Shoalhaven Heads Estuary Taskforce

Meeting Date: Wednesday, 20 March, 2024
Location: Jervis Bay Rooms, City Administrative Centre, Bridge Road, Nowra

Attachments (Under Separate Cover)

Index

6. Reports

Lower Shoalhaven River Pre-Dredge Feasibility Study

Report

Shoalhaven City Council

January 2024

311015-00354

Advisian
Worley Group

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PROJECT 311015-00354 - 311015-00354-MA-RP-0001: Lower Shoalhaven River Pre-Dredge Feasibility Study - Report

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
A	Issued for 50% Review	L.Freeman	B.Morgan	B.Morgan	20.04.23		
B	Reissued for Client Review	L.Freeman	B.Morgan	B.Morgan	20.06.23		
C	Reissued for Client Review	L.Freeman	B.Morgan	B.Morgan	29.06.23		
D	Issued to Stakeholders	L.Freeman	B.Morgan	B.Morgan	27.07.23		
E	Updated	L.Freeman	B.Morgan	B.Morgan	17.11.23		
F	Final	L.Freeman	B.Morgan	B.Morgan	17.01.24		

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Executive summary

Shoalhaven City Council (SCC) received a NSW Government Boating Access Dredging Program grant from the Maritime Infrastructure Delivery Office (MIDO) in 2022. As a result, SCC has undertaken preliminary environmental and engineering studies to assist in the preparation of a feasibility study for investigating the viability of dredging the Lower Shoalhaven River to improve boating safety and navigation if necessary, and potentially nourish a section of foreshore adjacent to the navigation channel to enhance community access and amenity.

SCC engaged Advisian to undertake a navigation and dredge feasibility assessment aimed at understanding whether there are constraints with navigation and the potential need for dredging. The extent of the assessment extended from the public jetty opposite Jerry Bailey Road to the boat ramp at the Northeastern extent opposite the Holiday Haven Caravan Park (~1000 m) (Figure 0-1).

Figure 0-1 Location and Extent of Study Area

Relevant background documentation was reviewed, assessment made of the existing environment and a navigation assessment completed. The navigation channel in this stretch of waterway is predominantly used by small power boats (4 – 6m at 47% and 6 – 8m at 13%) (Rhelm, 2022). The navigation assessment determined a minimal amount of dredging would be required if a design vessel of 8 m was selected and this dredging would only be required to achieve adequate depth in storm conditions. The assessment confirmed no dredging would be required if a design vessel of 6 m was selected. Based on the dredge requirements for the 8 m vessel navigating in storm conditions, four concept options were developed that included both dredging, nourishment and a combination of both. Preliminary cost estimates for each concept option were prepared.

The concept options were presented to relevant government authorities in a Stakeholder Consultation session. During the consultation it was established that any dredging of this section of channel was unjustified, given the absence of a navigation/safety risk and the unlikelihood of an 8 m vessel navigating the channel in storm conditions, and thus not supported given the lack of need to dredge and the potential negative impacts on the environment. As such, the direction of the project changed to focus on the beach amenity of the River Road foreshore. The site works undertaken in 2020 to address erosion along this area of foreshore included the construction of a ~240 m rock revetment which altered the beach amenity. SCC has undertaken recent beach nourishment of the River Road Foreshore following revetment rectification works on the eastern end of the rock revetment structure (June 2023). The beach nourishment aimed to increase the existing upper sand level to provide a more substantial sand buffer and to cover the toe of the rock revetment thus providing a wider beach for recreational amenity.

The recent beach nourishment work has been compared with the proposed beach nourishment concepts (Section 8) designed to improve beach amenity. The concepts nominated an upper beach level of 1 m AHD with a flat upper beach section of 3 m width. The assessment found that the recent beach nourishment achieved the proposed upper beach level (1.0 m AHD) along the majority of the foreshore.. The assessment found that the nourishment profiles had a consistent slope to the waterway (~1V:10H) which would likely readjust to a flatter profile with time. Analysis of the change in profiles between June and September 2023 shows a loss of sediment with the beach level reduced by approximately 0.2 m in the three-month period between surveys (likely a result of natural readjustment). A compatibility analysis was undertaken of the borrow material and native beach sand with result showing the nourishment as predominantly stable. Sediment sampling results of the nourishment sand were reviewed and compared with the sediment size adopted for sediment transport modelling. The D_{50}[1] adopted for sediment transport modelling was 0.25 mm compared with the nourishment sand which had a D_{50} of 0.33 mm. This slight increase in sediment size would result in a marginal reduction in the net longshore sediment transport rates.

In conclusions, the study has found a lack of justification for dredging due to the absence of any navigation or safety risk and the potential negative impact it would have on the environment. The assessment of the recent beach nourishment found a significant improvement in beach amenity along the majority of the study foreshore. It should be noted, whilst nourishment has successfully been implemented to achieved a positive outcome, this is not necessarily an ongoing long-term option that the State Government agencies will support. Further assessment of the management of this area is to be via the Lower Shoalhaven River Coastal Management Program (CMP).

[1] The median sediment particle size (D50) which is important for understanding and modelling sediment transport.

Acronyms and abbreviations

Acronym/abbreviation	Definition
ACM	Asbestos Containing Material
AHD	Australian Height Datum
AOBV	Areas of Outstanding Biodiversity Value
ARI	Average Recurrence Interval
BIA	Biologically Important Areas
BoD	Basis of Design
BOS	Biodiversity Offset Scheme
ECL	East Coast Low
EEC	Endangered Ecological Communities
LGA	Local Government Area
MGA	Map Grid of Australia
MIDO	Maritime Infrastructure Delivery Office
NAGD	National Assessment Guidelines for Dredging
NEPM	National Environmental Protection Measures
PCTs	Plant Community Types
PMST	Protected Matters Search Tool
RL	Reduced Level
ROV	Remotely Operated Vehicle
SAP	Sampling and Analysis Plan
SCC	Shoalhaven City Council
TECs	Threatened Ecological Communities

1 Project Overview

1.1 Introduction

Shoalhaven City Council (SCC) received a NSW Government Boating Access Dredging Program grant from the Maritime Infrastructure Delivery Office (MIDO) in 2022. As a result, SCC has undertaken preliminary environmental and engineering studies to assists the preparation of a feasibility study for investigating the viability of dredging the Lower Shoalhaven River to improve boating safety/navigation if necessary, and potentially nourish a section of foreshore adjacent to the navigation channel to enhance community access and amenity.

1.2 Study Area

The study area is located within the Shoalhaven Local Government Area (LGA) on the South Coast of NSW at Shoalhaven Heads (Figure 1-1). Classified as an estuary, it is where the Shoalhaven River meets the Pacific Ocean.

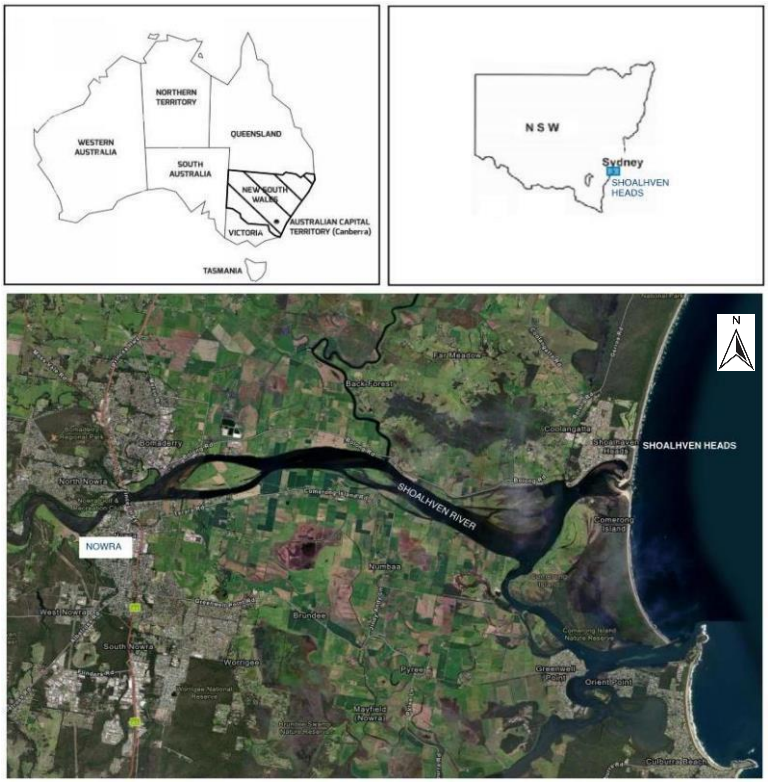

Figure 1-1 Location of Study Area

1.3 Project Description

SCC has engaged Advisian to undertake a navigation and dredge feasibility assessment aimed at understanding whether there are constraints with navigation and the potential need for dredging. The extent of the assessment is shown in Figure 1-2, extending from the public jetty opposite Jerry Bailey Road to the boat ramp at the Northeastern extent opposite the Holiday Haven Caravan Park. The navigation channel in this stretch of waterway is predominantly used by small power boats (4 – 6m at 47% and 6 – 8m at 13%) (Rhelm, 2022).

Figure 1-2 Extent of Study Area Shown by White Dashed Line

Various studies and subsequent on-site works have been undertaken to understand the processes occurring in the estuary and to address the erosion occurring along the foreshore predominantly attributed to the East Coast Low that occurred in 2016. The site works undertaken in 2020, to address erosion, included the construction of a ~240m rock revetment along the foreshore opposite River Road combined with a small quantity of beach nourishment (~1,060m^3 over 130m), replacement of beach access stairs at two locations, stormwater outlet improvement works at three locations, clearing of vegetation to facilitate the rock revetment and drainage upgrade works and revegetation works (Figure 1-3ab). The beach nourishment works aimed to raise the existing sand level from Relative Level (R.L) 0m Australian Height Datum (AHD) to R.L.1.3m AHD to provide a more substantial sand buffer and cover the toe of the rock revetment, thus providing a wider beach for recreational amenity.

This report uses the previous studies to input into a navigation assessment and develop and assess the feasibility of various dredging/nourishment options to improve boating safety/navigation if necessary and enhance community access and amenity along the foreshore.

Figure 1-3 Rock Revetment Along ~240m of River Road Foreshore Shoalhaven Heads. (a) Oblique View of Rock Revetment and (b) Extent of Rock Revetment Relative to the Shoalhaven Heads Opening.

1.4 Key Objectives

The key objectives of the study are:

- Assess the suitability of the navigation channel for trailable boat craft (~8 m).
- Develop a layout and profile for a deeper/wider channel for improved navigation if deemed necessary.
- Evaluation of channel dredging options and identification of the risks and constraints of each option.
- Develop beach nourishment options to improve beach amenity.
- Present options to Stakeholders in order to obtain feedback and select a preferred option.
- Assess at a preliminary level potential impacts any proposed dredging/nourishment may cause to terrestrial and aquatic biodiversity including sensitive habitats and species (i.e. seagrasses).
- Ensure the study considers and minimises environmental, social and economic impacts.
- Consider the future use of larger vessels entering the channel.
- Assess beach amenity and recent beach nourishment works.

2 Background Review

2.1 General

Relevant background documentation has been reviewed as listed in Table 2-1 and brief summaries are provided in the following sections.

Table 2-1 Relevant Background Documentation

Document Title	Organisation	Date
River Road Foreshore, Shoalhaven Heads: Assessment of Coastal Management Options	UNSW Water Research Laboratory	August 2017
Shoalhaven City Council Coastal Management Plan (CMP) Scoping Study	Advisian	August 2020
Shoalhaven Heads – Channel Dredging and Beach Nourishment Stage 1 Tasks	Royal HaskoningDHV	11 May 2021
Shoalhaven River Hydrographic Survey	Hydrographic and Cadastral Survey	21 February 2022
Sediment Sampling and Analysis Plan (SAP) Implementation Report	Environment and Natural Resource Solutions	June 2022
Flora and Fauna Assessment Lower Shoalhaven Dredging Project	Stantec	28 July 2022
Advice Regarding Planning Approval Pathway for Shoalhaven Heads Channel Dredging – Legal Advice	Shaw Reynolds Layers	12 August 2021
Flora and Fauna Assessment Lower Shoalhaven River Dredging Project	Stantec	July 2022
Lower Shoalhaven River Tidal Inundation Study	Stantec	30 August 2022
Coastal Process Modelling Shoalhaven Heads Nourishment	Stantec	20 October 2022
Lower Shoalhaven River Coastal Management Program Stage 2 Boating Study	Rhelm	November 2022

2.2 River Road Foreshore, Shoalhaven Heads: Assessment of Coastal Management Options (2017)

This study was undertaken by The Water Research Laboratory (WRL, 2017) on developing suitable conceptual foreshore management options to be implemented along the River Road foreshore to address erosion resultant from the 2016 East Coast Low. The study assessed the current condition of the foreshore, developed an understanding of the processes impacting the foreshore, identified risks and hazards, and subsequently scoped and evaluated achievable concept management options. The development of concept management options addressed only those areas of the foreshore identified as high priority based on risk. The primary outcomes from the study are summarised below:

- Embankment protection to be implemented along 240 m length of foreshore (adjacent to River Road between Renown Ave and Mathews St) posed as high risk. Conceptual options proposed of either rock or geotextile bag armouring.
- Stormwater diversion/upgrade concept options within the embankment.
- Beach nourishment over short-to-medium-term – recommended a minimum widening of the beach profile by 2 – 3 m along the area where embankment works are undertaken (~240 m beach length). A significant improvement in beach amenities would require a 4 – 5 m widening of the beach along the entire foreshore (~1000 m). Discussion concerning the location to source sand has identified either the sand notch at the entrance to the Shoalhaven River or from dredging the sand spit along the existing navigation channel. The estimated volume of nourish sand varied from 2,000 m^3 (2 – 3 m widening) to 15,000-20,000 m^3 (4 – 5 m widening).

2.3 Statement of Environmental Effects (SEE) River Road Foreshore Management – Coastal Protection Works (2019)

This report has not been viewed by Advisian however, a summary of the report has been sourced from Royal HaskoningDHV report (RHDHV,2021).

The proposed coastal protection works outlined in the Statement of Environmental Effects (SEE) included the following:

- improvement of stormwater outlets at three locations;
- rock revetment works ~240 m of foreshore;
- nourishment over a length of approximately 160 m, raising sand level from 0 m AHD to at least 1.1 m AHD over revetment toe, comprising approximately 1,060 m^3 with sand sourced from dry notch maintenance activities at the Shoalhaven Heads entrance;
- replacement of beach access stairs at two locations;
- vegetation clearing to accommodate rock revetment and stormwater upgrade works; and,
- revegetation within the project area including the face of the rock revetment.

2.4 Shoalhaven Heads – Channel Dredging and Beach Nourishment Stage 1 Tasks (2021)

Royal HaskoningDHV was engaged by SCC in 2021 to progress the beach nourishment design of the River Road foreshore with the objectives of improving foreshore amenity, mitigating future foreshore erosion, providing a navigation channel of suitable depth/width between the Holiday Haven Caravan Park and the public jetty at Jerry Bailey Road, and proposing 'value add' options for the benefit of water quality, flooding and ecology (Royal HaskoningDHV, 2021). A summary of the design criteria adopted and recommended in this study are provided below:

- proposed a target additional beach width of 5 m above high tide level, representing a significant increase in recreational amenity and foreshore access;
- Adopt an upper beach level of 1.5 m AHD (at the time of the report the beach was at a level of 1.3 m AHD) and lower level of -2 m AHD for the beach nourishment profile;
- average beach slope of 1V:10H to be adopted in conjunction with the beach nourishment and proposed channel dredging;

- length of beach nourishment 1000 m and a nourishment volume of 17.5 m^3/m with a total nourishment volume of 17,500 m^3;

The report outlined that the above proposed nourishment would partially infill the existing navigation which was proposed to be at a bed level of -2.0 m AHD, 20 m wide and maintaining the existing channel alignment.

2.5 Legal Advice Regarding Planning Approval Pathway for Shoalhaven Heads Channel Dredging (2021)

Advice received from Shaw Reynolds Lawyers (Shaw Reynolds Lawyers, 2021) regarding the planning approval pathway for Shoalhaven Heads channel dredging. Their advice is outlined below:

- Agree that the Beach Nourishment Works can be properly characterised as 'coastal protection works' under the *Coastal Management Act 2016* and carried out without development consent under clause 19(2)(a) of the *State Environmental Planning Policy (Coastal Management) 2018*[2].
- The dredging works are capable of being undertaken under the Coastal SEPP on the basis that the work falls within the category of "beach nourishment". The works would also be able to be undertaken under the Coastal SEPP if the works are identified in Council's Coastal Management Program.
- The dredging works are capable of being undertaken under the *State Environmental Planning Policy (Infrastructure) 2007*. However, the NSW Department of Planning and Environment (DPE) (previously Department of Planning, Industry and Environment) considers this categorisation to be problematic if works are proposed for navigational purposes as the proposed nourishment works includes the modification of the navigation channel.
- The advice recommended a special purpose licence pursuant to the *Crown Land Management Act* be obtained to remove sand for dredging purposes and that further technical input be provided with respect to environmental matters pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Native Title Act 1993* (NT Act), *Fisheries Management Act 1994* (FM Act) and *Biodiversity Conservation Act 2016* (BC Act).

2.6 Lower Shoalhaven River Tidal Inundation Study (2023)

Stantec (2023) undertook a study aimed at determining the risks associated with tidal and storm tide inundation in the study area. A range of linked Delft3D model systems were used to undertake the hydrodynamic and wave climate investigations. A total of 21 tidal inundation scenarios were modelled (Table 2-2), which included seven sea level rise values and three configurations of the entrance. Similarly, 21 coastal inundation scenarios were modelled assuming the seven different sea level rise values and the 1 year, 200 year and 100 year ARI storm tide events (Table 2-3).

[2] Note as of March 2022, the Coastal Management State Environmental Planning Policy (SEPP) has been incorporated into the Resilience and Hazards SEPP.

Table 2-2 Tidal Inundation Scenarios (Source: Stantec)

Water Level	Shoalhaven Entrance	Sea Level Rise (m)						
		0	0.1	0.23	0.36	0.6	0.9	1.2
HWSS	Closed	X	X	X	X	X	X	X
HWSS	Open - 100yr	X	X	X	X	X	X	X
HWSS	Open PMF	X	X	X	X	X	X	X

Table 2-3 Coastal Inundation Scenarios (Source: Stantec)

Water Level	Shoalhaven Entrance	Sea Level Rise (m)						
		0	0.1	0.23	0.36	0.6	0.9	1.2
1 yr ARI	Open - 100yr	X	X	X	X	X	X	X
20yr ARI	Open - 100yr	X	X	X	X	X	X	X
100yr ARI	Open - 100yr	X	X	X	X	X	X	X

The report concluded that tidal inundation is predicted to increase as sea levels rise with a summary of the increase in inundation for the various scenarios presented in (Table 2-4). Similarly, coastal inundation is predicted to increase, with a summary of results presented in Table 15-2. The study undertook an assessment of Berry's Canal and concluded that the canal is likely to continue experiencing morphological changes until a stable equilibrium is reached once the cross- sectional area of the channel doubles from its current state.

Table 2-4 Tidal Inundation Area for Various Sea Level Rise Scenarios (Source: Stantec)

Sea level rise	Inundated Area (Ha)	% Increase from 2022
0m SLR	3,922	0%
0.1m SLR	4,232	8%
0.23m SLR	4,964	27%
0.36m SLR	5,755	47%
0.6m SLR	8,398	114%
0.9m SLR	9,976	154%
1.2m SLR	11,536	194%

Table 2-5 Coastal Inundation Area for Various Sea Level Rise Scenarios (Source: Stantec)

Sea level rise	Inundated Area (Ha)		
	1 year ARI	20 year ARI	100 year ARI
0m SLR	4,995	5,963	6,986
0.1m SLR	5,553	6,561	7,550
0.23m SLR	6,265	7,484	8,505
0.36m SLR	7,269	8,458	9,345
0.6m SLR	9,081	10,087	10,800
0.9m SLR	9,747	11,674	12,200
1.2m SLR	12,287	12,630	12,918

2.7 Flora and Fauna Assessment, Lower Shoalhaven Dredging Project, Stantec (July 2022)

The Flora and Fauna Assessment (Stantec, 2022) aimed to describe the main ecological features of the Study Area and identify any constraints that should be considered based on the proposed dredging and beach nourishment program. The study area considered was the same as that under investigation in the current report.

The study included a review of existing literature, database searches for threatened and protected species and field investigations of the foreshore area and marine vegetation (including seagrass, mangroves, and saltmarsh (Figure 2-1ab)). A terrestrial field survey was conducted on 15 February 2022, and a marine vegetation survey was carried out on 27 April 2022. The terrestrial survey was carried out on foot, and the marine survey was carried out from a small vessel using a Remotely Operated Vehicle (ROV). The project also adopted a risk assessment to determine the likelihood of certain consequences occurring because of the project, overall, this risk assessment did not aim to deter the project but rather highlight different consequences in order to maintain discussion about best practice methods of construction with the project.

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SH24.1 - Attachment 1

Figure 2-1 *(a) Approximate Extent of Marine Survey Area with NSW DPI Fisheries mapping overlayed. Red Solid Lines Indicates Detailed Survey Extent. Orange Line Indicates Extent of Habitat Verification. (b) Approximate Extent of Marine Vegetation in the Lower Shoalhaven River (Source: Stantec, 2022)*

Overall, the key conclusions of the project are as follows:

- The proposed dredging could result in the direct loss of approximately 32,000 m^2 of the protected seagrass *Zostera capricorni*.
- SCC should consult with NSW DPI (Fisheries) and discuss the requirement for a section 205 permit to harm marine vegetation.
- There may be a requirement for compensation and/or habitat rehabilitation.
- This project has the potential to impact several threatened species. Therefore, an assessment of significance would be required as part of the environmental impact assessment process.
- Many of the moderate to high risks identified in the risk assessment are due to indirect factors such as poor water quality, noise and vibration, or risk of habitat disturbance during staging and construction.
- At the time of writing this report, proposed planning pathways had not been determined; therefore, the level of detail required for an environmental assessment had not been specified.

Results from this report have been used to populate the Section 4.1.

2.8 Coastal Process Modelling Shoalhaven Heads Nourishment (2022)

Stantec (2022) investigated the coastal processes and viability of sand nourishment to the River Road foreshore at Shoalhaven Heads. The assessment reviewed sediment transport rates and storm erosion and was based on dredging approximately 30,000 m^3 from the shoals within the navigation channel and placing the sand on the upper beach face over an approximate length of 1,150 m (Figure 2-2).

Figure 2-2 Extent of the Proposed Dredging and Nourishment at Shoalhaven Heads (Source: Stantec, 2022)

An assessment based on weighted mean wave direction provided a qualitative description of the shoreline changes and net transport, indicating that net sediment transport is to the north-east due to the predominant south-westerly wind and the longer fetch in this direction. Danish Hydraulic Institute's (DHI's) LITDRIFT was then used to quantify the sediment transport rates and concurred the mean wave direction assessment in that the longshore transport is to the north-east. The sediment transport rates are approximately 60 m^3/year with the largest transport rates predicted at Profiles 1 and 2 (Figure 2-3) with significantly less at Profiles 2 and 3. This indicates that nourished sand placed between profiles 1 and 2 will slowly move and deposit around Profiles 3 and 4. However, the magnitude of the transport is very small and as such this process is expected to occur over many years.

Figure 2-3 LITDRIFT Profiles, Bathymetry Included the Proposed Dredging and Nourishment at Each of These Locations (Source: Stantec (2022))

The storm erosion modelling through flooding and wave penetration was undertaking using Delft3D. A 100yr Average Recurrence Interval (ARI) flood event indicated most of the proposed nourishment area would undergo minor changes during this flood event, with erosion (less than 5 – 10 cm) over the nourishment area and a similar depth of deposition in the deeper areas. The model predicted a large amount of accretion on the south-western side of the nourished beach (over 0.5 m accretion). Under ocean waves (Offshore Hs=9.5 m from the south-east) and a scoured entrance (400 m wide) the model predicted the south-western portion of nourishment would experience erosion of up to 0.5 m (same area accreting in flood event).

2.9 Lower Shoalhaven River Coastal Management Program Stage 2 Boating Study (2022)

Rhelm were engaged by SCC to undertake a boating study aimed at obtaining a better understanding of boating related challenges in the lower Shoalhaven River (Rhelm, 2022). The study included an analysis of existing boat usage, review of existing boating facilities, estimates of future demand (both recreational and commercial) and recommendations for upgrades to existing facilities and actions to reduce boating related conflict. The study identified that the type of boats used on the lower Shoalhaven River are heavily weighted to small power boats (Figure 2-4), with 61% of respondents surveyed reporting they use powerboats of less than eight metres with 40% in the 4 – 5 m category. At Shoalhaven Heads 47% of respondents used powerboats of 4 – 6 m and 13% powerboats of 6 – 8 m. The study investigated boat ramp usage and found that when using the Shoalhaven Heads to Nowra Bridge area, from 181 respondents 16% used Hay Avenue Boat Ramp, 29% used the River Road Boat Ramp and 8% used the Wharf Road Boat Ramp at Shoalhaven Heads. The study identified that the River Road ramp is mainly used by local caravan park visitors and that navigation was hampered by

shoaling in the approaches. Hay Avenue ramp was identified as having limited area for manoeuvering vehicles and trailers to access the ramp and Wharf Road Ramp showed signs of concrete spalling.

Figure 2-4 Typical Most Popular Size Recreational Fishing Boat (Source: Rhelm, 2022)

2.10 Sediment Sampling and Analysis Plan (SAP) Implementation Report, Environment & Natural Resource Solutions (2022)

The report, commissioned by SCC, was conducted by Environment & Natural Resource Solutions (ENRS) in 2022 (ENRS, 2022). The investigation aimed to prepare a Sediment Sampling and Analysis Plan (SAP) Implementation report to test and analyse for a range potential contaminants within the sediments of the Shoalhaven River's channel and determine the suitability for use as nourishment material .

The report identifies that the Shoalhaven River foreshore adjacent to River Road, Shoalhaven Heads, has experienced significant localised erosion. This has been credited to storm events highlighting the 2016 East Coast Low (ECL). In addition, the open nature of the ocean entrance has created exposure to elevated water levels, large ocean swells, and wind-generated solid local swells.

The report aimed to meet the following objectives:

- document the investigation methods and preliminary analytical results;
- ensure that the data presented is representative and provides a robust basis for characterising the chemical and physical nature of the sediment to be dredged; and
- make an assessment based on contamination status whether dredging is a suitable source of the nourishment material.

Results:
During the 2022 investigations, the sediments were primarily reported as yellow to light brown sand with minor amounts of shell and shell grit. Visual core analysis and logging did not identify anthropogenic or foreign materials in recovered sediments.

For the purpose of risk-based assessment for potential terrestrial reuse of dredged sediment within the project area, the National Environment Protection Measure (NEPM) Health Investigation Levels (HILs) 'A' were applied. The analytes/contaminants tested included 15 metals, BTEXN, TRH, PAH, Organotins, OC/OP Pesticides, PFAS, TOC, PCBs and PSD. Metal concentrations in the sediments were identified to be homogenous laterally and vertically throughout the investigation area. For all the metals tested, the calculated 95% UCL values were below the respective National Assessment Guidelines for Dredging (NAGD) and NEPM criteria. Within surface sediments (0 – 0.5 m), organic compounds, pesticides and PFAS/PFOA were all present at concentrations below the assessment criteria, with most analytes not present at detectable levels. Acid sulphate screening results generally returned very low or no acidity or indications of potential acid sulphate material in sediment samples.

The primary analytical assessment did not identify contaminants of potential concern in exceedance of the assessment criteria in accordance with the NAGD. Therefore, no evaluation or characterisation of the bioavailability or ecotoxicity of sediments was required.

Recommendations:
Based on the findings present in the SAP implementation report. The following recommendations have been made:

- Undertake a project-specific review of sediment composition and aesthetic qualities to ensure that the material, if dredged, will generally meet nourishment requirements:
  - Colour: The colour of the sediment should align with the surrounding environment and the intended aesthetic of the project area.
  - Texture: The texture of the sediment, whether fine or coarse, should be consistent with the desired visual and tactile experience of the area.
  - Uniformity: A uniform appearance of the sediment contributes to a visually pleasing and harmonious environment.
  - Consistency: The sediment's consistency, including its levelness and smoothness, affects the overall visual appeal.
  - Natural Appearance: The dredged material should resemble natural sediment found in the area to maintain a cohesive and authentic aesthetic.
  - Compatibility: The sediment's appearance should complement existing natural features, architectural elements, and surrounding landscapes.
  - Reflectivity: Consideration of how the sediment's reflective properties interact with light and water can enhance the overall aesthetic.
  - Visual Blending: The ability of the sediment to seamlessly blend with the surrounding water and land features is crucial for a visually integrated environment.
  - Contrast: Controlled contrast with adjacent elements can create visual interest and highlight focal points within the project area.
  - Long-Term Appearance: Anticipating how the sediment's appearance might evolve over time due to weathering and usage is essential for a sustained aesthetic.
  - Community Perception: Understanding how the sediment's appearance is likely to be perceived by the community and stakeholders can influence design decisions.
  - Artistic Potential: Leveraging the sediment's qualities to enhance artistic or creative elements within the project area can contribute to a unique aesthetic.

- Historical analysis has identified ACM on the River Road side of the riverbank (beach nourishment area) to the lowest accessible point during low tide. As such, there remains potential for further ACM to be identified. Therefore, consideration should be placed into further characterisation with a method suitable to determine the extent of the area potentially impacted by ACM and undertake the management of areas potentially impacted by ACM before dredging/beach nourishment.

3 Site Conditions and Basis of Design

A summary of the Basis of Design Report (BoD) (refer Appendix A) describing the existing site conditions and design parameters is presented in this section.

3.1 General

Site Conditions means any physical conditions of the Site (including sub-surface conditions, weather conditions or other physical conditions which are a consequence of weather conditions).

3.2 Datum, Units and Tidal Planes

The following datums will be used for this Study.

- horizontal datum is the Map Grid of Australia (MGA) Zone 56 grid system (GDA2020);
- vertical level datum is the Australian Height Datum (AHD); and,
- in general, the SI system of metric units will be used for this Study.

3.3 Water Levels

Water levels at Shoalhaven Heads are dominated by the astronomical tides. Tidal planes for the study area, taken from the tidal recording station at Shoalhaven Heads, are provided in Table 3-1. The location and a photograph of the tide gauge is shown in Figure 3-1. An entrance open scenario will be adopted for the navigation assessment based on MLWS (-0.415m AHD).

