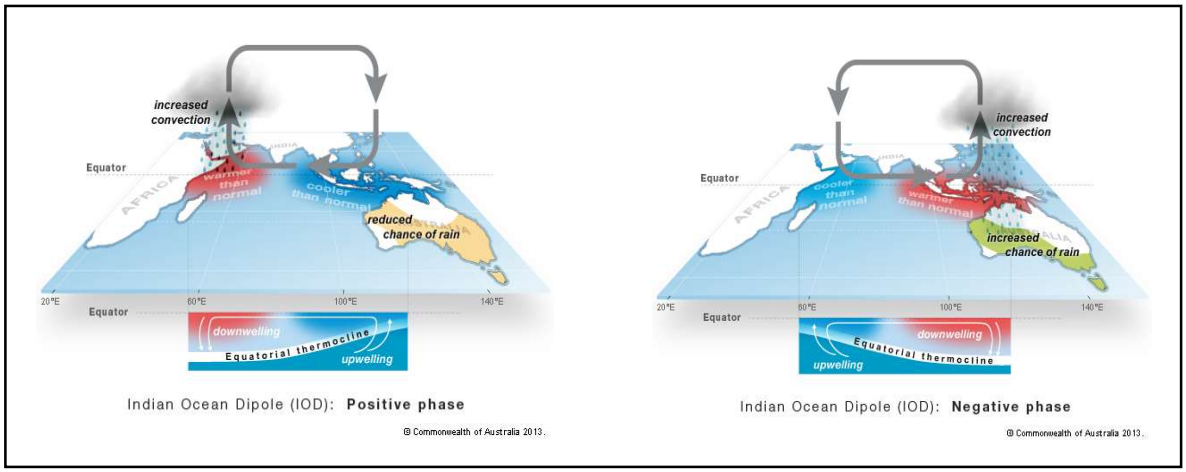


Figure 9: Illustration of a positive and negative IOD and resultant effects on Australia's climate. Source: BOM, 2022.

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021

Figure 10: IOD events from 2003-2019. Orange = Positive, Blue=Negative, White=Neutral. Source: BOM, 2021.

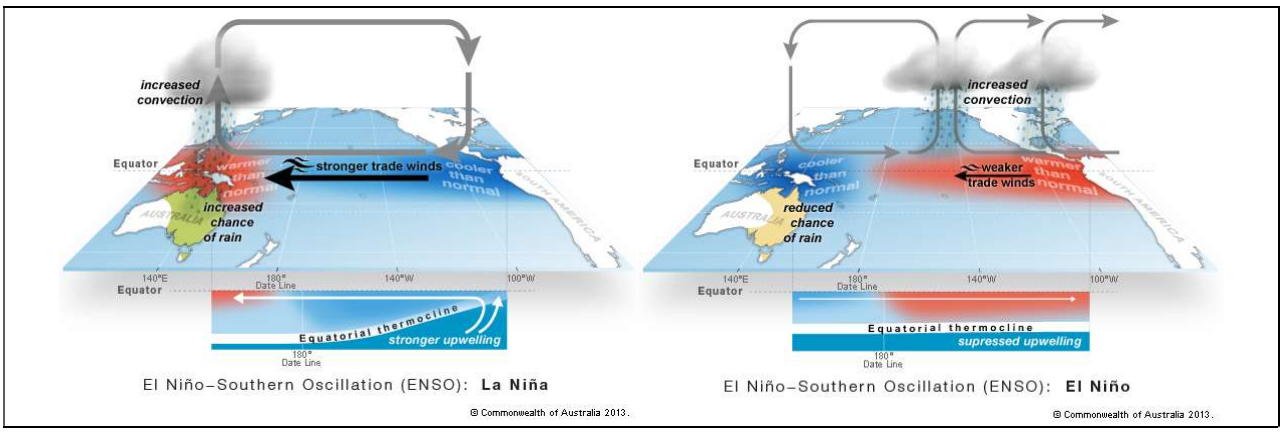


Figure 11: Illustration of a La Niña and El Niño event and resultant effects on Australia's climate. Source: BOM, 2022.

2.4.2 Climate Change

Effects of Climate Change are evident in the observed global sea level rise and broadscale climatic shifts. The average rate of sea level rise in 2018 was 3.7mm/year, compared with the 1.58mm rise observed from 1900 to 1995 (IPCC, 2021). Even with large reductions in carbon emissions (SSP[1]1-2.6) a global average sea level rise of 32–62 cm is still projected from climate change by 2100 (IPCC, 2021). The value of maintaining a healthy dune system along Adelaide's developed coastline will become increasingly relevant in providing a buffer for future sea level rise.

In addition to rising sea levels, climate change will increase the intensity and frequency of extreme events, including extreme intense storms. Increases in storm surge can result in overtopping of protective dunes

[1] Shared Socio-economic pathway

and structures. In southern Australia climate change is expected to bring dryer climatic conditions, which can inhibit dune vegetation and increase dune mobility (i.e, transgressive dunes).

2.4.3 Prevailing Winds and Waves

Prevailing winds and the annual cycle of storms and calm weather can have a significant effect on dune building and erosion. The prevailing wind direction along the metropolitan coastline is W-SW during spring and summer and W-NW during autumn and winter. The majority of strong winds are from the SW-W and the North, whilst the dominant net sand transport by wind is E-NE (Appendix 1). With regards to wave action, the predominant wave direction is from the SW, which supports a northward drift of sand deposits along the Adelaide metropolitan coastline (DHI, 2018).

3.0 DUNE STABILISATION METHODOLOGY

A number of stabilisation methods are available for use to address mobile sands and dune instability within the West Beach Dune system. A description of these methods, key principles, advantages, and disadvantages are presented below. Selected methodologies are then proposed for application within Section 4 of this management plan.

3.1 Surface Treatment

Mobile sands on seaward and landward slopes can be stabilised quickly by the application of various surface treatments. These include:

Geotextiles

Geotextiles such as Jute Mesh , which is specifically designed for sand dune stabilisation, allowing for the trapping of drifting sands and space for plant growth.

- Must be suitable for the slopes encountered/created in the dune system
- Mesh must be loosely woven for plant regeneration and growth
- Must be organic, able to breakdown and form part of the organic matter in the dune system.
- Must be durable enough to allow time for the desired level of plant growth

Seagrass Mulch

Seagrass mulch (wrack) acts as a surface wind barrier whilst also providing structure and a rich source of organic matter within the dune.

- Must be sustainable sourced
- Should be mixed in with the dune sand where possible
- Should be laid thickly to ensure its durability

Brush Mulch

Brush mulch acts as a surface wind barrier, slowing wind speeds over a slope and enhancing sand accretion on a slope. It also provides shelter for developing seedlings, assists in moisture retention and can act as a seed bank (DLWC, 2001).

- Must be sustainable sourced
- Ideal if cut with ripe seed
- Should be laid with the stem anchored facing downslope

Advantages

There are a number of advantages to surface treatments:

- Surface treatment is effective immediately with regards to arresting the mobilisation of loose sand
- Can complement long-term management actions such as stabilisation fencing
- Prepares the sands for revegetation works, enhancing revegetation success

Disadvantages

There are a number of disadvantages to surface treatments:

- Potentially expensive, depending on the material used and transport costs
- Can be aesthetically unpleasant for the time it takes to either breakdown or be covered by vegetation.
- Large amounts of suitable brush can be difficult to source

3.2 Stabilisation fencing

Drift net fencing is a common method for dune creation and sand stabilisation. It is useful for small blow-outs and long-term stabilisation projects (Page and Thorpe, 2010). The fences and netting are designed to capture mobile sands so that they are eventually buried by the sands to form a dune. The forming dunes are then planted out for stabilisation. Principles to consider are:

Blowout stabilisation

The most important areas of a sand blowout to stabilise are the edges, especially the forward edge and other places where the wind is funnelling sand away more quickly (Page and Thorpe, 2010).

Sand erosion/accretion balance

Drift net fencing is most effective in environments with a balance in sand accretion and erosion. It can be used in erosive environments, as long as there is enough sand to blow onto the fences and if prevailing winds blow straight onto the beach (Page and Thorp, 2010).

Fence alignment

Drift net fencing alignment is most effective at capturing sands when placed perpendicular to prevailing winds. This angle, however, may not always be parallel to the shoreline (beach berm), which is the most desirable alignment for fencing (DLWC,2001) particularly when creating or re-forming dune systems in public use areas.

Fence spacing

Sand will accumulate in a zone whose width is 5-10m the height of the fence (DLWC, 2001).

Materials

The Sand Drift Mesh should have a porosity of around 40%.

Fencing posts should be around 1.5m in height, to allow around 1m to show above ground.

High tensile wire to be 2.5mm in width.

Stabilisation

Sands accumulating around fencing should be planted as soon as they have reached the desired height, where possible, to stabilise the loose sands.

Advantages

- Useful as a long-term management action to create or modify the topography of a dune system.
- Cost effective and durable.
- Aesthetically acceptable as a common site on Adelaide's metropolitan beaches.

Disadvantages

- Can take a long time for sand to build up to required levels for stabilisation planting.
- Success is subject to local wind conditions (unless mechanical intervention is used).
- Can result in safety issues if infrastructure becomes exposed or damaged by erosion events.

3.3 Dune reshaping

Dune re-shaping and formation can be carried out as part of the long-term management plan for a beach and dune system. Drift net fencing (discussed above) can be used to create a wider foredune complex and to prevent the vertical growth of landward dunes (Itzkin et. Al., 2020). This can be desirable for highly erosive sections of coast and in areas where landward dune growth threatens public or private infrastructure. Dune re-shaping can also be carried out with earthmoving equipment, which can fast-track structural formation. Important principles for dune shaping are:

Alignment

Natural dune alignment most commonly runs parallel to a shoreline, although other types of dune formation can occur (Hesp and Walker, 2021). Any formed dunes should match the natural alignment found along the coast and be integrate with adjacent dunes (DLWC, 2001). It should be noted that 'speed-up' (i.e., increase in wind speed as it is compressed against a slope) across the seaward slope of a foredune is greater for winds blowing perpendicular to the dune, than when blowing at more oblique angles (Hesp et al, 2014).

Slope angle

Natural dune gradients range from zero to 1.5:1 (33^0, angle of repose, White and Tsoar, 1998) (DLWC, 2001). In general, the gentler the slope the lower the resultant wind speed moving up the slope, and therefore the less the erosion potential. Steep slopes (inflections) should be avoided on the seaward face, as these can cause the wind to eddy and remove more sand, and also facilitate wave incursion (DLWC, 2001).

Surface roughness

Surface cover, such as dune vegetation, will slow wind velocity and erosion potential (Page and Thorpe, 2010).

Dune shape

Seaward facing dune slopes should be flat to slightly convex in shape, to deflect onshore winds in an upward direction – this provides protection on the lee of the dune (DLWC, 2001). Protruding hummocks or steep-sided undulations can concentrate wind flow, and should be avoided (DLWC, 2001).

Dune structure

- Constructing an incipient dune, where there is space, will allow it to take the brunt of wave action providing protection for the foredune whilst vegetation is establishing. The construction of an incipient dune can also be used to reduce the beach fetch which in-turn can reduce the wind speeds that dunes are exposed to.
- The height of planned dunes should consider a number of factors including sea level rise, amenity disruption (where relevant) and associated dune slope.

Vegetation

Disturbance of existing vegetation should be avoided where possible (Page and Thorp, 2010). The timing of dune forming works should consider revegetation requirements. Revegetation works should be carried out on formed dunes as soon as possible.

Accessways

Public accessways through dunes systems should be carefully planned to prevent the creation of wind tunnels and blow-outs. They should be placed at an angle approaching perpendicular to strong prevailing winds.

3.4 Revegetation

The revegetation of replenished or established dunes is critical to long-term dune stability. Where possible, the timing of revegetation works should be planned to coincide not only with the planting season, but when dunes have formed to desired heights and shapes. Principles that apply to revegetation of dunes include:

Review

- Previous revegetation plans, preparation and works.
- Current site condition, priorities for weed control and stabilisation.

Site preparation

Ensure sands are weed free (where appropriate), with adequate moisture content and that bare, loose sands have been protected where possible with a surface treatment.

Revegetation structure:

- Plant species according to succession zones (Primary, Secondary, Tertiary).
- Avoid tunnel affects caused by gaps in plants, particularly clumpy plants, as this can lead to blow-outs.
- Ensure plants are not planted in the swash zone nor on the backshore below the high spring tide line, as dune species will not tolerate regular inundation.

Species selection

Use native, local providence species as much as possible, which are well suited to local conditions. On the seaward side of the foredune, use species that are spreading (such as local *Spinifex* sp) that will produce a flatter dune surface, and avoid taller species that can produce a hummocky form that can potentially increase wind erosion potential (Hesp and Walker, 2021).

Form of plants

Tubestock is suitable for dune plantings and can be supported by hand seeding. The seeding needs to occur on lightly scarified sands and at a time that will be followed by adequate rains.

Monitoring and follow-up

Ensure revegetation works are monitored quarterly and supported by in-fill planting and weed management.

3.5 Monitoring

It is important to ensure long-term actions are effective in achieving the desired outcome. Monitoring could include:

Dune building and stabilisation progress

- Remote review via aerial imagery and photo points.
- On-site inspections after high seas events.
- Ideally this should be carried out over multiple seasons, both before and after restoration works, to determine how the works are impacting dune building, particularly after high sea events.

Revegetation works

- Seasonal inspection of revegetation works to gauge the rate of success and plan for future infill planting.
- Seasonal inspection to detect impacts of environmental and any declared weeds.

Sand Drift Fencing

- Regular inspection of fencing works to detect any damage from storm events, public interference or erosion points developing under netting.

Community engagement

- Interviewing affected residents periodically to gauge changes in wind-blown sand effects on their properties.
- Receive input from involved community groups on the system as a whole.

4.0 PROJECT AREA AND MANAGEMENT ACTIONS

4.1 Overview

The West Beach Cell extends from the River Torrens outlet in the north to the West Beach Boat Ramp to the south (Figure 2), spanning approximately 2.5km of coastline. The coastline within the Cell contains a mixture of sand dunes and man-made protective structures, such as seawalls and boat ramps. Overall, the Cell is managed in order to maintain a continuous sandy beach. This goal is currently supported by sand replenishment works and the future commissioning of a sand pumping system that will see a regular supply of sand to various points distributed along the length of the Cell.

The dune systems that occur within the cell form foredunes, which rarely incorporate an incipient foredune. Where dunes occur, their widths range from around 10m to 110m and dune crests reach up to 12.5m in height. In some areas, dunes have been physically re-constructed and maintained to ensure a buffer remains between the sea and adjacent property.

The presence of infrastructure such as the West Beach Boat Ramp and the seawall in front of the West Beach Surf Club, coupled with periods of intense erosion, cause many challenges within this cell. Some sections of beach can disappear periodically, and others experience a high-level of dune erosion and low beach nourishment from natural sand drift. In general, the southern parts of the cell experience net erosion, whilst the northern parts of the cell experience net accretion. Dune stability throughout the cell is moderate to poor, with the most unstable areas being those adjacent to erosion hotspots, where dune width tends to be narrow and vegetation cover poor. Erosion hot-spots include the area immediately north of the West Beach Surf Club (Rockingham Street dune) and the area immediately north of the West Beach Boat Harbour (around Hamra Avenue and West Beach Parks).

Two main dune systems occur within this cell, separated by a seawall which extends from Rockingham Street to Chetwynd Street. Each system (or section) is dealt with separately in this Management Plan. The northern section is referred to as Seaview Road Dunes (SVRD) and the southern section as West Beach Parks Dunes (WBPD). Further, each section is divided into sub-sections for the formulation of detailed management recommendations.

The management recommendations presented in this section aim to:

- Develop dune shapes that limit wind speeds upslope, and therefore limit sand blown nuisance
- Develop dune shapes that reduce wave velocity impacts for the long-term sustainability of the main foredunes
- Develop crest shapes that reduce the risk of blow-outs
- Maintain and enhance current vegetation cover on dune crests and slopes
- Make use of current sand resources being deposited within the Cell

4.2 Seaview Road Dunes Site Descriptions and Proposed Management

Dune condition varies within the northern part of the West Beach Cell. As such, four sub-sections have been created within the SVRD system that reflect a set of conditions within each sub-section (Figure 12). The condition of each sub-section and management recommendations are described in the tables and figures that follow, with a summary of management actions provided in Table 1.

Figure 12: Seaview Road Dunes sub-sections.

Table 1: Summary of recommended management actions for Seaview Road Dunes sub-sections.

SITE	ACTION	YEAR	QUARTER	DETAILS
SVRD 1	• **Leave area roped off year-round**	• Ongoing	• All year	• Keep maintaining the roped area year-round, not only for the protection of the Hooded Plover but also to assist the recovery of the dune system amongst the stoss slope. Access to be maintained to the sand extraction pit.
	• **Monitor dune condition**	• 2022	• Q3 and every 6 months subsequent	• Using aerial photography and ground truthing • Monitor recovery of bare sand areas and spread of marram grass
	• **Discuss mitigation measures if required**	• Ongoing	• As required	• Where significant degradation of dunes is noted, discuss mitigation options with relevant stakeholders, including custodians of the Hooded Plover nesting area, to ensure any proposed works does not negatively impact the nesting value or nesting activity in the area.
SVRD 2	• **Support establishment of an incipient dune**	• 2022	• Q3	• This dune section would benefit from the development of an incipient dune to protect the main foredune. Due to the width of the foredune, it would be appropriate to monitor for the establishment of a naturally occurring incipient dune. • Where a naturally occurring dune does not develop and the main foredune is exposed to significant wave erosion, an incipient dune can be created by: traditional means (i.e. the installation of a 1m high sand drift fencing as per standard design (Appendix 2)), by mechanically building an incipient dune, or by laying a row of seagrass wrack which would catch wind-blown sand. • Locate incipient dune ~3m seaward of the toe of main dune along the length of the subsection, with gaps where beach access tracks are located. Alignment should match that of the replenished dune within SVRD4.
	• **Monitor dune growth**	• 2022	• Q4 and every 3 months subsequent	• Monitor fence condition and sand build level (where relevant). • Repair any damaged fencing.
	• **Plant dune crest**	• 2023	• Q2/3	• Plant colonising species within bare areas of dune crest during the planting season (see Revegetation Plan, Appendix 3)
	• **Plant incipient dune**	• 2023	• Q2/3 -	• IF sand level has developed appropriately, prepare and plant out incipient dune crest, swale and main foredune stoss slopes, integrating with vegetation on the main foredune (see Revegetation Plan, Appendix 3). If sand

				is yet to reach the desired height, plant to plant in the following planting season (i.e., 2024).
	• **Monitoring planting**	2023 • 2024	• Q4 • Q2	• Monitor progress of plantings undertaken • Monitor progress of plantings undertaken
	• **Infill planting**	• 2024	• Q2/3	• Infill planting as required
SVRD 3	• **Support the establishment of an incipient dune**	• 2022	• Q3	• This dune section would benefit from the development of an incipient dune to protect the main foredune. Due to the narrow width of the foredune, it would be appropriate to create, an incipient dune by: traditional means (i.e. the installation of a 1m high sand drift fencing as per standard design (Appendix 2)), by mechanically building an incipient dune, or by laying a row of seagrass wrack which would catch wind-blown sand. • Locate incipient dune ~3m seaward of the toe of main dune along the length of the subsection, with gaps where beach access tracks are located. Alignment should match that of the replenished dune within SVRD4.
	• **Monitor dune growth**	• 2022	• Q4 and every 3 months subsequent	• Monitor fence condition and sand build level (where relevant). • Repair any damaged fencing.
	• **Monitor stormwater gully**	• Ongoing	• Q3 each year	• Monitor erosion impacts of the stormwater outlet to detect any destabilisation that may occur.
	• **Plant dune crest**	• 2023	• Q2/3	• Plant colonising species within bare areas of dune crest during the planting season (see Revegetation Plan, Appendix 3)
	• **Plant incipient dune**	• 2023	• Q2/3 -	• IF sand level has covered fenceline, prepare and plant out incipient dune crest, swale and main foredune stoss slopes, integrating with vegetation on the main foredune (see Revegetation Plan, Appendix 3). If sand is yet to reach the fence height, plant to plant in the following planting season (i.e., 2024).
	• **Monitoring planting**	2023 • 2024	• Q4 • Q2	• Monitor progress of plantings undertaken • Monitor progress of plantings undertaken
	• **Infill planting**	• 2024	• Q2/3	• Infill planting as required
SVRD 4	• **Plant incipient dune, dune crest, stoss slope**	• 2022	• Q2/3 -	• Plant out incipient dune crest, swale and main foredune stoss slopes within the jute mesh area, integrating with vegetation on the main foredune (see Revegetation Plan, Appendix 3).

	• **Infill plant within the landward slope**	• 2022	• Q2/3	• Plant out bare areas within the landward slope of the dune*(see Revegetation Plan, Appendix 3).
	• **Monitoring planting**	2022 • 2023	• Q4 • Q2	• Monitor progress of plantings undertaken • Monitor progress of plantings undertaken
	• **Infill planting**	• 2023	• Q2/3	• Infill planting as required
	• **Monitoring effects of storm surge**	• Ongoing		• Storm events can severely damage this section of dune, both from wave action and the stormwater outlet. Impacts of storm events should be monitored and remedial action taken where necessary.

4.2.1 Sub-section SVRD1 – River Torrens to Burbridge Road

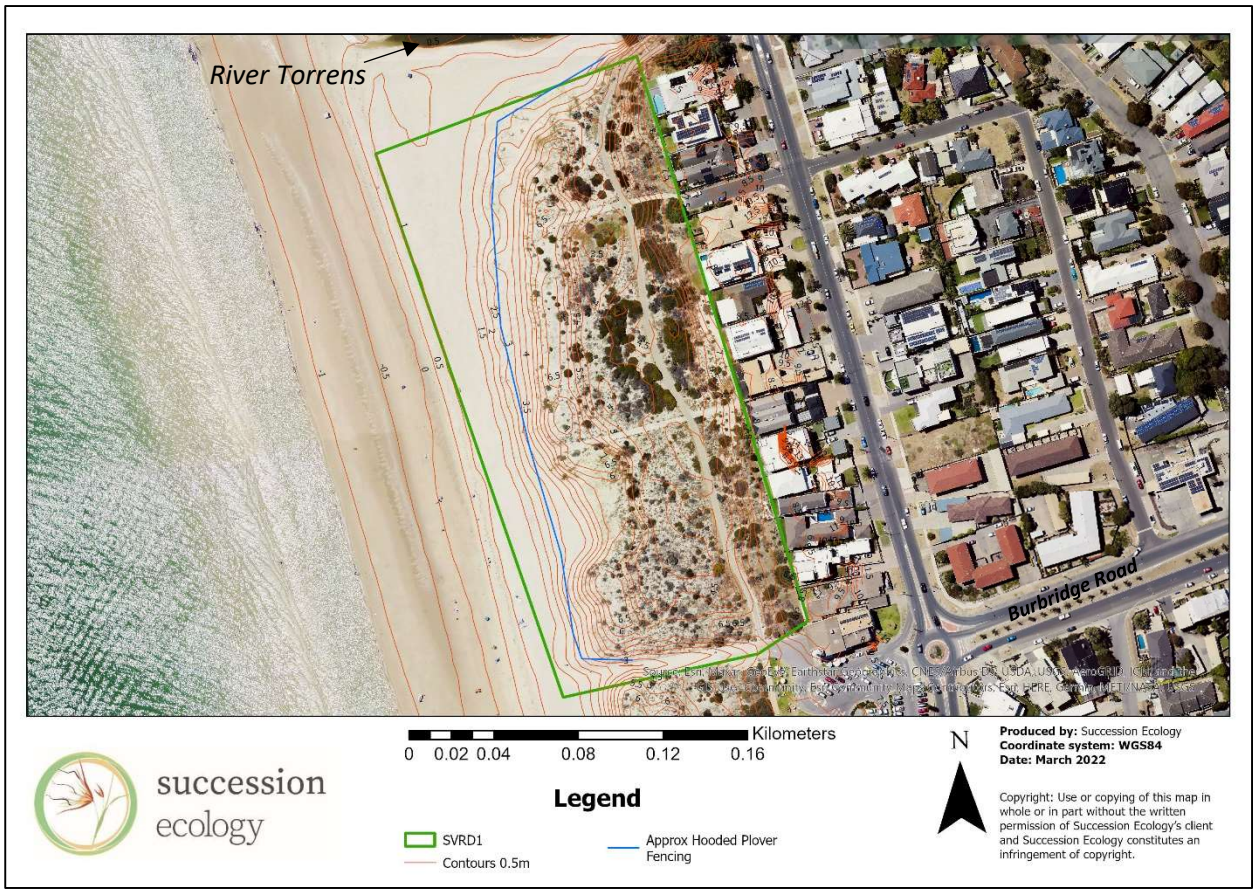


Figure 13: Seaview Road Dunes sub-section SVRD1

Figure 14: Images showing dune condition on the stoss slope (top) and landward dunes (bottom).

