



MAGRYN

Sand & Dredge Management Plan

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SOUTH AUSTRALIA

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1 EXECUTIVE SUMMARY

Magryn & Associates (Magryn) were engaged by Kingston District Council to develop a sand and dredge management plan to address the ongoing sand accumulation and maintenance required to maintain the Cape Jaffa Anchorage.

The Cape Jaffa Anchorage is a valuable asset for the Kingston District Council and community, providing crucial support for recreational boating, tourism, and marine-related businesses. Due to the anchorage's location and orientation along an active coastal sediment transport path, significant sand accumulation has presented challenges since the anchorage's inception in 2007/2008.

Comprehensive numerical modelling was undertaken as part of this study to quantify sediment transport rates and storm-driven infill. Longshore transport rates were found to exceed 100,000 m³/year in some years, particularly during extended high-energy storm events. In 2024, over 110,000 m³ of sand was mobilised into the marina region, temporarily closing the channel and requiring emergency dredging.

Based on this analysis, a proactive sand management strategy is proposed, centred around the following principles:

- Maintain a designated sand trap west of the breakwater to intercept sediment before it reaches the entrance channel.
- Define clear operational triggers to initiate dredging before access is compromised.
- Reuse dredged sand to nourish the eroding eastern beach and mitigate long-term recession.
- Implement a flexible dredging schedule (annual or biennial) aligned with variability and monitoring results.
- Employ a mix of marine- and land-based dredging equipment depending on access, season, and trap condition.

Recommended dredging volumes range from 100,000 m³ in typical years, with provision for up to 150,000 m³ during high-energy years. The trap and channel area should be surveyed regularly, with storm-triggered inspections following major wave events.

This strategy aims to transition Cape Jaffa's sand management from reactive emergency responses toward a sustainable, predictive and cost-effective maintenance cycle that supports the long-term viability of the marina and adjacent coastline.

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2 INTRODUCTION

2.1 SCOPE OF REPORT

Magryn were engaged by the Kingston District Council for the purpose of a sand and dredge management plan at the Cape Jaffa Anchorage, building on previous management plans undertaken, and incorporating results of numerical modelling and dredging volumetric analysis.

This report includes:

- Background
- Summary of prior works
- Coastal processes
- Proposed works
- Benefits of proposed works

2.2 OBJECTIVES

The proposed management plan is to address and discuss the ongoing sedimentation issues at the study site, and propose a comprehensive, data-driven dredging strategy. This updated sand and dredge management plan aims to balance the annual sand inflow into the western beach area by developing an efficient dredging strategy, and to minimise ongoing maintenance needs and costs. The benefits of the proposed works are generally discussed.

The site location (Figure 1) is shown below. This report shall be read in conjunction with Magryn drawings and/or outputs, attached.



Figure 1. Aerial view of the Cape Jaffa Anchorage, in relation to Cape Jaffa and Lacepede Bay. Adapted from Google Earth Pro.

2.3 METHODOLOGY OF STUDY

The methodology of this project is comprised of two stages. Stage 1 encompasses an investigation phase, inclusive of a background investigation and review of prior studies, including previous sand management reports produced by Magryn, to establish baseline conditions and refine volume estimates presented herein. This phase also includes wave and sediment modelling, and an in-depth storm analysis of the August/September 2024 storm by Port & Coastal Solutions (discussed further in [Section 5.3](#)).

Stage 2 of the project encompasses the development of a sand and dredge management plan, informed by information and data collected in Stage 1, detailing recommended dredging volumes, strategies, and trigger points.

3 BACKGROUND

The Cape Jaffa Anchorage is a marina and housing development constructed by the Cape Jaffa Development at Cape Jaffa, located 18 kilometres (km) southwest of Kingston SE, and 25 km north of Robe, on the Limestone Coast of South Australia. The anchorage is located at the southern end of Lacepede Bay (east of Cape Jaffa) and faces north into the bay (see Figure 1).

The anchorage consists of:

- A western breakwater, which extends perpendicular from the western side of the marina entrance and curves round to the north-east. This breakwater is the largest, and is approximately 380 m long.
- An eastern breakwater, which is approximately 180 m long, and extends out from the eastern end of Tonkins Beach and delineates the eastern side of the marina entrance channel.
- A marina entrance channel that faces to the northeast.
- A staged marina with boating facilities.
- A staged residential development around the marina.

Longshore sediment transport from west to east was recognised as a prominent coastal process prior to the construction of the anchorage. Hence, management of this sand transfer was always understood as a necessity of the development. Due to the orientation of the breakwaters in relation to longshore sediment transport, sand consistently builds up on the western side of the western breakwater, creating a sand fillet that builds the western beach seaward, and pushes sand around the north of the western breakwater. In recent years, this build-up of sand has resulted in closure of the marina entrance due to siltation. Furthermore, the disruption of longshore sediment transport has resulted in long-term recession of the eastern beach as it is starved for sediment.

3.1 PAST SAND MANAGEMENT OPERATIONS

Various sand carting and dredging operations have been undertaken since the construction of the breakwaters and marina in 2008, to move the sand which has accumulated on the western beach and within the marina channel. These operations are summarised in Table 1, below:

Table 1. Summary of sand management operations at the Cape Jaffa Anchorage to date (June 2025).

Date	Volume (m ³)	Location of removed sand	Method
Sept/Oct 2014	27,300	Western beach	Excavator & truck
	4,985	Entrance channel	
April 2015	4,930	Western beach	Excavator & truck
Aug/Sept 2016	121,240	Western beach	Excavator & truck
August 2018 – October 2019	33,361	Western beach	Excavator & truck
	~100,000	Entrance channel	Dredge
Jan–May 2024	92,500	Western beach & entrance channel	Dredge
Oct 2024	98,927	Western beach & entrance channel	Dredge

Between 2020 and 2023, Council owned and operated a cutter suction dredge and spent \$2,258,313.49 on completed dredging activities for this period. This figure includes costings for wages, labour overheads, internal plant hire, parts, fuel, and dredge pipe installation, etc. In 2023, Council resolved to sell the dredge and revert back to a contracted services model which remains in place with Maritime Constructions. This contractual agreement is in place until 2038.

3.2 REVIEW OF PRIOR ASSESSMENTS & MANAGEMENT PLANS

3.2.1 ENVIRONMENTAL IMPACT STATEMENT – FEBRUARY 2005

An Environmental Impact Statement (EIS) was undertaken in February 2005, prior to the construction of the anchorage, by Masterplan and Tonkin Consulting. This report studied and reviewed many aspects of the development, and included individual reports on a wide range of topics. The EIS summarised and collated the individual reports, presenting a cohesive impact statement in support of the anchorage development.

Coastal processes discussed within the EIS are summarised in [Section 4.2](#). Regarding longshore sediment transport, the EIS is clear in stating that monitoring and management of longshore sand drift and the natural cycles in the coastal processes would be an ongoing requirement.

The EIS determined sand transport rates of 3,400 to 13,800 m³/y into the area east of the marina breakwaters, and 6,900 to 17,200 m³/y out of the area. Cumulative sand transport rates from west to east were estimated at 15,000 m³/y. The worst-case upper limit of cumulative sand transport rates was estimated at 25,000 m³/y.

Whilst the EIS discussed the potential effects of groundwater/pollutant inflow and the removal of marine organisms, reef communities and seagrasses, there is no discussion related to the effects of increased sediment settlement on marine organisms (e.g., smothering of seagrasses).

3.2.2 SAND MANAGEMENT PLAN – FEBRUARY 2017

A sand management plan for the Cape Jaffa Anchorage was developed by Magryn in February 2017. This report discussed various sand management strategies, such as sand carting, pumping, and dredging, and recommended a cutter suction dredge as the most applicable for the environment and required dredging.

The management plan identified trigger points on the western beach that would indicate the need for recommencement of dredging. The proposed dredging strategy included: dredging the accumulation of sand on the western beach back to a beach width of 35 m; dredging the marina channel back to its original as-constructed profile, width, and -3.5 m AHD depth; implementation of trigger points on the western beach (approx. 120 m beach width) that would trigger the recommencement of dredging.

The volume of sand calculated for a typical dredge cycle was estimated to be 75,000 to 100,000 m³, with an initial dredging campaign of upward to 300,000 m³.

3.2.3 GUIDELINES FOR THE DREDGING METHODOLOGY AND ASSESSMENT OF DREDGING – SEPTEMBER 2017

A dredging methodology and assessment of dredging for sand management at the Cape Jaffa Anchorage was developed by Magryn in September 2017. This report follows that discussed in the above section, as Council accepted the recommendations of dredging and transport of sand by use of a cutter suction dredge.

Short term goals outlined in the report include dredging the marina entrance channel back to its as-constructed water depth of -3.5 m AHD, and preventing any further sand bypassing the western breakwater. Long term goals include ensuring the long-term viability of the marina, managing and transporting the sand from the western beach to the eastern beach, preventing continued recession of the eastern beach, and returning the western beach to its pre-construction alignment.

The dredging methodology proposed strategies for the western beach, marina entrance channel, and Tonkins Knob beach. To provide a long-term sand management solution at the western beach, a sand trap basin was proposed. This basin would be a minimum width of 60 m, from deep water alongside the western breakwater into the western beach, to a depth of -3.5 m AHD. A sand trap basin would trap the sand moving alongshore, rather than having it pile up against the breakwater leading to sedimentation and siltation issues within the marina. The volume of the excavated sand sink would be greater than the worst-case scenario of sand transport, as defined by the EIS, of 25,000 m³/y, therefore catching and holding all littoral sand drift in a one-year period.

Furthermore, cutting a sand trap into this location would halt the sand feeding around the breakwater, providing time to dredge the marina entrance channel to its as-constructed depth of -3.5 m AHD, without having sediment continuously flowing into it. Although not critical, the dredging methodology outlines that Tonkins Knob beach should be dredged to its originally designed even gradient to -3.5 m AHD at the entrance channel.

This report proposes dredging 100,000 m³ of sand from the western beach, marina entrance channel, and Tonkins Knob beach.

3.2.4 SAND MANAGEMENT PLAN – MARCH 2020

An updated sand management plan in response to the sand accumulation from 2016 through to 2020 at the Cape Jaffa Anchorage was developed by Magryn in March 2020. A Damen 350 cutter suction dredge was purchased by Council in 2017/18 following the reports discussed above. However, the dredge could not operate in the manner intended, as there was not a suitable pump discharge pipe installed across the marina entrance channel.

Sand accumulation from the anchorage's construction in 2008, to 2019 was of a higher volume than that removed across various sand management operations. This accumulation eventually led to the accreting sand fillet bypassing the western breakwater and depositing sediment in the marina entrance channel, resulting in restricted boat access at lower tides.

The cutter suction dredge was used intermittently from late 2018 to early 2020 in the marina channel to clear it of sedimentation, pumping the sediment directly from the dredge to the eastern beach. In March 2020, a dredge disposal pipe which fully crossed the marina channel was installed. This allows for the dredge to operate on the western beach and pump onto the eastern beach without impeding marina use.

