Ocean Beach and Peaceful Bay

Coastal Monitoring Action Plan

CW1055200

Prepared for
Shire of Denmark

6 June 2019

Cardno
Shaping the Future

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1 Introduction

This Coastal Monitoring Action Plan outlines techniques for simple, cost-effective and sustainable coastal monitoring to be undertaken by the Shire of Denmark (herein referred to as 'the Shire') over the next decade. The recommended coastal monitoring techniques aim to inform and support decision making for ongoing coastal adaptation and management at Ocean Beach and Peaceful Bay. The establishment of a structured monitoring program was recommended in the *Ocean Beach and Peaceful Bay Coastal Hazard Risk Management and Adaptation Plan* (CHRMAP) (Seashore, 2018).

1.1 Study Site

The Shire is situated approximately 360km south east of Perth along the south coast of Western Australia. With an 84 km section of mostly undeveloped coastline, the natural coastal foreshore areas in the Shire are a large focus for recreation and tourism in Western Australia.

Significant coastal development within the Shire is focused around Ocean Beach and Peaceful Bay (**Figure 1-1**), as these locations have been identified by the Shire as the highest value coastal reserves under their management. Infrastructure adjacent to Ocean Beach includes the Denmark Surf Life Saving Club, the Denmark Boating and Angling Club and a public car park. The Peaceful Bay Sea Rescue Emergency Centre lies adjacent to Peaceful Bay with a key access road also expected to be threatened in the future.

Given the close proximity of infrastructure to the shoreline and the inherent value provided by the coast itself, potential changes to sea level and coastal processes in the area, as a result of climate change, pose management challenges for the Shire.

1.2 Purpose

A ten-year, cost-effective and sustainable coastal monitoring plan was a key outcome of the CHRMAP (Seashore, 2018) and will be a fundamental tool for informed decision-making in coastal management. The outcomes of this Monitoring and Action Plan will inform the Shire of patterns of shoreline change at Ocean Beach and Peaceful Bay and help them to better understand the site's coastal behaviour, monitor exposure of high-risk assets and inform timeframes for implementation of coastal adaption options.

Accumulation of a short to medium term data set based on the implementation of this Plan is expected to allow decision-making specific to a number of CHRMAP management recommendations at each site, including:

<u>Ocean Beach</u>

- Confirm suggested cycles of erosion and recovery;
- Establish beach widths to assist in informing the 'managed retreat' management trigger of the lower Denmark Surf Life Saving Club (SLSC) building. The first two years of monitoring will be critical to informing this management recommendation;
- Monitor the erosion buffers and slope stability for the new SLSC building; and
- Better understand the influence of the Wilson Inlet on coastal hazards at Ocean Beach.

<u>Peaceful Bay</u>

- Better define the rate of erosion at Foul Bay in the vicinity of the Fisherman's lease area;
- Improve understanding of the potential causes of observed erosion at Foul Bay. E.g. realignment of wider beach planform, limited sediment for post-storm recovery;
- Inform management decisions related to managed retreat or protection of Peaceful Bay Road;
- Design and siting of new coastal access within Peaceful Bay; and

- Identify the trigger for long-term managed retreat of beach access and the car park adjacent to the Sea Rescue building.

Major threats to the coastline are those associated with natural processes, which may be exacerbated by climate change effects like predicted sea level rise and potential changes to meteorological and hydrodynamic conditions in the region. The coastline is constantly susceptible to erosion through short term processes, such as storm surge, and long term processes, such as rising sea levels and changes to longshore sediment transport regimes. The various forms of erosion are defined in the *State Planning Policy 2.6 - State Coastal Planning Policy* (SPP2.6; WAPC, 2013) as:

> (S1 Erosion) Allowance for the current risk of erosion;

> (S2 Erosion) Allowance for historic shoreline movement trends; and

> (S3 Erosion) Allowance for erosion caused by future sea level rise.

This Plan looks to incorporate monitoring methods that can quantify and validate these components, to better inform their associated risk levels.

Site Locations

OCEAN BEACH AND PEACEFUL BAY
COASTAL MONITORING ACTION PLAN
FIGURE 1-1

Legend

- Peaceful Bay
- Ocean Beach

N

1:200,000

Cardno

Map Produced by Cardno (1600)
Date: 2019-05-08
Coordinate System: GDA 1994 MGA Zone 50
Project: CW1055200
Map: CW1055200_SiteLocations.mxd 01

2 Photo Monitoring

2.1 Methodology

2.1.1 Manual Imagery

It is recommended that the Shire implements a manual imagery monitoring program to monitor beach sections at both Peaceful Bay and Ocean Beach.

The process should involve the manual capture of high resolution images using a single lens, 35mm digital camera with a resolution greater than 15 megapixels, by trained personnel. The images will need to be taken at the same location and vantage point each time and should provide an approximate 45° field of view (FOV) of the beach. To ensure that the photos are taken at the same location each time, the specified monitoring point will need to be located at an easily identifiable fixed point (where available), landward of the active coastal zone. Ideally a fixed point such as a rock, path or walkway should be selected as the monitoring point. Fixed features within the photo frame, such as trees and poles should be in a consistent position within the image frame on each sampling occasion.

An up-coast and down-coast image, as well as cross-shore image where appropriate, should be taken at each monitoring location. These images are to be captured at least once monthly, although images captured once fortnightly is ideal. Images should also be taken just prior to, and following, a severe storm event (identified through the Storm Monitoring program outlined in **Section 6**). For each image taken, the log sheet provided in **Appendix A** will need to be completed detailing the following:

> GPS coordinates of the site;

> Height of the camera from the ground when the photo was taken;

> Date and time that the photo was taken; and

> Any site observations and brief observations of beach characteristics (e.g. erosion scarp at the back of the beach).

The photos must be uploaded into a dedicated database. When uploading photos, ensure that photos can be viewed in chronological order for each individual FOV.

Suitable monitoring points for Peaceful Bay and Ocean Beach have been identified and are presented in **Figure 2-1**, **Figure 2-2** and **Table 2-1** below. Sample images taken from each manual imagery monitoring point, along with completed log sheets are provided in **Appendix B.** The suitability of the manual imagery monitoring points should be reviewed following the first year of data collection in terms of access constraints and changes to infrastructure being used as vantage or focal points.

Every year the images should be analysed to identify event based erosion or accretion events, such as those associated with storms and energetic wave conditions. Observations of seasonal trends in shoreline change can be made when at least 1 year of data is available. Some assessment of medium- to long-term trends can be made with 5 to 10 years of imagery data.

2.1.2 Remote Imagery

At present, there is limited existing infrastructure in the study areas that would be suitable as vantage/installation points for remote imagery units. The Shire should consider the implementation of remote imagery monitoring at the study areas in future, should new, suitable infrastructure be installed. Remote imagery has the following advantages over manual imagery:

> Considerably less labour intensive – automated image capture;

> Greater temporal resolution of data – hourly images;

> Greater spatial capture – generally installed at high vantage points;

> More comparable – same FOV for every image captured; and

> More accurate analysis of shoreline trends due to higher vantage point.

If incorporated in future monitoring, remote imagery units should be installed at locations that provide a good field of view of the beach, including for future shoreline recession scenarios (i.e. capture area behind existing shoreline). They should be installed at the highest possible vantage point, while considering the need for safe installation and ongoing servicing. Should existing structures be proposed as vantage points for camera installation, such as surf clubs and lookouts, consideration should be given to the permanency of these structures. Where existing installation locations are not feasible, poles would need to be installed.

The remote imagery units should be set up to capture high resolution images every hour, on the hour, between 05:00 and 19:00 each day (i.e. daylight hours). The units should be set up to transmit a low resolution sample of each captured photograph, via mobile network, to an online database for daily observation.

The remote imagery units will require periodic servicing for the following:

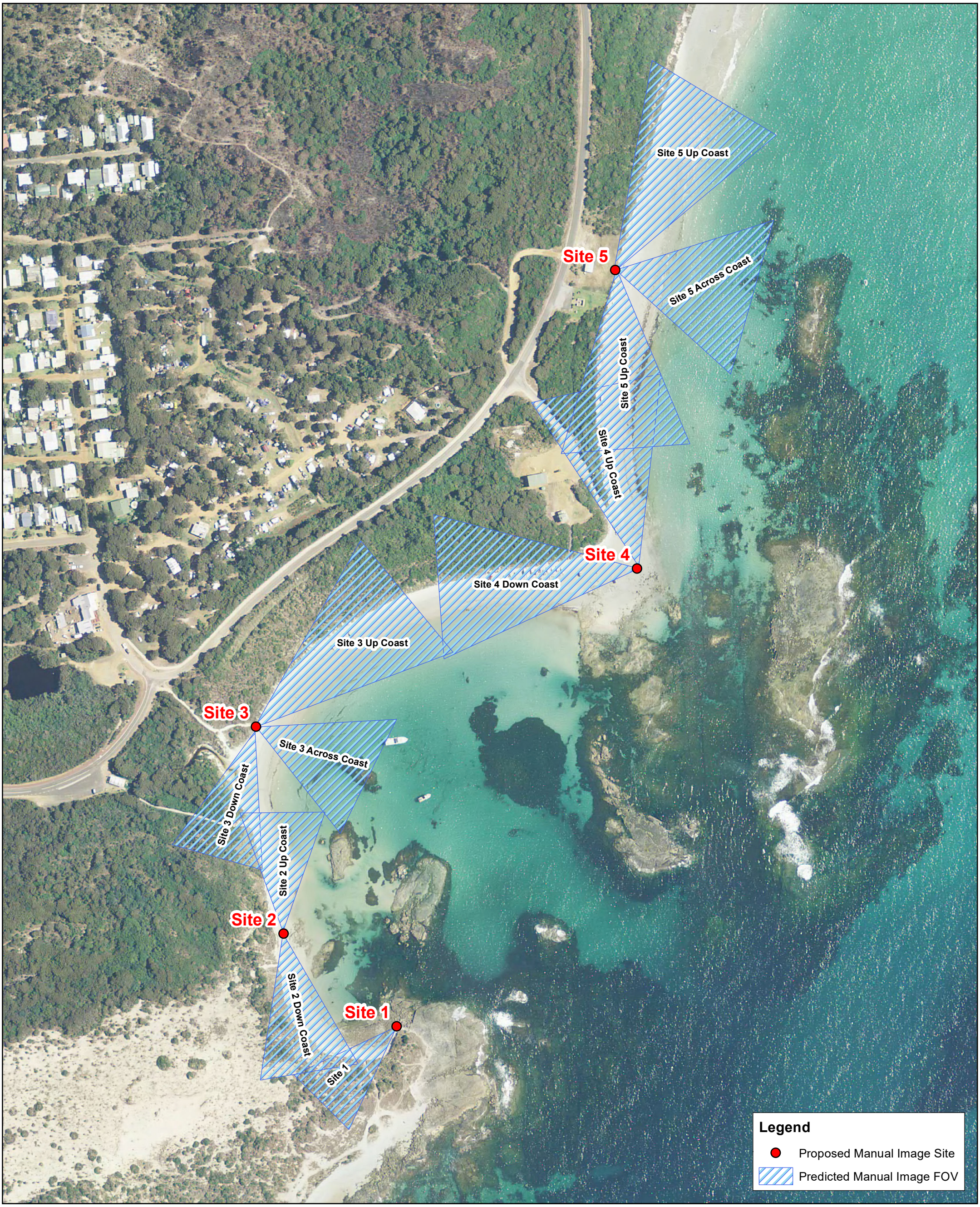
> Battery change – unless fitted with a solar panel, batteries will need to be changed every 2 to 3 months;

