Redhead Beach vegetation and dune management technical advice

WRL TR 2025/17, September 2025

By V M Miller and J T Carley

UNSW Water Research Laboratory

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1 Introduction

1.1 Overview

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney was engaged by the Lake Macquarie City Council (LMCC) to provide advice on long term resilient dune form design and management for the sand dune next to Redhead Surf Life Saving Club (SLSC).

The sand dune area is located at the north-eastern end of Redhead Beach (Figure 1-1, Figure 1-2 and Figure 1-3).

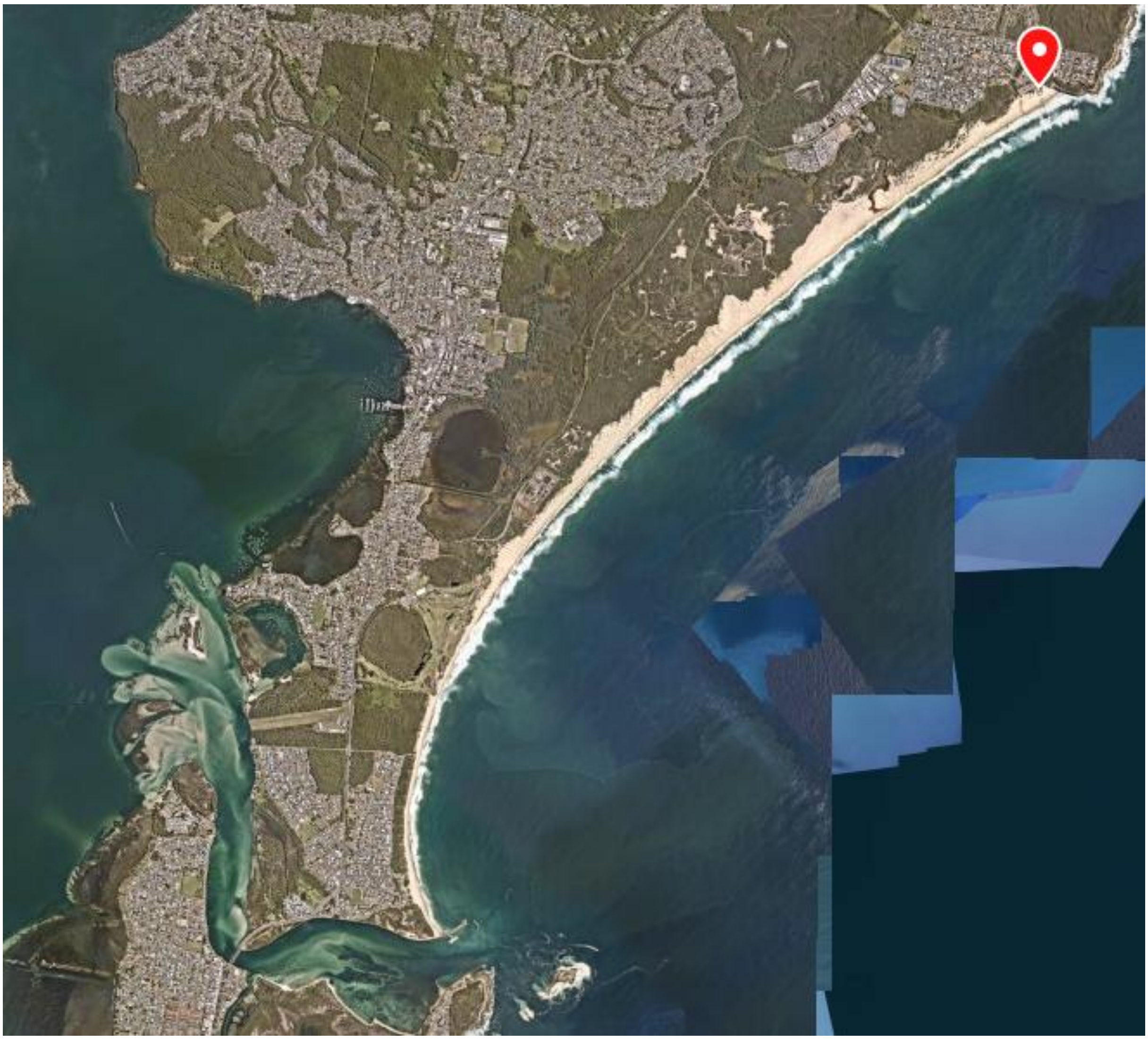

Figure 1-1 Redhead Beach (Nearmap ©)

Over the past decade, the sand dune located immediately south-west of the SLSC has experienced a loss of vegetation, with a consequent increase in windblown sand reaching the carpark and loss of ecological habitat.

Figure 1-2 Close up of Redhead Beach sand dune and SLSC, 2010 (Nearmap ©)

Figure 1-3 Close up of Redhead Beach sand dune and SLSC, 2025 (Nearmap ©)

2 NSW Coastal Management Act 2016

Lake Macquarie has a certified Coastal Management Program (CMP), the Lake Macquarie Coastal Management Program – 2023, which applies to the study area. The Coastal Management Act 2016 specifies that the CMP must be considered by LMCC and other public authorities when undertaking programs that impact on the coastal zone.

The NSW Coastal Management Act 2016 (as amended, as of 20 December 2024) lists the following coastal hazards, which are assessed where applicable in Section 5 of this WRL report:

(a) Beach erosion (Section 5.1)
(b) Shoreline recession (See Section 5.2)
(c) Coastal lake or watercourse entrance instability (Section 5.3)
(d) Coastal inundation (See Section 5.4)
(e) Coastal cliff or slope instability (not applicable, see below)
(f) Tidal inundation (not applicable, see below)
(g) Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters (not applicable, see below)

The following commentary is provided regarding hazards which do not directly apply to the site:

(e) Coastal cliff or slope instability
The site is not on a coastal cliff. The geotechnical instability due to sand dune scarping has been considered in Section 7.

(f) Tidal inundation
Most of the dune is above all plausible tidal inundation levels for the next 60 years. Some parts of the site are vulnerable to wave runup, which will significantly exceed tidal levels.

(g) Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters
The site is primarily on the open coast. There may be flooding and erosion from Freshwater Creek, as discussed in Section 5.3.

3 Bathymetry and topography

Redhead Beach is not covered within photogrammetry collated in the NSW Beach Profile Database (2025). LMCC provided WRL with the Digital Surface Model (DSM) file for a drone survey completed by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on 28 March 2025 using a 0.1 m resolution horizontal grid. The DSM was classified to remove the majority of natural features by DCCEEW, where the remaining outliers were removed by WRL to more accurately represent the bare-Earth surface. DCCEEW also generated eleven cross-shore beach profiles (PF1 to PF11 at 25 m spacing) across the greater Redhead dune area with the 2025 DSM data. Only PF4 to PF8 were included in this study and are shown in Figure 3-1 and Figure 3-3.

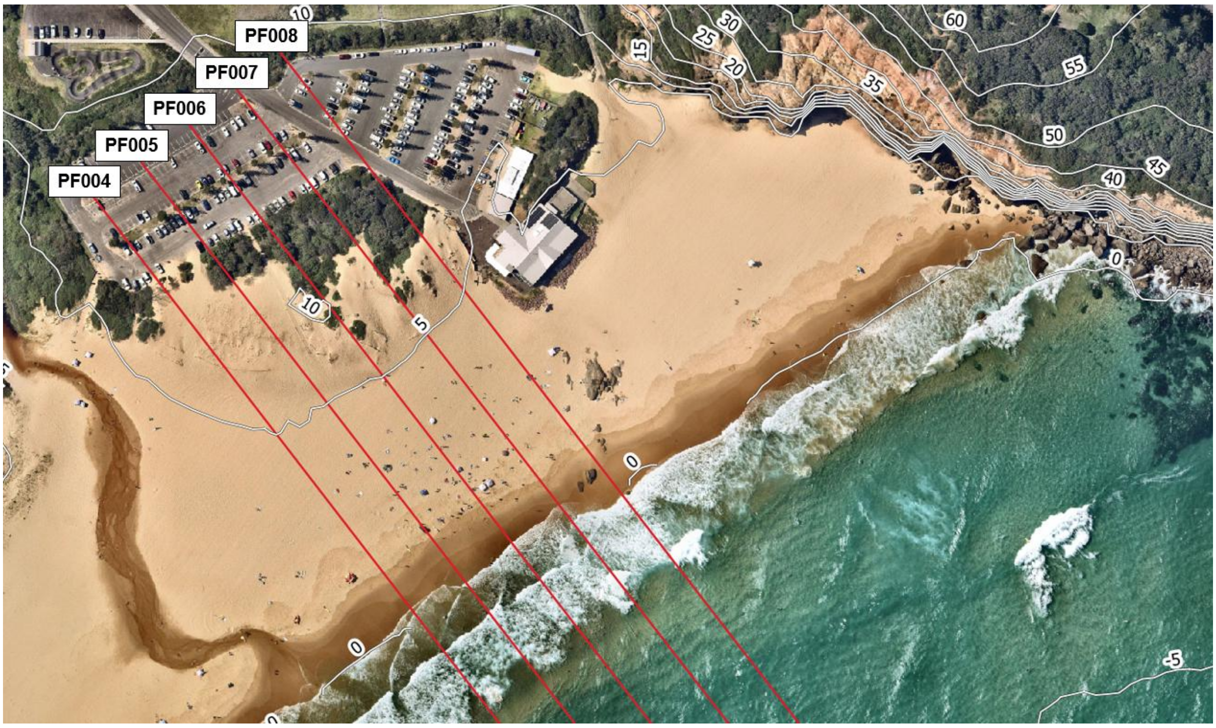

Figure 3-1 Close up of cross shore beach profiles (PF4 to PF8)

The cross-shore beach profile data of PF4 to PF8 for the DCCEEW and NSW marine LiDAR are shown in Figure 3-1 and Figure 3-3 respectively. Any remaining spikes from the classified DCCEEW drone survey, approximately between 60 to 100 m chainage, are assumed to be vegetation. The higher 0.1 m accuracy of the DCCEEW drone survey highlights the loss and movement of sand at the southern end of the dune.

