



Hoopers Beach Robe Dune Erosion Assessment Report

Quality Information

Document Draft Report




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1. Background

The District Council of Robe (Council) has in the past 3 years noted accelerated erosion of the existing foredune at Hooper Beach Robe resulting in the eroded dune edge getting close to existing private dwellings located on the north side of Seafarers Crescent.

The existing beach which is approximately 240m long and comprises limestone headlands at its western and eastern ends, is widely used by local residents and visitors however the existing erosion scar at the back of the beach towards the western end is causing a public safety hazard and is encroaching closer to private dwellings.

The beach is publicly accessible from an existing concrete ramp at the western end, a walking trail at the eastern headland and from informal tracks from the private dwellings abutting Seafarers Crescent.

Council has commissioned Civil & Environmental Solutions Pty Ltd to undertake a study of the problem comprising:

- An assessment of the likely causes of the erosion and coastal processes;
- Identifying long term erosion and inundation risk assessment under sea level rise;
- Identifying and evaluating potential adaptation options

The site is shown in Figure 1.



Figure 1-Study Locality Plan

Source: Google 2018 Imagery

The study provides the results of the assessment.

2. Assessment Methodology

The assessment involved the following tasks:

- Site visit and meeting with the Council CEO Mr Roger Sweetman to gain and appreciation of historical wave tidal and erosion events, observe existing erosion and wave breaking patterns;
- Review of available data (BOM wind and tidal data, Department of Environment and Water (DEW) including Coastal profile surveys and 1% AEP Still Water levels wave set up and wave run up);
- Undertaking a detailed engineering survey of the section of coast dune and beach from the seven private dwellings to the low water mark;
- Telephone and e-mail Liaison with DEW Coastal and River Murray Unit of Coast Protection Board to obtain critical current 2050 and 2100 wave climate information and historical coastal profiles and historical aerial photos;

- Calculate significant wave height for the critical north north-west fetch for the 1% AEP event;
- Undertake S Beach modelling to calculate the estimated dune erosion from a 1%AEP storm surge event and 5 May 2016 event;
- Estimate the projected long term erosion including storm surge annual recession and recession under sea level rise using the Bruun rule.
- Undertake a desk top risk assessment of the potential erosion and inundation impacts including mapping hazard lines arising from a breach of the existing dune under existing and projected 1% AEP still water levels and under sea level rise;
- Identify potential dune management options including access management options as well as a CAD sketch of the preferred option overlaid on the survey and aerial photography;
- Provide a draft and final report of the findings options and recommendations;
- Meeting with DEW staff in Adelaide to discuss draft report and options;
- Conduct an elected member briefing of the findings and options in Robe;
- Attend a public meeting organized by Council with abutting residents and land owners at Council's offices;
- Provide a final report.

3 Site Inspection & Site Observations

Based on an inspection and discussions with Mr Roger Sweetman the following observations were made:

- There are several dune erosion scars along the length of the back of the beach zone, with the dune erosion scar at the western end in close proximity to the dwelling at the western end of the beach;
- There are several localized dune erosion hot spots at five existing informal beach pedestrian access points;
- The crown land zone between the top of the dune and the private dwellings is heavy vegetated with native coastal vegetation;
- There beach is exposed to long fetch waves from the north north-west.



View of eroded dune towards western end of Hooper Beach looking east



View of eroded dune at Hooper Beach from eastern end looking west



View of eroded dune near dwelling at western end of Hooper Beach



Example of localized dune erosion at informal pedestrian access



Example of localized dune erosion at informal pedestrian access



Example of localized dune erosion at informal pedestrian access interface



Example of existing dune vegetation



Example of existing dune vegetation and informal pedestrian access

4 Discussions with Key Stakeholders

4.1 *Client*

Discussions were held with Mr Roger Sweetman CEO DC Robe to gain an appreciation of past storm surge events and erosion and access management activities at the site and the following information was offered:

- The erosion has been ongoing in recent years but began to accelerate approximately 3 years ago and the toe of the dune has receded inland by 2.5-3m since;

- The existing erosion scar at the western end of the beach is getting close to the western most dwelling and local residents are requesting protection works

4.2 **DEW**

Based on face to face discussions with DEW Coastal Management Branch staff on 21 August 2018, the Coastal Management Branch (CMB) agree that dune management measures are required at Hooper Beach and suggest an erosion monitoring program be implemented to inform triggers for more long term solutions.

Sand nourishment was encouraged as a short term measure subject to availability of suitable quantities of coarser sand together with beach access management strategies.

The use of a shore normal geotextile bag groyne at the eastern end of the beach was suggested as a possible option for encouraging sand build up at the front of the beach and additional beach width to offset any potential sand loss from annual and seasonal storm surges.

Estimated current 1 in 100 year ARI (1%AEP) storm surge SWL for Robe is 1.50m AHD with wave set up and wave run up of 0.2m and 0.3m respectively so current design water level =2.00m AHD with site levels to make provision for 0.3m of sea level rise by 2050.

5 Coastal Processes

5.1 **Reference Document Review**

A number of reference documents comprising various past studies investigations and designs as provided by Council DEWNR and public sources were perused and are summarised below.

- Robe Airport historical Wind Roses 9am and 3pm (BOM);
- Cape Jaffa Robe and Beachport 2016 & 2018 Tide predictions (BOM);
- Victor Harbor Monthly Tide Gauge Sea level observations 1964-2016
- Tidal planes from (National Tidal Unit; BOM;
- DEW coastal profiles 2000-2018 for profile Numbers 735002 approximately 2km to the east at Long Beach and 7355004 located approximately 0.3km to the west of the site;
- Near Maps Robe Coastal Bathymetry;
- District Council of Robe Development Plan;
- Engineering survey of the site and surrounds Alexander Symons July 2018.

The key findings from the review were:

- Highest recorded tide level=+1.37mAHD
- Highest Astronomical Tide (HAT)=+0.6mAHD;

- Mean High High Water (MHHW)=+0.50 AHD;
- Mean sea level (MSL) =0m AHD);
- Mean Low Water Springs (MLWS)=-0.4m AHD
- Lowest Astronomical Tide (LAT)=-0.6m AHD
- 1% AEP Storm Surge Still Water level=+1.50m AHD
- Council Development Plan Minimum site level-2mAHD

5.2 Wind Patterns

Winds generate currents and waves, which in turn are directly responsible for sand transport and erosion along the coast. Wind data from the Bureau of Meteorology (BoM) at the Robe airport weather station has been analysed for annual and seasonal distributions.

The seasonal wind patterns in the Southern Ocean and lower south east coast have been examined and show a distinct seasonal pattern where the dominant winds are from the south, south-south-west, and south-east in summer and north and west in winter. The cold fronts in winter and spring are associated with mid-latitude low-pressure systems. The westerlies and south-westerlies generate storm surges of at half a meter in height following the passage of cold fronts (Government of South Australia, 2013).