> Data download – fitted with a memory card, the cameras will be able to store at least 12 months' worth of images. It would be recommended that images are downloaded more regularly than this (at least 3 monthly) to prevent data loss and allow ongoing analysis;

> Cleaning lens – if image quality is lowered due to material on the camera lens, this will require cleaning (it should be noted that the remote imagery cameras that Cardno currently use rarely require lens cleaning); and

> Camera damage – the units may be damaged by vandalism, severe storm conditions or birds. They may require repair or replacement.

It would be recommended that images from the cameras are analysed annually to identify seasonal trends in shoreline movement and the impact of particular storm events on the shoreline. With 5 to 10 years of collected imagery, possible medium term patterns in shoreline movement can be assessed. The images can be used to assess volumes of beach users, to gain a measure of value (tourist value) of the beach to the Shire and community. The images will also provide qualitative information about coastal sea state conditions and water levels, on an ongoing basis.



Manual Imagery Photo Monitoring Site Locations

PEACEFUL BAY
FIGURE 2-1

N

1:3,000 Scale at A3

Cardno

Map Produced by Cardno WA (6100)
Date: 2019-05-30
Coordinate System: GDA 1994 MGA Zone 50
Project: CW1055200
Map: CW1055200_ManualImageSiteLocations_PeacefulBay_Figure2-4_C.mxd 01

Site 10 Down Inlet

Site 10 Up Coast

OCEAN BEACH
LOOK OUT

Site 10

Site 10 Down Coast

Site 9 Up Coast

Site 9 Across Coast

Site 9

Site 9 Down Coast

Site 8 Up Coast

Site 8 Across Coast

Site 8

Site 8 Down Coast

Site 7

Site 7

Site 6

LIONS
LOOKOUT

Legend

Predicted Manual Image Field of View

Proposed Manual Image Site

N

1:2,000 Scale at A3

Manual Imagery Photo Monitoring Site Locations

OCEAN BEACH
FIGURE 2-2

Cardno

Map Produced by Cardno WA (6100)
Date: 2019-05-30
Coordinate System: GDA 1994 MGA Zone 50
Project: CW1055200
Map: CW1055200_ManualImageSiteLocations_OceanBeach_Figure2-5_C_.mxd 01

Table 2-1 Proposed manual imagery site locations

Manual Imagery Monitoring Location	Easting	Northing	Location
Peaceful Bay			
1	493692	6122110	Rock headland –Peaceful Bay south
2	493593	6122191	Rock outcrop – Peaceful Bay south
3	493569	6122372	“Dog Owners” Sign –Peaceful Bay north
4	493902	6122510	Tombolo – East of boat ramp
5	493883	6122771	“Danger Keep Out” Sign – Foul Bay
Ocean Beach			
6	530210	6123438	Lions Lookout
7	530203	6123519	Rock headland –Ocean Beach south
8	530155	6123616	Surf Life Saving Club
9	530170	6123795	Rock outcrop – Ocean Beach north
10	530082	6124028	Ocean Beach Lookout

2.2 Historical Data

There are some historic images available for the two study areas.

Manual photographs at 17 monitoring locations were taken of Peaceful Bay on the following dates.

> 15th July 2008

> 23rd July 2009

Four of the monitoring locations (PE1, PE4, PE5 and PE6) are at similar locations to the proposed manual image Sites 3 and 4 (**Figure 2-1**). These images should be incorporated when assessing medium to long-term trends at Peaceful Bay.

Manual photographs at 23 monitoring locations were taken of Ocean Beach on the following dates.

> 29th July 2008

> 04th August 2009

> 09th March 2011

Two of the monitoring locations (OB1 and OB6) are at similar locations to the proposed manual image Sites 8 and 10 (**Figure 2-2**). These images should be incorporated when assessing medium to long-term trends at Ocean Beach.

2.3 Limitations

Photo monitoring allows shoreline changes to be captured, such as those associated with the impacts of storms, seasonal variations and longer-term trends. However, photo monitoring only facilitates a limited assessment of trends and does not provide a detailed quantitative framework for investigation. When used in conjunction with other quantitative datasets (e.g. nearshore topographical surveys) an effective analysis of short to long term trends of erosion can be undertaken.

3 Aerial Monitoring

3.1 Methodology

Aerial monitoring in this instance refers to the collection of data using drones or manned aircraft. The data that can be collected by this method includes:

> Photography, which can be used in the following ways:
  - Used as a qualitative record of shoreline condition and morphology;
  - Georectified to convert to aerial imagery (for analysis of shorelines, vegetation lines etc.); and
  - Used for photogrammetric analysis to convert to surface elevation.
> LiDAR (Light Detection and Ranging). This can provide high resolution elevation and bathymetry data over broad areas, to a known level of accuracy.

Due to the large coastal stretches, the presence of thick vegetation and steep topography of the beaches at Ocean Beach and Peaceful Bay, it is recommended that aerial monitoring techniques be implemented as a preferred option over traditional manual beach profile surveys.

It is recommended that aerial monitoring be undertaken during low spring tides, in calm conditions. This will allow data to be collected as far as possible offshore as well as limit the implications of turbulence in the surf zone. Monitoring should be undertaken to the extents shown in **Figure 3-1** and **Figure 3-2** and where possible, incorporate permanent or semi-permanent infrastructure (e.g. footpath, road “permanent’ rock). There is believed to be some influence of the Wilson Inlet entrance on the dynamics of southern end of Ocean Beach. In order to investigate the nature of the influence, it is recommended that aerial monitoring is extended to include the Wilson Inlet as depicted in **Figure 3-3**.

Shoreline dynamics in the south-west are seasonally influenced, with typical patterns in metocean conditions driving sediment on and offshore, leading to accretion and erosion of the beach face at different times of the year. In order to optimise the outcomes of the aerial monitoring, consideration must be given to the timing of surveys. It is recommended that aerial monitoring be undertaken biannually, and timed for intervals between the prevailing summer and winter condition periods - approximately April and October/November. Shoreline variance is expected to be the most pronounced between these periods. If possible, aerial monitoring should also be undertaken just prior to, and following, severe storm evets (identified through the Storm Monitoring program outlined in **Section 6**).

The aim of aerial monitoring should be to gain spatial elevation data, that can be compared across time to assess changes in beach profiles and volumes of beach sediment. The monitoring technique can also be useful in encouraging public interest in coastal processes and management issues.

3.1.1 Photogrammetry

Photogrammetry is the recommended technique to be used for aerial monitoring at Ocean Beach and Peaceful Bay. Photogrammetry can be carried out from drones or unmanned aerial vehicles (UAV) and is a relatively cost-effective method for determining ground elevations, by analysing a series of overlapping aerial photographs.

It is important to note the limitations of photogrammetry in the surf zone, where the fluctuating water surface restricts accurate elevation measurements. Additionally, photogrammetry cannot penetrate the water surface and hence should be undertaken in low spring tides to capture as much of the beach profile as possible. Photogrammetry is generally considered to have a lower accuracy than traditional survey or LiDAR techniques, but is considered to be sufficiently accurate to assess overall changes in the shoreline.

3.1.2 LiDAR

Light detection and ranging (LiDAR) uses light in the form of a pulsed laser to measure distances to the earth. LiDAR is a high accuracy aerial survey technique and has the ability to penetrate water surfaces, which for the

purpose of beach monitoring, could provide a useful tool in understanding changes in bathymetry and beach profiles both seaward and shoreward of the high tide mark. LiDAR however, is considerably more expensive than photogrammetry and at this stage, is not considered to be a value for money aerial monitoring technique for the Shire.

3.2 Historical Data

Cardno is not aware of any historical aerial monitoring data available for the study sites, other than standard aerial photography.

3.3 Limitations

At present, drone and aerial monitoring technology is still developing rapidly. The capture of aerial imagery by drone is possible, but requires a certain elevation and image quality to prevent image distortion. Most aerial photography is captured by manned aircraft of satellite. Imagery from a high vantage point, such as that provided by a drone, gives a different perspective of the coastline and has high qualitative value. With a high resolution camera and integration of GPS, photogrammetric analysis can be used to convert captured images into an elevation surface. There is still a reluctance of some operators to define the accuracy of photogrammetry, compared to traditional survey and LiDAR techniques. The elevation of white surfaces/objects (such as beaches) is difficult to define through photogrammetry, due to the lack of definition. Photogrammetry cannot be used to estimate levels anywhere seaward of the shoreline.