Table 3-1 Tidal Planes for Shoalhaven Heads (WRL, 2017)

Tidal Plane	Level m (AHD)	
	Entrance Closed	Entrance Open
High High Water Solstices Springs (HHWSS)	0.738	0.947
Mean High Water Springs (MHWS)	0.434	0.594
Mean High Water (MHW)	0.375	0.502
Mean High Water Neaps (MHWN)	0.315	0.410
Mean Sea Level (MSL)	0.067	0.090
Mean Low Water Neaps (MLWN)	-0.181	-0.231
Mean Low Water (MLW)	-0.240	-0.323
Mean Low Water Springs (MLWS)	-0.299	**-0.415**
Indian Spring Low Water (ISLW)	-0.516	-0.667

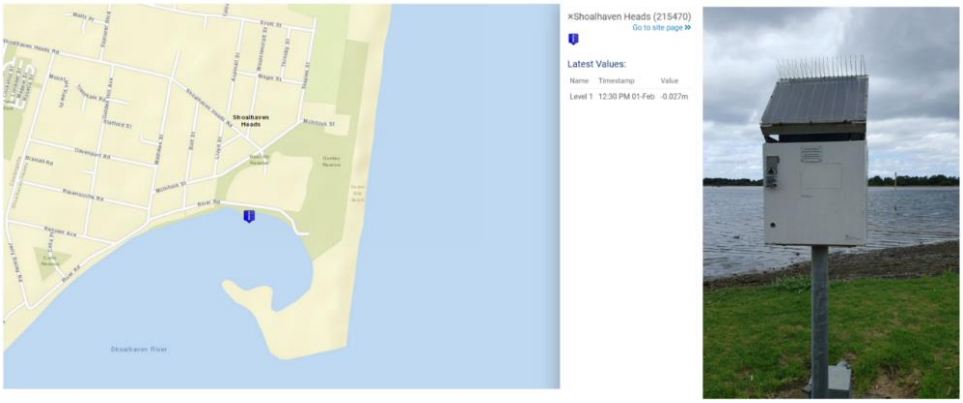


Figure 3-1 Location of MHL Tide Gauge at Shoalhaven Heads

During storms, coastal water levels may be further elevated by the effects of wind setup, barometric setup and wave setup. Elevated water levels including astronomical tide, wind and barometric setup (collectively referred to as storm surge (Figure 3-2)), but not wave setup, for the NSW Coast (m AHD), for a range of Average Recurrence Intervals (ARIs), are listed below (Manly Hydraulics Laboratory, 2018):

- 25 yr ARI 1.4 AHD (+SLR)
- 50 yr ARI 1.45 AHD (+SLR)
- 100 yr ARI 1.5 AHD (+SLR)

SCC's Sea level rise projections are stated in Section 3.4.

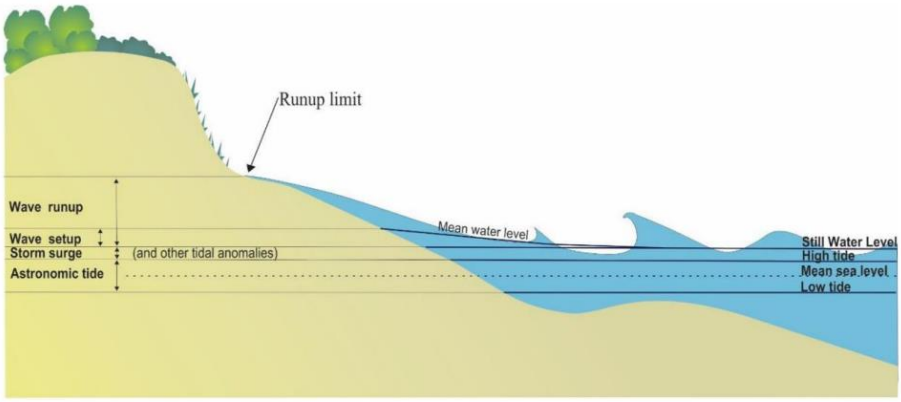


Figure 3-2 Wave Runup, Wave Setup and Storm Surge (Source: NSW Government Coastal Management Manual Part B)

3.4 Sea Level Rise

SCC have adopted sea level rise projections for planning purposes of 0.1 m by 2030, 0.23 m by 2050 and 0.36 m by 2100. The IPCC has recently released its 6th Assessment Report and has published sea level rise projections for selected locations throughout the world, including at Jervis Bay. For Jervis Bay, the sea level rise projections are given in Figure 3-3 (source https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool?psmsl_id=2312) based on a "high" Greenhouse gas emissions scenario. For a 25-year design life, it is suggested for SCC to adopt a sea level rise of **0.4 m** based on a precautionary approach.

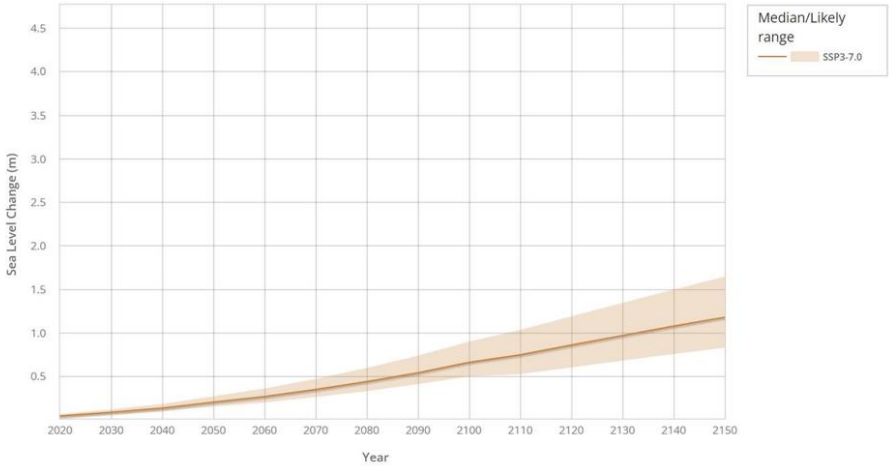


Figure 3-3 Jervis Bay Sea Level Rise Projections (Source: IPCC)

3.5 Wave Climate

The condition of Shoalhaven Heads entrance influences the wave climate. If the entrance is closed the site is only exposed to short period, local wind waves with a fetch from the South West. If the entrance is opened by flood, entrance intervention or natural break out in accordance with Council's Entrance Management Policy, the site may be exposed to diffracted, long period swell waves following the freshwater flood. The area is most vulnerable to wave attack immediately following a flood as ambient wave energy will narrow and close the entrance over time. Based on historical records over the period 1936 to 2016, the entrance was predominantly open, approximately 67% of the time compared with 33% closed (WRL, 2017). Entrance openings since 2016 are detailed below:

- mechanical opening February 2020;
- major flood event August 2020, required mechanical opening of the entrance;
- natural opening March 2021 due to flooding, remained open during May 2021 flooding event; and,
- mechanical opening 3rd March 2022, remained open until May 2023.

3.5.1 Boat Wake

Boat wakes are generated by passing vessels travelling the inlet. The height of the wave at the site caused by passing vessels is a function of the speed of travel, displacement and hull shape of the vessel and distance to the facility from the vessel's sailing line.

Based on experience and considering the speed limits within the channel a wave height of 0.3 m can be assumed to be appropriate for boat wake.

3.5.2 Wind Waves

With a closed entrance the greatest exposure to wave attack is from wind waves generated from the South West (upstream). Adopting a 20-year ARI the wave conditions are (WRL, 2017):

- Significant Wave Height (H_s) = 0.67 m; and
- Peak Spectral Wave Period (T_P) = 2.9 s.

3.5.3 Swell Waves

WRL (2017) determined the design wave conditions at the inner foreshore for both a small entrance opening (160 m) and large entrance opening (600 m) as shown in Figure 3-4 and Figure 3-5.

For a small entrance opening a diffraction coefficient of 0.4 was adopted with a corresponding significant wave height of 0.66 m at the inner foreshores and a peak spectral wave period of 12.2s (20-year ARI). For a large entrance opening a diffraction coefficient of 0.85 was adopted and a corresponding significant wave height of 1.82 m at the inner foreshore. This was further reduced to account for depth limitation with a depth limited significant wave height of 1.25 m adopted with a peak spectral wave period of 12.2 s (20-year ARI).

Figure 3-4 Irregular Wave Diffraction Coefficients and Significant Wave Heigh for a Small Entrance Opening (Aerial Photo 5 July 2013) (Source: WRL, 2017)

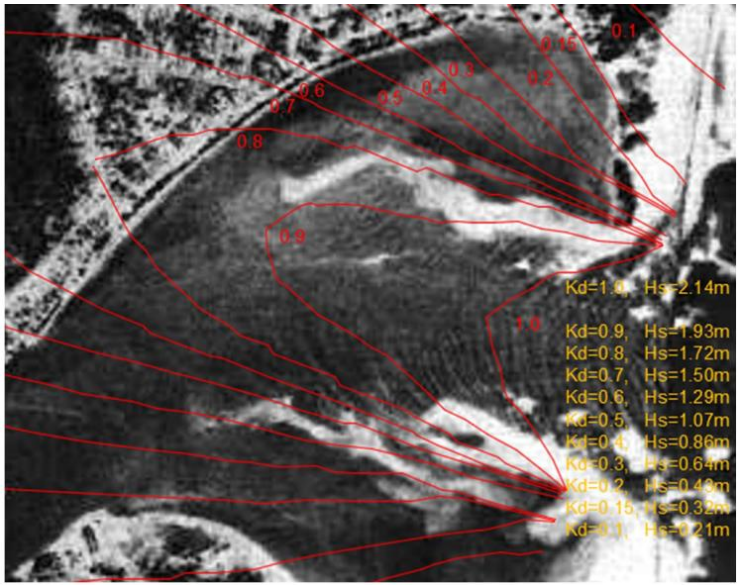


Figure 3-5 Irregular Wave Diffraction Coefficients and Significant Wave Heigh for a Large Entrance Opening (Aerial Photo 29 December 1974) (Source: WRL, 2017)

3.6 Sediment Data

Environment and Natural Resource Solutions (ENRS, 2022) took sediment samples from seven sampling points within the navigation channel (Figure 3-6). In total 21 samples were collected (3 from each sample site) to a total core depth of 2.0 m below riverbed. The composition of the sediment samples collected from the proposed dredge area were dominated by fine/medium grained sand, with minor components of silt, clay and gravel. No clear spatial or stratigraphic trends were identified. Sediment was largely reported as yellow to light brown sand with minor shell and shell grit. The particle size distribution percentages from the samples is shown in Table 3-2.

As described in Section 2.10, the primary analytical assessment did not identify contaminants of potential concern in exceedance of the assessment criteria in accordance with the National Assessment Guidelines for Dredging (NAGD). For the purpose of risk-based assessment for potential terrestrial reuse of dredged sediment within the project area, the National Environment Protection Measure (NEPM) Health Investigation Levels (HILs) 'A' were applied and were found not be exceeded. Acid sulphate screening results generally returned very low or no acidity or indications of potential acid sulphate material in sediment samples.

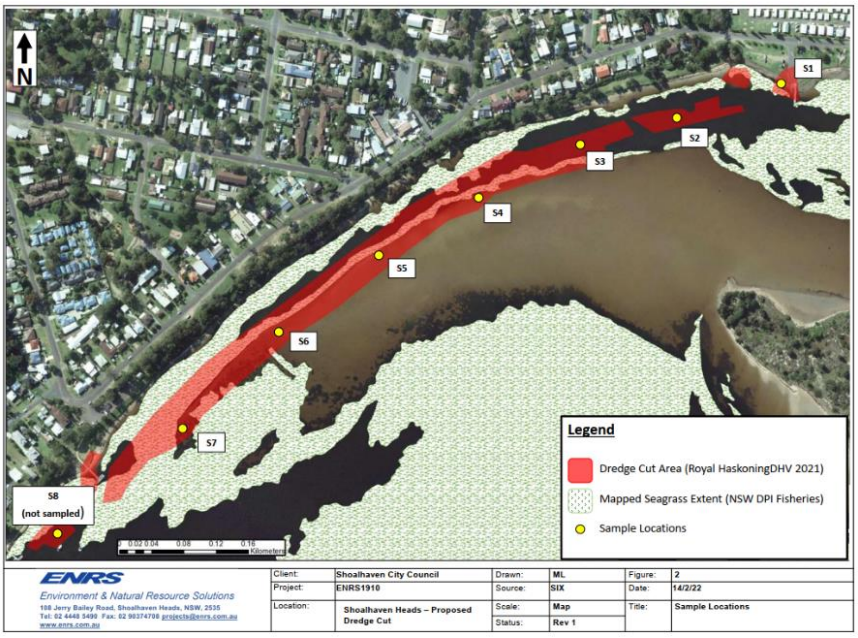


Figure 3-6 ENRS Sediment Sampling Locations and Royal Haskoning DHV Proposed Dredge Cut Area (Source: ENRS, 2022)

Table 3-2 Particle Size Distribution Percentages from Representative Depths (Source: ENRS, 2022)

Core/depth	Fines (<60 µm)	Sand (60 µm - 2mm)	Gravel (>2mm)
S1/0-0.5	4	93	3
S2/0-0.5	2	98	<1
S3/0-0.5	3	97	<1
S4/0-0.5	1	99	<1
S5/0-0.5	3	97	<1
S6/0-0.5	4	96	<1
S7/0-0.5	2	97	1
S1/0.5-1.0	5	88	7
S2/0.5-1.0	2	97	1
S3/0.5-1.0	17	82	1
S4/0.5-1.0	2	98	<1
S5/0.5-1.0	4	96	<1
S6/0.5-1.0	5	95	<1
S7/0.5-1.0	3	96	1
S1/1.0-2.0	2	97	1
S2/1.0-2.0	2	93	5
S3/1.0-2.0	22	78	<1
S4/1.0-2.0	3	97	<1
S5/1.0-2.0	4	96	<1
S6/1.0-2.0	9	91	<1
S7/1.0-2.0	8	89	3

3.7 Bathymetry

Bathymetry is required to describe the level of the channel bed over the extent of the study area. Channel depth is one of the key dimensions for assessing the adequacy of the navigation channel for the nominated design vessel measured below a particular reference water level.

Figure 3-7 depicts the bathymetry of the navigation channel based on survey undertaken by Hydrographic and Cadastral Survey in February of 2022. Typical depths at the centreline of the channel are approximately -2 m AHD. Channel width varies with the narrowest section approximately 20 m wide.

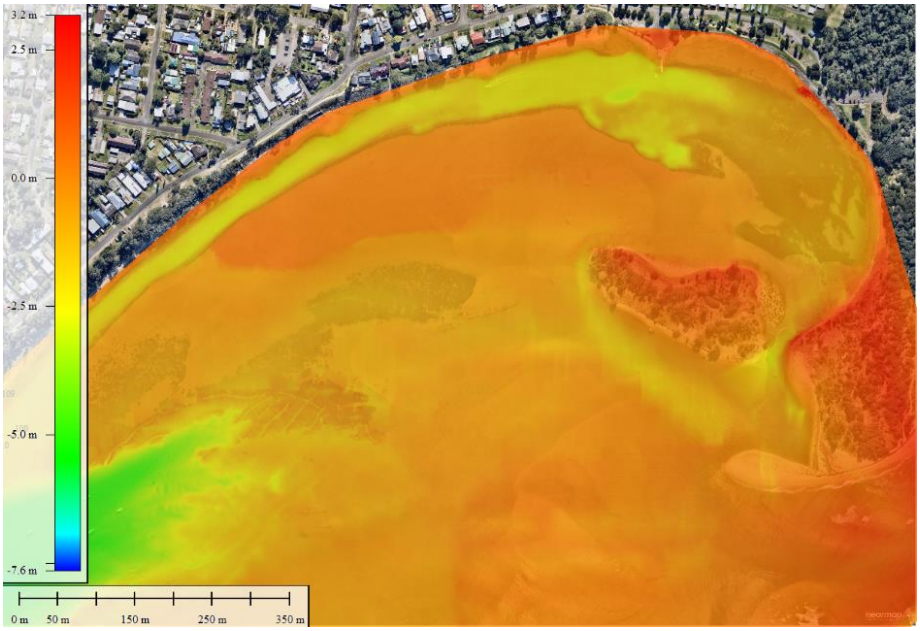


Figure 3-7 Bathymetry of Navigation Channel Based on Survey Obtained in 2022 (Hydrographic and Cadastral Survey)

3.8 Navigation

The navigation channel is a 4 knot zone marked with navigation aids as depicted in Figure 3-8, noting the northern extent of the channel is the downstream end. There are boat ramps located at the northern extent of the channel (Holiday Haven), the public wharf and Hay Avenue.

Figure 3-8 NSW Boating Map of the Study Area sourced from the TfNSW Website https://www.nsw.gov.au/sites/default/files/2021-07/11a-kiama-gerringong-gerroa-nowra-crookhaven.pdf

4 Existing Environment

An overview of key environmental assets/sensitivities in the Study Area and vicinity (Figure 1-2), including biodiversity, protected areas, geology, soil, sediments, waterways, and the human environment is provided in the Sections below.

Desktop and field investigations have been previously commissioned by SCC to understand the environmental assets and sensitivities within the Study Area. Field and desktop assessments as well as a risk assessment were undertaken by Stantec (2022) for both marine and terrestrial values, and sediment sampling by ENRS (2022). These reports are summarised in Section 2. An updated Protected Matters Search (PMS) was also undertaken by Advisian as part of the current study. The Study Area includes the marine foreshore and the lower Shoalhaven River estuary, where proposed dredging and beach nourishment is proposed to take place (Figure 1-2).

The desktop studies identified several sensitive environmental receptors within the Study Area, which, itself sits within the Lower Shoalhaven/Crookhaven Nationally Important Wetland (Wetland code NSW088). The wetland is classified as an Important Wetland by the Department of Climate Change, Energy, the Environment and Water due to the relatively large areas of mangroves, saltmarsh and seagrasses considered to be a representative example of estuarine wetland on the South Coast.

These environmental receptors include a number of threatened and protected species listed under the Biodiversity Conservation Act 2016 (BC Act), Fisheries Management Act 1994 (FM Act) and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EBPC Act).

Non-Environmental receptors have also been included within this report and will include examination of indigenous and non-indigenous heritage, land use, traffic and access, and socioeconomics.

4.1 Biodiversity

The Study Area contains diverse aquatic and foreshore habitats including seagrasses, saltmarshes and mangroves, coastal vegetation, and tidal flats. There are also several areas of landscaped trees and grasses. Results presented have been summarised from the Flora and Fauna assessment of the Study Area (Stantec, 2022) and an updated Protect Matters Search Tool (PMST) report. A high-level summary of key values only has been provided.

4.1.1 Marine Values

The proposed dredging area is contained within an estuary of approximately 31.9 km^2 with an average depth of 2.9 m.

The marine environment in the estuary consists of bare soft sediment areas or soft sediment areas colonised by marine vegetation. Benthic, soft sediment, infauna assemblages generally consist of burrowing organisms, such as polychaete worms, amphipod crustaceans, bivalve and gastropod molluscs and other worm-like phyla such as nemerteans and nematodes (which are often abundant).

Native vegetation – Mapping by NSW DPI indicates that the estuary contains approximately 1 km^2 of seagrass (primarily *Zostera capricornii*) (4.9% of the estuary area), 3.5 km^2 of grey mangrove (predominantly Avicennia marina) (17% of estuary area) and 1.5 km^2 of saltmarsh (7.4% of estuary area). Finding from Stantec (2022) indicated that of the total area surveyed (approximately 23 km^2) the

majority of marine vegetation recorded consisted of *Zostera capricornii* (0.3 km^2), followed by mangroves (0.04 km^2), a mixture of both mangrove and saltmarsh (0.03 km^2) and to a smaller extent saltmarsh (0.0003 km^2). Mangroves were all identified as grey mangrove and saltmarsh assemblages consisted mostly of *Suaeda australis* with occasional patches of *Sarcocornia quinqueflora*.

Threatened flora – There are no previous records of threatened marine flora in the study area and none were recorded in the field survey.

Threatened fauna – 110 Threatened fauna species (33 species under both the EPBC Act and BC/FM Act, 63 species under the EPBC Act and 14 species under the BC/FM Act) have been identified as potentially occurring in the study area based on both the PMST report and the Stantec desktop results (2022). These species are presented in Table 4-1. The field assessment by Stantec (2022) did not identify threatened marine fauna in the marine survey area.

Table 4-1 Threatened Marine Fauna with the Potential to Occur in the Study Area

Attribute	EPBC/BC/FM Listing	Number	Reference
Avifauna	EPBC only	18	Stantec (2022), Appendix A.
	BC/FM only	13	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC/FM	24	
Marine Mammals	EPBC only	1	Stantec (2022), Appendix A.
	BC/FM only	1	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC/FM	2	
Migratory Species	EPBC only	37	Stantec (2022), Appendix A.
	BC/FM only	0	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC/FM	4	
Fish and Sharks	EPBC only	7	Stantec (2022), Appendix A.
	BC/FM only	0	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC/FM	3	

Threatened ecological communities (***TECs***) – No TECs have been identified in the marine environment of the Study Area. Terrestrial based TECs are detailed in Section 4.1.2, some of which may extend into the intertidal zone.

Biologically Important Areas (***BIAs***) – There are 6 breeding and foraging based BIAs within the study footprint and surrounding buffer zone (Table 4-2).

Table 4-2 Biologically Important Areas (BIAs)

Attribute	Listing	Species	Reference
Biologically Important Areas	Foraging	*Ardenna pacifica* – Wedge-tailed Shearwater	

Attribute	Listing	Species	Reference
		Ardenna tenuirostris – Short-tailed Shearwater *Carcharias taurus* – Grey Nurse Shark *Megaptera novaeangliae* – Humpback Whale	Protected Matters Search (2023), List of Biologically Important Areas.
	Breeding	*Tursiops aduncus* – Indo-pacific/ spotted bottlenose dolphin *Pelagodroma marine* – White-faced Storm-petrel	

4.1.2 Terrestrial Values

A terrestrial survey was carried out on the foreshore areas within a 10 m buffer of the Study Area (Stantec, 2022). Prior to survey, desktop analysis had also been undertaken in the form of a PMST.

Flora, fauna and native vegetation

Stantec (2022) identified some significant ecological values present within the terrestrial environment. Initially, the desktop assessment identified the potential presence of native vegetation, threatened flora and fauna, Plant Community Types (PCTs) and Threatened Ecological Communities (TECs). The terrestrial flora and fauna field assessment subsequently verified the presence of PCTs and TECs within the study area, however, it did not record the presence of any threatened flora or fauna species.

Native Vegetation

The field assessment by Stantec (2022) identified 86 flora species in the Terrestrial Survey Area, including 42 native species (49% of all species identified) and 44 exotics (51%) across 48 families. The most diverse families were Poaceae (14 species) and Asteraceae (11 species). No threatened flora was detected during site inspections, however, the desktop assessment revealed that the study area has the potential to support 20 threatened species.

Within the study footprint, three Plant Community Types (PCTs) had been ground-truthed and are presented in Table 4-3.

Table 4-3 Plant Community Types

Plant Community Type Code	Description
659	Bangalay – Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and Southeast Corner Bioregion
772	Coast Banksia – Coastal Wattle dune scrub of the Sydney Basin Bioregion and Southeast Corner Bioregion
659	Bangalay Sand Forest in the Sydney Basin and South East Corner Bioregions

Native vegetation mapped within the Terrestrial Survey Area as part of the field survey included high- and low-quality areas of PCT 659 - Bangalay - Old-man Banksia open forest on coastal sands, Sydney

Basin Bioregion and Southeast Corner Bioregion (Figure 4-1). The species composition within the Terrestrial Survey Area included a high proportion of species that are also characteristic of PCT 772 (Coast Banksia - Coast Wattle dune scrub of the Sydney Basin Bioregion and Southeast Corner Bioregion), however this PCT is classified as a heathland vegetation formation and comprised of low, dense scrub that does not include many of the upper and mid-storey canopy species that dominated the vegetated zones within the Terrestrial Survey Area.

Figure 4-1 Figure showing (a) Ground Truth Vegetation Mapping Within the Terrestrial Survey Area (PCT 659) and (b) Photo Looking from the Shoreline out Towards the River (Stantec, 2022)

Threatened flora – Twenty (20) plant species of conservation significance have been previously recorded or could potentially occur within a 5 km buffer of the Study Area (Table 4-4), these species are listed under either or both the Commonwealth EPBC Act or the BC Act (NSW).

The field assessment by Stantec did not identify any threatened flora species present in the Terrestrial Study Area.

Table 4-4 Threatened Flora Species

Attribute	EPBC/BC Listing	Number	Reference
Flora	EPBC only	1	Stantec (2022), Appendix A.
	BC only	3	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC	16	

Threatened fauna – Fifty-two (52) fauna species of conservation significance have been previously recorded or could potentially occur within a 5 km buffer of the onshore area (Table 4-5). These are listed under one or more of the EPBC Act or the BC Act. Of these, 36 species are considered migratory.

The field assessment by Stantec did not identify any threated fauna species or habitat present in the Terrestrial Study Area.

Table 4-5 Threatened Fauna Species

Attribute	EPBC/BC/FM Listing	Number	Reference
Reptiles (Includes Turtles and Snakes)	EPBC only	6	Stantec (2022), Appendix A.
	BC/FM only	0	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC	0	
Frogs	EPBC only	0	Stantec (2022), Appendix A.
	BC/FM only	0	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC	3	
Terrestrial Mammals	EPBC only	2	Stantec (2022), Appendix A.
	BC/FM only	1	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC	6	
Migratory Species	EPBC only	27	Stantec (2022), Appendix A.
	BC/FM only	1	Protected Matters Search (2023), List of Threatened Species.
	EPBC & BC	6	

Threatened ecological communities (***TECs***) – Seven (7) nationally threatened (EPBC listed) ecological communities have been identified as potentially occurring in the study area (Table 15-2Table 4-6). The field assessment by Stantec (2022) identified one (1) TEC (PCT 659) present in the Survey Area (Bangalay Sand Forest).

Table 4-6 Threatened Ecological Communities with the Potential to Occur in the Study Area

Threatened Ecological Community	Status
Coastal Swamp Oak (Casuarina Glauca) Forest of New South Wales and Southeast Queensland Ecological Community	Endangered
Illawarra and South Coast Lowland Forest and Woodland Ecological Community	Critically Endangered
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered
Subtropical and Temperate Coastal Saltmarsh	Vulnerable
Coastal Swamp Sclerophyll Forest of New South Wales and Southeast Queensland	Endangered
River-flat Eucalypt Forest on Coastal Floodplains of Southern New South Wales and Eastern Victoria	Critically Endangered
Illawarra Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion	Critically Endangered
Bangalay Sand Forest of the Sydney Basin and Southeast Corner Bioregions (PCT 659 forms part of this)	Endangered

Bangalay Sand Forest of the Sydney Basin and Southeast Corner bioregions PCT 659 forms part of the Bangalay Sand Forest TEC - listed as Endangered under the BC Act and is defined as a finer scale community. As this PCT does not occur outside of the TEC, no further assessments in line with key diagnostics and condition assessments are required and PCT 659 in the Terrestrial Survey Area is commensurate with the BC Act listed TEC 'Bangalay Sand Forest of the Sydney Basin and Southeast Corner bioregions' listing description.

Bangalay Sand Forest of the Sydney Basin and Southeast Corner bioregions is currently known from parts of the Shoalhaven Local Government Area. It occurs on deep, freely draining to damp sandy soils on flat to moderate slopes within a few kilometres of the sea and at altitudes below 100 m. This TEC is characteristed by a large assemblage of species, including, *Acacia longifolia, Banksia integrifolia* subsp. *integrifolia, Banksia serrata, Breynia oblongifolia, Casuarina glauca, Commelina cyanea, Dianella caerulea* var. *caerulea, Eucalyptus botryoides, Kennedia rubicunda, Leptospermum laevigatum, Lomandra longifolia, Pittosporum undulatum, Pteridium esculentum* and *Themeda australis*.

Weed invasions, including those causing reduced ecological function, are common in this TEC. Invasion of native plant communities by exotic perennial grasses is listed as a Key Threatening Process for this community.

4.1.3 Protected Areas

There are no Areas of Outstanding Biodiversity Value (AOBV), critical habitats (as listed under the NSW BC Act, FM Act or EPBC Act) and no marine parks within the Study Footprint or Study Area.

There are several other notable areas of conservation value within the Study Footprint and Study Area (Table 4-7 and Figure 4-2).

Table 4-7 Protected Areas in both Study Footprint (broad area in the vicinity of the works) and Study Area (refers to direct footprint of the proposed dredging and nourishment area)

Within Study Area
Coastal wetlands and proximity areas as designated under the State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP)
Foreshore land directly adjacent to where dredging and nourishment works would take place is part of the Shoalhaven Heads Holiday Park crown reserve
Terrestrial Biodiversity Environmental Planning Instrument (EPI) (RH SEPP and Shoalhaven Local Environmental Plan 2014 (the LEP)) protection area
Comerong Island Nature Reserve (750 m south of Study Footprint) and Seven Mile Beach National Park (1750 m north of the Study Area)
Within the Study Footprint
Biodiversity Values Offset Areas as per the BC Act. This may therefore trigger a Biodiversity Offset Scheme (BOS) (refer to Section2);
Riparian lands and watercourses EPI (RH SEPP and the LEP) protection area. Areas where EPI protection areas apply may be subject to provisions of the LEP and restrictions to development in those locations may therefore apply
Shoalhaven/Crookhaven Estuary – Nationally Important Wetland

Figure 4-2 Areas of Conservation Significance (Source: DPE, 2022)

Marine and Coastal Protected Areas

There are no Nationally Significant Marine or Coastal Protected Areas within the Study area, however two State protected areas occur within the 5 km buffer:

- Comerong Island (Nature Reserve); and,
- Seven Mile Beach (National Park).

There are no international Wetlands of Importance nor are there any Commonwealth Marine Areas within the study footprint.

Nationally Significant Wetlands

Shoalhaven/Crookhaven Estuary of the Lower Shoalhaven River are amongst the most extensive on the NSW south coast. It is listed in the 3rd Edition of '*A Directory of Important Wetlands of Australia*' (2001).

State Significant Wetlands

No State Significant Wetlands have been identified within the study area.

Waterways

The Shoalhaven River is the significant waterway situated within the study area.