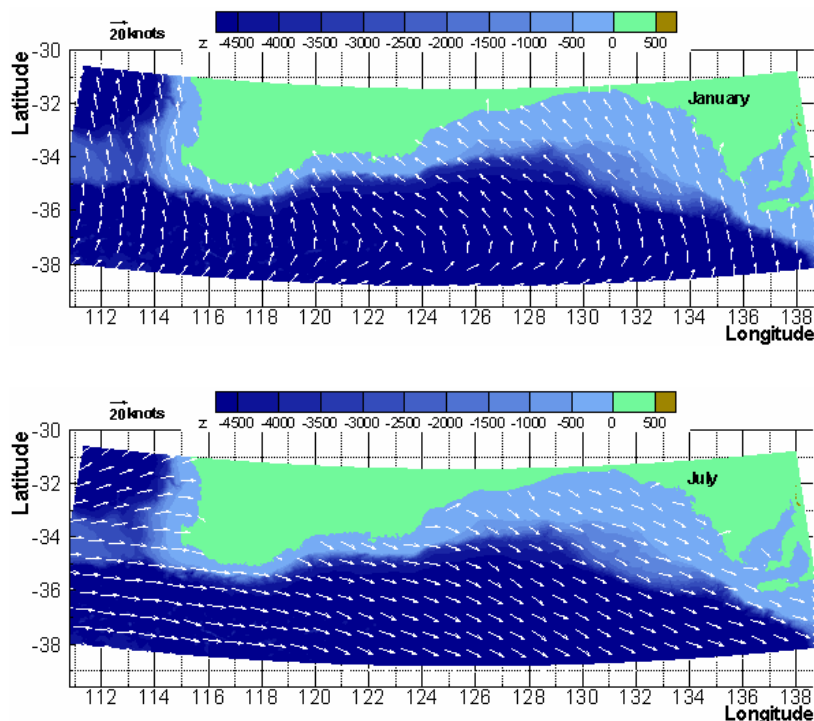


FIGURE 2 WIND PATTERNS IN SUMMER (UPPER) AND WINTER (LOWER).

The annual and winter wind distribution patterns at Robe are shown in Figures 3 & 4 where the 9 am winds blow from virtually all directions but the north west, west and south west are dominant at 3 pm with the winter winds being stronger.

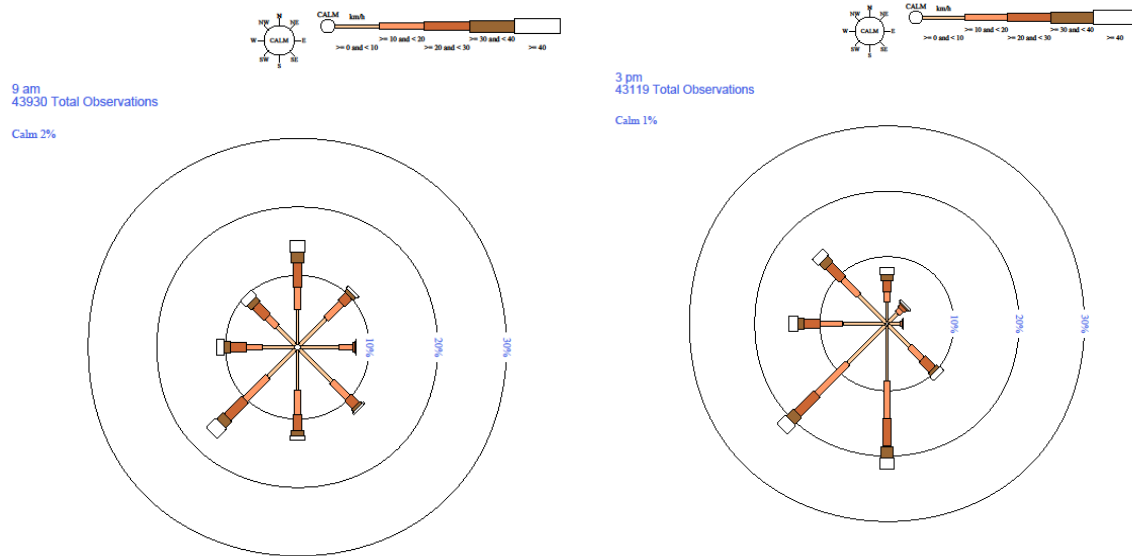


Figure 3 Annual wind roses at Robe Airport. Left panel shows winds (9 am) and the right panel shows winds at 3 pm (Source: Bureau of Meteorology).

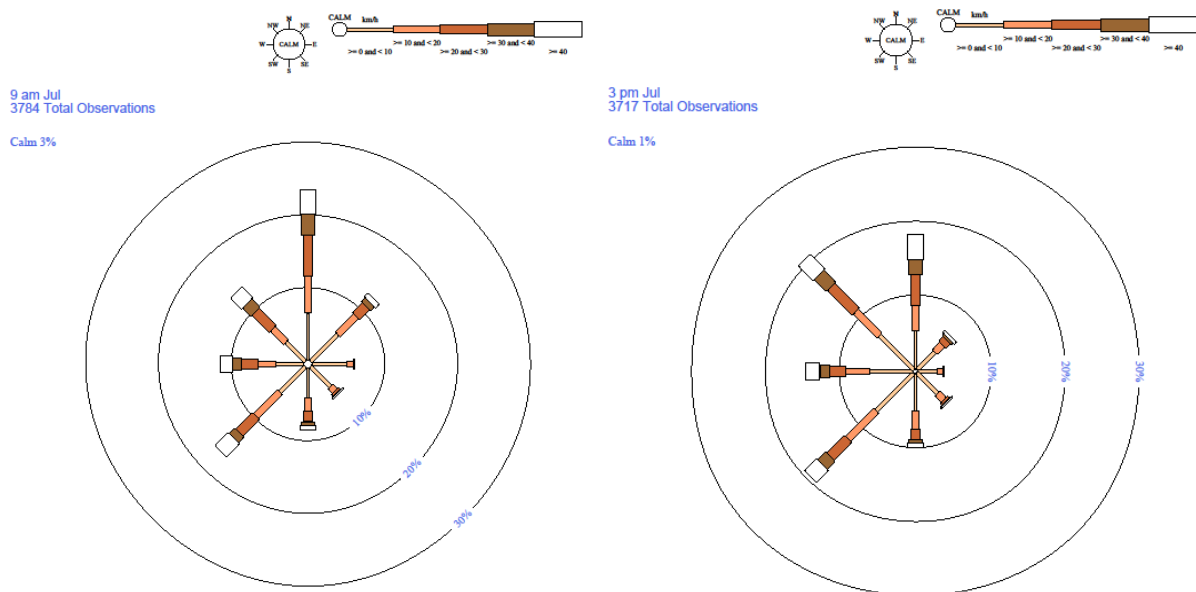


Figure 4 Winter wind roses at Robe. Left panel shows winds (9 am) and the right panel shows winds at 3 pm (Source: Bureau of Meteorology).

The above wind roses confirms a dominant north and north west wind in the winter period.

5.3 Waves

5.3.1 Swell Waves

The Southern Ocean is the most intense of all oceans. Large ocean swell waves from the Southern Ocean generated by winds blowing over the ocean in both the Southern and the Indian Oceans penetrate into the lower south east coast south of Cape Jaffa. Swells of up to 12m have been observed at the Cape De Couedic wave rider buoy south west of Kangaroo Island in the past three years(BOM.) and large swells have recently been observed in Guichen Bay.

An examination of SWAN wave modelling for the Cape Jaffa Anchorage EIS estimates swell waves of up to 4m entering Guichen Bay but due to the relatively shallow and sheltered nature of Guichen Bay, the flat relatively shallow bathymetry (depth range 6-10m) and the presence of emergent reefs in the near shore zone adjacent to the site and at Boatswain Point, some of the swell wave energy would be dissipated before reaching Hooper Beach.

5.3.2 Wind waves

The critical onshore shore-normal wind wave climate at Hooper Beach will be governed by local winds generated from the north north-west of Boatswain Point south of Cape Jaffa where the fetch is 22Km and an average water depth ranging from of 6-7.5m assuming depth limited conditions are considered representative for estimating Hooper Beach wind waves.