Both LiDAR and photogrammetry can provide very detailed spatial datasets, but only allow a single snapshot in time to be measured for one measurement exercise. The monitoring techniques have the advantage of being able to characterise elevation with respect to a known datum and to a known accuracy. The techniques become confounded, however, in nearshore/shallow areas due to water disturbance and light diffusion. Because of this, key areas of the beach profile can be omitted from LiDAR datasets. LiDAR is relatively expensive to collect. Therefore, it would be expensive to commit to a long-term monitoring program involving the collection of LiDAR data. The technology has become more cost effective with the use of drones, as opposed to light aircraft, and is likely to become cheaper in the future. Proposed beach transects taken from aerial survey at Peaceful Bay

Peaceful Bay Aerial Monitoring Northern Extent

Peaceful Bay Aerial Monitoring Southern Extent

Legend

- Proposed Survey Beginning and End Points
- Proposed Survey Profile Transects
- Sediment Sample Site
- Aerial Monitoring Extent

1:4,000 Scale at A3

Proposed Beach Transects and Sampling Locations

PEACEFUL BAY
FIGURE 3-1

Cardno

Map Produced by Cardno Perth
Date: 2019-06-05
Coordinate System: GDA 1994 MGA Zone 50
Project: CW1055200_001
Map: CW1055200_Proposed Beach Profile Survey Transects_PeacefulBay_Figure3-1_C.mxd 01

Ocean Beach Aerial Monitoring Northern Extent

7
Ocean Beach
Look Out

jk

7

6

6

OCEAN BEACH RD

5

5

4

jk

4

3

3

2

2
jk

1

1

Ocean Beach Aerial Monitoring Southern Extent

Legend

- Proposed Survey Beginning and End Points
- Proposed Survey Transect Lines
- jk Sediment Sample Site
- Aerial Monitoring Extent

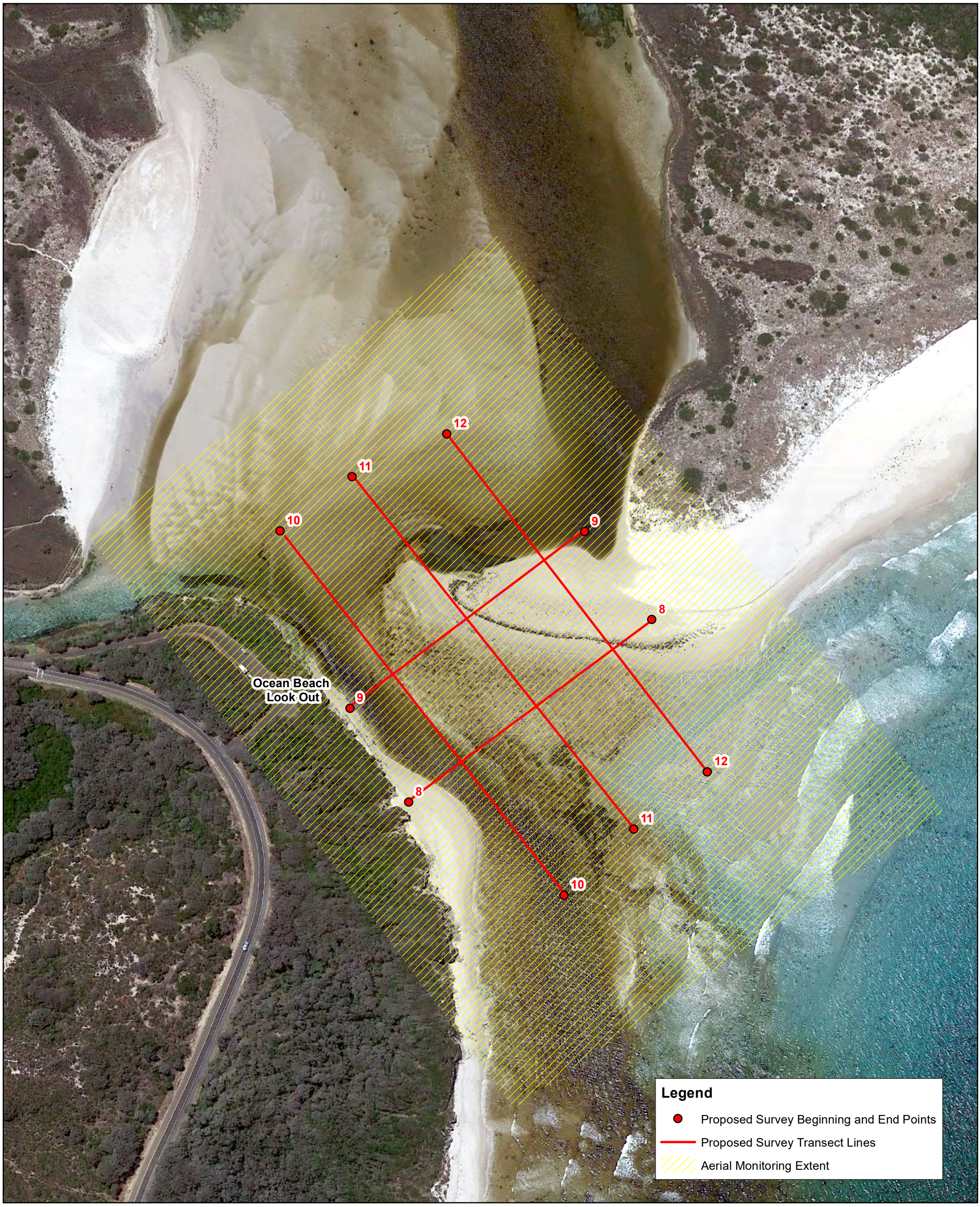
1:2,000 Scale at A3

Proposed Beach Transects and Sampling Locations

OCEAN BEACH
FIGURE 3-2

Cardno

Date: 2019-06-06
Coordinate System: GDA 1994 MGA Zone 50
Project: CW1055200_001
Map: CW1055200_Proposed Beach Profile Survey Transects_OceanBeach_Figure3-2_C.mxd 01
Imagery: nearmaps.com



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1:2,000 Scale at A3

Proposed Beach Transect Locations

WILSON INLET (OCEAN BEACH)
FIGURE 3-3

Cardno

Date: 2019-05-08
Coordinate System: GDA 1994 MGA Zone 50
Project: CW1055200
Map: CW1055200_Proposed Beach Profile Survey Transects_OceanBeachInlet_Figure3-3.mxd 01
Imagery: nearmaps.com

4 Beach Profile Surveys

4.1 Methodology

Manual beach profile surveying is an option for the Shire and could be undertaken to collect data on shoreline elevations (see **Section 3**). Please note that this section describes the techniques to be followed if manual surveying is used in lieu of aerial surveying. It is not necessary for both forms of data collection to be undertaken for a specific time and, as discussed in **Section 3**, capture of elevation data through photogrammetry would be the preferred technique in the Shire's case.

Transects are to be spaced at 50 to 100 metre intervals (dependant on the change in orientation of the shoreline) and are to be consistent on each survey occasion, to allow assessment of changes in beach profile. The proposed locations of the 14 transects at Peaceful Bay, 7 transects at Ocean Beach and 5 transects at Wilson Inlet are depicted in **Figure 3-1, Figure 3-2** and **Figure 3-3** and the proposed GPS start and end coordinates are presented in **Table 4-1.** Due to accessibility limitations, the survey end points may be used as a guide and survey points should be taken as far as is reasonably practicable inland or until a piece of hard infrastructure is reached (e.g. footpath, road, "permanent" rock). It is recommended that surveying be undertaken during low spring tides, in calm conditions. This will allow profiling to be carried out to as far as possible offshore for each transect.

Survey readings should be taken at survey points approximately 1 m apart along the predefined transect lines and must follow the same transect lines (i.e. be in a direct line between plotted start and end points) on each profiling occasion, to ensure consistency and allow assessment of changes in beach profile. The surveying should be timed to occur in the intervals between the seasonal summer and winter periods (approximately April and October/November, respectively). Where possible, surveying should also be undertaken just prior to, and following, a severe storm event (identified through the Storm Monitoring program outlined in **Section 6**).

The survey elevation profiles are to be plotted upon completion. The data management and evaluation process for survey elevation profiles is outlined in **Section 8**. Plotting of elevation profiles will allow for the comparison between previous beach profiles, for each transect. Profile comparisons between annual beach profiles will allow for the assessment of potential trends and changes to beach morphology over time. Additionally, the comparisons between summer and winter profiles allows an assessment of short-term, seasonal variations in beach morphology. Interpolation between profiles alongshore can also be carried out to estimate losses and gains of volume of beach sand.

Table 4-1 Suggested survey profile beginning and end GPS coordinates (MGA 50)

Transect No.	Peaceful Bay				Ocean Beach			
	Start Point		End Point		Start Point		End Point	
	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing
1	493908	6123279	494095	6123102	530169	6123516	530233	6123549
2	493866	6123069	494024	6123037	530156	6123561	530224	6123575
3	493858	6122988	494014	6122947	530160	6123618	530233	6123617
4	493856	6122882	493983	6122844	530137	6123686	530230	6123674
5	493845	6122787	493956	6122762	530151	6123770	530252	6123742
6	493804	6122685	493940	6122664	530154	6123864	530314	6123814
7	493856	6122608	493925	6122608	530078	6124025	530377	6123931
8	493856	6122559	493942	6122554	530141	6123953	530283	6124060
9	493846	6122559	493922	6122457	530107	6124008	530243	6124111
10	493816	6122577	493842	6122422	530066	6124112	530231	6123899
11	493728	6122597	493761	6122430	530109	6124143	530272	6123938
12	493628	6122530	493699	6122413	530163	6124168	530315	6123971
13	493514	6122433	493632	6122363				
14	493438	6122256	493620	6122247				

4.2 Historical Data

5 survey locations at Ocean Beach and the 18 proposed survey locations at Peaceful Bay were surveyed previously in December 2016 by Denmark Survey and Mapping. These surveys can be incorporated when analysing changes at Peaceful Bay and Ocean Beach.

4.3 Limitations

Biannual beach profile surveys allow for medium- to long-term changes in beach morphology to be assessed, but do not allow an assessment of short term trends (i.e. shorter than 6 months). When used in conjunction with other comprehensive datasets (e.g. photo monitoring surveys) they provide valuable qualitative, validation data.