The total accumulation of sand to the west of the anchorage from 2008 to 2019 is estimated to be 561,420 m³. In contrast, only 292,000 m³ is estimated to have been removed from the western beach and marina channel in the same timeframe. The average sediment transport from west to east is estimated to be 47,000 m³/y.

As an immediate action, this management plan suggests intercepting the sand transport along the western beach, through continued maintenance of a sand trap and/or realigning the western beach, and replenishing the receding eastern beach with the dredged sand.

3.2.5 EMERGENCY SAND MANAGEMENT – OCTOBER 2024

A sand dredging operation in February 2024 removed 75,000 m³ from the western beach and marina entrance channel. Following a large storm event in August/September 2024, a bathymetric analysis conducted by Maritime Constructions determined that approximately 98,000 m³ of sand had returned resulting in the temporary closure of the marina due to sedimentation in the channel entrance.

The closure of the marina resulted in temporary relocation of the commercial fishing vessels, and the commencement of emergency dredging works by Maritime Constructions, removing 98,927 m³ of sand from the entrance channel and western beach. A bathymetric LiDAR reconnaissance survey (16–17th September 2024) prior to this emergency dredging effort, shows the 0 m AHD contour wrapping around the end of the western breakwater and protruding into the marina entrance channel. Further narrowing and shallowing of the entrance channel is attributed to sediment accumulation at Tonkins Knob beach pushing into the channel.

Acknowledging the impact that the August/September 2024 storm had on the anchorage, Council engaged Magryn in 2025 (this study) to investigate the conditions that led to such an event, and develop a sand management plan to combat regular and storm-led sediment transport rates.

3.3 CURRENT SAND MANAGEMENT OPERATION

This section briefly outlines the current sand management operation at the Cape Jaffa Anchorage as of the issue of this report.

The cutter suction dredge primarily operates on the western beach, with the aim of reducing the sediment file to a width that will not overflow into the marina throughout the winter months. Dredging operations occur mainly in the summer months when weather and swell conditions are calmer. The dredge pumps directly onto the eastern beach through the dredge disposal pipe installed beneath the marina.

From previous sand carting operations, there remains a stockpile of sand at the top of the western beach face. At this time, there is no known management plan to address this stockpile.

4 GEOMORPHOLOGY

4.1 CONTOUR SURVEY

A site contour survey was provided by Maritime Constructions and was conducted on 20th February 2025. This survey was completed prior to a dredging campaign. Post-dredge surveys were not provided. The survey is to the Australian Height Datum (AHD) and comprises a topographic survey of the western and Tonkins Knob beaches, and a bathymetric survey within the marina channel and around the western breakwater with a 50 m buffer.

The survey clearly illustrates the remnants of the Aug/Sept 2024 storm. A sand island, remnant of the spit of sand that bypassed the western breakwater, approximately 100 m x 80 m x 1 m AHD (8,000 m³) is clearly shown immediately adjacent to the marina entrance channel. The 0 m AHD contour extends out to the tip of the western breakwater, widening the western beach to approximately 300 m wide. Tonkins Knob Beach has elevations of 0 m AHD and above, pushing into the marina entrance and affecting its depth and width.

4.2 COASTAL PROCESSES

4.2.1 WIND & WAVES AT SITE

Waves are the main drivers of sediment transport and shoreline alignment along our beaches. Cape Jaffa is impacted by both locally generated waves as a result of prevailing local winds, and swell waves generated in the open ocean.

4.2.1.1 Locally Generated Wind-Driven Waves

Prevailing winds at Cape Jaffa are strongest from the south-to-southwest, particularly during summer afternoons and evenings, resulting in offshore-directed waves (moving north-to-northeast). These winds also help to clear the Cape Jaffa beaches from seaweed wrack. During winter, the prevailing winds generally approach from the north, resulting in southerly, onshore waves. These conditions lead to a build-up of seaweed wrack on the beaches, up to 2 m high.

Locally generated waves during extreme wind events in Lacepede Bay were analysed in the Cape Jaffa Anchorage EIS. Using the 1:100 Average Return Interval (ARI) wind speed at Cape Jaffa of 55 knots (~102 km/h), significant wave heights (H_s) at locations 5–6 km offshore (10 m water depth), 1–2 km offshore (5 m water depth), and 0.6–1 km offshore (3 m water depth) were derived. These results are summarised in Table 2, below.

Table 2. Summary of significant wave heights (H_s) of local wind-generated waves in Lacepede Bay under 1:100 ARI wind speed at varying distances offshore (as detailed in the EIS).

Water Depth (m)	Approx. Distance Offshore (km)	H_s (m) under 1:100 ARI wind speed (102 km/h)
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10	5–6	1.2
5	1–2	1.2
3	0.6–1	0.9

4.2.1.2 Swell Waves

Cape Jaffa experiences relatively calm waters, despite Lacepede Bay being exposed to ocean swell from the Southern Ocean. This calm swell is a result of substantial attenuation of west-to-north-westerly swell which is associated with extensive areas of shallow water, dense seagrass cover, the presence of rocky reefs and the Cape headland, and the northerly orientation of the beach.

All of these factors contribute to the loss of wave energy approaching Cape Jaffa through processes of wave breaking, bottom friction, refraction, and diffraction. Refraction refers to the bending of a wave approaching the shore at an oblique angle. This process is driven by changes in bathymetry, whereby the portion of the wave in the deeper water travels faster than that in the shallower water causing the wave crest to turn. Refraction causes waves to converge on headlands and diverge into adjacent bays. Diffraction refers to the transfer of energy along wave crests due to obstructions to wave propagation (e.g., headland, breakwater). This phenomenon results in the wave bending around the obstacle and penetrating into the lee-side. These processes, in addition to wave breaking and bottom friction, dissipate wave energy and result in a complex hydrodynamic environment at Cape Jaffa.

The attenuation of swell waves at Cape Jaffa was clearly shown by SWAN modelling conducted in the EIS. Results of the modelling showed that deep water swell waves from offshore Cape Jaffa undergo significant wave transformation resulting in waves that are up to 90% reduced at Cape Jaffa Beach.

The SWAN modelling investigated the attenuation of 2 m and 4 m deep water swell waves originating from southerly and westerly directions. Waves approaching from the south were reduced by 84–90% whilst waves approaching from the west were reduced by 69–81%. This is likely due to southerly waves interacting with the Margaret Brock Reef and Cape headland more so than westerly waves, thereby attenuating more energy. All deep water swell waves, regardless of originating direction, approached the Cape Jaffa Beach from the northwest due to refraction.

4.2.2 SEDIMENT TRANSPORT

Waves breaking on the beach cause the formation of longshore currents, which move the sand either along the shoreline or offshore. Prevailing local wind is from the south-to-southwest, and prevailing waves are generally from the north-west, resulting in net sediment transport from west to east.

The most recent estimate of the longshore sediment transportation rate (as detailed by Magryn's 2020 sand management plan, [Section 3.2.4](#)) is 47,000 m³/y.

Due to the location of the Cape Jaffa Anchorage and orientation of (specifically) the western breakwater, the longshore sediment transport is disrupted resulting in accretion

to the west of the marina, and erosion to the east of the marina as the beach is starved for sediment.

4.2.2.1 Geotechnical Investigation

Magryn engaged SMS Geotechnical to conduct particle size distribution (PSD) and sediment density testing on six samples (see Figure 2). These samples were taken at the high and low water lines of three transects (two samples per transect). One transect was located at each of the following locations: western beach; Tonkins Knob Beach; eastern beach.

The results from these tests were used to validate the sediment transport modelling (as discussed in [Section 5.3](#)).



Figure 2. Locations of sediment sampled for PSD and density testing. Samples 1, 3, and 5 are from low water line. Samples 2, 4, and 6 are from high water line.

PSD Testing Results:

Particle size distribution testing was conducted on the six samples through a sieve analysis. This method involves passing each sediment sample through a series of sieves with increasingly finer meshes to determine the density gradient.

A summary of the PSD results is given below, please refer to the attached SMS Geotechnical reports for further details.

The material of the sediment samples taken were all described as sand, fine to coarse grained, and grey. With the exception of sample 3, every other sample was described with traces of fines ($\leq 75 \mu\text{m}$ sediment size; Geoscience Australia, 2018).

Samples taken at the low water line (samples 1, 3, and 5), were typically coarser at 10, 50, and 90% sediment sizes (d_{10} , d_{50} , d_{90} , respectively) compared to their high water line counterparts (samples 2, 4, and 6, respectively). This is not unexpected as finer sediment tends to accumulate upslope on beaches as it is transported through swash and aeolian processes. There is limited variability in PSD between the sites, indicating that the sediment is likely to be from the same source (i.e., longshore transport from the west).

Sediment Density Results:

The dry density of sediment samples can be used as an indicator of sediment composition. Please refer to the attached SMS Geotechnical report for further details.

The dry density of the samples in the field (at collection) ranged from 1.69–1.75 t/m³. This range of densities falls within that recorded for superfine silica sand, 1.497–1.774 t/m³ (Chow et al., 2019). As the particle sizes of the samples are described as “fine to coarse grained”, it is likely that the composition of the samples taken are a mix of silica (quartz) and carbonate (calcium carbonate fragments), as would be expected from the location of Cape Jaffa on the Limestone Coast.

5 COASTAL EXPOSURE

5.1 WATER LEVELS AT SITE

Water levels at Kingston SE (18 km northeast of Cape Jaffa) are shown in Table 3. Tides are as referenced from AUSTIDES and converted to AHD from Chart Datum (CD) using the conversion provided in the Tide Tables for South Australian Ports published by Flinders Ports (0 m CD = -0.76 m AHD).

Table 3. Tidal range of water levels at Kingston SE.

	Kingston SE (m AHD)
Highest Astronomic Tide (HAT)	0.84
Mean Higher High Water (MHHW)	0.44
Mean Lower High Water (MLHW)	0.14
Mean Sea Level (MSL)	-0.01
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MLLW)	-0.46
Lowest Astronomic Tide (LAT)	-0.76

Note: Kingston SE and Cape Jaffa display mixed semi-diurnal tidal regimes, with two high and two low tides of differing heights per day. Thus, these heights are referred to as the higher or lower of the respective high/low tide.

The current (2025) 1 in 100-year Average Return Interval (ARI) water level for Cape Jaffa is 1.92 m AHD, as calculated by CSIRO's Canute3 program. This value is estimated based on tide gauge observations from Victor Harbor (176 km away) under a very high (SSP5_8.5) greenhouse gas emissions scenario with an upper (95th) climate model

ensemble percentile based on the AR6 Intergovernmental Panel for Climate Change (IPCC) version (baseline 1995–2014). The 1 in 100-year ARI water level is the average water level which would occur once in a one-hundred-year period, or the level which has a probability of exceedance of 1% in any given year. It is determined from water level records by The National Tidal Facility of the Bureau of Meteorology.

5.2 PREDICTED SEA LEVEL RISE

Coastal Protection Board (CPB) Policy 1.4 (b) states: *“The Board will seek to minimise the exposure of new and existing development to risk of damage from coastal hazards and risks to development on the coast”*.