Refer Figures 5 & 6



Figure 5-Local Bathymetry

Source: NEARMAPS

Hooper
Beach

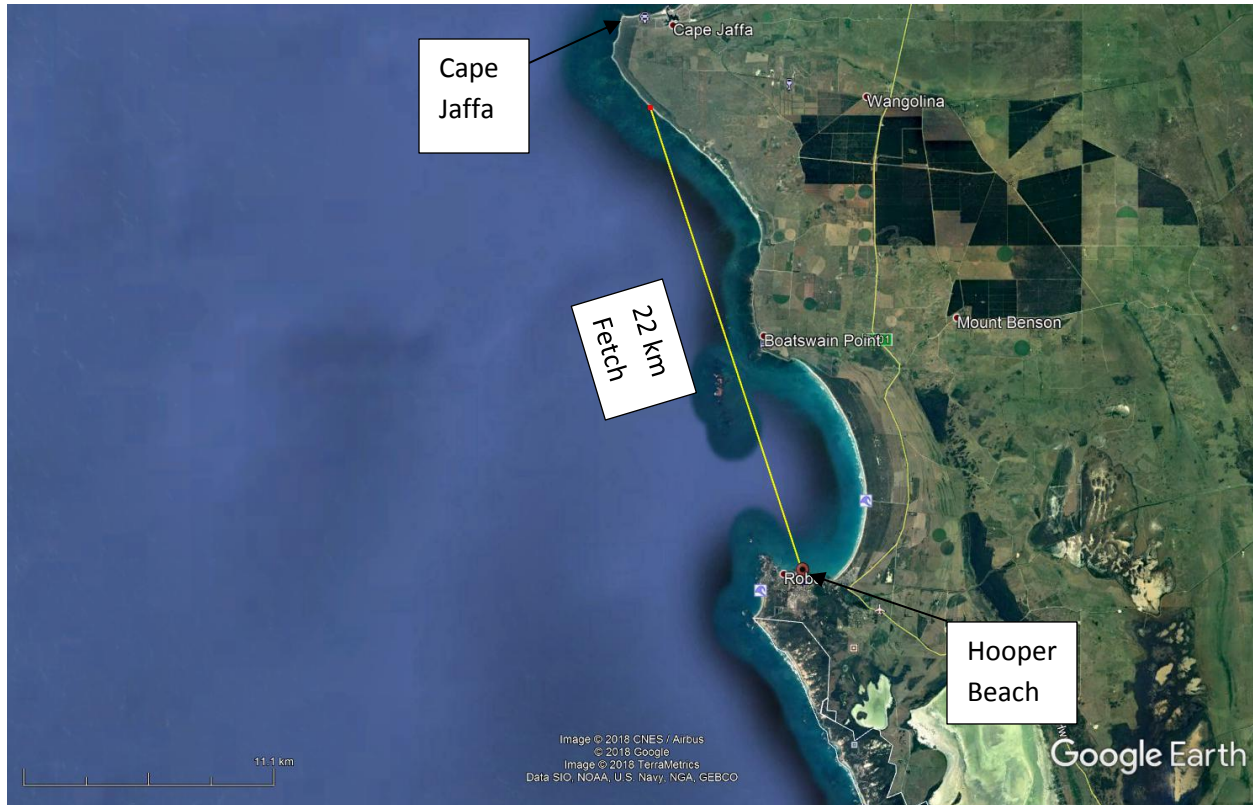


Figure 6-Hooper Beach North-North-West Fetch

Source: GOOGLE EARTH

Using the fetch above and the extreme wind speeds from the Australian Standard AS1170.2 wind code, the wind-waves generated by 1% (100 year) winds for 6m and 7.5m average water depths have been calculated. In this report, we will henceforth refer to extreme events using the AEP or the annual exceedance probability instead of the average recurrence interval (ARI).

The simple wind-growth functions (Coastal Engineering Manual) were employed to compute the wind-waves. The 3-s gust from AS1170.2 was converted to a mean-hourly wind speed at 10m elevation required for wave generation. Directional factors were applied to the wind speed. Table 1 presents the results of the wind-wave analysis.

TABLE 1: WIND-WAVE PARAMETERS AT HOOPER BEACH NNW WIND 1% AEP STORM EVENT

Average Water Depth(m)	Mean hourly wind speed (m/s)	Hs (m)	T (s)
6.0	36.2	1.8	7.0
7.5	36.2	2.1	7.0

It should be noted that this method assumes that the wind is constant across the fetch and the waves are coincident with the winds. It does not take into account the complex bathymetry. This may result in overestimation of wave heights. Long-term wave measurements at the site or a numerical wave model set-up with representative bathymetry and realistic boundary conditions would provide an accurate estimate of wave parameters at the site.

The presence of the partially submerged limestone reef immediately to the northwest of the existing beach may cause some wave shoaling and refraction of extreme waves prior to reaching the existing beach and may cause a localised elevation of water levels at the western end of the beach.

For the purpose of wave overtopping and S Beach modelling for short term storm surge erosion, an offshore significant wave height for the 1% AEP event of 2.1 m has been adopted with a corresponding wave period of 7.0s.

5.4 Sea levels including storm surge and sea level rise

5.4.1 Existing Climatic Conditions

The shape and bathymetry of the bay would lead to a low to moderate tidal range within the bay with an estimated average daily tidal range of 0.7-1.2m.

Extreme sea levels are caused by a combination of astronomical tides and storm surge (high wind stress and low atmospheric pressure), and wave setup. Extreme sea levels cause flooding and also facilitate wave damage by raising the base level for run up and overtopping, by allowing increased depth-limited wave heights, and by shifting the zone of wave attack further shoreward such that waves can damage coastal structures.

The tide observations from Table 4.12 of the Cape Jaffa EIS reported at Robe are shown in Table 2.

Table 2: Estimated Tidal Planes at Robe Main Beach (Cape Jaffa EIS 2005) & Tide Tables.

Tidal Planes	m AHD	m CD
Highest recorded tide (source: Ports Corp Flinders Ports)	1.37*	1.97*
HAT	0.6	1.2
MHWS	0.5	1.1
MSL	0.0	0.60
MLWS	-0.4	0.2
LAT	-0.6	0.0

* Based on 1952 observation by Ports Corp. NB Tides on 9 May 2016 were highest on record so would have been exceeded.

It should be noted that up to 90mm of sea level rise had been recorded at the former Port Stanvac tide gauge over a twenty-year period prior to its decommissioning so present tide levels may be up to 90-100mm higher than shown in Table 2.

South Australia is not deemed a tropical cyclone risk area with a low probability of occurrence, however coastal areas can still potentially be affected by storm surge. The South Australia planning guidance for coastal development refer to the 100-year Average Recurrence Interval (ARI) 1% AEP sea level rather than a storm surge level.

5.4.2 Future Climatic Conditions

All coastal infrastructure needs to incorporate allowances for future rises in sea level. Such provisions for a long term rise in sea levels will need to consider both the projected sea level rise and associated increases in storm surge. The sea level has been projected to rise by 1.0 m by 2100. However recent observations of faster than predicted melting of ice in the polar caps have led to increased sea level rise projections by 2100 to 1.1 - 1.4 m. For this study, following recommendations of DEW, sea level rise of 0.3 m to 2050 and 1.0 m to 2100 has been adopted.

2050 Projections

The 2050 projected sea level at Hooper Beach for the 1% AEP storm event is computed as 2.3m AHD. It includes the astronomical tide, storm surge, wave set-up, wave run-up, and sea level rise as shown in Table 3.

2100 Projections

The 2100 projected sea level at the beach for the 1% AEP storm event is computed as 3.0 m AHD. It includes the astronomical tide, storm surge, wave set-up, wave run-up, and sea level rise as shown in Table 3.

Whilst the changes in wind intensities and directions are not considered robust, CSIRO has undertaken studies that predict that extreme wind speeds will decrease in most parts of South Australia in summer and winter while these would increase in autumn in the north of the state (Government of South Australia, 2013).