5 Sediment Sampling

Sediment sampling will provide useful information regarding the particle size and potential source of the sediment accumulating and being lost from beaches within the study areas. This information will be beneficial in determining the key mechanisms of sediment movement, with swell waves generally having the ability to suspend and shift larger particles than the combination of water levels and currents. The information will also inform renourishment design and sediment transport modelling, should this be required in the future. Generally, finer sediments accrue on the beach face during the summer period where wind and wave set-up are less destructive. These finer sediments are subsequently mobilised and removed, leaving behind a coarser beach composition during the winter period. This change in sediment distribution is a key mechanism driving shoreline change, particularly around erosive events occurring at the beginning of winter.

5.1 Methodology

Sediment sampling in the study areas should be undertaken in conjunction with beach profile surveys (i.e. at least 6 monthly). Sediment sampling should also be undertaken just prior to, and following, a severe storm event (identified through the Storm Monitoring program outlined in **Section 6**). Ideally, a sample should be taken at the high tide mark along each survey transect during surveying. At least 500 grams of sample should be taken and placed in a heavy duty zip lock bag and sent to an accredited laboratory for particle size distribution (PSD) analysis.

In the event that laboratory analysis is considered too costly, sediment particle sizes can be assessed using sediment sizing cards. Sediment sizing cards are a guide that allows the sampler to estimate the particle sizes of the sediment, however sediment sizing cards do not allow for a detailed particle size distribution analysis of the sediment. The use of sediment sizing cards can also lead to different interpretation of sediment size between samplers/users. An example of a sediment sizing card, for reference, is shown in **Figure 5-1**. Should sediment samples by assessed using sediment sizing cards, the log sheet provided in **Appendix C** will need to be completed for each sediment sample detailing the following:

> Site ID;

> Date and time that the sediment was collected; and

> Details on sorting, sediment size and roundness.

It is recommended that at least three sediment samples are taken from each study area at the same time as the aerial monitoring campaign is carried out. GPS coordinates were taken during the first sampling campaign on 22 May 2019, all later samples should be taken at the same locations. Sediment sample locations are depicted in **Figure 3-1** and **Figure 3-2** above. Proposed coordinates for the sediment sample locations are shown in **Table 5-1** below. Sediment taken from each sampling point was analysed using sediment sizing cards and photographed for future reference. The images, along with completed log sheets are provided in **Appendix D**. The suitability of the sediment sampling locations should be reviewed following the first year of data collection in terms of access constraints.

Sediment samples can also be stored for future analysis, should it be deemed necessary. If stored, they should be carefully labelled and stockpiled in a secure location.

Table 5-1 Proposed sediment sampling site locations

Sediment Sample Location	Easting	Northing	Location
Peaceful Bay			
1	493666	6122468	High tide mark – Peaceful Bay transect 12
2	493874	6122674	High tide mark – Peaceful Bay transect 6
3	493984	6123064	High tide mark – Peaceful Bay transect 2
Ocean Beach			
4	530166	6123564	High tide mark – Ocean Beach transect 2
5	530154	6123684	High tide mark – Ocean Beach transect 4
6	530255	6123970	High tide mark – Ocean Beach transect 7

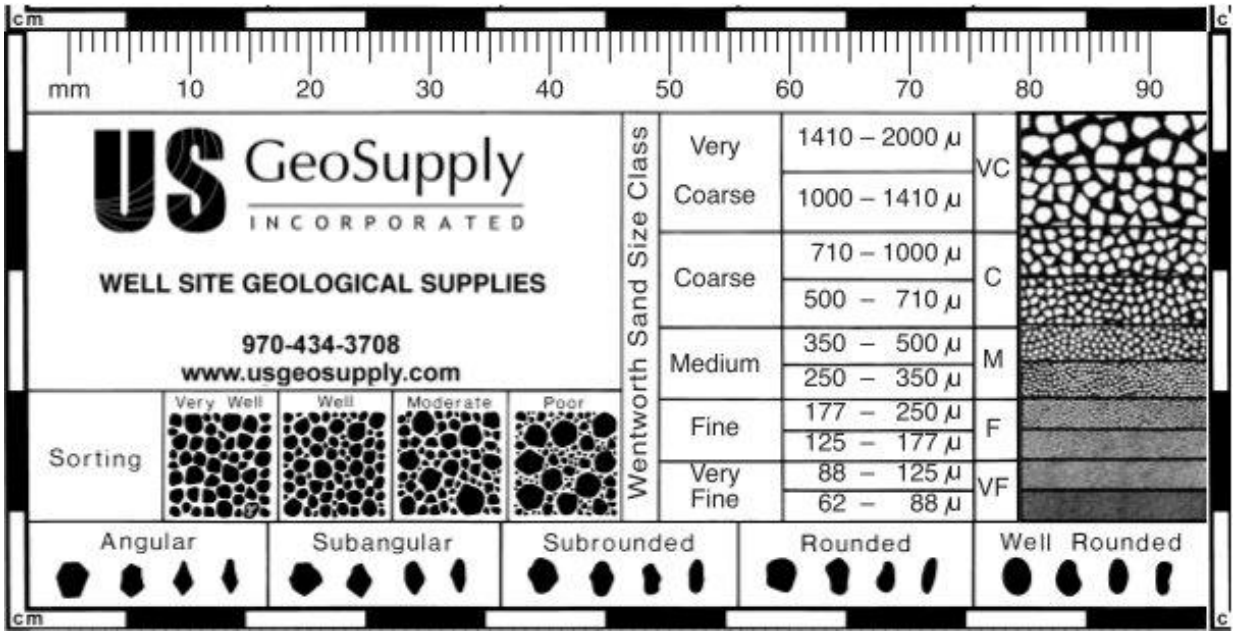


Figure 5-1 Example sediment sizing card

5.2 Historical Data

Sediment samples were taken at Ocean Beach and Peaceful Bay as part of the Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) completed in 2018, however a PSD analysis of the sediment samples was not undertaken (Seashore Engineering, 2018).

5.3 Limitations

Sediment sampling is useful when evaluating key mechanisms for sediment movement. The results derived from sediment sampling alone do not allow for effective analysis of erosion and sedimentation. When used in conjunction with other comprehensive datasets (e.g. long term beach profile surveys), an effective analysis of the mechanisms for erosion can be undertaken.

6 Storm Monitoring

A key aim of Western Australia's State Coastal Planning Policy (SPP2.6: WAPC, 2013) is to assess coastal hazards for coastal areas, to guide current and future planning. A key component of determining potential coastal hazards is defining an allowance for storm based erosion, known as the *S1 Erosion Allowance*. This allowance is added to allowances for other forms of erosion to develop coastal erosion hazard lines over various planning timeframes, up to 100 years into the future. The policy stipulates that a 1 in 100-year storm event should be modelled to assess the extent of coastal erosion that could occur during an extreme storm event. Considerable uncertainty around the application of storm erosion modelling (Ranasinghe et al, 2013) and quantifying what a 1 in 100-year event is for a particular area means that estimates are generally considered conservative, and potentially unrealistic.

The collection of data around storm events will be valuable in assessing how vulnerable beaches within the Shire are to storm based erosion, and help validate and qualify any modelled erosion extents. This is important because the S1 component is often used as a trigger distance in Coastal Hazard Risk Management and Adaptation Planning (CHRMAP). For example, when assets are within the S1 distance, this may be the trigger to remove them or protect them to prevent damage.

6.1 Methodology

Given that State Coastal Planning Policy requires erosion modelling and hazard assessment based on a 1 in 100-year storm, field measurements should target the most severe storm events, or those that have the greatest potential to cause erosion. Since available resources to sample storms are usually limited, storm selection is critical.

Predicting the duration and intensity of forecast storms is difficult and, furthermore, predicting their ability to impact the shoreline is impossible. Notwithstanding this, there are several key factors that should be assessed when selecting a storm to monitor. These are as follows:

> Predicted wave height, period and direction (forecast of these is available at websites such as seabreeze.com.au and Willy Weather). Higher wave height and longer wave period means higher wave energy and greater ability to erode the coastline.

> Predicted tide/water level (available from the Bureau of Meteorology website). Water level is highly important in a storms ability to impact the coastline. Storms should be chosen where the peak of the storm is predicted to occur at high tide, ideally during spring tides.

> Predicted storm duration. Generally, storms with a longer duration will have higher impact on the coast. Longer duration also means there is the potential for storm peak(s) to occur during elevated water levels.

Once a storm has been selected for measurement, data from the following proposed monitoring programs should be collected as close to the start and finish of storm conditions as practicable:

> Manual photo monitoring;

> Either aerial monitoring (photogrammetry) or beach profile surveys;

> Sediment sampling; and

> Metocean data collection.

6.2 Historical Data

It is understood that there has, as yet, not been any formal storm monitoring undertaken for either study area.

6.3 Limitations

Predicting the severity of storms is difficult and this method will not always allow for an accurate identification of a 'severe storm'. However, data accumulated prior to and following a non-severe storm will still assist in the assessment of potential future erosion in the area. Storm monitoring is only designed to assess changes over short periods of time.

7 Metocean Data Collection

Metocean data provides critical information on the drivers of coastal processes that lead to the vulnerability of shorelines and coastal assets. At present, there is the Albany Wave Rider Buoy 04 and Albany Tide Station located off the coast of Albany that is managed and operated by the Department of Transport (DoT). The Albany Wave Rider Buoy 04 is located approximately 40km east of Ocean Beach and 70km east of Peaceful Bay.

7.1 Methodology

The Albany Tide Station collects tidal readings every 5 minutes and the Albany Wave Rider Buoy 04 collects wave height and wave period readings every 30 minutes. This data can be viewed and downloaded for assessment via the Department of Transport (DoT) website.

Metocean data often provides only a snapshot of coastal conditions at a site and given the distance of the Albany Wave Rider Buoy from the Sites, Cardno would recommend that an Acoustic Doppler Current Profiler (ADCP) be installed at a selected location offshore of the project location. This should be installed for a period of 3 months, at each location at least once over the next 5 years. The installation of such an instrument would provide a valuable dataset for comparison with the data from the Albany Wave Rider Buoy. This will allow a relationship to be established, meaning that future data from the buoy (which is relatively permanent) could be used to inform ongoing risk at the project locations.

