Coastal Erosion Management Options

Cowes Main Beach Foreshore Reserve

Bass Coastal Shire Council

April 2018

Document Status

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Project Name	Cowes Main Beach Foreshore Reserve
Client	Bass Coastal Shire Council
Client Project Manager	Derek Hibbert
Water Technology Project Manager	Joanna Garcia-Webb
Water Technology Project Director	Dr Peter Riedel
Authors	Joanna Garcia-Webb & Oliver Nickson
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15 Business Park Drive
Notting Hill VIC 3168

Telephone	(03) 8526 0800
Fax	(03) 9558 9365
ACN	093 377 283
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26 April 2018

Derek Hibbert
Coordinator Coast and Bushland
Bass Coastal Shire Council
76 McBride Avenue
WONTHAGGI VIC 3995

Dear Derek

Cowes Main Beach Foreshore Reserve - Coastal Management Options

We are pleased to present our report describing the coastal management options at Cowes Main Beach Foreshore Reserve

Yours sincerely

Joanna Garcia-Webb
Assistant Group Manager – Coastal | Senior Coastal Engineer

joanna.garcia-webb@watertech.com.au

WATER TECHNOLOGY PTY LTD

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GLOSSARY & DEFINITIONS

Table 1-1 Glossary (Maritime Safety Queensland 2018, Smith 2003, NTC 2010)

Term	Definition
AHD	Australian Height Datum. 0m AHD approximately corresponds to mean sea level
AEP	Annual Exceedance Probability: The measure of the likelihood (expressed as a probability) of an event equalling or exceeding a given magnitude in any given year
ARI	Average Recurrence Interval:
Astronomical tide	Water level variations due to the combined effects of the Earth's rotation, the Moon's orbit around the Earth and the Earth's orbit around the Sun
HAT	Highest Astronomical Tide: the highest water level that can occur due to the effects of the astronomical tide in isolation from meteorological effects.
LAT	Lowest Astronomical Tide: the lowest water level that can occur due to the effects of the astronomical tide in isolation from meteorological effects
MHWN	Mean High Water Neaps: long-term mean of the heights of two successive high waters during the 24-hour period when the tidal range is at its lowest: during first and last quarter of the moon.
MHWS	Mean High Water Springs: long-term mean of the heights of two successive high waters during the 24-hour period when the tidal range is at its greatest: during a full and new moon.
MLWN	Mean Low Water Neaps: long-term mean of two successive low waters of the same period as MHWN
MLWS	Mean Low Water Springs: long-term mean of two successive low waters of the same period as MHWS
MSL	Mean Sea Level: the long-term average level of the sea surface
Peak Wave Period	Wave period corresponding to the peak energy of the wave spectrum
Percentage Passing	Percentage of total material small enough to pass through the sieve
Significant wave height	The average of the highest one third of all waves.
Storm surge	The meteorological component of the coastal water level variations associated with atmospheric pressure fluctuations and wind setup
Storm tide	Coastal water level produced by the combination of astronomical and meteorological (storm surge) ocean water level forcing
Wave set-up	Elevation of the mean water level at the shoreline due to wave action
Wave run-up	Maximum elevation of wave uprush above the still water level

1 INTRODUCTION

The Cowes Main Beach Foreshore Reserve is located adjacent to the Cowes Pier, at the northern end of the Cowes township main shopping precinct (refer Figure 1-1 for locality plan). It is a popular tourist destination, with visitation peaking in summer. The beach system is a highly modified environment, with the primary dune converted to lawn and recreational infrastructure. Two stormwater drainage outlets discharge into the system.

In recent years, the beach has experienced high rates of erosion during storm events. In an unmodified beach system, the primary dune acts as a natural buffer for erosion events. The dune face is eroded, and over time, is built back up again naturally. In this area, as the dune has been converted to recreational space, erosion events have a greater impact as the system has little tolerance to the erosion / accretion cycle. To date, erosion events have been mitigated with renourishment in the form of beach scraping.

In addition to storm events, human foot traffic and stormwater run-off are also significant contributors to erosion. Some measures have been implemented to reduce the impact of foot traffic. Some revegetation has also been carried out, which aids stabilisation of the system.

The aim of this project is to undertake a coastal processes analysis of the Cowes Main Beach Foreshore Reserve, and to determine the best approach for mitigating the erosion issue and ensuring the area maintains its recreational amenity. The embankment lawn area is a highly valued recreational asset with extremely high usage in the summer period. Water Technology has therefore been commissioned by the Bass Coast Shire Council to develop both short and long-term erosion management options for the Cowes Main Beach Foreshore Reserve. The design life of the erosion management options is 20-25 years.

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Figure 1-1 Study area and locality plan

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To achieve the primary objective of understanding the coastal processes at Cowes Main Beach Foreshore Reserve, and identifying the most appropriate mitigation method, the following overall study approach was taken:

- Site visit of the Cowes Main Beach Foreshore Reserve and surrounding beaches, to gain an understanding of the coastal processes of the overall area
- An assessment of the oceanographic conditions, particularly water levels and waves. These are the key drivers of coastal processes. Included in this assessment is the development of design conditions
- An investigation into the coastal processes at the study site. This includes:
  - Examining the historical shoreline movement
  - Investigating the longshore sediment transport regime
  - Investigating the cross-shore sediment transport regime
- A review of the available mitigation measures and their suitability at the study site; assess via an evaluation matrix
- Development of conceptual erosion management options based on the above analysis. An indicative design life of 20-25-years has been assumed for the development of the mitigation options.

2 SITE VISIT

Water Technology conducted a site visit to the Cowes Main Beach Foreshore Reserve on the 17th of November 2017. This visit was supplemented with photographs and commentary supplied by Council. The main observations made during the visit and from this information are listed below:

- Erosion scarp present at the interface between the beach and the foreshore reserve (Figure 2-1 and Figure 2-2)
- Beach access points; stairs, ramp and dune (Figure 2-3)
- Rocky headlands at both ends of the beach (Figure 2-4)
- Stormwater outfalls at two locations within the beach (Figure 2-5)
- A rocky / reef substrate is present around the water line at many locations along the beach. (Figure 2-6)
- A fence is located on the larger sections of the beach scarp with the aim of directing foot traffic. (Figure 2-7)

Regular photographic beach monitoring is a useful tool in analysing beach behaviour. This can be conducted at 6-monthly intervals at the end of the summer and winter. Photos should also be taken immediately following severe storms. They should be undertaken from a set vantage point to allow accurate comparisons between images. The images can be used to supplement available data when undertaking mitigation option design. These images can also be used to support mitigation option funding applications, and in educating the community about natural fluctuations in beach shape.

Figure 2-1 Erosion scarp at beach interface with foreshore reserve

Figure 2-2 Erosion scarp at beach interface with foreshore reserve

Figure 2-3 Beach access points (stairs, dune and ramp (far end of beach))

Figure 2-4 Rocky outcrop at the western end of Cowes main beach

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Figure 2-5 Storm water outfall located on Cowes main beach.

Figure 2-6 Rocky / reef substrate on Cowes main beach.

Figure 2-7 Fence to manage foot traffic located on Cowes main beach foreshore reserve.

3 SURVEY

Multiple bathymetric and topographic data sets of the site have been combined to develop an overall Digital Elevation Model (DEM); Table 3-1 presents the details. The landward section of the DEM consists of LiDAR provided by the Department of Environment, Water, Land and Planning (DEWLP 2007/2008). The nearshore section of the DEM from approximately 3 m AHD to -2 m AHD is a 2016 bathymetric survey of Cowes Main Beach (see Figure 3-1) undertaken by Gertzel Survey as part of previous work in the area (Gertzel Survey, 2016). The offshore section of the DEM is made up of DEWLP future coast bathymetric survey (2010).

Figure 3-1 2016 Cowes Main Beach bathymetric survey. (Gertzel Survey, 2016)

Table 3-1 Digital Elevation Model data sources.

Elevation (m AHD)	Data Source
3<	Bass Coast LiDAR (DEWLP 2007/2008)
3 to -2	Gertzel Survey (2016)
-2>	DEWLP future coast bathymetric survey (2010)

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4 OCEANOGRAPHIC CONDITIONS

4.1 Water Levels

Astronomical tide refers to the rise and fall of the sea surface due to the gravitational attraction between the earth, moon and sun. Water level variations in coastal areas due to the astronomical tide can be reliably predicted provided a reasonable length of continuous water level observations is available. Tidal plane information from a combination of Cowes Pier (where available) and nearby Stony Point, as listed in the Victorian Tide Tables (2017), is presented in Table 4-1.

Table 4-1 Cowes Tidal Plane (Victorian Tide Tables 2017), * Stony Point tidal data

Tidal Plane	Level (m AHD)
Highest Recorded Tide*	2
HAT*	1.62
MHWS	1.11
MHWN	0.71
MLWN	-0.59
MLWS	-1.09
LAT*	-1.99

Extreme water levels experienced during storm events is one of the main drivers for erosion observed at the site. The 10, 20, 50 and 100-year annual recurrence intervals of extreme water levels for Stony Point obtained through analysis of the Stony Point tide gauge can be found within Table 4-2 (McInnes et al, 2009). Stony Point is located within close proximity to Cowes (roughly 8km). As such these water levels provide a suitable estimate for the 10, 20, 50 and 100-year Annual Recurrence Intervals (ARI) for the Cowes Main Beach Foreshore Reserve.

Table 4-2 Extreme water level ARI for Stony Point (McInnes et al, 2009, VCC 2014)

ARI	Present Day (m MSL)	2030 (m MSL)	2040 (m MSL)	2070 (m MSL)
10	1.62	1.77	1.82	2.09
20	1.79	1.94	1.99	2.26
50	1.94	2.09	2.14	2.41
100	2.08	2.23	2.28	2.55

4.2 Waves

The waves experienced at Cowes are predominantly locally generated within the eastern and western arms of Western Port. Predicted wave roses in the vicinity of the study area as part of the 2014 Western Port Coastal Hazard Assessment undertaken by Water Technology are presented in Figure 4-1 by season. Waves are observed to vary with seasonal wind climate, such that the majority of waves arrive from the northwest in winter. Due to the study area's northerly aspect, waves are generally very small in the summer months, coinciding with the timeframe when strong winds are from the southwest to southeast.