For compliance with the CPB policy, allowance for 0.3 metre sea level rise to the year 2050 is required. CPB policy also required that the development is capable, by reasonable practical means, of being protected, adapted or raised to withstand a further 0.7 metres of sea level rise to the year 2100.

CSIRO’s Canute3 program has been used to estimate storm tides at Cape Jaffa in a very high (SSP5_8.5) greenhouse gas emissions scenario with an upper (95th) climate model ensemble percentile based on the AR6 IPCC version (baseline 1995–2014) that encompasses CPB policy requirements for 2050 and 2100 (Table 3). A storm tide includes the contribution of astronomical tide and atmospheric storm surge on water levels. Sea level rise of 0.3 m to 2050 and 1 m to 2100 are included in the values summarised below.

Table 4. Predicted 1:1, 1:50, and 1:100 ARI storm tide events for Cape Jaffa in 2025, 2050, and 2100.

ARI	Present (2025) (m AHD)	2050 (m AHD)	2100 (m AHD)
1	1.34	1.64	2.34
50	1.84	2.14	2.84
100	1.92	2.22	2.92

5.3 DATA ANALYSIS AND MODELLING

Port & Coastal Solutions (PCS) were engaged by Magryn to undertake a bathymetric analysis, and spectral wave and beach profile modelling of the Cape Jaffa Anchorage to determine longshore transport rates at the marina under typical conditions and specific ARI storm events. These results will help inform the sand management plan and dredging volumes required to ensure the marina remains operational following a large storm event, such as that experienced in Aug/Sept 2024.

A summary of the methodologies and results of the bathymetric analysis and modelling is provided below. Please refer to the PCS technical note (attached) for further details and results.

5.3.1 METHODOLOGIES

5.3.1.1 Bathymetric Analysis

Analysis of available bathymetric data, with a focus on pre- and post-storm bathymetry (especially the Aug/Sept 2024 storm event), was conducted to gain a better

understanding of sedimentation that occurred during these events. Volumetric analyses were conducted to determine the volume of sand that accumulated in different regions around the marina for the storm events. Further to this, beach profile data collected by the Department of Environment and Water (DEW) was analysed and applied to the regions examined by the volumetric analysis to determine more accurate sedimentation rates based on cross-shore regions of sediment accumulation.

The following bathymetric surveys were provided by Maritime Constructions for analysis as part of this study:

- 16th December 2023: a pre-dredging survey prior to the dredging undertaken in early 2024.
- 13th March 2024: during dredging survey to track the progress of maintenance dredging.
- 17th May 2024: post-dredging survey following completion of the 2024 maintenance dredging campaign.
- 15th November 2024: pre-dredging survey, which shows the high sedimentation which occurred from May to November 2024 (inclusive of Aug/Sept 2024 storm).
- 19th December 2024: post-dredging survey to show the bathymetry following the dredging to reinstate the Marina entrance channel:
- 20th February 2025: pre-dredging survey prior to proposed maintenance dredging in 2025.

Digital Elevation Models (DEMs) with a 1 m rectilinear grid resolution were created by interpolating the bathymetric data from the available surveys. The change in bathymetry between sequential surveys was calculated to determine the volumetric changes due to natural sedimentation and due to maintenance dredging. For ease of reference, nine polygons (zones) were defined for the volumetric change analysis, as shown in Figure 3. Refer to [Section 5.3.2.1](#) for a summary and to the PCS technical note (attached) for the details of these volumetric changes.

There are five DEW beach monitoring profiles around the Cape Jaffa Marina (see Figure 6). These cross-shore profiles have been used to collect beach elevation changes since 2006 and were analysed relative to the volumes of sediment accretion/erosion identified through the bathymetric analysis.



Figure 3. Polygons (zones) used to calculate volumetric changes in bathymetry.

5.3.1.2 Spectral Wave Modelling

PCS has an existing model of Lacepede Bay which was refined for this study. The model utilises the MIKE software suite by the Danish Hydraulics Institute, which is internationally recognised as state-of-the-art and has been adopted elsewhere in Australia and internationally for similar projects. The Spectral Wave (SW) module has been adopted for this study, allowing for the growth, decay, and transformation of wind-generated and swell waves in both offshore and coastal environments. The MIKE SW module allows for a flexible mesh to be varied throughout the model domain. Higher resolution (approximately 30 m) was applied at Cape Jaffa and coarser resolution offshore.

The existing PCS SW model of Lacepede Bay is driven using measured wave data from the Cape de Couedic waverider buoy as well as local wind data. The model bathymetry comprised of the following datasets: Cape Jaffa Marina bathymetric survey provided by Maritime Constructions; DEW beach profile data (Figure 6); digitised data from navigation charts; and bathymetric grid of Australia data from Geoscience Australia. The boundary conditions for the SW model (i.e., the incident wave, wind, and water level conditions applied to the edges of the model) were derived from the Cape du Couedic waverider buoy, and supplemented with wave directions from the Collaboration for Australian Weather and Climate Research (CAWCR) hindcast model. The SW model applied spatially uniform, time varying winds based on the measured data at Cape Jaffa. Additionally, a spatially uniform, time varying water level (based on measured water levels from Victor Harbor) was also applied.

Results from this model was used to provide input wave conditions for the beach profile modelling and to provide nearshore wave conditions to help determine the ARI of any storm events over the last 10 years. The model was used to simulate three ARI events:

- (1) a 10-year ARI wave height event;
- (2) a 100-year ARI wave height event; and,
- (3) a 10-year ARI wave height event combined with a 100-year ARI wave duration event.

The SW model conditions under these ARI events were used as boundary conditions for the beach profile modelling, to help predict longshore transport rates and potential sand accumulation at the marina for those events.

5.3.1.3 Beach Profile Modelling

The LP suite of tools developed by the Danish Hydraulics Institute were adopted to simulate sediment transport along the beach and how it varies. LP offers comprehensive coastal modelling tools which enable the simulation of intricate littoral processes and coastline evolution, making it ideal for evaluating and designing coastal management strategies.

A series of six cross-shore beach profiles was setup along the shoreline around the marina, extending 650 m to the west and to the east (Figure 4). Longshore transport rates were then simulated by adopting wave conditions derived by the SW model and bathymetric conditions from the 2024 DEW beach profile survey data. The sediment sampling (discussed in [Section 4.2.2.1](#)) showed that the PSD did not vary significantly in the region and as such, a D_{50} of 250 μm was adopted for all the profiles.

The modelled longshore transport rates were validated based on the bathymetric analysis of sediment accumulation between May and November 2024. Following model validation, longshore transport rates at the six cross-shore beach profiles (Figure 4) were modelled over the 10-year hindcast period (2015–2025) and for the three ARI events outlined above to help understand how longshore transport can vary during large wave events.

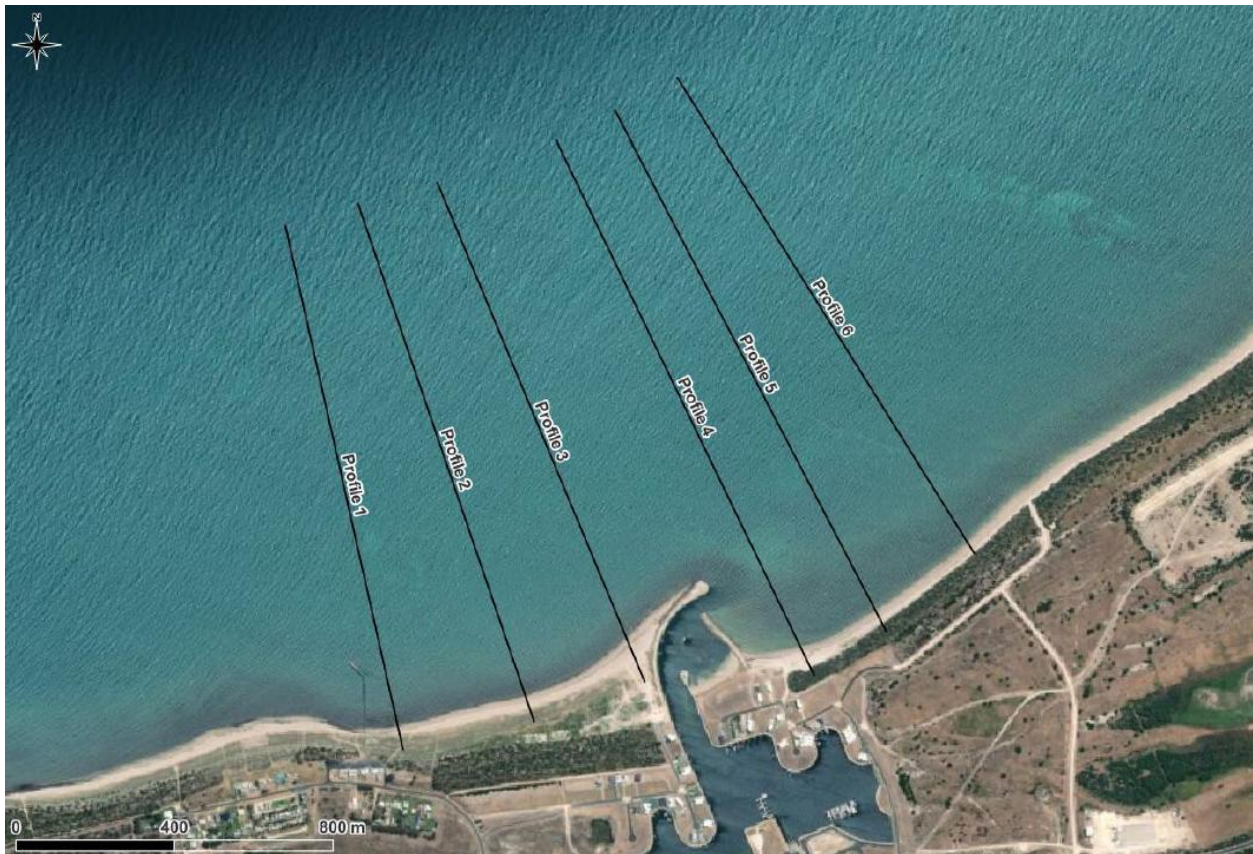


Figure 4. Locations of the six cross-shore beach profiles used for the longshore transport modelling.

5.3.2 RESULTS

5.3.2.1 Bathymetric Analysis

The volumetric changes are shown in Table 5, for periods when maintenance dredging was undertaken, and Table 6, for the periods without dredging operations. These tables reflect the following results:

- The maintenance dredging undertaken from January to May 2024 removed approximately 50,000 m³. However, the December 2023 survey did not cover any of the beach area to the west of the breakwater where the March 2024 survey shows extensive deepening occurred over a 10,000 m² area. A direct volumetric comparison is therefore not possible in this area, but could equate to 30,000 to 40,000 m³ if 3–4 m of deepening occurred.
- The Nov–Dec 2024 dredging campaign was much more localised than previous dredging, due to the Aug/Sept 2024 storm effects. Dredging during this campaign was predominantly focused at the east breakwater and in the marina entrance (Figure 3). Approximately 15,000 m³ was removed by dredging over this period.
- Extensive sedimentation to a total of approximately 115,000 m³ occurred between May and November 2024. This deposition occurred to the west of the western breakwater and in the entrance to the marina. Approximately 5,000 m³ of erosion occurred over the 100 m length of beach to the east of the marina due to a deficit in sediment supply through longshore transport during this same period.
- A net loss of sediment was experienced between December 2024 and February 2025, where the only region experiencing sedimentation was the east breakwater

(Figure 3; where maintenance dredging had recently been undertaken), with sedimentation of approximately 2,000 m³.