Groundwater dependent ecosystems

Aquatic Groundwater Dependent Ecosystem (Figure 4-3)

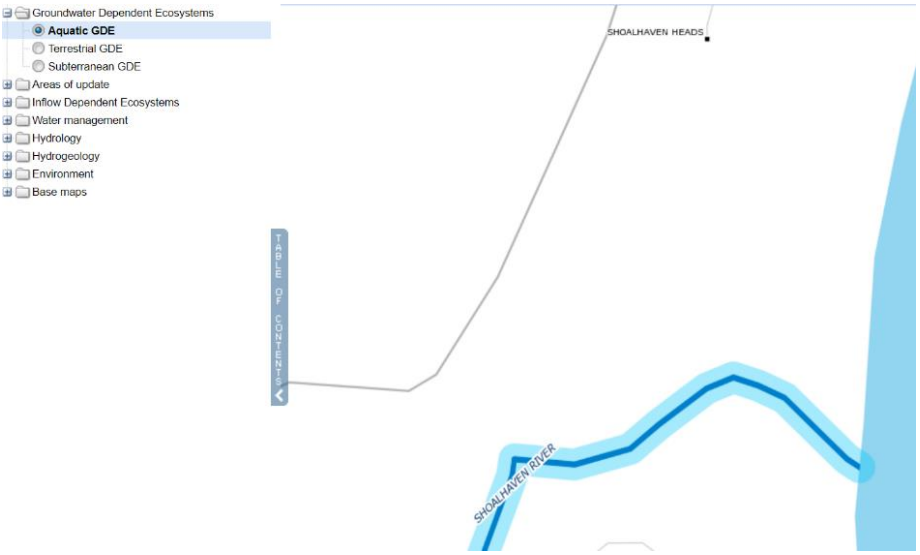


Figure 4-3 Aquatic Groundwater Dependent Ecosystems

*Terrestrial Groundwater Dependent Ecosystem (*Figure 4-4*).*

Figure 4-4 Terrestrial Groundwater Dependent Ecosystems

Subterranean Groundwater Dependent Ecosystem (Figure 4-5) were not present in the study area.

Figure 4-5 Subterranean Groundwater Dependent Ecosystems

4.2 Geology, Sediments and Soil

The Sediment Sampling and Analysis Plan (SAP) Implementation Report (ENRS, 2022) explains that historically the Lower Shoalhaven River area has been subject to the following processes and activities that have been identified as having the potential to impact geology, sediments, and soils within the Study Area:

- Discharges of contaminants from recreational vessels within the navigation channel and broader catchment area;
- Stormwater runoff from urban, rural, industrial and parkland areas; and,
- Discharges from industrial areas and defence. Erosion of riverbanks containing uncontrolled fill including bonded fibre cement sheeting.

No field work or additional investigations were undertaken by Advisian as part of the current report, results below are based on the findings of the Sediment Sampling and Analysis Plan (SAP) Implementation Report, ERNS (2022).

Within the Study Area, two soil classifications (Australian Soil Classification) are found.

- Hydrosols: Hydrosols are soils that are saturated with water for long periods of time—typically a grey (or greenish grey) colour.
- Rudosols: These soils orders generally have a low fertility and low water-holding capacity. Rudosols and Tenosols are poorly developed but widespread and can be shallow and stony.

Figure 4-6 Soil Mapping Within the Study Area (Source: Espade, 2023)

The underlying geology comprises mud, silt and sand (Minview, 2023).

4.2.1 Sediments Values

Field investigation by ENRS (2022) described the sediments as largely yellow to light brown sand with minor shell and shell grit. These observations are consistent with the physical location the investigation area and its proximity to intermittent river mount activations.

Metal concentrations in sediments were identified to be homogenous laterally and vertically throughout the investigation area. For all the metals tested, the calculated 95% UCL values were below the respective NAGD and NEPM assessment criteria. Within surface sediments (0-0.5 m), organic compounds (TRHs, BTEXN, PCBs, Organotins and PAHs), pesticides and PFAS/PFOA were all present at concentrations below the assessment criteria. No analysis of organic compounds, pesticides or PFAS/PFOS from deeper sediment profiles (0.5-2.0 m) were undertaken as no visual or olfactory triggers were identified.

For the purpose of risk-based assessment for potential terrestrial reuse of dredged sediment within the project area, the National Environment Protection Measure (NEPM) Health Investigation Levels (HILs) 'A' were applied. The analytes/contaminants tested included 15 metals, BTEXN, TRH, PAH, Organotins, OC/OP Pesticides, PFAS, TOC, PCBs and PSD. Metal concentrations in the sediments were identified to be homogenous laterally and vertically throughout the investigation area. For all the metals tested, the calculated 95% UCL values were below the respective NAGD and NEPM criteria. Within surface sediments (0 – 0.5 m), organic compounds, pesticides and PFAS/PFOA were all present at concentrations below the assessment criteria, with most analytes not present at detectable levels. Acid sulphate screening results generally returned very low or no acidity or indications of potential acid sulphate material in sediment samples.

The primary analytical assessment did not identify contaminants of potential concern in exceedance of the assessment criteria in accordance with the National Assessment Guidelines for Dredging (NAGD). Therefore, no evaluation or characterisation of the bioavailability or ecotoxicity of sediments was required.

4.2.2 Soil Values

Desktop analysis by ENRS (2022) and using ESPADE determined the following regarding Acid Sulfate Soil Risk mapping:

- The aquatic regions are classified as Hm: High probability, bottom sediments
- The terrestrial regions are classified as L2: Low probability 1-3m below ground surface

Further to this, the ENRS (2022) data stated that: The pHField and pHFOX results generally returned very low or no acidity or indications of potential acid sulphate material in sediment samples.

4.3 Heritage

4.3.1 Aboriginal Cultural Heritage

Aboriginal peoples have continuously utilised the resources of the South Coast region for at least 20,000 years. The Jerrinja Tribe are the traditional owners of the Shoalhaven region. Owing to the productive nature of the land and its proximity to the sea (which provides important food sources), there are many sites with significant Aboriginal heritage value across the Shoalhaven LGA. Along the coast this includes middens, burial sites, artefacts, rock shelters and ceremonial areas.

A review of the Aboriginal Heritage Information Management System (AHIMS) on 27 March 2023 identified one Aboriginal site recorded near the study area (Figure 4-7) along the foreshore between Wharf and River Roads. There are no declared Aboriginal places.

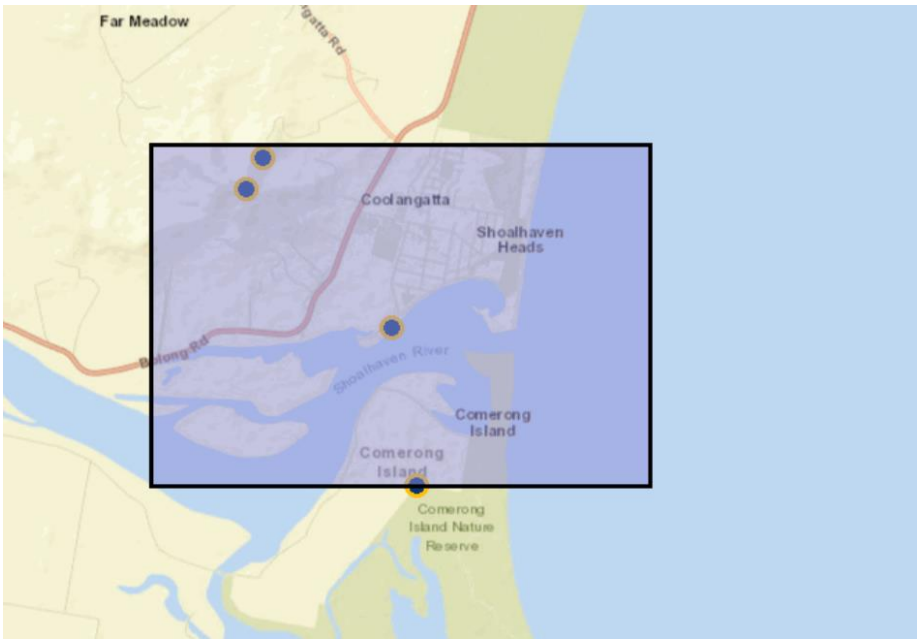


Figure 4-7 AHIMS Basic Search Showing Aboriginal Site Recorded at the Southern end of River Road

4.3.2 Historic Heritage

There are no listed heritage items, heritage conservation areas or archaeological sites located within the study area. The closest heritage item to the study area is the "Coomanderry Swamp Drainage Channel" (Item No. 39) listed under Schedule 5 of the *Shoalhaven Local Environmental Plan 2014* (the LEP). The study area is located about 150 m from the eastern edge of this item's curtilage.

4.4 Land Use and Property

The site features Shoalhaven River and a portion of the foreshore area along River Road at Shoalhaven heads. Shoalhaven River is a perennial river that rises from the Southern Tablelands and is characterised as a barrier river estuary with an open entrance that is wave dominated. The site is located on land zoned *RE1 Public Recreation* and *W2 Recreational Waterways* under the LEP as shown in (Figure 4-8).

Figure 4-8 Land Zoning Map (Source: NSW Planning Portal, 2023)

The waterway of Shoalhaven River and the foreshore land is Crown Land, administered by the Crown, with the foreshore area also being located on Crown Land Reserve. Crown Land Reserve Number 52855 is managed by SCC for the purpose of public recreation. Crown License Number 630902 is located along the adjacent foreshore which is for the purpose of the Coastal Protection Works.

4.5 Air Quality

The nearest air quality monitoring site is in Albion Park (https://www.environment.nsw.gov.au/topics/air/monitoring-air-quality/illawarra/monitoring-stations/albion-park-south), approximately 45 km north of Shoalhaven Heads. Air quality at this location is generally good and comparable with levels monitored throughout Australia, with occasional exceedances.

4.6 Traffic, Transport and Access

The study footprint area has one road running alongside Shoalhaven River: River Road. This road also contains access to an unnamed car park. There are two bus stops which are also situated on these sections of River Road. Houses which run alongside the river may also feature private boat ramps which lead directly into the study footprint.

4.7 Socio-Economic

The 2021 census data shows that there are 3,224 people residing within Shoalhaven Heads with a population density of 793.8 persons per square km. No current data is available to give a larger scope of the social and economic profile of Shoalhaven Heads as the data is currently password protected and only available to Council staff.

5 Navigational Requirements

5.1 Introduction

As detailed in the Basis of Design (BoD), the navigation requirements have been developed in accordance with *AS3962:2020 Marina Design,* the PIANC document *Harbour Approach Channels Design Guidelines* and other relevant standards/guidelines while considering the existing site conditions and design vessels for the waterway. Although the site is not a marina, parallels can be drawn from the above-mentioned standards given there are no other regulatory guidelines to utilise in Australia.

5.2 Design Vessel

The Boating Demand Study (Rhelm, 2022) identified that the type of boats used on the lower Shoalhaven River are predominantly small power boats (4 – 6 m at 47% and 6 – 8 m at 13%) accounting for approximately 60% of all boat users. As such for channel design purposes, the design vessel will be taken conservatively as an 8 m long power boat.

As per AS3962:2020 Marina Design, an 8 m long power boat has the following parameters (95th percentile) relevant to channel design:

- 0.9 m draft; and,
- 3.4 m beam.

The following design vessel data will be used for the assessment of the navigation channel.

Table 5-1 Design Vessel Specification

Vessel Type	Length (m)	Beam (m)	Draught (m)
Trailerable Power Boat	8	3.4	0.9

5.3 Design Channel Width

5.3.1 AS3962:2020 Marina Design Method

The width of an entrance channel is dependent on a number of factors including:

- Exposure to wind, waves and currents, which reduces the maneuverability of vessels
- Number of vessel movements
- Type and size of vessels
- Extent of navigation aids provided.

AS 3962:2020 states that for an entrance channel, the minimum width should be the greatest of:

(a) 20 m;

(b) (L + 2) m, where L is the overall length of the longest boat, therefore 8 m + 2 m = 10 m; or

(c) 5B m, where B is the beam of the broadest mono-hull boat, therefore 5 x 3.4 m = 17 m.

Based on the above, the preferred channel width would be 20m.

5.3.2 The PIANC document "Harbour Approach Channels Design Guidelines" Method

The PIANC document "*Harbour Approach Channels Design Guidelines*" bases the required channel width on the criteria presented in Figure 5-1 to Figure 5-4.

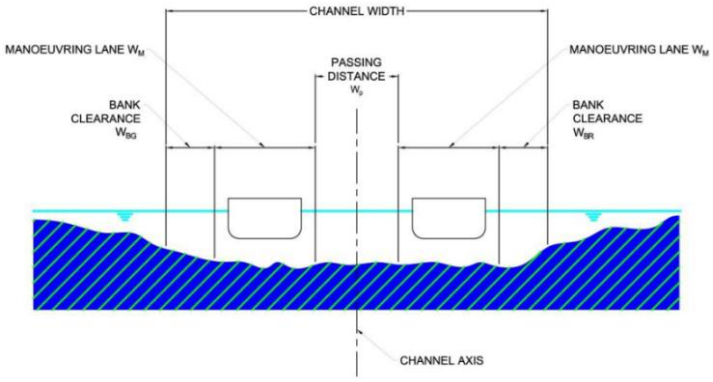


Figure 5-1 Channel Width Components (Source: PIANC Harbour Approach Channels Design Guidelines)

Ship Manoeuvrability	Good	Moderate	Poor
Basic Manoeuvring Lane, W_{BM}	1.3 *B*	1.5 *B*	1.8 *B*

Figure 5-2 – Channel Width Basic Manoeuvring Lane Criteria (Source: PIANC Harbour Approach Channels Design Guidelines

Width for bank clearance (W_{BR} and/or W_{BG})	Vessel Speed	Outer channel (open water)	Inner channel (protected water)
Gentle underwater channel slope (1:10 or less steep)	fast moderate slow	0.2 *B* 0.1 *B* 0.0 *B*	0.2 *B* 0.1 *B* 0.0 *B*
Sloping channel edges and shoals	fast moderate slow	0.7 *B* 0.5 *B* 0.3 *B*	0.7 *B* 0.5 *B* 0.3 *B*
Steep and hard embankments, structures	fast moderate slow	1.3 *B* 1.0 *B* 0.5 *B*	1.3 *B* 1.0 *B* 0.5 *B*
Note: W_{BR} and W_{BG} are widths on 'red' and 'green' sides of channel			

Figure 5-3 – Channel Width Bank Clearance Criteria (Source: PIANC Harbour Approach Channels Design Guidelines)

Width for passing distance W_p	Outer Channel (open water)	Inner Channel (protected water)
Vessel speed V_s (knots)		
- fast: $V_s \geq 12$	2.0 *B*	1.8 *B*
- moderate: $8 \leq V_s < 12$	1.6 *B*	1.4 *B*
- slow: $5 \leq V_s < 8$	1.2 *B*	1.0 *B*

Figure 5-4 – Channel Width Passing Distance Criteria (Source: PIANC Harbour Approach Channels Design Guidelines, 2014)

Based on applying the design vessel length of 8 m and a vessel beam of 3.4 m, the required navigation channel width should be 15.64 m (~4.6B) as presented in Table 5-2.

Table 5-2 Minimum and Preferred Channel Widths in Accordance with PIANC

Component	Criteria	Width (m)
Manoeuvring Lane (W_M)	1.5B (moderate)	5.1
Bank Clearance (W_{BG})	0.3B (slow vessel speed, protected water)	1.02
Width Passing Distance (W_P)	1.0 B (slow vessel speed, protected water)	3.4
Channel Width	W_M x 2 +W_{BG} x 2 + W_P	15.64 (~4.6B)

5.3.3 Adopted Channel Width for Navigation Assessment

Following consideration of both AS3962 and PIANC, the AS3962 channel dimension of **20 m** has been adopted given this is the larger of the two and the methodology is more appropriate for smaller recreational vessels.

5.4 Design Channel Depth

To determine the channel depth, the following key factors need to be considered with channel depths presented in Table 5-3:

- draft of the design vessel – 0.9 m;
- minimum design tidal level for used by the design vessels
    - a design tidal level of MLWS (-0.415 AHD) adopting the **worst-case** scenario of the entrance being open
- half of the design wave height for navigation – ½ of 0.67 = 0.34 m (0.67 m wave is based on wave hindcasting for 20year ARI); and,
- under keel clearance (UKC) – 0.3 m for soft material.

$$\text{Navigation Channel Depth} = \text{Design Water Level} - \text{Draught} - \frac{H}{2} - \text{UKC}$$

Based on the above the above channel depths have been determined (Table 5-3).

Table 5-3 Design Channel Depth Calculations

Vessel	Datum	Navigating Water Level (MLSW)	Draft	0.5H	Sedimentation	UKS	Navigating Depth Required (m)	Description
8m Powerboat	AHD	-0.415	0.9	0.335	0	0.3	-1.95	Entrance Open, no sedimentation and soft bottom
8m Powerboat	AHD	-0.415	0.9	0.335	0.2	0.3	-2.15	Entrance Open,sedimentation and soft bottom
8m Powerboat	AHD	-0.415	0.9	0.2	0	0.3	-1.815	Entrance open, no sedimentation and soft bottom 8m vessel 0.4m wind wave
6m Powerboat	AHD	-0.415	0.6	0.335	0	0.3	-1.65	Smaller 6m long vessel, MLWS, 0.67m wave height, soft bottom
6m Powerboat	AHD	-0.415	0.6	0.2	0	0.3	-1.515	Smaller 6m long vessel, MLWS, 0.4m wave height, soft bottom

The required channel depth for navigation based on the adopted design vessel is -1.95 m AHD. Anywhere higher than -1.95 m AHD would require dredging, an allowance of 200 mm would be added to those areas dredged taking it to -2.15 m AHD.

5.5 Required Navigation Channel Depth and Width

Based on the above a design channel width of 20 m and channel depth of -1.95 m AHD has been determined as necessary for an 8 m long vessel navigating the channel at MLWS when the entrance channel is open in a 20yr ARI wave height. This has been based on AS3962 the Australia Standard typically used for marina design and is classified as conservative for this situation.

6 Navigation Channel Assessment

6.1 General

Based on the hydrographic survey undertaken in 2022 (Hydrographic and Cadastral Survey), a three-dimensional terrain model has been established and navigation assessment plans developed showing the existing seabed depths. A colour gradient scale has been adopted for the varying depths.

The design channel requirements (depth and widths) developed in Section 5 have been overlayed on these plans to identify where the design channel requirements are not met. Areas coloured within the proposed navigation channel do not provide sufficient depth according to the requirements of AS3962 for the 8 m long design vessels. Figure 6-1 graphically depicts the areas within the 20 m wide channel that do not comply with the navigation channel design depth of -1.95 m AHD. If these specific areas were to be dredged, the dredge level would be 200 mm deeper (i.e. -2.15 m AHD) to provide a sedimentation allowance, and the dredge footprint would widen to allow for dredge batter slopes.

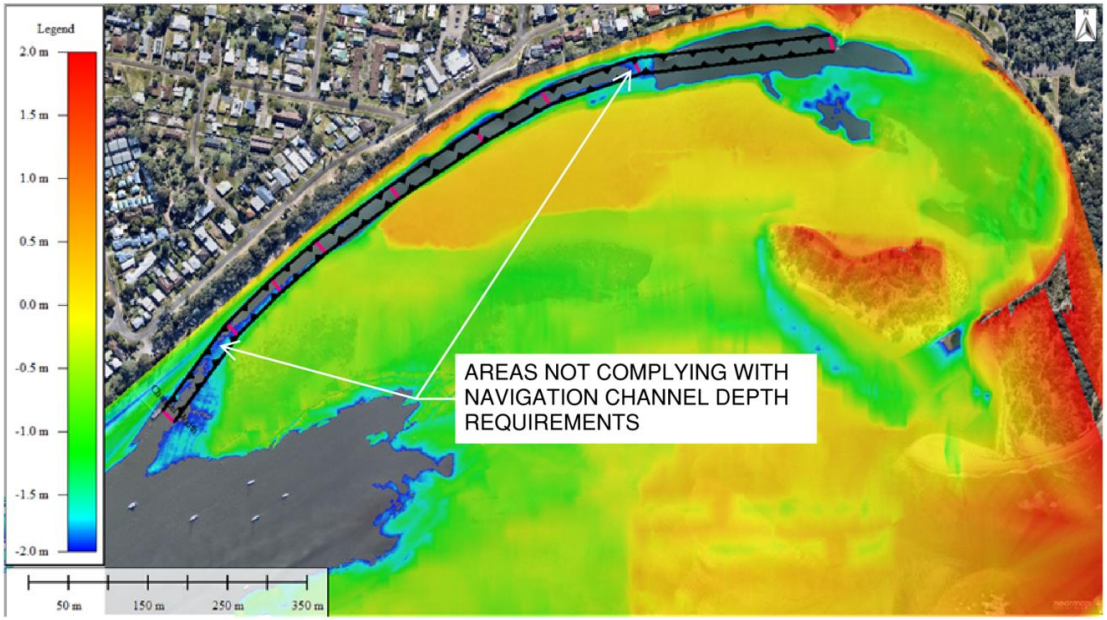


Figure 6-1 Plan Showing all Areas not Complying with the Navigation Channel Design Requirements Based on Navigation Channel Depth of -1.95 m AHD

6.2 Analysis of Navigation Depth Requirements

As detailed in Section 5, the navigation channel assessment has been based on the following criteria:

- 8 m long vessel with a draft of 0.9 m;
- significant wave height (H_s) of 0.67 m based on wave hindcasting, winds from the Southwest and a 20 year ARI;
- entrance open condition; and
- MLWS -0.415 m AHD (entrance open).

This criteria is considered conservative given the likelihood of the event and that a vessel would be using the channel during that event. As such, a sensitivity analysis has been undertaken to determine the necessity for dredging if the above criteria was refined for various scenarios.

Seven scenarios have been considered as follows:

- Scenario 1 – Design navigation channel as per Section 5;
- Scenario 2 – reduced wave height of 0.4 m to consider smaller storm events;
- Scenario 3 – reduced wave height of 0.3 m to consider smaller storm events;
- Scenario 4 – closed entrance condition giving a higher design low water level;
- Scenario 5 – closed entrance condition giving a higher design low water level and a reduced wave height of 0.4 m to consider smaller storm events;
- Scenario 6 - closed entrance condition giving a higher design low water level and reduced wave height of 0.3 m to consider smaller storm events; and,
- Scenario 7 – reduced design vessel length of 6 m.

The scenario with refined criteria values and the corresponding dredging requirements are presented in Table 6-1.

Table 6-1 Dredge Requirements for Scenarios

Scenario	Vessel Length	Entrance Condition	MLWS (m AHD)	Wave Height	Navigation Channel Depth Requirement	Dredging Required	Dredge Depth Required (Incl. tolerance)	Material Volume m^3 *
1	8	Open	-0.415	0.67	-1.95m AHD	Yes	-2.15m AHD	3,016
2	8	Open	-0.415	0.4	-1.815m AHD	Yes	-2.015m AHD	554
3	8	Open	-0.415	0.3	-1.765m AHD	Yes	-1.965m AHD	253
4	8	Closed	-0.299	0.67	-1.834m AHD	Yes	-2.034m AHD	897
5	8	Closed	-0.299	0.4	-1.699m AHD	No	-	-
6	8	Closed	-0.299	0.3	-1.649m AHD	No	-	-
7	6	Open	-0.415	0.67	-1.65m AHD	No	-	-

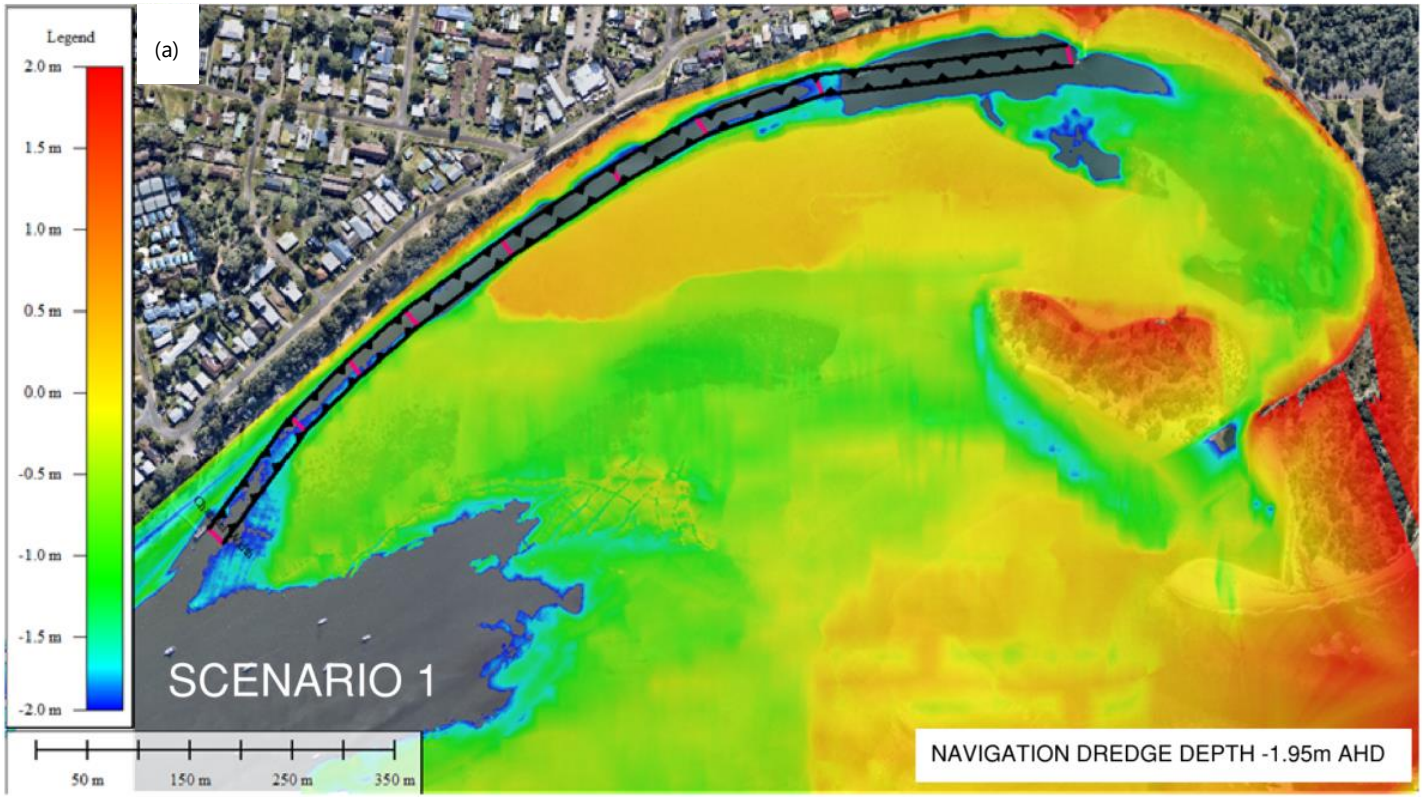
* material volumes are an estimate only and would be refined in the design phase. As shown on Figure 8-2, the volume includes 200 mm sedimentation allowance, 200 mm of dredging tolerance and an allowance for batter slopes.

Figure 6-2 graphically presents scenarios 1 – 4 with the coloured areas within the navigation channel highlighting areas that do not comply with the Navigation Channel Design Requirements (and would require dredging). If an "entrance closed" condition is adopted dredging is not required for an 8 m vessel for waves less than or equal to 0.4 m (noting 0.67 m wave height was based on a 20 year ARI). 8 m vessels would also be able to navigate the channel during the 1 in 20 year storm at water levels of -0.18 m AHD or higher. It should be noted if a 6 m design vessel were selected no dredging would be required regardless of entrance conditions.

AS3962:2020 the Australian Standard used for the channel assessment is intended for vessels approaching marinas of busy waterways. The study area comprises a natural, quieter channel generally only used by vessels that launch at the River Road boat ramp. This should also be considered in determining the requirement for dredging.

The navigation assessment has indicated a small area of the channel would require dredging to comply with the adopted Australia Standard; however, it is recommended consideration is given to whether there is requirement for the channel to provide access for an 8 m long vessel during extreme storm conditions, or whether a vessel of this length could use the nearby Hay Avenue / Wharf Road Boat ramps as alternatives.

Dredging would not be required if a 6 m vessel was adopted for the above assessment.