Long period swell waves propagate into Western Port Bay via Bass Strait and refract into the Cowes Main Beach Foreshore. The northern facing aspect of the beach means storm events will be driven by wind-generated waves from the north, as observed in Figure 4-1 below. Longer period swell waves are likely to only influence coastal processes within the study area during the calmer months and contribute to returning sediment onshore.

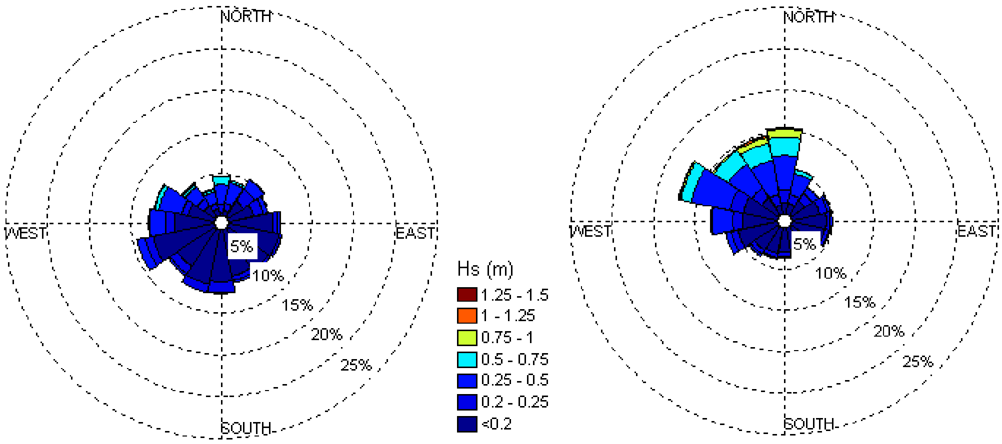

Figure 4-1 Wave Roses – Summer (2003) & Winter (2003) (Water Technology, 2014)

Wave modelling was undertaken to determine the design wave characteristics at the study site. DHI Water and Environment's MIKE 21 Spectral Wave (SW) model was utilised for this study. The model is based on an unstructured flexible mesh comprising of triangular elements. The wave model simulates the growth, decay and transformation of wind-generated waves and swell in offshore and coastal areas.

Water Technology's spectral wave model of Western Port was refined along the area of interest, and the new 2016 survey data incorporated into the model (Gertzel Survey 2016). In addition, LiDAR (DEWLP 2007/2008) was used to supplement topographic data further onshore than the extent of the survey.

Design wind speeds and water levels were input into the model. The design water levels are presented in Table 4-2. The hourly design wind speeds are presented within Table 4-3 and were applied as constant values in the modelling. The design wind speeds are derived from the Australian Standard, AS 1170.2 – 2011; the site was located between the regional boundary of Melbourne (A5) and southern Australia (A1). The A5 region was chosen as it resulted in the greater wind speed of the two for wind coming from a northerly direction.

Table 4-3 Design Wind Speeds AS 1170.2-2011; direction is from the north

ARI	Wind Speed (m/s)
10	25.2
20	27.5
50	28.9
100	30.4

Significant wave height (Hs) and peak wave period (Tp) were extracted from the model offshore from Cowes Main Beach at the -8 m AHD depth contour. These are presented in Table 4-4. Wave heights do not vary significantly between design levels, most likely due to the limited fetch.

Table 4-4 Design waves heights in 8m of water (present day)

ARI	Significant Wave Height – Hs (m)	Peak Wave Period – Tp (s)
10	0.94	3.51
20	0.95	3.51
50	0.96	3.51
100	0.98	3.53

4.3 Storm Effects

Figure 4-2 to Figure 4-4 were created to aid the understanding of the effects of extreme water levels and waves on the study site (refer glossary in Table 1-1 for definition of water level terms). In the figures, the design water levels are overlaid on the aerial imagery. Inundation of land behind the beach face due to extreme water levels is unlikely due to its elevation. The risk posed by extreme water levels at Cowes Main Beach is erosion of the dune system and the associated beach recession.

The 2040 climate change scenario has been utilised to predict the effects at the end of the design life, in line with the management option design life of 20-25 years. The difference between the existing and 2040 100-year ARI storm tide seen in Figure 4-2 revels only a slight lateral migration, corresponding to the 20cm of sea level rise accommodated in the 2040 scenario. The eastern end of the beach is at a greater risk to erosion as can be seen by the close proximity of both blue lines to the foreshore reserve behind the beach face.

Though the water levels do not reach the base of the scarp, as highlighted within Figure 4-3 and Figure 4-4, the water levels provided do not take into consideration wave set up and run up. Wave set up and run up can have a large impact on the scarp erosion observed between the sandy beach face and the vegetated foredune. The vegetation located on the eastern section of the beach is providing some stability to the scarp in this section, which limits the erosion during high water level events. As observed in Figure 4-5, water levels acted on the base of the scarp during the July 2016 storm.

Figure 4-2 Extent of 100-year ARI water levels on the site for present day and 2040