The current dune shape has the following characteristics:

- 1V:3H slope on the seaward face at PF6 to PF8 (see Figure 3-2)
- 1V:6H slope on the seaward face at PF4 and PF5 (see Figure 3-2)

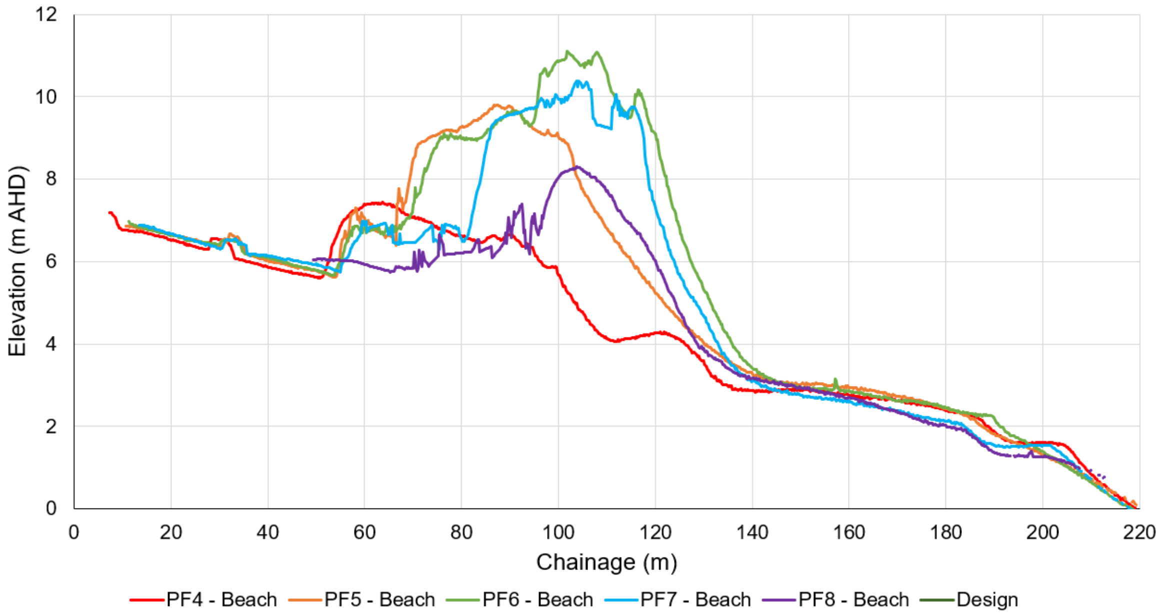

Figure 3-2 DCCEEW drone survey (March 2025)

Note: Some elevations landward of approximate chainage 120 m may be indicating the tree canopy and not the bare earth.

For offshore bathymetric data the NSW Department of Planning, Industry and Environment (NSW DPIE), provides topographic and bathymetric data based on Airborne LiDAR Bathymetry (ALB) technology conducted by Fugro Pty Ltd from July to December 2018. The bathymetric data was accessed through the ELVIS portal (https://elevation.fsdf.org.au/) and downloaded at a resolution of 5 m.

Figure 3-3 Cross shore beach profiles (PF4 to PF8)

The NSW marine LiDAR data is shown in Figure 3-4. Based on an active profile from +5 m AHD to -15 m AHD, this indicates an approximate Bruun Factor slope of 1V:33H.

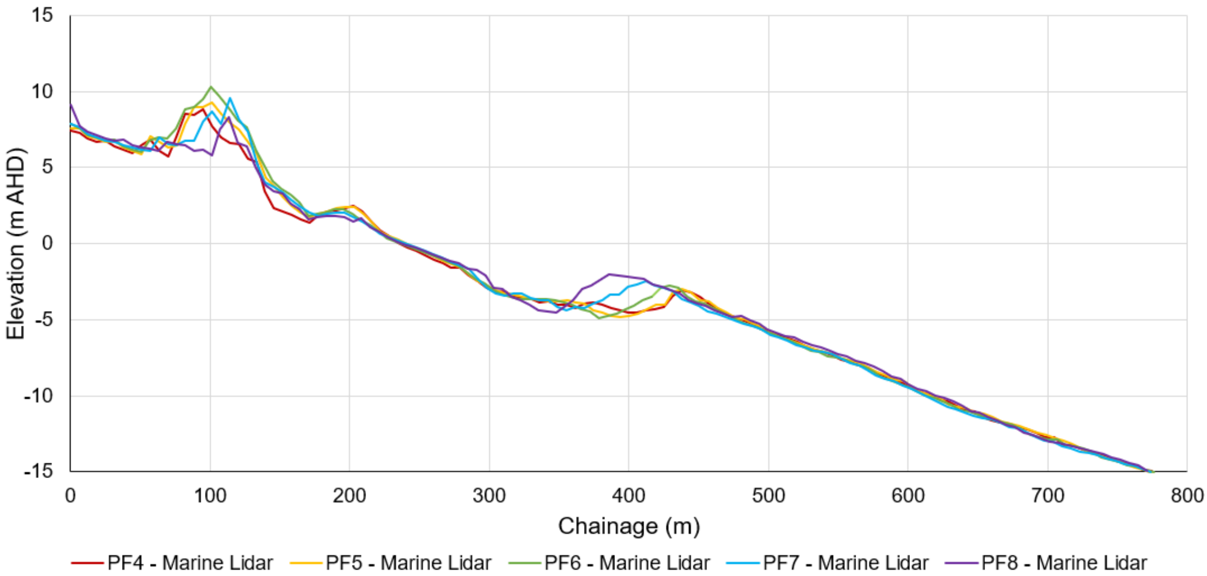

Figure 3-4 NSW marine LiDAR data (2018)

4 Waves and water levels

4.1 Preamble

Design water levels are caused by elevated water levels coupled with extreme waves impacting the coast. The elevated water levels consist of (predictable) tides and what is referred to as a tidal anomaly (or tidal residual). Tidal anomalies primarily result from factors such as wind setup and barometric effects, which are often referred to as "storm surge". Additionally, water levels within the surf zone (i.e. nearshore) are also subject to wave setup and wave runup.

4.2 Storm tide (astronomical tide + anomaly)

The proposed design water levels for 2025 were derived from studies completed by NSW Department of Climate Change, Energy, the Environment and Water (NSW DECCW, 2010) and Manly Hydraulics Lab (MHL, 2018).

The site is within the Lake Macquarie Mine Subsidence District (NSW Government, 2021; www.nsw.gov.au/sites/default/files/2021-12/lake-macquarie-mine-subsidence-map-PP5200.pdf).

Precise subsidence rates for Redhead are not known. Watson (2020) found the following rates of sea level rise and vertical land movement for Newcastle and Fort Denison (Sydney) over the period September 1992 to May 2019:

- Vertical land motion:
  - Newcastle: -0.8 mm/year (±0.8 mm/year, subsidence)
  - Fort Denison: +0.3 mm/year (±1.0 mm/year, uplift)
- Relative sea level rise:
  - Newcastle: +2.3 mm/year (±1.6 mm/year)
  - Fort Denison: +1.9 mm/year (±1.6 mm/year)

With recent sea level rise of approximately 2 mm/year, a summary of adopted design water levels is presented in Table 4-1; note that these values exclude wave setup and runup effects which can be substantial inside the surf zone.

Table 4-1 Design water levels (Sydney) excluding wave setup and wave runup

ARI (years)	2008 water level (m AHD) (NSW DECCW, 2010)	2017 water level (m AHD) (MHL, 2018)	2025 design still water level (m AHD)(1)
1	1.24	1.18(1)	1.22
10	1.35	1.31(1)	1.34
100	1.44	1.42	1.46

(1) The 2025 design water levels were derived from (NSW DECCW, 2010) and (MHL, 2018) adjusted to 2025 using a constant historical SLR rate of 2 mm/year. The proposed 2025 design still water levels are an average of the adjusted NSW DECCW and MHL water levels.

4.3 Future sea level rise

It is anticipated that the project will have an indefinite life, however, 10 to 50 years is suggested for analysis. The CMP (2023) generally adopted a sea level rise of 0.4 m by 2050 and 0.9 m by 2100.

4.4 Waves

Redhead Beach is characterised by a moderate to high energy wave climate as the offshore bathymetry has a moderate gradient and there are no protective offshore reefs. Estimates for 1, 10, and 100 year ARI (Average Recurrence Interval) non-directional offshore waves (Glatz et al., 2017) and directional offshore extreme waves (Shand et al., 2011a) in the Sydney region are provided in Table 4-2. The Sydney wave buoy data is suitable for the offshore wave conditions at Redhead Beach. For this analysis, unrefracted waves from the east to south-east wave direction H_s were used to quantify wave runup.

Table 4-2 Offshore directional extreme wave conditions at Sydney wave buoy

Offshore Wave Direction		One Hour Exceedance H_S (m)		
		1 year ARI	10 year ARI	100 year ARI
All directions[1]	-	5.8	7.6	9.4
N to E[2]	0 to 90	3.0	4.5	5.7
E to SE[2]	90 to 135	4.4	6.2	7.8
SE to SW[2]	135 to 225	5.9	7.5	9.0

(1) These values were reported in Galtz et al. (2017).

(2) These values were reported in Shand et al. (2011a).

Offshore peak wave period for design conditions from the Sydney wave buoy (Shand et al., 2011b) are provided in Table 4-3.

Table 4-3 Offshore (Sydney) extreme peak wave conditions

ARI (years)	Offshore Tp (s)
1	11.0
10	12.1
100	13.0

5 Coastal hazards

5.1 Coastal erosion

There is no historical beach profile data available along the northern end of Redhead Beach as shown in Figure 5-1.

Figure 5-1 Historical beach profiles from the NSW Beach Profile Database (2025)

Gordon (1987) presented storm erosion statistics for NSW and remains a primary tool utilised in NSW for estimating storm erosion. The Gordon (1987) statistics for erosion events (which may be clusters of storm events) for high demand rip heads and low demand open beaches are as follows:

- 1 year ARI: 5 to 40 m^3/m above AHD
- 10 year ARI: 75 to 130 m^3/m above AHD
- 100 year ARI: 140 to 220 m^3/m above AHD

Due to the exposed nature of Redhead Beach, the high demand rip head values would be more likely to prevail.
The Zone of Slope Adjustment (ZSA) would be applicable to Redhead Beach as there is no planned construction on top of the sand dune. To determine the ZSA, the procedure of Nielsen et al. (1992) could be followed, as shown in Figure 5-2.

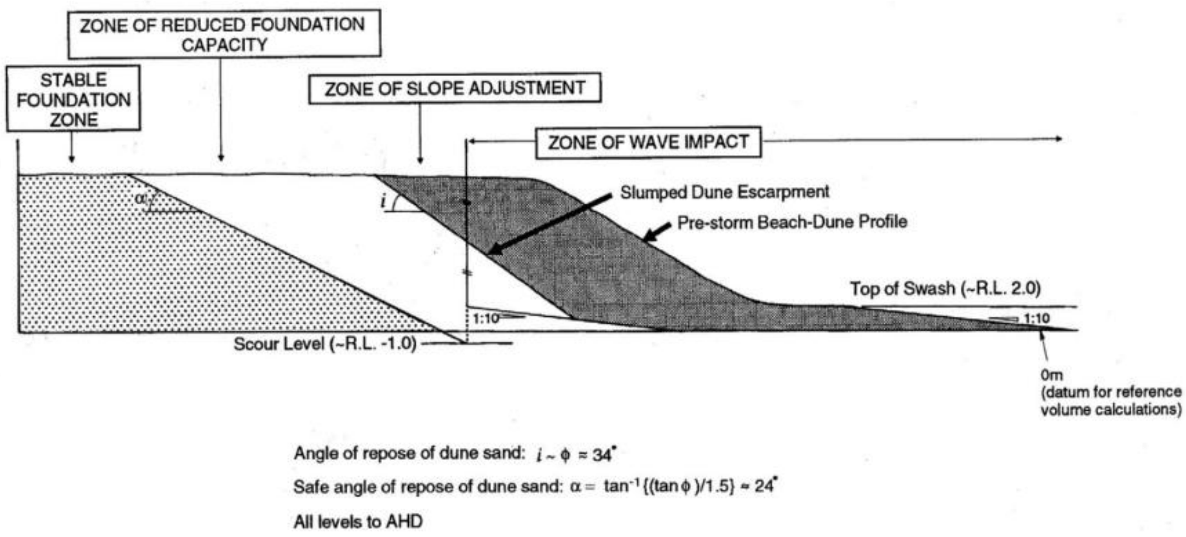

Figure 5-2 Definition of dune stability scheme from Nielsen et al. (1992)

5.2 Shoreline recession

The hazard of shoreline recession is the progressive landward shift in the average long-term position of the coastline (NSW Government, 1990). Two potential causes of shoreline recession are net sediment (i.e., volume) loss, and an increase in sea level.