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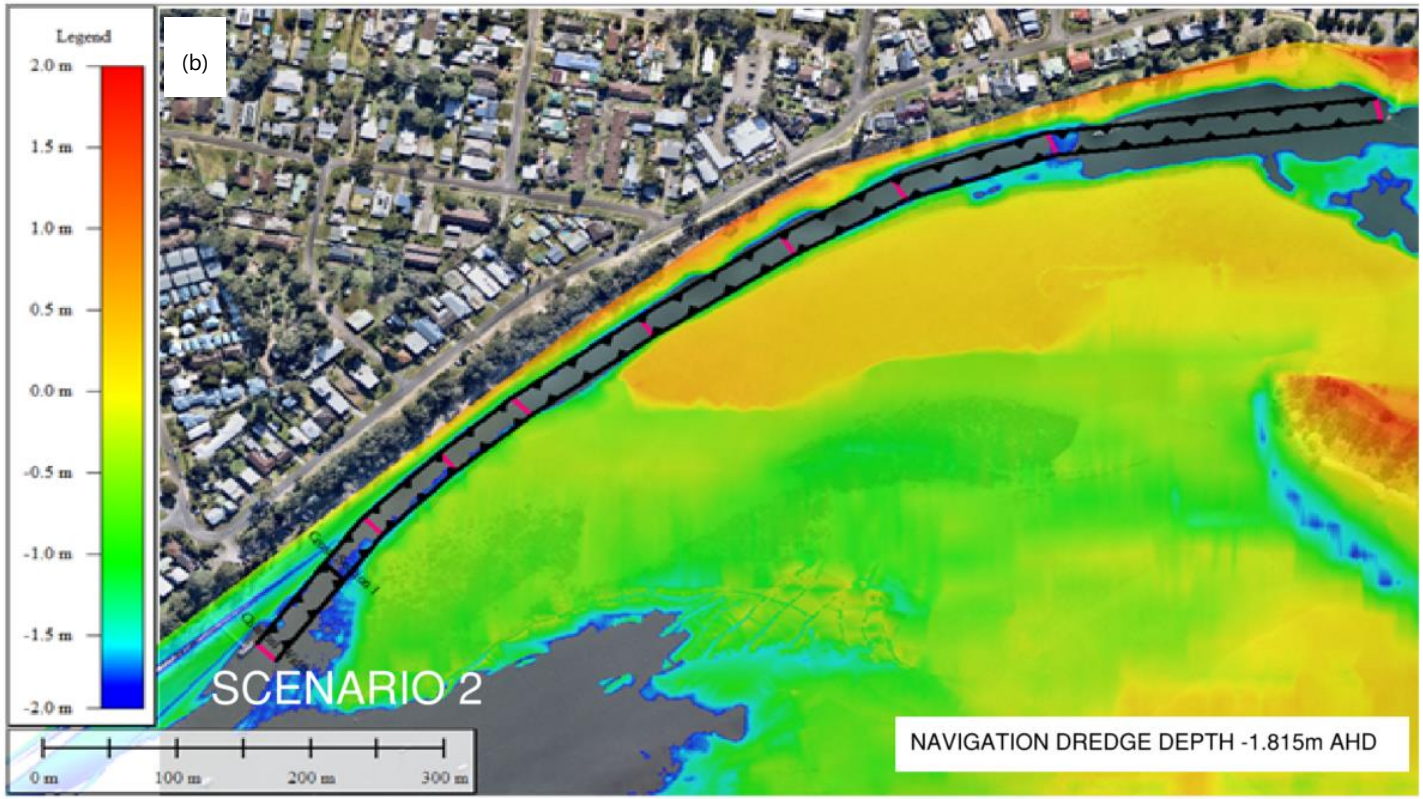

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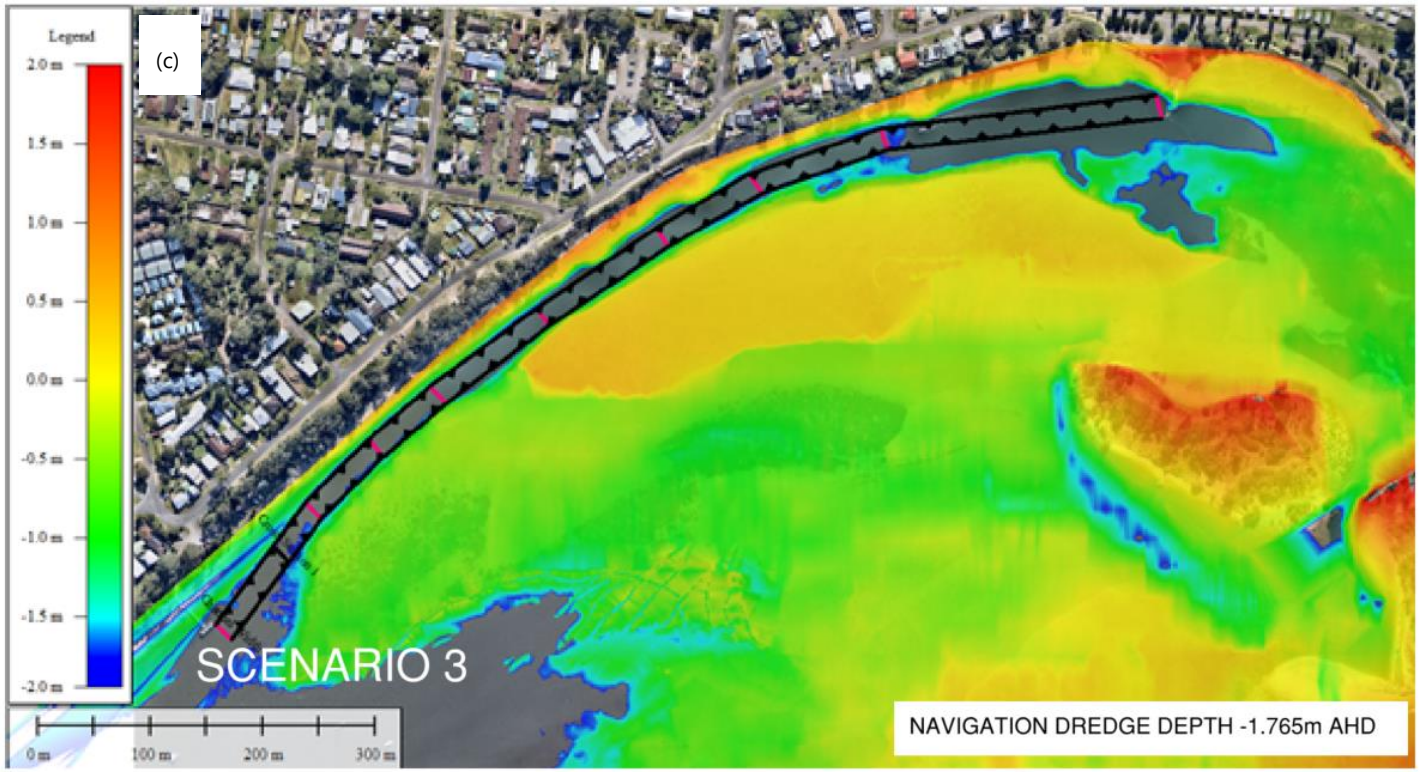

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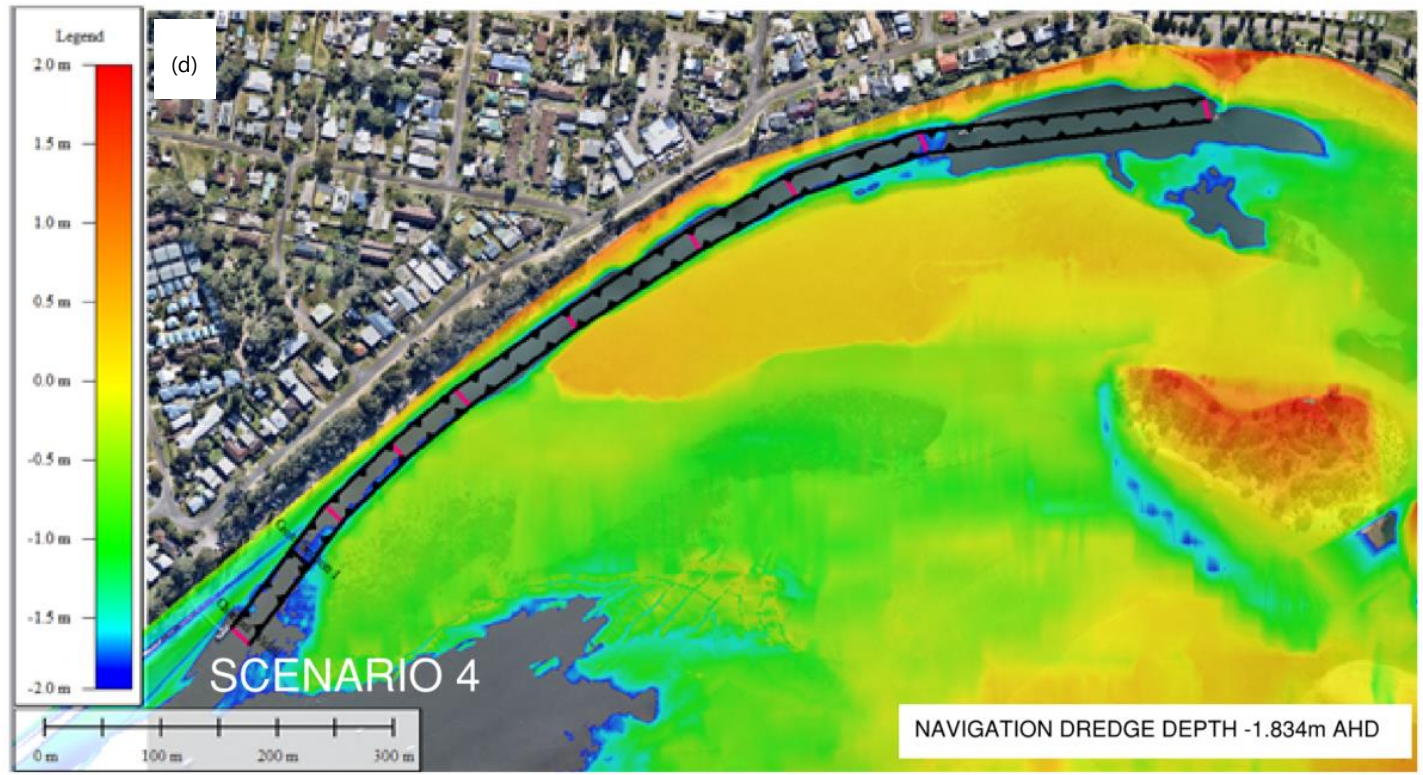


Figure 6-2 (a) – (d) Dredge Scenarios 1 – 4 Highlighting Dredging Required Based on Altering Criteria

6.3 Navigation Markers

The existing navigation aids are shown in Figure 6-3 and Figure 6-4. The navigation aids are positioned assuming the Holiday Haven Caravan Park is the downstream end of the channel and the markers would be on the left (port) side of a boat when travelling upstream towards Berry's Canal. Lights appear to be installed to all navigation aids. The location of the navigation aids is deemed appropriate. An additional port marker could be considered at the north eastern point of the shoal.

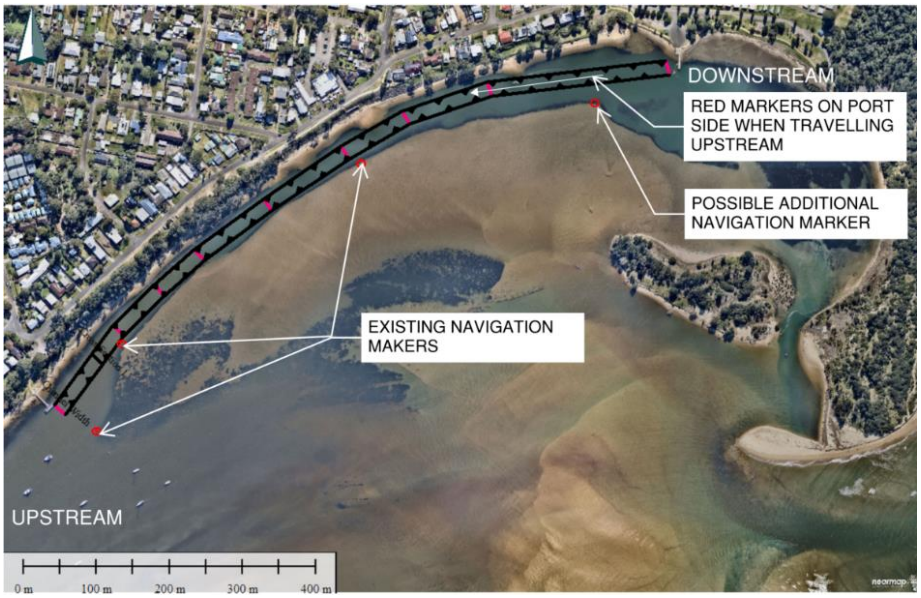


Figure 6-3 Existing Navigation Aids Along the Channel

Figure 6-4 Existing Navigation Mark at Downstream End of Channel

7 Opportunities and Constraints

The following opportunities and constraints have been identified in assisting with the development of well considered concept options. The opportunities and constraints have considered various aspects including environmental, social/recreational, engineering, costs, program and ongoing maintenance if channel dredging is to occur.

Table 7-1 Opportunities and Constraints

Opportunities
Aligning the design channel along the existing channel thalweg to minimise or avoid the need for dredging (in line with "working with nature" principals)
Sampling results of existing seabed material appears appropriate for beneficial reuse (clean, sandy, no ASS)
Adjacent shoreline has previously been identified to receive suitable material for beach nourishment to improve recreational amenity
Study Area generally has limited exposure to waves and material is granular and clean allowing for a wider variety of potential dredging and placement methods
Two alternative nearby boat ramps exist that provide waterway access to the main river channel without needing to navigate the channel in the Study Area
Constraints
Impact to biodiversity in the channel – in particular *Zostera* seagrass is present in shallower areas of the channel – potential to impact *Zostera* (based on Option 2)
Impact to biodiversity on the foreshore – impacts to existing ecology, no saltmarsh or mangroves present
Planning approvals may be complicated by impacts on natural environment, in particular seagrass
Future beach nourishment along the foreshore may impact on sedimentation in the channel
Relatively high mobilisation costs expected for a small-scale dredging campaign

8 Concept Options

As an outcome of the navigation assessment presented in Section 6, high level concept options have been developed comprising of both dredging and nourishment options. These concepts have been refined following stakeholder consultation.

8.1 Option 1 – 'Do Nothing'

This option would comprise leaving the navigation channel as is without undertaking any dredging works.

8.2 Option 2 – Design Channel Depth -1.95 m AHD

Option 2 comprises adopting a design channel depth of -1.95 m AHD and width of 20 m. This would require the non-compliant areas of the channel be dredged to -2.15 m AHD (+ 200mm dredge tolerance) to account for a sedimentation allowance. This would equate to around 3,000 m^3 of material to be dredged (Figure 8-1). The dredge material is expected to be clean sand based on ENRS (2022). The dredge sand could be beneficially reused to nourish the adjacent shoreline and rock revetment in areas that would not compromise the navigable depth of the channel. A typical cross section is provided in Figure 8-2.

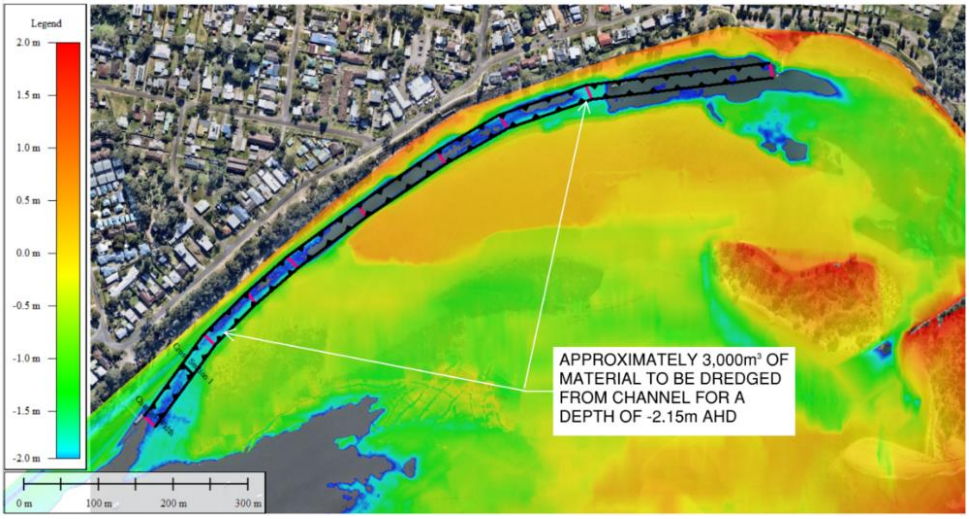


Figure 8-1 Area to be Dredged and Approximate Material Volume Based on Required Channel Depth and 200mm Sedimentation and Dredge Tolerance Allowance.

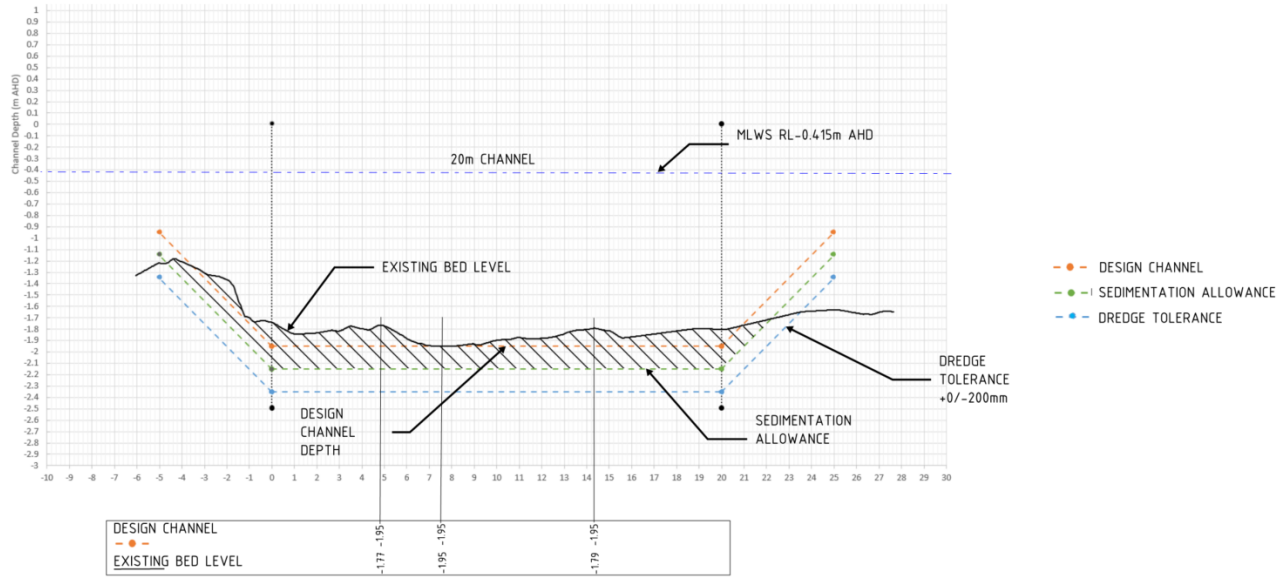


Figure 8-2 Typical Cross Section of the Dredge Profile

8.3 Option 3 – Design Channel Depth -1.95 m AHD with Beach Nourishment

SCC has requested a number of concept beach nourishment scenarios be investigated to ascertain their viability and potential impact on maintaining a 20 m wide navigation channel to -1.95 m depth (Section 5.4). These beach nourishment scenarios include:

- 5 m wide beach width to an upper beach level of 1.5 m AHD;
- 3 m wide beach width to an upper beach level of 1.5 m AHD; and,
- 3 m wide beach width to an upper beach level of 1.0 m AHD.

8.3.1 5 m Beach Width at Upper Beach Level of 1.5 m AHD

An initial beach nourishment scenario was adopted based on the conceptual option presented by RHDHV (2022). This option included the below attributes:

- target additional beach width = 5 m
- upper beach level = 1.5 m AHD
- lower beach level = -2.0 m AHD
- nourishment profile = 1V:10H

Based on the above attributes, cross sections along the extent of the study area shoreline (Figure 8-3) were developed to understand the implication of this scenario on the existing navigation channel (Figure 8-4(a)-(f)). It was deemed that this option would have significant impact on the navigation channel, encroaching into the channel by up to 35 m, and would require the existing channel to be shifted east with extensive additional dredging required (roughly estimated in excess of 70,000 m^3). The encroachment into the existing channel and additional dredging required would typically impact areas where seagrass is present. As such this option is not deemed feasible.

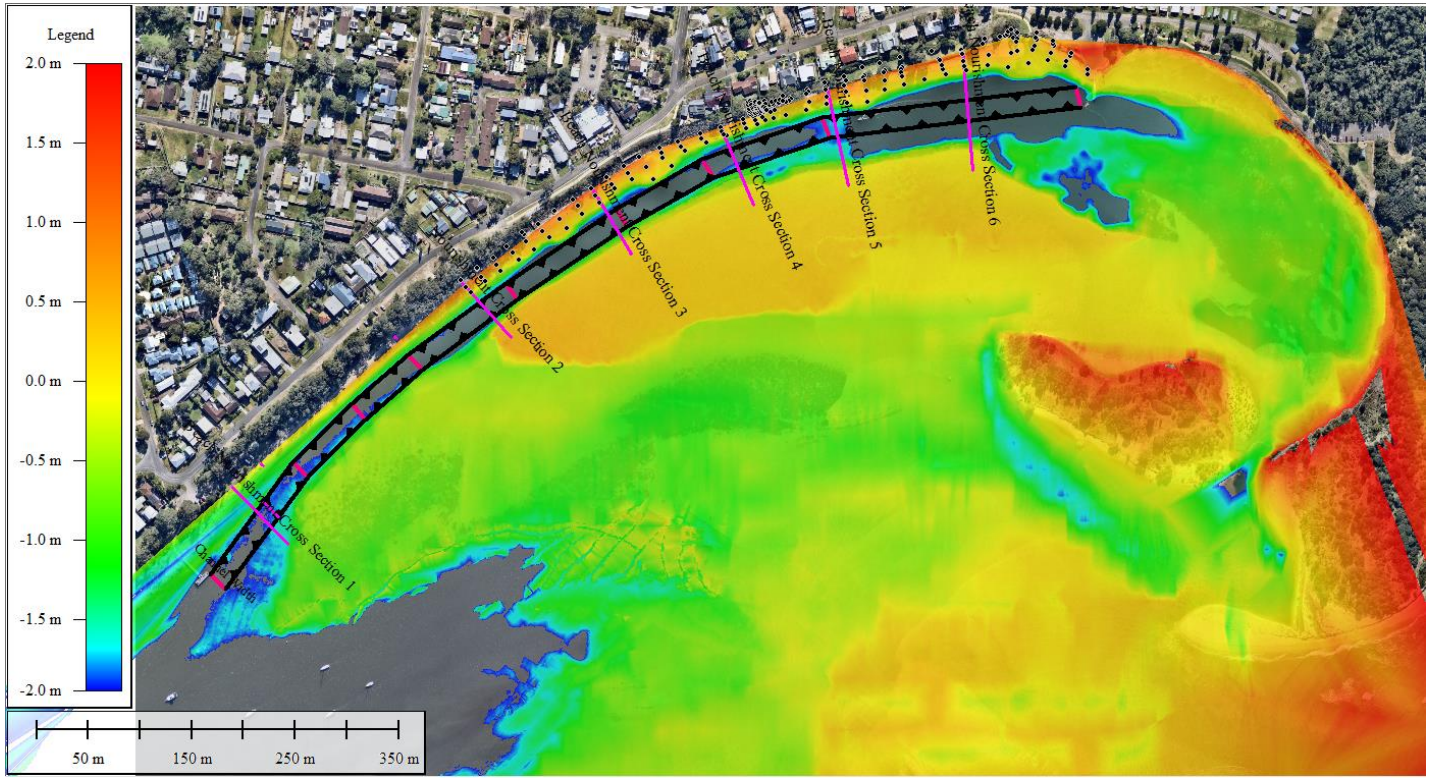
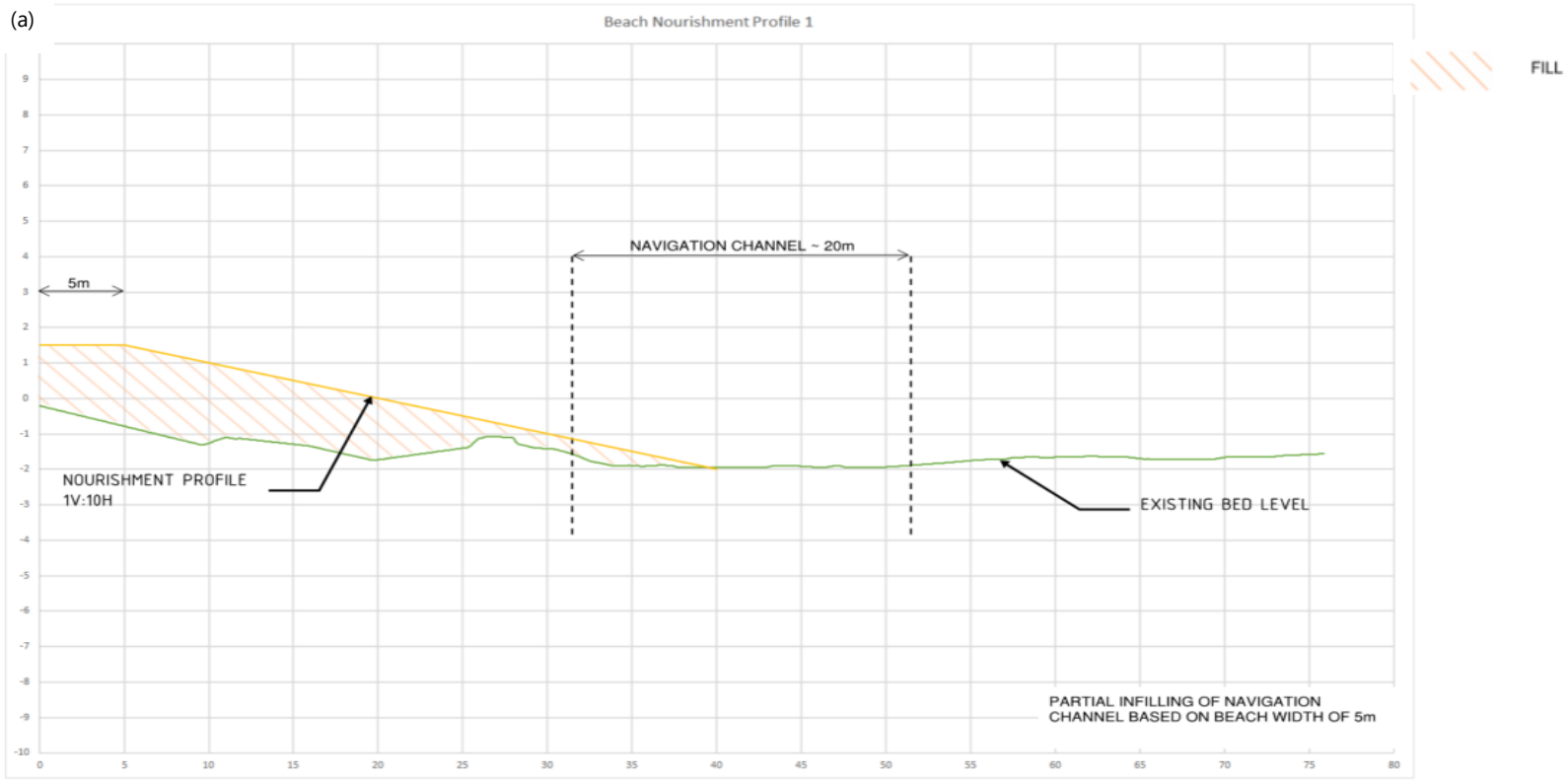


Figure 8-3 Location of Cross Sections Taken Along Shoreline

(a)



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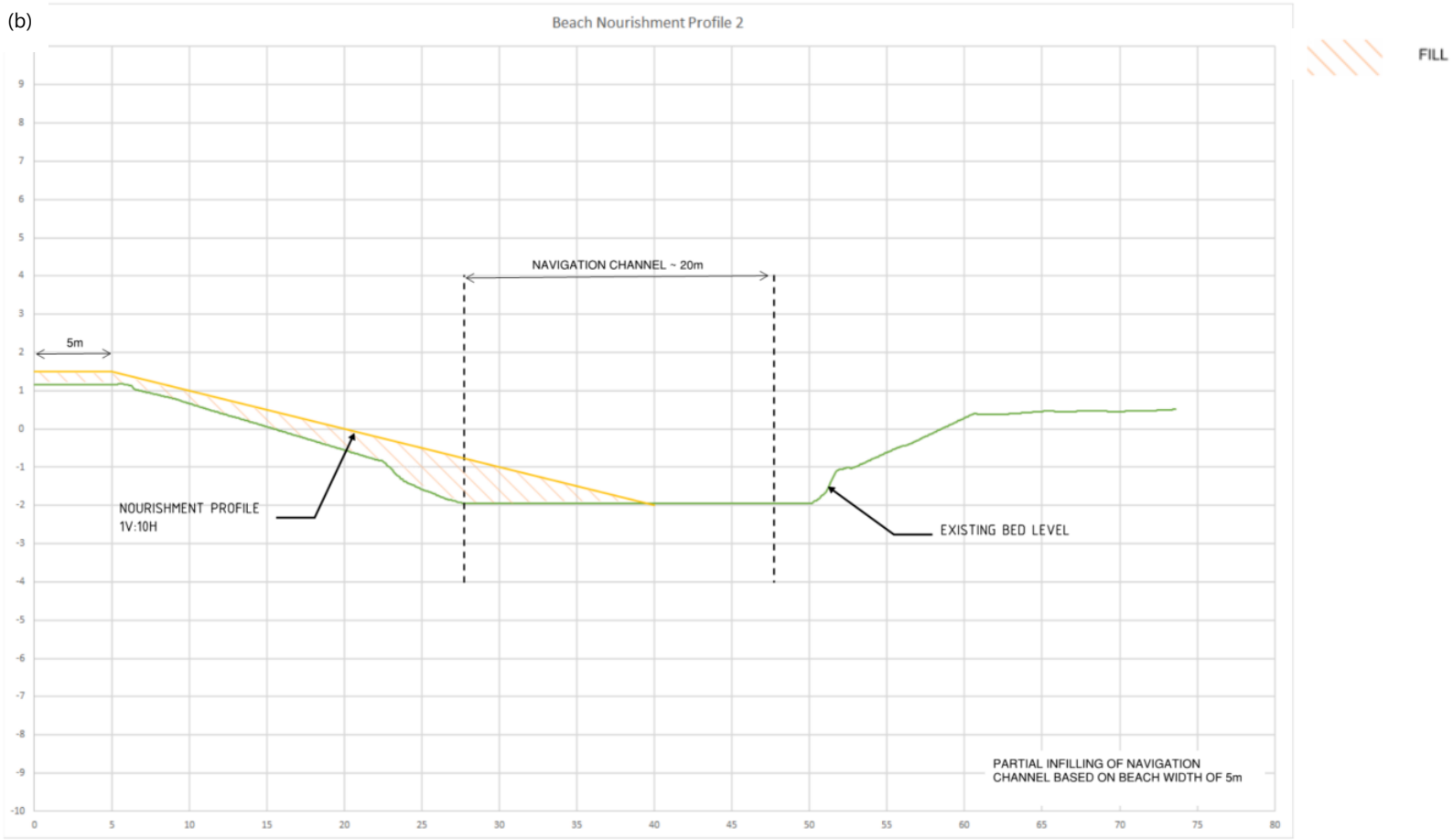
(b)