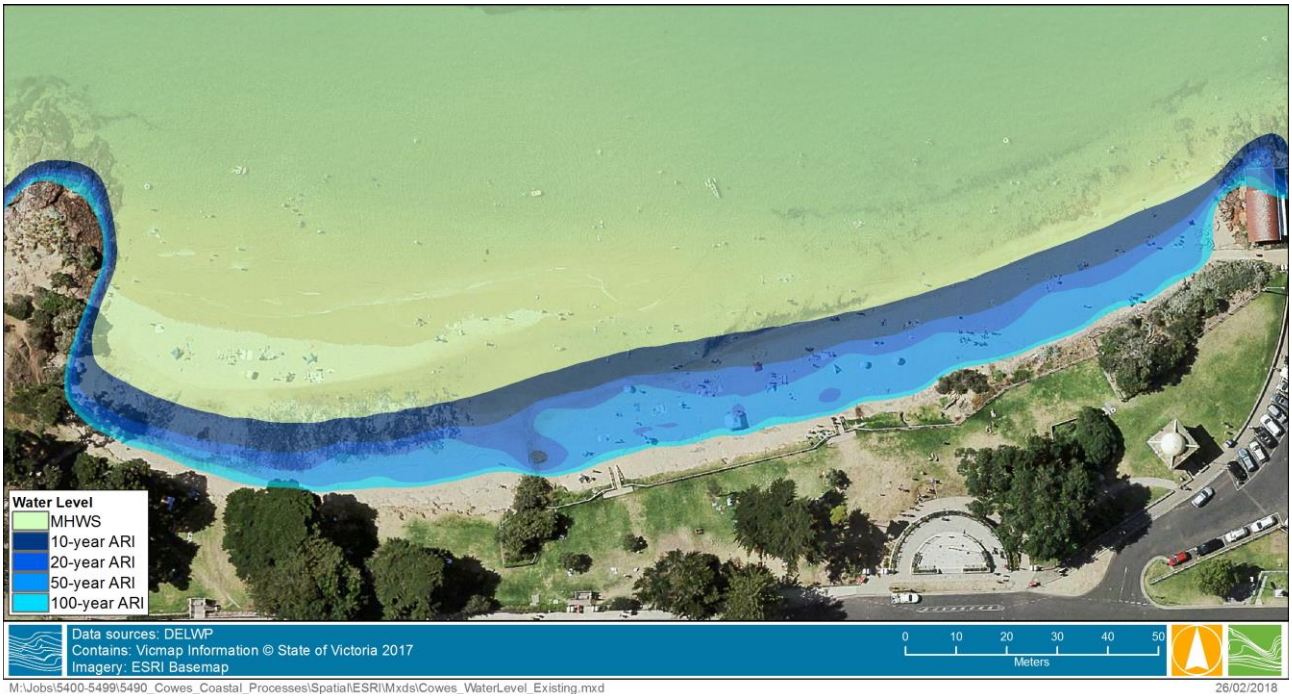

Figure 4-3 Extent of present day ARI water levels

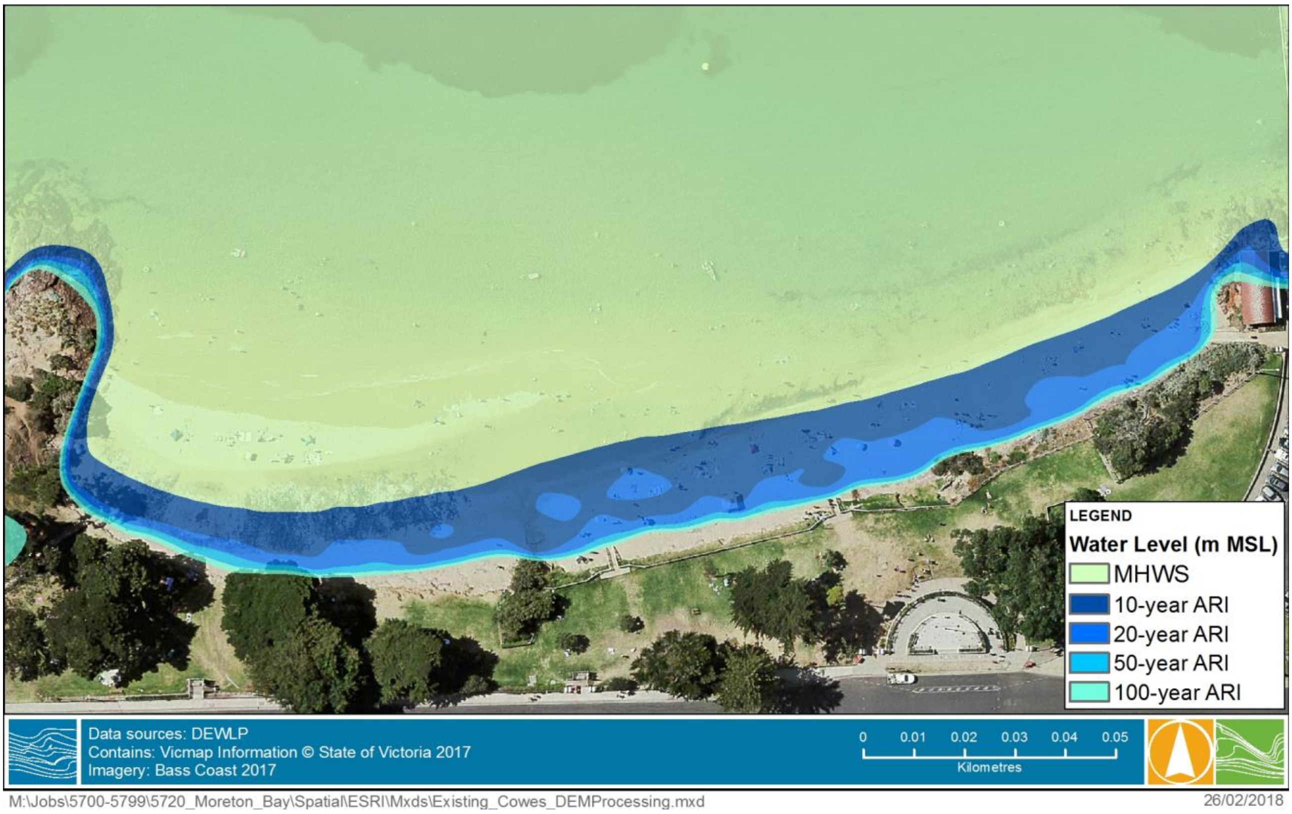

Figure 4-4 Extent of 2040 ARI water levels

Figure 4-5 Storm action leading to erosion, 22nd July 2016 (Bass Coast Shire Council)

5 COASTAL PROCESSES

5.1 Sediment

The strong tidal currents and circulation patterns through the Western Entrance of Western Port Bay drives the movement of sandy sediment to the site. The combination of net flow and wave induced transport make the Western Entrance channel a zone of strong inward movement of sand, providing a supply to the beaches along the northern shore of Phillip Island (Water Technology, 2014). This translates to a dominant sediment transport direction along the North Shore of Port Phillip Island from west to east (Water Technology, 2014).

A sediment sample was taken from the beach face in the upper intertidal zone during the site visit. Particle size analysis was undertaken by ALS Environmental; a summary of the results can be found within Table 5-1 and Figure 5-1. The sediment had a median particle size of 0.274mm, characterising it as medium sand.

Table 5-1 Particle Size Distribution of Cowes Main Beach.

Particle Size (mm)	Percentage Passing
0.600	100%
0.425	95%
0.300	59%
0.150	8%
0.75	1%

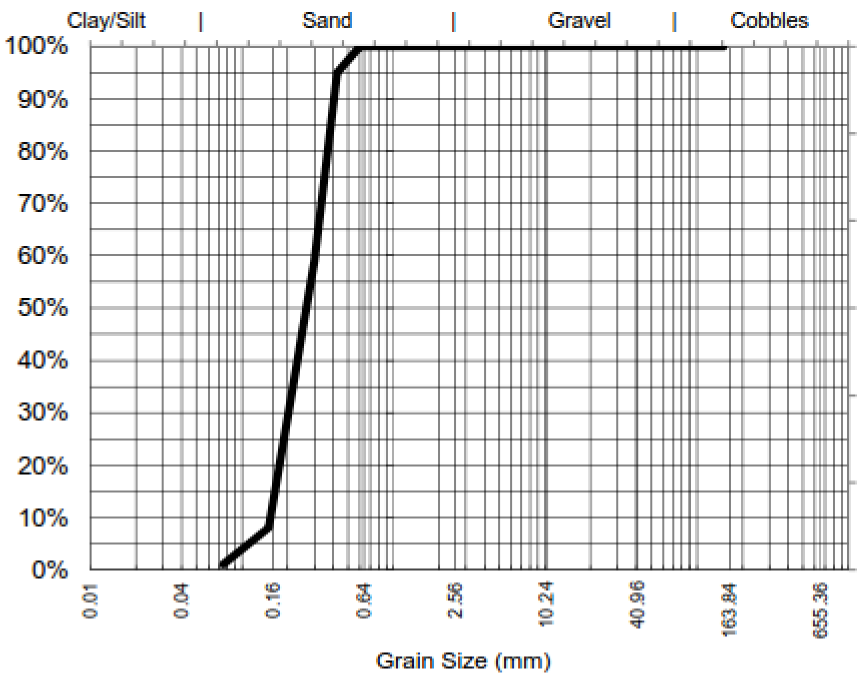

Figure 5-1 Cowes Beach Particle Size Distribution

5.2 Historical Shoreline Movement

To estimate the historical shoreline movement of Cowes Main **B**each, available aerial imagery from 2006, 2009, and 2014 was compared to the aerial imagery from 2017, by tracing the vegetation (grass) lines at the rear of the beaches (see Figure 5-2). The vegetation lines represent the point on the beach at which there is little to no wave action acting for the majority of the year, which facilitates the colonisation of the dune by certain vegetation species. It is understood the above time periods are the only aerial imagery available to Council. If additional imagery were available (for example from DEWLP) it would be beneficial to go back further to a time before the area was grassed, in order to get an understanding of the behaviour of the dune system prior to development.

The landward migration of the vegetation lines between 2006 and 2017 indicates that the shoreline can be classified as a recessive shoreline over this period. As seen in Figure 5-2, the greatest recession occurs on the western section of the beach, with the eastern section exhibiting little change over the 11 years. The western section of the beach has little vegetation at the beach / dune interface compared with the eastern section. The elevation of the dune is also lower, allowing greater erosion to occur during storm events.

A 2014 coastal hazard assessment of Western Port Bay undertaken by Water Technology identified the study area as “low earth cliffed shorelines”. Water Technology (2014) indicates that these shorelines are highly susceptible to future sea level rise impacts, with shoreline recession rates predicted to increase in the future. This is in line with the figures presented in Section 4.3, indicating the extreme water levels close to the beach / dune interface.

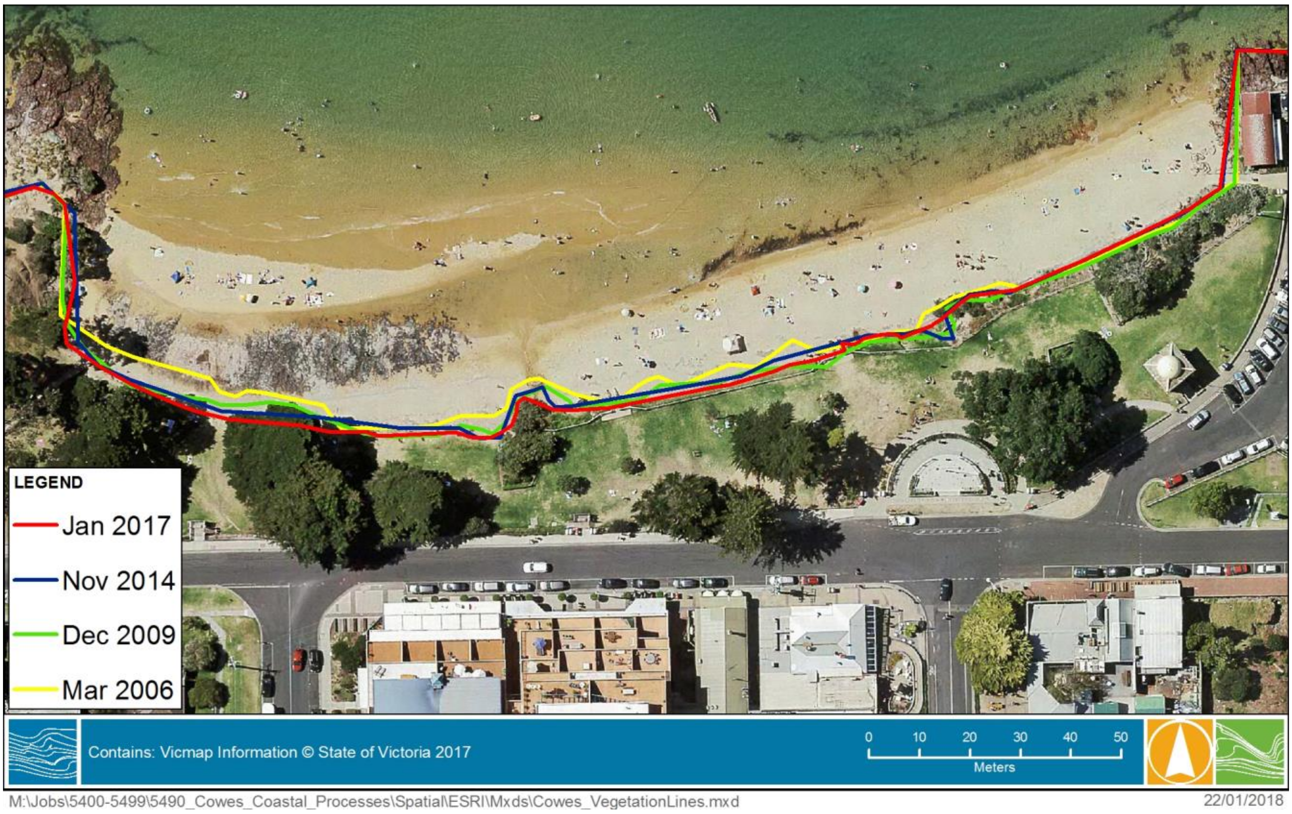

Figure 5-2 Vegetation Line Change Cowes Main Beach

5.3 Longshore Sediment Transport

Longshore sediment transport refers to the movement of sediment along the beach face parallel to the water line. Longshore sediment transport is driven by waves, which in turn drive currents; the direction and speed of which depend on wave angle and energy. An erosion management report undertaken by Water Technology for the Cowes East Foreshore beach (Water Technology 2011), identified the net longshore sediment transport occurs from west to east. This is validated by the beach angle of the study site. The compartment is oriented slightly to the east-northeast, indicating sediment is moving from west to east, and accumulating at the eastern headland before it exits the system.