This data will also be critical in any future design of protection options, particularly hard protection such as seawalls and groynes. Instruments should be deployed directly offshore of areas that are prone to significant erosion. They should be installed on flat seabed in at least 6 metres water depth at low tide.

7.2 Historical Data

The following historic metocean data for Albany is available from the DoT.

> The DoT Albany Tide Station has historic data available from 01/01/1987 to present.

> The DoT Albany Wave Rider Buoy 04 (ALB50) has historic data available from 26/07/2005 to present.

> The Historic DoT Albany Wave Rider Buoy 01 (ALB15) has historic data available from 24/06/1981 to 12/09/1983.

> The Historic DoT Albany Wave Rider Buoy 02 (ALB44) has historic data available from 26/07/2001 to 21/03/2002.

> The Historic DoT Albany Wave Rider Buoy 03 (ALB44A) has historic data available from 25/07/2001 to 26/08/2001.

7.3 Limitations

Metocean data often provides only a snapshot of coastal conditions at a site and may not represent the entire area of interest. Metocean data assists in determining the drivers of sedimentation and erosion but does not give an indication as to the extent of erosion at the site. When metocean data collection is used in conjunction with other comprehensive datasets (e.g. long term beach profile surveys), an effective analysis of the mechanisms for erosion can be undertaken.

8 Data Management

Appropriate data management and quality control is essential for an effective monitoring campaign. Data management and quality control ensures that data is:

> In the appropriate format for analysis;

> Suitable for the users; and

> Maintained in a consistent and easily identifiable/accessible structure.

8.1 Photo Monitoring

A detailed data management method for the photo monitoring program will ensure that data is maintained in a consistent manner that will be easily accessible for analysis.

8.1.1 Manual Imagery

Appropriate data management for manual imagery photo monitoring is crucial to the assessment process. The following steps for appropriate data management should be followed for each manual imagery photo monitoring campaign.

1. Ensure that the following file structure is set up:
    - Photo Monitoring Program
        - Ocean Beach
            - Site # (e.g. *Site 6*)
                - Field of View (e.g. *Up Coast*)
        - Peaceful Bay
            - Site # (e.g. *Site 3*)
                - Field of View (e.g. *Up Coast*)
2. Ensure that photos are taken at the same location each time (note GPS coordinates).
3. Take photos in sequential order for each photo campaign (this will assist with final data management).
4. Once all of the photos have been taken in one photo campaign, save photos in the predefined file structure. Photos for each site are to be saved in the specific site folder. To ensure that the photos can be reviewed in chronological order, each photo should be saved using the heading structure:

    Site_Site#_***YYYYMMDD*** (e.g. OceanBeach_Site3_20190101).

8.1.2 Remote Imagery

Should the Shire incorporate remote imagery in the monitoring campaign, the methodology for managing data for a remote imagery photo monitoring is outlined in the following steps. There are two parts to data management for remote imagery, this includes daily monitoring of photos and quarterly servicing:

1. Photographs are sent remotely to an online database.
    - These photographs are to be monitored daily through the online database for quality assurance. These photographs are stored for 1 month on the database and can be downloaded directly if needed.
2. Cameras are to be serviced every 3 months. Memory cards and batteries are to be replaced.
    - The high definition photographs are to be extracted from the memory cards into a shared drive.
    - Photos are to be saved onto the shared drive into a dedicated ‘Remote Imagery Data’ folder.

> Each time the camera is serviced, photos are to be saved in a separate folder within the 'Remote Imagery Data' folder. This folder is to be labelled as follows:

Site_Camera***Number***_Download_***YYYYMMDD*** (e.g. OceanBeach_Camera2_Download_20190101).

8.2 Aerial Monitoring

Aerial monitoring datasets may be received in various formats from the supplier. The Shire should check the following when commissioning collection of this data:

> They can access, inspect and use the data;

> That it contains full coverage of x, y and z data in the study area, at the specified resolution;

> Horizontal and vertical accuracy has been included for each data point;

> The supplier has stated the height datum and that recorded heights look sensible at permanent landmarks (roads, paths etc.); and

> A summary plot of the data has been provided stating the datum, geographic reference and date of collection.

Labelling and filing of this data should include site or study area name, date of collection, datum and geographic coordinate system.

8.3 Beach Profiling Transects

Should the Shire incorporate manual beach profile transects in the monitoring campaign, the methodology for data management to ensure that transects can be easily interpreted and evaluated is outlined in the following steps. Previously collected survey data should also be incorporated into this format, to allow easy future comparison. GIS software can also be used to extract survey profiles from photogrammetry or LiDAR data sets. These extracted profiles can then be added to the spreadsheet for comparison of shorelines. Alternatively, profile data can be interpolated to an elevation surface (if spatial resolution is sufficient) for comparison with spatial datasets.

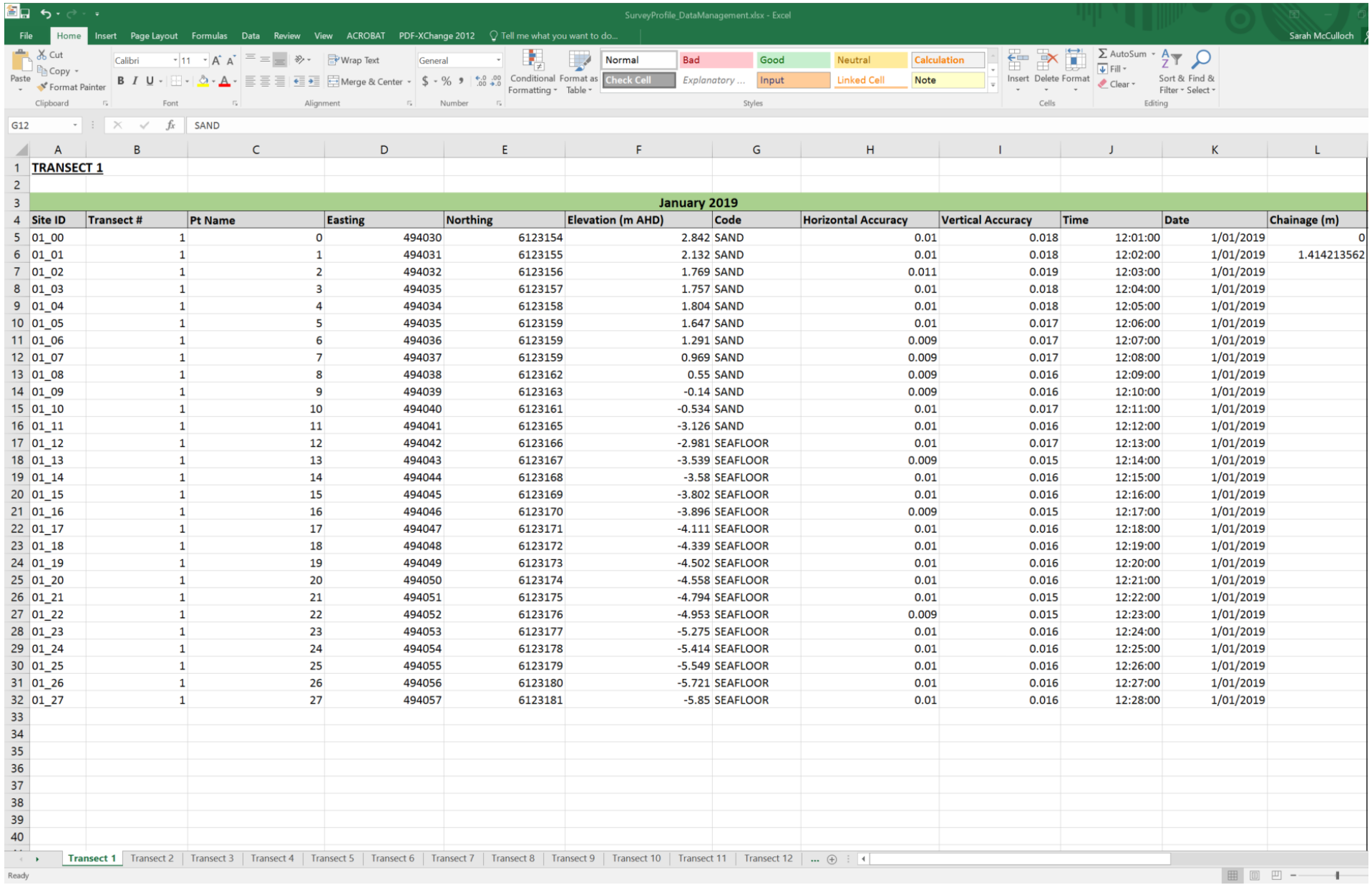
The profiling data will need to be imported into the structured Excel file setup by Cardno. There will be a separate Cardno Survey Excel File for Peaceful Bay and for Ocean Beach and there will be a separate tab for each of the survey transects.

Make sure to fill out the **Survey Period** and copy all of the data from the submitted survey profiles into the corresponding column for each of the survey transects. Take care to ensure that the correct data is filled into the correct column, e.g. the correct measurement for elevation (AHD) must be copied into the 'Elevation' column. Once completed, the Cardno Survey Excel File should look similar to **Figure 8-2**.

Once all of the data is copied into the appropriate locations, the chainage can be calculated. The calculation for chainage is embedded into the Cardno Survey Excel File, and just needs to be copied into the remaining cells.

Ensure that there is always an additional period with the appropriate formatting in each of the transect tabs, i.e. ensure that the blank formatting is copied next to the current survey period data to ensure that data can be transferred into the Cardno Survey Excel File with ease following the next survey period.

This process needs to be completed for all of the transects in each survey. Once this is completed, the elevation plots, that are located in the 19th tab of the file, can be populated. This is done by selecting the appropriate data for each of the plots. The plots depict the elevation (on the y-axis) along the chainage values (x-axis). **Figure 8-1** is an example of elevation plot comparing the changes in erosion and sedimentation over different survey periods.