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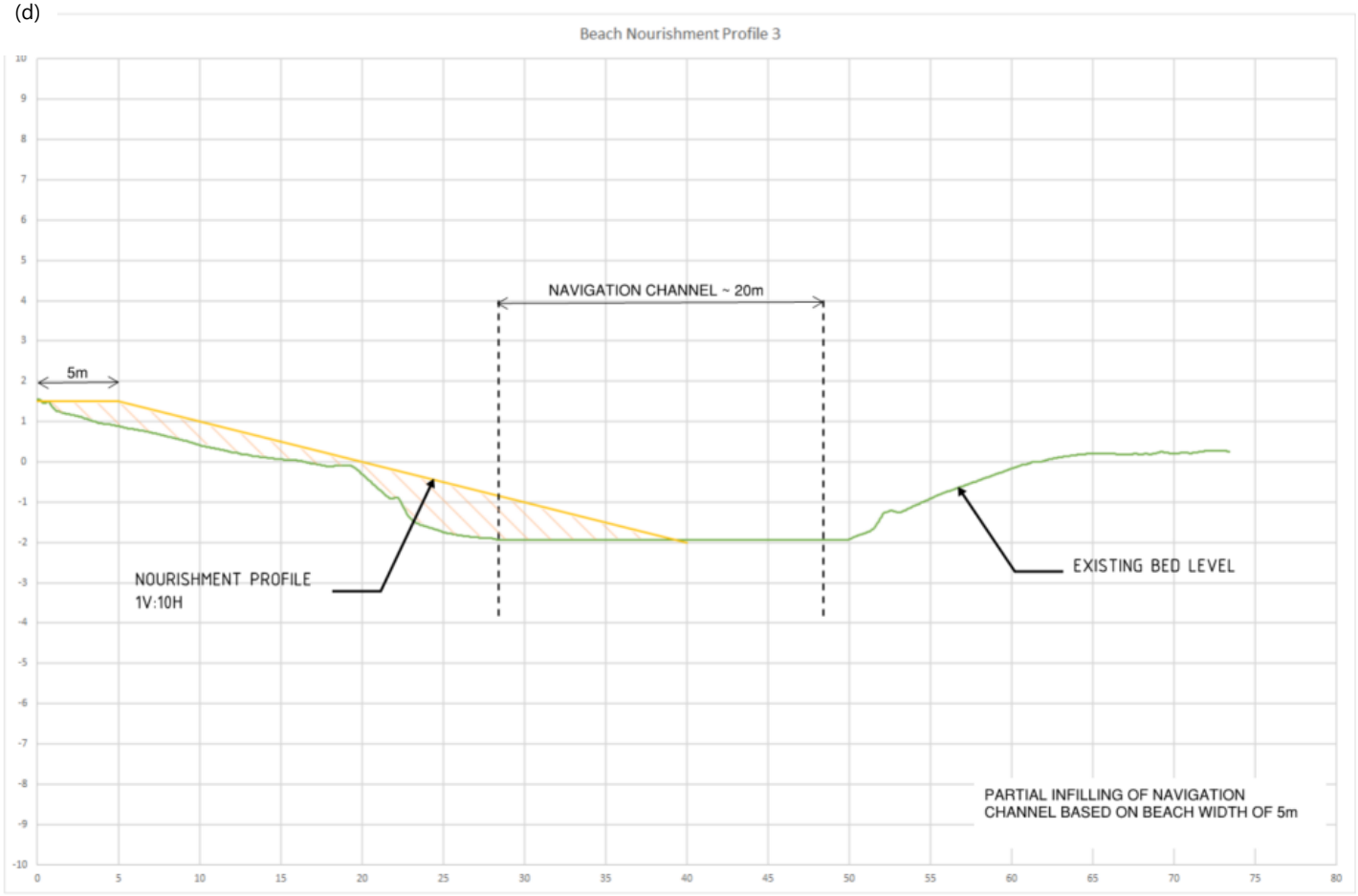
(d)



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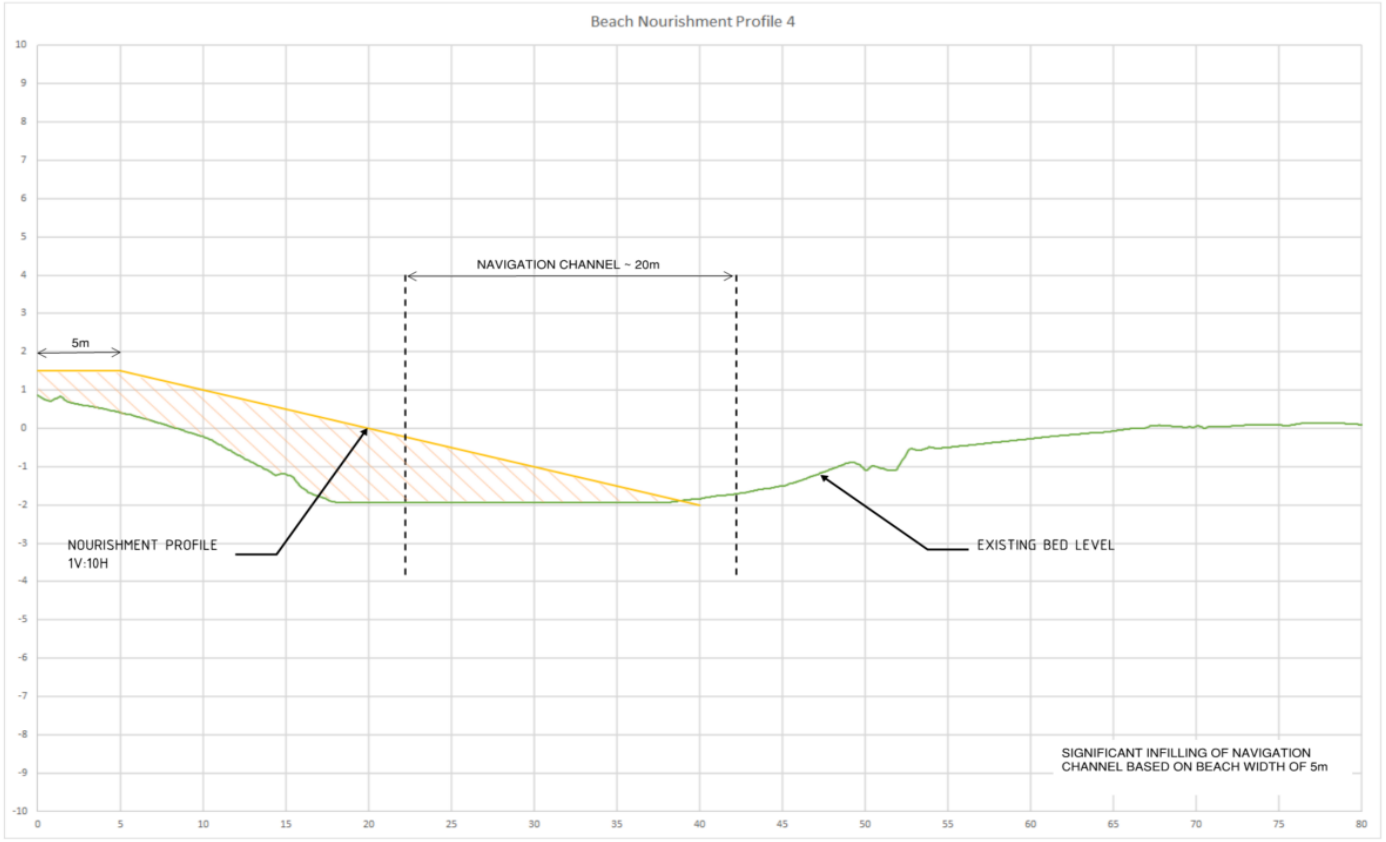

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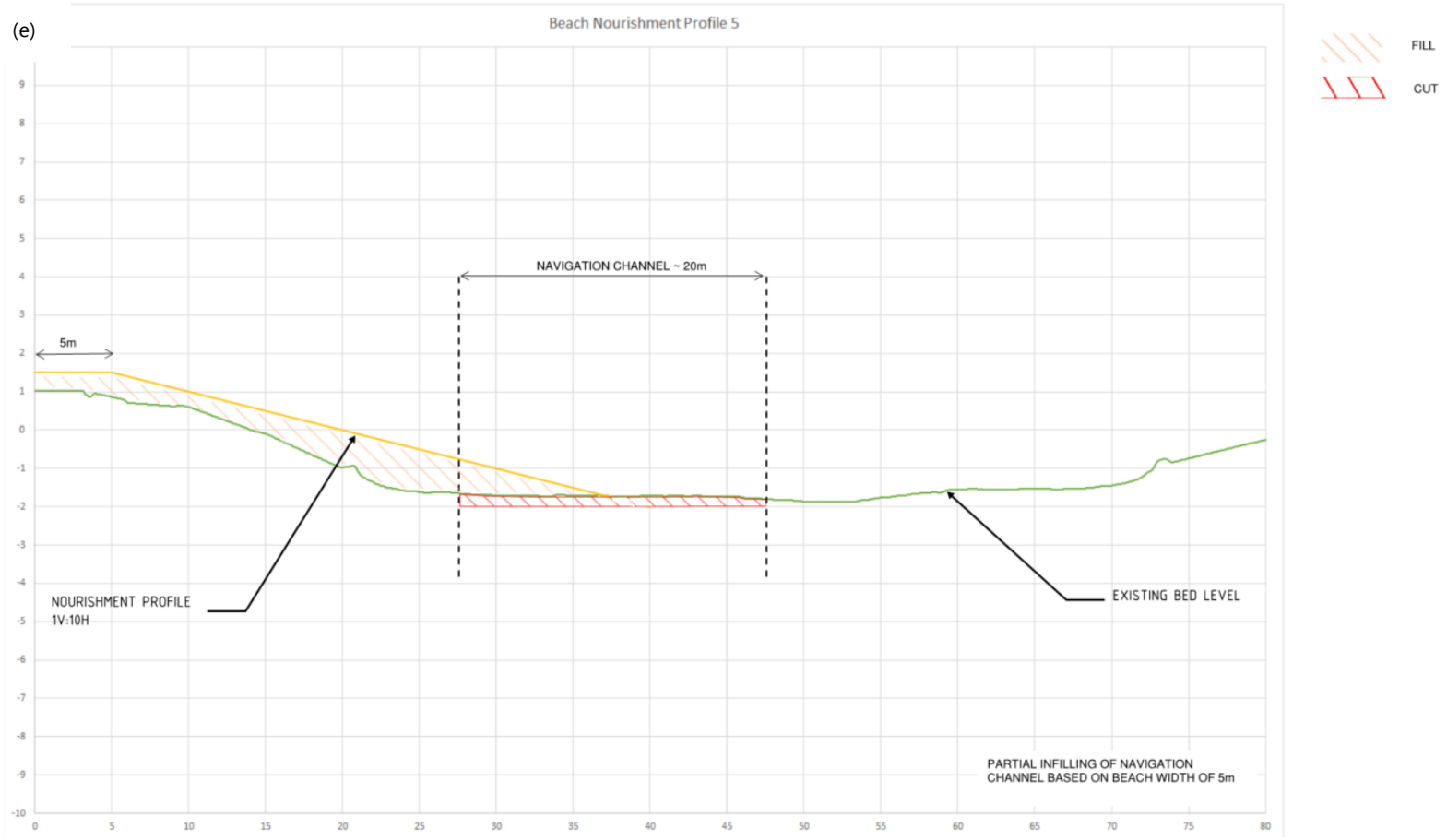
(e)



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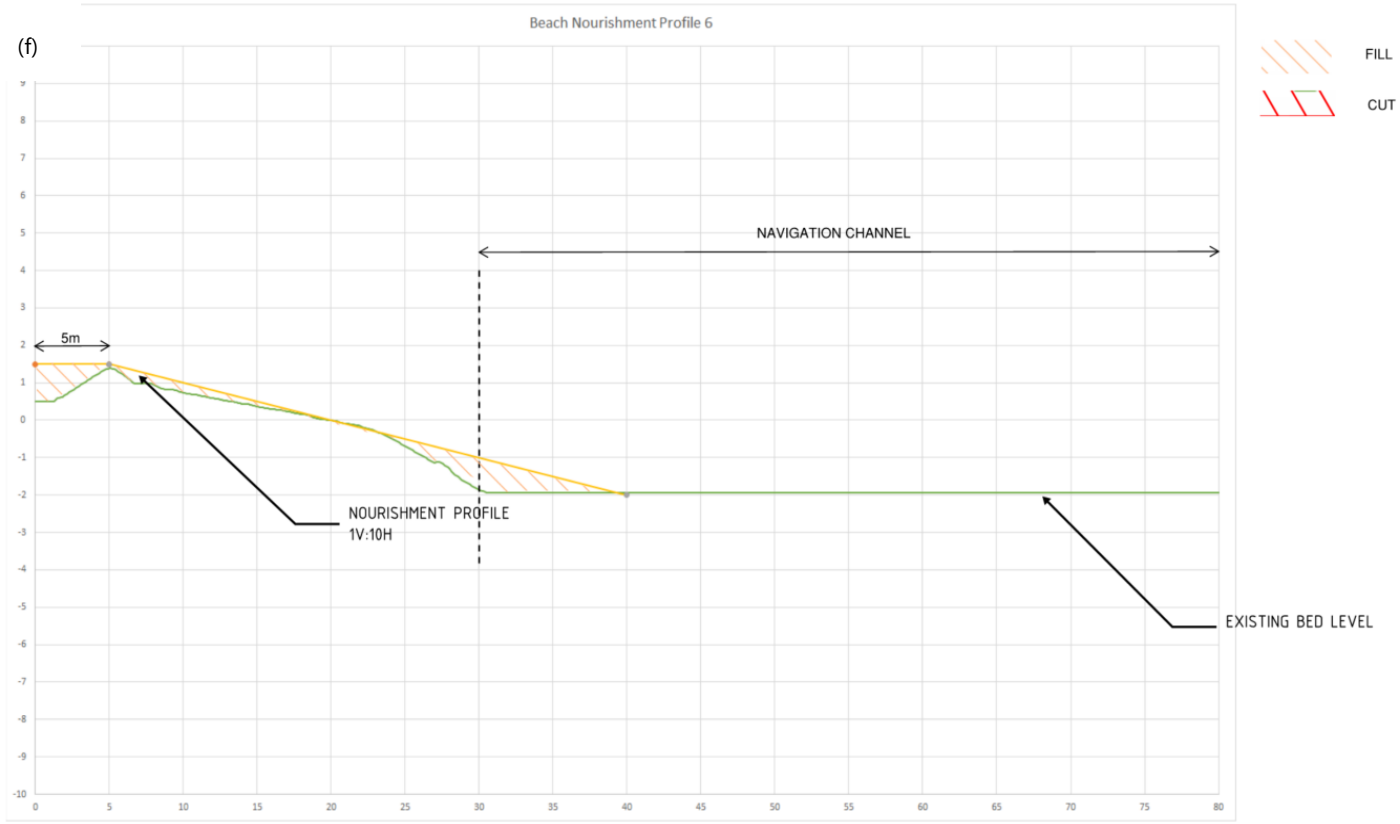

Figure 8-4 Beach Nourishment Cross Sections – (a) – (f) Profiles 1 - 6

8.3.2 3 m Beach Width at 1.5 m AHD and 3m Beach Width at 1m AHD

The viability of a 3 m beach width, at two alternative upper beach levels, 1.5 m AHD and 1.0 m AHD, has been assessed. The attributes of the two concept beach nourishment options are presented below:

- beach width = 3 m
- upper beach level = 1.5 m AHD and 1.0 m AHD
- lower beach level = -2.0 m AHD
- nourishment profile = 1V:10H

Based on the profiles presented below, at an upper beach level of 1.5 m AHD and with a beach width of 3 m the nourishment profile would infill the navigation channel at all profiles, requiring the channel to be shifted to the east and subsequent dredging undertaken. The volume of material required for nourishment in order to achieve the upper beach level and width would equate to approximately 10,500m^3 . The additional dredging required to shift the channel that would be suitable for safe navigation would be approximately 8,000 m^3.

Adopting an upper beach level of 1.0 m AHD and beach width of 3 m would generally have minimal impact to the navigation channel. The existing beach largely follows this upper beach level and beach width profile at present. Additional beach nourishment could be implemented at Profile 1 with minimal impact to the navigation channel. If Profile 4 were nourished to raise the beach level to 1.0 m AHD there would be an impact to the navigation channel requiring it to be shifted east by approximately 15 m. No other profiles would require additional nourishment if a beach level of 1 m AHD and beach width of 3 m was adopted. The nourishment volume would equate to approximately 4,000 m^3 and the additional dredging approximately 3,500 m^3.

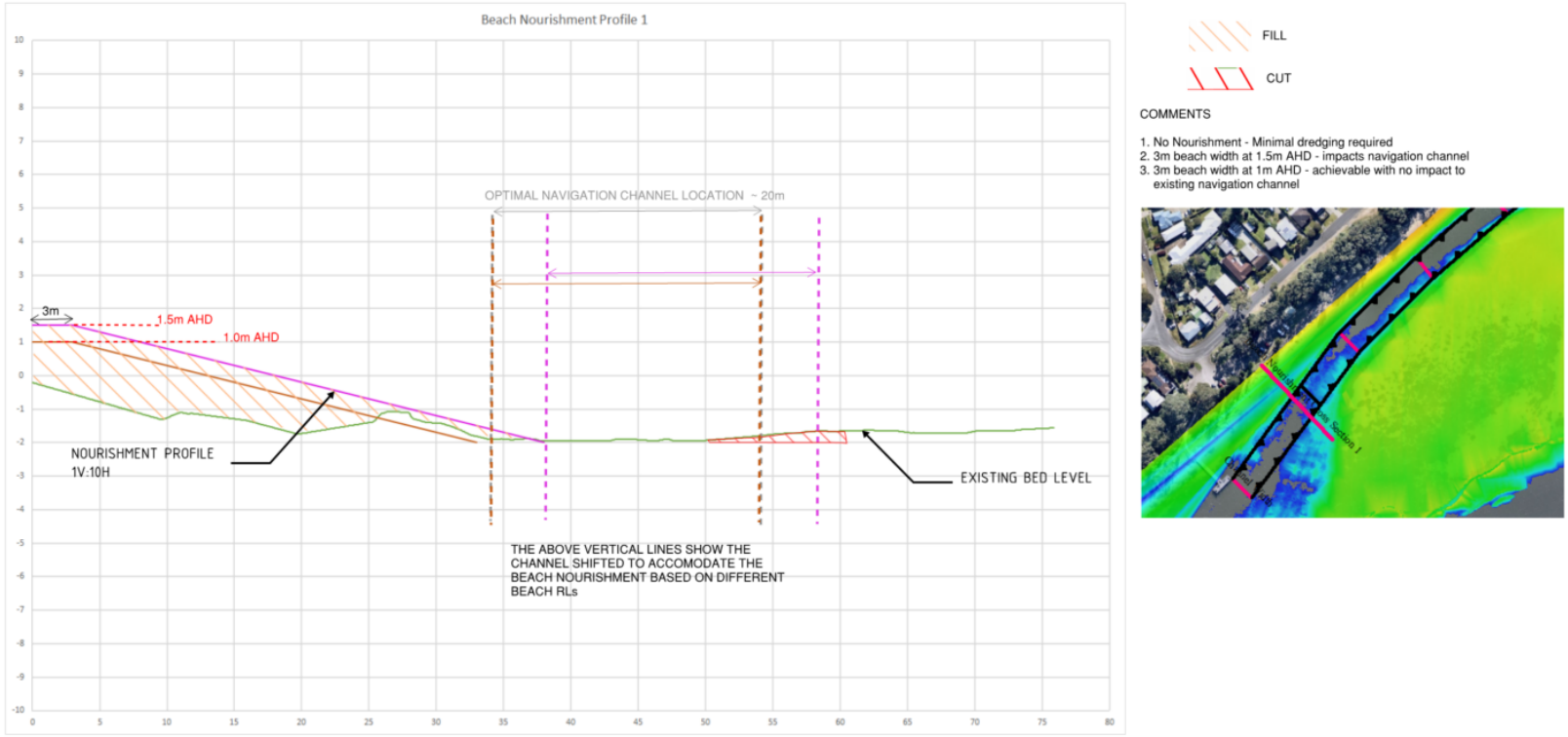

Figure 8-5 Beach Nourishment Profile 1 Adopting an Upper Beach Level of 1.5 m AHD and 1.0 m AHD and Beach Width of 3 m

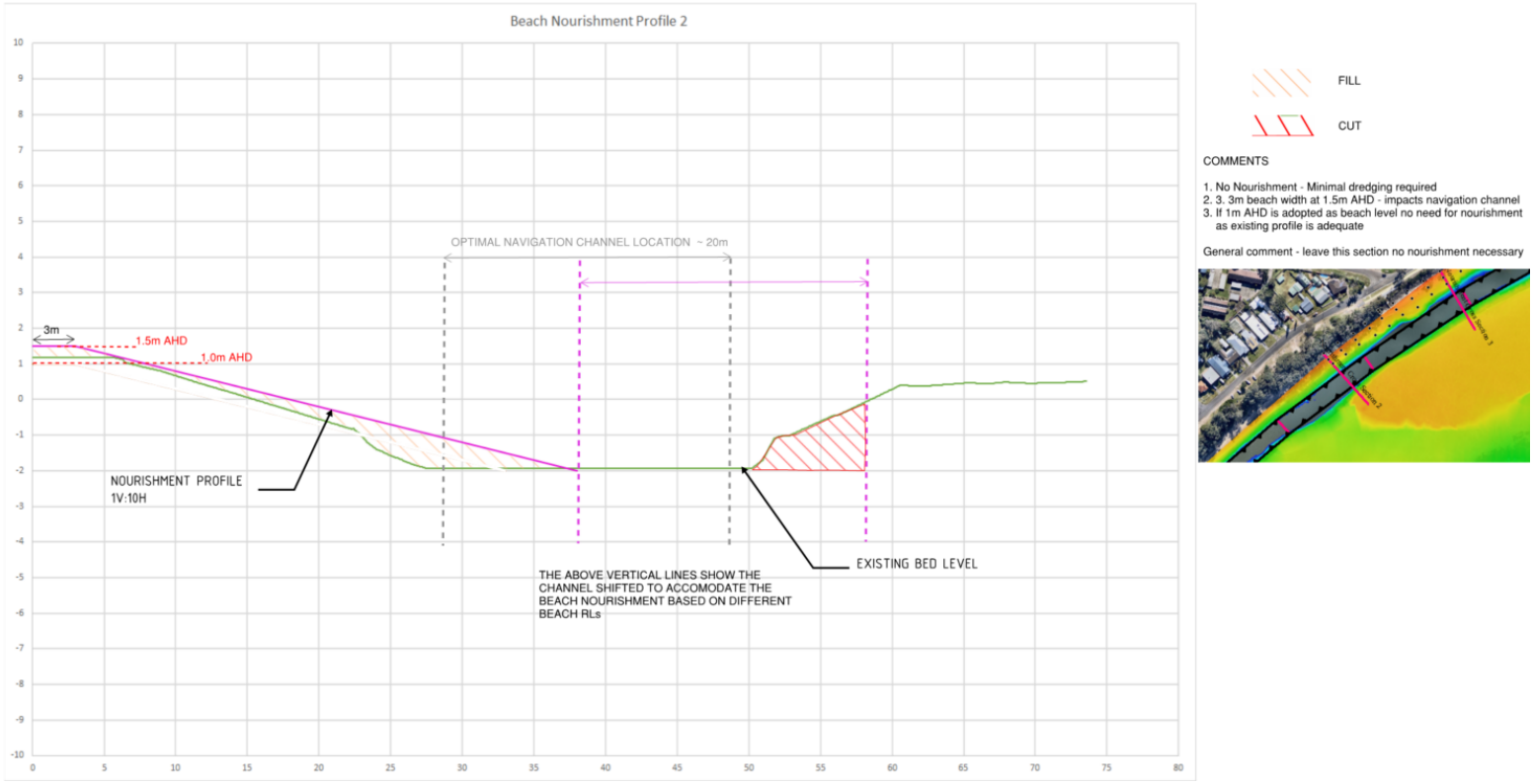

Figure 8-6 Beach Nourishment Profile 2 Adopting an Upper Beach Level of 1.5 m AHD and 1.0 m AHD and Beach Width of 3 m

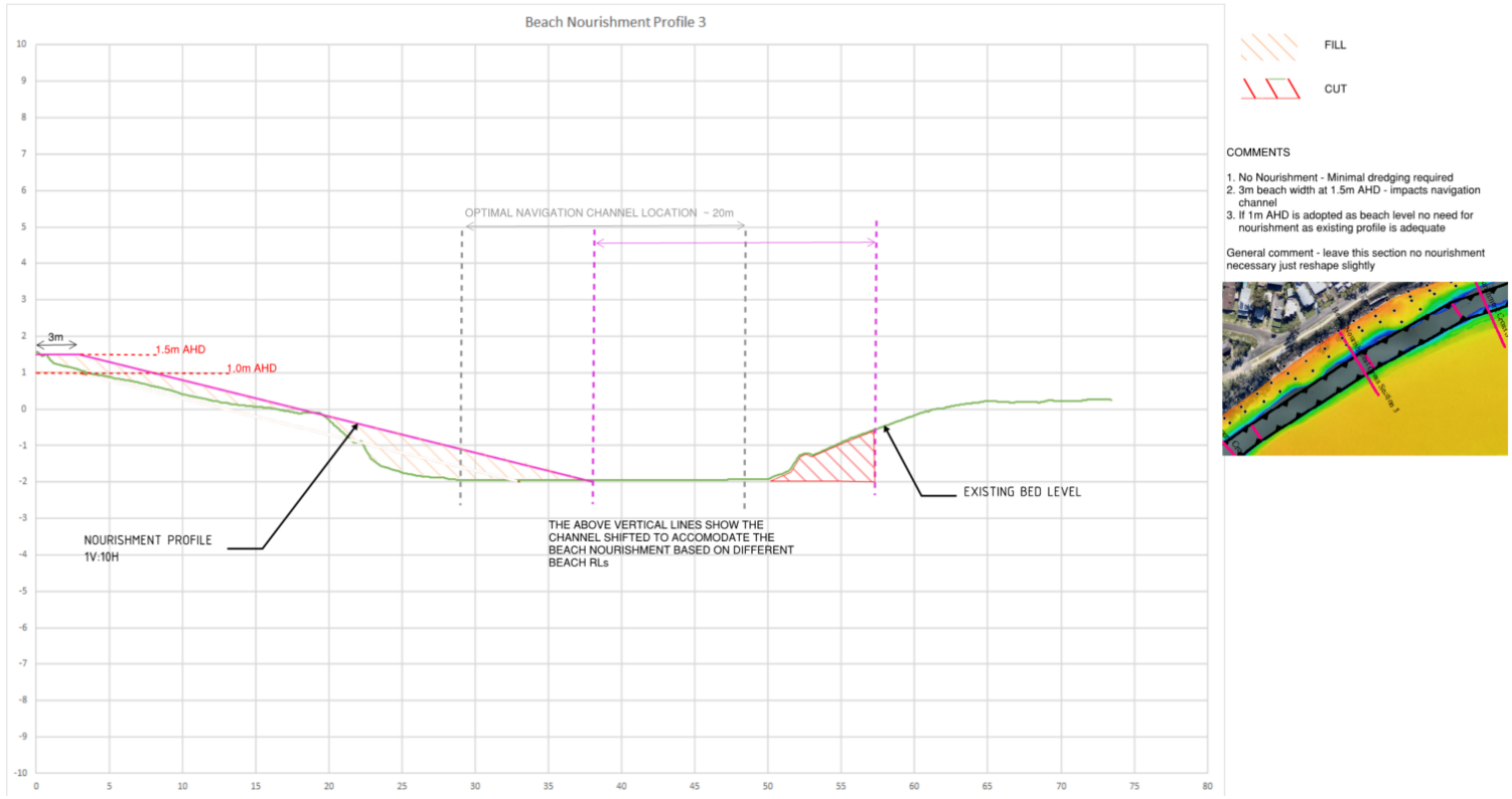

Figure 8-7 Beach Nourishment Profile 3 Adopting an Upper Beach Level of 1.5m AHD and 1.0m AHD and Beach Width of 3m

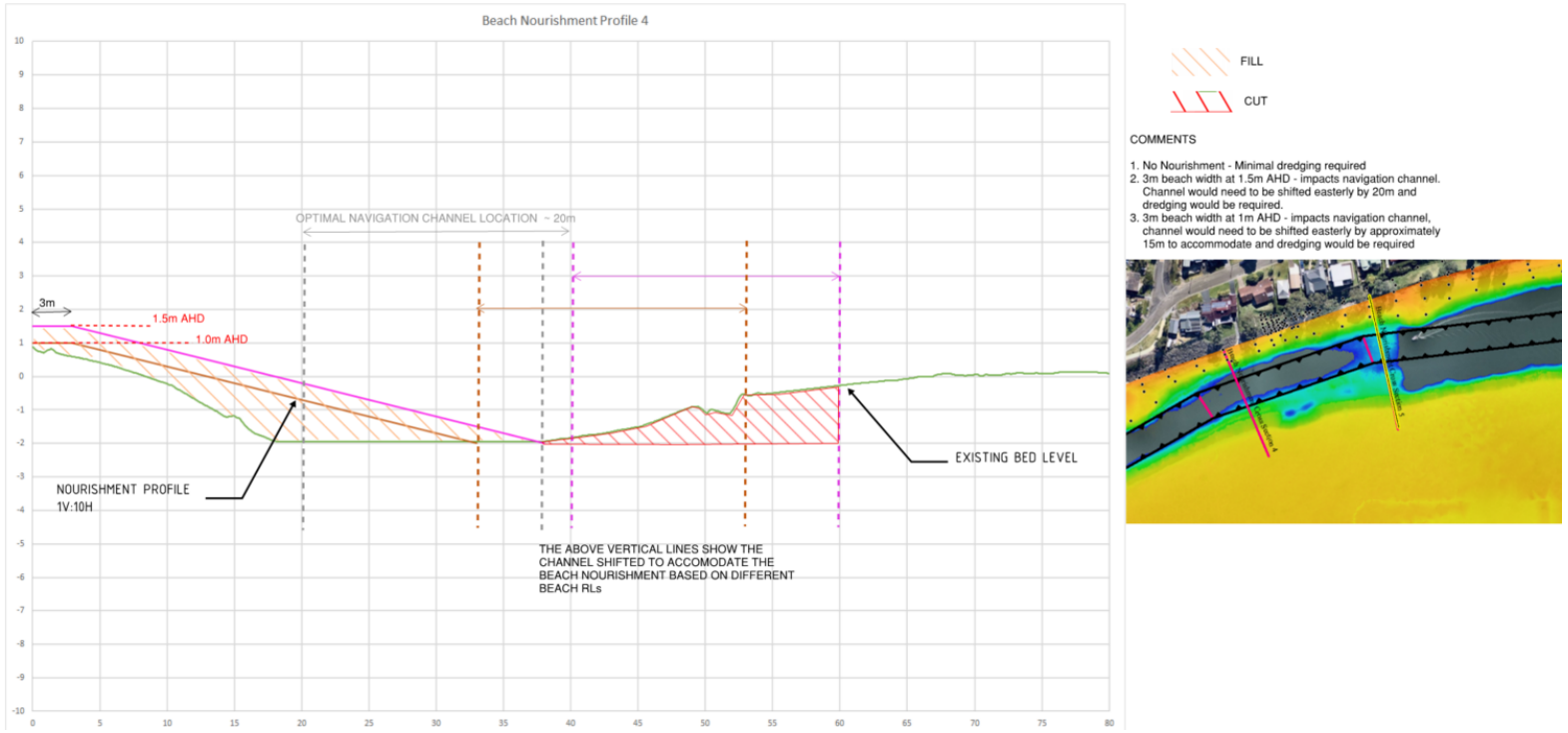

Figure 8-8 Beach Nourishment Profile 4 Adopting an Upper Beach Level of 1.5 m AHD and 1.0 m AHD and Beach Width of 3 m

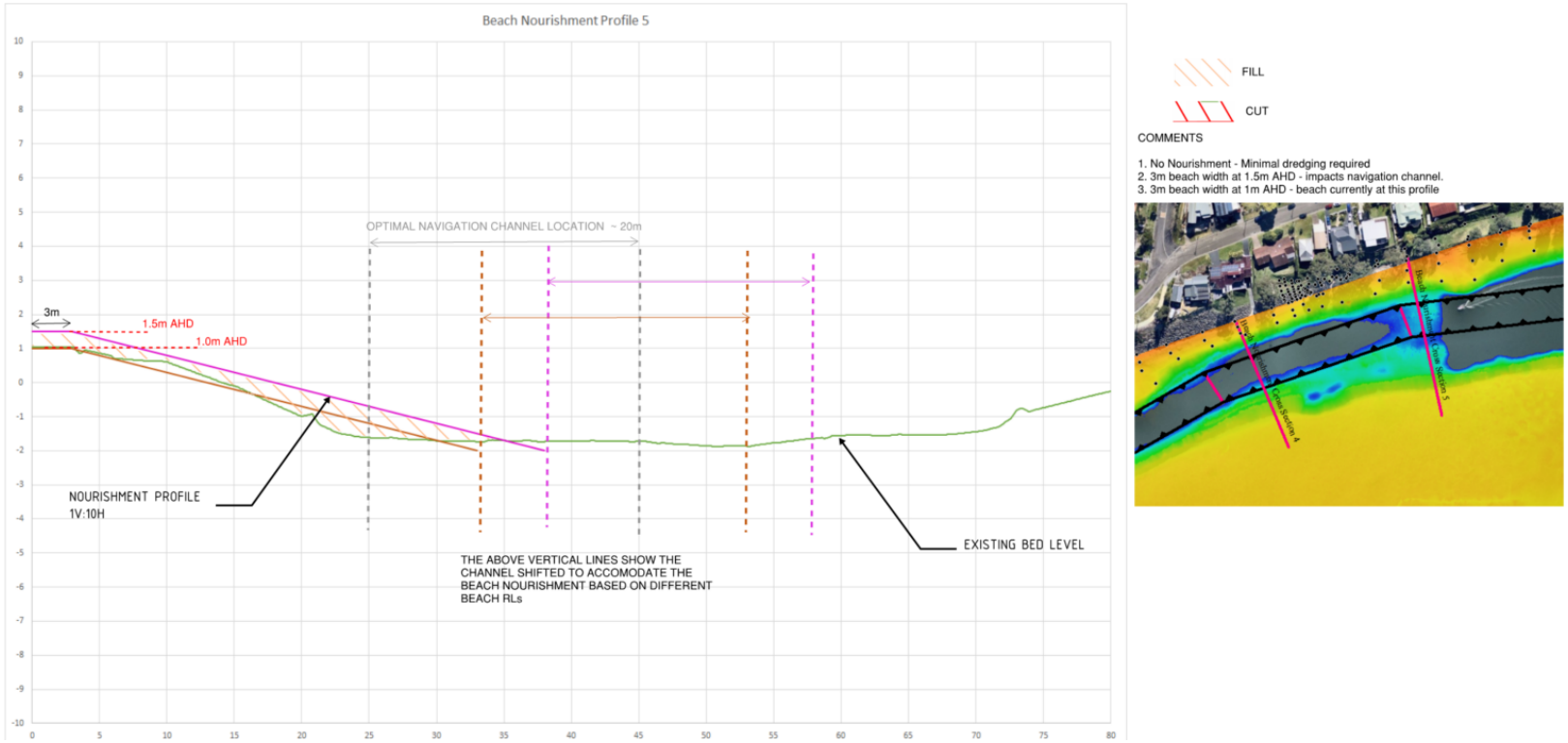

Figure 8-9 Beach Nourishment Profile 5 Adopting an Upper Beach Level of 1.5 m AHD and 1.0 m AHD and Beach Width of 3 m

SH24.1 - Attachment 1

8.4 Option 4 – Shifting Channel to Minimise User Conflict

Option 4 aims to address perceived user conflict between foreshore users and boats within the navigation channel. Passive recreational activities such as swimming and standup paddle boarding regularly take place within the navigation channel which could pose a potential conflict with boat users.