Cowes Main Beach is entrapped between two headlands which play a role in reducing the impact of longshore sediment transport and create a compartmentalised beach (semi-closed sediment system). The headlands act as a physical barrier to sediment movement which limits the volume of sediment which can enter and exit the system in the longshore direction.

5.4 Cross-Shore Sediment Transport

Cross-shore sediment transport describes the process of sediment exchange between onshore and offshore. Storm erosion is a form of cross-shore sediment transport and involves the movement of sand from the beach and dune system offshore. The erosion occurring at Cowes Main Beach is the result of storms, and therefore can be classified as cross-shore sediment transport. The scarp observed at the interface between the grass and sand within the dune system is a typical feature observed from storm induced erosion (see Figure 5-3). As cross-shore sediment transport is driven by wave energy and water levels there is a seasonal trend observed between the low wave energy period in summer and higher energy wave period in winter. The summer trend of grass covering the scarp face verifies this with the lower energy summer waves resulting in a greater period of time for the grass to colonise the area (see Figure 5-4). It is expected that the swell energy refracting around from the entrance to Western Port drives the onshore return of sediment during summer.

Figure 5-3 Cowes Main Beach Erosion Scarp 3/08/2016 (Bass Coast Shire Council)

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Figure 5-4 Cowes Main Beach 16/04/2018 (Bass Coast Shire Council)

5.4.1 SBEACH

The numerical model SBEACH (Storm-induced BEAch Change) was used to assess the susceptibility of the beach to short-term, storm-induced erosion. SBEACH was developed to calculate beach and dune erosion under storm wave action as described in Wise et al (1995). The model was run over four simulations which included the 10, 20, 50 and 100-year extreme water levels as outlined within Table 4-2, in conjunction with the corresponding wave heights and wave periods derived within the spectral wave model (Table 4-4). A representative storm time-series was generated for each of these parameters and adjusted to meet the levels needed for the differing scenarios; the general shape can be seen within Figure 5-5.

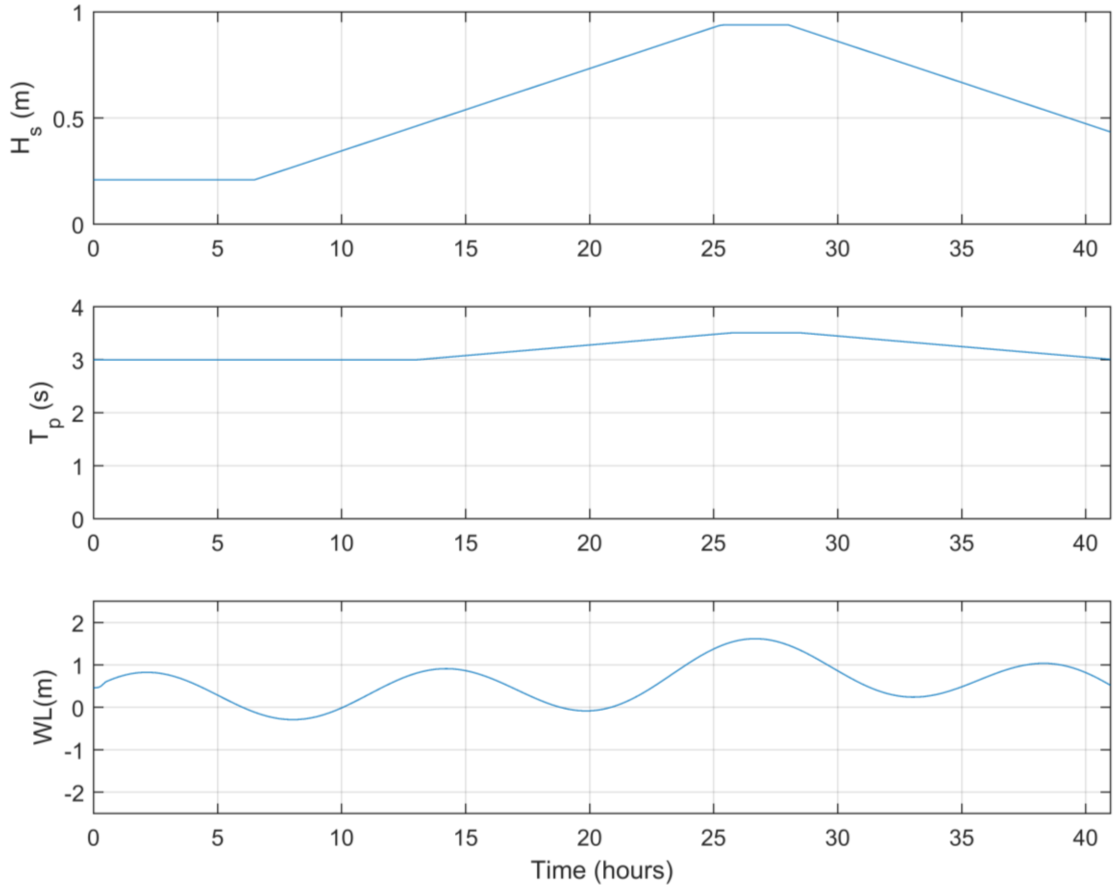

Figure 5-5 Time series of 20-year ARI design water level and wave conditions applied in SBEACH.

A cross-shore profile was extracted from the beach survey data, LiDAR and coastal DEM (refer Section 3). The profile extends landward to The Esplanade, which is located at an elevation of 10 m AHD, and offshore to a depth of -8 m AHD (see Figure 5-6). By extending to -8 m AHD, this ensured that the depth of closure (limit of cross-shore sediment transport) is captured within the profile. The results of the 10, 20, 50 and 100-year ARI events for this profile can be found within Figure 5-7. A more detailed view of the main erosion zone seen in Figure 5-8. This is simply a zoomed-in view of Figure 5-7, chainages 30 to 60.

Due to the relatively low resolution of the beach survey, the detail of the beach profile which can be obtained from the data is restricted. To test the sensitivity of the scarp slope to erosion, a second profile was created. Observations made during the site visit were applied to resolve the scarp to a greater detail than the provided survey. The resultant profile was tested for the 50 and 100-year ARI events (see Figure 5-9 and Figure 5-10; the latter is a zoomed-in view of chainages 25 to 60).

The beach recession which occurs within SBEACH at the scarp location is different between the two modelled profiles (see Table 5-2). This indicates there is a sensitivity within the results to the profile shape, which may be partly due to the influence this has on where the wave impacts the beach face. The profile with a steeper scarp (Profile 2) was predicted to experience less recession than Profile 1. Conducting regular, more detailed survey of the beach and scarp will enable changes to be monitored, which can also assist in detailed design of the preferred solution.

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Figure 5-6 SBEACH Profile Location