Table 2: Seaview Road Site 1 (SVRD1) parameter description.

PARAMETER	DETAIL	DESCRIPTION/NOTES
Dune Width	60m – 110m	-
Dune Height	8.5m	Highest elevation is at the rear of the dune adjacent houses
Stoss Slope (steepest)	3.8:1; 15^0	Relatively gentle stoss slope
Infrastructure	• Roped off area for Hooded Plover Breeding • Walking path • 3 x beach access tracks	• The whole seaward edge of dune fenced off for Hooded Plover nesting. Rope fence type allows birds access to the beach. • Walking path towards rear of dunes, running north to south • Dissecting dunes from east to west
Veg cover	• Stoss slope – 50% • Crest – 60% • Landward slope –75%	• Mostly *Spinifex sp.*, scattered marram grass, large bare areas • Mostly *Spinifex sp.*, scattered marram grass • Good coverage from ground covers to tall shrubs
Stability	• Landward – stable • Stoss - moderate	• Stable soils, good vegetation coverage • Large bare areas over extraction pit, some vegetation cover that is spreading
Issues	• Hooded Plover breeding site • Bare sands • Weeds – low level	• Whole section is a designated protection area for Hooded Plovers and is roped off during the nesting season • Bare sands amongst the stoss slope – will continue as this is the sand extraction site • Weeds are considered at a low level with scattered marram grass on crests. *Gazania* sp (Declared weed) occurs within landward dunes.

Table 3: Recommended management actions for SVRD1.

ACTION	YEAR/QUARTER	DETAILS
Leave area roped off year-round	• All year, ongoing	• Keep maintaining the roped area year-round, not only for the protection of the Hooded Plover but also to assist the recovery of the dune system amongst the stoss slope. Access to be maintained to the sand extraction pit.
Monitor dune condition	• Every 6 months	• Using aerial photography and ground truthing. • Monitor recovery of bare sand areas and spread of marram grass.
Weed control	• Annually	• Treat *Gazania sp.* via approved methods and in accordance with regulations.
Discuss mitigation measures if required	• As required	• Where significant degradation of dunes is noted, discuss mitigation options with relevant stakeholders, including custodians of the Hooded Plover nesting area, to ensure any proposed works does not negatively impact the nesting value or nesting activity in the area.

4.2.3 Sub-section SVRD2 – Burbridge Road to Stanhope Street

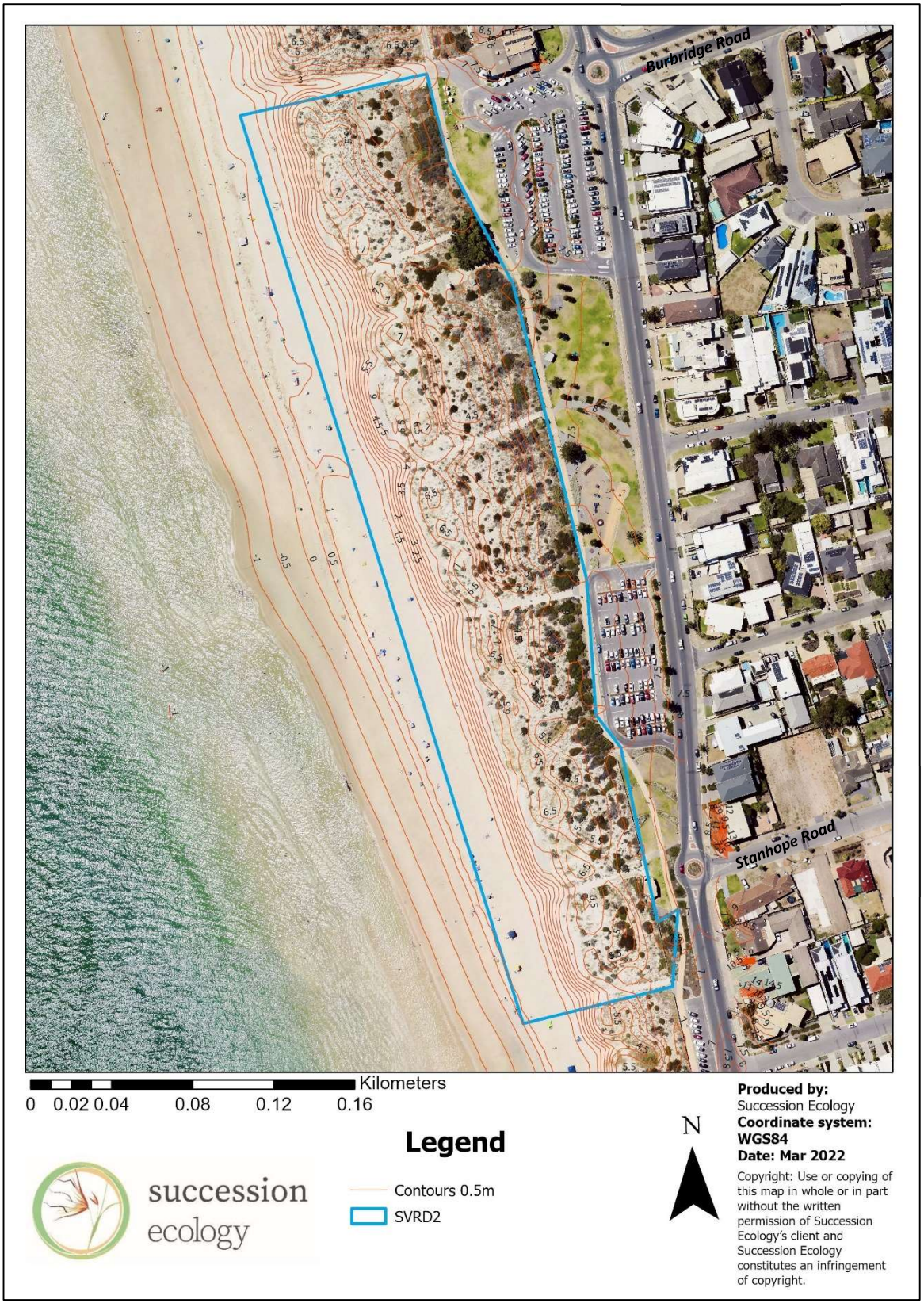


Figure 15: Seaview Road Dunes sub-section SVRD2

Figure 16: Images showing dune condition on the stoss slope (top) and landward dunes (bottom).

Table 4: Seaview Road Site 2 (SVRD2) parameter description.

PARAMETER	DETAIL	DESCRIPTION/NOTES
Dune Width	65m – 95m	-
Dune Height	7.5m	Highest area is on the foredune crest
Stoss Slope (steepest)	3:1; 18^0	Relatively steep slope. May be contributing to high wind speed-up levels, potentially supressing natural regeneration along the crest.
Infrastructure	• 5 x beach access tracks • Keep out of dune signs on dune crest	• Dissecting dunes from east to west • Running north to south
Veg cover	• Stoss slope – 0-10% • Crest – 0-10% • Landward slope –70%	• Where sand has not been recently deposited, mostly *Spinifex sp.*, scattered marram grass. Where sand has recently been deposited, mostly bare sands (Figure 16). • As above • Good coverage from ground covers to tall shrubs.
Stability	• Landward – stable • Stoss - vulnerable	• Stable soils, good vegetation coverage. • Large bare areas, some vegetation cover that will spread. No incipient dune to provide protection for the main dune from wave action.
Issues	• Potentially mobile sands on crest • Dune slope • Weeds	• Bare areas on crest and stoss slope creates vulnerability to mobile sands • Dune slope is within natural range, however it is relatively steep compared to other dunes in the area. • Weed level is considered low, with scattered marram grass on crest. *Gazania sp.* (Declared weed) is present.

Table 5: Recommended management actions for SVRD2.

ACTION	YEAR	QUARTER	DETAILS
Support establishment of an incipient dune	2022	• Q3	• This dune section would benefit from the development of an incipient dune to protect the main foredune. Due to the width of the foredune, it would be appropriate to monitor for the establishment of a naturally occurring incipient dune. • Where a naturally occurring dune does not develop and the main foredune is exposed to significant wave erosion, an incipient dune can be created by: traditional means (i.e. the installation of a 1m high sand drift fencing as per standard design (Appendix 2)), by mechanically building an incipient dune, or by laying a row of seagrass wrack which would catch wind-blown sand. • Locate incipient dune ~3m seaward of the toe of main dune along the length of the subsection, with gaps where beach access tracks are located. Alignment should match that of the replenished dune within sub-section 4.
Monitor dune growth	2022	• Q4 and every 3 months subsequent	• Monitor fence condition and sand build level (where relevant). • Repair any damaged fencing.
Plant dune crest	2023	• Q2/3	• Plant colonising species within bare areas of dune crest during the planting season (see Revegetation Plan, Appendix 3).
Plant incipient dune	2023	• Q2/3 -	• IF sand level has developed appropriately, prepare and plant out incipient dune crest, swale and main foredune stoss slopes, integrating with vegetation on the main foredune (see Revegetation Plan, Appendix 3). If sand is yet to reach the desired height, plant to plant in the following planting season (i.e., 2024).
Monitoring planting	2023 2024	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2024	• Q2/3	• Infill planting as required.
Weed control	Annually		• Treat *Gazania sp.* via approved methods and in accordance with regulations.

4.2.4 Subsection SVRD3 – Cavendish Street and Renwick Street

Figure 17: Seaview Road Dunes sub-section SVRD3.

Figure 18: Images showing dune condition on the stoss slope (top left), landward dunes (top right), stormwater gully (bottom left) and dune crest (bottom right).

Table 6: Seaview Road Site 3 (SVRD3) parameter description.

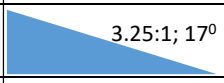
PARAMETER	DETAILS	DESCRIPTION/NOTES
Dune Width	35m – 45m	-
Dune Height	8m	Highest area is on the foredune crest
Stoss Slope (steepest)	 3.25:1; 17^0	Moderately steep slope. May be contributing to high wind speed up levels, potentially supressing natural regeneration along the crest.
Infrastructure	• Stormwater outlet with sandbags and geotextile • 2 x beach access tracks • Keep out of dune signs on dune crest	• A major stormwater outlet occurs at the northern end of the section which appears to have formed a major gully erosion. This gully appears relatively stable at present, with sand-bags, geotextile and vegetation stabilising the area. • Dissecting dunes from east to west. • Running north to south.
Veg cover	• Stoss slope – 0-10% • Crest – 0-10% • Landward slope –60%	• Where sand has not been recently deposited, mostly *Spinifex sp.*, scattered marram grass. Where sand has recently been deposited, mostly bare sands. • As above • Reasonable coverage from ground coverage to tall shrubs.
Stability	• Landward – stable • Stoss - vulnerable	• Stable soils, good vegetation coverage. Vulnerability along the stormwater gully. • Large bare areas, some vegetation cover that will spread. No incipient dune to provide protection for the main dune from wave action.
Issues	• Potentially mobile sands on crest • Dune slope • Weeds	• Bare areas on crest and stoss slope creates vulnerability to mobile sands. • Dune slope is within natural range, however it is moderately steep. • Weed level is considered low, with scattered marram grass on crest. *Gazania sp.* (Declared weed) is present.

Table 7: Recommended management actions for SVRD3.

ACTION	YEAR	QUARTER	DETAILS
Support the establishment of an incipient dune	2022	• Q3	• This dune section would benefit from the development of an incipient dune to protect the main foredune. Due to the narrow width of the foredune, it would be appropriate to create, an incipient dune by: traditional means (i.e. the installation of a 1m high sand drift fencing as per standard design (Appendix 2)), by mechanically building an incipient dune, or by laying a row of seagrass wrack which would catch wind-blown sand. • Locate incipient dune ~3m seaward of the toe of main dune along the length of the subsection, with gaps where beach access tracks are located. Alignment should match that of the replenished dune within SVRD4.
Monitor dune growth	2022	• Q4 and every 3 months subsequent	• Monitor fence condition and sand build level (where relevant). • Repair any damaged fencing.

Monitor stormwater gully	Ongoing	• Q3 each year	• Monitor erosion impacts of the stormwater outlet to detect any destabilisation that may occur.
Plant dune crest	2023	• Q2/3	• Plant colonising species within bare areas of dune crest during the planting season (see Revegetation Plan, Appendix 3
Plant incipient dune	2023	• Q2/3 -	• IF sand level has developed appropriately, prepare and plant out incipient dune crest, swale and main foredune stoss slopes, integrating with vegetation on the main foredune (see Revegetation Plan, Appendix 3). If sand is yet to reach the desired height, plant to plant in the following planting season (i.e., 2024).
Monitoring planting	2023 2024	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2024	• Q2/3	• Infill planting as required.
Weed control	Annually		• Treat *Gazania sp.* via approved methods and in accordance with regulations.

4.2.6 Sub-section SVRD4 – Rockingham Street

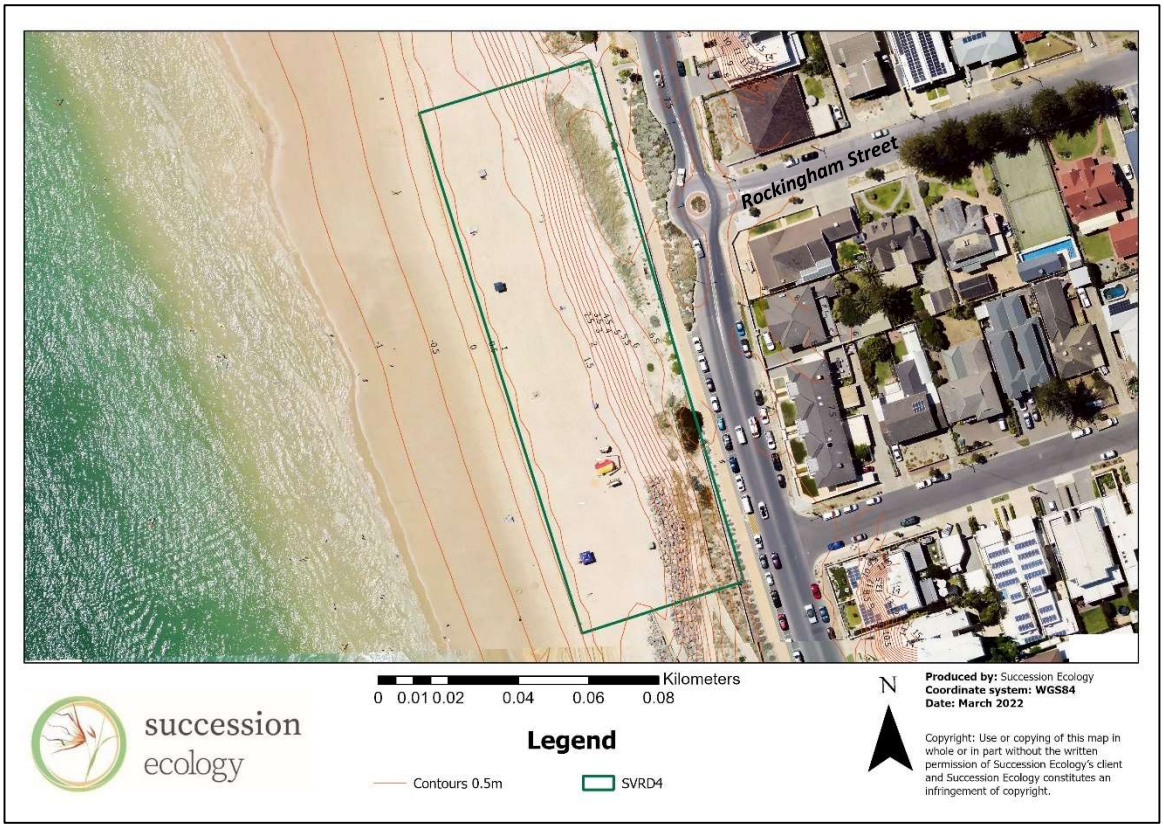


Figure 19: Seaview Road Dunes sub-section SVRD4

Figure 20: Dune condition on the replenished incipient dune and foredune stoss with jute mesh covering (top) and landward slope (bottom).

Table 8: Seaview Road Site 4 (SVRD4) parameter description.

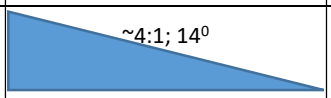
PARAMETER	DETAILS	DESCRIPTION/NOTES
Dune Width	35m	This dune was recently extended and shaped to form an incipient dune in front of the main foredune
Dune Height	8m	Highest area is on the main foredune crest
Stoss Slope (steepest)		Replenished dune shape has created a gentle slope on both the incipient dune and main foredune. This aims to lessen the wind speed-up.
Infrastructure	• Stormwater outlet • *Future sand pumping outlet* • 2 x beach access tracks • Keep out of dune signs on dune crest • Irrigation piping • Jute mesh geotextile	• A stormwater outlet occurs at the southern end of the section, within the rock wall. • *It is probable that a sand pumping outlet will be located at the southern end of the sub-section within the existing rock wall – location TBA.* • Dissecting dunes from east to west. • Located on the main foredune crest and (temporarily) along the base of the replenished incipient dune. • Amongst the landward slope, operational. • Jute mesh is currently being installed on the crest of the incipient dune up to the crest line/vegetation line of the main dune.
Veg cover	• Stoss slope – 0% • Crest – 0-80% • Landward slope – 40%	• Where sand has recently been deposited, mostly bare sands. • New crest of incipient dune is bare of vegetation. Approx. 30% of the crest of the main foredune has an excellent cover of *Spinifiex*, while the remainder has a cover of 0-50% cover. • Moderate coverage from ground coverage to tall shrubs, with lots of bare sand areas.
Stability	• Landward – stable • Stoss - vulnerable	• Moderately stable soils with vulnerability amongst bare areas. • Most bare sands are in the process of being covered with jute mesh, and will require planting to maximise stability into the future.
Issues	• Potentially mobile sands amongst landward slope • Freshly made dune • Weeds • Ongoing risk from storm survey	• Bare areas on landward slope creates vulnerability to mobile sands. • Replenished dune requires planting during the autumn/winter to secure its stability. • Weed level is considered low. • This section of dune experiences severe erosion from storm events.

Table 9: Recommended management actions for SVRD4.

ACTION	YEAR	QUARTER	DETAILS
Plant incipient dune, dune crest, stoss slope	2022	• Q2/3	• Plant out incipient dune crest, swale and main foredune stoss slopes within the jute mesh area, integrating with vegetation on the main foredune (see Revegetation Plan, Appendix 3).
Infill plant within the landward slope	2022	• Q2/3	• Plant out bare areas within the landward slope of the dune*(see Revegetation Plan, Appendix 3).

Monitoring planting	2022 2023 2024	• Q4 • Q2/Q4 • Q2	• Monitor progress of plantings undertaken • Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2023 2024	• Q2/3 • Q2/3	• Infill planting as required. • Infill planting as required.
Monitoring effects of storm surge	Ongoing		• Storm events can severely damage this section of dune, both from wave action and the stormwater outlet. Impacts of storm events should be monitored, and remedial action taken where necessary.

* This could be carried out in conjunction with the local dune care group which has already carried out extensive plantings on this dune system. See Appendix 3 – Revegetation Plan, for more detail.

4.3 West Beach Parks Dunes Descriptions and Management

Dune condition varies within the southern part of the West Beach Cell. As such, five sub-sections have been created within the WBPD system that reflect a set of conditions within each sub-section (Figure 21). The condition of each sub-section and management recommendations are described in the tables and figures that follow, with a summary of management actions provided in Table 10. Sub-section numbering has been aligned with DEW management zones, as noted.

Figure 21: West Beach Parks Dunes sub-sections (and DEW zones).

Table 10: Summary of recommended management actions for West Beach Parks Dunes

SITE	ACTION	YEAR	QUARTER	DETAILS
WBPD0	• **Build beach volume**	• 2022	• Q2	• Where appropriate with regards to maintain beach access, build up volume of beach to help maintain volume at the erosion point around the staircase
	• **Monitor dune condition**	• 2022	• Q3 and every 6 months subsequent	• Using aerial photography and ground truthing, monitor for deterioration in vegetation cover
	• **Discuss mitigation measures if required**	• Ongoing	• As required	• Where significant degradation of dunes is noted, discuss mitigation options with relevant stakeholders.
WBPD1	• **Clean-up**	• 2022	• Q2	• All above ground disused infrastructure should be removed careful, without impacting dune stability, and if safe to do so (Figure 26).
	• **Seaward - Sand deposition and Shaping into an incipient dune**	• 2022	• Q2	• Continue the deposition and shaping of sands to create an incipient dune at the crest of the 'upper sand deposit', along the length of the sub-section (Figure 26 and Figure 27). The stoss slope should target 4:1 fall. This incipient dune should be in line with that created in sub-sections 2, 3 and 4. • NOTE: If the incipient dune cannot be achieved by mechanical shaping, an alternative option is to install a sand drift fence at the seaward edge of the upper sand deposit to create an incipient dune over time. This may take 1-2 seasons to build, depending on levels of wind-blown sand reaching the fenceline.
	• **Monitor dune condition**	• 2022	• Q4 and every 6 months subsequent	• Monitor dune condition, particularly after storm events and high wind events, to determine effectiveness of works and rectify where required.
	• **Extend exclusion fencing**	• 2022	• Q2	• Extend the current planned access exclusion fencing further south to meet the existing fenceline at the base of the landward slope (Figure 29).
	• **Monitor access**	• 2002	• Q4 and ongoing	• Ensure access through this section of dune remains effectively closed. Recommend that no new access is formed in this area.
	• **Landward – excess sand**	• 2022	• Q2	• Where practical to do so, relocate some of the excess sand accumulated on the landward slope at the end of Hamra Ave to the blowout areas that have developed, to assist in closing off the blow-out depression (Figure 28). Sand could also be deposited seaward of the sand drift fence which is to be installed as part of interim sand control measures.