The frequency of winter time low pressure systems is projected to decrease by about 20% in the vicinity of South Australia based on current water levels, however research by DEW and others indicates that 0.3m of sea level rise would equate to a 1%AEP storm occurring at 5 yearly intervals.

The information on sea levels provided by DEWNR is provided in Table 3.

TABLE 3 ESTIMATES OF SEA LEVEL COMPONENTS PROVIDED BY DEW.

Sea level components	m
Current 1% AEP (100 year ARI) sea level (tide plus storm surge)	1.50 m AHD
Wave set-up	0.2 m
Wave run-up	0.3 m
Current sea level for planning	2.0m AHD
Future Sea level to 2050 for planning	2.3m AHD
Future Sea level rise to 2100 for planning	3.0 m AHD

5.5 Erosion

5.5.1 Coastal Erosion and Recession

Coastal erosion refers to the erosion of beaches and cliffs due to waves, tides and storm surge while shoreline recession is the long-term change in shoreline position due to waves, sea levels and sediment transport patterns. Both affect the safety of assets and the people living and working within the risk areas.

Coastal erosion can have both long and short term impacts. These include the loss of land as well as short term damage due to storm erosion.

Coastal erosion can be caused by three different mechanisms:

- 1) Short-term storm erosion

It is the combination of vertical erosion of the beach profile and the horizontal recession of the coastline that occurs during a storm event. During a large storm event, sand can be moved from the beach, to deeper water. Over time, the beach profile generally returns to the original configuration as sand is redistributed.

2) Long-term coastal erosion

Long term coastal erosion refers to historical changes in the shoreline position where the shoreline is receding landward over time due to various natural and man-made processes. It includes longshore transport, the movement of sand parallel to the shore, induced by waves or currents running parallel to the coast line. This can be either erosion or deposition of sand from coastal processes such as tides, waves or currents.

For Hooper Beach longshore transport would be limited due to the presence of the rock headlands at each end.

3) Recession due to sea-level rise

Increases in sea level can lead to erosion of unconsolidated sands. Bruun hypothesized that a beach assumes a profile that is in equilibrium with the incoming wave energy (Bruun, 1954) (Bruun, 1962) (Bruun, 1983), therefore, a rise in sea level would cause the profile to adjust.

Bruun's rule is defined as follows.

$$R = \frac{S}{(h_c + B)/L}$$

Where:

R = Shoreline recession due to sea level rise

S = Sea level rise

B = Berm height

h_c = Depth of closure

L = Length of active zone

Utilising the Bruun Rule, it is possible to determine the potential erosion due to sea level rise. This takes into consideration the magnitude of the sea level rise and the profile of the beach. Application of the Bruun Rule is subject to certain assumptions and limitations, which include presence of unconsolidated sands, equilibrium profile and cross-shore transport only.

Short-term Storm Erosion

Morphological response of the shoreline due to storm wave conditions occurs over relatively short periods of time (hours to days). This response primarily involves the erosion of the sub aerial beach face or storm cut through offshore transport and deposition near the storm wave break point to form an offshore bar. It is referred to as cross-shore or onshore-offshore transport. During a large storm event, sand can be moved from the beach, to deeper water. Over time, the beach profile generally returns to the original configuration as sand is redistributed.

Short term storm based erosion has been assessed using S Beach as part of this study and the results are shown in Figure 7 based on the DN 50=0.2mm sand grain size determined from the laboratory Particle size distribution and the surveyed beach and dune profile.

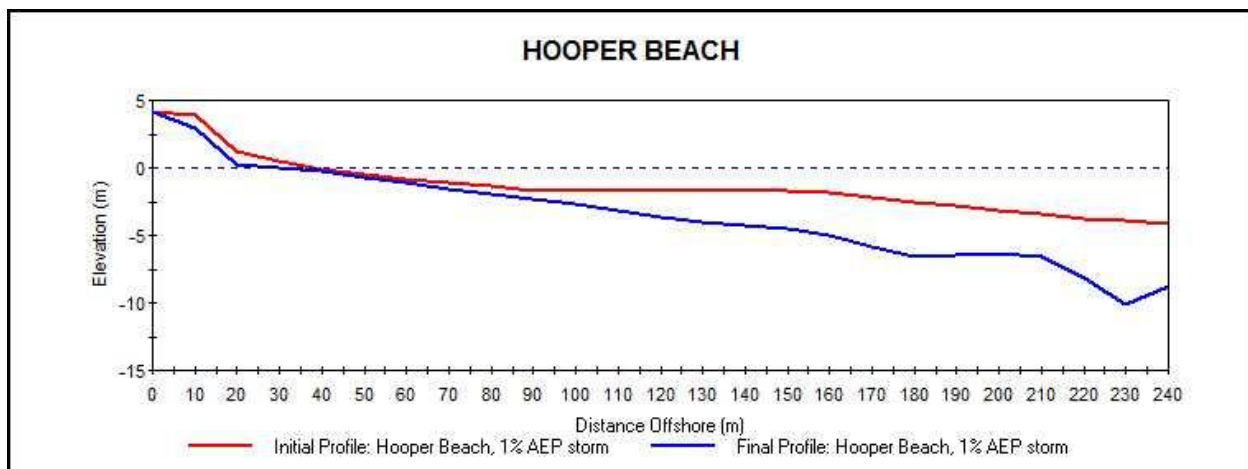


Figure 7-Storm surge erosion under 1%AEP storm

The estimated volume of sand eroded from the front and back of the beach in such a storm over the 195m beach length is 10,200m³.

This compares to an estimated eroded volume of 1730m³ since 2016.

5.5.2 Long Term Recession

Long term landward recession of the coastline can vary significantly along sandy coastlines ranging from 0.25m/pa to more than 1m/pa and would be expected to be greater on unprotected sections of coastline.

An examination of DEW Profile Number 735004 located at the Caravan Park 300m to the west in Figure 8 which has an alignment and near shore reefs similar to Hooper Beach indicates that between 2014 and 2018 the beach profile has been modified as shown in Table 4.

Table 4: Estimated Historical Changes in Beach Profile

Location	Recession (m)
Profile 735004 Back of Beach (2m AHD) 2013-2018	0
Profile 735004 Back of Beach (1.0m AHD) 2013-2018	+1
Profile 735004 front of beach (0mAHD) 2013-2018	-2
Profile 735004 Nearshore Zone (-1m AHD) 2013-2018	-3*
Profile 735004 Nearshore Zone (-2m AHD) 2013-2018	-5*