SurveyProfile_DataManagement.xlsx - Excel

G12: SAND

TRANSECT 1

	A	B	C	D	E	F	G	H	I	J	K	L
1	TRANSECT 1											
2												
3						January 2019						
4	Site ID	Transect #	Pt Name	Easting	Northing	Elevation (m AHD)	Code	Horizontal Accuracy	Vertical Accuracy	Time	Date	Chainage (m)
5	01_00	1	0	494030	6123154	2.842	SAND	0.01	0.018	12:01:00	1/01/2019	0
6	01_01	1	1	494031	6123155	2.132	SAND	0.01	0.018	12:02:00	1/01/2019	1.414213562
7	01_02	1	2	494032	6123156	1.769	SAND	0.011	0.019	12:03:00	1/01/2019	
8	01_03	1	3	494035	6123157	1.757	SAND	0.01	0.018	12:04:00	1/01/2019	
9	01_04	1	4	494034	6123158	1.804	SAND	0.01	0.018	12:05:00	1/01/2019	
10	01_05	1	5	494035	6123159	1.647	SAND	0.01	0.017	12:06:00	1/01/2019	
11	01_06	1	6	494036	6123159	1.291	SAND	0.009	0.017	12:07:00	1/01/2019	
12	01_07	1	7	494037	6123159	0.969	SAND	0.009	0.017	12:08:00	1/01/2019	
13	01_08	1	8	494038	6123162	0.55	SAND	0.009	0.016	12:09:00	1/01/2019	
14	01_09	1	9	494039	6123163	-0.14	SAND	0.009	0.016	12:10:00	1/01/2019	
15	01_10	1	10	494040	6123161	-0.534	SAND	0.01	0.017	12:11:00	1/01/2019	
16	01_11	1	11	494041	6123165	-3.126	SAND	0.01	0.016	12:12:00	1/01/2019	
17	01_12	1	12	494042	6123166	-2.981	SEAFLOOR	0.01	0.017	12:13:00	1/01/2019	
18	01_13	1	13	494043	6123167	-3.539	SEAFLOOR	0.009	0.015	12:14:00	1/01/2019	
19	01_14	1	14	494044	6123168	-3.58	SEAFLOOR	0.01	0.016	12:15:00	1/01/2019	
20	01_15	1	15	494045	6123169	-3.802	SEAFLOOR	0.01	0.016	12:16:00	1/01/2019	
21	01_16	1	16	494046	6123170	-3.896	SEAFLOOR	0.009	0.015	12:17:00	1/01/2019	
22	01_17	1	17	494047	6123171	-4.111	SEAFLOOR	0.01	0.016	12:18:00	1/01/2019	
23	01_18	1	18	494048	6123172	-4.339	SEAFLOOR	0.01	0.016	12:19:00	1/01/2019	
24	01_19	1	19	494049	6123173	-4.502	SEAFLOOR	0.01	0.016	12:20:00	1/01/2019	
25	01_20	1	20	494050	6123174	-4.558	SEAFLOOR	0.01	0.016	12:21:00	1/01/2019	
26	01_21	1	21	494051	6123175	-4.794	SEAFLOOR	0.01	0.015	12:22:00	1/01/2019	
27	01_22	1	22	494052	6123176	-4.953	SEAFLOOR	0.009	0.015	12:23:00	1/01/2019	
28	01_23	1	23	494053	6123177	-5.275	SEAFLOOR	0.01	0.016	12:24:00	1/01/2019	
29	01_24	1	24	494054	6123178	-5.414	SEAFLOOR	0.01	0.016	12:25:00	1/01/2019	
30	01_25	1	25	494055	6123179	-5.549	SEAFLOOR	0.01	0.016	12:26:00	1/01/2019	
31	01_26	1	26	494056	6123180	-5.721	SEAFLOOR	0.01	0.016	12:27:00	1/01/2019	
32	01_27	1	27	494057	6123181	-5.85	SEAFLOOR	0.01	0.016	12:28:00	1/01/2019	
33												
34												
35												
36												
37												
38												
39												
40												

Transect 1 | Transect 2 | Transect 3 | Transect 4 | Transect 5 | Transect 6 | Transect 7 | Transect 8 | Transect 9 | Transect 10 | Transect 11 | Transect 12

Ready

Figure 8-1 Example Cardno survey Excel file

9 Cost and Time Indication

Approximate cost and time indications for the Ocean Beach and Peaceful Bay Coastal Monitoring Action Plan are listed in **Table 9-1**. Please note that staff time has been estimated where it is assumed Shire staff will undertake the activity.

Table 9-1 Cost and time estimates for coastal monitoring components

Photo Monitoring Option 1 - Remote Imagery	
Camera cost: 5 x remote image cameras	$ 3750.00
5 x solar battery charger	$ 650.00
Camera online portal	$ 260.00/year
Installation time	2 days x 2 personnel
Servicing time	1 day / 2 months x 2 personnel
Data analysis	$ 750.00/year
Photo Monitoring Option 2 - Manual Imagery	
Camera cost: 1 x high resolution hand held camera	$ 600.00 - $1000.00
Manual image capture	1 day / 2 weeks x 1 person
Data analysis	$ 750.00/year
Beach Profile Surveys	
Bi-annual surveys	2 days / 6 months x 2 personnel
Equipment hire	$650.00/day (Equipment only) $2,200.00/day (Work undertaken by Contractor) Assumed to be owned by Shire
Data analysis	$ 750.00/year
Sediment Sampling Option 1 – Laboratory Analysis	
Bi-annual sampling	Incorporated in survey time
Bi-annual laboratory analysis	$150.00 per sample
Data analysis	$ 750.00/year
Sediment Sampling Option 2 – Manual Sediment Particle Size Assessment	
Bi-annual sampling and assessment	½ day / 6 months x 1 person

Sediment Sampling Option 1 – Laboratory Analysis	
Data analysis	$ 750.00/year
Metocean Data Collection – ADCP Deployment and Recovery	
ADCP data collection (1 instrument for 3 months)	$15,000.00
Data analysis (per deployment dataset)	$ 2,500.00
Aerial Monitoring	
100mm resolution photogrammetry	
Ocean Beach - Baseline Survey (Including establishment of permanent survey control at each site)	$1,200.00
Peaceful Bay - Baseline Survey (Including establishment of permanent survey control at each site)	$1,500.00
Ocean Beach – Subsequent Surveys (Including establishment of permanent survey control at each site)	$600.00
Peaceful Bay - Subsequent Surveys (Including establishment of permanent survey control at each site)	$900.00
30mm resolution photogrammetry	
Ocean Beach - Baseline Survey (Including establishment of permanent survey control at each site)	$3,000.00
Peaceful Bay - Baseline Survey (Including establishment of permanent survey control at each site)	$2,500.00
Ocean Beach – Subsequent Surveys (Including establishment of permanent survey control at each site)	$4,000.00
Peaceful Bay - Subsequent Surveys (Including establishment of permanent survey control at each site)	$3,300.00
15mm resolution photogrammetry	
Ocean Beach - Baseline Survey (Including establishment of permanent survey control at each site)	$4,000.00
Peaceful Bay - Baseline Survey (Including establishment of permanent survey control at each site)	$3,500.00
Ocean Beach – Subsequent Surveys (Including establishment of permanent survey control at each site)	$5,000.00
Peaceful Bay - Subsequent Surveys (Including establishment of permanent survey control at each site)	$3,800.00
UAV borne LiDAR	$10,000.00 per study area

References

Ranasinghe, R., Callaghan, D. P. & Roelvink D. (2013) 'Probabilistic estimation of storm erosion using analytical, semi-empirical, and process based storm erosion models', *Coastal Engineering*, vol. 82, pp. 64-75.

Seashore Engineering (2018) *Ocean Beach and Peaceful Bay Shire of Denmark, Coastal Hazard Risk Management and Adaptation Plan.*

WAPC (2013) *State Planning Policy No. 2.6. State Coastal Planning Policy*. Published by the Western Australian Planning Commission, Perth, Western Australia.

APPENDIX A

MANUAL IMAGERY LOG SHEET

Photographic Monitoring Sheet

Job No. & Name	

Site ID	
Location	
Date & Time	

Coordinates	

Camera	
Focal Length, Settings etc.	

FOV Direction	
Height of Camera	
Feature Focussed On	
Foreground	
Right FOV Frame	
Left FOV Frame	

Notes (relevant notes on beach condition, features, works etc.)	

Photographer	

APPENDIX

B

MANUAL IMAGERY EXAMPLES AND LOG SHEETS

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 1
Location	Rock headland - Peaceful Bay south
Date & Time	22/05/2019 12:32PM

Coordinates	493692
	6122110

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Pole protruding vegetated dune cover
Foreground	Beach
Right FOV Frame	Beach
Left FOV Frame	Vegetated dune cover

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at rock headland
	Beach is relatively narrow, ~1:15 slope
	Beach is covered with medium size rock and presence of seaweed wrack
	Dunes eroded and steep

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 2
Location	Rock outcrop - Peaceful Bay south
Date & Time	22/05/2019 12:37PM

Coordinates	493593
	6122191

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Beach
Foreground	Beach
Right FOV Frame	Inshore reef
Left FOV Frame	Vegetated dune cover

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at rock outcrop between the southern headland and the creek
	Beach is relatively narrow, ~1:10 slope
	10-15m beach width continues north
	Dunes eroded and steep

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 2
Location	Rock outcrop - Peaceful Bay south
Date & Time	22/05/2019 12:37PM

Coordinates	493593
	6122191

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Beach
Foreground	Beach
Right FOV Frame	Inshore Vegetated dune cover
Left FOV Frame	Rock outcrop

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at rock outcrop between the southern headland and the creek
	Beach is relatively narrow, ~1:10 slope
	High tide mark at toe of dune, narrow beach width continues south
	Dunes eroded and steep

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 3
Location	"Dog Owners" sign - Peaceful Bay north
Date & Time	22/05/2019 12:43PM

Coordinates	493569
	6122372

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Vegetated dune cover
Foreground	Beach
Right FOV Frame	Peaceful Bay jetty
Left FOV Frame	Vegetated dune cover

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at "Dog Owners" sign
	Beach is relatively narrow and steep, ~1:5 slope
	High tide mark at toe of dune, narrow beach width continues north
	Dunes eroded and steep

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 3
Location	"Dog Owners" sign - Peaceful Bay north
Date & Time	22/05/2019 12:42PM