				• Any excavation works will need to be done carefully due to underlying infrastructure such as the hand-rail that has been engulfed by mobile sands. • Sands that have accumulated a little further south but now have vegetation cover commencing should be left and vegetation cover enhanced to stabilise sands (Figure 28). • If this work can be completed before the 2022 planting season, jute mesh should be laid over disturbed and deposited sands to help stabilise sands and support planting efforts. • Sand will need to be carefully excavated from the junction box at the southern end of the sub-section.
	• **Weed control**	• 2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during planting events.
	• **Plant existing dune crests and landward slope**	• 2022	• Q2/3	• Prepare bare sands on the main crest and landward slope adjacent Hamra Ave with jute mesh prior to planting. Consider surface cover for other bare crests areas further south, if resources allow. • Plant colonising ground cover species within bare areas of dune blowouts, main dune crests and within the bare landward slope (see Revegetation Plan, Appendix 3).
	• **Plant replenished dune crests, swales and stoss slope**	• 2023	• Q2/3	• Plant colonising ground cover species on crests and swale of replenished dunes (see Revegetation Plan, Appendix 3).
	• **Monitoring planting**	2022 • 2023	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
	• **Infill planting**	2023 2024	• Q2/3 • Q2/3 •	• Infill planting on main crests, stoss slopes and swales with appropriate species to allow for natural succession (see revegetation plan – Appendix 3). • Infill planting on replenished dune crests and swales and landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3).

WBPD2	• **Clean-up**	2022	• Q2	• All above ground disused infrastructure should be removed, without impacting dune stability and where safe to do so.
	• **Crest re-shaping**	2022	• Q2	• Smooth out the crest line by knocking off the sandy hummocks that have formed and use this material to fill in the gaps between hummocks. • This action should try to minimise the exposure of the soil layer. Where soil is exposed, the exposed area should be treated with a surface coverage (e.g., jute mesh) and planted within the first season (2022).
	• **Sand deposition and Shaping into an incipient dune**	2022	• Q2	• Continue the deposition and shaping of sands to create an incipient dune at the crest of the 'upper bench', along the length of the sub-section (Figure 32 and Figure 33). The stoss slope should target a 4:1 fall. This incipient dune should be in line with that created in sub-sections 1, 3 and 4. • NOTE: If the incipient dune cannot be achieved by mechanical shaping, an alternative option is to install a sand drift fence at the seaward edge of the upper bench to create an incipient dune over time. This may take 1-2 seasons to build, depending on levels of wind-blown sand reaching the fenceline.
	• **Monitor dune condition**	2022	• Q4 and every 6 months subsequent	• Monitor dune condition, particularly after storm events and re-work shaping where required. •
	• **Weed control**	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during planting events.
	• **Plant dune crest where disturbed**	2022	• Q2/3	• Plant colonising ground cover species within the disturbed areas of the crest line.
	• **Plant dune crests and swales**	2023	• Q2/3	• Plant colonising ground cover species within bare areas of dune crests (existing and formed) and within the swales between crests (see Revegetation Plan, Appendix 3).
	• **Monitoring planting**	2022 2023	• Q4 • Q4	• Monitor progress of plantings undertaken.

		2024	• Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
	• **Infill planting**	2023 2024	• Q2/3 • Q2/3	• Infill planting on main crests, stoss slopes and swales and landward slopes with appropriate species to allow for natural succession (see revegetation plan – Appendix 3). • Infill planting on landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3).
WBPD3	• **Shape deposited sand into an incipient dune**	2022	• Q2	• Use deposited sands to create an incipient dune in front of the main foredune along the length of the sub-section, targeting a stoss slope of 4:1. The sand deposition undertaken (as per 3rd March) has provided most of the shape. Build beach volume and lessen to seaward slope to the beach (Figure 37 and Figure 38).
	• **Monitor dune condition**	2022	• Q4 and every 6 months subsequent	• Monitor dune condition, particularly after storm events and carry out maintenance of dune structure when required. •
	• **Weed control**	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during planting events.
	• **Plant dune crests and swales**	2023	• Q2/3	• Plant colonising ground cover species within bare areas of dune crests (existing and formed) and within the swales between crests (see Revegetation Plan, Appendix 3).
	• **Infill planting**	2023	• Q2/3	• Infill planting within landward slope with shrub and ground cover species, (see revegetation plan – Appendix 3).
	• **Monitoring planting**	2023 2024	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
	• **Infill planting**	2024	• Q2/3	• Infill planting on main crests, stoss slopes and swales with appropriate species to allow for natural succession (see revegetation plan – Appendix 3).

				• Infill planting on landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3).
WBPD4	• **Shape deposited sand into an incipient dune**	2022	• Q2	• Shape deposited sands to create an incipient dune in front of the main foredune along the length of the sub-section, targeting a slope of 4:1 (Figure 42 and Figure 43).
	• **Install sand drift fencing in bare area**	2022	• Q3	• Use (or replace) sand drift fencing posts to install a sand drift fence part-way up the stoss slope at the northern end of the dune (Figure 42) to address that area of bare sands.
	• **Monitor dune growth and condition**	2022	• Q4 and every 3 months subsequent	• Monitor fence condition and sand build level. • Repair any damaged fencing. • Monitor dune condition, particularly after storm events and carry out maintenance of dune structure when required.
	• **Weed control**	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during infill planting events.
	• **Plant dune crests and swales**	2023	• Q2/3	• Plant colonising ground cover species within bare areas of dune crests (existing and formed) and within the swales between crests (see Revegetation Plan, Appendix 3).
	• **Infill planting**	2023	• Q2/3	• Infill planting within landward slope with shrub and ground cover species, (see revegetation plan – Appendix 3).
	• **Monitoring planting**	2023 2024	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
	• **Infill planting**	2024	• Q2/3	• Infill planting on main crests, stoss slopes and swales with appropriate species to allow for natural succession (see revegetation plan – Appendix 3) • Infill planting on landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3)

4.3.1 Sub-section WBPD0

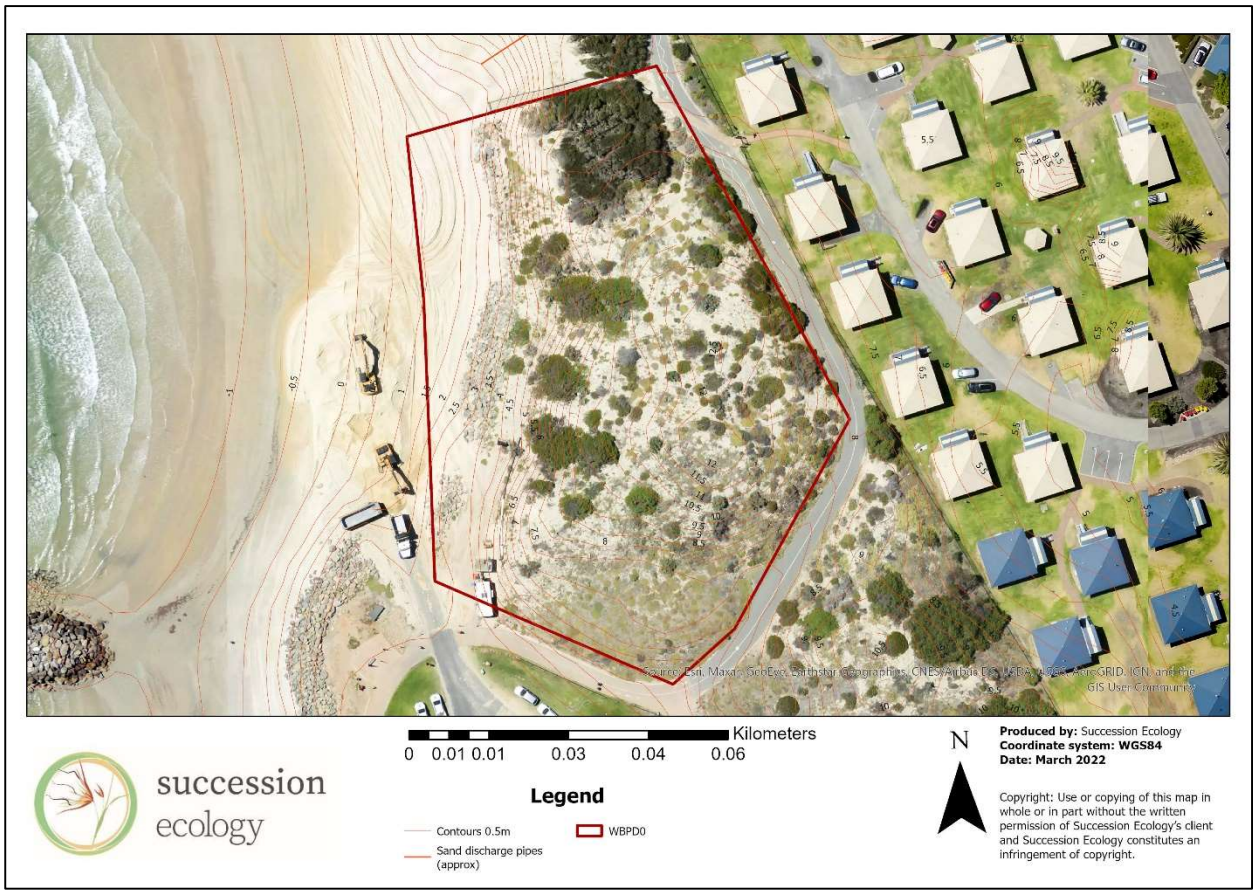


Figure 22: West Beach Parks Dunes sub-section WBPD0.

Figure 23: Dune stoss slope well vegetated (top left). Landward slope showing a high level of cover with Declared and environmental weeds present (other).

Table 11: West Beach Parks Dunes site 0 (WBPD0) parameter description.

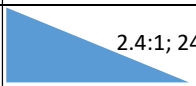
PARAMETER	DETAIL	DESCRIPTION/NOTES
Dune Width	40-75m	-
Dune Height	12.5m	Highest elevation is on the foredune.
Stoss Slope (steepest)	 2.4:1; 24^0	Relatively steep stoss slope, but well vegetated.
Infrastructure	• 1 x beach access track	• To the north of the sub-section.
Veg cover	• Stoss slope – 70% • Crest – 70% • Landward slope –85%	• Well vegetated with a mixture of shrubs and ground covers, providing stability. • Includes *Spinifex sp.* and other ground covers. • Good coverage from ground covers to tall shrubs.
Stability	• Landward – stable • Stoss - stable	• Stable soils, good vegetation coverage. • Stable soils, good vegetation coverage.
Issues	• Weeds	• Weeds are considered at a moderate level with at least one Declared Weed present and other environmental weeds scattered through the native vegetation.

Table 12: Recommended management actions for WBPD0.

ACTION	YEAR/QUARTER	DETAILS
Build beach volume	• 2022/Q2	• Where appropriate with regards to maintaining beach access, build up volume of beach to help maintain volume at the erosion point around the staircase.
Monitor dune condition	• Every 6 months	• Using aerial photography and ground truthing, monitor for deterioration in vegetation cover.
Discuss mitigation measures if required	• As required	• Where significant degradation of dunes is noted, discuss mitigation options with relevant stakeholders.

4.3.2 Sub-section WBPD1 (Zone 1) – Hamra Ave

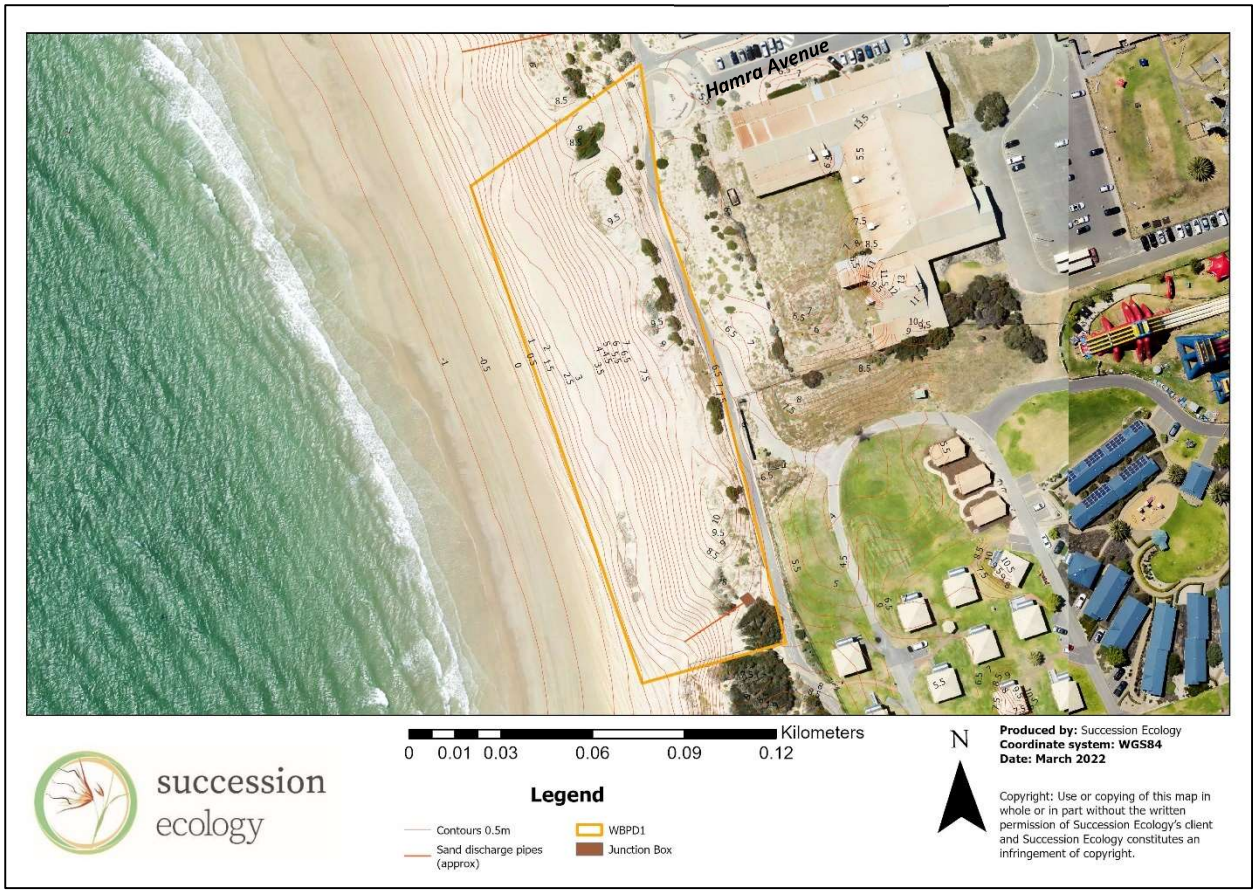


Figure 24: West Beach Parks Dunes sub-section WBPD1 (Zone 1).

Figure 25: Dune crest and stoss slope sparsely vegetated; sand deposition to be completed (top). Landward slope showing some vegetation cover with large bare patches and mobile sands (bottom).

Table 13: West Beach Parks Dunes Site 1 (WBPD1; Zone 1) parameter description.

PARAMETER	DETAILS	DESCRIPTION/NOTES
Dune Width	50-80m	Sand deposition yet to be completed at the toe of this dune. More sand is needed to shape the dune.
Dune Height	10m	Highest area is on the main foredune crest.
Stoss Slope (steepest)	2.8:1; 19^0	Relatively steep slope (in steepest section).
Infrastructure	• Sand discharge station, including junction box • 2 x beach access tracks • Sand drift fence base of landward slope • Disused, broken infrastructure	• One sand discharge station occurs at the southern end of this sub-section. This is not currently operational but is due for re-commissioning in 2023. • An informal access point occurs at the northern end of the sub-section. This is due to be fenced off to prevent future access. A beach accessway (staircase) occurs on the southern end of the sub-section. • A sand drift fence occurs along part of the base of the landward slope. • An old lookout and other disused fencing infrastructure present on the crest (Figure 25).
Veg cover	• Stoss slope – 0-5% • Crest – 10-20% • Landward slope – 20-50%	• Very little to no vegetation cover on the stoss slope. • Very poor overall vegetation cover on the crest. Large shrubs form most of the cover, which can exacerbate the risk of sand blow-out. Scattered weeds, including African Boxthorn. Large areas of bare sand and two large blow-outs present at Hamra Ave. • Poor to moderate coverage from ground covers to large shrubs and weeds. However, the majority of the vegetation form weeds (alive and dead). Some bare areas, particular on upper slopes.
Stability	• Landward – vulnerable • Crest – unstable • Stoss – vulnerable	• Low level of stability. Mobile sands regularly encroach on path at base of landward slope. Vulnerability amongst bare areas. • Poor stability, with some cover. Large areas of bare ground with large shrubs and little ground cover. Hummocky crest line increasing the risk of blow-outs. • Bare sands, requires stabilisation.
Issues	• Informal beach access • Mobile sands amongst the crest and stoss slopes • Steep stoss slope • Excess sand on landward slope • Weeds	• The informal beach access from Hamra Ave is exacerbating the sand blow-out in this area. Fencing is to be installed to close the access. • Bare sands on crest, the presence of large shrubs and a former walking path to a lookout have contributed to the formation of significant blow-outs adjacent Hamra Ave. Sand drift fencing is to be installed seaward of the crest to disrupt winds through this area and attempt to block the blow-out areas. • The stoss slope is relatively steep and mostly bare. The addition of sand to this area will help to build volume in the dune and provide opportunity for shaping an incipient dune. • Mobile sands have caused an excess of sand to build on the landward slope, which is impacting the walking path and other infrastructure. • Weed level is considered very high. At least one declared weed (African boxthorn) present; very large cover of environmental weeds on landward slope mixed with native species.

	• Infrastructure	• Junction box is inundated with mobile sands. Above ground disused infrastructure forms a hazard.

Table 14: Recommended management actions for WBPD1 (Zone 1).

ACTION	YEAR	QUARTER	DETAILS
Clean-up	2022	• Q2	• All above ground disused infrastructure should be removed careful, without impacting dune stability, and if safe to do so (Figure 26).
Seaward - Sand deposition and Shaping into an incipient dune	2022	• Q2	• Continue the deposition and shaping of sands to create an incipient dune at the crest of the 'upper sand deposits', along the length of the sub-section (Figure 26 and Figure 27). The stoss slope should target 4:1 fall. This incipient dune should be in line with that created in sub-sections 2, 3 and 4. • NOTE: If the incipient dune cannot be achieved by mechanical shaping, an alternative option is to install a sand drift fence at the seaward edge of the upper sand deposits to create an incipient dune over time. This may take 1-2 seasons to build, depending on levels of wind-blown sand reaching the fenceline.
Monitor dune condition	2022	• Q4 and every 6 months subsequent	• Monitor dune condition, particularly after storm events and high wind events, to determine effectiveness of works and rectify where required.
Extend exclusion fencing	2022	• Q2	• Extend the current planned access exclusion fencing further south to meet the existing fenceline at the base of the landward slope (Figure 29).
Monitor access	2002	• Q4 and ongoing	• Ensure access through this section of dune remains effectively closed. Recommend that no new access is formed in this area.
Landward – excess sand	2022	• Q2	• Where practical to do so, relocate some of the excess sand accumulated on the landward slope at the end of Hamra Ave to the blowout areas that have developed, to assist in closing off the blow-out depression (Figure 28). Sand could also be deposited seaward of the sand drift fence which is to be installed as part of interim sand control measures. • Any excavation works will need to be done carefully due to underlying infrastructure such as the hand-rail that has been engulfed by mobile sands. • Sands that have accumulated a little further south but now have vegetation cover commencing should be left and vegetation cover enhanced to stabilise sands (Figure 28). • If this work can be completed before the 2022 planting season, jute mesh should be laid over disturbed and deposited sands to help stabilise sands and support planting efforts. • Sand will need to be carefully excavated from the junction box at the southern end of the sub-section. • NOTE: Where management actions do not result in an acceptable reduction of sand deposition on the bike path adjacent the landward slope, it may be worth considering the feasibility of diverting the path further east, against adjacent buildings. This may allow for the widening of the dune, which may enable any windblown sands to settle before encroaching on key infrastructure.

Weed control	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during planting events.
Plant existing dune crests and landward slope	2022	• Q2/3	• Prepare bare sands on the main crest and landward slope adjacent Hamra Ave with jute mesh prior to planting. Consider surface cover for other bare crests areas further south,if resources allow. • Plant colonising ground cover species within bare areas of dune blowouts, main dune crests and within the bare landward slope (see Revegetation Plan, Appendix 3).
Plant replenished dune crests, swales and stoss slope	2023	• Q2/3	• Plant colonising ground cover species on crests and swale of replenished dunes (see Revegetation Plan, Appendix 3).
Monitoring planting	2022 2023	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2023 2024	• Q2/3 • Q2/3	• Infill planting on main crests, stoss slopes and swales with appropriate species to allow for natural succession (see revegetation plan – Appendix 3). • Infill planting on replenished dune crests and swales and landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3).

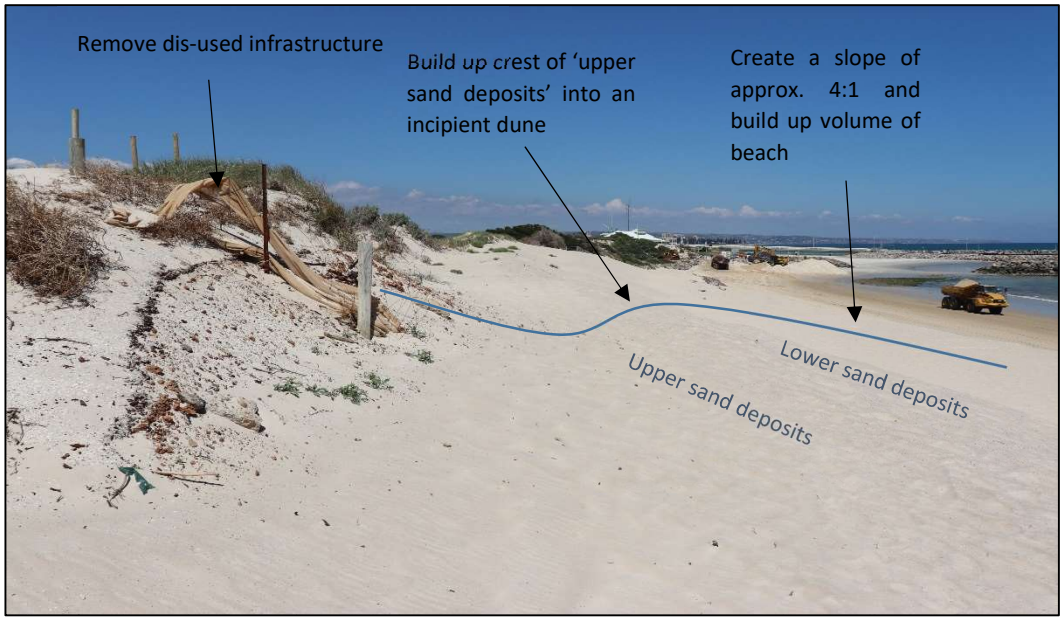


Figure 26: Proposed works for WBPD1 (Zone 1); remove disused infrastructure, create an incipient dune, build beach level.