Figure 5 visualises the change in bathymetry around the Cape Jaffa Marina between May 2024 and November 2024 due to the large sedimentation event that occurred during the Aug/Sept storm. Up to +4 m of change is shown in the West Beach01, West Beach02, West Breakwater, East Breakwater, and Marina Entrance regions (Figure 3; Figure 5). Change of -3 to -4 m is shown in region East Beach01 (Figure 3; Figure 5), illustrating the erosion that is occurring due to disruption of longshore transport. Refer to the PCS technical note for further visualisations of bathymetry changes between sequential surveys.

Table 5. Change in *in-situ* volume (m³) due to maintenance dredging.

Region (Figure 3)	Dec 23 to Mar 24	Mar 24 to May 24	Nov 24 to Dec 24
West Beach01		-1,834	657
West Beach02		-20,978	313
West Breakwater	-2,023	-108	40
East Breakwater	-5,047	78	-5,595
Marina Entrance	-389	-24	-8,023
Entrance Channel	-4,282	-11,244	-1,720
Inner Marina	-4,031	-1,569	14
East Beach01			910
East Beach02			
Total	-15,772	-35,679	-13,404

Table 6. Change in *in-situ* volume (m³) due to maintenance dredging.

Region (Figure 3)	May 24 to Nov 24	Dec 24 to Feb 25
West Beach01	7,769	176
West Beach02	37,529	-133
West Breakwater	26,953	-277
East Breakwater	12,244	2,080
Marina Entrance	20,019	-1,581
Entrance Channel	10,027	-913
Inner Marina	1,573	-42
East Beach01	-5,272	-420
East Beach02		-347
Total	110,843	-1,456

Based on the volumes of sediment accretion and erosion identified through the volumetric analysis, the DEW beach profiles relative to the large sedimentation event that occurred between May and November 2024 is shown in Figure 6. Two profiles are located to the west of the marina where high sedimentation has historically occurred, and three profiles are located to the east of the marina where erosion has historically occurred.

Analysis of each profile revealed that changes to the cross-shore profile are predominantly above -2 m AHD, with limited changes occurring further offshore. Based on this, the change in beach profile area above the -2 m AHD level has been calculated between the sequential bathymetric surveys and this has been used to estimate the

volumetric changes across the beach (assuming each profile is representative of a certain width of beach).

Combining the results for profiles 715054 and 715050, to represent the 400 m length of beach adjacent to the western breakwater, shows that sedimentation of approximately 40,000 m³/y occurred on average between 2006–2010 and 2016–2017. Sedimentation of approximately 10,000 m³/y occurred between 2017 and 2018, although it is possible that some sediment management could have occurred over this period.

Combining the results for the profiles to the east of the marina (715051, 715052, and 715053), to represent the 800 m length of beach immediately to the east of the marina, show that erosion of 23,000 m³/y occurred between 2010 and 2011, and 27,000 m³/y occurred between 2017 and 2018. It should be noted, however, that years of lower erosion rates have occurred, with 6,000 m³/y eroded between 2015 and 2016.

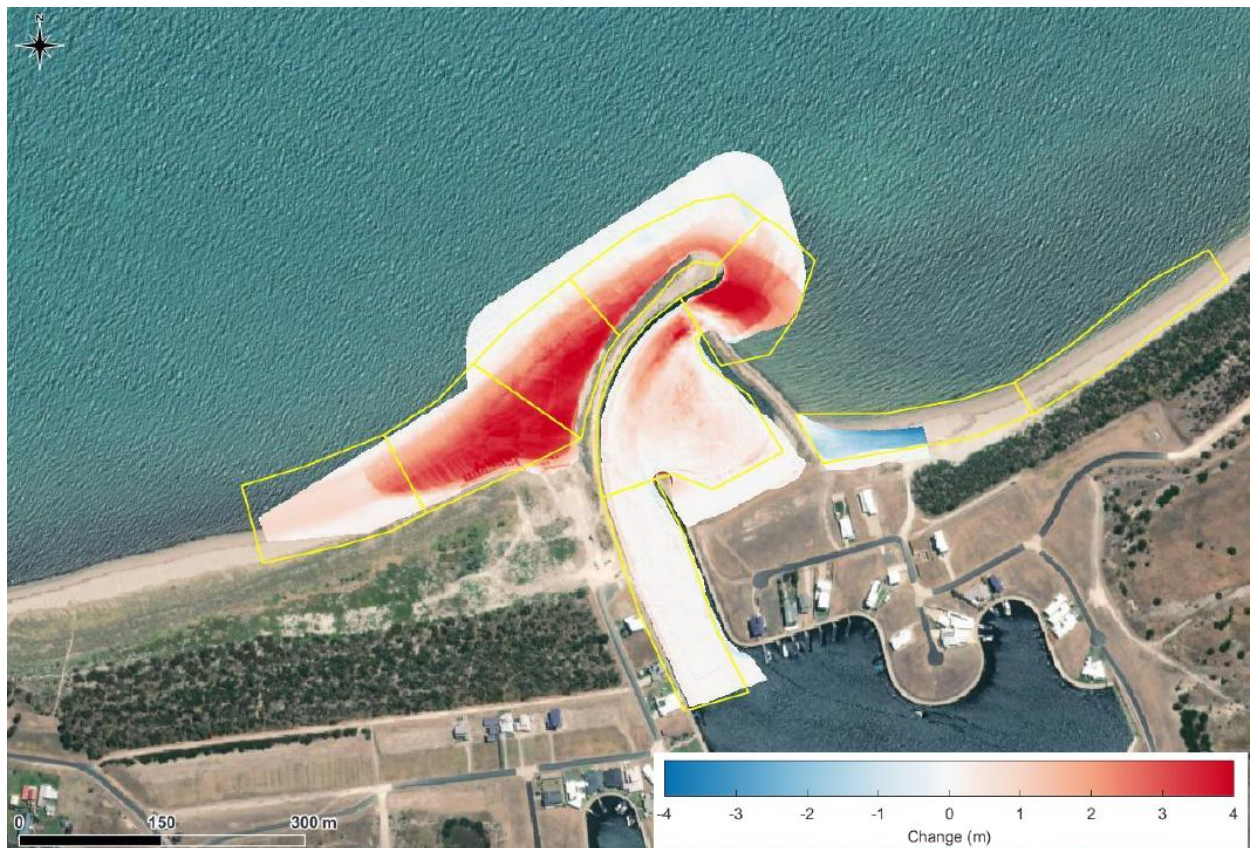


Figure 5. Change in bathymetry around Cape Jaffa Marina between May 2024 and November 2024 due to large sedimentation event.

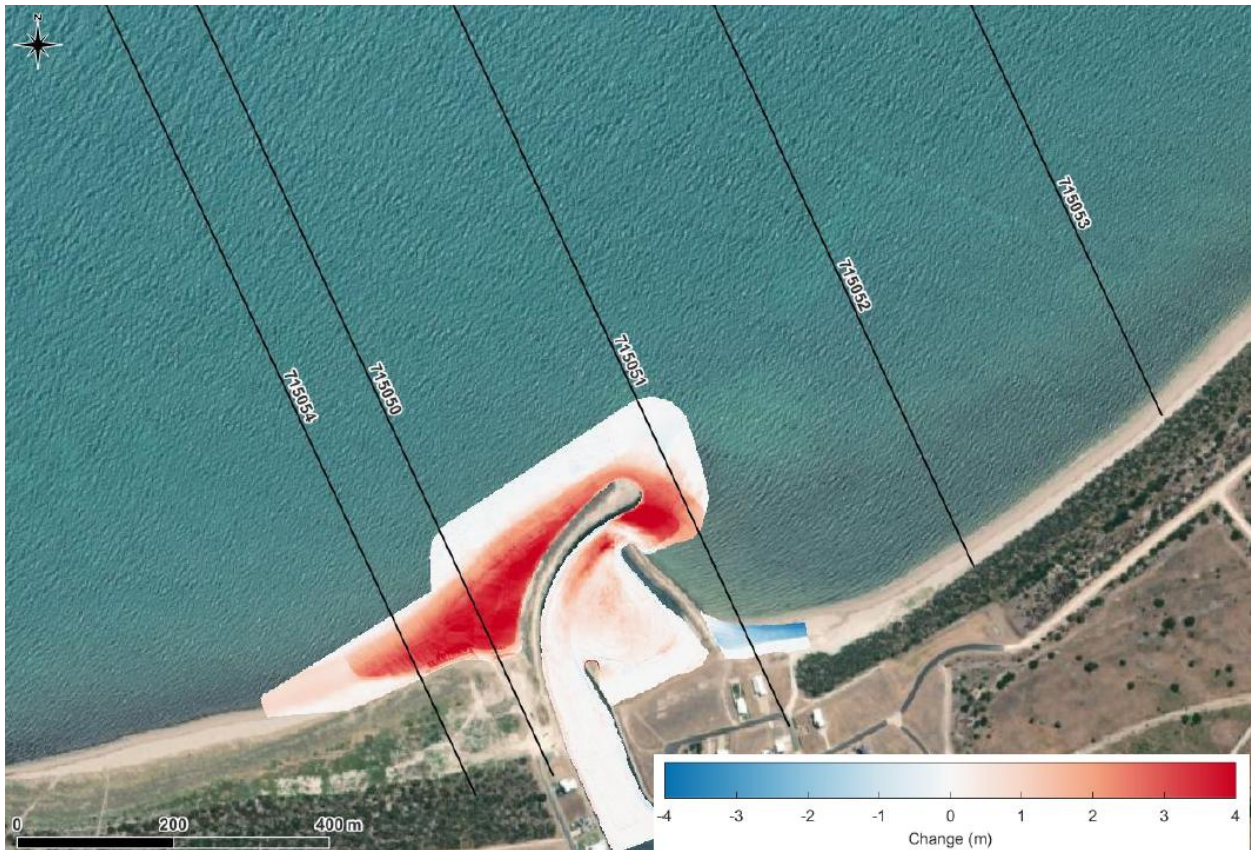


Figure 6. Locations and names of DEW beach profiles relative to the high sedimentation which occurred between May and November 2024.

5.3.2.2 Spectral Wave Modelling

Long-term Wave Climate

Wave conditions were extracted from three locations around Cape Jaffa:

- P01 is located approximately 5.5 km northwest of the marina with a bed level of -12 m AHD;
- P02 is located approximately 1.2 km north of the marina with a bed level of -5 m AHD; and,
- P03 is located 150 m north of the marina with a bed level of -2.5 m AHD.