*Possibly influenced by nearshore reef

Source: DEW

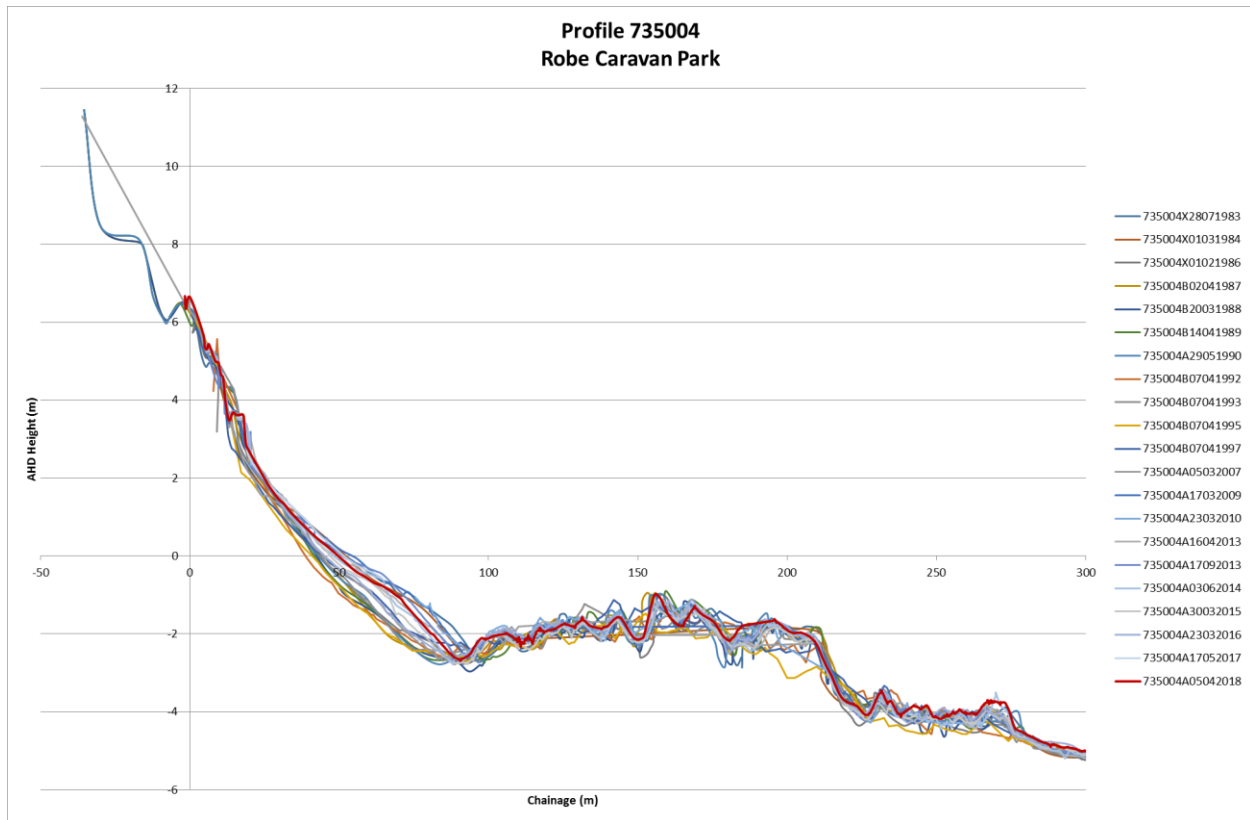


Fig 8-DEW Profile 735004

Source-DEW

This indicates between 2010-2018 significant erosion has occurred at the front of the beach and intertidal near shore zone with minimal erosion above 2m AHD at the existing sandy beaches east and west of Hooper Beach site.

An examination of a 1986 oblique photograph provided by Council indicates that the front of beach and toe of dune position is several metres seaward of the current position with a small 1m high vegetated foredune present at the back of the beach. This would indicate up to 7-10m of recession since 1986.

It should be noted that although the profile data does show a loss in recent times, the erosion currently experienced is still within historic levels.

Based on the above an average annual recession rate of 0.2m pa at the back of the beach may be an appropriate estimate of long term recession for Hooper Beach.

Long term variability in beach levels indicates that this current erosion trend may be cyclic, with a current trend towards loss. Therefore there is the potential for the system to recover which may impact on the timing of any long term hard engineering options.

An examination of the August 2018 engineering survey of Hooper beach, indicates the current back of the beach/toe of dune level ranges from 1.60m AHD at the western end to 2.3m AHD at the eastern end.

This confirms the current toe of dune in the main beach section is currently at or above the 1% AEP Storm tide planning level of 2m AHD.

It is noted that the back of beach above RL 0.49m AHD 1.2m AHD has a 7.1% slope. This compares closely with the intertidal profile measured at Profile 735004 in 2018.

It is also noted that the current top of dune erosion line is approximately 6.8m from the western edge of the western most dwelling fronting Seafarers Crescent and also extends inland at five existing informal beach access points.

The dune crest is typically set back 3m from the current erosion line and has an elevation abutting the dwellings ranging from 4.4m AHD at it's lowest point at the western end to 5.7m AHD at its highest point at the eastern end.

A low lying area at an elevation of 1.7m AHD set back behind the primary dune approximately 85m from the coastal edge within native coastal vegetation, exists at the eastern end.

5.5.3 Recession due to Sea Level Rise (future climate)

The application of the Bruun Rule requires the presence of unconsolidated sand and an equilibrium profile as described above. The requirements of the Bruun rule are considered to be satisfied for this section of beach.

The berm height (4.80m), depth of closure (depth beyond which there is minimal sediment movement) of 4.0m (from 0 to -4.0 m AHD), and the active length of the profile (200 m) have been taken from the profile 735004 shown in Figure 7.

The recession due to sea level rise for future climate projections is computed as shown in Table 5

TABLE 5 RECESSION DUE TO SEA LEVEL RISE ON FOX BEACH ASSUMING NO PROTECTION FROM A SEA WALL.

Recession due to sea level rise (m) – Bruun Rule		
	2050 (0.3m SLR)	2100 (1m SLR)
L = 200	6.8	22.7

There are large uncertainties associated with the estimates in Table 5 therefore these estimates should be treated with caution.

5.5.4 Total estimated coastal recession

The total estimated coastal recession in 2050 & 2100 allowing for short term erosion, long term recession and erosion from sea level rise is estimated at 18.2m and 47.1m respectively as shown in Figure 9.

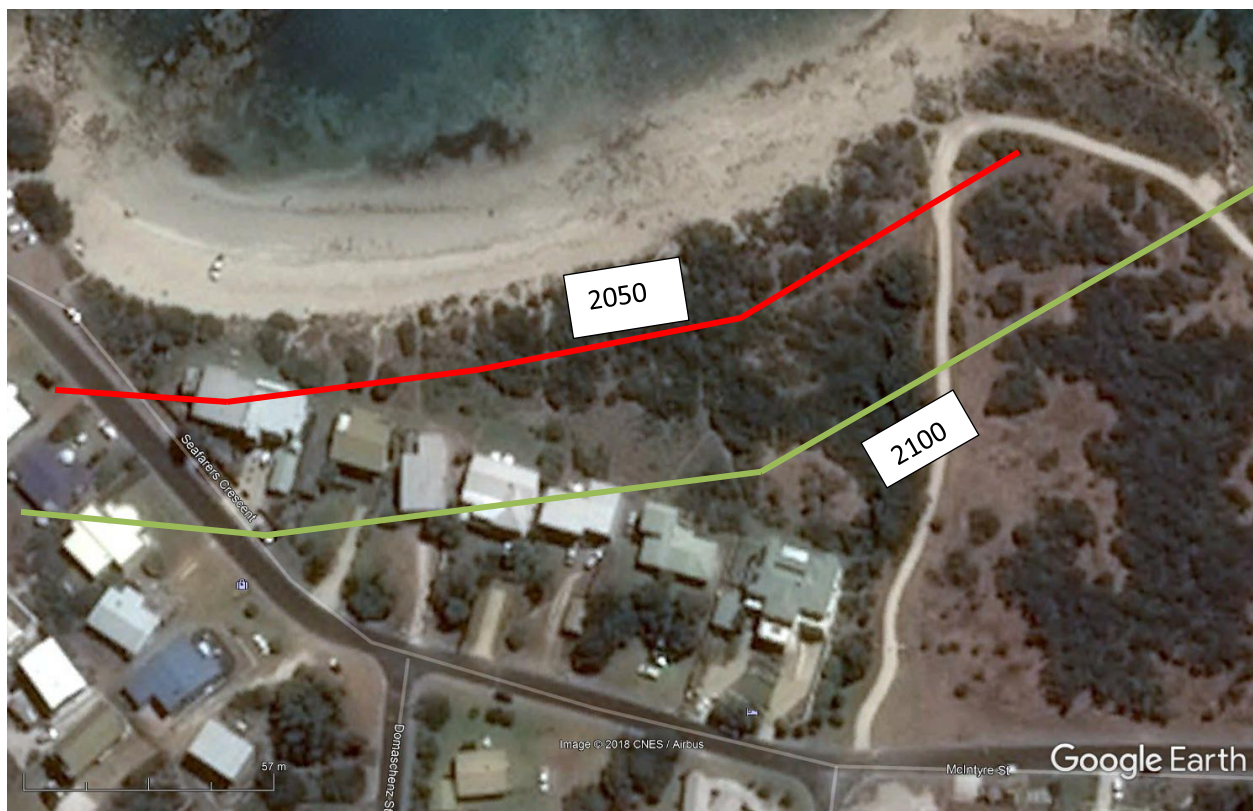


Figure 9 -Hooper Beach Long Term recession

5.5.5 Causes of Current Accelerated Dune Erosion

The recent accelerated erosion experienced at Hooper Beach is considered to be a result of the following factors:

- Large storm surge events in 2016 in conjunction with record tide levels forcing waves directly onto coastal dunes with high wave run up eroding the toe of the dune causing dune collapse;
- Large swells in the past few weeks in Guichen Bay generated from abnormally large swells in the Southern Ocean;
- The resultant storm cut and wave run up erosion and fine sand grain size causing the dune along the 195m beach length to become unstable and collapse.
- Additional top of dune erosion from five existing uncontrolled pedestrian access.

6 Coastal Hazards Risk Assessment

6.1 Coastal Hazards

6.1.1 Current Hazards & Risks (0-10 years)

The current hazards and risks at Hooper Beach are:

- Personal injury risk to pedestrians due to dune collapse;
- Loss of dune vegetation and sand drift due to wave erosion and uncontrolled pedestrian access

6.1.2 Future Hazards & Risk (Beyond 10 years)

The key future coastal hazards and risks at Hooper Beach are:

- Increased frequency of extreme storm events and short-term storm induced dune erosion due to sea level rise;
- Further Loss of dune vegetation and sand drift due to wave erosion and uncontrolled pedestrian access
- Potential erosion/structural damage to western most private dwelling and associated Telstra infrastructure and parts of Seafarers Crescent by 2050 arising from coastal recession under storm surge and under 0.3m of sea level rise;
- Erosion/structural damage to more of Seafarers Crescent and to up to 7-8 houses, additional Telstra infrastructure and additional coastal vegetation by 2100 arising from coastal recession dune erosion under storm surge and under 1.0m of sea level rise;
- Erosion damage to some of the coastal trail east of the private dwellings.

6.1.3 Likelihood Consequence & Risk Rating

The likelihood consequence and risk rating of the above risk factors without mitigation measures prior to 2050 are summarized in Table 6 below.

TABLE 6 RISK MATRIX ASSUMING DO NOTHING BEFORE 2050.

Risk factor	Likelihood	Consequence	Risk rating	Control Measures
Personal Injury or death from dune collapse onto beach	Likely	Major/catastrophic	High/extreme	Protect/stabilize batter Restrict/control beach access Warning signs
Foundation/structural damage to 1 or more private dwellings & associated Infrastructure	Likely	Major/catastrophic	High/extreme	Protect dune-hard or soft engineering structures or relocate dwellings
Inundation to houses	Unlikely	Low	Minor	
Inundation to private land	Possible	Low	Moderate	Raise dune crest & revegetate
Erosion damage to Seafarers Crescent	Unlikely	Low	Minor	

7 Potential Management Options

Whilst Hooper Beach is located in a relatively low wave energy environment it does receive up to one to two significant storm surge events annually and some swell and in 2016 received large storm surge events which have accelerated the rate of erosion of the front and back of the beach and with sea level rise and higher water levels, larger waves will reach the beach and dune more frequently further accelerating the rate of dune erosion.

Uncontrolled foot traffic over the dune also at the five existing locations has the potential to further destabilize the foredune and beach which could contribute to further erosion and sand drift.

However longshore drift is also contained by virtue of the existing rocky headlands at each end of the beach and hence any end scour impacts arising from use of hard engineering options would be minimal compared to an unconfined beach.

Notwithstanding the installation of a trial shore normal groyne at the eastern end of the beach using 2.5m³ geotextile bags presents an opportunity to widen the beach width through sand accretion.

7.1 *Short Term Management Options*

Short term management options to address public safety dune stability and sand drift issues and public access damage and identify triggers for more permanent management options include:

- Erection of fencing and warning signs at the back of the dune;
- Close off all 5 existing uncontrolled pedestrian access points located on Crown land reinstate dune at beach interface & revegetate and erect a post and wire fence at the top of the dune and 3m from private land boundary;
- Encourage abutting land owners and visitors to use existing beach access points at the eastern and western end of the beach;
- The development and implementation of a detailed monitoring program including methodology and trigger levels in consultation with CMB which could include installation of sand movement monitoring galvanised or marine grade stainless steel poles at the toe of dune and front of beach at sixty metre intervals along the beach to annually survey changes in beach level and toe position and inform triggers for longer term management options;
- Initial beach nourishment program involving importation of (2000m³pa) of coarser (D_n 50=0.5mm) similar coloured sand to restore the dune and reduce rate of erosion subject to availability of suitable local sand possibly mixed with imported seagrass wrack from nearby beaches subject to availability and costs coupled with extensive re-vegetation of the top and back face of the dune;
- Installation of a trial shore normal groyne at the eastern end of the beach using 2.5m³ geotextile bags

7.2 *Long Term Management Options*

Long term coastal measures that provide both protection of the back of the beach and foredune for storm surge conditions in conjunction with revegetation of the top and back of the dune, are considered appropriate for Hooper Beach.

Possible long term options are summarized below.

7.2.1 *Soft Engineering Options*

- **Option 1**-Annual beach nourishment program (2000m³pa) of coarser imported (D_n 50=0.5mm) similar coloured sand to restore the dune and reduce rate of erosion subject to availability of suitable local sand possibly mixed with imported seagrass wrack from nearby beaches subject to availability and costs coupled with extensive re-vegetation of the top and back face of the dune-**low capital cost but moderate whole of life cost**;
- **Option 2**-Construction of a shore parallel geotextile bag sea wall along the coastal edge of the existing dune coastal face (Elcorock or equivalent) up to the dune crest or 3.5m AHD and extensive re-vegetation of the top and back face of the dune coupled with annual beach nourishment - **Expensive whole of life cost bags <25 year life**;

- **Option 3**-Construction of a shore parallel geotextile sand sock container revetment (25m long x 0.5m diameter sand sausage) at the back of the beach up to 3.5m AHD (6 stacked bags /m) in conjunction with beach nourishment to cover sand socks and extensive re-vegetation of the top and back face of the dune-**Lower capital cost < 25 year life;**
- **Option 4**-Construction of Geoweb (Plastic honeycomb sand filled vegetated panels) or Defence Cell (geotextile cover) on coastal and landward face of dune and extensive re-vegetation- application in a coastal environment and durability not adequately tested -**Moderate cost**

7.2.2 Hard Engineering Options

- **Option 5**-Construction of 1T-2.5T local limestone or igneous rock 3m thick two- layer armor revetment wall along the coastal edge of the existing dune face initially up to 3.5m AHD and extensive re-vegetation of the top and back face of the dune in conjunction with annual beach nourishment **High capital cost but low Whole of life cost > 100 years life**
- **Option 6**-Construction of 1m³ random placed concrete cube revetment wall up to 3.5m AHD in conjunction with annual beach nourishment **Low to moderate capital cost low whole of life cost > 50 years life**
- **Option 7**- Construction of 1.6-2.4 T buried concrete blocks laid in terraced pattern up to 3.5m AHD covered with sand on coastal side-used in trail applications only over past 3-4 years **Low to moderate capital cost low whole of life cost > 50 years life**

A multi-criteria comparison of options is summarized in Table 7 below.