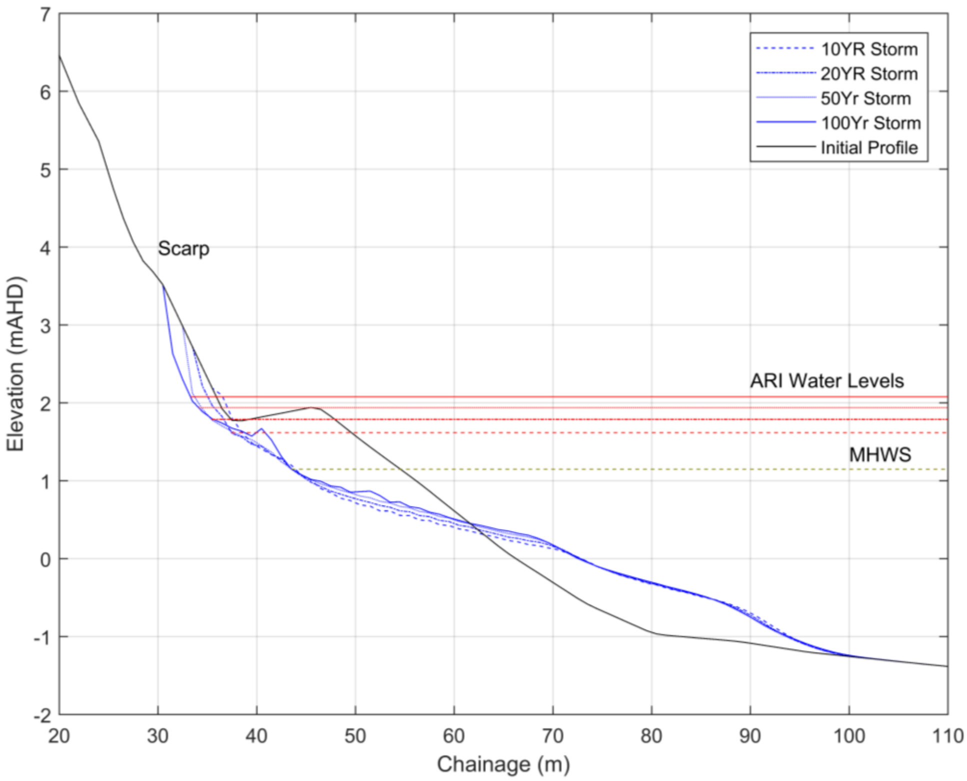

Figure 5-7 SBEACH results

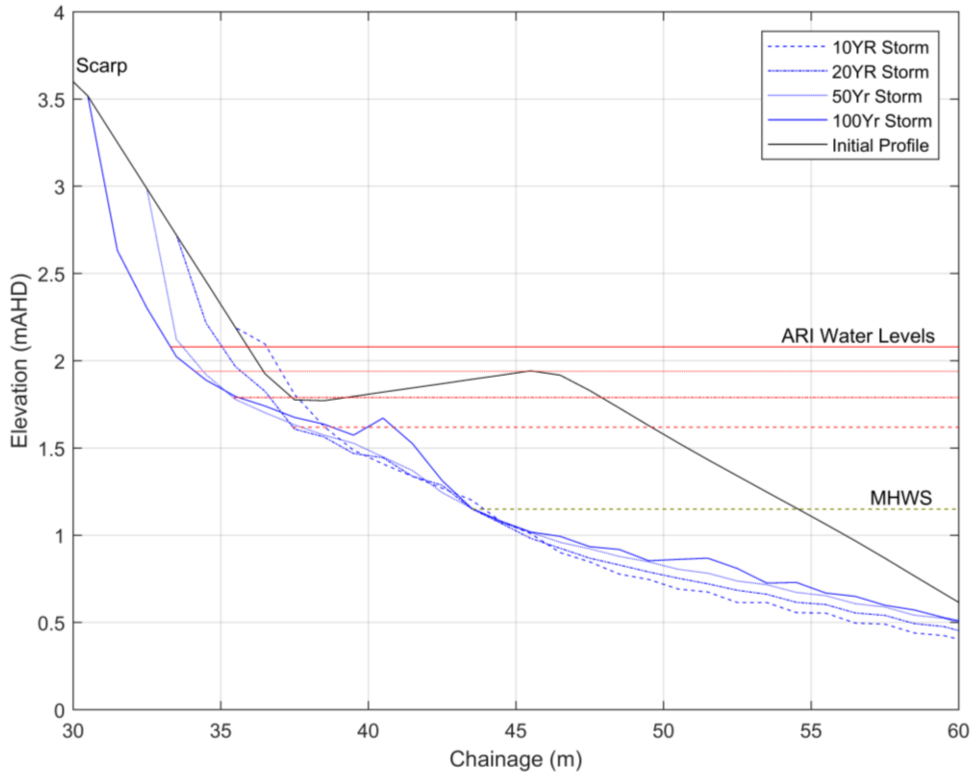

Figure 5-8 **SBEACH results - main erosion area (chainage 30-60).**

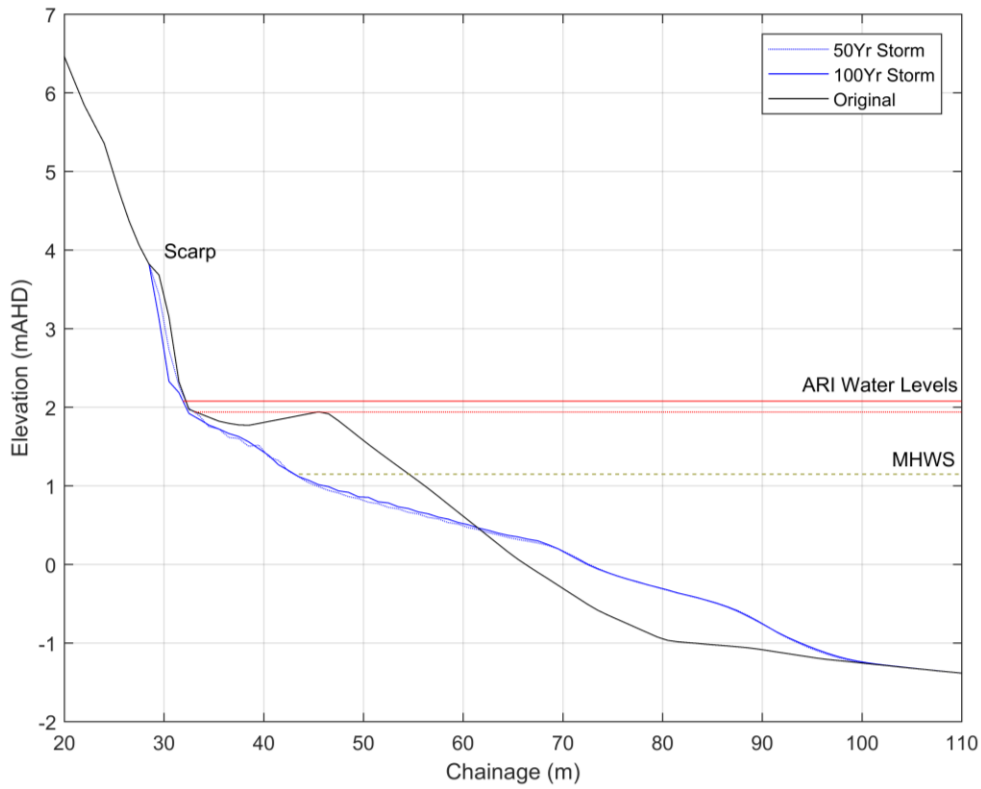

Figure 5-9 **SBEACH results - adjusted profile**

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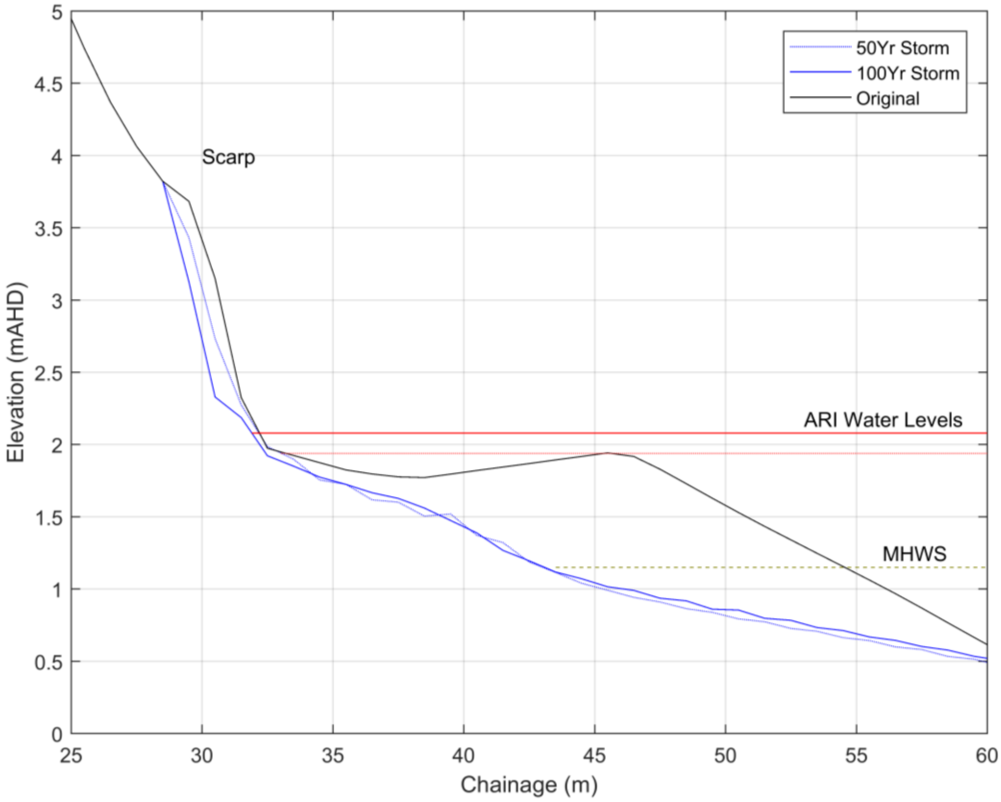

Figure 5-10 SBEACH results – adjusted profile: main erosion area (chainage 25-60).

Table 5-2 Maximum observed recession SBEACH for profiles 1 & 2

ARI Storm	Maximum Scarp Recession Profile 1(m)	Maximum Scarp Recession Profile 2(m)
10	-	-
20	0.9	-
50	2.1	0.7
100	2.5	1.0

6 GENERAL MITIGATION OPTIONS REVIEW

Four main concepts guide coastal management and planning processes. These can be summarised as follows:

- Do Nothing - do nothing to protect the assets in the immediate coastal region. This provides the basis to compare against for the proposed alternative.
- Planned / Managed Retreat - relocation of coastal infrastructure to somewhere inshore of the affected land.
- Adapt / Accommodate - this involves taking measures to allow extended use of affected land. For example, elevating or flood proofing existing structures. They include management strategies that render the risks from identified coastal hazards acceptable (but don't constitute 'protect' options).
- Protect - protection options can either be "soft‟ options, such as beach renourishment, or "hard‟ options, that involve the placement of a structure.

This study considers the options available under the "protect‟ and "adapt / accommodate" concepts. Do Nothing is not considered appropriate for the site given the high value of the Cowes Main Beach Foreshore Reserve, and the high likelihood of ongoing erosion should no management take place. Planned / Managed Retreat is not considered necessary within the planning timeframe of this study.

As discussed earlier in this report, to a certain extent, sandy coastlines are considered to be "self-healing" unless coastal processes are interrupted. During a storm, the dune and beach face can be eroded, but a new profile is created, and the beach still exists. Over time, and under more benign wave conditions, the beach can potentially build itself up again if the erosion is not too great. If significant erosion occurs, infrastructure can become at risk, and it becomes necessary to protect the coast. Protection options on a sandy beach can either be "soft" options, such as beach renourishment, or "hard" options that involve the placement of a structure. "Hard" options cannot self-heal, and whilst they have a greater ability to protect, have a larger impact on the beach system, in particular the downdrift areas. The most important factor for "soft‟ options is that there is enough sand on a beach to provide a buffer during a storm. For self-healing to occur, there must still be a beach present post-storm. "Hard" options are themselves the buffer system.

"Hard‟ structures can be grouped into two types: energy absorbing structures, for example rock and geotextile container seawalls; and energy reflecting structures, for example vertical concrete seawalls and sheet piling. Energy absorbing structures are closer representations of a natural beach system. Some of the wave energy is absorbed into the structure and there is less beach erosion around the structure. Energy reflecting structures reflect all the wave energy and, whilst they will protect the coastline, the beach immediately around the structure has the potential to be completely eroded away.