This option would comprise shifting the navigation channel by approximately 20 m to the south east partially or along the full 1,000 m channel length to provide a larger area for beach amenity and passive water activities.

Due to the estimated environmental impact (in particular removal of seagrass and harm to other marine organisms) and high cost associated with this option, it is not considered justifiable or feasible, and therefore has not been considered further. It is however recommended that signage be installed similar to that shown in Figure 8-10 in order to educate and make users aware of the risk associated with boats navigating the channel. Vessels navigating the channel are limited to a speed of 4 knots with unobstructed lines of sight which works to mitigate conflict. Swimmers could also be encouraged to swim to the north of the boat ramp where vessels tend not to navigate.

Figure 8-10 Example Education Signage to make Swimmers and Beach Users Aware of Risk from Navigating Boats

9 Potential Dredging and Disposal Methods

Should dredging be considered as a preferred option the potential dredging methodologies considered include using a small backhoe dredger (BHD) arrangement which would likely comprise of an excavator mounted on a barge, or a small cutter suction dredger (CSD). These methodologies are subsequently described in this section. A land based long reach excavator has also been considered however, it has been determined it would not have the required reach to undertake the works.

It is recommended to be flexible with either of these dredging methodology options and let the market present dredging configurations based on the specific plant and equipment available at the time.

9.1 Backhoe Dredger (excavator on a barge)

A simple BHD arrangement consisting of a land-based excavator secured to a flat top barge could be considered for the works as shown below in Figure 9-1. An excavator in the order of 10 to 15 t would be appropriate, working in conjunction with two hopper barges, a work boat and a similarly configured backhoe excavator onshore. The flat top barge would be secured to the seabed via spud anchors and/or cable anchors with the barge mounted excavator, dredging material with a bucket attachment and placing it in a hopper barge. Once the barge is full, it would be taken to the onshore disposal location where water would be drained from the barge, and the barge unloaded with the onshore base excavator and placed on the foreshore. The material on the foreshore would be reworked with a dozer or a series of bobcats. While the dredged material is being unloaded from the first hopper barge, the second hopper barge would be filled by the barge mounted excavator and cycle accordingly with the other hopper barge. The work boat would be used to maneuver the hopper barges and flat top barge.

Figure 9-1 Example of a small barge mounted excavator

The BHD arrangement requires several pieces of plant, however, is a relatively simple operation that can be undertaken by a wide range of smaller contractors. The mechanical method is slow, involves double handling of material, and can become inefficient for larger quantities. Alternatively, to the barge mounted excavator an appropriate amphibious (i.e. floating) excavator can be used. The equipment spread of the backhoe dredge is shown on Figure 9-2.

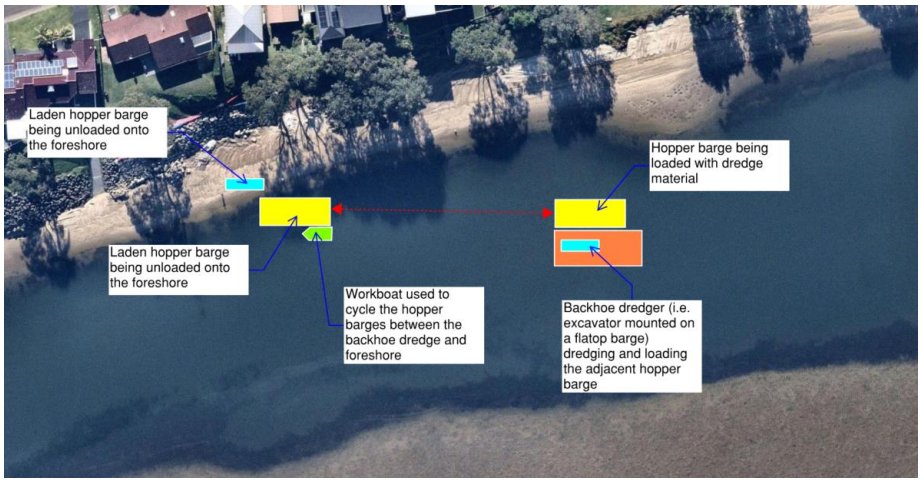

Figure 9-2 Spread of the Backhoe Dredger

9.2 Cutter Suction Dredger

A small cutter suction dredger (CSD) or variation of a suction dredger could be considered for the works as shown in Figure 9-3. A smaller CSD would likely require a work boat to position it, and it would be secured to the river bed using rear spud anchors and side anchors. The CSD would lower the cutter head on the river bed and swing it from side to side using while sucking in a sand slurry containing water and typically around 20% sand by volume. The sand slurry would be pumped along a pipeline (floating, submerged and/or along the foreshore) and discharged onto the beach. Booster pumps are unlikely to be required given the close proximity of the disposal location. Onshore settling ponds constructed from dredged sand may be required to receive the dredged slurry prior to the return water discharging back to the river to meet the water quality criteria. However, for smaller dredging operations with slower pumping rates and when material is fairly granular with limited fines, pumping directly onto the foreshore without the use of settling ponds may be permitted. Sediment curtains can still be used to assist with containing potential sediment plumes. The discharge pipeline would be progressively moved along the foreshore to assist with distributing the dredge material. Once dredged material is placed onshore and dewatered, it can be reworked with land based plant and equipment such as a dozer or a small excavator paired with a series of bobcats.

Figure 9-3 Example of a small cutter suction dredger that was used at Lake Conjola in 2016

The CSD is a specialised piece a of plant and would need to be road transportable to minimise mobilisation costs. This hydraulic dredging method is relatively fast but due to mobilisation costs, it is not cost effective for smaller dredging quantities. The equipment spread of the CSD is shown on Figure 9-4.

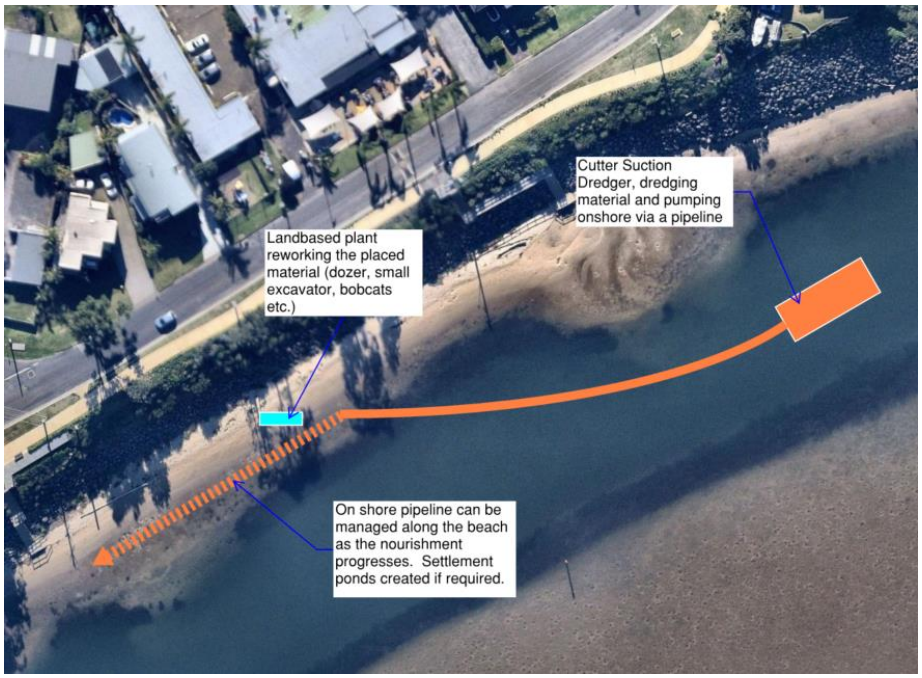

Figure 9-4 Spread of the Cutter Suction Dredge

10 Cost Estimates

Indicative cost estimates for each of the concept options and two dredge methods (backhoe dredge and cutter suction dredge) have been prepared. As the options are at the early concept phase, cost estimates are within ±50% accuracy and contain a 25% contingency in accordance with Advisian's cost estimating guidelines.

The cost estimates summarised in Table 10-1 with a more detailed breakdown provided in Appendix B.

Table 10-1 Cost Estimate for Concept Options Presented[3]

Option	Description	Cost ($)	
		Backhoe Dredge	Cutter Suction Dredge
Option 1	Do Nothing	$0	$0
Option 2	Deepen existing channel and beach nourishment in areas that do not compromise navigation	$552,960	$886,788
Option 3a	Deepen and widen existing channel and beach nourishment (3 m Beach @ 1 m AHD)	$742,380	$1,003,674
Option 3b	Deepen and widen existing channel and beach nourishment (3 m Beach @ 1.5 m AHD)	$985,920	$1,153,956

The per cubic metre rate for dredging with a BHD is generally more expensive than a CSD however, is usually cheaper to mobilise. It is not usual for mobilisation/demobilsation costs to govern the overall costs of smaller dredging project that can make it difficult to accurately cost. This is influenced by several factors including type and size of the plant proposed, availability/demand for the plant, and distance required to travel.

[3] *Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practicing professional engineers familiar with the construction industry. The quantities have been estimated from this report dated January 2024. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies and should not be relied upon for establishing project budgets.*

11 Potential Environmental Impacts

11.1 Potential Impacts

The following potential impacts relate to Option 2 and 3 detailed in Section 8 above.

11.1.1 Biodiversity

There is potential for unintended impacts to the terrestrial and aquatic biodiversity including:

- Removal and/or changes to terrestrial and aquatic habitat structure during construction and operation within the study area. This can include damage to intertidal and subtidal zones because of dredging procedures such as potential accelerated sedimentation may lead to the burial of marine vegetation such as seagrasses and macroalgae. Approximately 3,800 m^2 of Zostera seagrass would be impacted because of the dredging (Figure 11-1).
- Shading of vegetation by work equipment during construction and boats during operation.
- Impacts associated with increased turbidity.
- Entrapment of fish and mobile invertebrates within air bubbles produced by work equipment.
- Potential harm of terrestrial (esp. Migratory Shorebirds) and aquatic biodiversity protected under Federal and State legislation during construction and operation (refer Section 4).
- Impacts associated with artificial lighting on both terrestrial and aquatic fauna, particularly avian species.
- Impacts associated with vehicle strike during construction and operation.

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Shoalhaven City Council

SH24.1 - Attachment 1

Figure 11-1 (a) Mapping of Seagrass (Zostera) with Navigation Channel Shown to Indicate Impact to Zostera. and (b) Approximate Extent of Marine Survey Area with NSW DPI Fisheries mapping overlayed. Red Solid Lines Indicates Detailed Survey Extent. Orange Line Indicates Extent of Habitat Verification (Source: Stantec, 2022)

11.1.2 Hydrology, Water Quality and Groundwater

There is potential for unintended impacts on the hydrological and hydrogeological characteristics of the study footprint area which can be associated with the dredging procedure. It should be noted that varying levels of the same risk can occur at different stages of construction and operation.

- Changes in water quality because of dredging activities can impact flora and fauna.
- Increased turbidity of water due to disruption of sediments.
- Potential for harmful substances to enter the water because of accidents during construction and operation stages (i.e., fuel and/or oil spills).
- Change in water levels due to dredging activity. It should be noted this is very case specific and would require further investigation as to whether this would be an impact.
- Increase risks to flood and channel flow speed.

11.1.3 Geology, Sediments and Soil

There is potential for unintended impacts on the geological composition of the study footprint area which can be associated with the dredging procedure. It should be noted that varying levels of the same risk can occur at different stages of construction and operation.

- Disruption to sediments can cause changes in the surrounding environment which can impact flora, fauna, and overall water quality.
- Changes in coastal processes as a result to changes to landforms can include; Changes to currents and water circulation, Habitat disturbance, Navigation changes and Sediment distribution.
- Direct or indirect increase of erosion as a result from construction activities.

11.1.4 Heritage Risks

There is potential for indirect impacts to the recorded Aboriginal site near the study area along the foreshore between Wharf and River Roads from any land-based construction works. There is also potential for impacts to Aboriginal cultural heritage due to the high significance of the area and to impact to any unrecorded sites.

Conversely, impacts to historic heritage are not anticipated as there are no listed heritage items, heritage conservation areas or archaeological sites located within the study area. The closest heritage item, "Coomanderry Swamp Drainage Channel" (Item No. 39), listed under the LEP, is not anticipated to be impacted by the proposal.

11.1.5 Land Use and Property Risks

The proposal is unlikely to result in changes to land use of the study area and site, provided appropriate mitigation measures are adopted.

Notwithstanding, the main potential for impacts of construction activities on surrounding land uses include:

- Biodiversity;
- Geology, sediments and soil;
- Heritage;

- Air quality;
- Traffic, transport, and access; and
- Socio-economic.

11.1.6 Landscape Character and Visual Amenity Risks

There is potential for unintended impacts on the landscape character and visual amenity of the study footprint area which can be associated with the dredging procedure. It should be noted that varying levels of the same risk can occur at different stages of construction and operation.

- During the construction phase, the study footprint area may face visual amenity risks in the form of construction vehicles.
- The study area may experience future risks of visual amenity with a potential for increase boat presence.
- There is risk that dredging/nourishment activity may change the shape of land.
- Short-term loss of pedestrian access during operations.

11.1.7 Air Quality

There is potential for unintended impacts on air quality of the study footprint area which can be associated with the dredging procedure. It should be noted that varying levels of the same risk can occur at different stages of construction and operation.

- An increase in air pollutants because of refuelling during construction.
- If there are any land-based construction activities, there may be an increase of dust in the air.

11.1.8 Traffic, Transport and Access

There is potential for unintended impacts to traffic, transport and access to the study footprint which can be associated with the dredging procedure. It should be noted that varying levels of the same risk can occur at different stages of construction and operation.

- There may be temporary road blockages during construction phase to allow the carrying out of potential construction activities.
- Traffic may be slightly increased in the area during the construction phase.
- There may be temporary impacts to navigation while dredging is being undertaken.

11.1.9 Socio-Economic Risks

There is potential for unintended impacts on the socio-economic characteristics of the study footprint area which can be associated with the dredging procedure. It should be noted that varying levels of the same risk can occur at different stages of construction and operation.

- Short-term reductions in local amenity due to construction activities.
- Potential social risks for locals who do not wish to see the proposed activity be moved into construction.

12 Planning and Approvals

A review of relevant legislative, regulatory, Commonwealth, State and Local statutory planning instruments has been undertaken to identify any preliminary planning issues and to advise on the expected planning approvals that would be required.

12.1 Federal Legislation

12.1.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance (MNES). The EPBC Act requires assessment of whether proposed actions are likely to significantly impact on MNES or Commonwealth land. MNES which include 7 TECs, 92 threatened species and 76 migratory species are identified in an EPBC Act Protected Matters Search undertaken for the study area (see Section 4).

12.1.2 Native Title Act 1993 (NT Act)

The NT Act recognises the traditional rights and interests to land and waters of Aboriginal and Torres Strait Islander people. Under the NT Act, native title claimants can make an application to the Federal Court to have their native title recognised by Australian law. A search of the National Native Title Register indicates there is a Native Title Claim over the land (South Coast People NC2017/003).

Under the NT Act, a future act includes proposed public infrastructure on land or waters that affects native title rights or interest. The proposal, defined as a future act, will not extinguish any Native Title interests in the land and waters affected as the non-extinguishment principle would apply. Notification is typically made to NTSCORP.

12.2 NSW Legislation

12.2.1 Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act is the principal planning and development legislation in NSW. The EP&A Act establishes planning approval pathways and environmental planning instruments which include State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs).

Part 4 Developments

Division 4.3 of the EP&A Act sets out the provisions for development that needs consent. Section 4.15 of the EP&A Act details the matters requiring consideration by the consent authority in determining a development application (DA).

Under Section 4.10 of the EP&A Act, certain DAs may be declared to be designated development by an EPI or the regulations which are high-impact developments. A designated development can also be integrated development, when under Section 4.46 of the EP&A Act, certain DAs may require the approval (such as a permit or license) from an NSW Government agency (approval body) before determination can be made by the consent authority.

Part 5 Activities

Section 5.5 of the EP&A Act requires determining authorities, when assessing an 'activity' under Part 5, to "*examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*". A Review of Environmental Factors (REF) is prepared and determined in accordance with these provisions.

As per Section 4.1 of the EP&A Act, if an environmental planning instrument provides that development may be carried out without the need for development consent, a person may carry out the development, in accordance with the environmental planning instrument, on land to which the provision applies.

12.2.2 Environmental Planning and Assessment Regulation 2021 (EP&A Regulation)

Section 171 of the EP&A Regulation defines the factors which must be considered when determining if an activity assessed under Division 5.1 of the EP&A Act has or is likely to have a significant impact on the environment. DPE published in 2022 the *Guidelines for Division 5.1 assessments* in accordance with Section 170 of the EP&A Regulation and are to be followed when preparing REFs.

12.2.3 Crown Land Management Act 2016 (CLM Act)

The CLM Act includes provision for the ownership, use and management of the State's Crown land. Crown land is administered by DPE. The waterway of Shoalhaven River and the foreshore land is Crown Land, administered by the Crown, with the foreshore area also being located on Crown Land Reserve. Crown Land Reserve Number 52855 is managed by Council for the purpose of public recreation. Crown License Number 630902 is located along the adjacent foreshore which is for the purpose of the Coastal Protection Works (Figure 12-1).

Crown reserves are identified in Figure 12-2. All of the mapped reserve trusts are managed by Council.

Under Division 3.4 of the CLM Act, if a Council is a manager of a reserve trust and the reserve is a public reserve, the trust has all the functions of a Council under the *Local Government Act 1993* (LG Act). However, the trust has no authority to classify a public reserve or any part of it as operational land under the LG Act.

Given that the land is Crown land, Council will require a special purpose licence to remove the sand for dredging. Further, as there is a Native Title claim over the land, Part 8 of the CLM Act will apply in relation to the granting of the licence, unless Native Title has been extinguished.

Figure 12-1 Crown land mapped around the study area (Source: NSW Planning Portal)

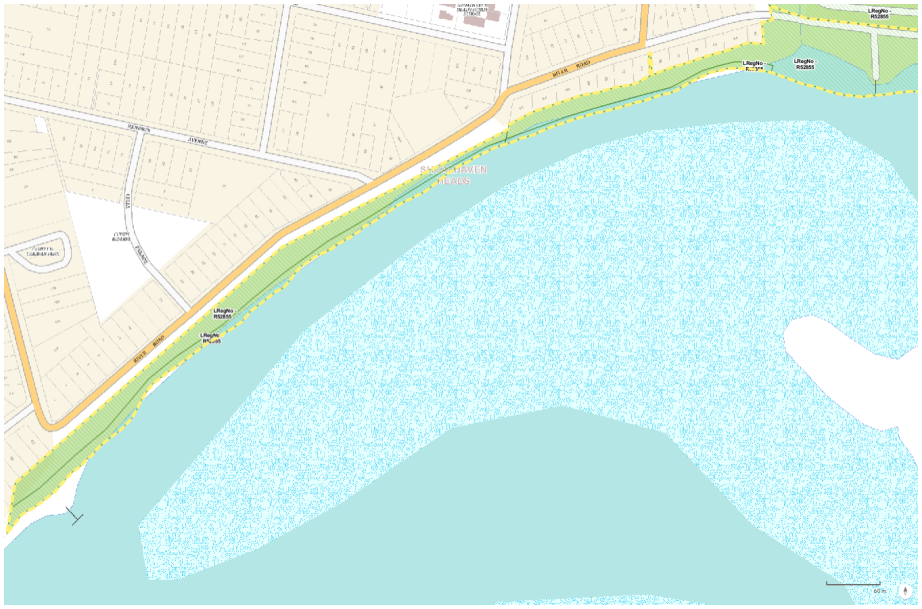

Figure 12-2 Crown reserves around the study area (Source: NSW Planning Portal)

12.2.4 Biodiversity Conservation Act 2016 (BC Act)

The purpose of the BC Act is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future consistent with the principles of ecologically sustainable development.

The BC Act outlines the protection of threatened species, communities and critical habitats in NSW. In the aquatic environment seabirds, waders, aquatic reptiles, aquatic mammals and insects, endangered aquatic ecological communities and key threatening processes are addressed under the BC Act. A number of threatened species listed under the BC Act have the potential to occur within the study area (refer to Section 4).

Part 7 of the BC Act contains the biodiversity assessment and approvals provisions for which developments or activities are to be assessed. There are not expected to be any significant impacts on any threatened species or on any endangered ecological community (EEC) listed under the BC Act as a result of the proposal. Therefore, preparation of a Species Impact Statement (SIS) would not be expected to be necessary and entry into the Biodiversity Offsets Scheme (BOS) under the BC Act would not be required.

12.2.5 Fisheries Management Act 1994 (FM Act)

The FM Act aims to conserve threatened species, populations and ecological communities of fish and key fish habitats. Part 7 of the FM Act relates to the protection of aquatic habitats including providing management of dredging and reclamation work within permanently or intermittently flowing watercourses as well as for the management of marine vegetation. The FM Act is administered by NSW Department of Primary Industries (DPI).

NSW DPI administers legislation, which protects marine vegetation (mangroves, seagrasses and seaweeds) on public water land and foreshores. Harming or removal of marine vegetation is generally only permissible by permit. In addition, the *Policy and guidelines for fish habitat conservation and management* (NSW DPI, 2013) are to be followed when planning for the protection of key fish habitat during dredging.

NSW DPI applies the following policies in relation to harm to marine vegetation:

- Under most circumstances damage to live seagrass is only permitted for replanting and scientific research purposes.
- Strapweed (*Posidonia australis*) seagrass must not be directly or indirectly impacted by any activity or development.
- The collection of living macroalgae, with the exception of green 'bait weed' (Enteromorpha and Ulva spp.), requires a permit from NSW DPI.
- Removal of marine vegetation, such as mangroves, requires a permit. No removal of marine vegetation will generally be permitted in certain areas, such as coastal wetlands mapped under the State Environmental Planning Policy (Resilience and Hazards) 2021.

There are a number of threatened fish species listed under the FM Act with the potential to occur in the study area, which have been identified and discussed in Section 4.1.1. No significant impacts on these species are expected to occur.

Marine vegetation is discussed in Section 4.1.1.

No areas of declared Critical Habitat under the FM Act occur within the study area and would not be impacted by any of the proposed options.

Permits to DPI that would likely be required under the following sections of the FM Act are as follows:

- Section 200: Permit for carrying out of dredging and reclamation works.
- Section 205: Permit for works that harm marine vegetation (i.e. mangroves, saltmarsh, seagrass or macroalgae).
- Section 219: Permit for activities temporarily or permanently obstructing fish passage.

However, Section 200(2) of the FM Act provides that there are two circumstances where a permit is not required. A permit is not required where the works are authorised under the CLM Act. Accordingly, as the works would be the subject of a special purpose licence under the CLM Act, it will not be necessary to also obtain a permit under Section 200 of the FM Act.

12.2.6 Protection of the Environment Operations Act 1997 (POEO Act)

The POEO Act regulates activities which may result in pollution impacts (for example land, air, water and noise pollution). Part 3.2 of the POEO Act requires an environmental protection licence (EPL) for scheduled development work and to carry out scheduled activities as identified in Schedule 1 of the POEO Act. Examples of schedules activities from Schedule 1, Section 19 include:

> *"(a) for maintenance dredging of a navigation channel for vessels carried out by or on behalf of a public authority—30,000 cubic metres of extractive materials per year, or*
>
> *(b) otherwise—30,000 tonnes extractive materials per year, where 0.65 cubic metres of extractive material that is wet is taken to weigh 1 tonne."*

As such, the concept options are not expected to require an EPL.

12.2.7 Water Management Act 2000 (WM Act)

Under Section 91 of the WM Act, an approval is required for a "*controlled activity that is undertaken on waterfront land*". Waterfront land includes beds of any river, lake and estuary. Development of any of the options would be exempt from the requirement to obtain a 'controlled activity' approval under Clause 41 of the Water Management (General) Regulation 2018 for work on waterfront land as it would be conducted by a public authority.

12.2.8 National Parks and Wildlife Act 1974 (NPW Act)

The NPW Act provides controls in relation to the protection of land reserved under the NPW Act as well as controls in relation to the protection of items of cultural heritage. It is an offence under the NPW Act to 'harm' Aboriginal objects or sites of Aboriginal significance without an Aboriginal Heritage Impact Permit (AHIP). Refer to Section 9.1.4 for further discussion on potential impacts to any Aboriginal places and sites.

12.2.9 Heritage Act 1977

The *Heritage Act 1977* contains provisions for listing sites or places on the State Heritage Register (SHR), establishment of State Government Agencies Heritage and Conservation Registers and the

protection of relics. None of the option locations are listed on the SHR or any Agency's Heritage and Conservation Register.

The Heritage Act 1977 defines a "relic" as follows:

> "*relic means any deposit, artefact, object or material evidence that:*
>
> *(a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and*
>
> *(b) is of State or local heritage significance.*"

There are no known relics at the option locations or any known maritime heritage (such as shipwrecks) that would be directly impacted. Refer to Section 9.1.4 for further discussion.

12.3 Environmental Planning Instruments

12.3.1 State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP)

Chapter 2 of the RH SEPP aims to manage development in the coastal zone. The RH SEPP contains provisions relating to the four coastal management areas that comprise the NSW coastal zone.

Under Chapter 2 of the RH SEPP, the foreshore area is located partly within the "coastal use area" whilst Shoalhaven River is mapped within the "coastal environment area" (Figure 12-3). The site is not mapped as coastal wetlands or littoral rainforest or as a proximity area to either. Under the RH SEPP, development on land within the coastal environment area and coastal use area zones must not be granted unless the consent authority (for developments under Part 4 of the EP&A Act) has considered whether the proposed development is likely to cause an adverse impact on the matters outlined in Sections 2.10 and 2.11.

As noted in Section 2.5, dredging works were considered in the legal advice as capable of being undertaken under the now Section 2.16(2)(a)(ii) of the RH SEPP on the basis that the work falls within the category of "beach nourishment" as development for the purpose of "coastal protection works" by or on behalf of a public authority without development consent. The proposed activity would be carried out by Council, therefore, it can be assessed and determined by Council under Division 5.1 of the EP&A Act. An REF would be prepared to describe the proposed activity, its potential environmental impacts, and safeguards and management measures to be implemented. In doing so, the REF helps to fulfil the requirements of Section 5.5 of the EP&A Act, including that Council examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

Chapter 3 of the RH SEPP contains the provisions for determining whether proposals are categorised as "potentially offensive development" and/or a "potentially hazardous development". It is unlikely that the proposal would fall under either category.