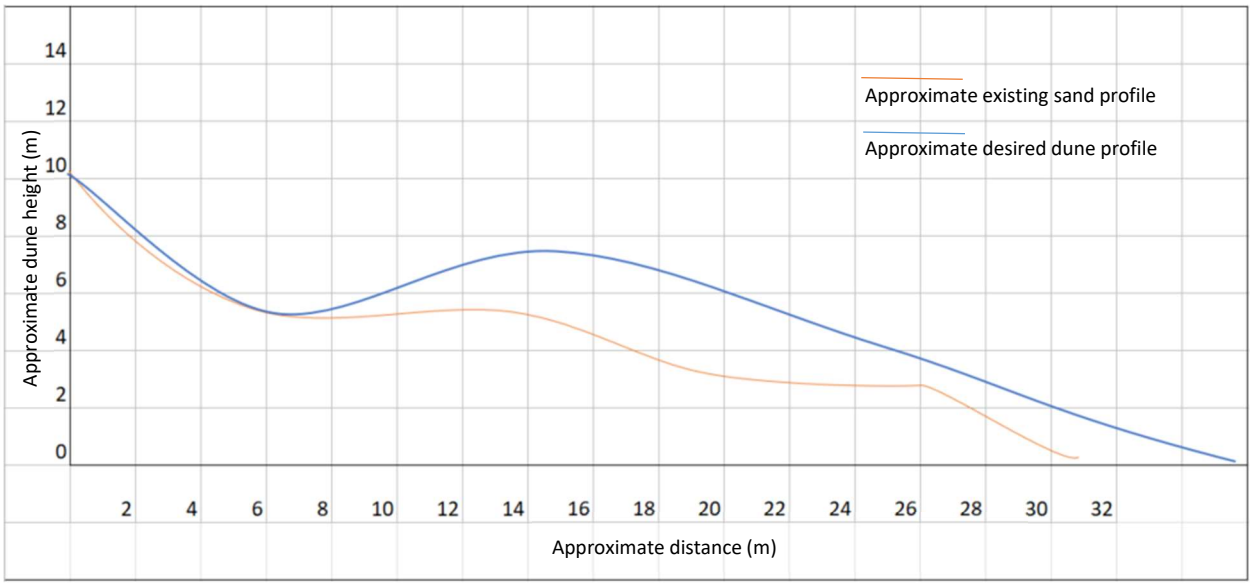


Figure 27: Approximate existing and desired dune profile, WBPD1 (Zone 1).

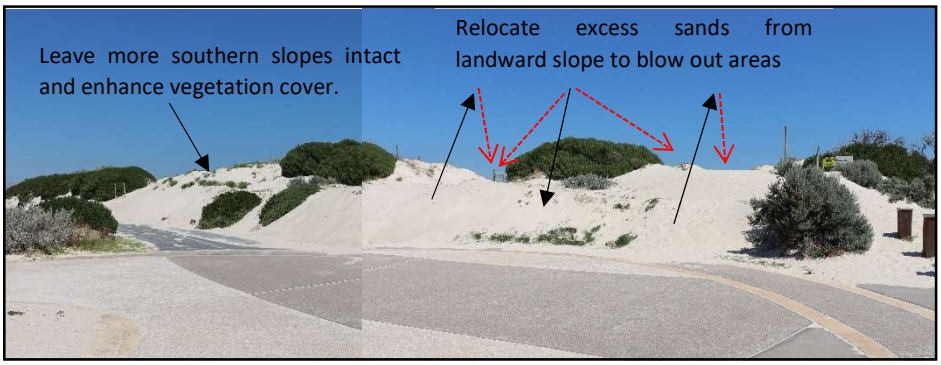


Figure 28: Excess mobile sands that have accumulated on the landward slope could be moved carefully to fill the blow-out areas further seaward.

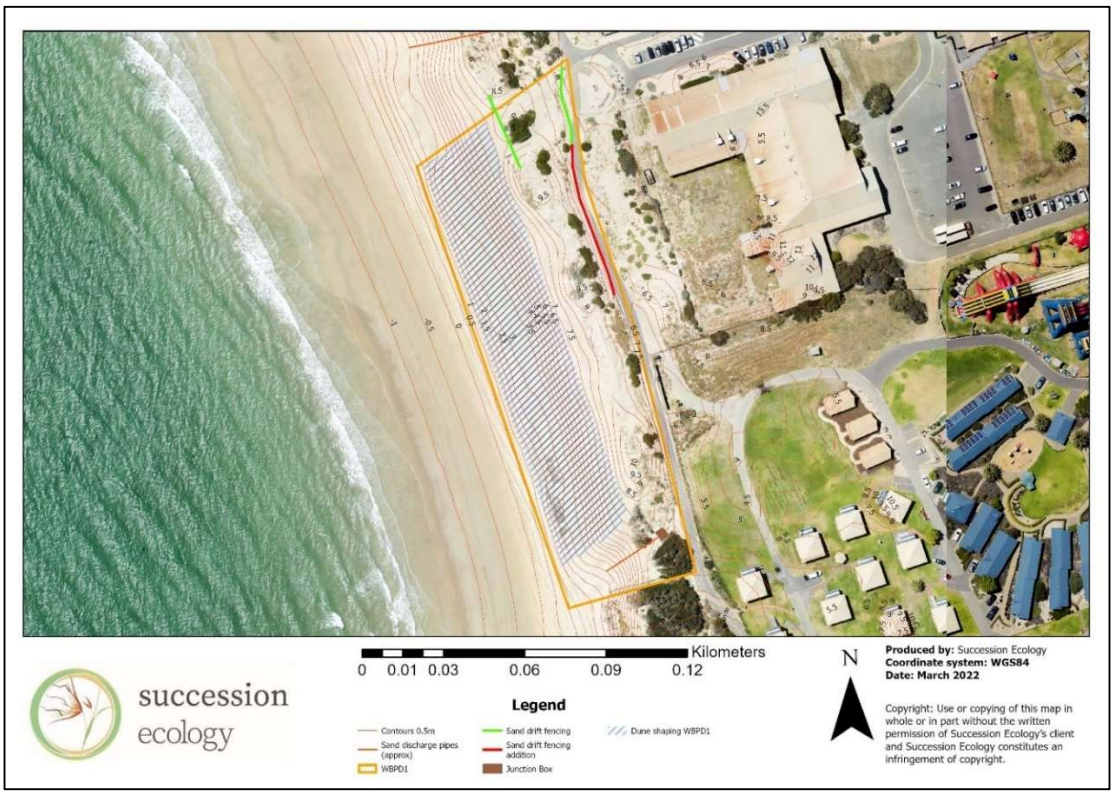


Figure 29: Location of proposed dune and crest shaping works within the WBPD1 sub-section (Zone 1). Note: planned sand drift/access exclusion fencing in green; proposed addition to access exclusion fencing in red.

4.3.3 Sub-section WBPD2 (Zone 2)

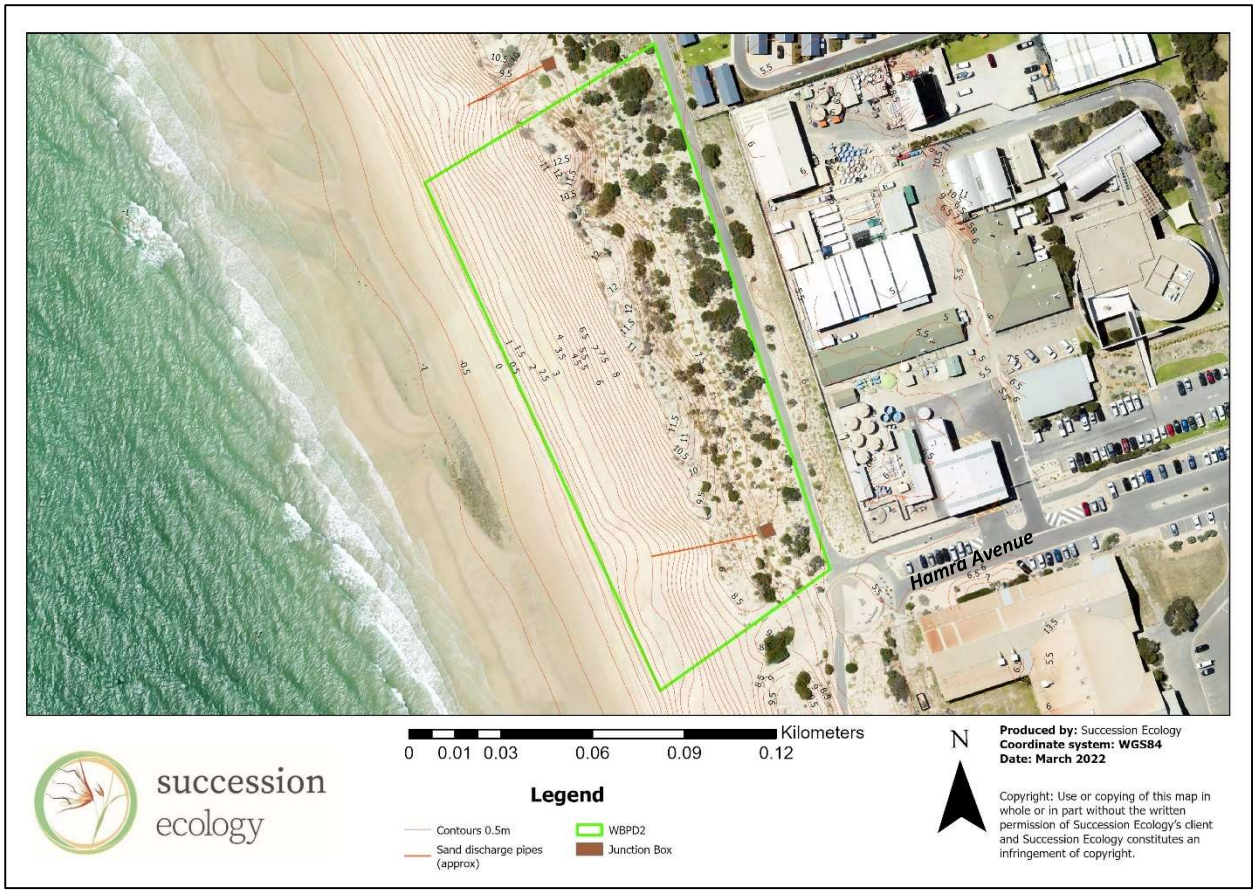


Figure 30: West Beach Parks Dunes sub-section WBPD2 (Zone 2).

Figure 31: Sands yet to be deposited on the stoss slope; poor crest condition of mostly dead weeds and hummocky shape (top). Landward slope showing a high level of environmental weeds and bare patches, particularly in upper slope (bottom).

Table 15: West Beach Parks Dunes Site 2 (WBPD2; Zone 2) parameter description.

PARAMETER	DETAILS	DESCRIPTION/NOTES
Dune Width	70-90m	Sand deposition yet to be completed at the toe of this dune. More sand is needed to shape the dune.
Dune Height	12.5m	Highest area is on the main foredune crest. Hummocky crest shape, increasing vulnerability to sand blow-outs (Figure 31).
Stoss Slope (steepest)	2.8:1; 19^0	Relatively steep slope (in steepest section).
Infrastructure	• Sand discharge station • 1 x beach access tracks • Disused, broken pipes and fencing	• One sand discharge station occurs at the southern end of this sub-section. This is not currently operational but is due for re-commissioning in 2023. • An informal access point occurs at the southern end of the sub-section. This is due to be fenced off to prevent future access. • Many white irrigation pipes protrude out of the stoss slope near the crest (Figure 31). Old wire fencing also present.
Veg cover	• Stoss slope – 0-5% • Crest – 10% • Landward slope – 50-60%	• Very little to no vegetation cover on the stoss slope. • Very poor overall vegetation cover on the crest. Most of the cover is scattered dead weeds, including African Boxthorn. Large areas of bare sand and small blow-outs starting. • Moderate coverage from ground covers to tall shrubs. However, the majority of the vegetation form weeds (alive and dead). Some bare areas, particular on upper slopes.
Stability	• Landward – stable • Crest – vulnerable • Stoss – vulnerable	• Moderately stable soils. Some vulnerability amongst bare areas. • Poor stability, with little cover. Lots of bare ground and dead weeds amongst the crest, and a hummocky crest line increasing the risk of blow-outs. • Bare sands, requires stabilisation.
Issues	• Bare areas amongst the crest and stoss slopes • Hummocky crest shape • Soil layer close to surface • Steep stoss slope • Weeds • Infrastructure	• Bare areas on crest and stoss slope creates vulnerability to sand mobility and potential blow-outs. • The crest line has particularly hummocky form, which can increase risk of blow-outs. • A layer of soil occurs close to the surface of the crest and is exposed in some areas along the crest. Origin unclear. • The stoss slope is relatively steep and mostly bare. The addition of sand to this area will help to build volume in the dune and provide opportunity for shaping an incipient dune. • Weed level is considered very high. At least one declared weed (African boxthorn) present; very large cover of environmental weeds on landward slope mixed with native species. • All works need to consider damage to existing infrastructure such as sand deposition pipes and junction boxes. Above ground disused infrastructure forms a hazard.

Table 16: Recommended management actions for WBPD2 (Zone 2).

ACTION	YEAR	QUARTER	DETAILS
Clean-up	2022	• Q2	• All above ground disused infrastructure should be removed, without impacting dune stability and where safe to do so.
Crest re-shaping	2022	• Q2	• Smooth out the crest line by knocking off the sandy hummocks that have formed and use this material to fill in the gaps between hummocks. • This action should try to minimise the exposure of the soil layer. Where soil is exposed, the exposed area should be treated with a surface coverage (e.g., jute mesh) and planted within the first season (2022).
Sand deposition and Shaping into an incipient dune	2022	• Q2	• Continue the deposition and shaping of sands to create an incipient dune at the crest of the 'upper sand deposits', along the length of the sub-section (Figure 32 and Figure 33). The stoss slope should target a 4:1 fall. This incipient dune should be in line with that created in sub-sections 1, 3 and 4. • NOTE: If the incipient dune cannot be achieved by mechanical shaping, an alternative option is to install a sand drift fence at the seaward edge of the upper sand deposits to create an incipient dune over time. This may take 1-2 seasons to build, depending on levels of wind-blown sand reaching the fenceline.
Monitor dune condition	2022	• Q4 and every 6 months subsequent	• Monitor dune condition, particularly after storm events and re-work shaping where required.
Weed control	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during planting events.
Plant dune crest where disturbed	2022	• Q2/3	• Plant colonising ground cover species within the disturbed areas of the crest line.
Plant dune crests and swales	2023	• Q2/3	• Plant colonising ground cover species within bare areas of dune crests (existing and formed) and within the swales between crests (see Revegetation Plan, Appendix 3).
Monitoring planting	2022 2023 2024	• Q4 • Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2023 2024	• Q2/3 • Q2/3	• Infill planting on main crests, stoss slopes and swales and landward slopes with appropriate species to allow for natural succession (see revegetation plan – Appendix 3). • Infill planting on landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3).

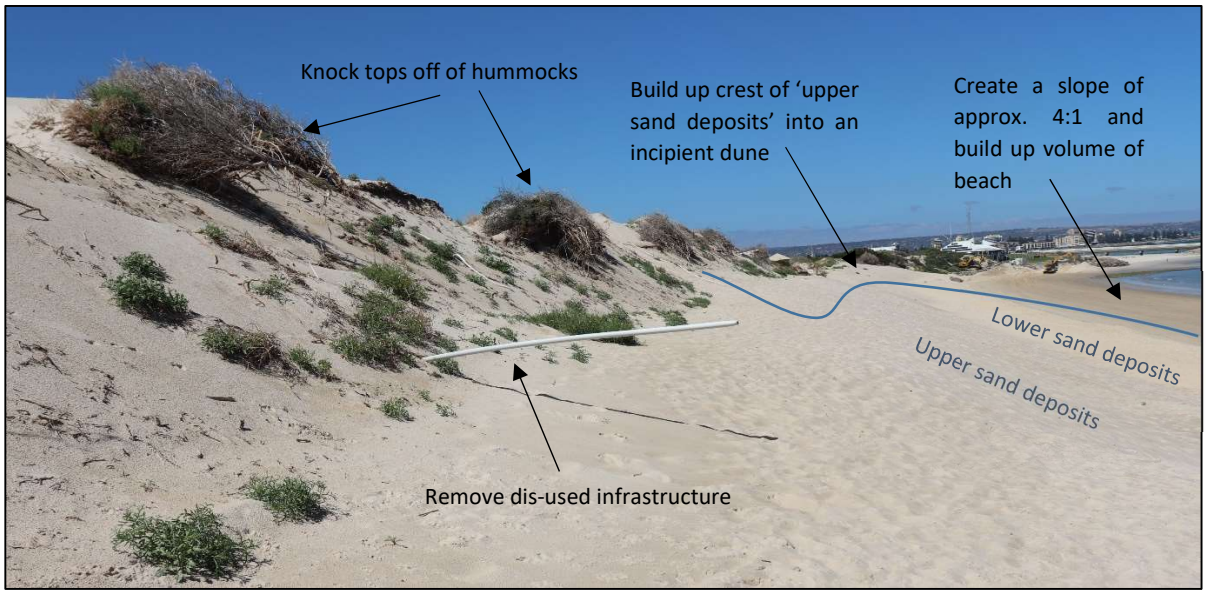


Figure 32: Proposed works for WBPD2 (Zone 2); remove disused infrastructure, re-shape crestline, create an incipient dune, build beach level.

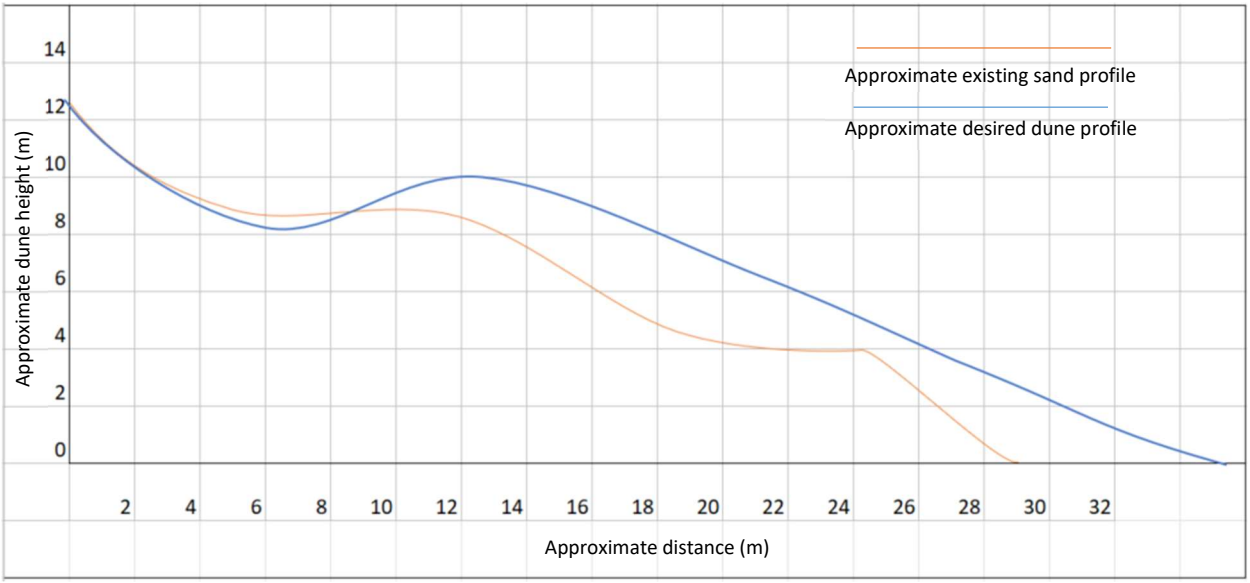


Figure 33: Approximate existing and desired dune profile, WBPD2 (Zone 2).

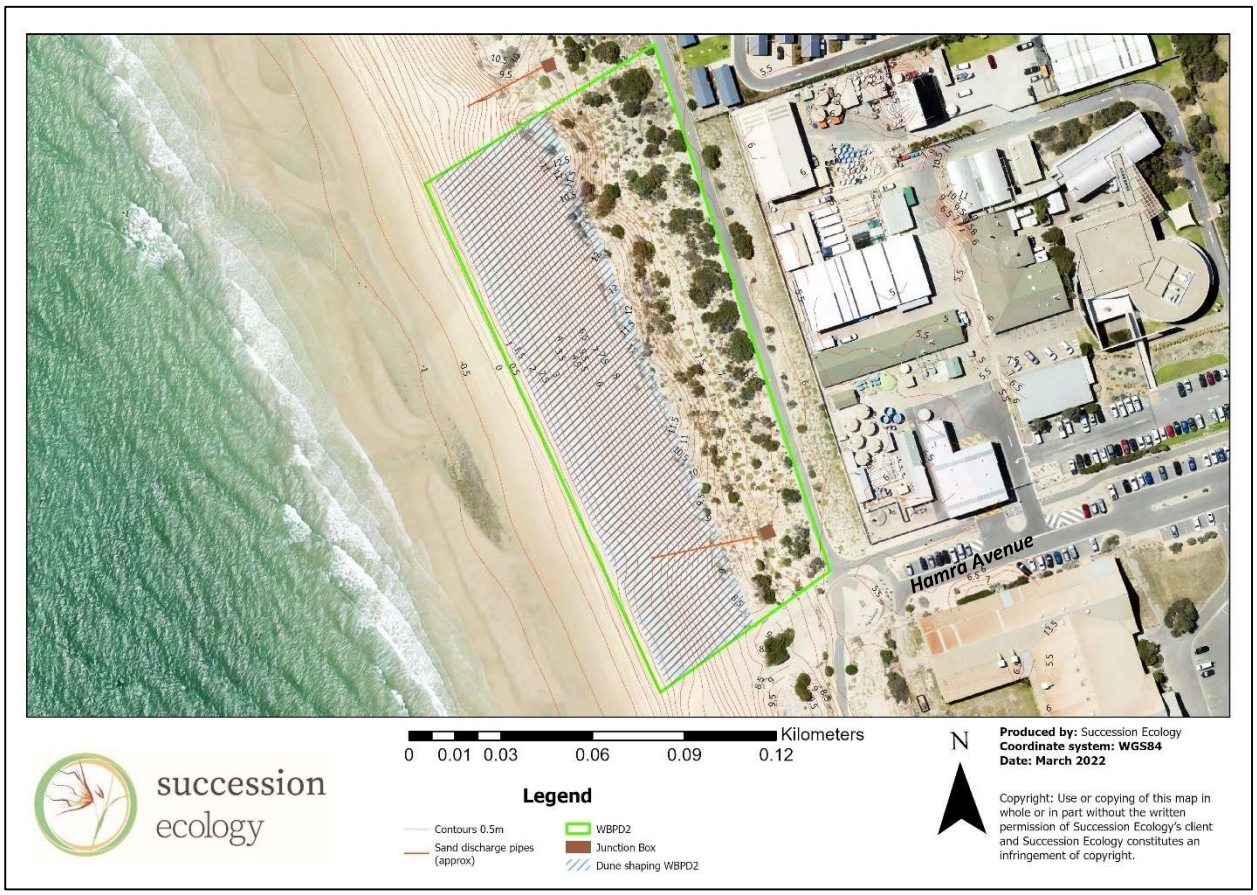


Figure 34: Location of proposed dune and crest shaping works within the WBPD2 sub-section (Zone 2).