Wave conditions over the 10-year simulation extracted from P01 show that significant wave height (H_s) is typically between 0.5 and 2.5 m with waves > 2.5 m only occurring during larger wave events. There is a clear seasonal trend to the wave heights, with larger waves occurring during the winter and smaller waves during the summer. The peak wave period (T_p) is typically between 5 and 15 seconds, which is indicative of swell wave dominance. Dominant wave direction at P01 is from the west, which aligns with the direction of swell waves generated in the Southern Ocean.

The largest H_s over the 10-year simulation period occurred at the start of September 2024 ($H_s \geq 4.5$ m), while the second largest occurred in July 2016 with a H_s just below 4.5 m. Comparison between these two wave events shows that the September 2024 event had a much longer duration of elevated wave heights (threshold set arbitrarily at 2.5 m based on visual assessment of wave events) at 175 hours, compared to the July 2016 event

which had a duration of 42 hours. In terms of longshore transport, the duration of a wave event is very important as it represents the duration when increased sediment mobilisation and transport can occur.

Comparisons of H_s and wave direction between P01, P02, and P03 show that the offshore waves decrease substantially in height and change dominant direction due to refraction from west to northwest. This aligns with the coastal processes identified in the EIS (see [Section 4.2](#)). Furthermore, the modelled H_s at P01 for a 100-year wave height ARI is substantially larger than the modelled H_s at P01 for a 10-year wave height ARI. However, the wave heights for these two ARI events return similar H_s at P02 and P03, showing that the waves become depth limited as they are attenuated in the shallower water of Lacedpede Bay.

ARI Wave Conditions

An extremes analysis of the modelled H_s over the 10-year simulation at P01 was undertaken to better understand extreme wave conditions in the region. This analysis is to inform the sediment transport assessment only. The wave events with the largest wave heights were identified and the duration that $H_s > 2.5$ m was calculated for each identified event. The largest 10 wave events are detailed in Table 7. These results show that the September 2024 wave event resulted in the largest wave height and longest duration of $H_s > 2.5$ m, with the duration being almost double any of the other 10 largest wave event durations. In addition, the third largest wave event and second longest wave height duration event over the 10-year period also occurred in 2024 (July), showing that 2024 can be considered a very energetic year in terms of wave conditions.

The ARI for the H_s and wave event durations ($H_s > 2.5$ m) were calculated and are shown in Table 8. The ARI conditions indicate that the September 2024 wave event was between a 10 to 25-year ARI based on peak H_s , but was between a 100 and 200-year ARI based on the duration of time H_s remained above 2.5 m. The July 2024 event was approximately a 5-year ARI event based on both peak H_s and the duration of time the H_s remained above 2.5 m. This further highlights how extreme the wave conditions were in 2024.

Table 7. The 10 largest modelled wave events over the 10-year simulation period at P01.

Date and Time	Peak H_s (m)	Duration $H_s > 2.5$ m (hrs)
01/09/2024 05:00	4.66	175
12/07/2016 19:00	4.45	42
19/07/2024 23:00	4.40	94
23/07/2019 11:00	4.21	46
07/07/2023 22:00	4.18	78
14/04/2018 09:00	4.16	43
29/09/2016 18:00	4.13	31
16/06/2023 10:00	4.09	84
08/08/2019 19:00	4.07	41
04/06/2022 22:00	4.01	46

Table 8. ARI H_s (m) and wave duration ($H_s > 2.5$ m; hrs) at the P01 model output location.

ARI	Peak H_s (m)	Duration $H_s > 2.5$ m (hrs)
1	4.03	61
5	4.38	97
10	4.53	113
25	4.72	134
50	4.86	151
100	5.00	168
200	5.14	185
500	5.32	208

Note: the ARI conditions for the H_s and wave duration are independent from each other and not part of a joint probability analysis.

5.3.2.3 Beach Profile Modelling

Long-term Transport Rates

As expected, the longshore transport modelling showed dominant easterly transport, with very little transport occurring in a westerly direction. The modelled longshore transport rates vary between the six beach profiles (Figure 4) and also vary along (cross-sectionally) the beach profiles.

These results show that for all the profiles the longshore transport is only predicted to occur close to the shoreline between the 1 m and -2 m AHD levels, with the peak longshore transport rate predicted to occur around the -0.5 m AHD level. This result is in agreement with the calculated changes to the bathymetry ([Section 5.3.2.1](#)) which showed that the changes occurred close to the shoreline above the -2 m AHD level.

To understand how the longshore transport varies between the years, the easterly longshore transport rates for each year of the 10-year simulation was determined for the six cross-shore profiles (Figure 4; Figure 7). It should be noted that Profile 4 is removed from these results as it is located immediately to the east of the marina breakwaters and these structures would block any wave action from a north-westerly direction thus blocking any sediment transport in this leeward zone. Figure 7 shows the following:

- There is a reduction in longshore transport rate from Profile 1 to Profile 3, with approximately twice as much transport predicted at Profile 1 compared to Profile 3. This indicates a substantial build-up of sand in the area from the jetty to the western marina breakwater, which aligns with observations of the western beach since the marinas construction in 2008. The longshore transport rate predicted at Profiles 2 and 3 are representative of the build-up of sand around the western breakwater and at the entrance to the marina.
- The longshore transport rates predicted at Profiles 5 and 6 are similar, with slightly higher rates predicted at Profile 5. These rates are significantly lower than the longshore transport rates predicted on the western side of the marina, predominantly due to the change in shoreline alignment blocking sediment transport. The longshore transport rates at these two profiles varies between ~20,000 m³/y to 44,000 m³/y.
- There is significant annual variability in the longshore transport rates, with the predicted transport during 2024 (the year with the highest transport rates) being more than double the predicted transport during 2015 (the year with the lowest

transport rates). Transport rates at Profile 3 during 2023 and 2024 were predicted to be 88,000 and 114,000 m³/y, respectively.

The majority of the longshore transport is predicted to occur during the 6 months around winter (May to October), as this is when larger waves occur. At Profile 3, immediately to the west of the marina, the annual average longshore transport rate over the 6 months around summer (November to April) was ~20,000 m³ compared to the 48,000 m³ predicted over the 6 months around winter.

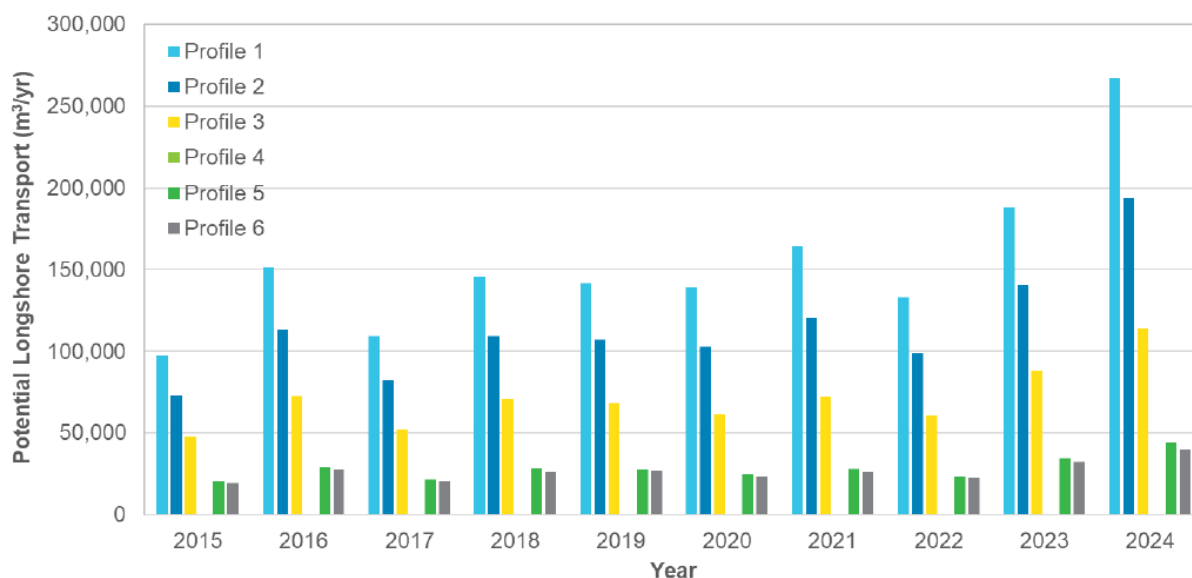


Figure 7. Modelled annual net easterly longshore transport over the 10-year simulation period at the 6 cross-shore profiles.

ARI Wave Event Transport

The 10-year simulation predicted that the highest longshore transport occurred during 2024, with the second largest transport predicted to have occurred in 2023. These two years occurring concurrently would result in significantly more sedimentation occurring in the marina region compared to other two-year periods over the 10 years.

To understand how much of the longshore transport which occurred over 2024 was due to the single largest wave event (September 2024), the longshore transport predicted to occur between mid-August and mid-September 2024 was calculated for each profile (Figure 4). The predicted longshore transport rates over this event represented between 37% (Profile 1) and 25% (Profile 6) of the total annual rate for 2024, with predicted transport rates as follows:

- Profile 1: 100,000 m³;
- Profile 2: 70,000 m³;
- Profile 3: 36,000 m³;
- Profile 5: 12,000 m³; and,
- Profile 6: 10,000 m³.

To better understand how the longshore transport rates vary depending on the offshore wave height and the event duration, the models were setup to simulate the transport over

a 10-year ARI H_s event (80-hour duration), a 100-year ARI H_s event (80-hour duration), and a 10-year ARI H_s event combined with a 100-year ARI wave duration (168-hour duration). The total predicted easterly longshore transport for these three events is shown in Figure 8. This result shows an increase in predicted longshore transport rates of approximately 10% for the 100-year ARI H_s event compared to the 10-year ARI H_s event. At Profile 2, the predicted longshore transport rate for the 10-year ARI H_s event was 37,600 m³, while the 100-year ARI H_s event predicted 42,400 m³.

When the duration of the 10-year ARI H_s event is increased from a typical duration (80 hours) to a 100-year ARI duration (168 hours), the predicted longshore transport rate more than doubles. This is evidenced at Profile 2 with an increase from 36,600 m³ to 76,000 m³ (Figure 8). These results therefore highlight how the duration of time a wave event lasts, as opposed to the magnitude of the wave event, has a larger influence on the longshore transport rates and therefore the potential for sand accumulation at the Cape Jaffa Marina.