Coordinates	493569
	6122372

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Vegetated dune cover
Foreground	Beach
Right FOV Frame	"Dog Owners" sign
Left FOV Frame	Beach

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at "Dog Owners" sign
	Beach is relatively narrow and flat, ~1:20 slope
	10-15m beach width continues south
	Creek partially inundated

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 3
Location	"Dog Owners" sign - Peaceful Bay north
Date & Time	22/05/2019 12:43PM

Coordinates	493569
	6122372

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Across Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Horizon
Foreground	Beach
Right FOV Frame	Rock headland
Left FOV Frame	Inner reef platform

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at "Dog Owners" sign
	Beach is relatively narrow, ~1:10 slope

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 4
Location	Tombolo - East of boat ramp
Date & Time	22/05/2019 12:58PM

Coordinates	493902
	6122510

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	boat ramp access track
Foreground	Beach
Right FOV Frame	Beach
Left FOV Frame	Left of sea rescue building

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at rock formation on end of tombolo, suitability of monitoring location to be monitored
	Beach is relatively flat, ~1:30 slope
	Seaweed wrack build up to high tide mark
	Monitoring location was inundated during spring tide monitoring campaign

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 4
Location	Tombolo - East of boat ramp
Date & Time	22/05/2019 12:59PM

Coordinates	493902
	6122510

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Pedestrian access stairs
Foreground	Beach
Right FOV Frame	Right of sea rescue building
Left FOV Frame	Mid length jetty

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at rock formation on end of tombolo, suitability of monitoring location to be monitored
	Beach is relatively flat, ~1:30 slope
	Seaweed wrack build up to high tide mark
	Monitoring location was inundated during spring tide monitoring campaign

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 5
Location	"Danger Keep Out Sign" - Foul Bay
Date & Time	22/05/2019 1.06PM

Coordinates	493883
	6122771

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Vegetated dune cover
Foreground	Beach
Right FOV Frame	Beach
Left FOV Frame	Dunes

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at existing "Danger Keep Out" sign
	Beach is relatively narrow and flat, ~1:25 slope
	20-30m wide beach continues north, vehicles in use along beach
	Heavily eroded dunes continue north

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 5
Location	"Danger Keep Out" sign - Foul Bay
Date & Time	22/05/2019 1.07PM

Coordinates	493883
	6122771

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Vegetated dune cover
Foreground	Beach
Right FOV Frame	Dunes
Left FOV Frame	Beach

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at existing "Danger Keep Out" sign
	Beach is relatively narrow and flat, ~1:30 slope
	20-30m wide beach continues south, vehicles in use along beach
	Heavily eroded dunes continue south

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Peaceful Bay- Site 5
Location	"Danger Keep Out" sign - Foul Bay
Date & Time	22/05/2019 1.07PM

Coordinates	493883
	6122771

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Across Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Horizon
Foreground	Beach
Right FOV Frame	Beach
Left FOV Frame	Left of vegetated peak on horizon

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at existing "Danger Keep Out" sign
	Beach is relatively narrow and flat, ~1:30 slope
	Seaweed wrack build up at high tide mark
	Vehicles in use along beach

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 6
Location	Wilson Inlet lookout
Date & Time	22/05/2019 11.33AM

Coordinates	530210
	6123438

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Rested on top railing
Feature Focussed On	Wilson Inlet
Foreground	Vegetation below lookout
Right FOV Frame	Ocean
Left FOV Frame	Vegetation, rear of Surf Life Saving Club

Notes (relevant notes on beach condition, features, works etc.)	Wilson inlet closed
	Narrow beach width in front of Surf life saving Club
	Eroded dune with no vegetation north of Surf Life Saving Club
	Several surfers in water

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 7
Location	Rock headland - Ocean Beach south
Date & Time	22/05/2019 10.50AM

Coordinates	530203
	6123519

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Vegetated dune cover
Foreground	Rock headland
Right FOV Frame	Right of beach access track
Left FOV Frame	Vegetation

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location on rock headland south of Ocean Beach, suitability of monitoring location to be monitored
	Beach is very narrow, less than 5m wide at high tide mark, ~1:15 slope
	Scoured tyre markings at toe of access ramp
	Sediment appears quite fine at toe of headland

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 8
Location	Surf Life Saving Club
Date & Time	22/05/2019 10.56AM

Coordinates	530155
	6123616

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Wilson Inlet
Foreground	Surf Life Saving Club railing
Right FOV Frame	Beach
Left FOV Frame	Left of Surf Life Saving Club roof column

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at approximately mid point of brick paving, monitoring location to be monitored and revised upon completion of new Surf Life saving Club
	Beach relatively narrow, approximately 15-20m wide at high tide mark, ~1:20 slope
	Eroded vegetation immediately north of Surf Life Saving Club

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 8
Location	Surf Life Saving Club
Date & Time	22/05/2019 10.54AM

Coordinates	530155
	6123616

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Wilson Inlet
Foreground	Surf Life Saving Club railing
Right FOV Frame	Beach
Left FOV Frame	Left of Surf Life Saving Club roof column

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at approximately mid point of brick paving, monitoring location to be monitored and revised upon completion of new Surf Life saving Club
	Prominent beach cusps south of Surf Life Saving Club
	Beach width approximately 10m at highest tide mark
	Surf Life Saving Club protrudes seaward of natural dune line

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 8
Location	Surf Life Saving Club
Date & Time	22/05/2019 10.56AM

Coordinates	530155
	6123616

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Across Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Beach
Foreground	Beach
Right FOV Frame	Rock headland
Left FOV Frame	Dip in vegetation landform on horizon

Notes (relevant notes on beach condition, features, works etc.)	Monitoring location at approximately mid point of brick paving, monitoring location to be monitored and revised upon completion of new Surf Life saving Club
	High tide mark less than 10m from Surf Life Saving Club
	Several surfers in water

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 9
Location	Rock outcrop - Ocean Beach north
Date & Time	22/05/2019 11.02AM

Coordinates	530170
	6123795

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Wilson Inlet
Foreground	Rock Outcrop
Right FOV Frame	Right of vegetated peak
Left FOV Frame	Vegetated dune cover

Notes (relevant notes on beach condition, features, works etc.)	Inlet closed, beach wide and flat, ~1:50 slope
	Footprints indicate popular pedestrian access

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 9
Location	Rock outcrop - Ocean Beach north
Date & Time	22/05/2019 11.01AM

Coordinates	530170
	6123795

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Vegetation
Foreground	Beach
Right FOV Frame	Rock outcrop in dune
Left FOV Frame	Left of southern headland toe

Notes (relevant notes on beach condition, features, works etc.)	Prominent beach cusps along high tide mark
	Exposed rock in dune face
	Beach relatively narrow and flat, 15-20m wide at high tide mark, ~1:30 slope

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 9
Location	Rock outcrop - Ocean Beach north
Date & Time	22/05/2019 11.02AM

Coordinates	530170
	6123795

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Across Coast
Height of Camera	Chest height ~1.5m
Feature Focussed On	Beach
Foreground	Exposed rock outcrop
Right FOV Frame	Toe of southern headland
Left FOV Frame	Low segment of vegetation cover on horizon

Notes (relevant notes on beach condition, features, works etc.)	Prominent beach cusps along high tide mark
	Beach approximately 15-20m wide at high tide mark, ~1:30 slope

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 10
Location	Ocean Beach lookout
Date & Time	22/05/2019 10.32AM

Coordinates	530082
	6124028

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Up Coast
Height of Camera	Rested on top railing, tilted down
Feature Focussed On	Vegetated peak
Foreground	Beach
Right FOV Frame	Beach
Left FOV Frame	Left of vegetation toe

Notes (relevant notes on beach condition, features, works etc.)	Inlet closed
	Beach is very flat
	Footprints indicate popular walking route across inlet

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 10
Location	Ocean Beach lookout
Date & Time	22/05/2019 10.35AM

Coordinates	530082
	6124028

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Coast
Height of Camera	Rested on top railing, tilted down
Feature Focussed On	Terminated vegetation on horizon
Foreground	Vegetation below lookout
Right FOV Frame	Corner of Ocean Beach lookout
Left FOV Frame	Beach

Notes (relevant notes on beach condition, features, works etc.)	Inlet closed
	Beach offset several hundred meteres

Photographer	BD

Photographic Monitoring Sheet

Job No. & Name	CW1055200 - Peaceful Bay & Ocean Beach Monitoring

Site ID	Ocean Beach - Site 10
Location	Ocean Beach lookout
Date & Time	22/05/2019 10.35AM

Coordinates	530082
	6124028

Camera	Panasonic Lumix DMC-TZ20
Focal Length, Settings etc.	4mm focal length, 24mm lens

FOV Direction	Down Inlet
Height of Camera	Rested on top railing, tilted down
Feature Focussed On	Vegetated peak behind Holiday Park
Foreground	Vegetation below lookout
Right FOV Frame	Right of terminated vegetation
Left FOV Frame	Corner of Ocean Beach lookout

Notes (relevant notes on beach condition, features, works etc.)	Inlet closed and very flat

Photographer	BD

APPENDIX C

SEDIMENT SAMPLING LOG SHEET

Site ID: _____

Date: _____ **Time:** _____

Sorting

Very Well	☐	Moderate	☐
Well	☐	Poor	☐

Sediment Size

Very Coarse	☐	Fine	☐
Coarse	☐	Very Fine	☐
Medium	☐	Size Range	_____

Roundness

Angular	☐	Rounded	☐
Subangular	☐	Well Rounded	☐
Subrounded	☐		

See Sediment Sizing Card for further information.
Once completed save in Peaceful Bay Ocean Beach Monitoring Data file.

APPENDIX

D

SEDIMENT SAMPLING EXAMPLES AND LOG SHEETS

Site ID: Peaceful Bay - Transect 12

Date: 22/05/2019 **Time:** 1.17PM

Sorting

Very Well	☐	Moderate	X
Well	☐	Poor	☐

Sediment Size

Very Coarse	☐	Fine	☐
Coarse	☐	Very Fine	☐
Medium	X	Size Range	125-350µm

Roundness

Angular	☐	Rounded	☐
Subangular	☐	Well Rounded	☐
Subrounded	X		

See Sediment Sizing Card for further information.
Once completed save in Peaceful Bay Ocean Beach Monitoring Data file.