TABLE 7: POTENTIAL LONG TERM COASTAL MANAGEMENT OPTIONS COMPARISON

Treatment Option	Indicative Capex \$/m	Benefits	Dis-benefits	Staging Potential
Option 1-Sand Nourishment 2,000m ³ pa - imported sand and imported sea wrack bund wall to 3.0m AHD in front of dune and additional sand on the beach	120*	Sand would require replacement annually and seasonally to balance loss from storm surge erosion and nourishment volumes would increase as sea level rises. Lowest capital cost option. No loss of beach width. High social benefit	Short life maintenance only solution. Still long term erosion from sea level rise Increase in annual cost High whole of life costs.	Good
Option 2- Elcolrock sea wall 0.75m ³ bags (1V:3H) crest height 3.5m AHD	2500*	Reduces potential for dune toe undercutting in wave run up zone Reasonably effective for higher waves with SLR Crest height can be increased in the future.	Higher wave run up and overtopping due to steep slope and hard surface Some storm erosion damage	Good

Treatment Option	Indicative Capex \$/m	Benefits	Dis-benefits	Staging Potential
		Effective in reducing storm surge erosion and long term recession Matches natural sand colour. Potentially encourages natural revegetation in accreted sand	potential and moderate maintenance. Bags may need to be replaced every 15-20 years Very High capital and whole of life costs Potential negative impacts on natural sand supply at the ends and in front of the structure so nourishment required. Some loss of beach width so potential social impacts	
Option 3- Longitudinal geotextile bag sand sausage in front of dune 6 x 0.5m diameter 2 wide x 3 high) between RL 0.9m AHD and RL 2.4m AHD with beach nourishment above and in front Medium life solution 8-10 years	413*	Stronger potential to reduce collapse of dune toe under wave run up and marginal reduction in sand loss in spring tides. Moderate capital cost. Could encourage natural sand accretion and natural vegetation propagation in front of and behind the structure	Containers may need replacement every 10 years Some sand in front of containers would require replacement annually and seasonally. High whole of life costs. Used in limited application eg Victor Harbor	Good
Option 4-Sand bund in front of dune to 3.5m AHD with Geoweb or Defence cell and planting over bund and dune	290*	Reduced frequency of sand replacement. Assists in reducing long term recession Helps control dune stability and wind blown sand drift if vegetated. Moderate capital cost	Short –medium life option. Untested locally in coastal applications High whole of life costs.	Good

Treatment Option	Indicative Capex \$/m	Benefits	Dis-benefits	Staging Potential
Option 5-1-2.4 Tonne limestone rock armour sea wall with crest height at 3.5m AHD (two layers)	3000-3500*	Most effective in reducing storm surge erosion of dune. Crest height can be increased in the future. Low annual maintenance cost and lowest whole of life cost overall. Structure could last > 100 years	High capital cost. Dependant on availability of affordable adequate volume of suitable local rock Potential for further erosion on beach at front of wall and at wall ends so annual nourishment required as well. Loss of beach width and potential social impacts Poor Aesthetics.	Good
Option 6- Randomly placed 1m3 concrete cube revetment wall with crest height at 3.5m AHD (two layers)	1700*	Very effective in reducing storm surge erosion of dune. Crest height can be increased in the future. Low annual maintenance cost and low whole of life cost. Structure could last > 50 years Concrete cubes could be manufactured locally	High capital cost Aesthetics Some concrete blocks may crack Potential for further erosion on beach at front of wall and at wall ends so annual sand nourishment required as well. Loss of beach width and potential social impacts Not been tested in SA but used on breakwater along NSW coast	Good
Option 7- Terraced sand covered concrete block wall	800*	Potentially effective in reducing storm surge erosion of dune. Crest height can be increased in the future. Low annual maintenance cost and low whole of life cost.	Moderate capital cost Some concrete blocks may crack Potential for further erosion on beach at front of wall and at wall ends so annual	Good

Treatment Option	Indicative Capex \$/m	Benefits	Dis-benefits	Staging Potential
		Structure could last > 50 years Concrete blocks could potentially be manufactured locally Moderate capital cost.	sand nourishment required as well. Loss of beach width and potential social impacts Treatment has only been used as a trial at Victor Harbor since January 2015 with no displacement since. Not a standard coastal; treatment and long term performance yet to be proven.	

*All costing assumes the use of local labour plant & equipment and materials without the need for accommodation and per diem allowances and excludes construction contingencies design and project management costs and costs of re-vegetation and dune protection fencing assumed to be funded by NRM grant and volunteer labour.

Option 1 assumes sand nourishment at \$10/m³ and importation of sea wrack from Kingstone at \$10/m³.

8 Development Plan Provisions

The site is located in the Coastal Open Space Zone and coastal protection works are considered complying development.

The minimum site levels for this zone are set at 2m AHD however the crest level for any protection structures would need to be set above this level to ensure adequate freeboard from wave overtopping dune erosion damage in a 1% AEP storm surge event.

All the identified long term management options would require development approval and sand extraction for any beach nourishment may also trigger an EPA Dredging Licence.

9 Council and Community Briefing

A briefing on the causes of the erosion and the above potential short term and long term coastal management options was provided to elected members on 4 September and the Robe Community on 30 September 2018.

The then Council acknowledged that coastal management measures were required and was supportive of the management options identified in Section 7 of this report.

The community briefing on 30 September was attended by 27 residents and property owners who also acknowledged that coastal management measures were required and attendees were supportive of the short term management options identified in Section 7 of this report with stronger support for Long Term Options 1 and Option 7 given the shortage of rock and aesthetics.

Information on seasonal sand movement adjacent to the existing concrete ramp was also offered by a long term resident from Seafarers Drive.

Questions and answers raised at the community briefing are attached in Appendix B.

10 Conclusions

Based on the study outcomes the following conclusions can be drawn:

- The recent accelerated erosion experienced at Hooper Beach is considered to be a result of the following factors:
 - Large storm surge events in 2016 in conjunction with record tide levels forcing waves directly onto coastal dunes with high wave run up eroding the toe of the dune causing dune collapse;
 - Large swells in the past few weeks in Guichen Bay generated from abnormally large swells in the Southern Ocean;
 - The resultant storm cut and wave run up erosion and fine sand grain size causing the dune along the 195m beach length to become unstable and collapse.
 - Additional top of dune erosion from five existing uncontrolled pedestrian access.
- The total estimated coastal recession in 2050 & 2100 allowing for short term erosion, long term recession and erosion from sea level rise is estimated at 18.2m and 47.1m respectively.
- The estimated volume of sand eroded from the front and back of the beach in a 1% AEP storm surge over the 195m beach length is 10,200m³.
- The current hazards and risks at Hooper Beach are:
 - Personal injury risk to pedestrians due to dune collapse;
 - Loss of dune vegetation and sand drift due to wave erosion and uncontrolled pedestrian access

- The key future coastal hazards and risks at Hooper Beach are:
 - Higher water levels and higher waves during extreme storm events causing accelerated erosion due to sea level rise;
 - Further Loss of dune vegetation and sand drift due to wave erosion and uncontrolled pedestrian access;
 - Potential erosion/structural damage to western most private dwelling and associated Telstra infrastructure and parts of Seafarers Crescent by 2050 arising from coastal recession under storm surge and under 0.3m of sea level rise if no long term management measures are implemented;
 - Erosion/structural damage to more of Seafarers Crescent and to up to 7-8 houses, additional Telstra infrastructure and additional coastal vegetation by 2100 arising from coastal recession dune erosion under storm surge and under 1.0m of sea level rise if no long term management measures are implemented;
 - Erosion damage to some of the coastal trail east of the private dwellings if no long term management measures are implemented.
- Management measures are required to reduce the rate of coastal erosion at Hooper Beach and protect infrastructure from erosion damage in the longer term and the local community are supportive of the short term and long term management options identified in Section 7 of this report.