Structures can have negative impacts on the adjacent coastline. For example, a groyne can build the beach up on one side but result in erosion on the other. Similarly, an offshore breakwater will protect the coast immediately behind it, but there may be serious consequences for the coast on either side. A seawall can result in scouring immediately in front of it and at either end.

Table 6-1 below presents possible mitigation options for the study area, together with Water Technology's comments as to their suitability, based on the analysis undertaken during the present study.

Table 6-1 Erosion management options

Concept Name	Description	Suitability
Managed Status Quo	No change to the present management regime – basic vegetation management, beach scraping to provide protection at the scarp location	The ongoing erosion at the site indicates the present management measures are not enough to mitigate the erosion issue.
Seawall	Construct a seawall at the interface between the beach and foreshore reserve. This could be a vertical structure, such as presently in place immediately to the east of the study area, or a sloped / stepped structure.	A seawall provides a last line of defence and stabilises the erosion scarp. However, erosion immediately seaward of the structure may be enhanced due to increased wave reflection off the seawall, and the recreational beach would be lost. A sloped seawall results in less wave reflection, however there is not much space on the beach for this type of structure.
Renourishment	Renourish the beach and scarp area to reduce the scarp slope. Revegetate the beach / foreshore interface to provide greater stability.	This option allows the retention of the recreational function of the beach, whilst mitigating the ongoing erosion issue
Foreshore Reconfiguration	Reconfigure the foreshore reserve to maximise the amenity whilst providing natural resilience. This might include revegetation, a clear delineation of pedestrian access to minimise scarp slump, reconfiguration of the stormwater discharge to minimise erosion impacts	This is recommended for the study site, in conjunction with renourishment above.
Extension of headlands / groynes	Extend the eastern headland with a groyne structure, in combination with renourishment to retain more sediment in the compartment.	Whilst this may allow more sediment to be held within the beach compartment, it will likely lead to reduced sediment supply to the east and could cause erosion issues downdrift. This option would also be expensive to construct. This option is not recommended for the study site.

An example of a vertical seawall is observed immediately to the east of the study area, at Cowes East. This beach is lined along its length with a vertical masonry wall. This beach is narrower than the Cowes Main Beach, as indicated by the aerial image dated 31st July 2016 extracted from Google Earth (Figure 6-1). At the high-water mark in this image the beach is almost non-existent. Comparatively, a wider beach was present during the 17th November 2017 site visit, as shown in Figure 6-2. However, this is still narrower than the observed beach at Cowes Main Beach (refer Section 2). Whilst there are many factors that could contribute to the beach width, the presence of the seawall is likely a contributing factor as there is no sediment buffer available to mitigate the impacts of cross-shore erosion. In addition, the vertical wall results in wave reflection which introduces increased turbidity and erosion at the toe of the seawall – exacerbating the movement of sand offshore.

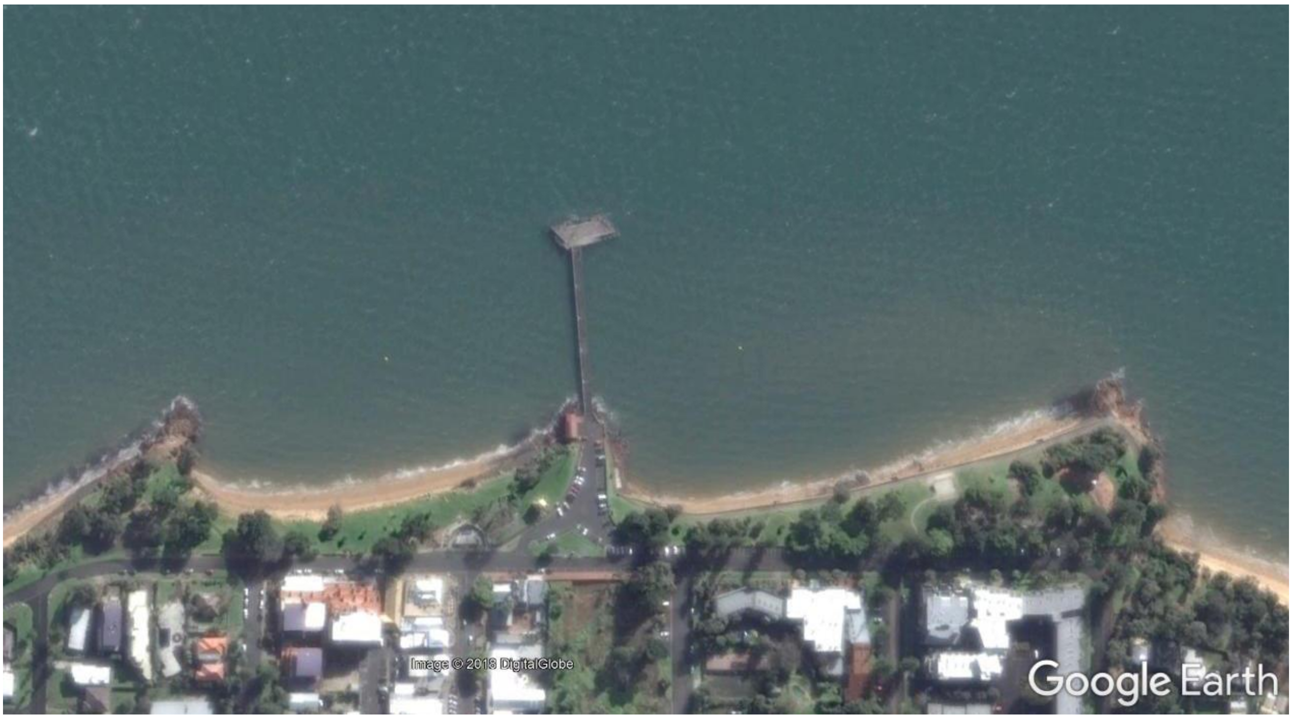

Figure 6-1 Comparison of beach widths at Cowes Main Beach and Cowes East - 31st July 2016 (image source: Google Earth)

Figure 6-2 Cowes East Beach at time of site visit – 17th November 2017

7 MITIGATION OPTIONS ASSESSMENT

The preliminary options assessment provided in Section 6 identifies two main options that are discussed further within this section:

- Beach Renourishment, combined with reconfiguration of the Foreshore Reserve to maximise its effect; two renourishment options are presented
- Seawall

Factors considered in assessing the options include:

- Public perception / social impact
- Environmental impacts / impact on adjacent coastline
- Likely effectiveness
- Capital & maintenance costs
- Safety
- Adaptability for climate change

7.1 Beach Renourishment

Beach renourishment is a soft protect option for erosion management that has minimal impact on the surrounding coastline. A 2016 Atkins Maritime Engineering (AME) beach nourishment report for the Cowes Main Beach also highlights beach renourishment as a method for erosion management at Cowes (Atkins Maritime Engineering, 2016). Counter to the Atkins report which recommends a nourishment of "*60m length… in the central section of Cowes West beach*", the renourishment outlined within this report is designed to be implemented across the entire beach face from the rocky outcrops of each headland.

7.1.1 Renourishment Profile

Two renourishment options have been developed with different sand volumes (see Table 7-1). This allows Council to understand the effectiveness of differing renourishment volumes, as well as considering the limited budget available to Council for the mitigation works:

- **Option 1:** considers the minimum renourishment required to achieve an effective erosion buffer for Cowes Main Beach. This option "fills in" the erosion scarp observed from chainages 30 to 45 to reduce its slope and continues to follow the gradient of the beach face (1:10).
- **Option 2:** considers greater protection but more expensive option than Option 1. Option 2 extends the beach from the scarp offshore at a gradient of 1/15 instead of the existing beach slope of 1/10. This option requires approximately 5.5 times more sand than Option 1 and hence will require a greater capital cost. However, this option would provide a greater resilience to the beach system meaning that the maintenance required is likely to be less than that that of Option 1.

Table 7-1 Renourishment Characteristics

	Gradient	Volume (m^3)	Relative Cost
Existing beach face	1:10	N/A	N/A
Option 1	1:10	2,870	Low
Option 2	1:15	16,000	High

7.1.2 Effectiveness & Maintenance Requirements

The renourished profile was modelled using SBEACH for the present day 10, 20, 50 and 100-year ARI storms, as per Section 5.4.1. The blue lines in Figure 7-2 to Figure 7-5 indicate the response of the renourished profiles to the storms.

- Option 1 provides protection greater than that of the present situation. Maintenance nourishment would be required following significant events, or at approximately 5-yearly intervals.
- Option 2 appears to provide a resilient solution that retains recreational beach face under the predicted storms. If vegetation is maintained at the dune face, this option could last up to 15-years, depending on sea-level rise rates. Some of the sediment moved offshore during storms has the potential to be moved eastward with this option. This would not be lost completely however, as it will contribute to the supply of sediment to the beaches to the east.

The cost difference between the two options suggests a volume between the two modelled would be appropriate for a medium-term solution for the site.

7.1.3 Sediment Source

As identified by Atkins Maritime Engineering (2016) there is ongoing sand removal occurring at the Anderson Road boat ramp, approximately 1.6km west of the study area. This ongoing sediment movement provides an opportunity to transfer sand to the site, however it is preferable to place and shape the renourishment volume all at the same time, rather than in small ongoing quantities. If not done at the same time, there is a high chance that as sand is added it would be redistributed by coastal processes such as waves and currents resulting in a reshaping of the desired profile, and potentially losing the placed sand altogether. As outlined by Atkins Maritime Engineering (2016), stockpiling of the sand would need to occur until the desired nourishment volume has accumulated and can be placed all at the same time.

The sediment size at the Anderson Road boat ramp would need to be measured to ensure its suitability at the site. The median particle size should be the same or greater than that of Cowes Main Beach.

Option 2 would need a section of beach roughly 300m long to be removed from the Anderson Road location. Option 1 would only require a 60m section to be removed. Given the results of the SBEACH modelling above, perhaps a section of 100-200m long would be appropriate, corresponding to a volume of approximately 10,000 m3. This would be a compromise between impacts at the sediment source site, and effectiveness of the option at Cowes Main Beach.