Peaceful Bay and Ocean Beach
Sediment Sample Log Sheet

Cardno
Shaping the Future

Site ID: Peaceful Transect 12

Date: 22/05/19 **Time:** _____

Site ID: Peaceful Bay - Transect 6

Date: 22/05/2019 **Time:** 1.15PM

Sorting

Very Well	☐	Moderate	☐
Well	☒	Poor	☐

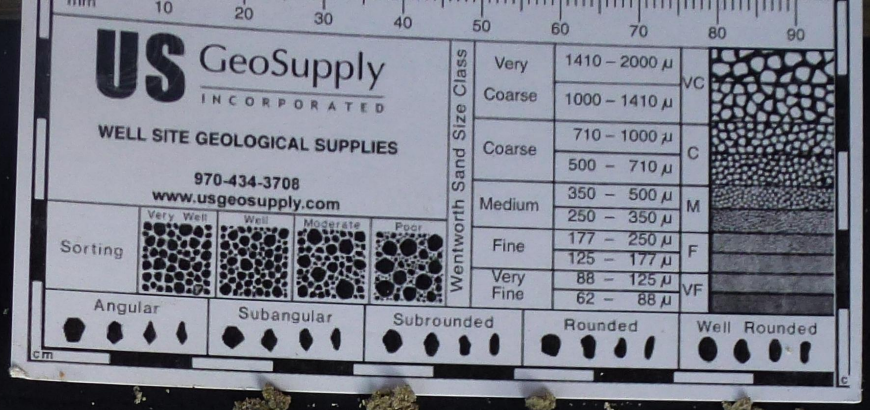
Sediment Size

Very Coarse	☐	Fine	☒
Coarse	☐	Very Fine	☐
Medium	☐	Size Range	125-250µm

Roundness

Angular	☐	Rounded	☐
Subangular	☒	Well Rounded	☐
Subrounded	☐		

See Sediment Sizing Card for further information.
Once completed save in Peaceful Bay Ocean Beach Monitoring Data file.



Peaceful Bay and Ocean Beach
Sediment Sample Log Sheet

Cardno
Shaping the Future

Site ID: Peaceful Bay Transect 6-

Date: 22/05/19 **Time:** _____

Site ID: Peaceful Bay - Transect 2

Date: 22/05/2019 **Time:** 1.10PM

Sorting

Very Well	☐	Moderate	☐
Well	☒	Poor	☐

Sediment Size

Very Coarse	☐	Fine	☒
Coarse	☐	Very Fine	☐
Medium	☐	Size Range	125-250µm

Roundness

Angular	☐	Rounded	☐
Subangular	☒	Well Rounded	☐
Subrounded	☐		

See Sediment Sizing Card for further information.
Once completed save in Peaceful Bay Ocean Beach Monitoring Data file.

Peaceful Bay and Ocean Beach
Sediment Sample Log Sheet

Cardno
Shaping the Future

Site ID: Peaceful Bay Transect 2

Date: 22/05/19 **Time:** _____

Site ID: Ocean Beach Transect 2

Date: 22/05/2019 **Time:** 11.19AM

Sorting

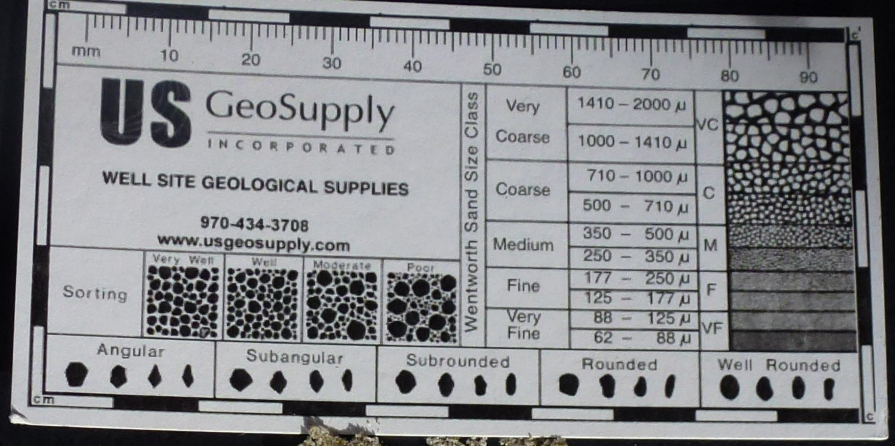
Very Well	X	Moderate	
Well		Poor	

Sediment Size

Very Coarse		Fine	
Coarse		Very Fine	
Medium	X	Size Range	250-350µm

Roundness

Angular		Rounded	
Subangular	X	Well Rounded	
Subrounded			



Peaceful Bay and Ocean Beach
Sediment Sample Log Sheet

Cardno
Shaping the Future

Site ID: Ocean Beach Transect 2.

Date: 22/05/19. **Time:** _____

Site ID: Ocean Beach Transect 4

Date: 22/05/2019 **Time:** 11.15AM

Sorting

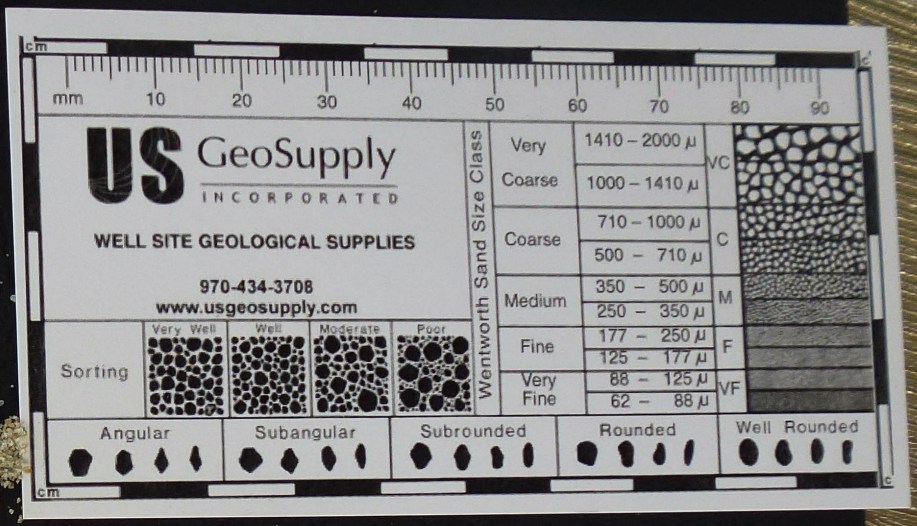
Very Well	X	Moderate	
Well		Poor	

Sediment Size

Very Coarse		Fine	
Coarse		Very Fine	
Medium	X	Size Range	350-500µm

Roundness

Angular		Rounded	
Subangular	X	Well Rounded	
Subrounded			



Peaceful Bay and Ocean Beach
Sediment Sample Log Sheet

Cardno®
Shaping the Future

Site ID: Ocean Beach Transect 4.

Date: 22/05/19. **Time:** _____

Site ID: Ocean Beach Transect 7

Date: 22/05/2019 **Time:** 11.04AM

Sorting

Very Well	☐	Moderate	X
Well	☐	Poor	☐

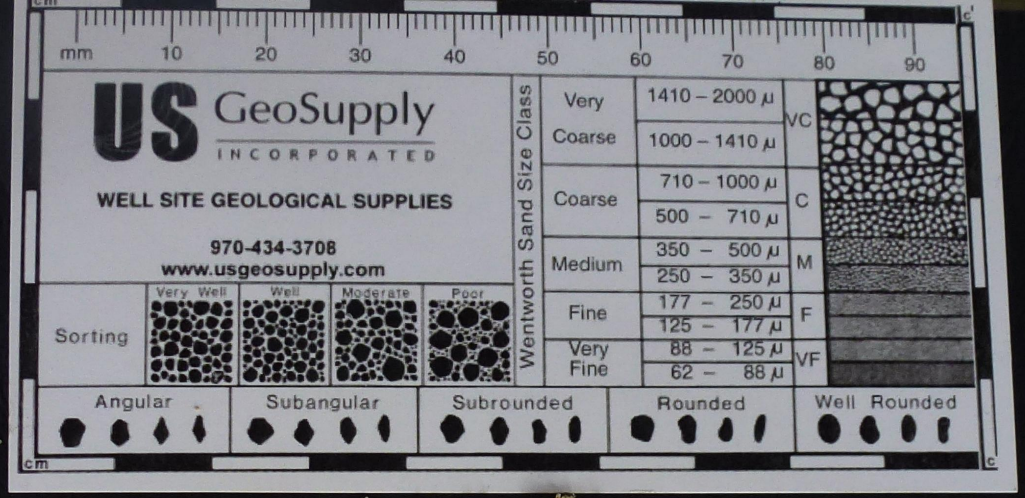
Sediment Size

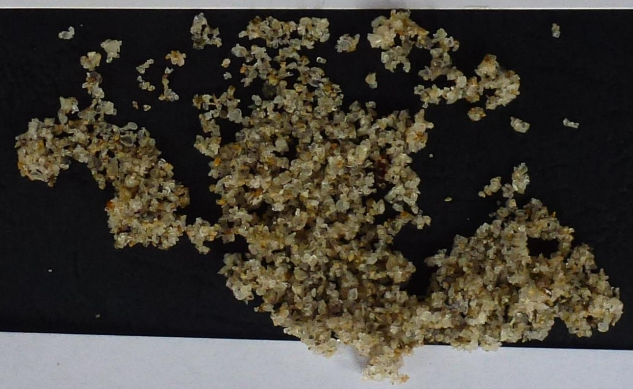
Very Coarse	☐	Fine	☐
Coarse	X	Very Fine	☐
Medium	X	Size Range	350-710µm

Roundness

Angular	☐	Rounded	☐
Subangular	X	Well Rounded	☐
Subrounded	☐		

See Sediment Sizing Card for further information.
Once completed save in Peaceful Bay Ocean Beach Monitoring Data file.





Peaceful Bay and Ocean Beach
Sediment Sample Log Sheet

Cardno
Shaping the Future

Site ID: Ocean Beach Transect #

Date: 22/05/19. **Time:** _____