4.3.4 Sub-section WBPD3 (Zone 3)

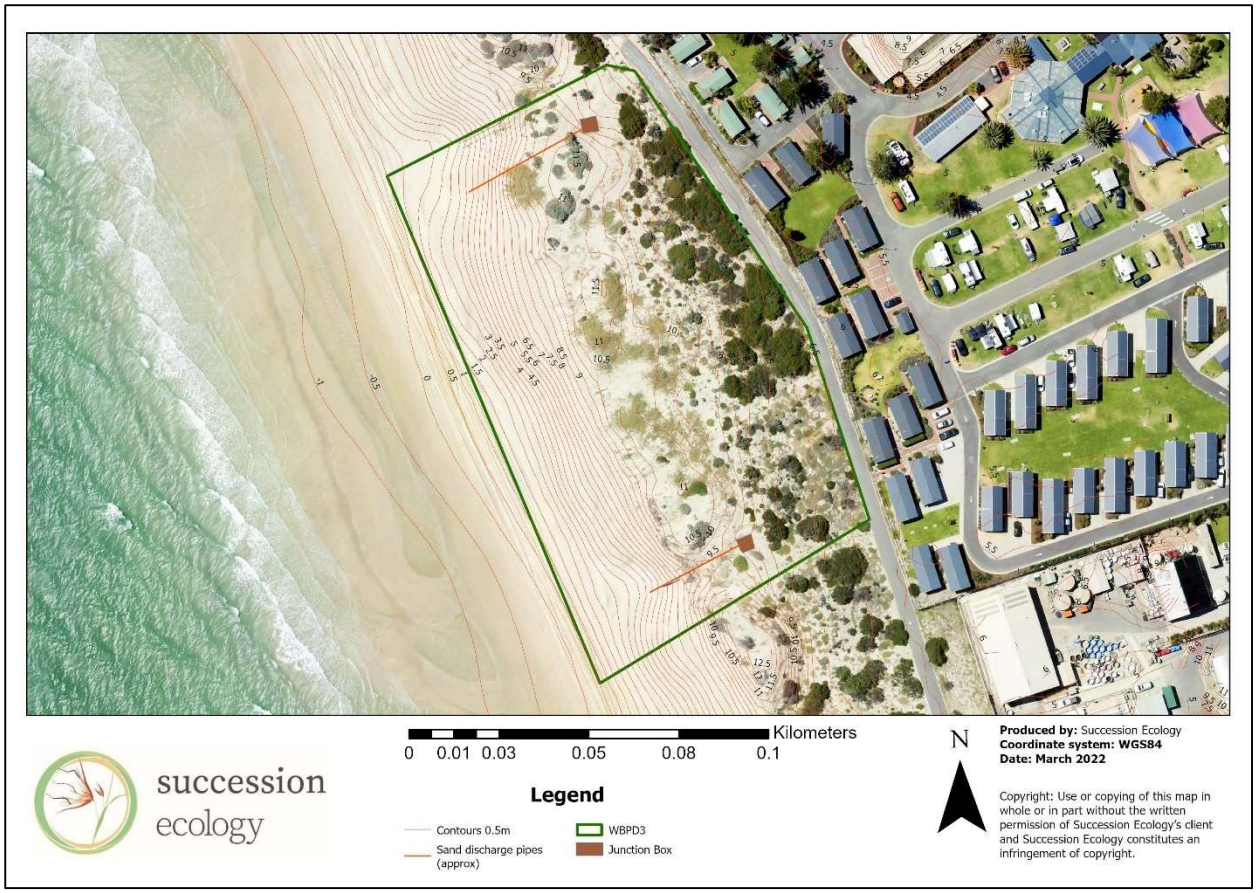


Figure 35: West Beach Parks Dunes sub-section WBPD3 (Zone 3).

Figure 36: Sand replenishment building volume on the stoss slope (top) and condition of the landward slope showing a high level of environmental weeds and bare patches scattered throughout. Junction box pictured bottom right.

Table 17: West Beach Parks Dunes Site 3 (WBPD3; Zone 3) parameter description.

PARAMETER	DETAILS	DESCRIPTION/NOTES
Dune Width	70-90m	Sand is currently being deposited at the toe of this dune to build volume. Replenished sand is able to be shaped as needed.
Dune Height	11.5m	Highest area is on the main foredune crest.
Stoss Slope (steepest)	2.8:1; 19^0	Relatively steep slope (prior to sand deposition).
Infrastructure	• Sand discharge station • Sand deposition pipe • 1 x beach access tracks	• Two sand discharge stations occur at the northern and southern ends of this sub-section. They are not currently operational but are due for re-commissioning in 2023. • The southern-most sand deposition pipe is exposed at one point (Figure 36). • At the northern end of the sub-section, dissecting dunes from east to west.
Veg cover	• Stoss slope – 0-5% • Crest – 40% • Landward slope – 60-70%	• Very little to no vegetation cover on the stoss slope. • Poor to moderate overall vegetation cover on the crest. Scattered clumps of *Spinifex.* Large areas of dead weeds, including African Boxthorn (Declared weed). Large areas of bare sand susceptible to blow-out. • Moderate to good coverage from ground covers to tall shrubs. However, the majority of the vegetation form weeds (alive and dead). Some bare areas.
Stability	• Landward – stable • Crest – vulnerable • Stoss - vulnerable	• Mostly stable soils with some vulnerability amongst bare areas. • Moderately stable where there is cover. Lots of bare ground and dead weeds amongst the crest with a risk of developing blow-out. • Bare sands, requires stabilisation.
Issues	• Potentially mobile sands amongst the crest and stoss slopes • Steep stoss slope and replenished sands • Weeds • Infrastructure	• Bare areas on crest and stoss slope creates vulnerability to sand blow-out and mobility. • The original stoss slope is relatively steep and mostly bare. The addition of sand to this area will help to build volume in the dune break-up the slope. Provides opportunity for shaping. • Weed level is considered high. At least one declared weed (African boxthorn) present, large cover of environmental weeds on landward slope mixed with native species. • All works need to consider damage to existing infrastructure such as sand deposition pipes and junction boxes, and beach access walkways.

Table 18: Recommended management actions for WBPD3 (Zone 3).

ACTION	YEAR	QUARTER	DETAILS
Shape deposited sand into an incipient dune	2022	• Q2	• Use deposited sands to create an incipient dune in front of the main foredune along the length of the sub-section, targeting a stoss slope of 4:1. The sand nourishment undertaken (as per 3rd March) has provided most of the shape. Build beach volume and lessen to seaward slope to the beach (Figure 37 and Figure 38).
Monitor dune condition	2022	• Q4 and every 6 months subsequent	• Monitor dune condition, particularly after storm events and carry out maintenance of dune structure when required.
Weed control	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during planting events.
Plant dune crests and swales	2023	• Q2/3	• Plant colonising ground cover species within bare areas of dune crests (existing and formed) and within the swales between crests (see Revegetation Plan, Appendix 3).
Infill planting	2023	• Q2/3	• Infill planting within landward slope with shrub and ground cover species, (see revegetation plan – Appendix 3).
Monitoring planting	2023 2024	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2024	• Q2/3	• Infill planting on main crests, stoss slopes and swales with appropriate species to allow for natural succession (see revegetation plan – Appendix 3). • Infill planting on landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3).

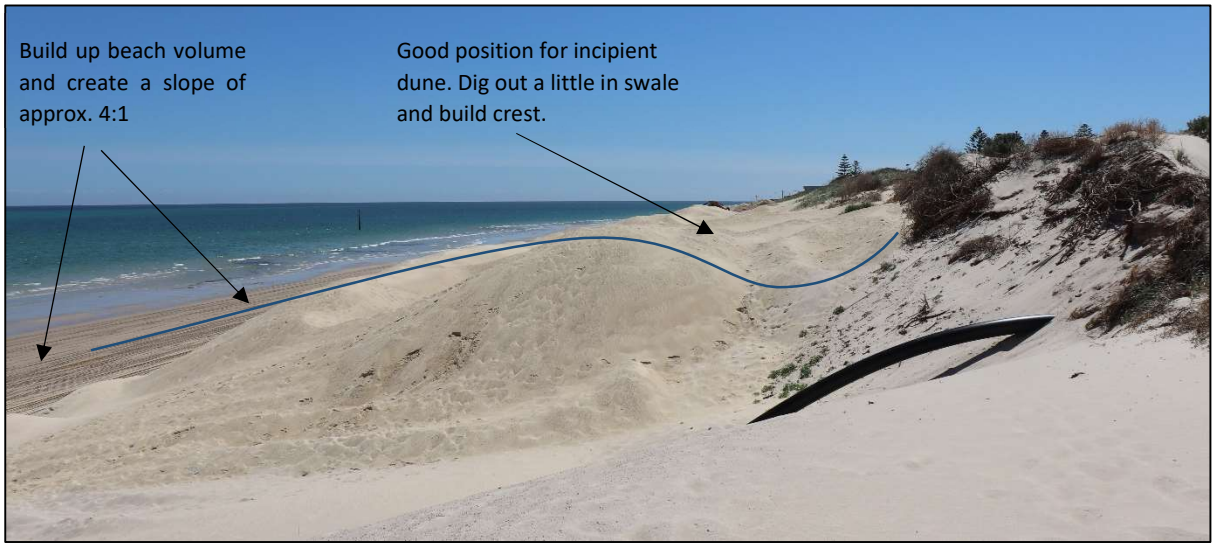


Figure 37: Proposed works for WBPD3 (Zone 3); create an incipient dune, build beach level.

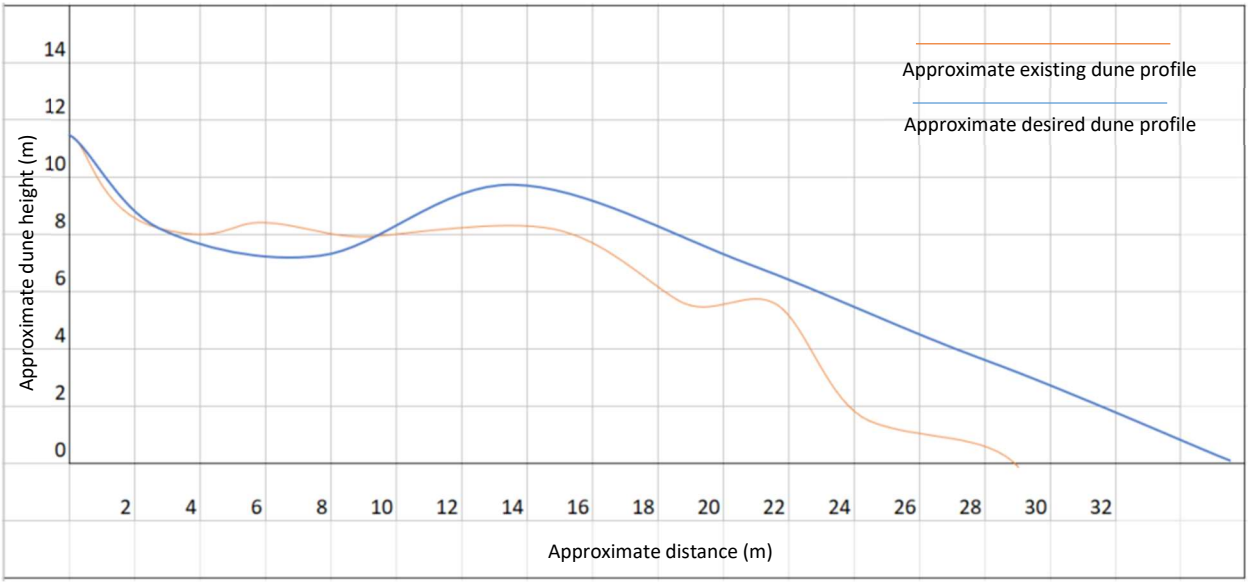


Figure 38: Approximate existing and desired dune profile, WBPD3 (Zone 3).

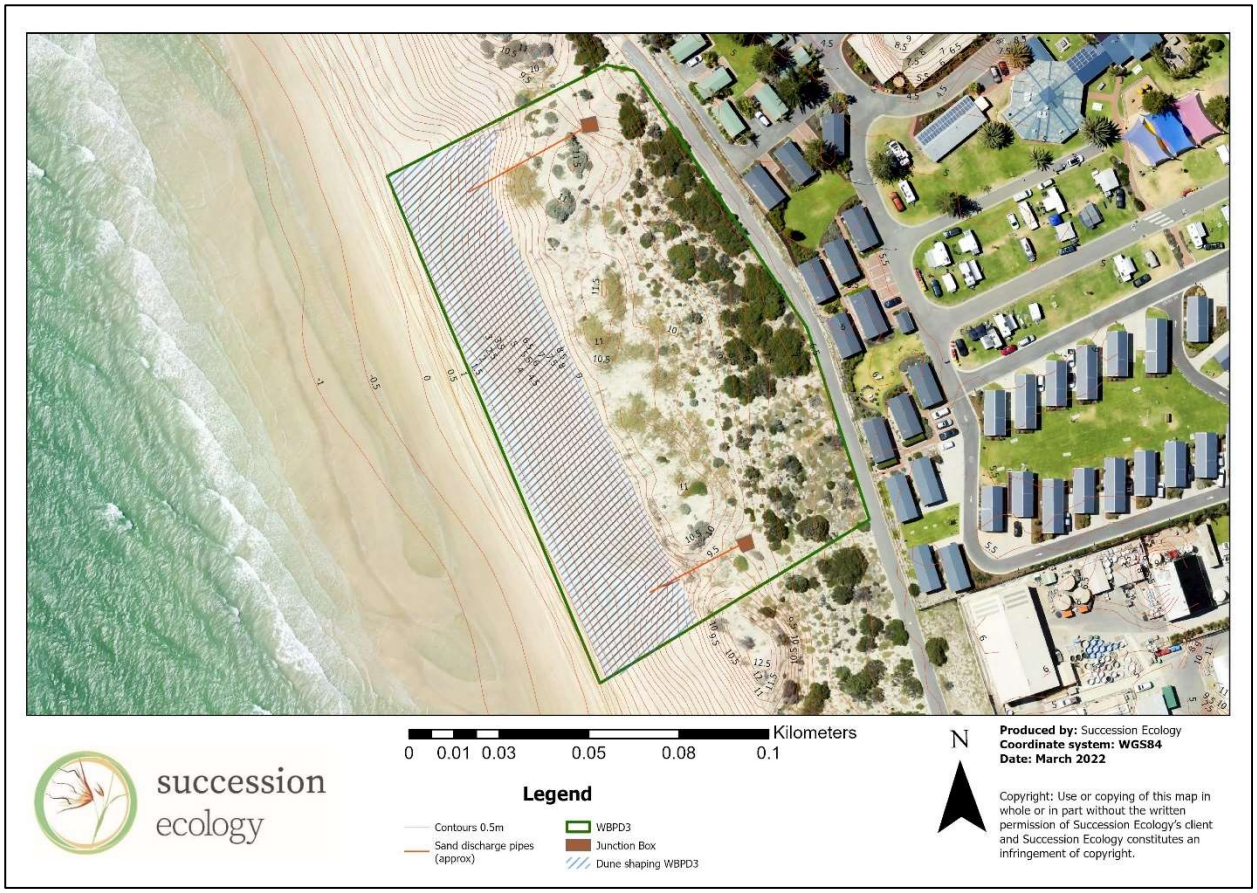


Figure 39: Location of proposed dune shaping within the WBPD3 sub-section (Zone 3).

4.3.5 Sub-section WBPD4 (Zone 4)

Figure 40: West Beach Parks Dunes sub-section WBPD4 (Zone 4)

Figure 41: Sand replenishment building volume on the stoss slope (top left) and condition of the landward slope showing mostly good vegetation cover, with some bare patches and a moderate to high level of weeds (other).

Table 19: West Beach Parks Dunes Site 4 (WBPD4; Zone 4) parameter description.

PARAMETER	DETAILS	DESCRIPTION/NOTES
Dune Width	30-50m	Sand is currently being deposited at the toe of this dune to build volume. Replenished sand can be shaped as needed.
Dune Height	13.5m	Highest area is on the main foredune crest.
Stoss Slope (steepest)	2.5:1; 22^0	Relatively steep slope (prior to sand deposition).
Infrastructure	• Sand discharge station • 1 x beach access tracks • Sand drift fencing	• A sand discharge station occurs at the northern end of this sub-section. However, this outlet is no longer in operation and very unlikely to resume operation in the future. • At the southern end of the sub-section, dissecting dunes from east to west. • A line of posts occurs at the northern end below the crest (does not contain drift mesh). Other lines of sand drift fencing occur along the crest, some functional, some not.
Veg cover	• Stoss slope – 0-20% • Crest – 40% • Landward slope – 60%	• The northern most area of the sub-section has a large bare area on the stoss slope. The southern half of the sub-section has scattered *Spinifex* and shrub cover. Extensive bare areas. • Overall, there is moderate vegetation cover amongst the crest, with a mixture of shrubs, *Spinifex* and environmental weeds. Large areas of bare sand susceptible to blow-out. • Moderate to good coverage from ground covers to tall shrubs. Some bare areas.
Stability	• Landward – stable • Crest – vulnerable • Stoss - vulnerable	• Mostly stable soils with some vulnerability amongst bare areas • Moderately stable where there is cover. Lots of bare ground amongst the crest with a risk of developing blow-out. • Mostly bare sands with some vegetation growth down the slope
Issues	• Potentially mobile sands amongst the crest and stoss slopes • Steep stoss slope and replenished sands • Weeds	• Bare areas on crest and stoss slope creates vulnerability to sand blow-out and mobility. • The original stoss slope is relatively steep and mostly bare. The addition of sand to this area will help to build volume in the dune break-up the slope. Provides opportunity for shaping. • Weed level is considered moderate. At least one declared weed (African boxthorn) present; large cover of environmental weeds on landward slope mixed with native species.

Table 20: Recommended management actions for WBPD4 (Zone 4).

ACTION	YEAR	QUARTER	DETAILS
Shape deposited sand into an incipient dune	2022	• Q2	• Shape deposited sands to create an incipient dune in front of the main foredune along the length of the sub-section, targeting a slope of 4:1 (Figure 42 and Figure 43).
Install sand drift fencing in bare area	2022	• Q3	• Use (or replace) sand drift fencing posts to install a sand drift fence part-way up the stoss slope at the northern end of the dune (Figure 42) to address that area of bare sands.
Monitor dune growth and condition	2022	• Q4 and every 3 months subsequent	• Monitor fence condition and sand build level. • Repair any damaged fencing. • Monitor dune condition, particularly after storm events and carry out maintenance of dune structure when required.
Weed control	2023	• Q1/Q2	• Identify and eliminate any Declared Weeds within the sub-section. Recommend leaving the dead material in-situ to provide sand binding via the roots and habitat via dead branches. • Recommend leaving environmental weeds in-situ, as they are providing some soil stability, and will be eventually outcompeted by native species, or can be carefully removed and replaced with native species during infill planting events.
Plant dune crests and swales	2023	• Q2/3	• Plant colonising ground cover species within bare areas of dune crests (existing and formed) and within the swales between crests (see Revegetation Plan, Appendix 3).
Infill planting	2023	• Q2/3	• Infill planting within landward slope with shrub and ground cover species, (see revegetation plan – Appendix 3).
Monitoring planting	2023 2024	• Q4 • Q2	• Monitor progress of plantings undertaken. • Monitor progress of plantings undertaken.
Infill planting	2024	• Q2/3	• Infill planting on main crests, stoss slopes and swales with appropriate species to allow for natural succession (see revegetation plan – Appendix 3) • Infill planting on landward slopes with ground covers and shrub species (see revegetation plan – Appendix 3)

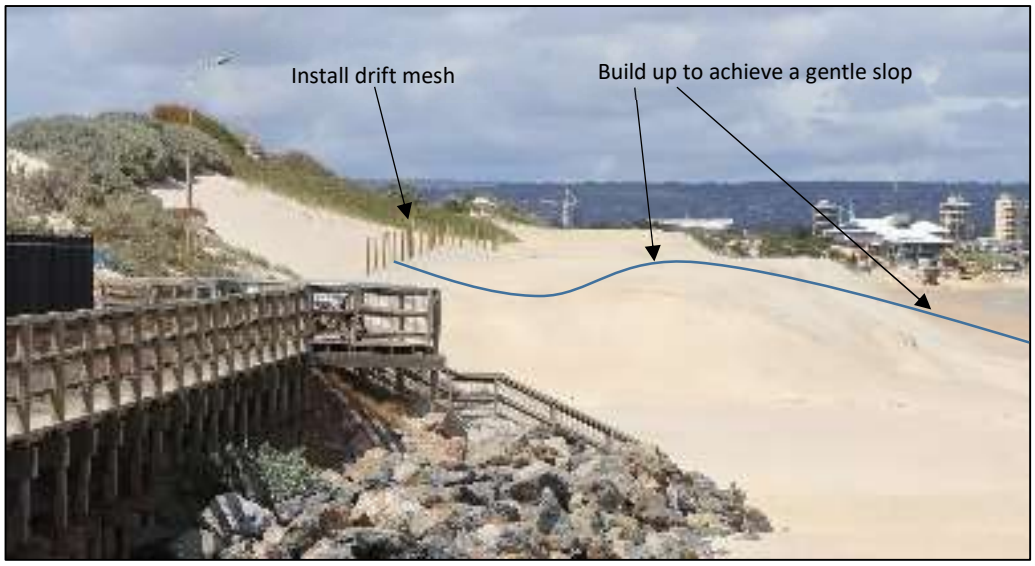


Figure 42: Proposed works for WBPD4 (Zone 4); create an incipient dune, build beach level and install sand drift mesh.

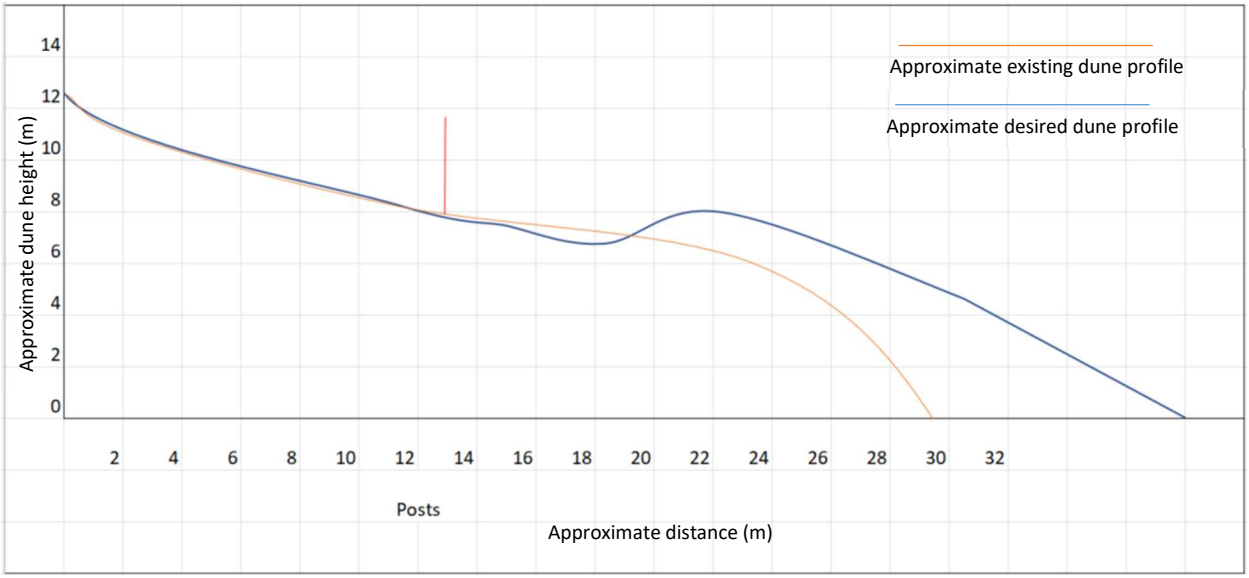


Figure 43: Approximate existing and desired dune profile, WBPD4 (Zone 4).