7.1.4 Foreshore Reserve Reconfiguration

The renourishment would be combined with revegetation at the dune / beach interface to provide stability. Low shrubs can be selected in order to retain coastal views when utilising the reserve. It is recommended that fencing be constructed across the full extent of the dune / beach interface, with formal access provided at key points. This will minimise erosion caused by foot traffic. Designated beach access points also allow for safety considerations in accessing the beach.

Whilst moving the storm water drains is preferred from an erosion management perspective, this would be an unrealistic cost for Council at the present time. As such, the discharge could just be incorporated into the vegetation plan to minimise its effect on the beach. For the long-term, it is recommended to realign the drains to exit through the rocky headlands. If the seawall option is considered in future, this could be undertaken at the same time.

A sketch of this option is provided in Figure 7-1. This includes an indicative renourishment volume, the location of the revegetation, fencing and beach access points.

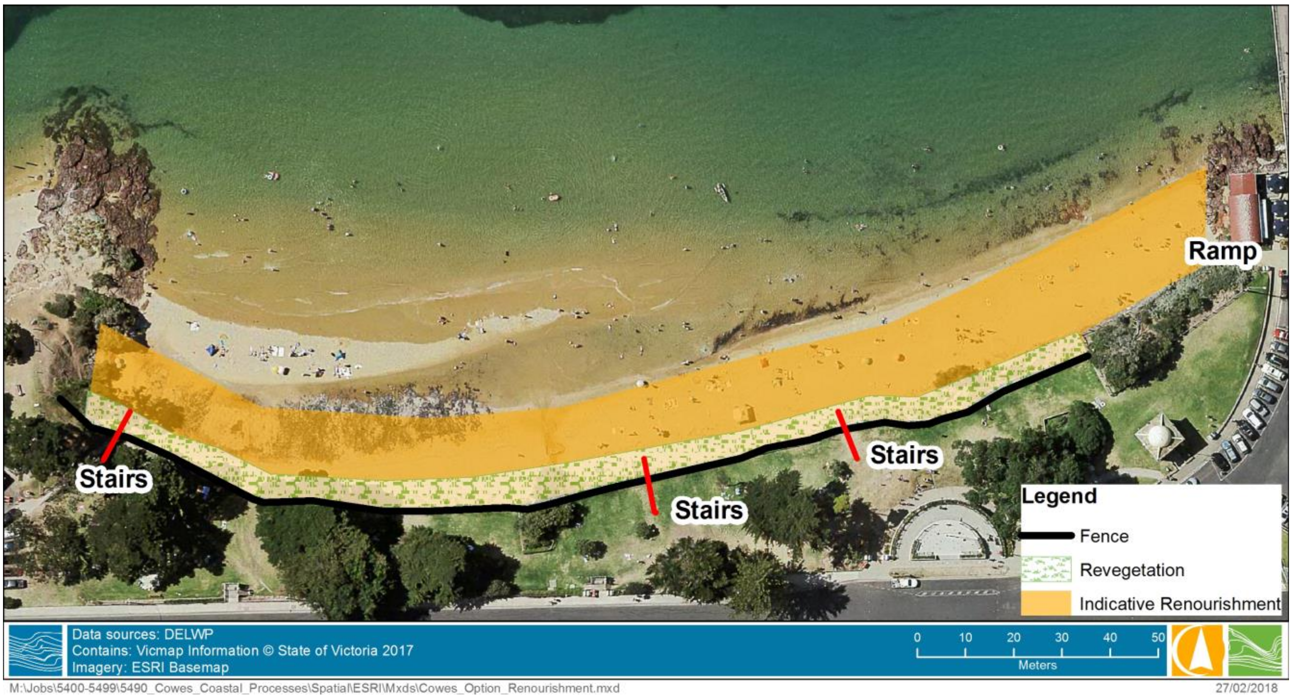

Figure 7-1 Indicative renourishment and revegetation in plan view

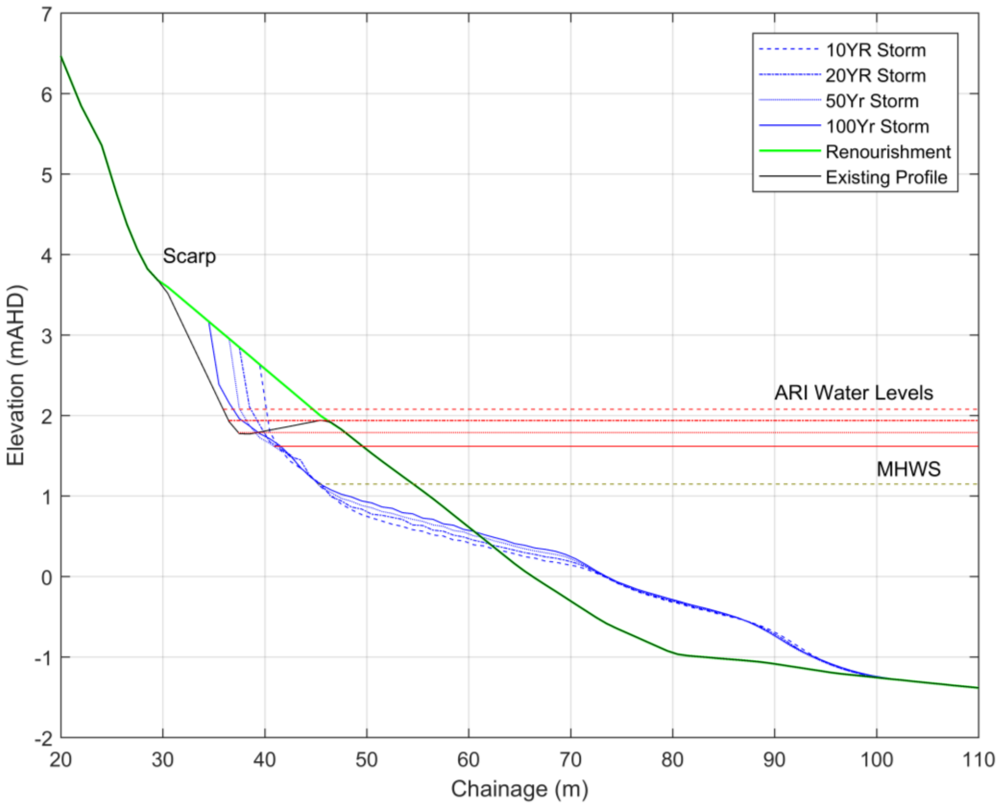

Figure 7-2 SBEACH: Renourishment Option 1

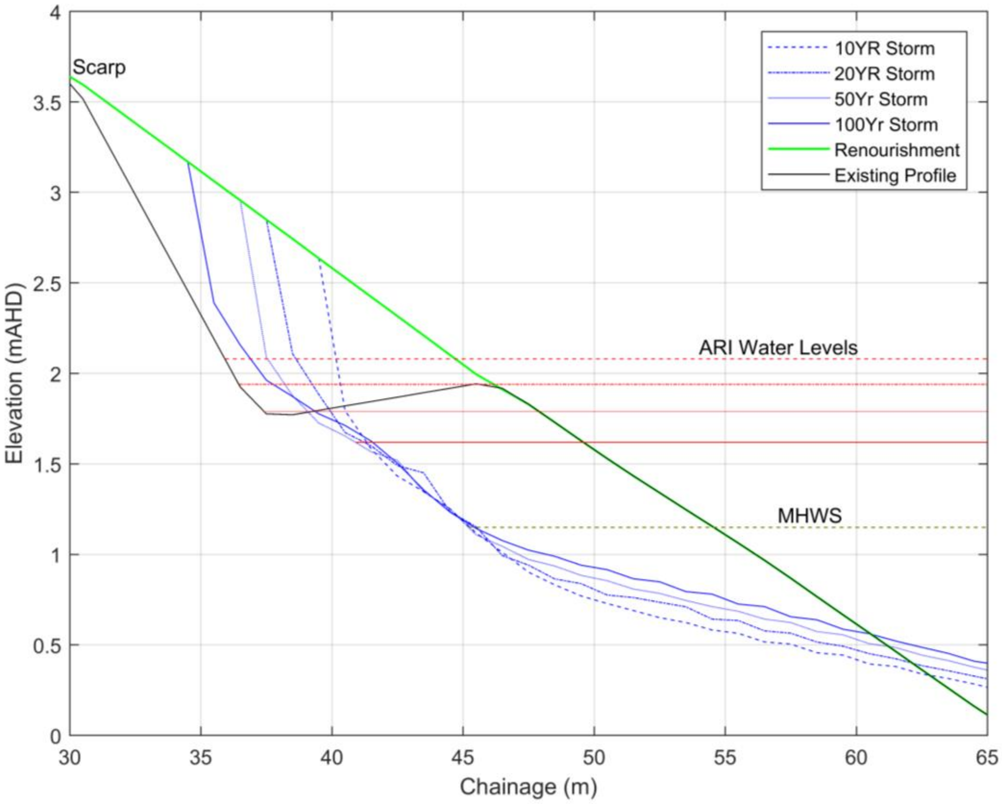

Figure 7-3 SBEACH: Renourishment Option 1 (chainages 30-65)