Beach width (distance from a baseline to the mean high water mark, 0.7 m AHD) was sourced from the CoastSat database hosted by WRL (http://coastsat.wrl.unsw.edu.au/). The beach profiles located at Redhead Beach dune were profiles aus0179-0001 to aus0179-0004, shown in Figure 5-3. While there is apparent periods of erosion and accretion, and likely other cycles, Redhead Beach shows a mean beach recession trend of -0.03 m per year between 1987 to 2021. This is effectively zero and has occurred during a period where relative sea level rise has been approximately 2 mm per year (Watson, 2020). The time series of beach width from CoastSat is shown in Figure 5-4.

A preliminary check was also made using Geoscience Australia (2025), Digital Earth Australia Coastlines, and no significant recession was noted for 1988 to 2024.

Figure 5-3 CoastSat profiles

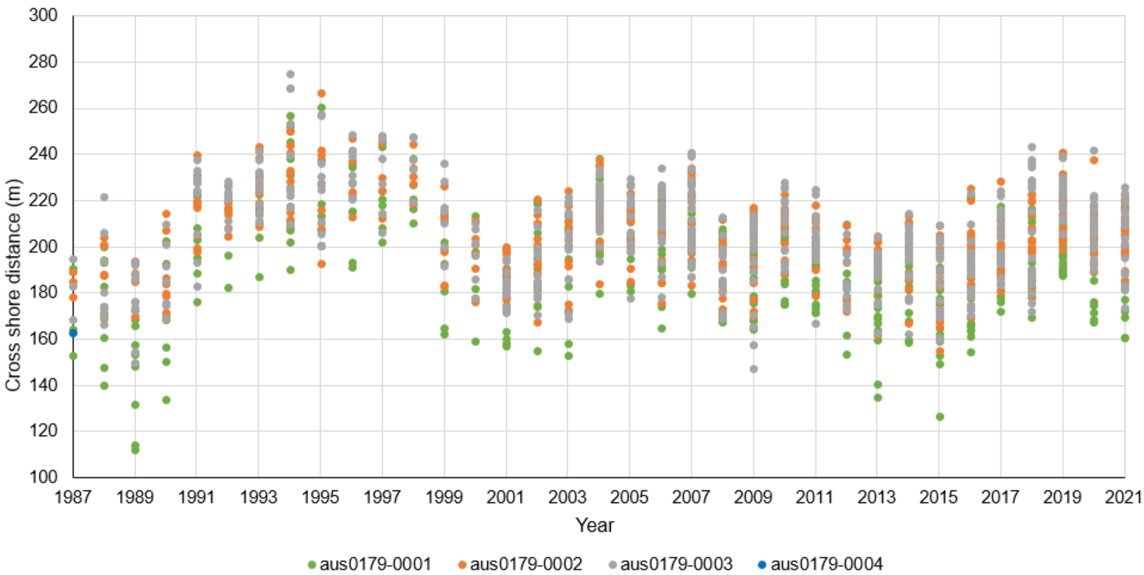

Figure 5-4 Cross shore distance from 1987 to 2021

5.3 Coastal lake or watercourse entrance instability

A small creek (Freshwater Creek) runs along the southern end of the subject dune (Figure 5-5). The northward meander of this creek can cause some erosion of the dune and loss of vegetation. More extensive meander is limited due to restrictions further upstream, such as passing under Beach Road.

The meander of Freshwater Creek was quantified using the “InletTracker” software (Heimhuber, 2021) developed at WRL. This software estimates the historical location of the centreline/thalweg of a waterway (in this case Freshwater Creek) using satellite images between 1987 to 2024. The InletTracker analysis for Freshwater Creek is shown in Figure 5-6 and shows that Freshwater Creek did impact the dune on its northern bank on occasions. This would lead to some erosion of the dune and loss of vegetation.

Figure 5-5 Freshwater Creek and Beach Road

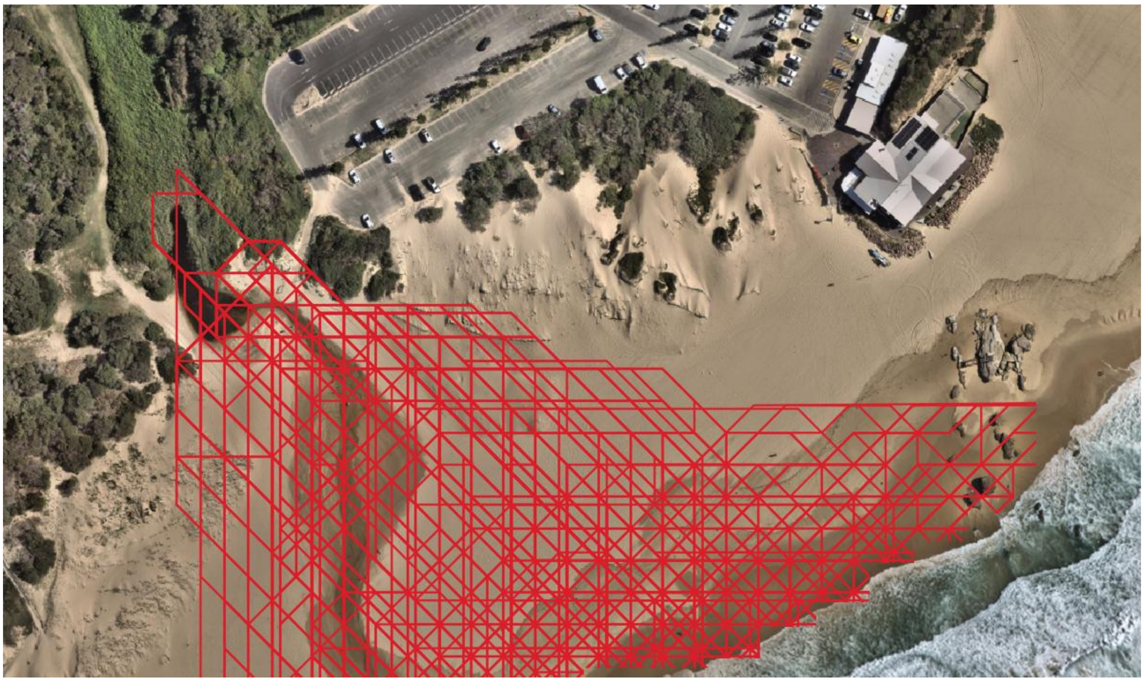

Figure 5-6 Locations of Freshwater Creek across beach between 1987-2024 (7 February 2025 image)

5.4 Coastal inundation - wave runup

A wave runup and overtopping study was completed for the surf club building by Salients (Wainwright and Nevell), noting that the surf club involves a seawall/revetment, concrete promenade and building façade.

This WRL study is for a natural dune which is not overtopped, so involves different processes to those examined in the Wainwright and Nevell (2021) study. Wave runup elevation was estimated for 1, 10, and 100 year ARI conditions in 2025 and 2050 sea level using the Mase et al. (1989) method. The results are shown in Table 5-1.

Table 5-1 R2% wave runup height (Mase et al, 1989)

ARI (years)	Year	SLR (m)	Still water level (m AHD)	Wave runup R2% (m AHD)
1	2025	0.0	1.22	3.8
10	2025	0.0	1.34	4.7
100	2025	0.0	1.46	5.8
1	2050	0.4	1.12	4.2
10	2050	0.4	1.74	5.1
100	2050	0.4	1.86	6.2

The highest R2% wave runup for all the considered scenarios was 6.2 m AHD as shown in Figure 5-7. The current sand dune crest height is between 8 m AHD to 9 m AHD, so there is no wave overtopping risk into the carpark. Dune reshaping works should retain a dune crest elevation above 6.2 m AHD to prevent wave overtopping into the carpark.

Figure 5-7 2050 100 year ARI wave runup

6 Changes to vegetation

6.1 Measured change

Aerial photos were available for the period 1941 to 2025. All historic aerial photos and a selection of recent Nearmap images are shown in Appendix A and have been incorporated into a timelapse video at Redhead Dune Timelapse 1941 to 2025.

Vegetation change was quantified by measuring the distance from the carpark to the seaward vegetation line along five transects. All data used for the analysis is outlined in Table 6-1 with a horizontal accuracy of approximately 1 m, using historical aerial photos provided to WRL for the period between 1975 to 2001 and Nearmap satellite imagery from 2010 to 2025. There was no clear vegetation line present prior to or in the 1975 aerial photo, hence this was chosen as a starting point. A visual representation of the primary vegetation zone from the NSW Coastal Dune Management Manual (DLWC, 2001) is shown in Figure 6-1. By measuring the vegetation width from historical photographs, a stable vegetation width and the date when it destabilised can be determined.