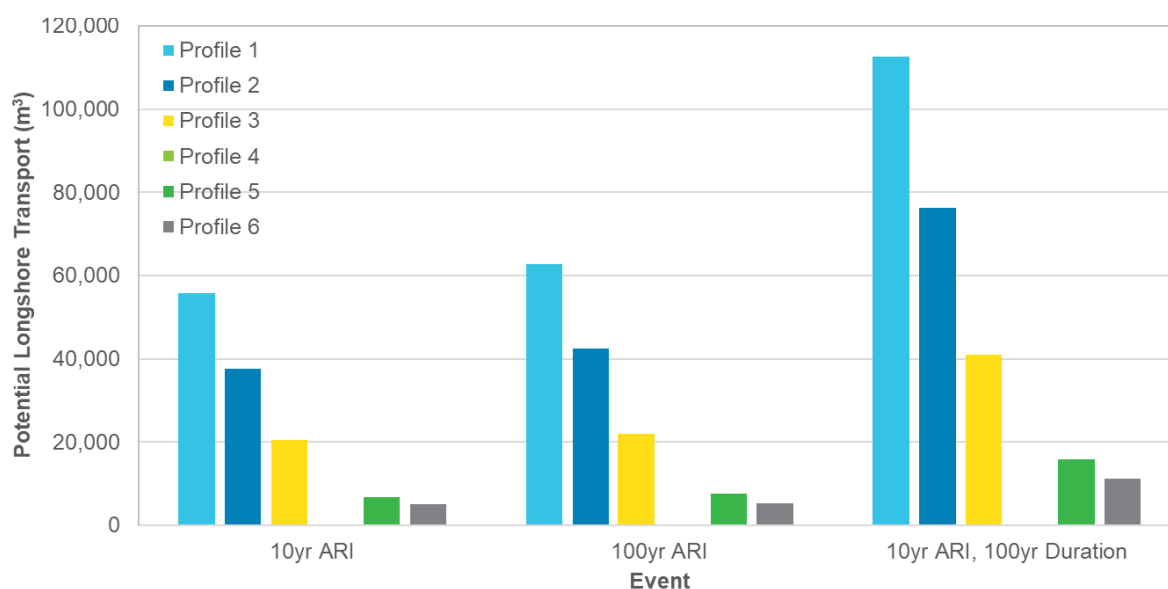


Figure 8. Modelled net easterly longshore transport during three different wave events at the 6 cross-shore profiles.

5.3.2.4 Future Sedimentation Rates

The numerical modelling has shown that the annual longshore transport rate is more dependent on the duration of time that larger waves occur than the absolute magnitude of the event. Sensitivity analysis was conducted to determine the correlation between the duration a wave event exceeds heights of 3–4 m, and the predicted longshore transport rates. This analysis showed that the longshore transport rate, and therefore the potential sand which could require management around the Cape Jaffa Marina, can be estimated based on the wave conditions offshore of Cape Jaffa.

The longshore transport at Profile 2 (Figure 4) represents the sand which is predicted to be transported within 500 m of the western breakwater, where occasional maintenance may be required. The longshore transport at Profile 3 (Figure 4) can be considered to represent the sand predicted to be transported within 150 m of the western breakwater

and along the breakwater. The longshore transport at Profile 5 (Figure 4) can be considered to represent the minimum sand requirement for the eastern beach to limit the ongoing erosion. A summary of the results at each of the three profiles is provided below:

- Profile 2: during a typical year in the order of 70,000 to 120,000 m³/y of sand is predicted to be transported, with the potential for more than 150,000 m³/y during a year with extreme wave conditions.
- Profile 3: during a typical year in the order of 50,000 to 70,000 m³/y of sand is predicted to be transported, with the potential for more than 100,000 m³/y during a year with extreme wave conditions.
- Profile 5: during a typical year in the order of 20,000 to 30,000 m³/y of sand is predicted to be transported, with the potential for more than 40,000 m³/y during a year with extreme wave conditions.

Overall, these numerical modelling results agree well with the sedimentation estimated based on bathymetric changes calculated using the hydrographic surveys and the DEW beach profiles (see [Section 5.3.2.1](#) and Figure 6).

The wave modelling has shown that two out of the ten years simulated had much higher transport rates compared to other years. To represent a longer duration of time, the measured wave data at the Cape du Couedic waverider buoy was analysed to derive similar threshold duration exceedances as at P01 for the 2015 to 2024 period, and then the entire 24 years of data were analysed. These values were then used to estimate annual longshore transport at Profile 2, 3, and 5 (Figure 4) from 2001 to 2024 to provide a better long-term indication of the annual variability in transport.

The results indicate that in the order of 2.76 million m³ of longshore transport can occur over 24 years. On average, longshore transport rates at Profile 2 are 115,000 m³/y, at Profile 3 are 72,000 m³/y, and at Profile 5 are 28,000 m³/y. This can be used to estimate the future ongoing transport **over 10 years** and therefore sedimentation or erosion as follows:

- Total sedimentation predicted to occur within approximately 500 m of the western breakwater is in the order of 1,150,000 m³.
- Total sedimentation predicted to occur within 150 m of the western breakwater and along the breakwater is in the order of 720,000 m³. This sedimentation will require ongoing maintenance to ensure the marina entrance remains operational. The ongoing maintenance of this area may limit the requirement for maintenance further to the west.
- Total erosion predicted to occur on the eastern beach is 280,000 m³.

6 POST STORM INSPECTION

An onsite inspection of the Cape Jaffa marina and adjacent coastal areas was undertaken by Magryn on 14th June 2025, following the large storm surge event that occurred in late May (Figures 9 and 10). The purpose of the inspection was to assess the post-storm sediment dynamics, entrance condition, and effectiveness of the existing sand trap in preventing channel infill.

Key observations are summarised below:

- The sand trap west of the breakwater has completely filled.
- Western beach sediment has built up to within approximately 40 m of the breakwater tip. This level of accumulation poses a near-term risk of sediment entering the marina entrance channel.
- Shoaling was observed off the end of the breakwater, suggesting that bypassing sand is beginning to intrude into the navigable channel area. While access remains possible at the time of inspection, another moderate storm event may cause partial blockage, limiting marina usability.
- A substantial volume of seagrass wrack was observed deposited on top of the breakwater. This was reportedly stockpiled on the breakwater by Council, as part of maintenance works.
- The dredged material from the previous campaign was observed to be stockpiled on the upper beach west of the breakwater. As discussed further below in section 7, this would result in wind-blown transport back into the system.

These observations indicate that emergency dredging is required as a matter of priority. However, the feasibility of deploying marine-based plant during winter months may be limited by sea conditions and contractor availability.

A proactive scheduling approach is recommended to initiate dredging as soon as practicable, before further sediment mobilisation occurs.



Figure 9. Photo of breakwater looking east, at low tide on June 14th.



Figure 10. Aerial photo of breakwater at low tide on June 14th.

7 OPERATIONAL CONSTRAINTS

As part of preparing this strategy, Magryn consulted with Maritime Constructions, who have undertaken multiple dredging campaigns at Cape Jaffa. Their input has informed the refinement of key recommendations and clarified several operational constraints and logistical considerations that should shape how the strategy is implemented in practice.

7.1 VOLUME AND RECOVERY EXPECTATIONS

Maritime Constructions estimate that approximately 500,000 m³ of accumulated sand would need to be removed over multiple years to return the beach system to an equilibrium state that reduces bypassing into the entrance channel. This volume reflects years of longshore transport buildup since the marina's construction and cannot feasibly be removed in a single campaign.

Accordingly, the strategy should be viewed as a staged recovery program, likely spanning several years, with each campaign targeting 70,000–100,000 m³ depending on conditions and trap availability.

7.2 TRAP LIMITATIONS AND DREDGING SEQUENCING

Maritime Constructions advised that the cutter suction dredge (CSD) can only remove a limited volume from a given trap area before needing to pause. Once material is removed, the trap must refill with newly transported sand before further dredging in that zone is viable. This limits the efficiency of repeated dredging in the same footprint without adaptation.

Two options were proposed to address this:

- Expand the sand trap footprint, to allow for sequential dredging in adjacent zones.
- Begin removing sand from the southern section of the western beach (within 1 km of the marina) using land-based equipment such as long-reach excavators and truck haulage.

These measures could allow higher annual removal rates and help reduce long-term infill pressure.

7.3 DREDGING TIMING AND SEASONAL CONSTRAINTS

The ideal time for dredging is during summer, when conditions are more stable and sea states are calmer. Winter months bring more frequent northerly winds and swells, reducing available dredging windows and increasing operational hazards.

However, if necessary, the dredge can be positioned on the eastern side of the breakwater, where it is partially protected from wave energy, allowing some degree of winter operation.

7.4 MATERIAL PLACEMENT AND WIND TRANSPORT ISSUES

During the last dredging campaign, logistical issues in trucking material from the western beach to the eastern placement area resulted in sand being temporarily stockpiled on the upper western beach. This created unintended consequences, as sand was blown back into the trap area via wind-driven transport, undermining the effectiveness of the dredging effort.

Future campaigns should prioritise direct transfer to the eastern beach (or designated placement areas), to avoid reintroduction of dredged material into the sediment transport loop.

7.5 MOBILISATION DELAYS AND THE ROLE OF MONITORING

The dredge used at Cape Jaffa is also committed to other sites, meaning it is not available on short notice. Mobilisation typically involves a delay of weeks, which makes it challenging to respond rapidly when triggers are hit (e.g. post-storm infill).

This limitation reinforces the importance of regular monitoring and predictive planning, ensuring that dredging campaigns can be scheduled in advance, rather than relying on emergency response.

8 **MANAGEMENT OBJECTIVES**

This section defines the purpose, performance targets, and critical success criteria that guide the Cape Jaffa Sand and Dredge Management Plan. These criteria form the benchmark for assessing dredging effectiveness and informing adaptive changes to the management plan. Generally, the success criteria align with the recommendations provided in the 2017 Guidelines for the Dredging Methodology.

8.1 DESIRED OUTCOMES FOR THE MARINA

Modelling undertaken for this study predicts that the coastal sediment transport regime will continue to deliver substantial volumes of sand toward the Cape Jaffa marina for the foreseeable future. Specifically, over 720,000 m³ of sediment is expected to accumulate within 150 m of the western breakwater and along the entrance channel over 10 years, based on historical transport rates of up to 115,000 m³/year near the entrance.

This volume of material presents an ongoing infill risk that will not resolve without sustained intervention.

Accordingly, the dredging strategy outlined in this plan is not limited to a fixed 10-year window, but should be viewed as a long-term, adaptive maintenance program.

Short-Term Objectives:

- Maintain safe, navigable depths in the marina access channel year-round.
- Prevent sediment bypass around the tip of the western breakwater.
- Intercept the majority of sand transport via a defined sand trap.
- Place dredged sand on the eastern beach to mitigate ongoing erosion.

Long-Term Objectives:

- Achieve a sustainable sand management cycle (reduced frequency and volume).
- Return the western beach to a near pre-construction alignment.
- Maintain a balanced sediment budget between the western and eastern beaches.
- Minimise the need for emergency dredging through predictive monitoring.
- Reduce operational costs through improved scheduling and equipment efficiency.

8.2 SUCCESS CRITERIA

Performance criteria for the sand management have been defined, and are summarised in Table 9, below:

Table 9. Success Criteria.

Objective	Target Metric	Assessment Method
Maintain navigable entrance	Channel Depth/Level	Biannual bathymetric survey
Intercept sand before bypass	No visible spit into channel	Aerial photography + field survey
Maintain effective sand trap	Trap depth in AHD pre-dredge	Bathymetric trigger survey
Nourish eastern beach	m ³ /year sand placement	Dredge logs + profile comparison
Respond to storm infill	Dredging within 1–2 months post-event	Trigger-based monitoring response

9 RECOMMENDED MANAGEMENT STRATEGY

The purpose of this Sand and Dredge Management Plan is to provide a clear, evidence-based framework for managing sediment accumulation and coastal processes at Cape Jaffa Anchorage. The plan builds upon earlier sand management strategies and integrates updated bathymetric survey data, sediment transport modelling, and operational experience. Its aim is to protect the function and access of the marina, sustain the surrounding coastal environment, and support cost-effective long-term maintenance. The report does not replace previous strategies and dredging guidelines provided, but rather builds on and refines. In particular, the Dredge Management Methodology Guidelines (Magryn, 2017) provides further details and specific requirements for dredging, including licenses, survey and water quality monitoring (beyond the scope of this report).