Chapter 4 of the RH SEPP requires that a consent authority is to consider whether the land is contaminated, and if so, that it is satisfied that the land can be made suitable for its intended purpose through remediation. The site is mapped as having the potential for Class 1 and, potentially, Class 3 acid sulfate soils to occur (Figure 12-4), along with other potential contamination associated with historical uses at the site.

Field investigations by ENRS (2022) determined the acid sulfate field screening results returned very low or no acidity or indications of potential acid sulfate material in sediment samples. Further, no ACM was identified during the investigations, however, building debris fill was observed on the riverbank which indicates that this fill may likely continue to be uncovered during rainfall and tidal events. Hence, there remains the potential for ACM to be present within the proposed dredge disturbance footprint.

For further discussion related to soil values and potential ACM, refer to Section 4.2.2 and Section 2.10, respectively.

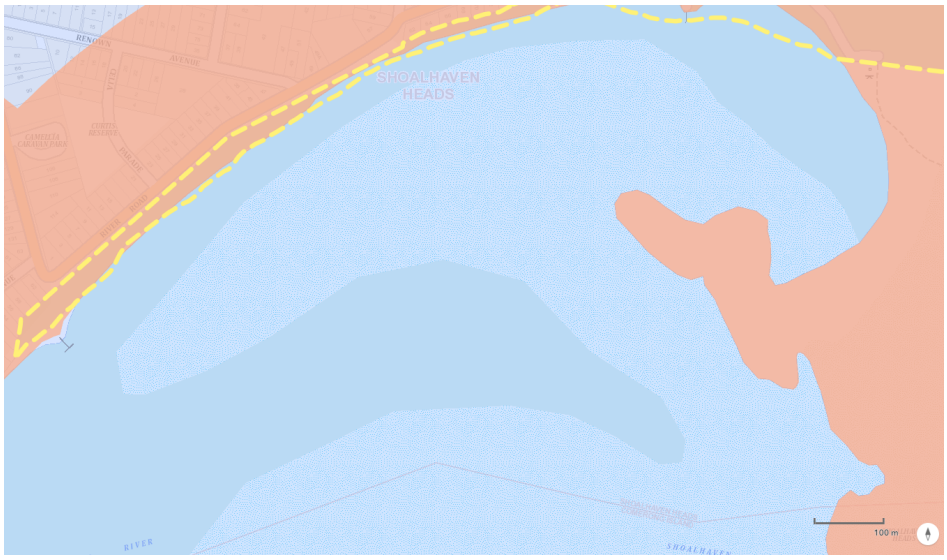

Figure 12-3 Coastal wetlands mapping (Source: NSW Planning Portal)

Figure 12-4 Acid sulfate soils mapping (Source: NSW Planning Portal)

12.3.2 State Environmental Planning Policy (Transport and Infrastructure) 2021 (TI SEPP)

Chapter 2 of the TI SEPP aims to facilitate the effective delivery of infrastructure across the State, including provisions for exempt and complying development, development without consent and development permitted with consent.

In the event that the planning approval pathway under the RH SEPP is not available, other potential pathways under the TI SEPP include Section 2.80 and 2.165, which are discussed below.

Section 2.80(2) permits development for the purpose of "navigation and emergency response facilities" by or on behalf of a public authority without consent on any land. The definition of "navigation and emergency response facilities" under the TI SEPP is as follows:

> "*navigation and emergency response facilities means facilities for—*
>
> *(a) water traffic control, safe navigation and other safety purposes (such as beacons, navigation towers, radar towers, communication facilities, vessel monitoring facilities, lighthouses, buoys, marine markers, pilot stations, jetties, breakwaters or training walls), and*
>
> *(b) emergency response, including rescue stations and emergency communication facilities and jetties.*"

In conjunction with the above definition, Section 2.80(9) then states that:

> "(9) *In this section, a reference to development for the purpose of navigation and emergency response facilities, wharf or boating facilities or associated public transport facilities for a public*

ferry wharf also includes a reference to dredging, or bed profile levelling, of existing navigation channels, if that dredging or levelling is—

(a) carried out for safety reasons, or

(b) carried out in connection with any such facilities that, at the time of the dredging or levelling, exist."

The legal advice referred to in Section 2.5 examined the use of the above provisions and indicated that this planning approval pathway is potentially available to Council, however further legal advice may be required if Council applied these provisions for dredging over the RH SEPP.

Section 2.165 of the TI SEPP permits development for the purpose of "waterway or foreshore management activities: on any land by or on behalf of a public authority without consent. An REF would be prepared and determined by Council. The definition of "waterway or foreshore management activities" under the TI SEPP is as follows:

"waterway or foreshore management activities means—

(a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways, and

(b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes, and

(c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways, and

(d) salt interception schemes to improve water quality in surface freshwater systems, and

(e) installation or upgrade of waterway gauging stations for water accounting purposes."

Section 2.165(3) allows the following to be undertaken when in connection with development for the purpose of waterway or foreshore management activities:

"(3) In this section, a reference to development for the purpose of waterway or foreshore management activities includes a reference to development for any of the following purposes if the development is in connection with waterway or foreshore management activities—

(a) construction works,

(b) routine maintenance works,

(c) emergency works, including works required as a result of flooding, storms or erosion,

(d) environmental management works."

12.3.3 Shoalhaven Local Environmental Plan 2014 (LEP)

Land zoning at the site under the LEP includes *RE1 Public Recreation* and *W2 Recreational Waterways* under the LEP.

In accordance with Clause 1.9 of the LEP, these are subject to the provisions of any SEPP that prevails over LEP as provided by Section 3.28 of the EP&A Act. Therefore, the proposal is permitted without consent pursuant to the provisions of the TI SEPP and is to be assessed under Division 5.1 of the EP&A Act.

12.4 Planning Approvals Pathway

It is expected that the proposal can be carried out under the provisions of the RH SEPP or the TI SEPP. As such, the proposal may be carried out without development consent subject to the preparation and determination of a REF under Part 5, Division 5.1 of the EP&A Act where the proposed activity is not likely to significantly affect the environment. For an activity that is likely to significantly affect the environment, an Environmental Impact Statement (EIS) is required to be prepared under Division 5.2 of the EP&A Act.

Other licence, notification and permits that are likely to be required for the proposal include:

- A special purpose licence pursuant to the CLM Act to remove the sand for dredging.
- Permit under Section 205 of the FM Act for any works that harm marine vegetation.
- Permit under Section 219 of the FM Act for activities that temporarily or permanently obstructing fish passage.
- Notification to NTSCORP in relation to a future act under the NT Act.

A flowchart is presented in Figure 12-5 to provide an overview of how any future dredging works can be approved under the relevant legislative requirements and what licences and permits would be required to be obtained.

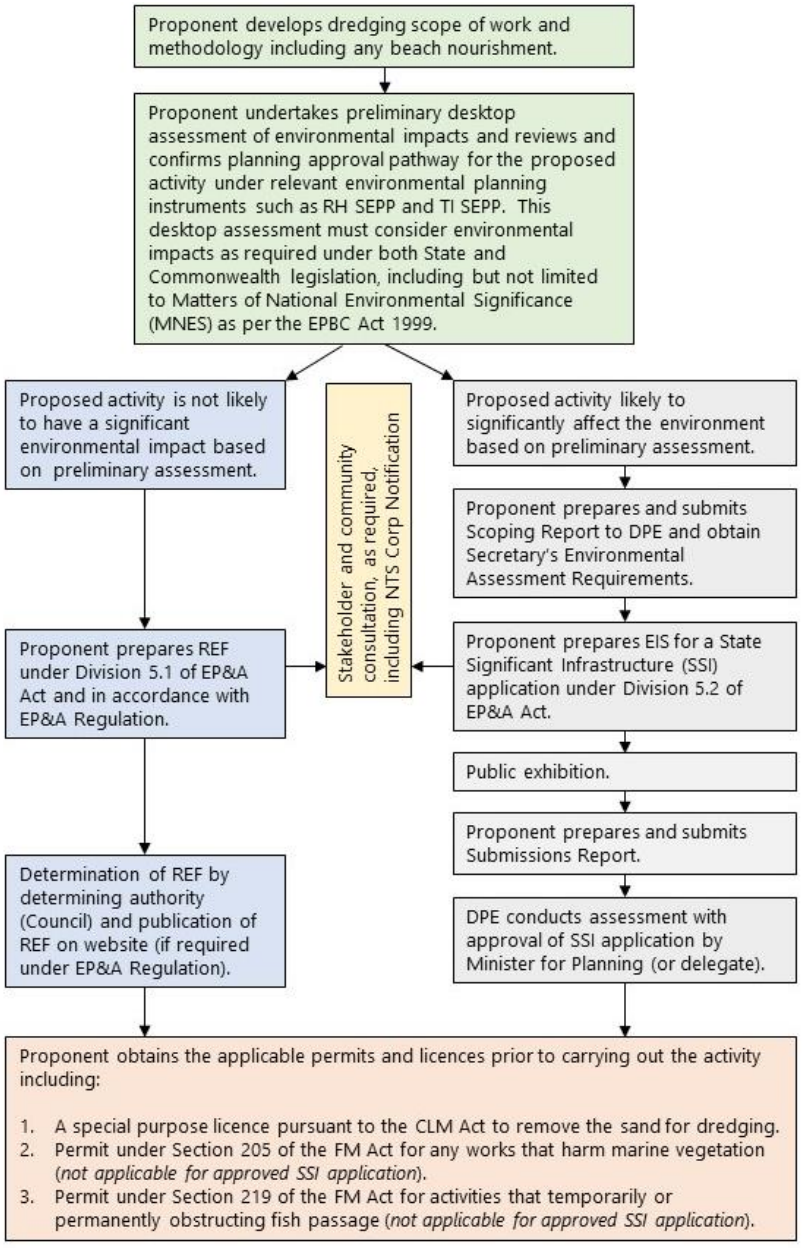

Figure 12-5 Dredging approvals flowchart

13 Feasibility and Viability Assessment

13.1 Assessment

Advisian has developed three concept options for the project. The options presented (excluding Option 1) aim to satisfy the key objectives of the project (adequate navigation/beach amenity) and have been designed in accordance with the navigation requirements outlined in Section 5. A summary of the options is provided below:

- Option 1 – Do nothing
- Option 2 – Design channel depth of -1.95 m AHD
- Option 3a – Design channel depth of -1.95 m AHD and beach nourishment (beach width 3 m @ 1.0m AHD)
- Option 3b – Design channel depth of -1.95 m AHD and beach nourishment (beach width 3 m @ 1.5 m AHD)

Option 2 has been based on achieving the navigation requirements within the existing channel. Areas where navigation requirements are not met would be dredged and the material used for beach nourishment in areas along the foreshore that would not compromise the depth of the navigation channel. Option 3a and 3b have been designed based on achieving the navigation requirements within the existing channel and improving beach amenity for users by increasing the beach width to 3 m and height to 1 m and 1.5 m AHD respectively along the full length of foreshore. Subsequent channel dredging is required for both Option 3a and 3b to widen the channel due to encroachment of the nourishment on the existing navigation channel.

A qualitative multicriteria assessment of the presented options has been undertaken (Table 13-1).

Advisian
Worley Group

Shoalhaven City Council

Table 13-1 Qualitative Multicriteria Assessment of the Options

Criteria	Option 1	Option 2	Option 3a	Option 3b	Comment
Improves navigation access	✗	✓	✓	✓	All options, including Option 1 – Do Nothing, provide good navigation access with the required minimum channel widths and depths. Note: The current channel conditions are adequate for a 6 m vessel navigating in all conditions.
Improves foreshore access and beach amenity	✗	✓	✓✓	✓✓	Option 2 would look to reuse the dredge material in areas requiring nourishment, it would not raise the beach profile along the full extent of the foreshore. Option 3a would provide improved beach amenity raising the beach level to 1 m AHD and widening the upper beach by 3 m. Option 3b would provide the most improved beach amenity raising the beach profile to 1.5 m AHD and widening the upper beach by 3 m.
Is sustainable with regards to maintenance dredging required (Dependant on frequency and severity of flood and storm events and entrance conditions) (boat wake will also cause some level of impact and has not been included in modelling)	✓	✗	✗✗	✗✗	Option 1 would be most sustainable in regard to the need for future maintenance dredging as the existing channel is currently stable, no sand is being placed on the foreshore and the existing natural channel alignment is not being changed. Option 2 could potentially require maintenance dredging if the sand placed on the foreshore was to slump into the navigation channel. Option 3a and 3b would be least sustainable regarding maintenance dredging. Nourished sand may re-enter the channel and the changed channel alignment may revert back to the natural channel thus requiring dredging. These options would also be more

Criteria	Option 1	Option 2	Option 3a	Option 3b	Comment
					susceptible to sand deposition due to growth of flood tide deltas.
Impact on seagrass (area m^2)	-	✗ (3,800 m^2)	✗ (5,150 m^2)	✗✗ (9,630 m^2)	Option 1 would have no impact on the seagrass. Option 2 would have limited impact on the seagrass at those locations identified as requiring deepening. Option 3a would have slightly more impact than Option 2 given the need to shift the channel at Profile 4 thus impacting on more seagrass. Option 3b would have the most significant impact on seagrass due to impacting on the largest area. Impacts to seagrass would require offsets which would add additional costs to the concept options.
Complexity of environmental approvals	NA	✗	✗✗	✗✗	Option 3a and 3b would be the most complex in regard to environmental approvals as they cover the largest area and would shift the existing navigation channel towards the sand shoals where seagrass is established.
Construction complexity/challenges	NA	-	✗	✗✗	Option 1 would require no construction, Option 2 would require minimal dredging/nourishment and Both Option 3a and 3b would be more complex in regards to channel widening and managing larger quantities of material onshore where space is limited. Option 3b would be the most complex as it involves the largest quantity of material
Dredge volume	Nil	3,000m^3	6,500m^3	11,000m^3	Dredge volume includes sedimentation allowance, 200mm dredge tolerance and batter slopes.
Dredge Area	Nil	8,650m^2	10,000 m^2	14,480m^2	

Criteria	Option 1	Option 2	Option 3a	Option 3b	Comment
Nourishment volume	Nil	3,000m^3	4,000m^3	10,500m^3	Surplus material to be used on foreshore where the navigation channel would not be further impacted.
Cost					
Backhoe Dredge Methodology	$Nil	$552,960	$742,380	$985,920	More expensive dredging rate with cheaper mobilisation/demobilisation.
Cutter Suction Dredge Methodology	$Nil	$886,788	$1,003,674	$1,153,956	More expensive mobilisation/demobilisation with a cheaper dredging rate.

✔✔ Option provides great benefits compared to the other options.

✔ Option provides some perceived benefits compared to the other options.

- Option provides a neutral benefit and impact compared to the other options.

✗ Option has some perceived impacts compared to the other options.

✗✗ Option has adverse impacts compared to the other options.

13.2 Discussion on Option Assessment

Option 1, that is the do nothing option, would not provide navigation access for 8 m vessels during design storm conditions at low tide however this would be achieved for 6 m long vessels. Furthermore, 8 m vessels would still be able to navigate the channel on calmer days when waves are not greater than 0.3 m at low tide. Option 1 would have no environmental impact, likely no maintenance dredging and no cost. This option would not provide improved foreshore access or beach amenity.

Option 2 would provide improved navigation for larger vessels up to 8 m as well as an improvement in beach amenity where the dredged material is used for beach nourishment. Comparing with Option 3a and 3b this option would have a lesser impact on the environment, lower construction cost, likely less maintenance dredging as the natural channel alignment is being maintained and would be less complex in regard to construction.

Option 3a is similar to Option 2 however, would provide better beach amenity with a consistent 3m wide beach at 1.0 m AHD. This option also requires more dredging and a shifting of the navigation channel (at Profile 4 Figure 8-8) which would increase cost, make environmental approvals slightly more complex and potentially lead to a requirement for more future maintenance dredging resulting from nourishment sand entering the channel and the channel wanting to revert back to the natural alignment.

Option 3b is similar to Option 3a however, would provide further improvement to beach amenity with a consistent 3m wide beach at 1.5 m AHD. This option would have a significantly larger environmental impact, higher cost and would likely require the most maintenance dredging as the option requires a significant change to the current alignment of the natural channel.

Regardless of the chosen option, ongoing survey of the channel is to continue to be undertaken as is done by most of the waterways by TfNSW.

14 Stakeholder Consultation

A stakeholder meeting was held on the 8th August 2023 to present the options developed as part of the study and obtain agency feedback. Formal comment was requested from Stakeholders with a summary of the agency feedback provided in Table 14-1.

Table 14-1 Stakeholder Consultation Feedback

Agency	Feedback
DPI-Fisheries	As stated at the meeting, the dredging and beach nourishment projects are not one and the same. When dredging volumes exceed the minimal that might be required for boating reasons, the primary purpose for the dredging is as a source of sand for beach nourishment. DPI Fisheries is not supportive of harm of seagrass from dredging activities associated with beach nourishment. As the justification for the proposed beach nourishment activity is unclear and unquantified, the proposed harm of seagrass from this activity in some of the options presented cannot be fully assessed in accordance with DPI Fisheries *Policy and Guidelines for Fish Habitat and Management* (the Policy), due to a lack of information (see comments below) nor supported by DPI Fisheries. The environmental impacts from the creation of a beach along river road that extends into the nearshore habitat would be significant and looking at current justifications provided likely not be supported by DPI Fisheries. Given the significance of impacts to seagrass, some of the options may trigger the need for an Environmental Impact Statement due to the scale of impact to seagrasses. DPI Fisheries recommends that further consideration of the dredging and beach nourishment raised in this report, be assessed under the Coastal Management Framework. In addition to the comments above, DPI Fisheries provides the following comments on the report: DPI Fisheries provides the following comment on the options: <u>Option 1:</u> This option is reasonable and viable, considering that: • For vessels 6m or less, there are no navigation issues with the existing channel. • Vessels greater than 8m, can use the channel in all instances, except when the entrance is open and waves are greater than 0.4m, likely during a 1:20 storm event. • There are alternative boat ramp access options for larger vessels within Shoalhaven Heads, that locals and tourists could be redirected to. • The standard used for the proposed dredging dimension is intended for vessels approaching marinas of busy waterways. The study area is a natural quieter channel generally only used by vessels that launch at the River Road boat ramp. This option has no environmental impact. It doesn't cover the call for sand nourishment, however the purpose of both activities are not the same and the need for sand nourishment is not clearly justified or

Agency	Feedback
	quantified. Further, there is already a process in place to nourish sand along the River Road foreshore. Option 2: With this option, will the sand deposited on the riverbank have a 5m buffer to seagrass as per the current Crown License? DPI Fisheries would require this. Is this option justified given the overly conservative estimates of boating channel navigation needs, and the alternatives for large boat access in the area? (see the points raised under Option 1) Options 3a & 3b: These proposals seem more about the creation of a sandy beach along the riverfront along River Road. As stated previously the reasons for this are not clear or quantified. Environmental Impacts to seagrass from these proposals would be significant. As the justification for the proposed beach nourishment activity is unclear and unquantified, the proposed harm of seagrass from this activity in some of the options presented cannot be assessed in accordance with DPI Fisheries *Policy and Guidelines for Fish Habitat and Management* (the Policy), nor supported by DPI Fisheries. Option 4: DPI Fisheries agrees with the assessment of this option in the report.
TfNSW	The design criteria used for the channel depth (section 5.4) are very conservative these include using the: • The Mean Low Water Spring tide (this doesn't occur all the time during the tidal cycle) • That the entrance is open (this occurs approximately 67% of the time assuming that mechanical opening will continue at the current rate) • 20 year ARI wave height (this assumes that a boat will be present during these wind conditions) • Design vessel is an 8m trailer boat (assuming that this boat uses the channel in these conditions) For there to be any impact to current navigation of the existing channel all of these assumptions need to align. The probability of all these occurring at once is extremely small, to put in plain terms it would be much less likely than one occasion in 20 years, ie once in 7300 days (assuming the wind event occurs for a day). These conditions are extremely unlikely and Transport for NSW would not support the dredging of the channel to accommodate this rare event, especially when there is a boat ramp in close proximity that would be much more protected from these wind conditions, and avoids this portion of channel. This should be clearly described in the report, and a quantification of the likelihood and frequency of the design criteria may be useful. In relation to the Option 3 (Section 8.3) to undertake some beach nourishment adjacent to the channel, which necessitates further dredging to accommodate the beach nourishment. Transport for NSW does not support the further dredging for navigation to accommodate beach nourishment this activity would not be eligible for existing Transport for NSW grants.
Crown Lands	Crown Lands notes that: • The purpose of the report was to determine the feasibility of dredging a navigation channel from the River Road boat ramp at Jerry Bailey Avenue to

Agency	Feedback
	the main channel of the Shoalhaven River close to the junction of River Road and Hay Avenue. • Dredged sand was proposed to be used to nourish a 'beach' along River Road with sand. • There have been no navigation incidents reported to either TfNSW or Council. • Generally bigger boats use the other access points in Shoalhaven Heads or along the Crookhaven to enter deeper water sooner. • Dredging options would be prohibited by cost, lack of available funds and ecological impacts to seagrass. • The Shoalhaven Heads frontage to the Shoalhaven River is an estuarine area characterised by fine grained sediments and provides a sheltered and shallow area for non-motorised watercraft and those not confident to swim in the open sea. • Seven Mile Beach, which fronts Shoalhaven Heads, provides abundant opportunities for use of 'white sand' beaches with clear marine waters. Any proposed dredging is unlikely to be supported by Crown Lands based on the ecological impact on the natural estuarine nature of the Shoalhaven River at Shoalhaven Heads and the lack of data showing any need to dredge the waterway for boating safety.

15 Proposed Works – Beach Nourishment

The stakeholder consultation identified no support from the relevant State Government Agencies for the proposed dredge options with stakeholders conceding a lack of justification or need to dredge the navigation channel.

SCC has recently (June 2023) undertaken beach nourishment along the River Road foreshore using sand obtained from Shoalhaven Heads Beach (Figure 15-1). The recent nourishment also included planting of native/endemic foreshore dune species as well as fencing to delineate foreshore access points to provide better erosion protection measures. Survey of the beach nourishment was undertaken in June 2023 and September 2023. Sediment analysis of the borrow material obtained from Shoalhaven Heads Beach has been completed (November 2023). An assessment of the recent nourishment, including analysis of survey and sediment characteristics, has been undertaken to ascertain the following:

- beach nourishment cross sections from the June and September 2023 survey data;
- comparison with the proposed concept nourishment profiles (Section 8) to ascertain whether beach amenity has improved; and,
- sediment compatibility analysis (borrow sand to native sand) and longshore sediment transport modelling sensitivity analysis.

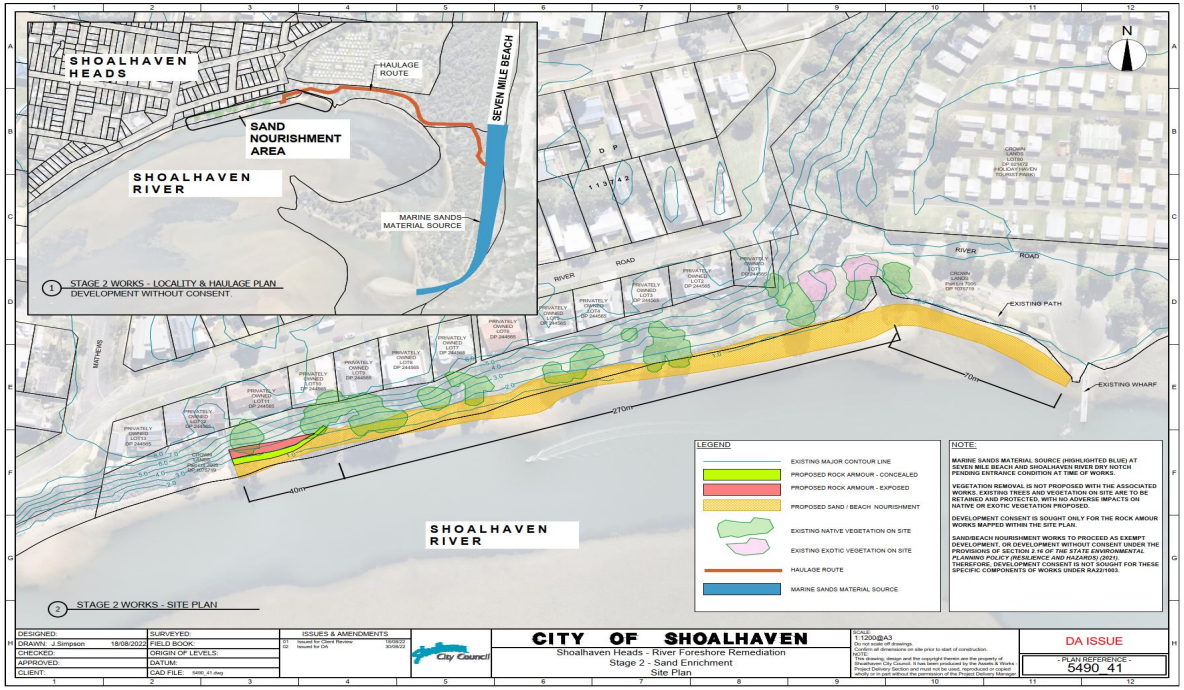

Figure 15-1 Shoalhaven Heads River Foreshore Remediation Works (SCC, June 2023)

SH24.1 - Attachment 1

15.1 Nourishment Cross Sections

SCC provided Advisian with the Work as Executed (WAE) survey of the beach nourishment (June 2023) and subsequent survey obtained from the site in September 2023. The survey data has been compared against the proposed option to nourish to an upper beach level of 1 m AHD adopting and upper beach width of 3 m and a slope of 1V:10H (Option 3, Section 8.3.2.3).

The following figures show the location of the survey transects (Figure 15-2) and cross sections depicting hydrographic profile (2022), initial nourishment profile (June 2023), subsequent survey of nourishment profile (September 23) and concept proposed nourishment (Figure 15-3 to Figure 15-15). The latest survey (September 2023) is compared to the proposed nourishment to ascertain whether the concept profile has been achieved. On the figures, where the September 2023 survey profile is above the proposed nourishment profile no further nourishment works would be required.