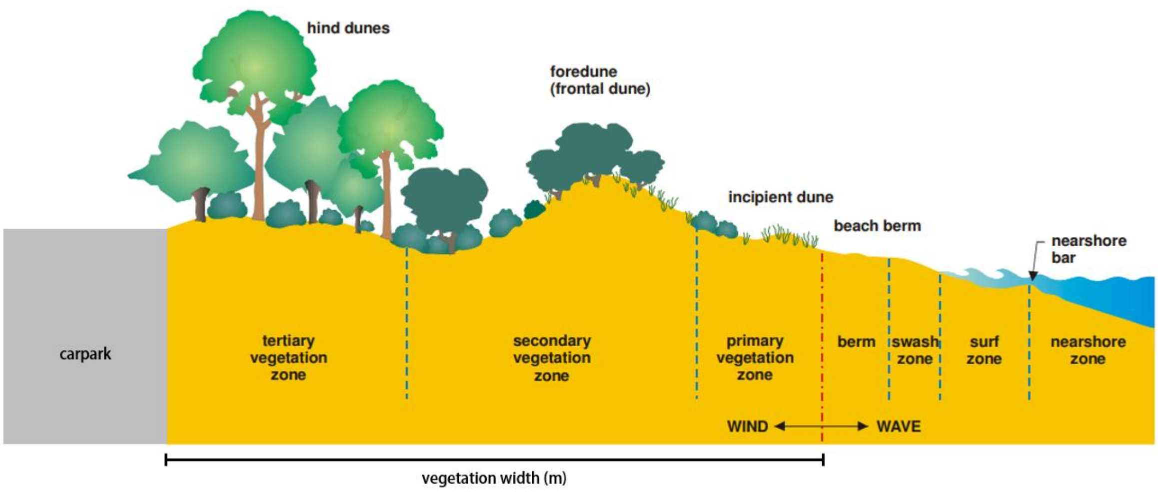

Figure 6-1 Vegetation width measurement method (DLWC, 2001)

The vegetation width was measured for each historical aerial photo and results are shown in Figure 6-2 and Figure 6-3. The measurements show that from 1975 the vegetation width increased in the early 1980s, presumably due to managed planting under the NSW Beach Improvement Program. The vegetation continued to grow and reached a stable width of 85 to 90 m from the carpark in 2010 to 2018. Then in 2019 the vegetation width began to decrease across all five cross-sectional profiles. However, due to lower-quality images prior to 2010 and the gap of imagery from 2001 to 2010 the results prior to 2010 are less certain.

Table 6-1 Vegetation data summary

Date	Source
1965	LMCC
1975	LMCC
1983	LMCC
1987	LMCC
1990	LMCC
1993	LMCC
1996	LMCC
2001	LMCC
20/03/2010	Nearmap
26/10/2010	Nearmap
17/09/2011	Nearmap
30/01/2014	Nearmap
08/05/2015	Nearmap
04/05/2016	Nearmap
06/10/2016	Nearmap
02/07/2017	Nearmap
23/07/2017	Nearmap
26/09/2017	Nearmap
20/08/2018	Nearmap
24/10/2018	Nearmap
08/12/2018	Nearmap
04/03/2019	Nearmap
12/04/2019	Nearmap
26/04/2019	Nearmap
11/06/2019	Nearmap
15/08/2019	Nearmap
27/10/2019	Nearmap
11/02/2020	Nearmap
30/06/2020	Nearmap
26/08/2020	Nearmap
08/11/2020	Nearmap
28/02/2021	Nearmap
19/04/2021	Nearmap
15/06/2021	Nearmap
01/08/2021	Nearmap
01/02/2022	Nearmap
20/04/2022	Nearmap
16/06/2022	Nearmap
02/08/2022	Nearmap
06/12/2022	Nearmap
15/03/2023	Nearmap
22/05/2023	Nearmap
15/07/2023	Nearmap
10/09/2023	Nearmap
30/12/2023	Nearmap
02/02/2024	Nearmap
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07/02/2025	Nearmap

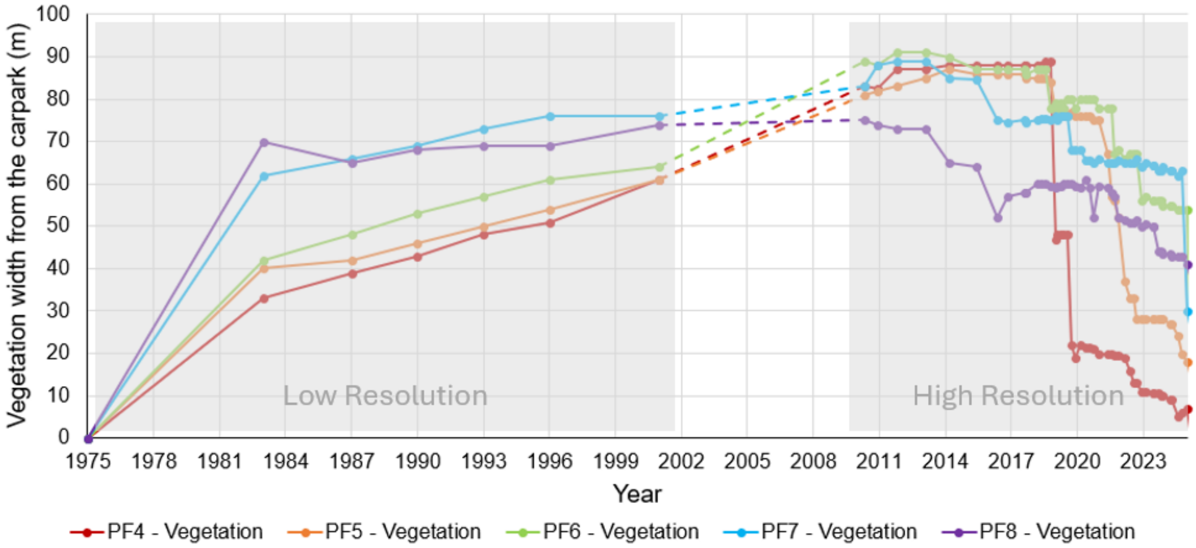

Figure 6-2 Vegetation width from 1975 to 2025

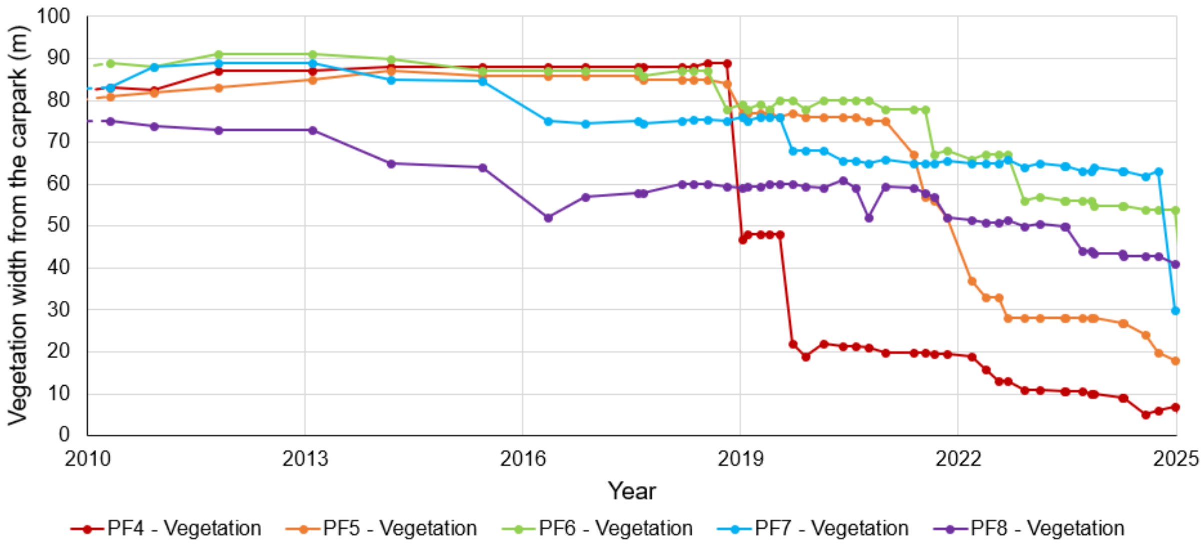

Figure 6-3 Vegetation width from 2010 to 2025

The results show that PF4, PF5, and PF6 had a vegetation width between 80 to 90 m from 2010 to 2019 whereupon the vegetation narrowed and was lost. The measurements have shown a narrowing trend with no sign of recovery at the southern three profiles (PF4 to PF6). The exception to this is the northern end of the sand dune (PF7 and PF8) where the vegetation width has been narrowing at a slower rate. Some uncertainty in measurements may be a result of windblown sand covering areas of the primary vegetation zone, image quality or alignment.

Aerial images taken in 1993, 2010, and 2025 are shown in Figure 6-4, Figure 6-5, and Figure 6-6 respectively to illustrate these changes.

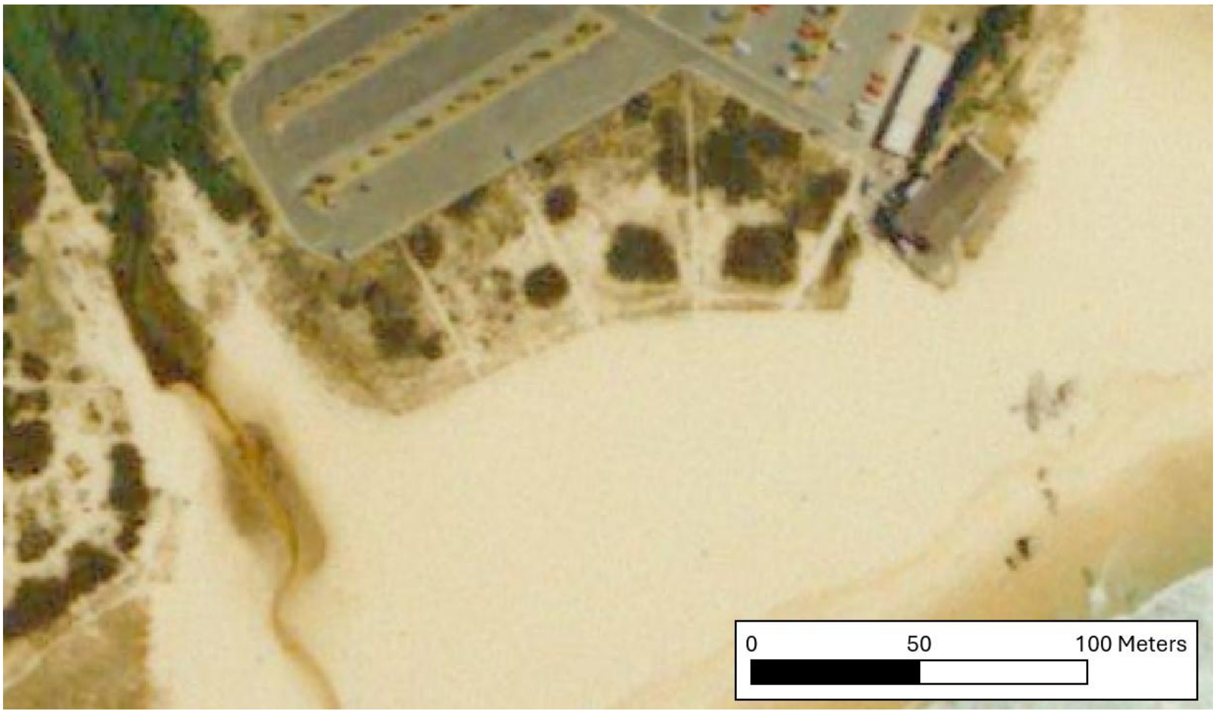

Figure 6-4 Sand dune and vegetation at Redhead carpark in 1993

Figure 6-5 Sand dune and vegetation at Redhead carpark in 2010

Figure 6-6 Sand dune and vegetation at Redhead carpark in 2025

6.2 Stable vegetation width

As noted above, the vegetation on the dune increased in width from c1983 to c2011, and was generally stable in width until 2019. A width of 60 to 90 m is feasible with focussed management.