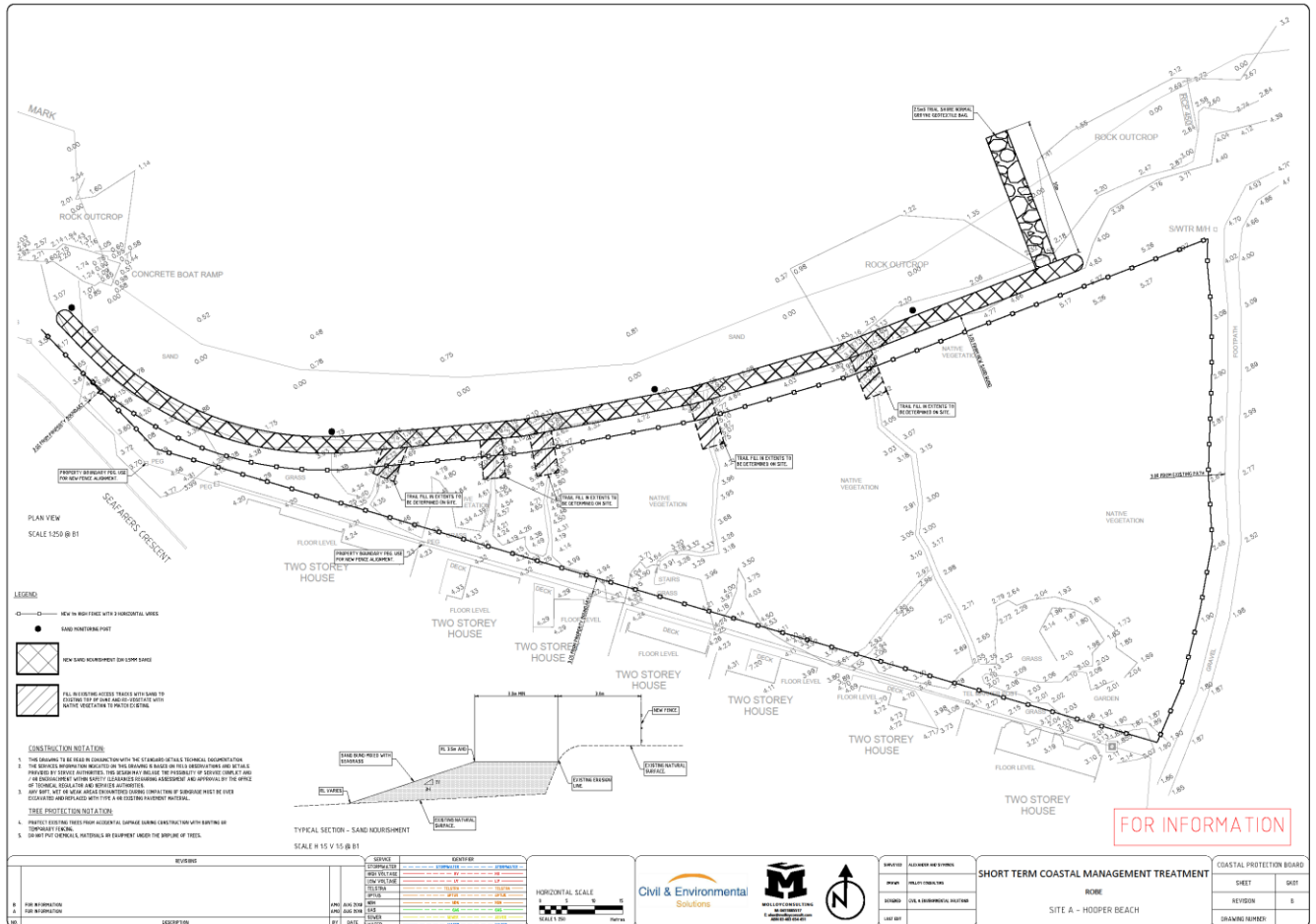
11 Recommendations

Based on the above assessment it is recommended that Council:

- Undertake an assessment of potential nearby sand borrow areas with a $D_{50}=0.50\text{mm}$ grain size of similar colour and a quantity in excess of 40,000m³ including Particle Size distribution samples to confirm grain size;
- Undertake discussions with neighboring Councils eg Kingstone DC & Wattle Range Council to see if sea grass wrack can be obtained economically for any beach nourishment mixing;
- Erect fencing and unstable cliffs warning signs at the back of the dune;
- Close off all existing uncontrolled pedestrian access points located on Crown land reinstate dune at beach interface & revegetate and erect a post and wire fence at the top of the dune and 3m from the private land northern title boundary as shown in Figure SK01 Appendix A;
- Encourage abutting land owners and visitors to use existing beach access points at the eastern and western end of the beach;
- Develop and implement a detailed monitoring program including methodology and trigger levels in consultation with CMB which could include installation of sand movement monitoring galvanised or marine grade stainless steel poles at the toe of dune and front of beach at sixty metre intervals along the beach to annually survey changes in beach level and toe position and inform triggers for longer term management options;
- Undertake initial and annual beach nourishment involving importation of (2000m³pa) of coarser ($D_{50}=0.5\text{mm}$) similar coloured sand to restore the dune and reduce rate of erosion subject to availability of suitable local sand possibly mixed with imported seagrass wrack from nearby beaches subject to availability and costs coupled with extensive re-vegetation of the top and back face of the dune as shown in Figure SK01 Appendix A and obtain all required Development approvals and licences;
- Install a trial shore normal groyne at the eastern end of the beach using 2.5m³ geotextile bags;
- Should the top of dune erosion line get closer than 3m from to the northern title boundary of the western most dwelling, then consider installation one of the long term management options identified above.

Appendix A

Figure SK01



Appendix B

Community briefing Questions and Answers

Coastal Erosion Information Session | Sunday 30 September 2018

Questions brought forward

Question	Response
Is the fence proposed at Hooper's Beach going in front of every property?	It is only a proposal at this point in time, and yes, if it were constructed it would be placed along the entire length of the coastal dunes at Hooper's Beach.
Will the plan involve financial modelling of all the options presented and who will do this work?	The report in its current form only presents options, once an option has been agreed upon and if that option involves considerable expense then the whole of life financial impact of the option would be ascertained. Who would actually do this financial modelling has not been considered.
Will council continue to undertake sand replenishment?	Yes, Council will remove the sand from the buildup of sand at Karatta Beach and replenish the beaches east of the breakwater.
Does the groyne at the eastern end of Main Beach work in holding back the sand?	Yes.
Does the groyne at the eastern end of Main Beach affect the sand levels at Hooper's and Fox Beach's?	Without sand movement modelling our understanding of the movement of sand along Guichen Bay would suggest that it has a level of impact. What that level of impact is not known.
Is the sand that Council places on Main Beach enough to replenish the sand that is lost?	From the impact on the beach and dunes it would appear that the sand carted by Council is not enough to replenish sand loss.
What are council's short term plans for Fox Beach?	Council will need to consider closing the beach, installing appropriate signs, or undertaking sand replenishment at the beach as soon as possible. It is unlikely that Fox Beach will be able to be in a safe condition for the upcoming summer.
Could Council consider a concrete access to Fox Beach as the concrete ramp has not eroded at Hooper's Beach?	Any constructed access at Fox Beach will be engineered, requires Coastal Management Branch approval and must be regarded as sacrificial.
Council must engage the community in an education process to inform them of the value of the dunes?	Agreed and work will be done over the holiday period.