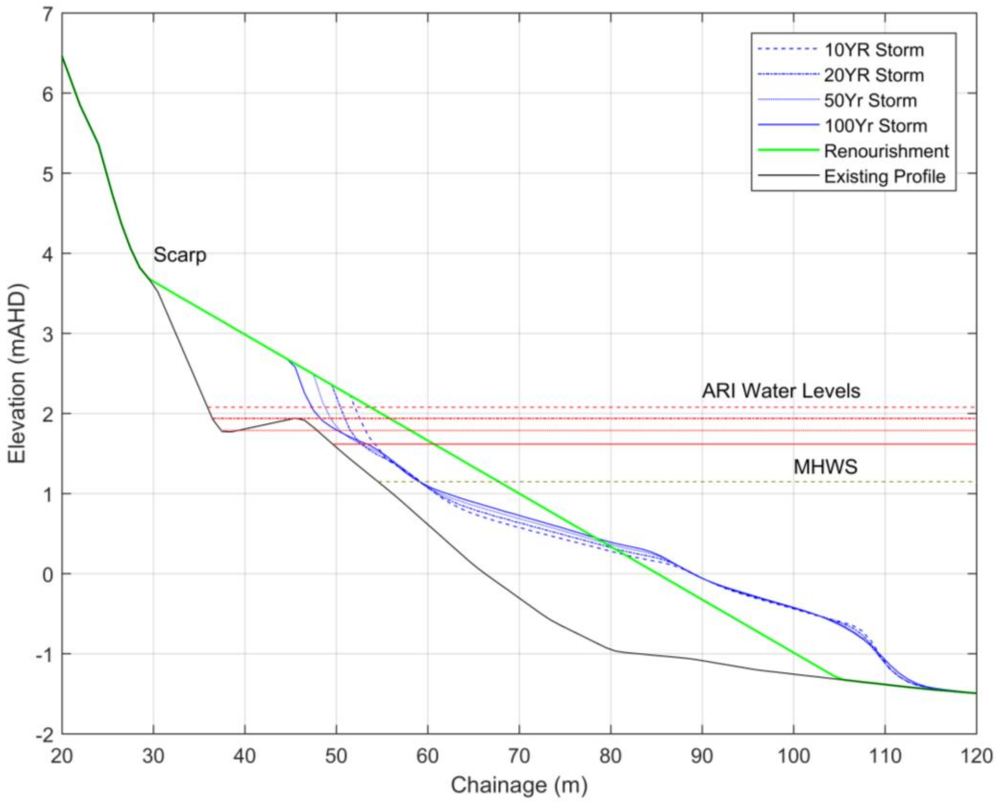

Figure 7-4 SBEACH: Renourishment Option 2

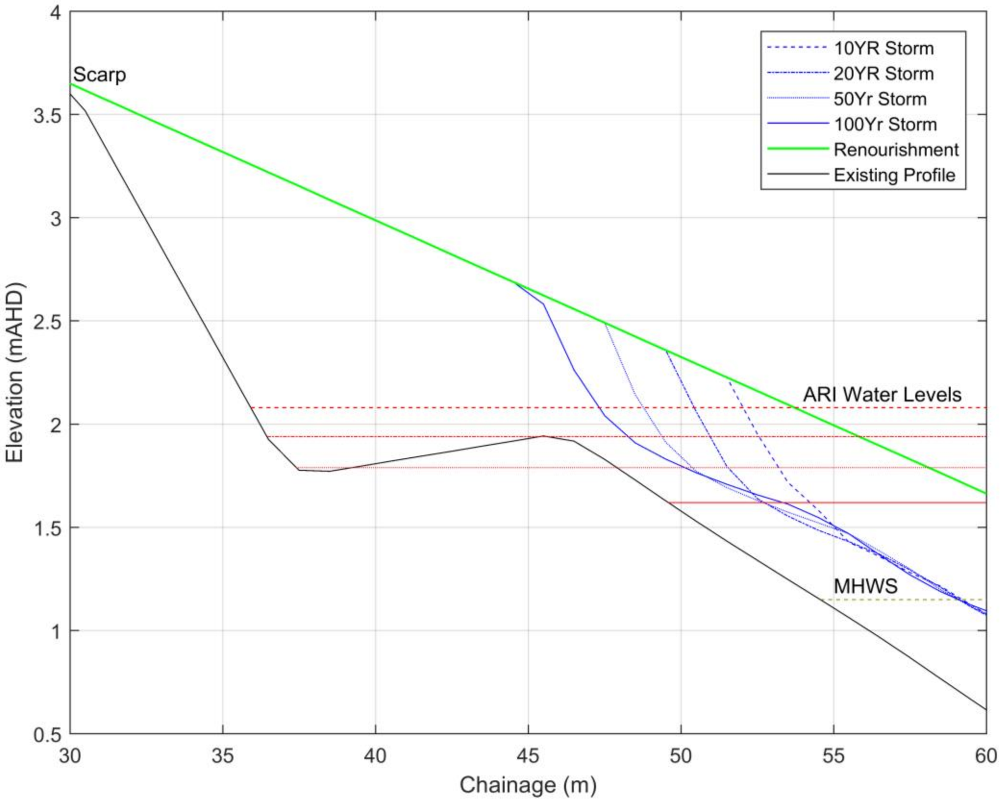

Figure 7-5 SBEACH: Renourishment Option 2 (chainages 30-60)

7.2 Seawall

As discussed in Section 7.1 above, renourishment combined with revegetation is considered a viable option for the study area in the medium term. Depending on the rate of sea-level rise, a seawall may become necessary in the next 20-years, in order to prevent major erosion at the site. Similarly, the quantity of sediment available from the identified source may be reduced as sea level rises.

As seawalls define where the shore-sea interface shall be in the shore section it protects, a discontinuity will form between the structure, which does not move, and the shore, which continues to recede. Erosion of the seabed immediately in front of the structure will in most cases be enhanced due to increased wave reflection caused by the seawall. This problem can be reduced by renourishing the beach in front of the seawall, or by constructing a buried seawall, or locating the seawall landward of the predicted wave action.

At the study site, the most suitable option would be to construct the seawall by cutting into the existing foreshore reserve in order to retain some recreational beach seaward of the structure. This would require considerable earthworks, adding to the cost of the structure.

As the headlands at both ends of the beach are made of rock, terminal scour would not be a problem (in general one of the main issues with construction of seawalls).

A seawall is potentially required at the site in the long-term, if the amenity and recreational values are planned to be retained by Council. The form of the seawall could be vertical or stepped, to maximise the amenity of the site. Formal beach access points would be included in the design to ensure safety of beach users. The stormwater drains could be realigned at the time of the construction and directed to exit at the rocky headlands in order to minimise their erosion effects. Excavated sand can be used as renourishment material seaward of the wall. Any silt and clay would be removed.

A sketch of the indicative seawall location is provided in Figure 7-6; access points are not included.

Figure 7-6 Indicative seawall location in plan view

7.3 Comparative Cost Estimates

The close proximity of the proposed sediment source, and its availability means the costs associated with the renourishment option are plant to move and place the sediment, plus the costs of revegetation. Access to the site will be difficult due to the steep slope of the foreshore reserve. Potentially the sand could be trucked across the beach from the Cowes Yacht Club, and around the western headland if undertaken at low tide. Alternatively, the beach could be accessed through Cowes Main Beach Foreshore Reserve if a suitable access gradient could be constructed. This would damage the foreshore reserve, which would need to be reinstated post construction.

An indicative cost estimate for the renourishment option would be $100,000 to $300,000 ex-GST, depending on the quantity of sand selected for the renourishment. This would include the revegetation. A more detailed cost estimate is recommended to be obtained from a contractor should this option be selected to proceed as there is the potential for the costs to reduce.

Construction of the seawall would require sourcing appropriate rocks, plus the plant needed to construct the seawall. This could be of the order of $1 million ex-GST, depending on rock source and the level of geotechnical assessment required to cut into the foreshore reserve. A vertical structure would likely have a similar cost if built above the high tide line (that is, if the construction site were dry, and no bunding required to prevent inundation).

8 CONCLUSIONS & RECOMMENDATIONS

The Cowes Main Beach Foreshore Reserve has experienced coastal recession which is impacting the amenity of the beach for both residents and tourists. The beach provides an area of great public value within the township of Cowes. As such, Council would like to address the observed coastal recession at the site to ensure this public value is retained into the future.

A summary of the key coastal processes impacting the recession rates can be found below:

- Extreme Water Levels
  - Extreme water levels play a significant role in erosion to the beach face. Storm tides which focus the wave energy on the scarp of the Cowes Main Beach are a key factor to take into consideration when designing any mitigation measure.
- Wave Environment
  - Though the Cowes Main Beach is in a relatively sheltered bay, there is a large fetch to the north which, during winter, can result in relatively large waves to break on the beach. It is the combination of these waves with the elevated water levels that lead to erosion.
- Sediment Transport
  - The sediment transport system at is relatively closed with the two headlands at either end of the beach acting as barriers to sediment movement. The erosion observed at Cowes Main Beach is related to cross shore sediment transport initiated by storm events.

The following mitigation measures are recommended to maintain the amenity of the beach and foreshore reserve into the future:

- Renourishment
  - Two renourishment options have been provided by with the aim of providing a natural buffer for Cowes Main Beach to storm erosion events. The aim of these management options is that they provide a solution without taking away from the natural feel of the beach or the amenity of the area which may not be the case with a seawall. The design life of this option is 20-25 years.
- A seawall could be required in the long-term (20+ years) in response to sea-level rise, if the present amenity of the Cowes Main Beach Foreshore Reserve is to be retained. It is suggested the stormwater drains be realigned at this time to exit through the rocky headlands in order to minimise their effect on erosion.

To aid the understanding of the coastal processes at the site, and identify triggers for when maintenance renourishment, and, in time, a seawall is required, the following ongoing data be collected at the site:

- Beach survey, ideally every 6-months following the summer and winter periods. If possible, immediately following storms
- Beach photo monitoring at the same time as the collection of the survey data.
- Ongoing aerial photographs

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Melbourne
15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800
Fax (03) 9558 9365

Wangaratta
First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Geelong
PO Box 436
Geelong VIC 3220
Telephone 0458 015 664

Wimmera
PO Box 584
Stawell VIC 3380
Telephone 0438 510 240

Brisbane
Level 3, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460
Fax (07) 3846 5144

Perth
PO Box 362
Subiaco WA 6904
Telephone 0438 347 968

Gippsland
154 Macleod Street
Bairnsdale VIC 3875
Telephone (03) 5152 5833

www.watertech.com.au

info@watertech.com.au