6.3 Plausible causes of change

No direct cause of the loss of vegetation can be determined. A list of potential plausible causes includes:

- Damage, degradation or vandalism to fences and screens delineating the dunes
- Human foot traffic walking through the dune and along the beach
- Dogs and other animals walking through the dune
- Migration of the mouth of Freshwater Creek
- Extreme ocean wind events, rainfall, drought or flood events in Freshwater Creek
- Dieback in some species or some vegetation reaching the end of its life
- Changes to winds and salt content
- Changes to flows from Freshwater Creek

In reality, vegetation loss probably resulted from a combination of several of these factors.

7 Proposed work

7.1 Designed dune shape

A stable or growing vegetated area prevailed for almost 40 years from c1983 to 2019. With appropriate geometry, species selection, protection and maintenance, vegetation of comparable stability should be able to be established. This would prevent significant windblown sand reaching the carpark and would expand the ecological habitat.

The NSW Coastal Dune Management Manual (DLWC, 2001) states that when reshaping a dune, “The primary objective in reforming degraded dunes should be to re-establish the diversity of landform that existed before initial disturbance”. Due to limited dune cross shore beach profile data before the disturbance in 2019, the existing well vegetated (2025) north-eastern cross-section has been considered the stable dune shape. Therefore, the designed dune shape will contain the following:

- 1V:4H hind dune slope
- Hind dune slope beginning approximately 30 m seaward from the carpark (tertiary vegetation)
- 30 m crest width at 8.4 m AHD crest height (secondary vegetation)
- 1V:3H seaward facing slope (primary vegetation)

The detailed designs for each profile (PF4 to PF8) are shown in Figure 7-1 to Figure 7-5. Red hatching represents cutting and grey hatching represents filling.

7.2 Dune components

7.2.1 Hind dune slope

Given that the DCCEEW drone survey and available data cannot accurately determine the existing hind dune slope, an assumed 1V:4H slope has been used for the proposed design. A 1V:4H slope is the steepest slope that does not require additional infrastructure such as timber steps or switchback ramps (DLWC, 2001). Additionally, the hind dune slope is proposed to start approximately 30 m seaward of the carpark to ensure a large enough area for primary vegetation development.

7.2.2 Crest

A crest width of approximately 30 metres was identified as the existing width, based on a review of the northern stable section of the existing dune. However, it was determined that the crest width should be reduced to 20 m to minimise any disturbance to existing vegetation between PF7 and PF8. An 8.4 m AHD crest height was assessed to be optimal to minimise vegetation disturbance and distribute excess sand volume, while also being approximately 2 m above the design wave runup estimates.

7.2.3 Seaward facing slope

As stated above, the shape of the north-eastern sand dune has been adopted as the representative form of a stable dune. Therefore, a designed 1V:3H seaward facing slope has been used to match the current seaward facing slope at PF6 to PF8. Adopting a 1V:3H slope across the sand dune area may present issues during the reconstruction works due to the steepness of the slope. However, due to the extent of revegetation required, a steeper seaward facing slope is suitable as it provides additional protection from wind for vegetation up the slope, creating a better environment for revegetation (DLWC, 2001).

7.2.4 Available volume

The designed dune shape also considers the total volume required for the reconstruction process. The design produces an approximately even spread of sand across the dune. To account for the deficit of sand across the dune, the crest height can be slightly reduced to ensure that the seaward facing slope holds the design shape.

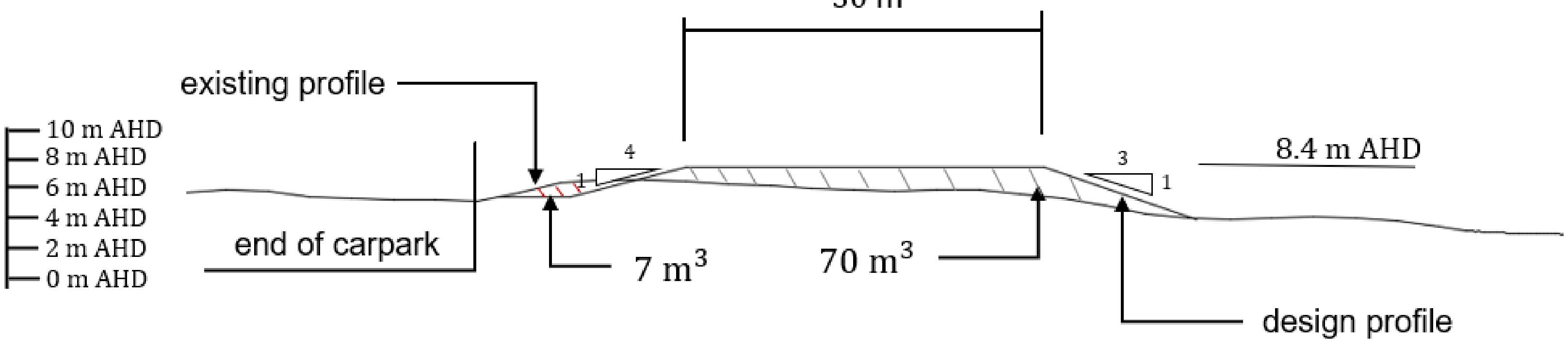

Figure 7-1 Design profile PF4

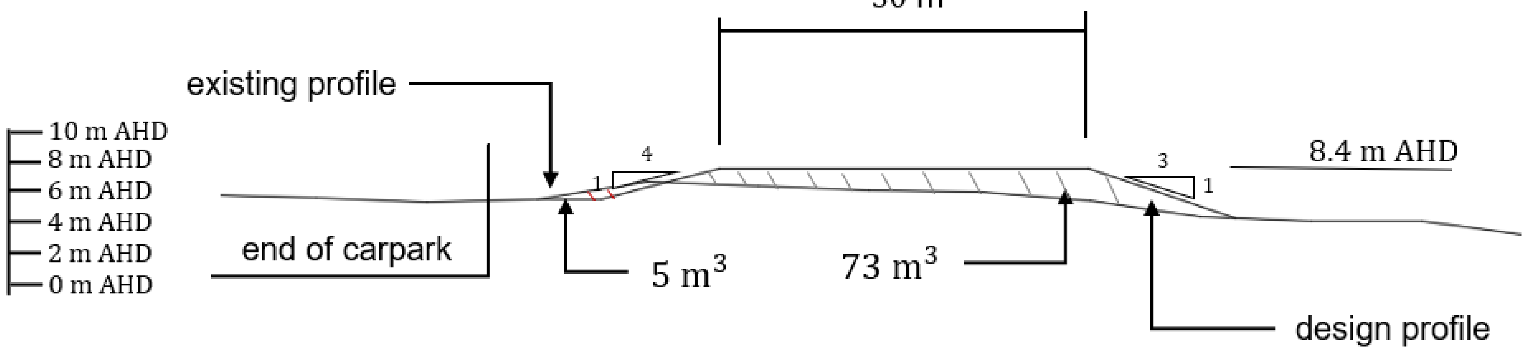

Figure 7-2 Design profile PF5

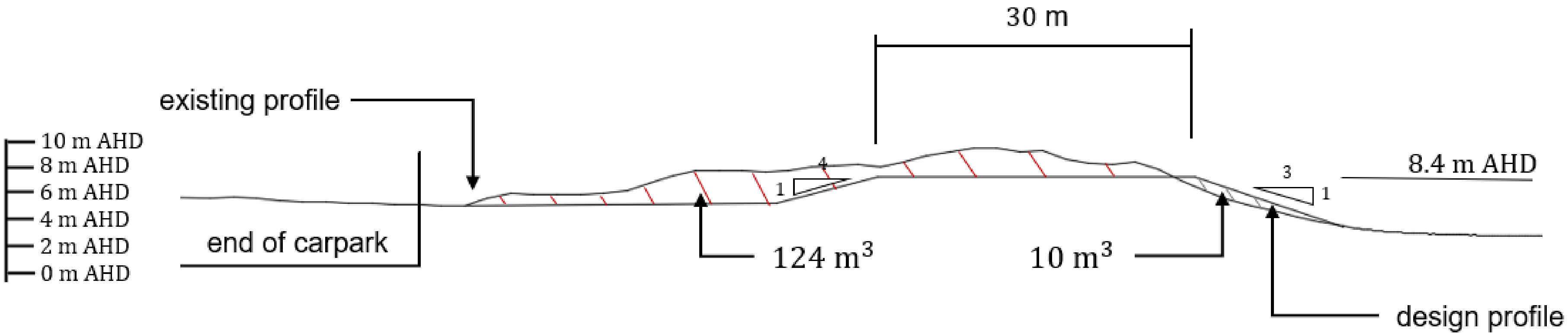

Figure 7-3 Design profile PF6

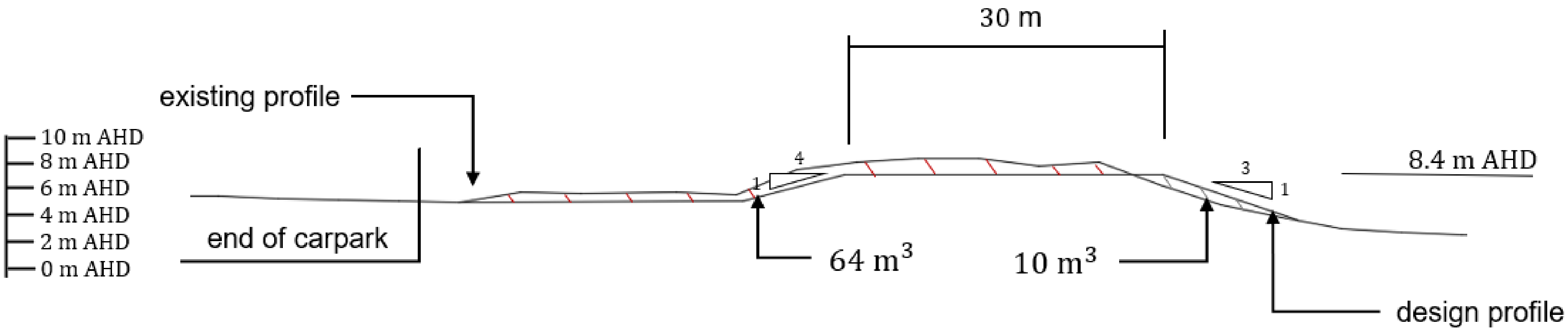

Figure 7-4 Design profile PF7

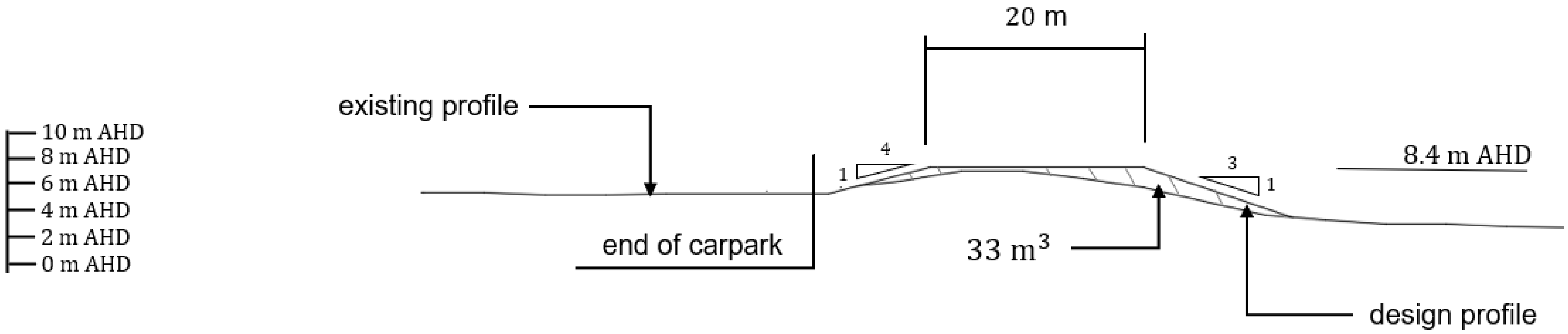

Figure 7-5 Design profile PF8

7.3 Cut and fill analysis

A cut and fill analysis was conducted to visualise the major locations for sand change and is shown in Figure 7-6. The heatmap shows the proposed areas for removal of sand in red and addition of sand in grey. A more detailed representation using contour lines is shown in Figure 7-7. Sections of the cut and fill have been removed to account for areas of no data or areas where natural features impacted the results.