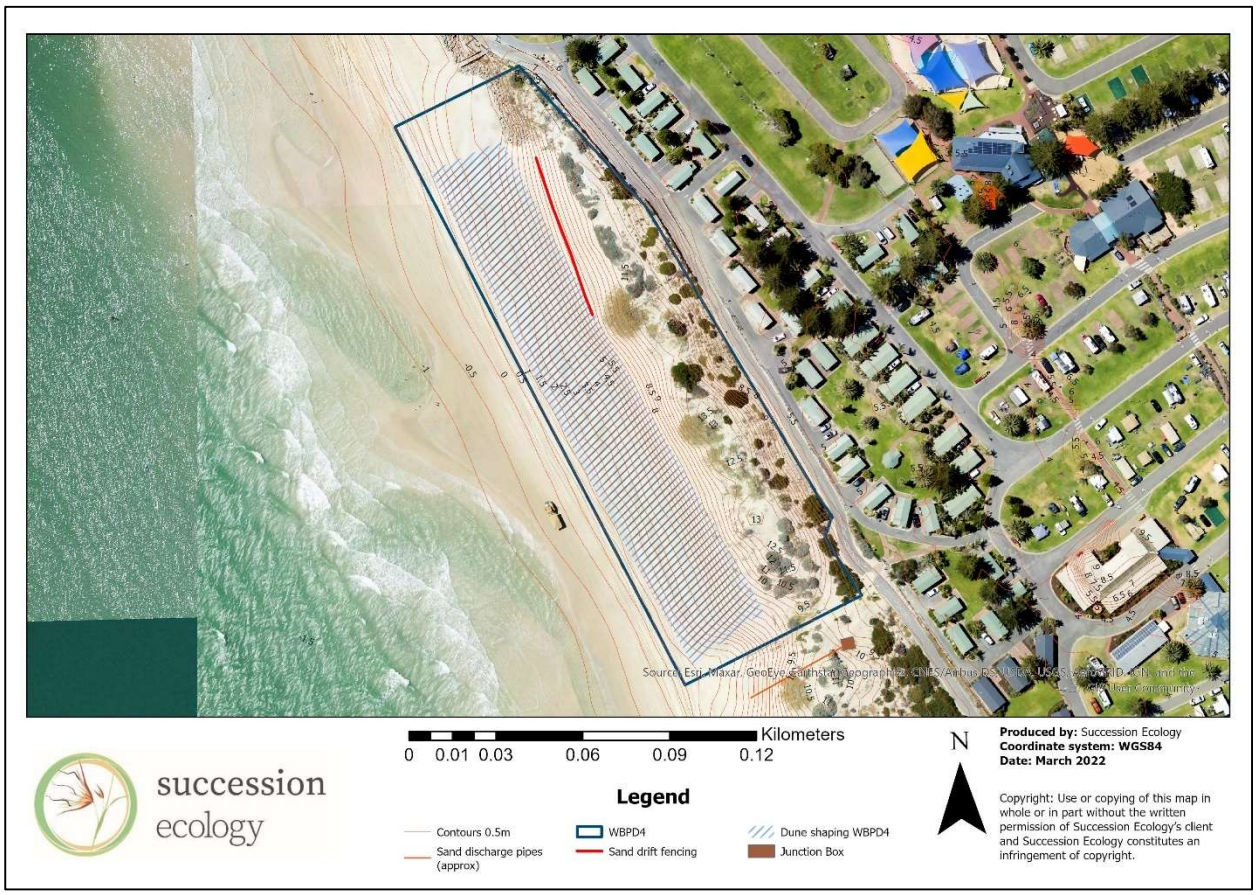


Figure 44: Location of proposed works within the WBPD4 sub-section (Zone 4).

4.4 Alignment and positioning of replenished dunes

Overall, the following principles should be followed as far as practicable:

- Replenished dunes along the length of the beach should be in the same alignment and parallel to the shoreline, as far as practicable.
- Incipient dune crests should be placed approximately 10-15m from the main crest (making use of existing sand deposition location).
- Stoss (seaward) slopes should be shaped at a gentle angle (4:1) and slightly convex where possible.
- Beach level should be raised (resources permitting) to aid in achieving required slopes and providing space for recreational use.

5.0 CONCLUSION AND RECOMMENDATIONS

Dune management within the West Beach management cell (Cell 3) continues to face challenges, as the majority of the cell is exposed to net erosion. Management actions have been recommended here to improve dune stability and sustainability and for overall restoration.

The Cell 3 has been divided into two sections and further sub-sections for the purposes of review and management actions. A summary of management actions are provided below.

Seaview Road Dunes

- Northern section (SVRD1) - Monitor dune condition behind the Hooded Plover roped area and consider mitigation measures as needed.
- Central dune sections (SVRD2, 3) – Install sand drift fencing to create incipient dune at the toe of the foredune or provide sand replenishment to achieve an incipient dune. Monitor dune growth and plant out crests and stoss slope of foredune during 2023 planting season
- Southern dune section (SVRD4) – Plant out replenished incipient dune and infill plant within the rest of the dune system in 2022. Monitor plant growth and carry out infill planting as required.

West Beach Parks Dunes

- Northern section (WBPD4, 3) – Shape deposited sands into incipient dune and plant out in 2023. Build up beach level as much as possible. Monitor dune condition and planting works periodically.
- Central dune sections (WBPD2, 1) – Shape deposited sands to create incipient dune along the upper bench of the deposited sands and plant out in 2023. Even the crest line for WBPD2 and plant out in 2022. Monitor dune condition and planting works periodically.
- Southern dune section (WBPD0) – Monitor dune condition periodically.

6.0 REFERENCES

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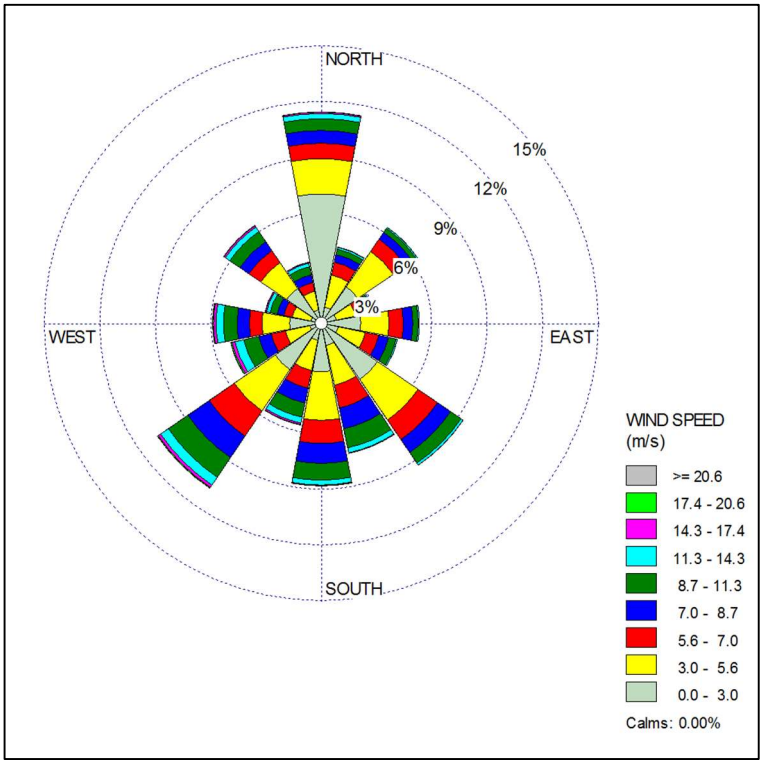
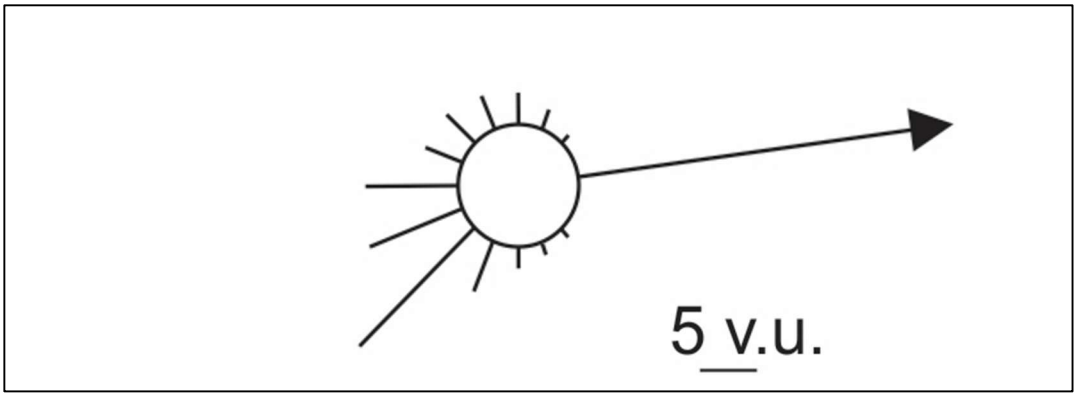
7.0 APPENDICES

Appendix 1 - Wind Rose and Sand Rose

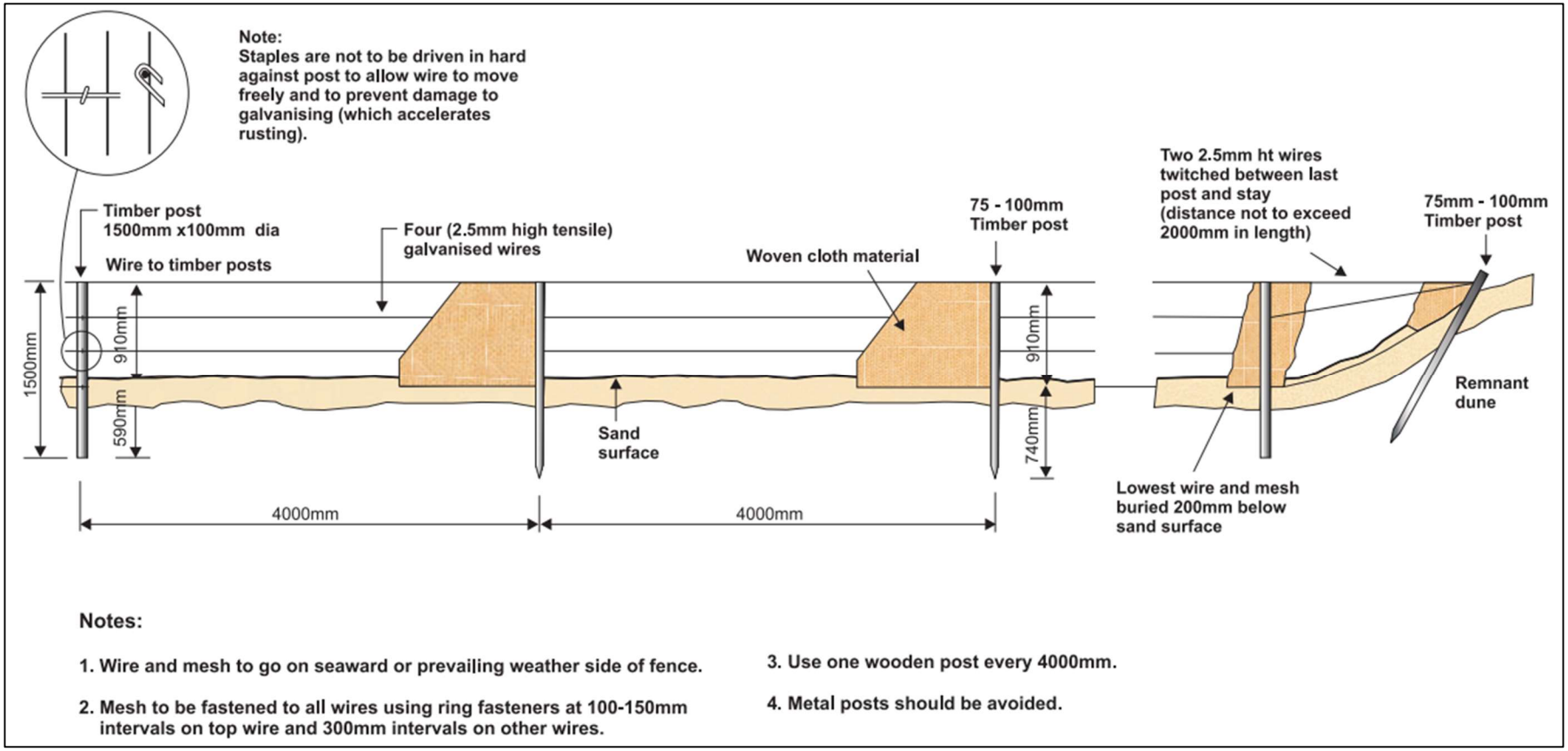


Mean annual wind rose for Adelaide Airport, 1957 – 2015 (Courtesy G. Miot da Silva, Flinders University).



Fryberger and Dean (1979) sand rose for Adelaide. The wind data utilised extends from 1957 to 2015. The length of the lines are in vector units (see scale) and indicate how much sand would be transported from that direction towards the circle. The total sand drift potential (DP) is 43.85 vector units. The resultant drift potential and direction (RDP) is 25.38 vector units and is indicated by the arrowed line. This shows the net overall sand transport direction which is from slightly South of West to slightly North of East. Wind blown sands are predominantly transported onshore on Adelaide beaches (towards 73 degrees resultant drift direction [RDD]).

Appendix 2 - Standard Drift Net Fencing Design



Source: DLWC, 2001

Appendix 3 – Revegetation Plan

See Over

succession ecology

Appendix 3 – Revegetation Plan

1.0 INTRODUCTION

This Revegetation Plan sets out the revegetation objectives, framework and restoration actions for the West Beach dune restoration project. It supports the dune restoration works recommended in the West Beach Dune Stabilisation Management Plan (Management Plan), providing a restoration plan for each sub-section described. The restoration project will span three planting seasons from 2022 to 2024.

1.1 Objectives

- To present a revegetation plan that aims primarily to support dune stabilisation at West Beach, and to improve biodiversity.
- To identify key areas for revegetation works in 2022, incorporating all plants ordered by the Department for Environment and Water (DEW)
- To identify key restoration areas for works in 2023 and 2024, including those requiring follow-up infill planting and seeding
- To distribute species according to their natural position within a dune system, within the appropriate season, in order to maximise effectiveness and success of the restoration works.

1.2 Summary of Actions

Revegetation works have been staged over three years. Works include:

- 2022 – primary planting and seeding in key areas and infill planting and seeding within vegetated landward slopes. Follow-up monitoring of key restoration areas.
- 2023 – primary planting and seeding in remaining key areas, and infill planting and seeding in areas planted the previous year. Follow-up monitoring of all restoration areas.
- 2024 – Infill planting and seeding in all areas as required, with a focus on the more herbaceous species that are suited to landward slopes, to increase biodiversity of those areas.

Planting in 2022 will utilise coastal native plants grown by nursery specialists and indigenous to the Adelaide area. Supplementary plants grown locally at a community nursery will also support restoration actions. Seeding will utilise predominantly hardy species with a focus on colonisers that will provide dune stabilisation.

Planting and seeding in 2023 will utilise predominantly hardy species with a focus on colonisers that will provide dune stabilisation of replenished dunes. Seeding will utilise predominantly hardy species with a focus on colonisers that will provide dune stabilisation.

Planting in 2024 will consist of all species for infill work as required, with a focus on more delicate herbaceous species that will provide diversity to landward slopes. Seeding in 2024 will focus on problem areas where planted stock is difficult to establish with a focus on coloniser species for stabilisation.

2.0 PLANNING

2.1 Revegetation Planning

2.1.1 Restoration zones within the dune system

The dune areas to be restored as part of this revegetation plan have been divided into zones (Figure 1), which identify the dune feature and allow allocation of particular species to the appropriate zone. Within the dune systems of West Beach, the Landward slope, Crest rear and Stoss rear are dune features in existence prior to restoration works. The Swale, Crest front and Stoss front are features that have been constructed, or are recommended to be constructed, as part of the Management Plan. These restoration zones will be used for all dune revegetation planning.

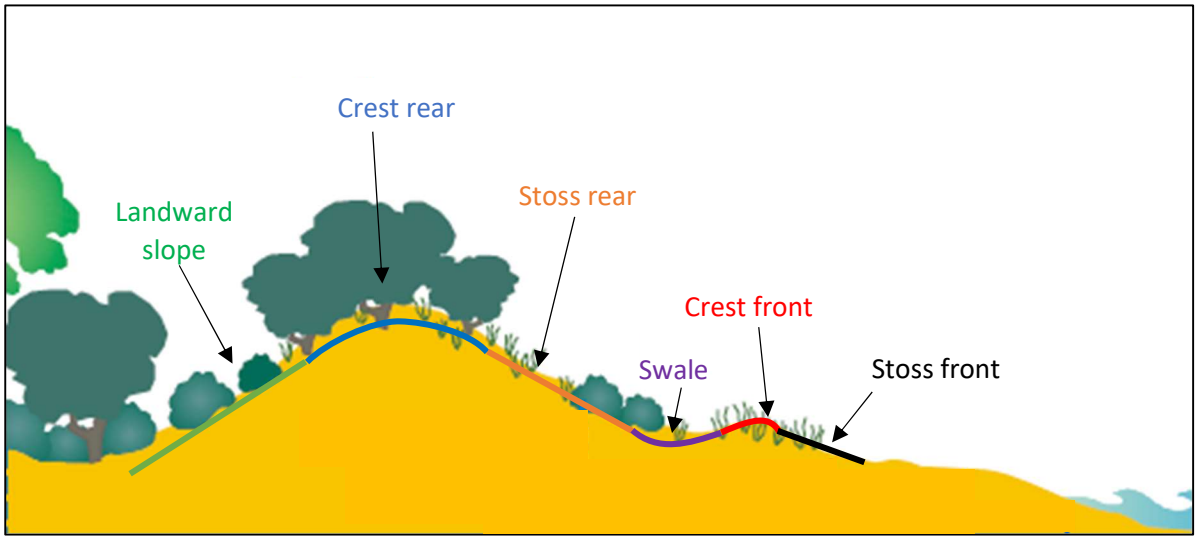


Figure 1: Dune features and associated planting zones. Adapted from DLWC, 2001.

2.1.2 Restoration areas

The schedule for the restoration areas is shown in Table 1 and Figures 2-9, and detailed below:

Restoration in 2022

Key areas planned for primary planting in 2022 include:

- SVRD4 (Rockingham St dune) – replenished dune (to swale) and infill planting in existing dune and landward slope
- SVRD2&3 – existing dune crest and infill planting within landward slope, with preference given to SVRD3
- WBPD1 (Hamra Ave dune) – existing dune crest and landward slope
- WBPD2 – existing dune crest and infill planting within landward slope
- WBPD4 – replenished dune (to crest incipient dune) and infill planting within existing dune and landward slope

All bare dune plantings and WBPD1 to be supported by seeding.

Table 1: Planting schedule for each sub-section from 2022 through to 2024.

Sub-section	2022 No. stems: 18,000+ Vol. seed: 3.75kg	2023 No. stems: ~25,500 – 27,600 Vol. seed: 5.5	2024 No. stems: ~13,500 Vol. seed: TBA
SVRD1	-	-	-
SVRD2	Existing dune crest	Existing dune crest infill	-
	Landward slope infill	Existing dune crest infill	
SVRD3	Existing dune crest	Existing dune crest infill	-
	Landward slope infill[#]	Replenished dune (TBA)	
SVRD4	Replenished dune	Replenished dune infill	Replenished dune infill as required
	Existing dune, landward slope infill[#]	Existing dune, landward slope infill	Existing dune infill as required
WBPD4	Replenished dune	Replenished dune infill	Replenished dune infill as required
	Existing dune, landward slope infill	Existing dune, landward slope infill	Existing dune infill as required
WBPD3	-	Replenished dune	Replenished dune infill as required
		Existing dune, landward slope infill	Existing dune infill as required
WBPD2	Existing dune crest	Replenished dune	Replenished dune infill as required
	Landward slope infill	Existing dune, landward slope infill	Existing dune infill as required
WBPD1	Existing dune crest	Replenished dune	Replenished dune infill as required
	Landward slope	Existing dune infill	Existing dune infill as required
WBPD0	-	-	-

[#]*Community planting opportunities*

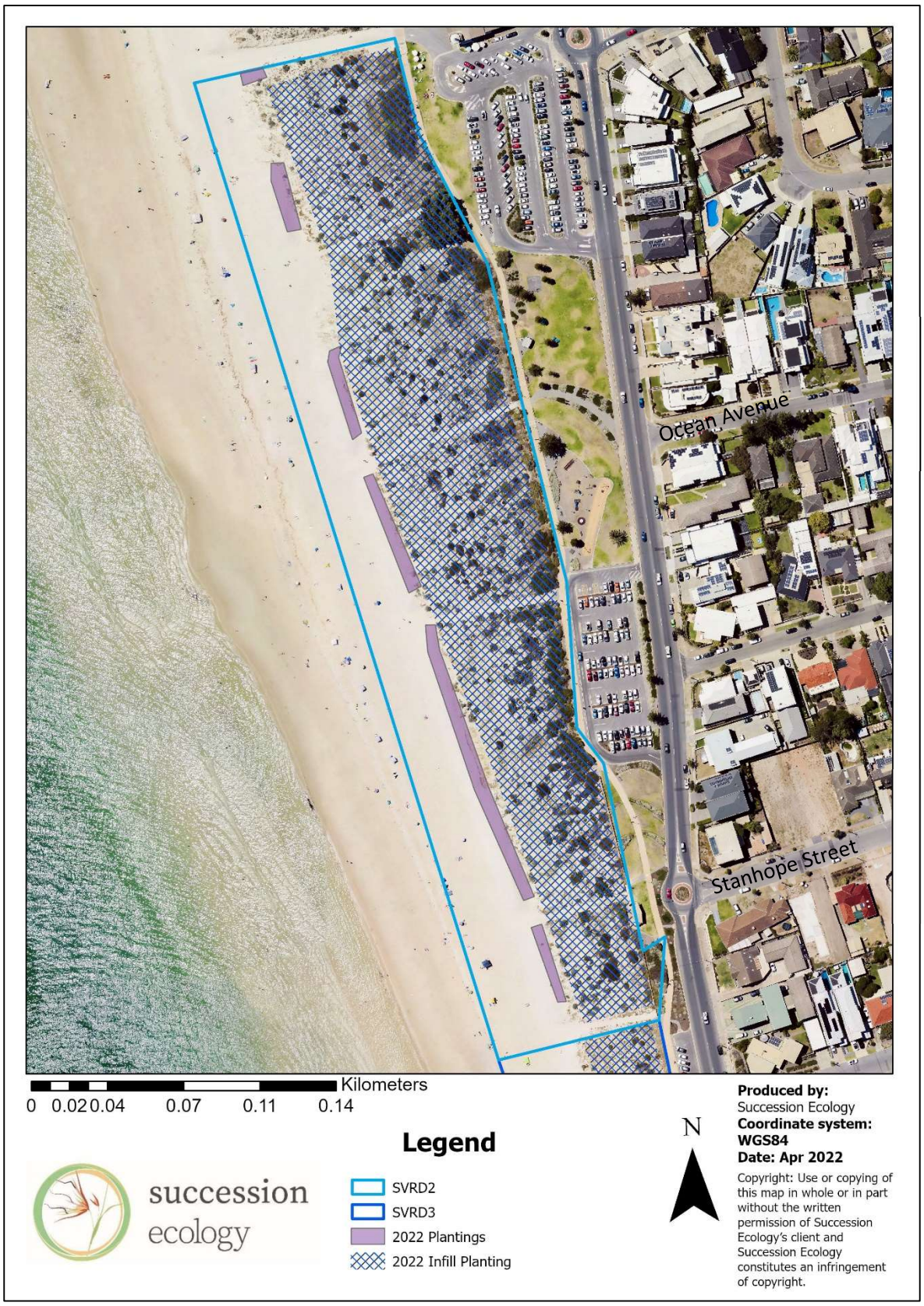


Figure 2: Restoration areas earmarked for 2022 within SVRD2.

Figure 3: Restoration areas earmarked for 2022 within SVRD3 and SVRD4.

Figure 4: Restoration areas earmarked for 2022 within WBPD4.

Figure 5: Restoration areas earmarked for 2022 within WBPD1 and WBPD2.