All recommendations in the previous reports still apply and should be read in conjunction with this report. The key update this report brings is the refined dredging volumes and frequency based on the modelling and volumetric analysis.

This plan is guided by the following key principles:

- **Proactive, not reactive** – Management actions are to be triggered based on monitoring thresholds and predictive modelling, rather than emergency response.

- **Interception before entry** – Sediment transport is to be intercepted west of the marina entrance using a defined sand trap, reducing the likelihood of infill within the navigable channel.
- **Sediment nourishment** – Sand removed from the western beach is to be reused to nourish the eastern beach, helping to address erosion and maintain the natural sediment budget.
- **Scalable and adaptive operations** – The plan accommodates varying dredging volumes and timing, allowing for flexibility across different energy years (e.g., storm-dominated vs calm years), and can be adapted over time based on ongoing monitoring results.
- **Operational practicality based on proven methods** – The use of both marine and land-based dredging methods provides options for seasonal, tidal, and environmental constraints.

The following alternative/additional adaptation options have been considered unfeasible for the sand management at the Cape Jaffa Marina and are briefly summarised in Table 10, below.

Table 10. Alternative and/or additional adaptation options for management of sand at the Cape Jaffa Marina.

Adaptation Option	Justification
Removal of marina's breakwaters entirely	Whilst this option may theoretically resolve the sedimentation issue to the west of the marina, removal of the breakwaters would expose the marina to open coastal conditions, making it unsafe and effectively unviable for its intended recreational and commercial use. As such, this option is considered unfeasible and the breakwaters are considered critical infrastructure with all management strategies designed to work within their existing footprint.
Installation of groynes to the west of the marina	The installation of groynes along the beach to the west of the marina may impede the sediment transportation arriving from the Southern Ocean and travelling to the east along Lacedepede Bay. Sediment accretion to the west of these groynes and sediment starvation to the east of these groynes is anticipated. Without sand management at these areas, the sand will build up against the groynes before spilling out to the east, towards the marina. Whilst this option may temporarily impede the sediment building up along the western breakwater, sand management would still be required at the breakwater (to manage the groyne spill-over), and/or at the groynes. Furthermore, prevailing waves from the north-west in the region would still mobilise sand between the groynes and marina, thus sedimentation at the marina would still be an occurrence.

Offshore artificial reef/submerged breakwater	This option has not been assessed within the scope of this project. Cape Jaffa has a relatively calm wave environment due to dissipation of wave energy, and it is the high wave energy events and years that are mobilising large volumes of sand leading to sedimentation at the marina. In these high wave energy events, an artificial reef or submerged breakwater would be ineffective at dissipating wave energy without being a substantially large structure. This is considered to carry significant environmental risks, be extremely costly, and also disruptive to maritime navigation given the commercial and recreational use of the marina. It would also interfere with natural sediment transport pathways, potentially leading to unintended accumulation or erosion in adjacent areas. Hence, this has thus been discounted as a feasible option.
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9.1 INITIAL MANAGEMENT ACTIONS (YEARS 1–5)

During the first few years of implementation, the strategy focuses on high-frequency intervention to manage accumulated sand. A substantial volume of sediment must be removed over several years to draw down the western beach and re-establish the trap's function. This will require a mix of marine-based and land-based excavation, potentially extending beyond a five-year horizon.

Drawing on past studies and the modelling results (PCS technical note), key actions include:

- Maintain a defined sand trap west of the breakwater at a depth of -2.0 m AHD (nominally 15,000 – 20,000 m² sand trap area with an average depth of approximately 3-4 m below seabed; 60,000 m³ total storage capacity).
- Refer to the below dredging management layout plan.
- Dredge 150,000 m³ per year, including 60,000 m³ for the sand trap, and further dredging along the beach to the west. This ensures capacity for an extreme short-duration accumulation of sediment to occur (including some buffer) without impacting the marina entrance channel.
- Use cutter suction dredge (CSD) or land-based excavators and trucks, depending on tide and access.
- Cutter suction dredging is limited by how much can be removed from a given area before it must refill. The trap may need to be expanded or shifted westward, or material removed from further along the western beach using land-based plant.

- Dredged sand should be placed directly on the eastern beach where feasible, to mitigate erosion and restore buffer width. Stockpiling on the western beach should be avoided, as wind-blown transport can reintroduce material to the trap.
- Apply clear operational triggers, as outlined below.
- Conduct biannual land/bathymetric surveys and annual review of strategy performance.

9.2 LONG TERM MANAGEMENT AND ADAPTIVE REFINEMENT OVER TIME (YEARS 5 AND BEYOND)

As previously recommended in the Magryn dredge management plans (2017, 2020), in order to balance the ongoing inflow of sand from the west into the western beach over time, the same average amount of sand inflowing must be removed. This can be done as a yearly operation, or, if there is sufficient storage capacity of sand in the western beach, then it can be done every few years.

As the western beach is progressively drawn down and the trap begins to stabilise sediment entry, the management approach can be refined to reduce intervention frequency and improve cost efficiency.

Refinements may include:

- Extending or re-profiling the sand trap further westward/landward.
- If a sufficient buffer is achieved with the dredging in the first few years, reducing dredge frequency to every 2 years, with similar or smaller total volumes (refer table below).
- Adjusting or extending the nourishment placement area east of the marina based on erosion trends and changes in beach capacity.
- Continuing to improve predictive modelling using new monitoring data and refined bathymetry.

9.3 ENVIRONMENTAL CONSIDERATIONS

In addition to its operational and navigational benefits, ongoing sand management at Cape Jaffa has the potential to provide indirect environmental benefits, particularly in relation to the protection of nearshore seagrass meadows. Seagrass is a critical component of the local marine ecosystem, supporting biodiversity, stabilising sediment, and playing a role in water quality and carbon storage. It also contributes to natural wave energy attenuation, providing secondary protection to adjacent coastlines.

One of the potential risks of unmanaged sediment accumulation and bypass around the breakwater is the smothering of nearby seagrass beds by displaced sand, particularly during storm-driven mobilisation events. By intercepting and managing sediment in a defined area, the proposed strategy may reduce the risk of these beds being buried or degraded. While no site-specific ecological studies have been conducted to validate this effect at Cape Jaffa, and this is beyond the scope of Magryn's engineering expertise, it is considered a relevant factor in the broader environmental context of the management plan.

Future refinements to this strategy could benefit from targeted ecological monitoring or collaboration with marine science experts to better understand and quantify these co-benefits.

10 DREDGING VOLUMES AND FREQUENCIES

The required dredging volumes and timing at Cape Jaffa vary depending on wave climate, seasonal sand transport, and storm activity. The strategy is designed to match these variations with flexible but predictable operational targets.

10.1 MODEL-INFORMED VOLUME ESTIMATES

The modelling provided the following estimates for sediment transport (described in further detail in [Section 5](#), above), are shown in Table 11.

Table 11. Modelling Results.

Location	Sediment Transport Estimate
Net longshore transport west of breakwater	~115,000 m ³ /year in typical years
Accumulation within 150 m of entrance	~70,000–100,000 m ³ /year
Storm event mobilisation (1:50–1:100 ARI)	Up to 70,000 m ³ in a single storm event

10.2 DREDGING OPERATIONAL TARGETS

Table 12 presents the dredging operational targets recommended.

Table 12. Dredging Volume Operational Targets.

Condition	Volume Estimate	Frequency	Notes
Typical year	70,000–100,000 m ³	Annual or biennial	Suits average sediment inflow
High-energy / storm year	Up to 150,000 m ³	Emergency campaign as needed	May require rapid response post-event
Low-energy / calm year	50,000–70,000 m ³	Monitor only	Dredging may be deferred if trap below trigger level

Nourishment volumes must also match the absorptive capacity of the eastern beach. Based on beach profile analysis, the eastern beach can accommodate approximately 30,000–40,000 m³/year under typical conditions, and approximately 50,000–70,000 m³ following erosion events.

If the beach cannot receive the full dredge volume, a secondary placement area may be required as previously recommended in the 2017 Guideline. Additional nourishment further along the eastern beach (towards the east) may be viable.

10.3 DREDGING/TRAP LAYOUT PLAN

The following plan (Figure 11) shows the intended layout of the sediment trap, to achieve the target trap area/volume (60,000 cubic metres), and the additional dredging to increase the buffer. The plan reflects the dredging cells shown in the latest pre-dredge survey from Maritime Constructions.

The plan is indicative only, as the beach is dynamic and the extent of the trap with vary.