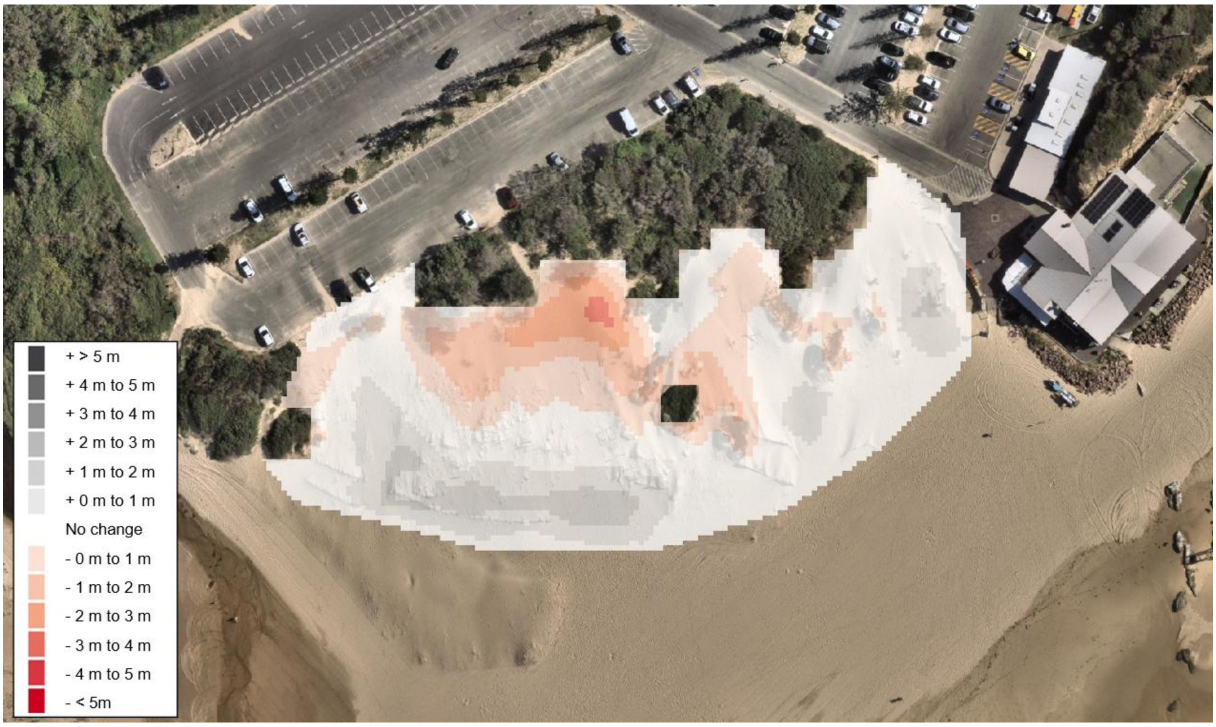

Figure 7-6 Cut and fill heatmap

Figure 7-7 Cut and fill contour lines

7.4 Vegetation plan

LMCC has experience with species selection in environments such as these, so the following information from the NSW Coastal Dune Management Manual (DLWC, 2001) is generic only. LMCC should utilise its own or external expertise regarding watering, weeding and nourishing newly planted vegetation so that it thrives. A visual representation of the cross sectional and aerial positions of each vegetation zone is shown in Figure 7-8 and Figure 7-9 respectively. To avoid removing plants at the eastern end of the dune, the hind dune will be extended to the creek. The proposed design consists of different vegetation types in the following areas:

- Tertiary vegetation: between the carpark and the hind slope
    - Ficus rubiginosa
    - Diospyros australis
    - Banksia integrifolia
- Secondary vegetation: from the start of the hind slope to the end of the crest
    - Lomandra longifoli
    - Leucopogon parviflorus
    - Acacia longifoli
- Primary vegetation: along the seaward facing slope
    - Spinifex sericeus
    - Carpobrotus glaucescens
    - Canavalia rosea

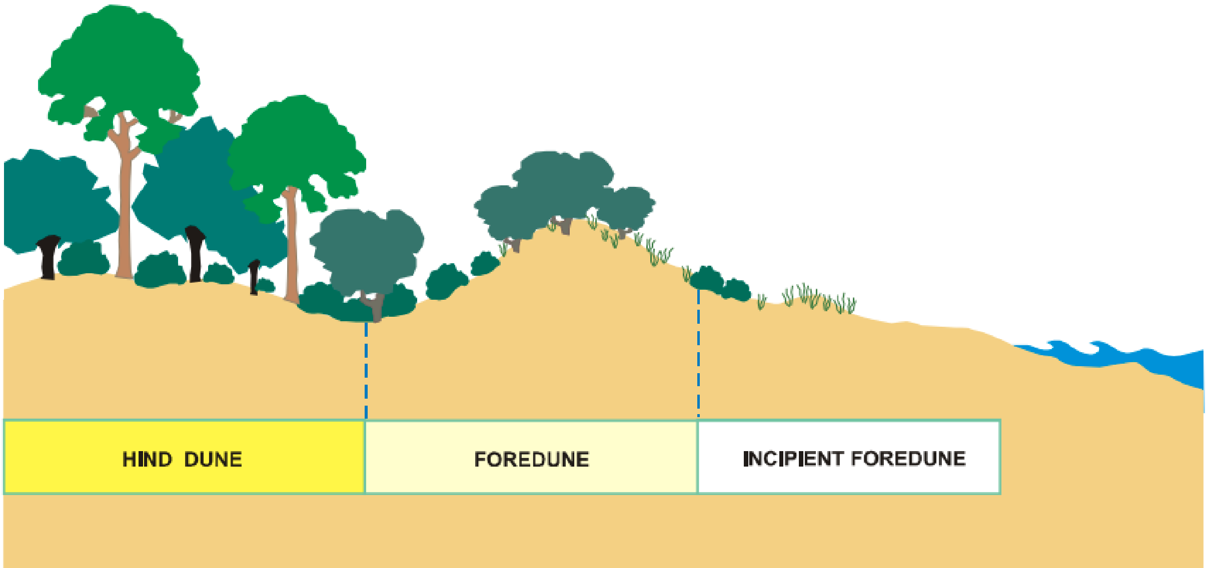

Figure 7-8 Visual representation of vegetation zones

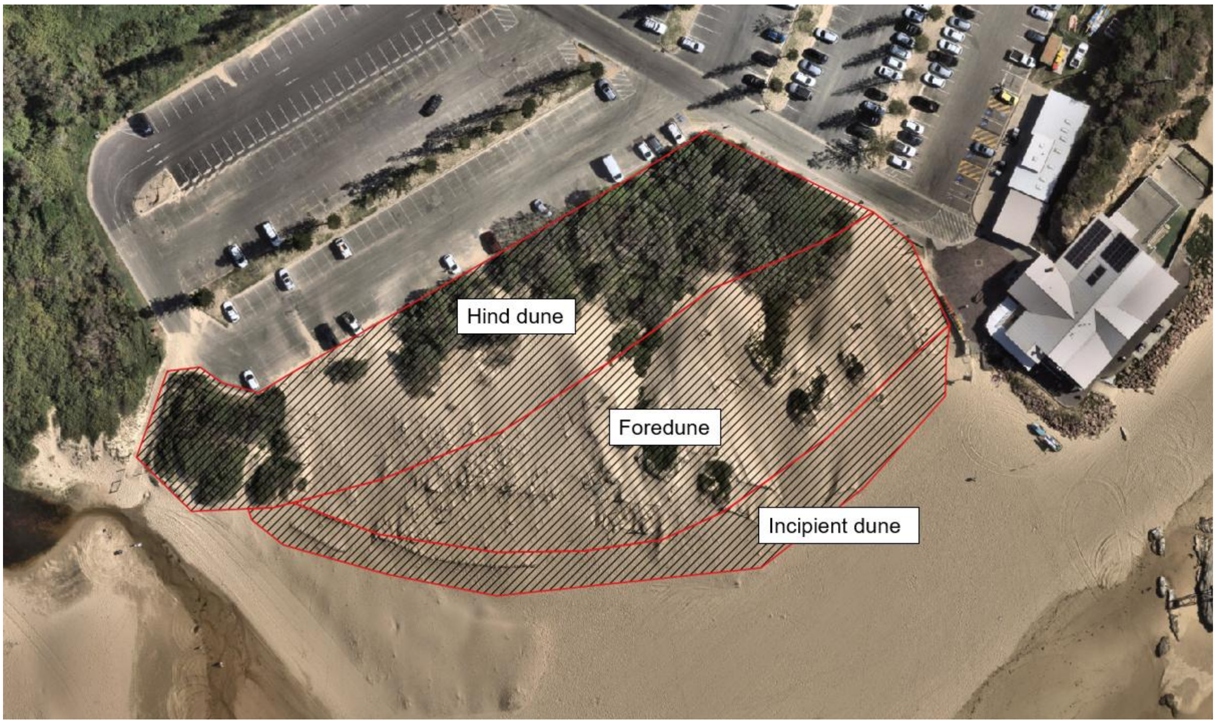

Figure 7-9 Proposed vegetation zones

7.5 Beach access ways

It may be feasible to rationalise/reduce the number of beach access ways from the carpark. By reducing the number of access paths, the foot traffic over the sand dune can be reduced to fewer sections. WRL suggests (Figure 7-10 using 2010 aerial imagery) that the south-western emergency access and north-eastern SLSC access are retained, the two intermediate paths be closed and the future of the central beach access path be further considered.