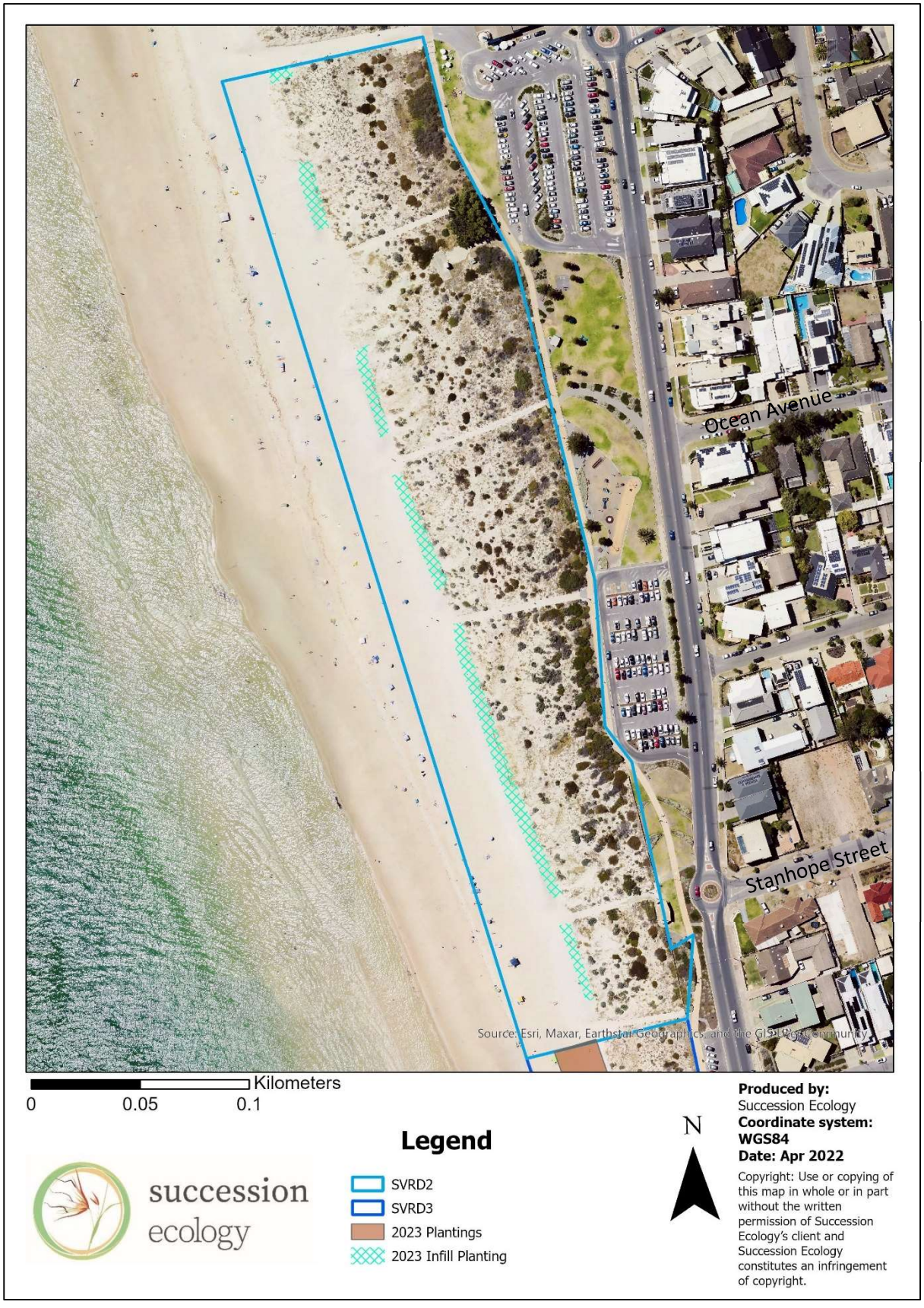


Figure 6: Restoration areas earmarked for 2023 within SVRD2.

Figure 7: Restoration areas earmarked for 2023 within SVRD3 and SVRD4. Note: 2023 Planting areas for SVRD3 are subject to dune replenishment.

Figure 8: Restoration areas earmarked for 2023 within WBPD4 and WBPD3. NOTE: Planting areas for WBPD3 and WBPD2 are subject to dune replenishment.

Figure 9: Restoration areas earmarked for 2023 within WBPD1 and WBPD2. NOTE: Planting areas are subject to dune replenishment.

Restoration in 2023

Key areas planned for primary planting in 2023 will be determined following the condition of the dunes post winter 2022 and subsequent replenishment. They may include:

- WBPD1 – replenished dune (TBA) and infill planting of areas planted in 2022
- WBPD2 – replenished dune (TBA) and infill planting of areas planted in 2022
- WBPD3 – replenished dune (TBA) and infill planting of existing dune and landward slope
- WBPD4 – infill planting of areas planted in 2022
- SVRD4 – infill planting of areas planted in 2022
- SVRD2&3 – infill planting of areas planted in 2022 and replenished dune (TBA).

All bare dune plantings should be supported by seeding.

Restoration in 2024

Infill planting/seeding of all areas as required, with a focus on more delicate herbaceous species that will provide diversity to landward slopes.

2.2 Plant and seed stock management

2.2.1 Nurseries

A number of nurseries are available in Adelaide for both large and small orders of plant stock. The revegetation contractor could recommend a number that will provide high quality stock and have the capacity to supply large quantities. Normal orders for these nurseries are around 20,000 plants. It is recommended that the plant stock be inspected a month or two before the planting season, to gauge the quality of the stock. If gaps are evident, then plants from other nurseries may need to be sourced.

The contractor engaged for this revegetation project, should conduct an inspection of the stock prior to planting in 2022. Where there are incidents of sub-standard stock, DEW should be advised and supported to achieve a revision to the planting program. The contractor should also be engaged to manage future orders, with inspections of stock carried out at least twice from the time of order to receipt.

2.2.2 Plant Orders for Nurseries

Nurseries need a long lead-time to ensure orders can be filled. It is recommended that plants are ordered by October for any stock needed in the following year. These should be ordered in the 'P2 Forestry tubes' size. This allows the seedlings to have developed to a size that supports a good level of root stock, and a higher success rate.

2.2.3 Seed Orders

Succession Ecology is available as a source of viable native seed and can supply seed to nurseries to support the growth targets required.

3.0 REVEGETATION METHODOLOGY

3.1 Site preparation

3.1.1 Weed Control

Whilst a complete vegetation survey was not included in the scope of this restoration project, a number of key weed species were opportunistically identified within the project area, including Declared Weeds. Overall, the Seaview Road dune system was found to have high native vegetation cover and only scattered incidence of weeds. However, one Declared Weed, *Gazania sp*, was identified within SVRD1, SVRD2 and SVRD3 subsections. Within the West Beach Parks dune system, a much higher proportion of weed cover was identified, particularly within WBPD2 and WBPD3. The Declared Weed species *Lycium ferocissimum* (African Boxthorn) was identified in all West Beach Parks Dunes sub-sections.

Weed control in dune systems, particular within sensitive dunes such as those within the West Beach cell requires careful consideration. All plant matter, including weed species, provide an important sand-binding function within the dune and contribute organic matter. Any weed plant removal can put dune stability at risk and as such must be carried out with minimal disturbance. Overall, it is recommended to leave the majority of weed material in situ. If Declared Weeds are managed it is important to ensure that they are treated strategically and in the appropriate season to prevent reproduction and reduce the weed seed bank.

Key weed species identified and associated recommended management actions are presented below.

African Boxthorn *(Lycium ferrocissimum)*

Rating: Declared Weed, Weed of National Importance
Risk to coastal areas: High
Located: WBPD0, WBPD1, WBPD2, WBPD3, WBPD4
Treatment: Search and locate, poison in late winter and leave dead material in situ.

Discussion

This species occurs scattered throughout the West Beach Parks Dunes system. Past treatment is evident with dead plants occurring throughout, particularly on or near dune crests. It is recommended that the restoration contractor search and locate individual plants and work with a qualified weed technician to have the plants treated with a suitable poison, then left in situ to continue to provide a sand-binding function. Nearby juveniles should be located and either hand-pulled (if small enough) or treated with a suitable poison. Any removed individuals must be contained, transported and disposed of in accordance with required regulations.

Gazania *(Gazania sp.)*

Rating: Declared Weed
Risk to coastal areas: Medium
Located: SVRD1, SVRD2, SVRD3
Treatment: Search and locate, poison in winter and early spring (prior to or during early flowering) using a surfactant and remove juveniles.

Discussion

This species appeared to be confined mainly to the edges of beach access tracks, as scattered plants. It is recommended that the restoration contractor search for and locate individual plants and work with a qualified weed technician to have the plants treated with a suitable poison. Nearby juveniles should be located and hand-pulled, being careful to remove all rhizomes. Any removed individuals must be contained, transported and disposed of in accordance with required regulations.

Marram Grass *(Ammophila arenaria)*

Rating: Environmental
Risk to coastal areas: Medium
Located: SVRD1, SVRD2, SVRD3, SVRD4
Treatment: Monitor infestations. Leave in situ in sensitive dune areas or carefully remove small infestations before replacing them immediately with revegetation.

Discussion

This species was detected mostly amongst the crest of the main foredunes as small infestations. This species can be invasive in areas of mobile sands and can also create large hummocks which can be detrimental to dune structure and stability. However, it also has sand stabilisation properties. It is recommended that the restoration contractor search for and map local infestations and work with a qualified weed technician to determine the need for treatment. Small infestations (comprising a few square meters) in non-sensitive areas can be manual removed, with all rhizomes requiring removal and appropriate disposal. Where this occurs, it is recommended that the area is immediately planted with native creepers, such as *Spinifex hirsutus* and *Carpobrotus rossii.* Chemical treatment could be considered for larger infestations, if considered a threat to the surrounding native plant community.

Showy Honey-myrtle *(Melaleuca nesophila)*

Rating: Environmental
Risk to coastal areas: Low
Located: SVRD1, SVRD2, SVRD3, WBPD0, WBPD1
Treatment: Leave adults in situ. Locate and hand-pull juveniles.

Discussion

This species occurs mostly as scattered plants, sometimes thickets, within both the Seaview Road and West Beach Parks dunes, close to beach access walkways. It is recommended that the restoration contractor search and locate individual adult and juvenile plants and hand-pull juvenile plants with minimal disturbance. As this species is not considered high risk, adult plants should remain in situ as they provide a sand-binding function.

Ice-plant *(Mesembryanthemum crystallinum)*

Rating: Environmental
Risk to coastal areas: Low
Located: WBPD1, WBPD2, WBPD3, WBPD4
Treatment: Leave in situ in sensitive dune areas and carefully remove small adults and juveniles in non-sensitive areas throughout spring and summer. Large adults to be left in place due to the cover provided.

Discussion

Ice-plant occurs in large areas of the dune systems of WBPD2 and WBPD3, and scattered throughout WBPD0, WBPD1 and WBPD4. Where the plant occurs in sensitive dune areas, such as slopes or crests it is recommended that the restoration contractor leave the plants in situ as they provide a sand-binding function. Where they occur on very gentle slopes or flat areas amongst the landward section of the dune, small adults and juveniles can be removed during spring and summer (before they set seed). Removed material should be bagged and disposed of appropriately.

Galenia *(Galenia sp.)*

Rating: Environmental
Risk to coastal areas: Low
Located: WBPD0, WBPD1, WBPD2, WBPD3, WBPD4
Treatment: Leave in situ in sensitive dune areas or carefully remove adults and juveniles before replacing them immediately with revegetation.

Discussion

Galenia sp. occurs scattered or in large areas throughout the West Beach Parks dune system. Where the plant occurs in sensitive dune areas, such as slopes or crests it is recommended that the restoration contractor leave the plants in situ as they provide a sand-binding function. Where they occur on very gentle slopes to flat areas amongst landward sections of the dune, plants can be removed immediately prior to revegetation. The plant mat can be rolled up and the taproot carefully dug out. Removed material should be bagged and disposed of appropriately.

Other environmental weeds

A number of other environmental weed species were identified within the project area, including Sea-rocket (*Cakile edentula*) and Kikuyu grass (*Cenchrus clandestinus*). These species occur scattered throughout the project area and do not appear to form a dominant invasive cover in any area. The plants of these species provide a very important sand-binding function within the dune system, and it is recommended they are left in situ, monitored and treated only if considered an invasive problem.

3.1.2 Site Management

Access

Access for the revegetation works will require some planning, as not all sites are accessible from local roads. There is some roadside access available for most of the Seaview Road subsections, where revegetation materials can be carried onto the site from parking areas along Seaview Road. Where appropriate, beach access for vehicles could be arranged with the local council to provide more efficient access to some sites. This will need to be timed with the occurrence of a low tide and at times of low beach usage by the public.

Road access for the West Beach Parks dunes is limited to WBPD1 and WPBD2. Other subsections will need access via the beach, which could be arranged with local council and timed with the occurrence of a low tide and low beach usage by the public.

Signage and Exclusion Fencing

Any major revegetation works that occur adjacent to publicly accessible areas should incorporate temporary exclusion fencing to eliminating foot and vehicle traffic from the restoration area, and

signage to advise that restoration works are in progress. The fence should be a simple post and flag fence.

Community Planting

The Department for Environment and Water (DEW) will be organising community planting days with members of the local community and interested stakeholders, throughout each planting season. These events will be organised and managed by DEW and their contractors, and they will need access to some of the tubestock plants ordered for sub-sections ear-marked for community planting. Planting areas have been allocated within this Plan for the 2022 planting season (see Section 4.0), and the restoration contractor can allocate future planting areas for community planting days ahead of the coming seasons.

3.2 Tubestock planting

3.2.1 Stock Preparation and Planning

Batching

It is very important for the restoration contractor to ensure that tubestock species are organised into batches with reference to the plant distribution tables set out in Section 4.4. This will allow for efficient distribution of tubestock on-site during the revegetation program. It is possible that nurseries with which orders are placed can organise such batches before plant collection, but if this is not possible then it should be done by the restoration contractor.

DEW will need batches that correspond to their allocated plantings areas for the community planting days.

Collection

Plants would be collected from the relevant nursery and/or collection point as they are needed. Any collected plants that need to be held overnight should either be stored securely on-site, out of public access, or securely within the restoration contractor's yard.

3.2.2 Planting Methodology

Planning

It is important that planting contractors are familiar with the Revegetation Plan and planting methodology proposed. To assist in this, it is recommended that a project manager from Succession Ecology be present, where other third-party contractors are engaged, to assist with the interpretation of this Revegetation Plan and appropriate planting methodologies. The project manager would provide advice on:

- Interpretation of plant distribution tables
- Species distribution across the planting area
- General planting techniques and those for particular species, to maximise success
- Appropriate use of fertilizer and mulch
- Spacing of plants according to various species
- Support the coordination of revegetation across all sites

Distribution

It is extremely important that the right species are planted in the appropriate location of the dune profile, as set out in the plant distribution tables and with reference to Figure 1. When at the site, an ecologist or senior revegetation consultant should distribute or instruct the distribution of species appropriately amongst the dune profile.

Spacing

Plant spacing for tubestock generally follows the rule of 1 plant/m^2. However, some species perform better if the following planting practices are implemented:

- *Austrostipa flavescens, Poa poiformis, Rytidosperma caespitosum*
    - Plant in clumps of 5-10, depending on the area and number of plants available
- *Dianella brevicaulis, Ficinia nodosa, Lepidosperma gladiatum*
    - Plant in clumps of 5, or place around larger shrubs
- *Helichrysum leucopsidium, Kennedia prostrata, Lotus australis, Pelargonium austral, Senecia pinnatifolus*
    - Can be planted in groups; should be planted amongst other vegetation that can provide protection from elements.

Planting Depth & Fertilizer Application

Plants must be planted deep within the dune sands, to ensure the root-ball is in contact with moist sands. Ideally, they should be planted to the basal leaf. This can be done via a Pottiputki tree planter or a narrow shovel. A 10g native plant fertilizer pellet can be inserted into each plant hole before the plant is planted, to support the growth of roots deeper into the dune prolife. Fertilizer pellets should be covered by some sand before the plant is planted to ensure the roots do not get burned by the pellets.

3.2.3 Maintenance

Mulching & Watering

To ensure reasonable rates of survival, the plantings conducted for this project will require mulching and, if possible, watering. As described in the management plan, dune system soils, particularly in the stoss rear, swale, crest front and stoss front are very low in carbon and drain rapidly. Mulch will add carbon and improve moisture retention, in particular it will reduce desiccation over the summer period. The application of mulch material, such as seagrass wrack, will greatly increase survivability of seedlings and support seed germination. A couple of handfuls of mulch would be required for each plant, particularly in replenished dunes. This may equate to ~1kg per plant, or 10 tonnes of seagrass wrack for all plants in replenished dunes and foredune crests.

Where possible and feasible, plants should also be watered in and subject to regular irrigation. We understand that the logistics of providing a watering system throughout the whole dune system is unlikely to be feasible, but it can help to more quickly stabilise key areas.

3.3 Hand seeding

3.3.1 Stock Preparation and Planning

Seed Mix

The seed mixtures for this restoration program aim to provide dune stability and to support the overall growth of dune vegetation. As such, the species mix will consist of hardy species and colonisers.

The seed mix for crests and stoss slopes will include:

- *Spinifex hirsutus (where available)*
- *Carpobrotus rossii*
- *Ficinia nodosa*
- *Rhagodia candolleana*
- *Tetragonia implexicoma*
- *Threlkeldia diffusa*
- *Atriplex cinerea*

Where swales are seeded, the following species can be added to the mix:

- *Nitraria billardierei*
- *Scaevola crassifolia*
- *Austrostipa flavescens*
- *Poa poiformis*

Seed Volume

Seed will be applied at 5kg per ha. While this seeding rate does not provide thick cover it will provide sufficient seed to provide a seedbank to respond to suitable climatic conditions and provide germinants between the plantings.

3.3.2 Seeding Methodology

The seed will be hand sown by Success Ecology across all sites with bare dunes in small handfuls across the surface of the ground (a little like feeding chickens) and then lightly raked into the top centimetre of soil following hand dispersal. This should be done before planting.

4.0 REVEGETATION PROGRAM

This section outlines the restoration program for each year. It should be noted that plant numbers and seed volume recommended are indicative only, and final numbers will be dependent on monitoring results of the previous season's planting and seeding.

4.1 Actions for 2022

Restoration works in 2022 include the planting of more than 18,000 plants over six of the nine sub-sections within the project area. This will address bare sands in replenished dunes and infill planting of partially vegetated landward slopes. The allocation of the 18,000+ plants was carried out using the following order of priority:

1. SVRD4 (Rockingham St dune), replenished and existing
2. WBPD1 (Hamra Ave dune), existing
3. SVRD2 and SVRD3, existing
4. WBPD2, existing
5. WBPD4, replenished and existing.

The restoration plan for 2022 is shown in Table 2, Table 3 and Table 4. Maps showing the areas to be restored are shown in Figures 2-5 (above). Notes and assumptions are as follows:

- Tubestock plants have been allocated with a distribution of 1 plant/ha. During planting particular species should be spaced in accordance with their growth habit (see section 3.0).
- Figure 3 shows areas that would be suitable for community planting days.
- The dune dimensions for WBPD4 were estimated at 30m in width. This needs to be confirmed once dune shaping works are completed.
- Due to WBPD4 being the final sub-section in the priority list, many key species were not available for the 2022 planting but will be included in the 2023 species order list.
- Seed mixtures will be used to support plantings in replenished dunes, due to the expected success rate of between 30-70% (depending on climatic conditions). Seed volume has been calculated with a seeding rate of 5kg/ha.

4.2 Actions for 2023

Restoration works in 2023 includes the planting of an estimated 25,500 to 27,600[1] plants over seven of the nine sub-sections within the project area. This will address infill planting of key areas planted in 2022 and may include planting of bare sands in replenished dunes (TBA). The allocation of plants for 2023 is shown in Table 5, Table 6, Table 7 and Table 8. Maps showing the planting areas are shown in Figures 6-9 (above). Notes and assumptions are as follows:

- A dune continues to grow in volume (or is replenished) for SVRD3
- The tables assume some planting is possible on the replenished crest for SVRD4, although this is dependent on future erosion levels and sand replenishment of this dune.
- The tables assume dune replenishment for WBPD1, 2 and 3, although this is highly dependent on the sand resources that remain post 2022 winter and any further sand replenishment.
- Plant numbers include an assumption of 50% losses from 2022 key plantings. Plant numbers may need to be adjusted prior to the 2023 order being placed.

[1] The higher number of plants assumes that the dune grows or is replenished to sufficient levels for planting.

- Tubestock plants have been allocated with a distribution of 1 plant/ha. During planting particular species should be spaced in accordance with their growth habit (see section 3.0).
- Plant species recommended focus on hardy, dune colonising species.
- The replenished dune dimensions for WBPD3, WBPD2 and WBPD1 were estimated at 30m in width. This needs to be confirmed once dune shaping works are complete.
- The dune dimensions for SVRD3 are estimated at 20m in width. This needs to be confirmed once the dune has formed.
- Seed mixtures will be used to support plantings in replenished dunes, due to the expected success rate of between 30-70% (depending on climatic conditions). Seed volume has been calculated with a seeding rate of 5kg/ha.
- Community planting days could also occur in 2023. It is recommended that community planting areas include any infill planting zone that provides ease of access for local groups.

4.3 Actions for 2024

Restoration works in 2024 includes the planting of an estimated 13,500 plants over 5-7 of the nine sub-sections within the project area. This will address infill planting any sites that require it. The planting plan for 2024 is shown in Table 9, Table 10 and Table 11. Notes and assumptions are as follows:

- Plant numbers include an assumption of 50% losses from 2023 key plantings. Plant numbers may need to be adjusted prior to the 2024 order being placed.
- Tubestock plants have been allocated with a distribution of 1 plant/ha. During planting particular species should be spaced in accordance with their growth habit (see section 3.0).
- Plant species recommended include more of the delicate, landward suited plants and herbs such as *Kennedia prostrata*, *Lotus australis, Pelargonium austral, Pimelea serpyllifolia, Clematis microphylla* and *Chrysocephalum apiculatum.*
- Seed mixtures can be sourced for this year's planting. The need and suitability of seed will be determined during the 2023 monitoring event.

4.4 Plant Distribution Tables

Table 2: 2022 plant distribution for SVRD2, SVRD3 and SVRD4.

		SVRD4 (Rockingham St)							SVRD2 and SVRD3		
Species	**Total No.**	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	**Total No.**	**Stoss Rear**	**Crest Rear**	**Landward**
Grasses											
Austrostipa flavescens	40			20	10		10	200			200
Poa poiformis	30			10	10		10	280			280
Creepers; Mat								0			
Carpobrotus rossii	230			20	140	60	10	450		350	100
Disphyma crassifolium	70			10	20	30	10	20		20	
Spinifex hirsutus	540				420	120		940		940	
Kennedia prostrata	0	-	-	-	-	-	-	0			
Kunzea pomifera	30			10			20	110			110
Shrubs, small								0			
Dianella brevicaulis	70			10	30	20	10	330		100	230
Chrysocephalum apiculatum	20			10			10	160			160
Clematis microphylla	10						10	80			80
Enchylaena tomentosa	30			10			20	0			
Ficinia nodosa	120			20	60	40		200		200	
Helichrysum leucopsidium	0	-	-	-	-	-	-	0			
Leucophyta brownil	50			10	10	10	20	50			50
Lepidosperma gladiatum	20			10			10	20			20
Lomandra leucocephala ssp. robusta	20			10			10	20			20

		SVRD4 (Rockingham St)							SVRD2 and SVRD3			
Species	**Total No.**	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	**Total No.**	**Stoss Rear**	**Crest Rear**	**Landward**
Lotus australis	10						10	270			270
Muelhenbeckia gunnii	40			10	10	10	10	60		60	
Pelargonium australe	10						10	100			100
Rhagodia candolleana	90			10	40	30	10	250		150	100
Scaevola crassifolia	40			10		20	10	50			50
Senecio pinnatifolius	10						10	220			220
Tetragonia implexicoma	70			10	40	20		135		85	50
Threlkeldia diffusa	80			10	40	30		125		75	50
Shrubs, tall								0			
Acacia cupularis	5						5	75			75
Acacia longifolia var. sophorae	5						5	75			75
Adriana quadripitarta	10						10	185			185
Atriplex cinerea	85			10	40	20	15	110		110	
Myoporum insulare	15				10		5	75			75
Nitraria billardieri	15					10	5	75		50	25
Olearia axilllaris	120			20	50	30	20	300		200	100
Totals:	**1885**	**0**	**0**	**230**	**930**	**450**	**275**	**4965**	**0**	**2340**	**2625**

Table 3: 2022 plantings for WBPD1 and WBPD2.