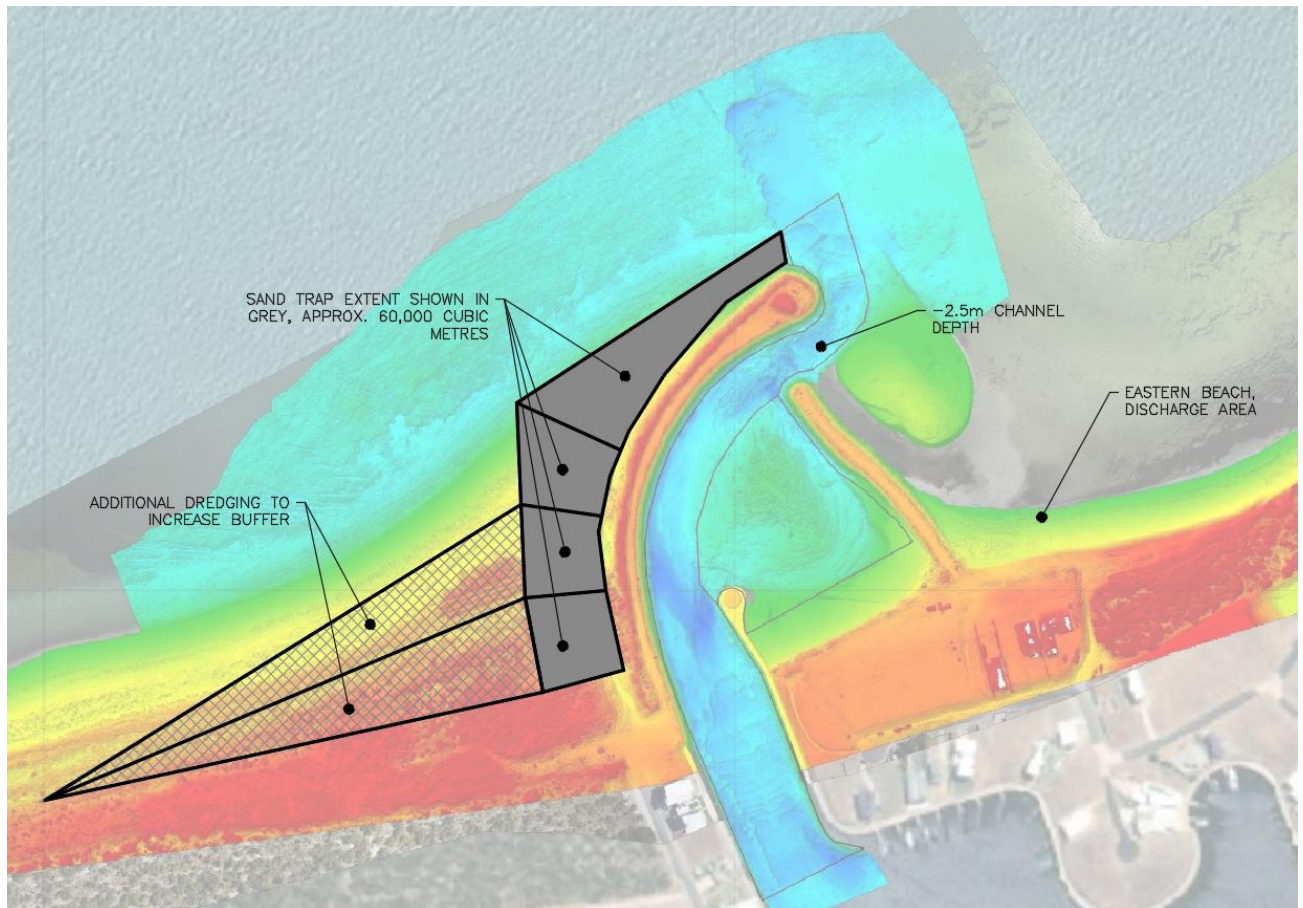


Figure 11. Dredge management layout plan.

10.4 TRIGGERS AND MONITORING PLAN

To ensure a proactive and cost-effective dredging program, management actions should be guided by a set of clearly defined operational triggers. These triggers are based on observable conditions and measured thresholds that indicate when intervention is necessary to maintain navigability and prevent costly emergency responses.

The following three triggers form the basis of the plan's decision-making framework:

1. Trap Fill Depth

- The designated sand trap west of the breakwater is designed to operate at effective depth of -2.0 m AHD.
- When sediment accumulation raises the bed level to -0.5 m AHD or higher (meaning there is 37,500 m³ of volume capacity remaining in the trap, of the

- total 60,000 m³). The capacity of the trap could be exceeded under a single high energy event and become at risk of bypassing sand into the channel.
- This threshold can be monitored using routine bathymetric surveys. When exceeded, it signals that a dredging campaign should be scheduled.
2. Sand Spit Forming at Breakwater Tip
 - Visual or aerial detection of a tongue or spit of sand wrapping around the tip of the western breakwater is a physical indicator that sediment is beginning to enter the entrance channel.
 - This often precedes shoaling in the navigable zone and presents an elevated risk to vessel access.
 - Triggering dredging at this point can prevent the need for more urgent and extensive removal if infill progresses further.
 3. Entrance channel depth
 - The entrant channel depth should be maintained at -2.5m AHD
 - If survey monitoring or anecdotal evidence shows a reduction in channel depth, this is a trigger point that dredging may be required.
 4. Post-Storm Sediment Inflow Events
 - High-energy storm events can rapidly mobilise and transport large volumes of sand toward the marina entrance, particularly when coinciding with elevated water levels or prolonged wave attack.
 - After such events (especially where the storm duration matches 1:10 to 1:100 ARI thresholds) post-event inspections (bathymetry, drone imagery) should be carried out.
 - If significant infill is detected, an emergency dredging trigger is activated, allowing Council to respond quickly before access becomes compromised.

10.5 RISK MANAGEMENT CONSIDERATIONS

Effective implementation of the sand and dredge management strategy requires consideration of key operational, environmental, and strategic risks (Table 13). While the plan is based on the best available data and modelling, variability in coastal processes, weather events, and operational constraints must be actively managed.

Table 13. Risk Assessment Table.

Risk	Description	Potential Consequences	Mitigation Strategy
Storm-driven rapid infill	Large sediment volumes transported during storms	Sudden channel shoaling, unsafe navigation	• Maintain depth buffer in trap (considered low residual risk); • enable rapid post-storm surveys; • allow for emergency dredge mobilisation

Delayed dredging or trigger response	Survey data not acted on in time or delays in contractor availability	Loss of access, increased dredge volumes and cost	- Establish annual schedule with pre-approved contractor; - link surveys to defined triggers; - include emergency clause in contract
Overfilling of eastern beach	Dredged sand exceeds capacity of eastern placement area	Smothering of vegetation, profile steepening, erosion risk	- Monitor beach profile response; - vary placement extent; - contingency placement site
Trap inefficiency	Sand bypasses trap and enters channel before dredge trigger (low risk, given the trap volumes are based on detailed modelling)	Unplanned dredging, navigation hazard	- Adjust trap dimensions and trigger level; - review sediment behaviour annually
Budget constraints	Insufficient funding for recommended volumes or frequency	Reduced effectiveness, risk of emergency-only response	- Advocate for multi-year funding; - Undertake detailed cost planning; - Explore grant opportunities for long-term options
Risks to breakwater	Dredging too close to the breakwater or with steep side slopes may destabilise	Structural damage to breakwater toe, increased wave overtopping	- Maintain adequate offset distance from breakwater during dredging; - ensure batter slopes are stable and not overly steep; - review dredge plans for geotechnical compliance

11 IMPLEMENTATION AND REVIEW FRAMEWORK

11.1 RECOMMENDED IMPLEMENTATION SCHEDULE

This 10-year dredging plan aligns with the modelled sediment transport rates and long-term accumulation forecasts near the Cape Jaffa marina (Table 14). The modelling predicts approximately 720,000 m³ of sand will accumulate within 150 m of the western breakwater and along the channel over a multi-year period.

The plan aims to gradually remove this volume while supporting ongoing nourishment of the eroding eastern beach.

Table 14. Implementation Schedule.

Year	Target Dredge Volume (m ³)	Approach	Notes
2025	150,000	Marine + land-based	Immediate dredge triggered (post-storm); short-term catch-up
2026	150,000	Marine + land-based	Continue removing high-priority accumulation within 150 m zone. Remove material predicted to enter trap; reduce inflow load
2027	90,000	Marine + land-based	Remove material predicted to enter trap; reduce inflow load
2028	80,000	Marine	Routine campaign, informed by monitoring, adjust volume as required
2029	80,000	Marine	Routine campaign, informed by monitoring, adjust volume as required
2030	70,000	Marine	Maintain / monitor
2031	60,000	Marine	Maintain / monitor
2032	60,000	Marine	Maintain / monitor
2033	50,000	Marine	Maintain / monitor
2034	50,000	Marine	Maintain / monitor, and review strategy moving forward

Total estimated removal over 10 years: ~850,000 m³.

This plan should be reviewed annually in line with monitoring data and adjusted based on storm frequency, transport variability, and operational constraints.

11.2 RECOMMENDED MONITORING AND SURVEY SCHEDULE

Monitoring is essential to determine when dredging is required, assess the effectiveness of sand placement, and track shoreline and bathymetric changes over time. A combination of scheduled and event-based monitoring is recommended, as discussed in Table 15.

Table 15. Monitoring Schedule.

Survey Type	Frequency	Purpose
Bathymetric survey (trap and channel)	Biannual (April and October)	Assess sand trap volume, detect shoaling at entrance, validate triggers
Drone or aerial imagery	Quarterly or post-storm	Visual monitoring of western spit formation and eastern nourishment
Post-dredge confirmation survey	After each campaign	Confirm dredged volumes and final trap depth
Beach profile surveys	Annual (in line with DEW program)	Track erosion/accretion trends on eastern and western beaches
Post-storm rapid assessment	Following major storm events	Detect emergency infill or bypass risk

11.3 RECOMMENDATIONS FOR ADAPTATIONS TO THE CURRENT SAND MANAGEMENT OPERATION

The recommendations proposed in this section relate to potential adaptations that could be made to the current sand management operation (see [Section 3.3](#)) in addition to and/or in conjunction with the dredge management plan outlined above. The adaptations focus on the management of the sand stockpile on the upper beach face of the western beach.

Land-Based Pump & Hopper System:

One adaptation to manage the stockpile of sand could be to install a land-based hopper sand pump station on the western beach. A land-based sand slurry pump system typically comprises a hopper and slurry pump set-up positioned on the beach, where excavated sand is deposited into the hopper. Water is added to create a sand-water slurry, which is then pumped through a pipeline to the target deposition area. At Cape Jaffa, this would involve transferring material to the eastern beach and could be incorporated into the current dredge disposal pipe that runs beneath the marina. If the slurry pump is incorporated into the existing disposal pipe, it will not be operational during dredging programs. Alternatively, the slurry pump could be installed to a new disposal pipe.

Benefits of a sand/slurry pump system include:

- Allows large volumes of sand to be moved efficiently over long distances.
- Minimises reliance on truck haulage, reducing environmental footprint, and social impacts such as traffic, noise, and damage to road surfaces.
- Complements dredging campaigns by enabling land-based sediment to be efficiently re-located.

This option cannot run when the dredge is active, however could be advantageous in clearing the stockpile of sand during times when the dredge is non-operational due to, for example, weather conditions. Furthermore, once the stockpile of sand is transported, the

hopper can be utilised with a loader to reduce the elevation of the sub-aerial beach, creating a more efficient environment for the dredge to operate. A land-based hopper sand pump adaptation is a costly effort.

This approach aligns with adaptive coastal management practices and has been successfully implemented in similar foreshore environments around South Australia, such as along the Adelaide metropolitan coast. When paired with appropriate monitoring and dredge maintenance, it provides a reliable method to support long-term sediment management objectives at Cape Jaffa.

Loader & Dredge System:

Another adaptation to the current sand management operation could be to take advantage of the dredge while it is operating on the western beach. Under this option, a loader would transport the stockpile of sand from the upper beach face to the active dredge site, where it would be incorporated into the dredged sediment. It should be noted that this would slow down the rate at which the dredging of the western beach is accomplished, thus is only recommended as an adaptation option after an extensive dredging campaign.

11.4 PERFORMANCE TARGETS/INDICATORS

As defined in success criteria above.

11.5 PLAN REVIEW FREQUENCY

The Sand and Dredge Management Plan should be reviewed and updated at regular intervals to incorporate new data, respond to changing coastal conditions, and ensure continual improvement. The following schedule and triggers apply:

- Routine review every 5 years, with a formal update prepared and submitted to Council.
- The plan should be reviewed earlier if:
 - Annual sediment inflow exceeds modelling results;
 - Monitoring indicates significant divergence from expected shoreline or beach response;
 - Regulatory changes or stakeholder requirements shift.

Each review should include updated survey analysis, dredging and placement history, performance assessment, and stakeholder consultation.

12 REFERENCES

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Attachments:

- SMS Geotechnical Reports:
 - o Dry Density Ratio Report.pdf
 - o PSD_Sample_1 through PSD_Sample_6 PDFs
- PCS Technical Note: P104_R01v1_CapeJaffaSedimentation.pdf