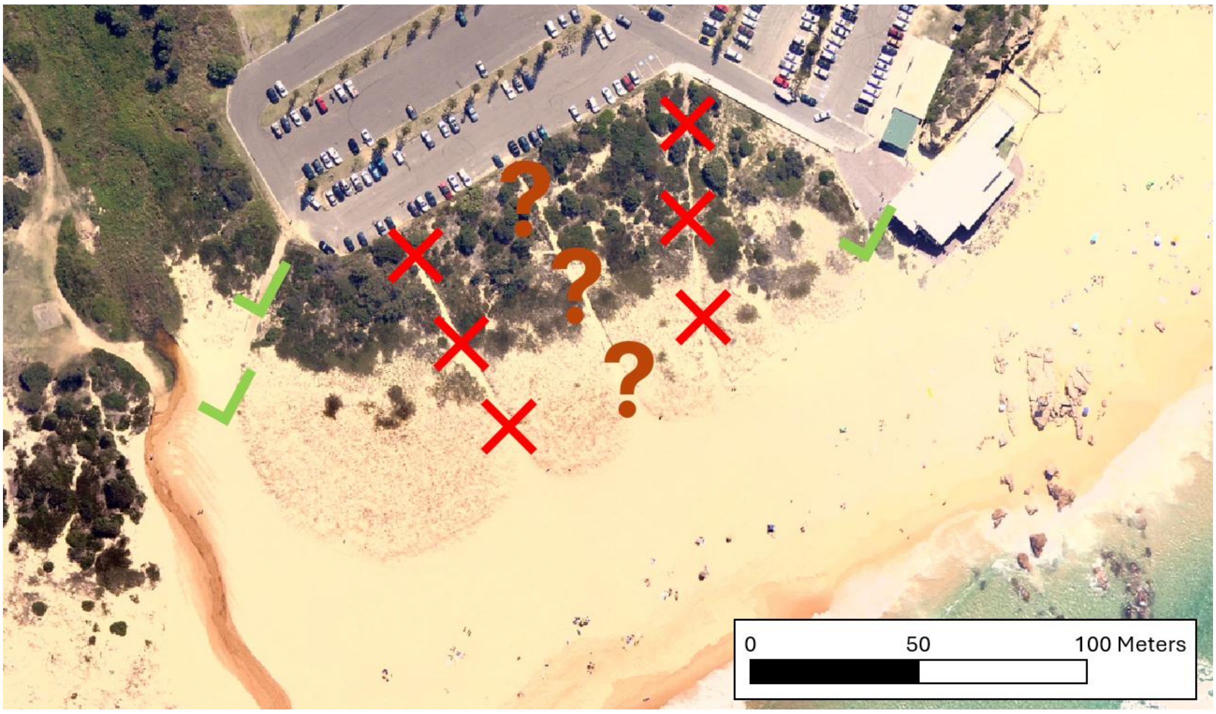

Figure 7-10 Suggested beach access ways from Redhead carpark

8 Conclusions

The vegetation on the sand dune to the south of Redhead SLSC was growing or stable from c1983 to 2019. Much of the vegetation has been lost since 2019. This has resulted in wind blown sand reaching the carpark and a reduction of ecological habitat.

The carpark at Redhead Beach is at low risk from the hazards of beach erosion, beach recession, or coastal inundation through wave overtopping. The meander of Freshwater Creek can cause some erosion of the southern portion of the subject dune area and loss of vegetation in this area. The use of satellite images through the InletTracker software showed that the proposed primary vegetation zone did overlap with historical locations of Freshwater Creek by up to 10 m on some occasions. This may result in some vegetation loss, noting, however, that a well stabilised vegetated dune may further inhibit this migration.

The proposed dune stabilisation works considered the following factors:

- The shape of the remaining stable at the north-eastern end of the sand dune towards the SLSC
- A vegetated extent (85 to 90 m from the carpark seaward edge) comparable to the extent that was stable or growing prior to 2019
- A dune crest level that is above the design wave runup level

The designed dune shape has the following characteristics:

- 1V:4H hind dune slope
- Hind dune slope begins approximately 30 m seaward from the carpark (tertiary vegetation)
- 30 m crest width at 8.4 m AHD crest height (secondary vegetation)
- 1V:3H seaward facing slope (primary vegetation)

The specific vegetation types to be used for the proposed works are outside of WRL's expertise and need to be determined externally to WRL. LMCC should utilise its own or external expertise regarding watering, weeding and nourishing newly planted vegetation so that it thrives.

Consideration should also be given to reducing/rationalising the cross shore beach access paths. There are presently five such paths – these could likely be reduced to two or three. Suitable fencing, irrigating, weeding and nourishment will provide the maximum opportunity for the new vegetation to establish, thrive and stabilise.

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Appendix A Historical aerial photos