		WBPD1 (Hamra Ave)			Crest Front	Swale	WBPD2 Crest	
Species	Total No.	**Crest Rear**	**Landward**	Total No.			**Crest Rear**	**Landward (infill)**
Grasses								
Austrostipa flavescens	40		40	270				270
Poa poiformis	40		40	300				300
Creepers; Mat	0			0				
Carpobrotus rossii	250	150	100	380	50	20	200	100
Disphyma crassifolium	60	40	20	0				
Spinifex hirsutus	460	460		700	200		425	
Kennedia prostrata	0	-	-	0		-		
Kunzea pomifera	100		100	110				110
Shrubs, small	0			0				
Dianella brevicaulis	200	100	100	650		50	200	400
Chrysocephalum apiculatum	10		10	160				160
Clematis microphylla	0			60				60
Enchylaena tomentosa	10		10	170		25	75	70
Ficinia nodosa	140	100	40	700		100	150	430
Helichrysum leucopsidium	0	-	-	0		-		
Leucophyta brownil	10		10	50				50
Lepidosperma gladiatum	20		20	20				20
Lomandra leucocephala ssp. robusta	20		20	140				140
Lotus australis	20		20	200				200
Muelhenbeckia gunnii	50		50	0				

		WBPD1 (Hamra Ave)			Crest Front	Swale	WBPD2 Crest	
Species	Total No.	**Crest Rear**	**Landward**	Total No.			**Crest Rear**	**Landward (infill)**
Pelargonium australe	20		20	70				70
Rhagodia candolleana	90	50	40	130		30	100	
Scaevola crassifolia	60	30	30	230		30		230
Senecio pinnatifolius	0			120				120
Tetragonia implexicoma	45	25	20	0				
Threlkeldia diffusa	45	25	20	0				
Shrubs, tall	0			0				
Acacia cupularis	20		20	120				120
Acacia longifolia var. sophorae	20		20	120				120
Adriana quadripitarta	20		20	185				185
Atriplex cinerea	60	30	30	100		100		
Myoporum insulare	20		20	75				75
Nitraria billardieri	40	10	30	20				20
Olearia axilllaris	280	130	150	450		100	150	200
Totals:	**2150**	**1150**	**1000**	**5530**	**250**	**455**	**1555**	**3270**

Table 4: 2022 plantings for WBPD4

		WBPD4					
Species	**Total No.**	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Grasses							
Austrostipa flavescens	0						
Poa poiformis	0						
Creepers; Mat							
Carpobrotus rossii	270		60	20	130	60	
Disphyma crassifolium	0						
Spinifex hirsutus	635	100	200		260	75	
Kennedia prostrata	0	-	-	-	-	-	-
Kunzea pomifera	0						
Shrubs, small							
Dianella brevicaulis	900			200	500	150	50
Chrysocephalum apiculatum	0						
Clematis microphylla	0						
Enchylaena tomentosa	165			50		35	80
Ficinia nodosa	660		120	120	200	120	100
Helichrysum leucopsidium	0	-	-	-	-	-	-
Leucophyta brownil	190			50	50	60	30
Lepidosperma gladiatum	70			35			35
Lomandra leucocephala ssp. robusta	100			60			40
Lotus australis	0						

		WBPD4					
Species	**Total No.**	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Muelhenbeckia gunnii	0						
Pelargonium australe	0						
Rhagodia candolleana	120		30	20	30	30	10
Scaevola crassifolia	170			60		60	50
Senecio pinnatifolius	0						
Tetragonia implexicoma	0						
Threlkeldia diffusa	0						
Shrubs, tall							
Acacia cupularis	30					10	20
Acacia longifolia var. sophorae	30					10	20
Adriana quadripitarta	0						
Atriplex cinerea	295			60	100	70	65
Myoporum insulare	65				50		15
Nitraria billardieri	0						
Olearia axilllaris	550			100	100	150	200
Totals:	**4250**	**100**	**410**	**775**	**1420**	**830**	**715**

Table 5: 2023 plantings for SVRD4.

		SVRD4 (Rockingham St) Infill					
Species	Total Number	**Stoss front**	**crest front**	**swale**	**stoss rear**	**crest rear**	**landward**
Grasses							
Austrostipa flavescens	20			10	5		5
Poa poiformis	15			5	5		5
Rytidosperma caespitosum	0						
Creepers; Mat	0						
Carpobrotus rossii	115		20	5	55	30	5
Disphyma crassifolium	35		5	5	5	15	5
Spinifex hirsutus	290		65		165	60	
Kennedia prostrata	0						
Kunzea pomifera	15			5			10
Shrubs, small	0						
Dianella brevicaulis	35			5	15	10	5
Chrysocephalum apiculatum (infill)	0						
Clematis microphylla (infill)	0						
Enchylaena tomentosa	15			5			10
Ficinia nodosa	80		5	10	30	15	20
Helichrysum leucopsidium (infill)	0						
Leucophyta brownil	25			5	5	5	10
Lepidosperma gladiatum	10			5			5
Lomandra leucocephala ssp. robusta	10			5			5
Lotus australis (infill)	0						

		SVRD4 (Rockingham St) Infill					
Species	Total Number	**Stoss front**	**crest front**	**swale**	**stoss rear**	**crest rear**	**landward**
Muelhenbeckia gunnii	20			5	5	5	5
Pelargonium australe (infill)	0						
Pimelea serpyllifolia (infill)	0						
Rhagodia candolleana	45		5	5	15	15	5
Scaevola crassifolia	20			5		10	5
Senecio pinnatifolius	5						5
Tetragonia implexicoma	45		5	5	15	10	10
Threlkeldia diffusa	50		5	5	15	15	10
Shrubs, tall	0						
Acacia cupularis	3						3
Acacia longifolia var. sophorae	3						3
Adriana quadripitarta	5						5
Allocasuarina verticillata	0						
Atriplex cinerea	43			5	20	10	8
Myoporum insulare	8				5		3
Nitraria billardieri	8					5	3
Olearia axilllaris	60			10	25	15	10
Totals	**980**	**0**	**110**	**105**	**385**	**220**	**160**

Table 6: 2023 plantings for SVRD3 and SVRD2.

		SVRD3			SVRD3 Infill			SVRD2 Infill	
Species	Total No.	**Stoss front**	**Crest Front**	**Swale**	**Stoss rear**	**Crest rear**	Total No.	**Stoss Rear**	**Crest Rear**
Grasses									
Austrostipa flavescens	40			20	10	10	0		
Poa poiformis	30			10	10	10	0		
Rytidosperma caespitosum	20			10		10	0		
Creepers; Mat									
Carpobrotus rossii	250		80	20	100	50	155	30	125
Disphyma crassifolium	65		20	20	20	5	10	5	5
Spinifex hirsutus	550	150	200		100	100	310	60	250
Kennedia prostrata	0						0		
Kunzea pomifera	50			50			0		
Shrubs, small									
Dianella brevicaulis	70			20	30	20	30		30
Chrysocephalum apiculatum (infill)	0						0		
Clematis microphylla (infill)	0						0		
Enchylaena tomentosa	40			20		20	0		
Ficinia nodosa	160		20	40	70	30	70		70
Helichrysum leucopsidium (infill)	0						0		
Leucophyta brownil	70			20	30	20	0		
Lepidosperma gladiatum	20			20			0		
Lomandra leucocephala ssp. robusta	20			20			0		
Lotus australis (infill)	0						0		

		SVRD3			SVRD3 Infill			SVRD2 Infill	
Species	Total No.	**Stoss front**	**Crest Front**	**Swale**	**Stoss rear**	**Crest rear**	Total No.	**Stoss Rear**	**Crest Rear**
Muelhenbeckia gunnii	70			40	20	10	20		20
Pelargonium australe (infill)	0						0		
Pimelea serpyllifolia (infill)	0						0		
Rhagodia candolleana	115		20	40	30	25	80	30	50
Scaevola crassifolia	40			20		20	0		
Senecio pinnatifolius	0						0		
Tetragonia implexicoma	110		20	30	40	20	60	30	30
Threlkeldia diffusa	110		20	30	40	20	60	30	30
Shrubs, tall									
Acacia cupularis	0						0		
Acacia longifolia var. sophorae	0						0		
Adriana quadripitarta	0						0		
Allocasuarina verticillata	0						0		
Atriplex cinerea	70			10	40	20	35		35
Myoporum insulare	20			10	10		0		
Nitraria billardieri	10					10	15		15
Olearia axilllaris	170			40	100	30	70		70
Totals:	**2100**	**150**	**380**	**490**	**650**	**430**	**915**	**185**	**730**

Table 7: 2023 plantings for WBPD1 and WBPD2.

		WBPD1 (Hamra Ave)				WBPD1 (Hamra Ave) Infill	
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Grasses							
Austrostipa flavescens	170			50	100		20
Poa poiformis	170			50	100		20
Rytidosperma caespitosum	60			30			30
Creepers; Mat							
Carpobrotus rossii	725	200	100	100	200	75	50
Disphyma crassifolium	230		50	50	100	20	10
Spinifex hirsutus	1160	330	300		300	230	
Kennedia prostrata	0						
Kunzea pomifera	120			70			50
Shrubs, small							
Dianella brevicaulis	250			50	100	50	50
Chrysocephalum apiculatum (infill)	0						
Clematis microphylla (infill)	0						
Enchylaena tomentosa	25			20			5
Ficinia nodosa	420		100	50	200	50	20
Helichrysum leucopsidium (infill)	0						
Leucophyta brownii	220			50	150	10	10
Lepidosperma gladiatum	40			30			10

	WBPD2				WBPD2 Crest infill	
Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward (infill)**
305			50	120		135
320			50	120		150
60			30			30
0						
860	220	120	120	250	100	50
290		60	60	120		50
1270	380	350		320	220	
0						
120			100			20
0						
250			40	110	50	50
0						
0						
120			30		40	50
655		100	60	220	75	200
0						
300			50	170	30	50
50			40			10

		WBPD1 (Hamra Ave)				WBPD1 (Hamra Ave) Infill	
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Lomandra leucocephala ssp. robusta	50			40			10
Lotus australis (infill)	0						
Muelhenbeckia gunnii	245			50	150	20	25
Pelargonium australe (infill)	0						
Pimelea serpyllifolia (infill)	0						
Rhagodia candolleana	245		60	40	100	25	20
Scaevola crassifolia	60			30		15	15
Senecio pinnatifolius	30			20			10
Tetragonia implexicoma	365		100	40	200	15	10
Threlkeldia diffusa	365		100	40	200	15	10
Shrubs, tall							
Acacia cupularis	15			5			10
Acacia longifolia var. sophorae	15			5			10
Adriana quadripitarta	10						10
Allocasuarina verticillata	0						
Atriplex cinerea	280		70	30	150	15	15
Myoporum insulare	125			15	100		10
Nitraria billardieri	25					10	15
Olearia axilllaris	305			15	150	65	75
Totals:	**5725**	**530**	**880**	**880**	**2300**	**615**	**520**

	WBPD2				WBPD2 Crest infill	
Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward (infill)**
90			40			50
0						
320			50	170	50	50
0						
0						
320		100	50	120	20	30
60			20			40
30			20			10
440		100	50	220	20	50
440		100	50	220	20	50
0						
65			5			60
65			5			60
50						50
50						50
360		70	40	170	30	50
150			20	100		30
25					10	15
340			20	170	50	100
7405	**600**	**1000**	**1000**	**2600**	**715**	**1490**

Table 8: 2023 plantings for WBPD3 and WPBD4.

		WBPD3						WBPD4 Infill						
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Grasses														
Austrostipa flavescens	310			50	120		140	290			90	150		50
Poa poiformis	320			50	120		150	290			90	150		50
Rytidosperma caespitosum	60			30			30	60			30			30
Creepers; Mat	0							0						
Carpobrotus rossii	920	170	160	100	230	200	60	400	100	50	50	150	30	20
Disphyma crassifolium	240		80	50	60		50	50		10	10	10	10	10
Spinifex hirsutus	1130	330	200		300	300		550	100	200		200	50	
Kennedia prostrata	0							0						
Kunzea pomifera	140			90			50	70			50			20
Shrubs, small	0							0						
Dianella brevicaulis	250			40	100	50	60	160			50	50	50	10
Chrysocephalum apiculatum (infill)	0							0						
Clematis microphylla (infill)	0							0						
Enchylaena tomentosa	130			30		50	50	85			25		20	40
Ficinia nodosa	590		140	50	200	50	150	330		60	60	100	60	50
Helichrysum leucopsidium (infill)	0							0						
Leucophyta brownil	240			40	120	20	60	95			25	25	30	15
Lepidosperma gladiatum	50			30			20	40			20			20
Lomandra leucocephala ssp. robusta	70			30			40	50			30			20
Lotus australis (infill)	0							0						

		WBPD3							WBPD4 Infill						
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Muelhenbeckia gunnii	310			40	150	50	70	170			50	50	50	20
Pelargonium australe (infill)	0							0						
Pimelea serpyllifolia (infill)	0							0						
Rhagodia candolleana	260		70	30	80	50	30	60		15	10	15	15	5
Scaevola crassifolia	50			10			40	85			30		30	25
Senecio pinnatifolius	20			10			10	20			10			10
Tetragonia implexicoma	380		70	40	170	50	50	150		30	30	50	30	10
Threlkeldia diffusa	380		70	40	170	50	50	150		30	30	50	30	10
Shrubs, tall	0							0						
Acacia cupularis	55			5			50	20			5		5	10
Acacia longifolia var. sophorae	55			5			50	65			50		5	10
Adriana quadripitarta	50						50	20						20
Allocasuarina verticillata	50						50	0						
Atriplex cinerea	310		40	30	140	50	50	170		20	30	50	35	35
Myoporum insulare	140			10	100		30	45			10	25		10
Nitraria billardieri	40					20	20	20					10	10
Olearia axilllaris	300			20	140	60	80	275			50	50	75	100
Totals:	**6850**	**500**	**830**	**830**	**2200**	**1000**	**1490**	**3720**	**200**	**415**	**835**	**1125**	**535**	**610**

Table 9: 2024 planting distribution for SVRD4.

		SVRD4 (Rockingham St) Infill					
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Grasses							
Austrostipa flavescens	10			5	5		
Poa poiformis	10			5	5		
Rytidosperma caespitosum	0						
Creepers; Mat							
Carpobrotus rossii	75		20	5	50		
Disphyma crassifolium	15		5	5	5		
Spinifex hirsutus	170	20	50		100		
Kennedia prostrata	10						10
Kunzea pomifera	5			5			
Shrubs, small							
Dianella brevicaulis	10			5	5		
Chrysocephalum apiculatum (infill)	30			10			20
Clematis microphylla (infill)	20						20
Enchylaena tomentosa	5			5			
Ficinia nodosa	35		5	10	20		
Helichrysum leucopsidium (infill)	20						20
Leucophyta brownil	10			5	5		
Lepidosperma gladiatum	5			5			
Lomandra leucocephala ssp. robusta	5			5			
Lotus australis (infill)	25			5			20

		SVRD4 (Rockingham St) Infill					
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Muelhenbeckia gunnii	10			5	5		
Pelargonium australe (infill)	20						20
Pimelea serpyllifolia (infill)	40			20			20
Rhagodia candolleana	25		5	5	15		
Scaevola crassifolia	5			5			
Senecio pinnatifolius	20			10			10
Tetragonia implexicoma	25		5	5	15		
Threlkeldia diffusa	25		5	5	15		
Shrubs, tall							
Acacia cupularis	0						
Acacia longifolia var. sophorae	0						
Adriana quadripitarta	0						
Allocasuarina verticillata	0						
Atriplex cinerea	10				10		
Myoporum insulare	5				5		
Nitraria billardieri	0						
Olearia axilllaris	15			5	10		
Totals	**660**	**20**	**95**	**135**	**270**	**0**	**140**

Table 10: 2024 planting distribution for WBPD1 and WBPD2

		WBPD1 (Hamra Ave) Infill							WBPD2 Infill						
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward (infill)**
Grasses														
Austrostipa flavescens	130		45	25	50		10	185		50	25	60		50
Poa poiformis	130		45	25	50		10	185		50	25	60		50
Rytidosperma caespitosum	45			15			30	35			15			20
Creepers; Mat														
Carpobrotus rossii	360	100	50	50	100	30	30	425	110	60	60	125	50	20
Disphyma crassifolium	120		25	25	50	10	10	140		30	30	60		20
Spinifex hirsutus	565	165	150		150	100		620	190	170		160	100	
Kennedia prostrata	20						20	20						20
Kunzea pomifera	55			35			20	70			50			20
Shrubs, small														
Dianella brevicaulis	115			25	50	20	20	135			20	55	30	30
Chrysocephalum apiculatum (infill)	50						50	40			10			30
Clematis microphylla (infill)	50						50	30						30
Enchylaena tomentosa	15			10			5	65			15		20	30
Ficinia nodosa	40					30	10	310		30	30	110	40	100
Helichrysum leucopsidium (infill)								30						30
Leucophyta brownil	110			25	75	5	5	150			25	85	20	20
Lepidosperma gladiatum	20			15			5	25			20			5
Lomandra leucocephala ssp. robusta	30			20			10	40			20			20
Lotus australis (infill)	0							30						30

		WBPD1 (Hamra Ave) Infill							WBPD2 Infill						
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward (infill)**
Muelhenbeckia gunnii	120			25	75	10	10	170			25	85	30	30
Pelargonium australe (infill)	20						20	30						30
Pimelea serpyllifolia (infill)	20						20	50			20			30
Rhagodia candolleana	115		25	20	50	10	10	140		25	25	60	10	20
Scaevola crassifolia	25			15		5	5	30			10			20
Senecio pinnatifolius	20			10			10	20			10			10
Tetragonia implexicoma	160		25	20	100	10	5	205		30	25	110	10	30
Threlkeldia diffusa	160		25	20	100	10	5	205		30	25	110	10	30
Shrubs, tall														
Acacia cupularis	8			3			5	22.5			2.5			20
Acacia longifolia var. sophorae	8			3			5	22.5			2.5			20
Adriana quadripitarta	5						5	20						20
Allocasuarina verticillata	0							50						50
Atriplex cinerea	135		25	15	75	10	10	170		25	20	85	10	30
Myoporum insulare	60			5	50		5	80			10	50		20
Nitraria billardieri	15					5	10	15					5	10
Olearia axilllaris	120			5	75	20	20	175			10	85	30	50
Totals	**2846**	**265**	**415**	**411**	**1050**	**275**	**430**	**3940**	**300**	**500**	**530**	**1300**	**365**	**945**

Table 11: 2024 planting distribution for WBPD3 and WBPD4.

		WBPD3 Infill						WBPD4 Infill						
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Grasses														
Austrostipa flavescens	200		45	25	60		70	195		50	45	75		25
Poa poiformis	205		45	25	60		75	195		50	45	75		25
Rytidosperma caespitosum	30			15			15	30			15			15
Creepers; Mat	0							0						
Carpobrotus rossii	430	85	50	50	115	100	30	200	50	25	25	75	15	10
Disphyma crassifolium	105		25	25	30		25	25		5	5	5	5	5
Spinifex hirsutus	615	165	150		150	150		275	50	100		100	25	
Kennedia prostrata	20						20	20						20
Kunzea pomifera	70			45			25	35			25			10
Shrubs, small	0							0						
Dianella brevicaulis	125			20	50	25	30	80			25	25	25	5
Chrysocephalum apiculatum (infill)	60			30			30	60			30			30
Clematis microphylla (infill)	30						30	30						30
Enchylaena tomentosa	65			15		25	25	43			13		10	20
Ficinia nodosa	250		25	25	100	25	75	165		30	30	50	30	25
Helichrysum leucopsidium (infill)	30						30	30						30
Leucophyta brownil	120			20	60	10	30	47			12	12	15	8
Lepidosperma gladiatum	25			15			10	20			10			10

		WBPD3 Infill							WBPD4 Infill						
Species	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**	Total No.	**Stoss Front**	**Crest Front**	**Swale**	**Stoss Rear**	**Crest Rear**	**Landward**
Lomandra leucocephala ssp. robusta	35			15			20	25			15			10
Lotus australis (infill)	60			30			30	60			30			30
Muelhenbeckia gunnii	155			20	75	25	35	85			25	25	25	10
Pelargonium australe (infill)	30						30	30						30
Pimelea serpyllifolia (infill)	60			30			30	60			30			30
Rhagodia candolleana	110		15	15	40	25	15	32		8	5	8	8	3
Scaevola crassifolia	25			5			20	40			15		15	10
Senecio pinnatifolius	10			5			5	10			5			5
Tetragonia implexicoma	175		20	20	85	25	25	75		15	15	25	15	5
Threlkeldia diffusa	175		20	20	85	25	25	75		15	15	25	15	5
Shrubs, tall	0							0						
Acacia cupularis	28			3			25	11			3		3	5
Acacia longifolia var. sophorae	28			3			25	11			3		3	5
Adriana quadripitarta	25						25	10						10
Allocasuarina verticillata	25						25	30						30
Atriplex cinerea	155		20	15	70	25	25	100		20	15	25	20	20
Myoporum insulare	70			5	50		15	20			5	10		5
Nitraria billardieri	20					10	10	10					5	5
Olearia axilllaris	150			10	70	30	40	140			25	25	40	50
Totals	**3716**	**250**	**415**	**506**	**1100**	**500**	**945**	**2274**	**100**	**318**	**486**	**560**	**274**	**536**

5.0 MONITORING

5.1 Weed Control

Site inspection for weeds should be carried out prior to each planting season, to both monitor the effectiveness of any weed eradication works conducted in the previous year, and to detect any new plants that require eradication either during or after the planting season.

Where the restoration contractor is engaged to undertake a weed control program, a weed control plan should be developed.

5.2 Pest Control

Inspection of planted areas should be carried out to detect any grazing from pest animals such as rabbits. If significant evidence of rabbit grazing is detected, or active warrens detected, the local council or land manager should be noted to ensure appropriate eradication measures can be enacted.

5.3 Planting inspection

Before placing a tubestock order for the following year an inspection of recent plantings should be undertaken to help estimate the infill numbers required to be ordered. This will only be an estimate, as orders need to be placed in October for the following year, which means the inspection will only take place a few months after the planting event. Plantings can be inspected again in February of the following year to determine survivorship and adjust seeding levels, and possibly tubestock numbers, for the coming planting season.

5.4 Infrastructure

Annual inspection should also be carried out for any infrastructure installed to support the revegetation program. This includes irrigations systems, fencing signage. Where damage or wear and tear is detected, it should be fixed as soon as possible.

6.0 REFERENCES

Department of Land and Water Conservation (2001), *Coastal Dune Management.* NSW Government, Newcastle.