A-1 Aerial photo 1941

A-2 Areial photo 1950

A-3 Aerial photo 1965

A-4 Aerial photo 1975

A-5 Aeiral photo 1983

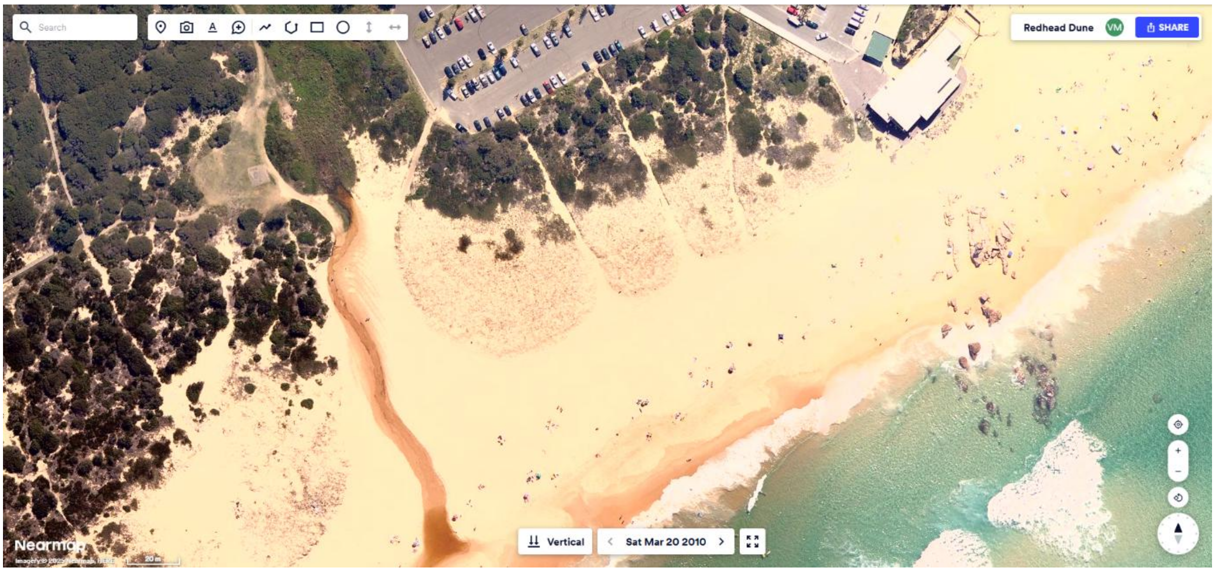
A-6 Aeiral photo 1987

A-7 Aerial photo 1990

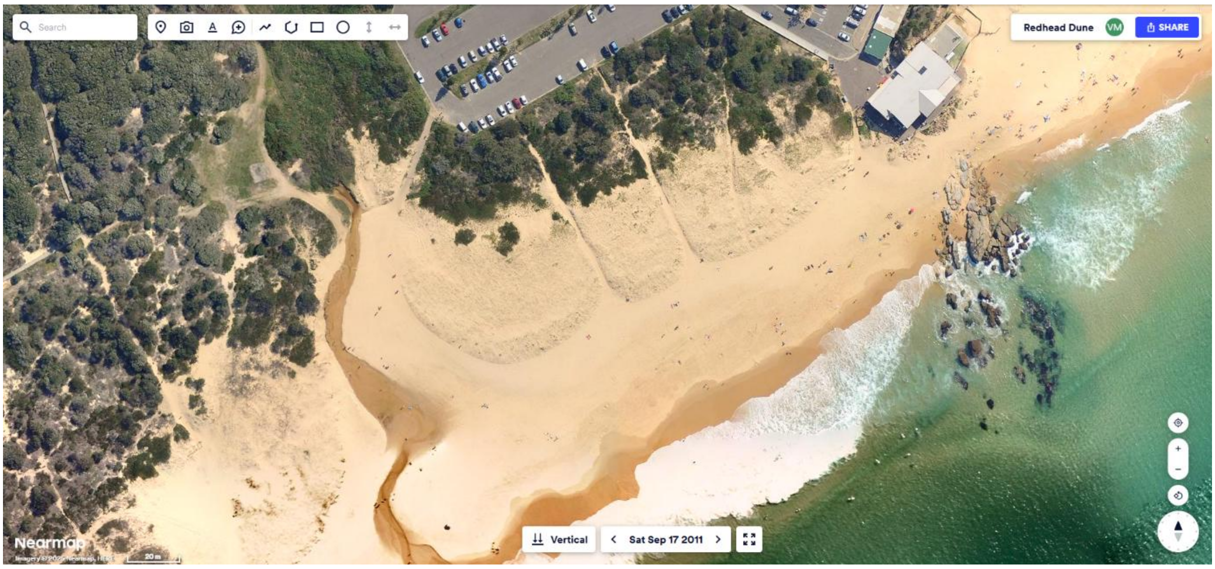
A-8 Aerial photo 1993

A-9 Aerial photo 1996

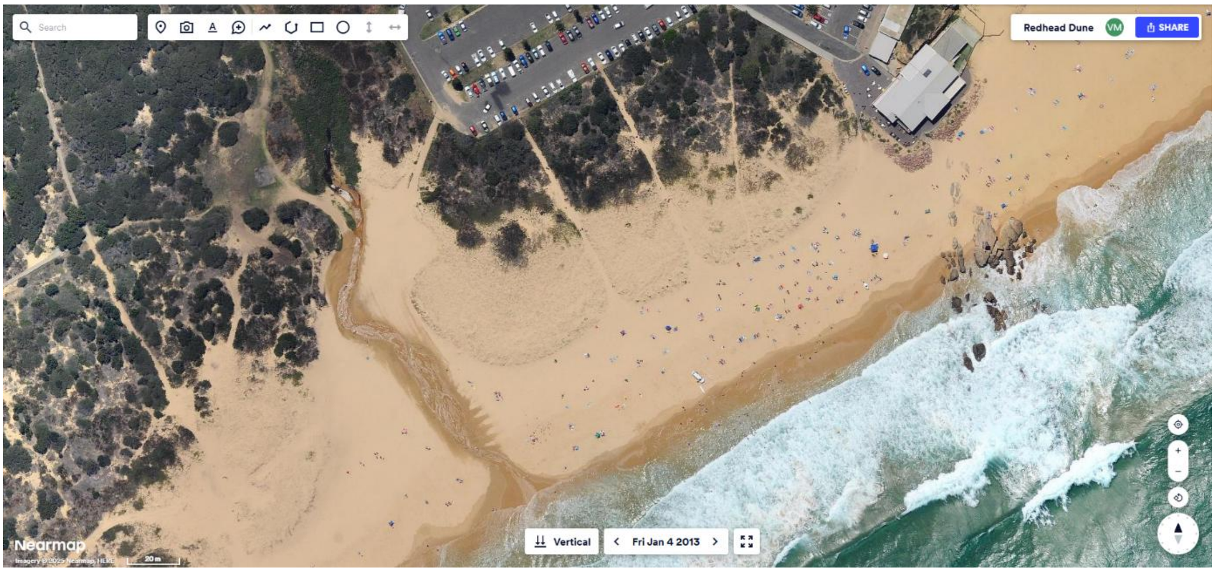
A-10 Aerial photo 2001



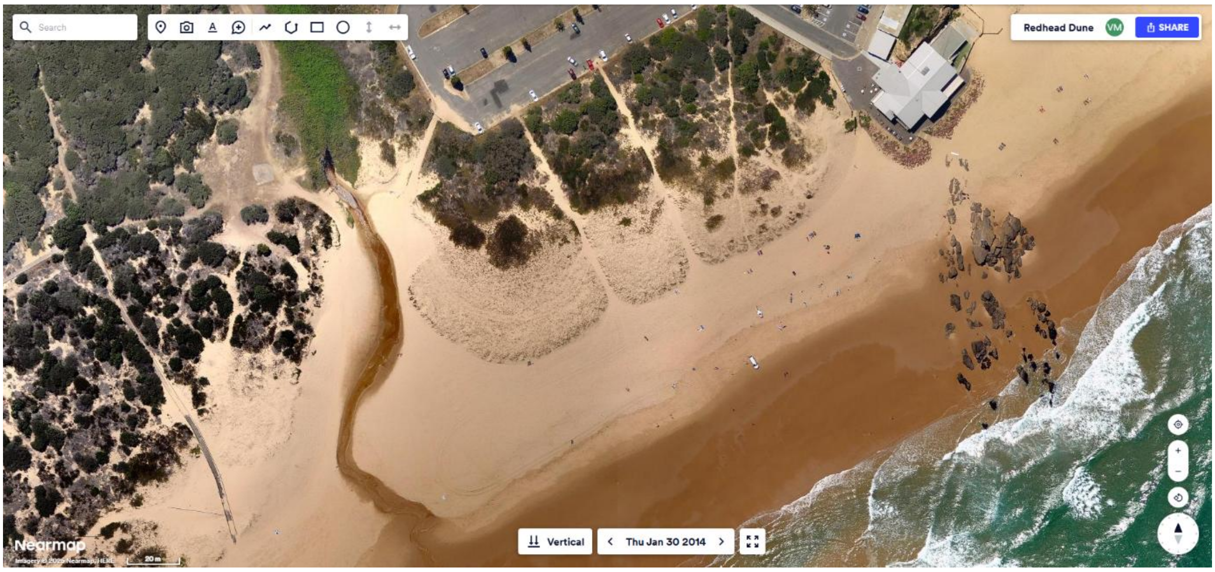
A-11 Aerial photo 20/03/2010



A-12 Aerial photo 17/09/2011

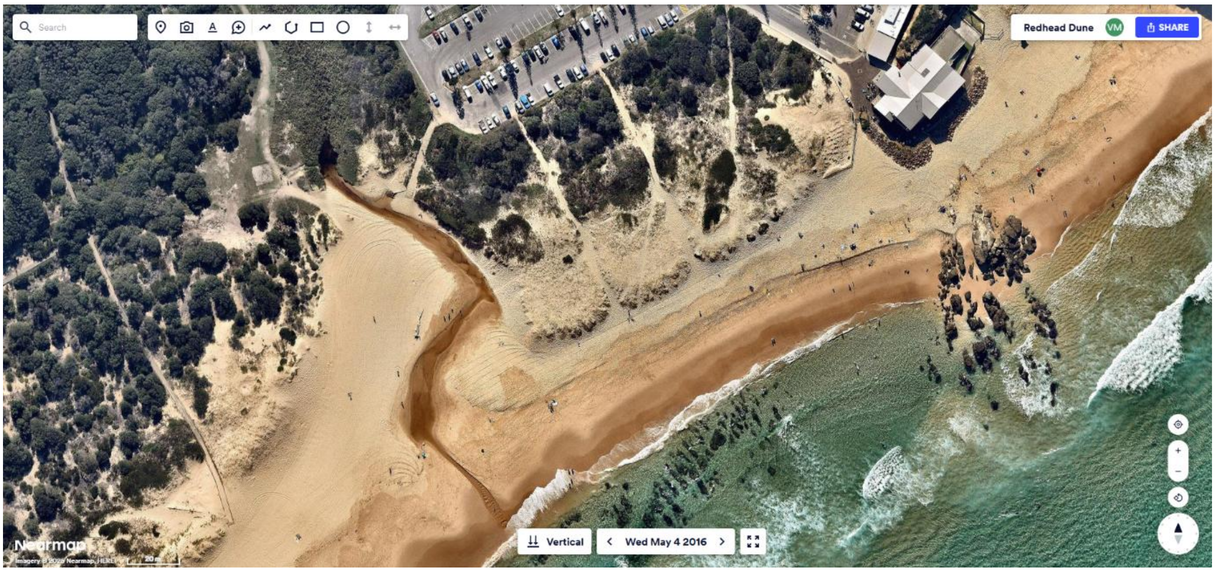


A-13 Aerial photo 04/01/2013



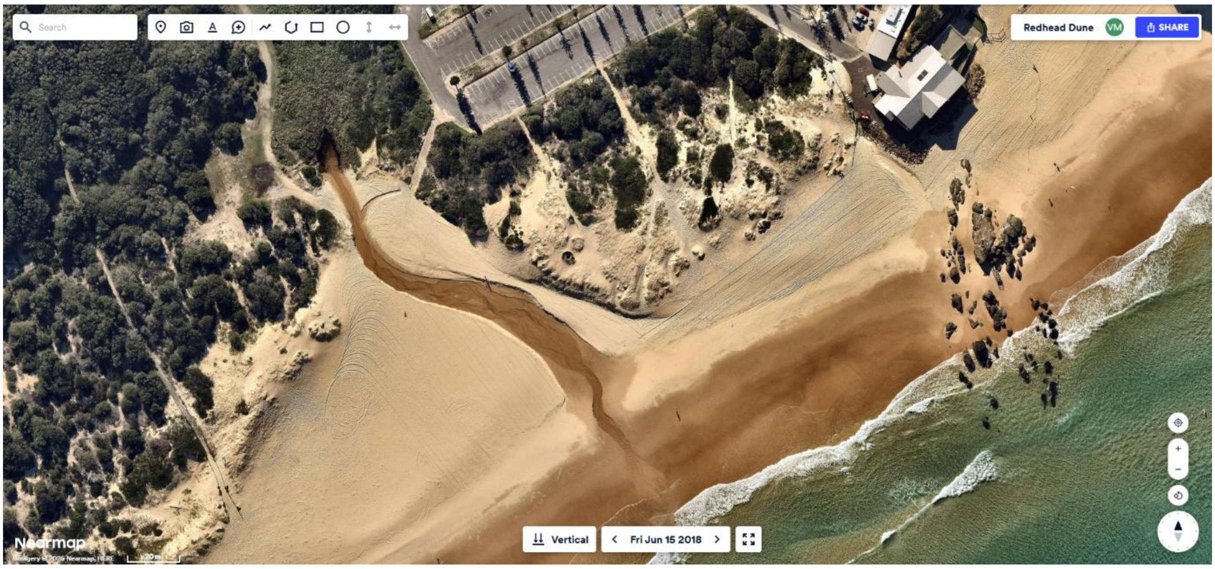
A-14 Aerial photo 30/01/2014

A-15 Aerial photo 08/05/2015



A-16 Aerial photo 04/05/2016

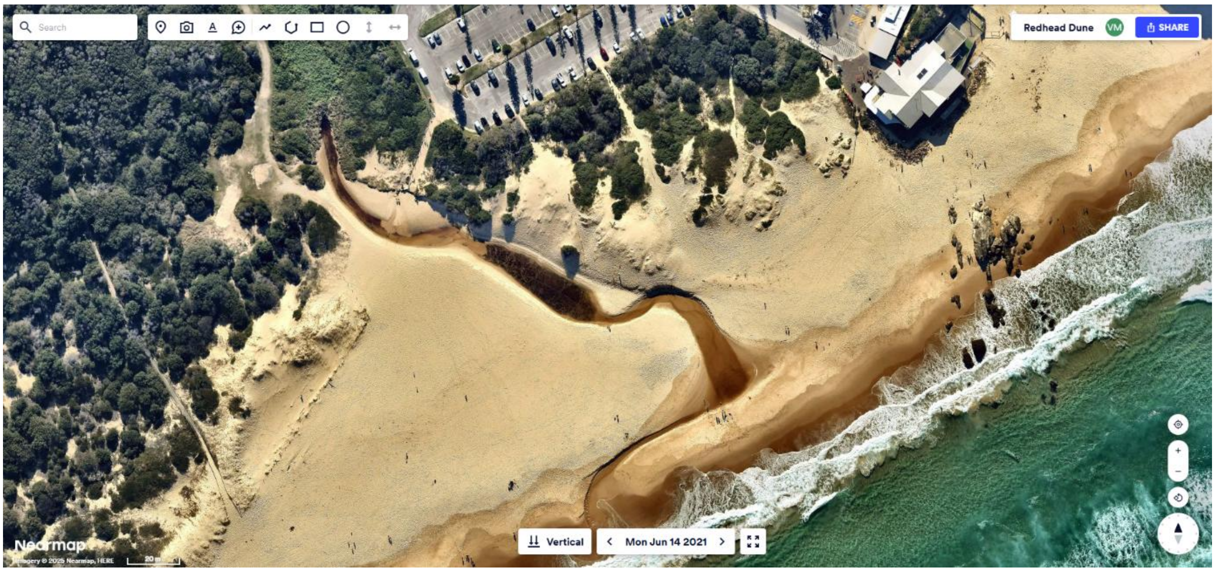
A-17 Aerial photo 02/07/2017



A-18 Aerial photo 15/06/2018

A-19 Aerial photo 11/06/2019

A-20 Aerial photo 30/06/2020



A-21 Aerial photo 14/06/2021

A-22 Aerial photo 02/08/2022

A-23 Aerial photo 19/08/2023

A-24 Aerial photo 25/06/2024

A-25 Aerial photo 07/02/2025