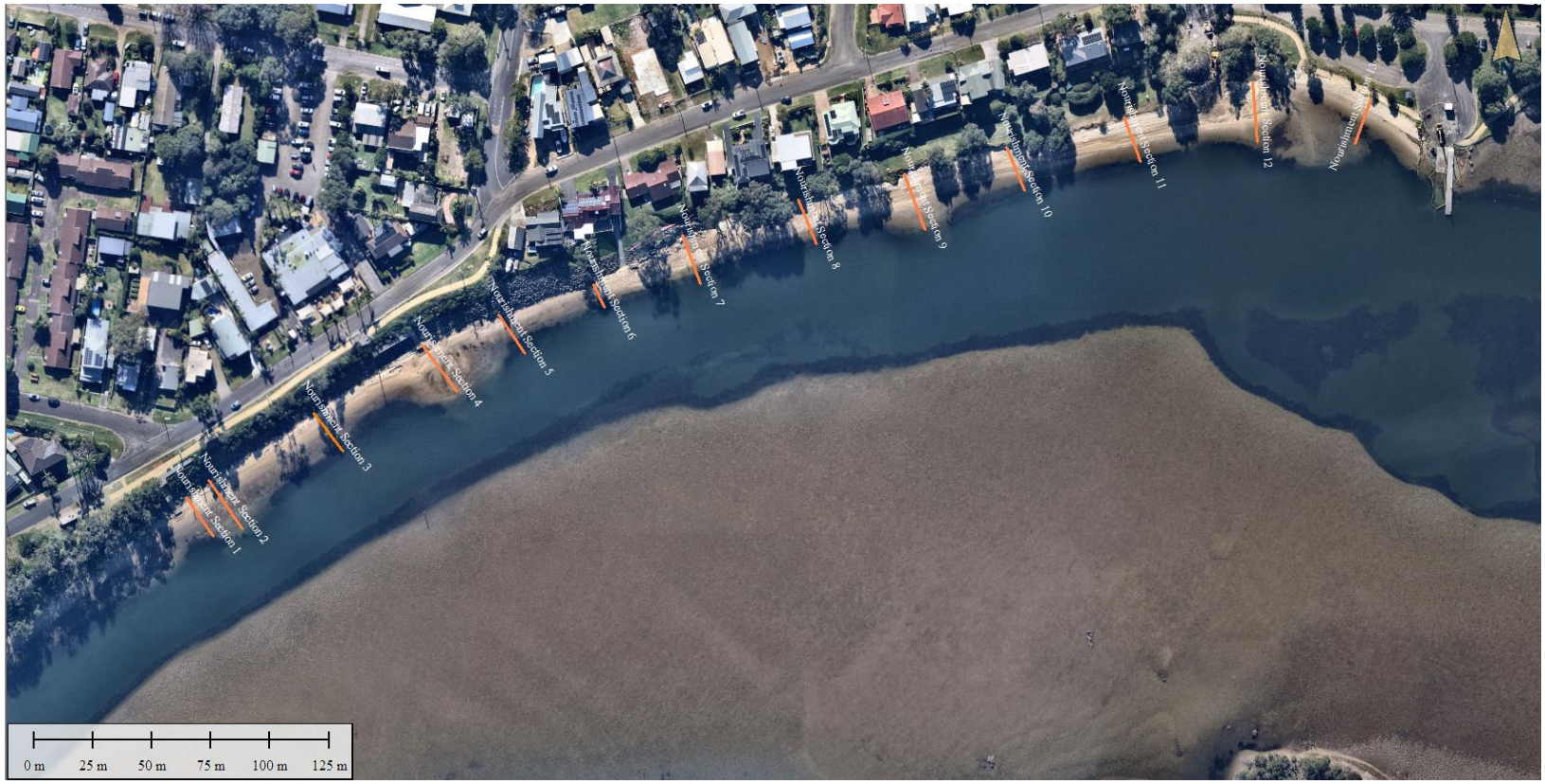

Figure 15-2 Location of Beach Nourishment Survey Transects

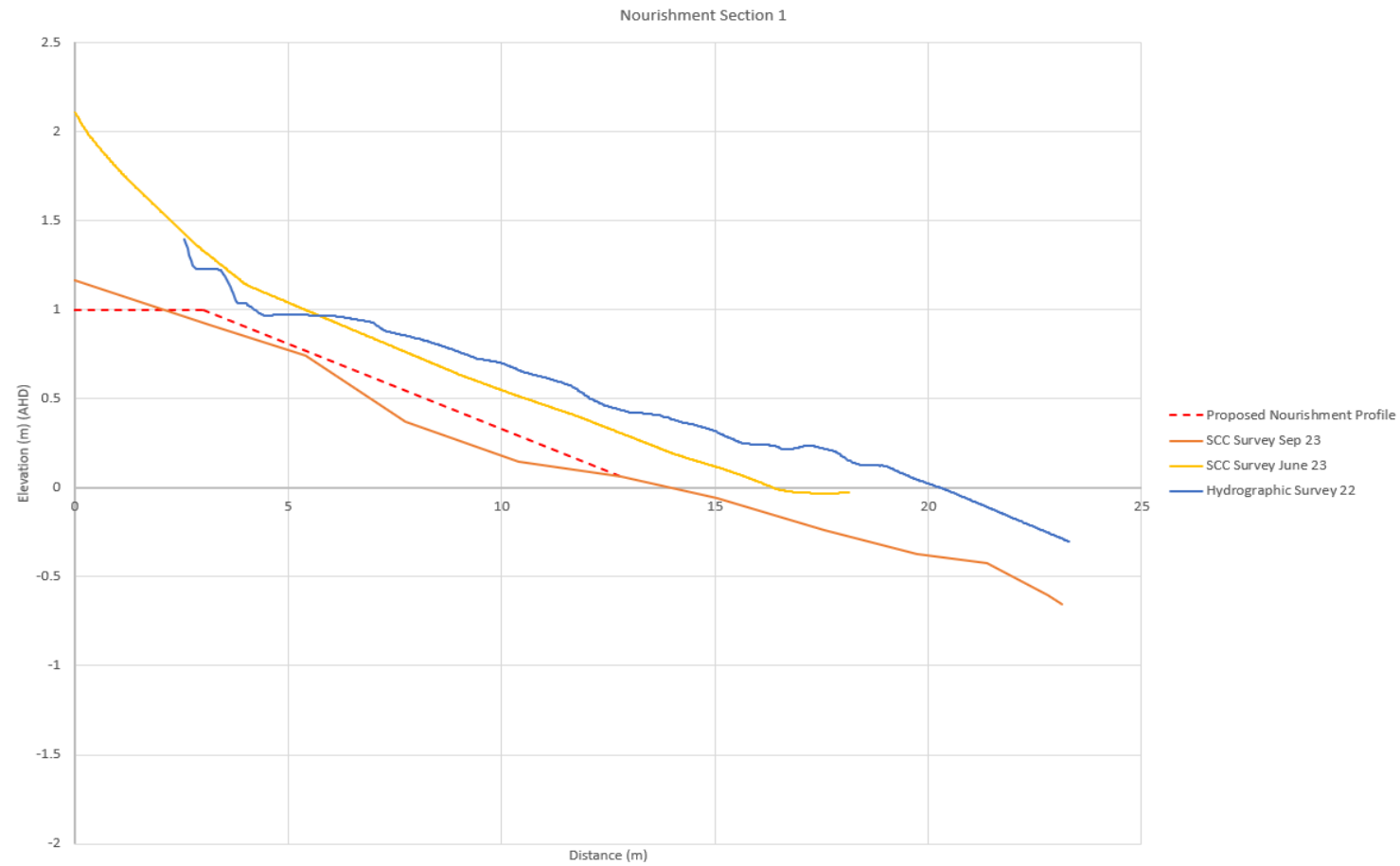

Figure 15-3 Cross Section Nourishment Section 1

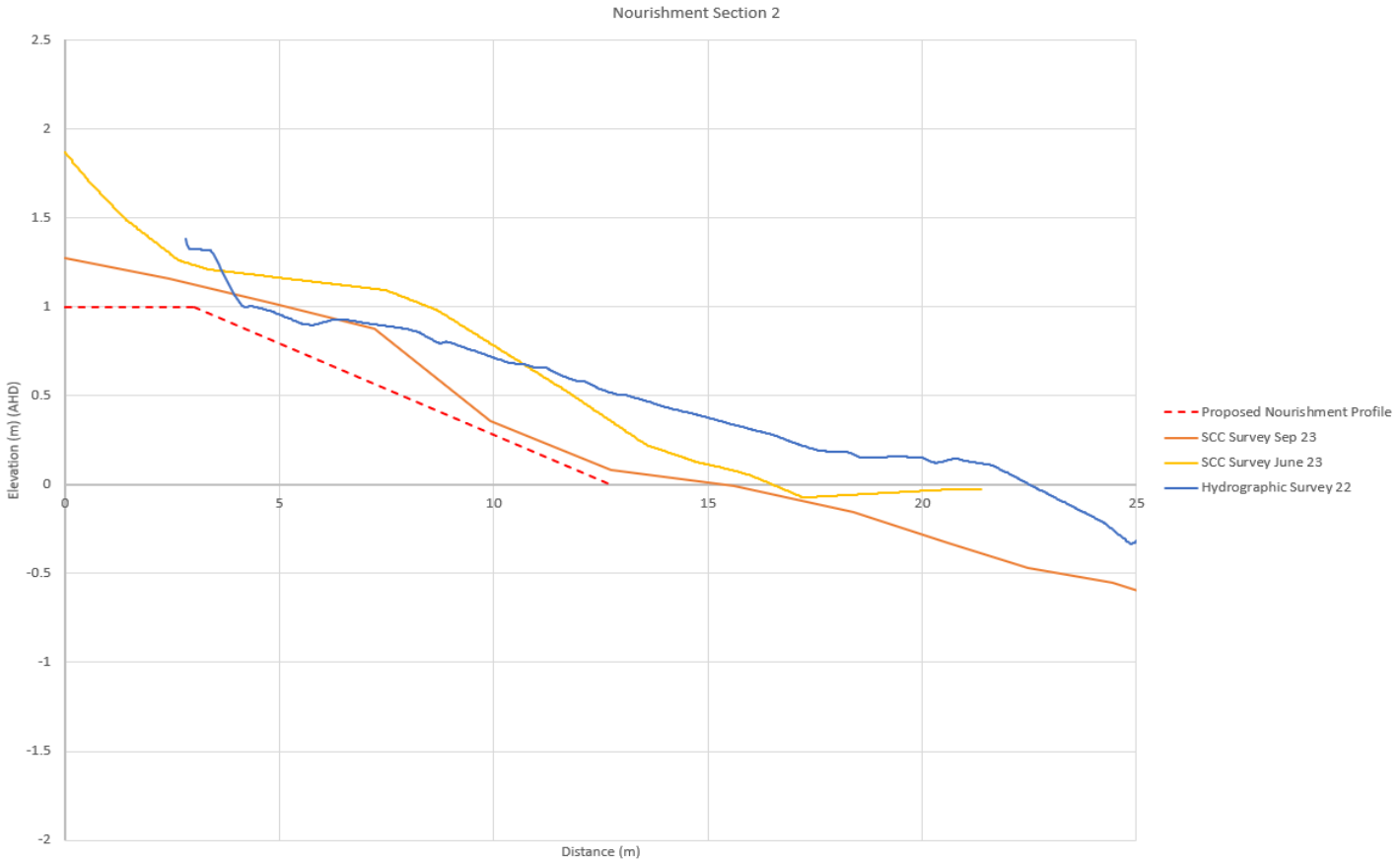

Figure 15-4 Cross Section Nourishment Section 2

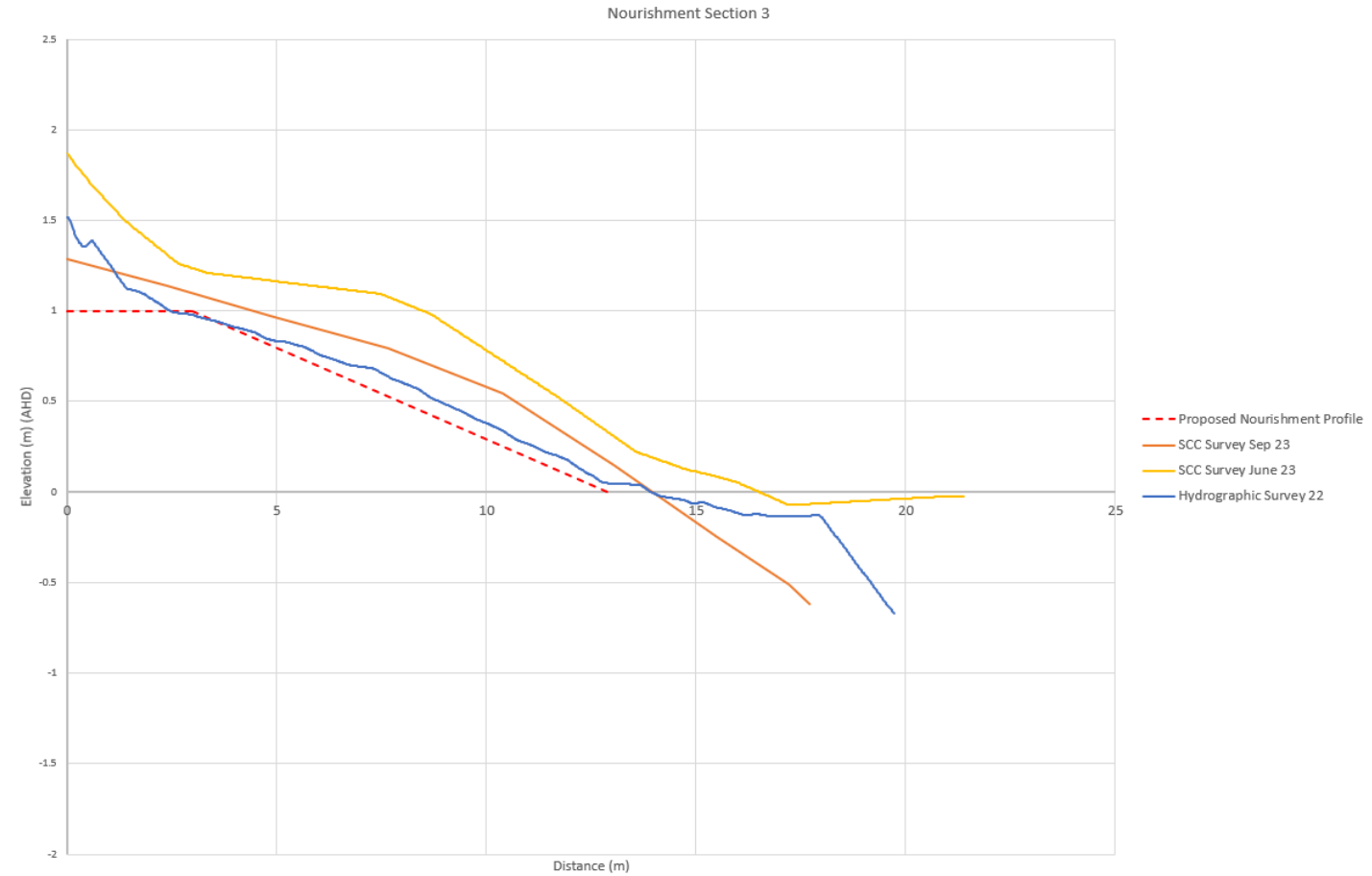

Figure 15-5 Cross Section Nourishment Section 3

SH24.1 - Attachment 1

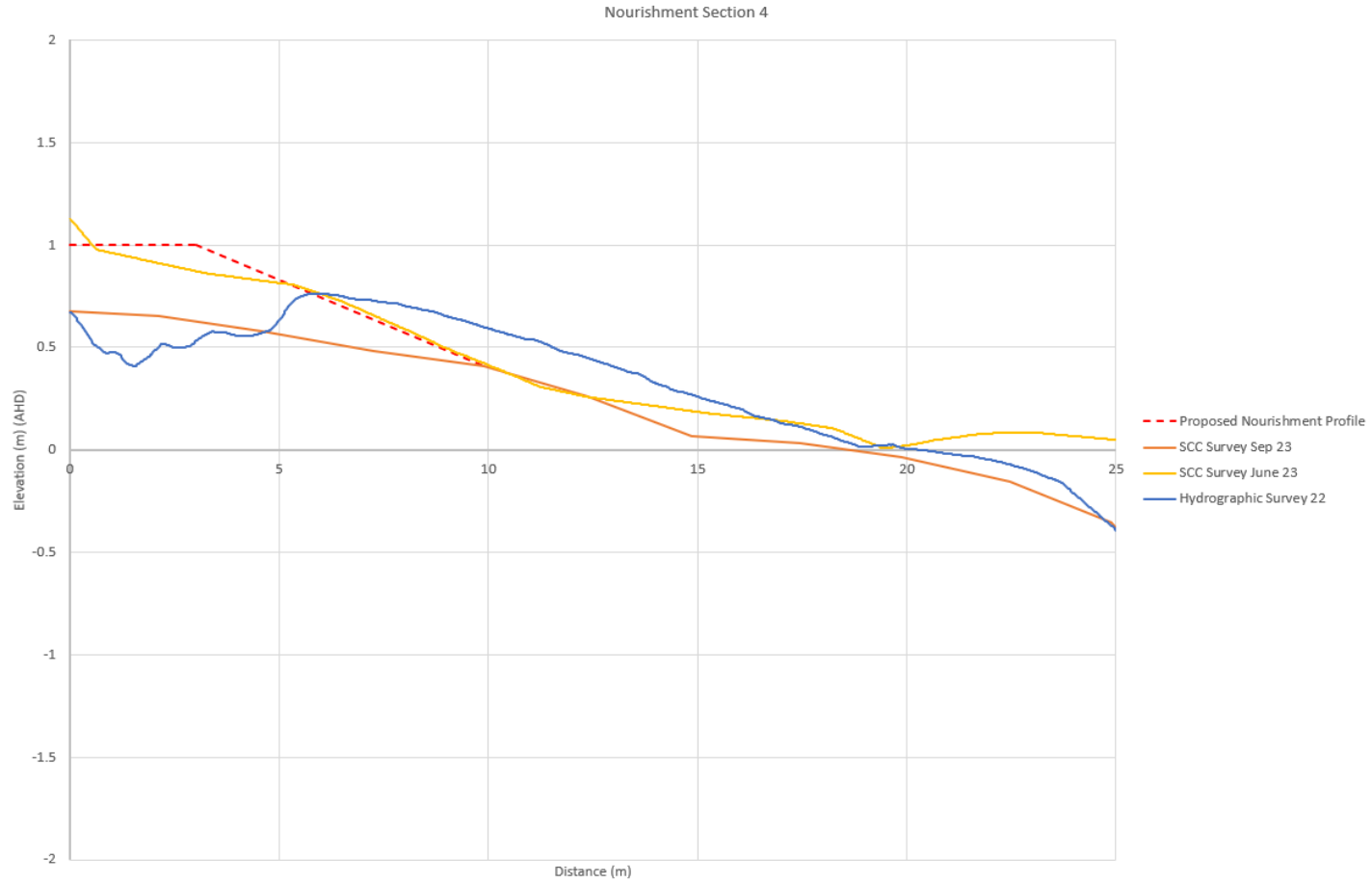

Figure 15-6 Cross Section Nourishment 4

SH24.1 - Attachment 1

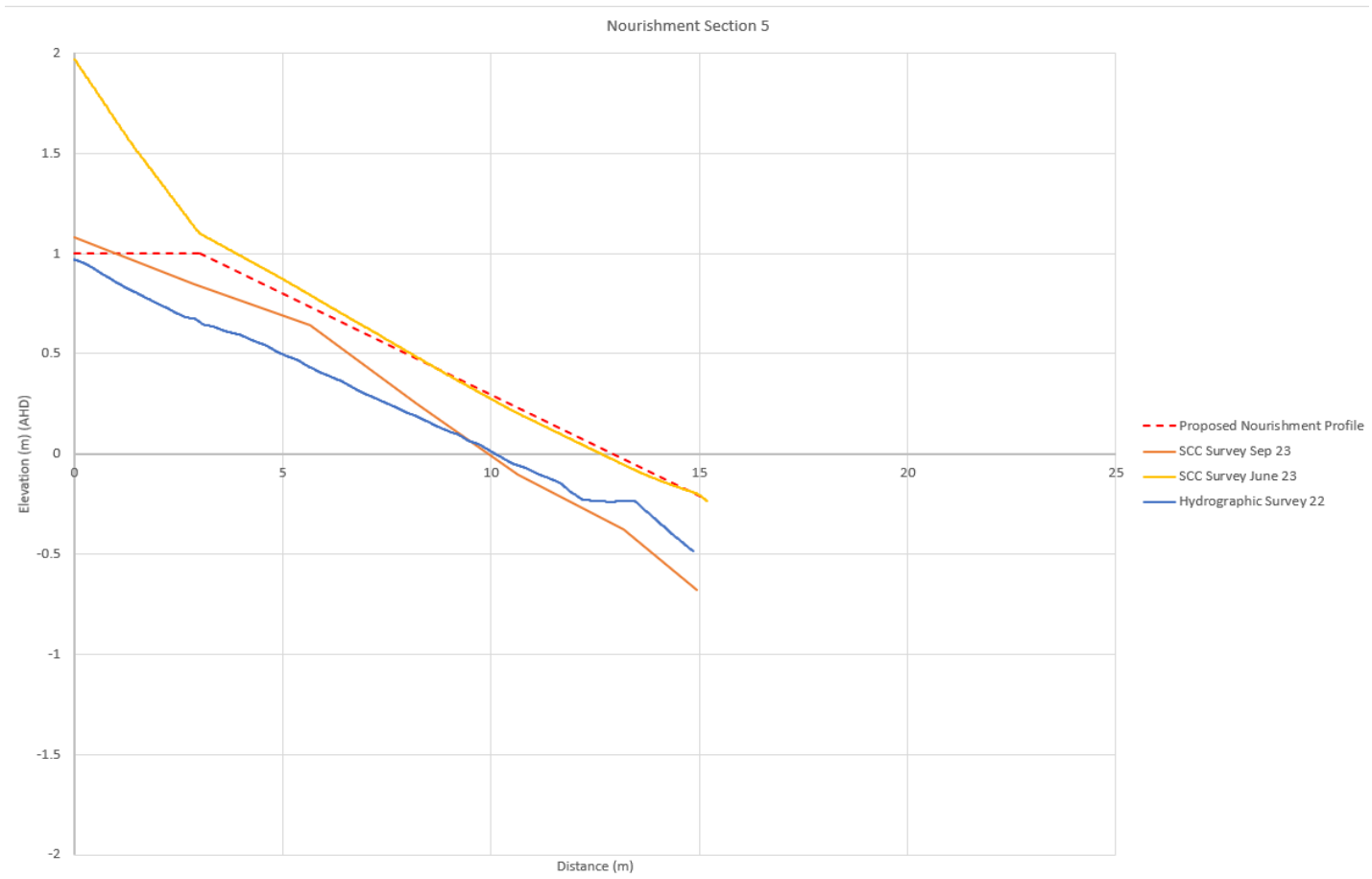

Figure 15-7 Cross Section Nourishment Section 5

SH24.1 - Attachment 1

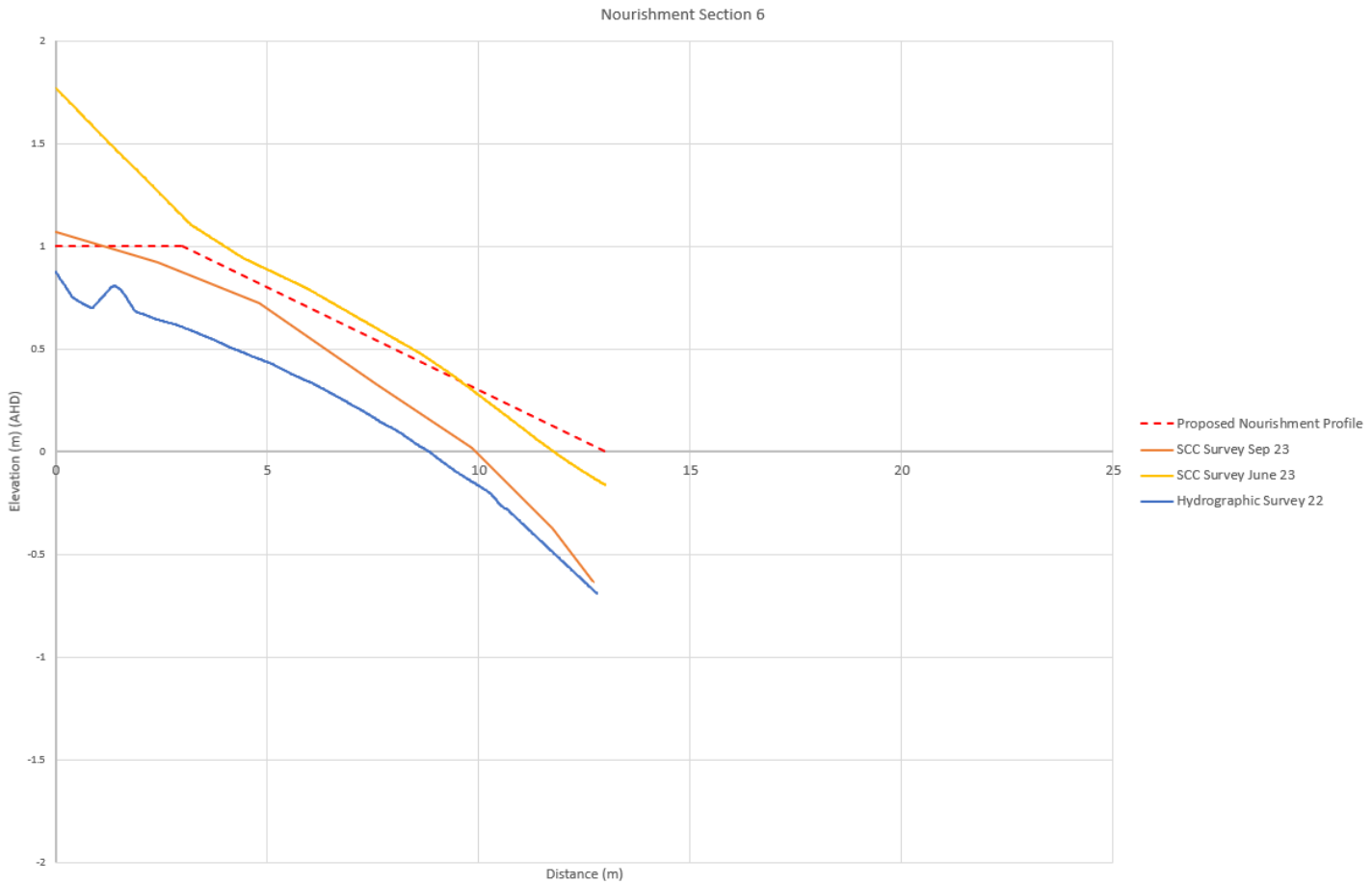

Figure 15-8 Cross Section Nourishment Section 6

SH24.1 - Attachment 1

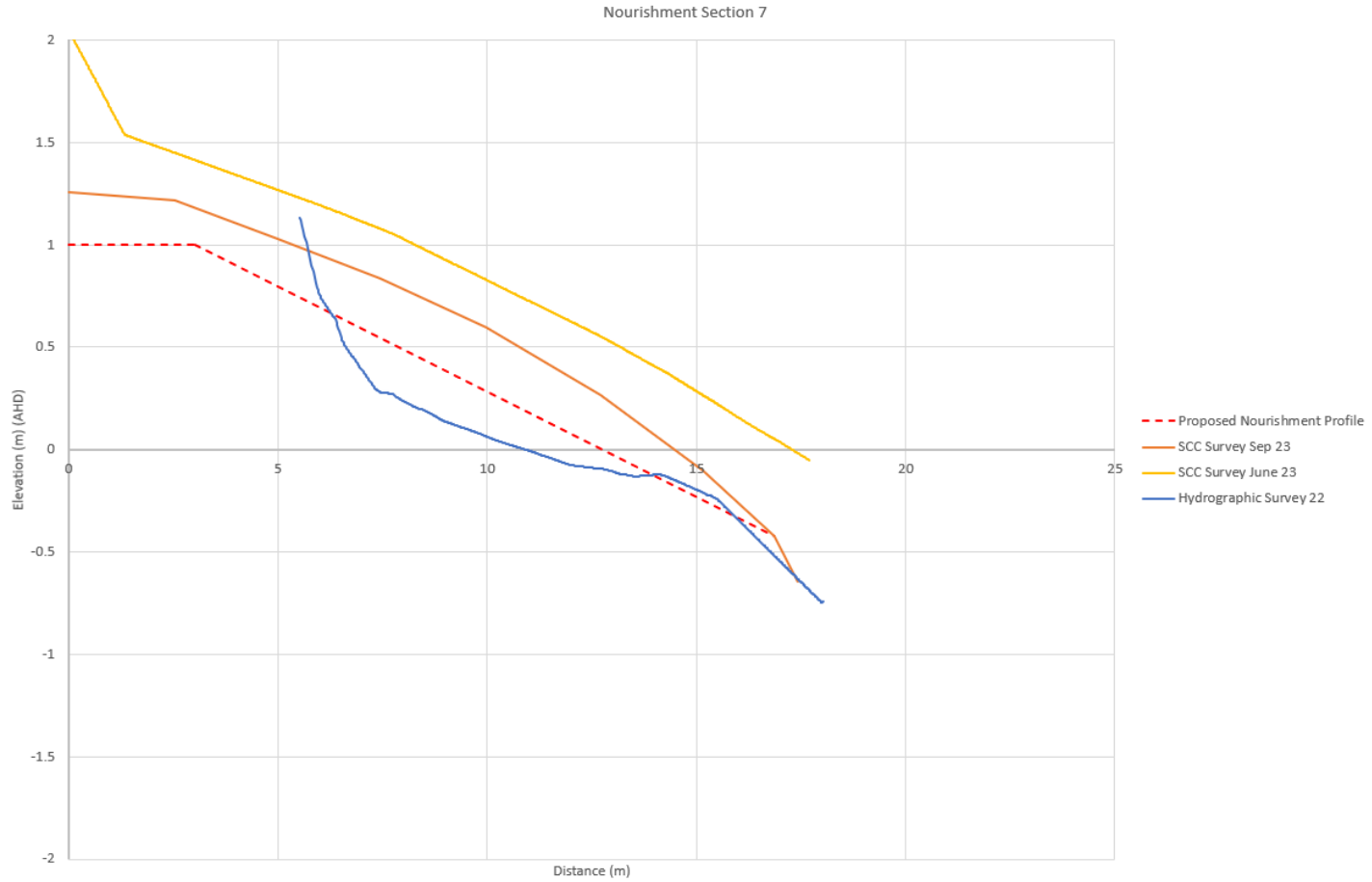

Figure 15-9 Cross Section Nourishment Section 7

SH24.1 - Attachment 1

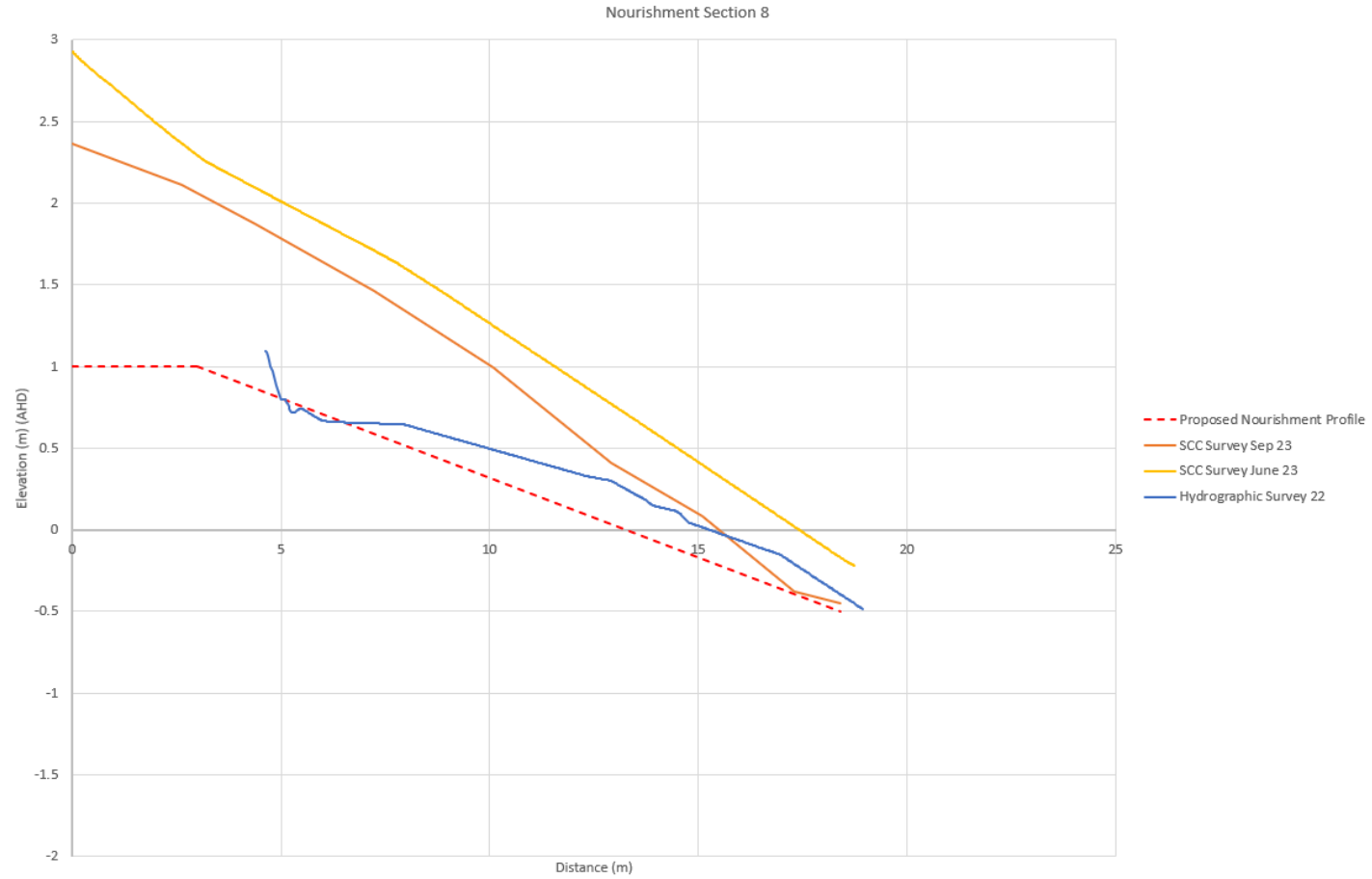

Figure 15-10 Cross Section Nourishment Section 8

SH24.1 - Attachment 1

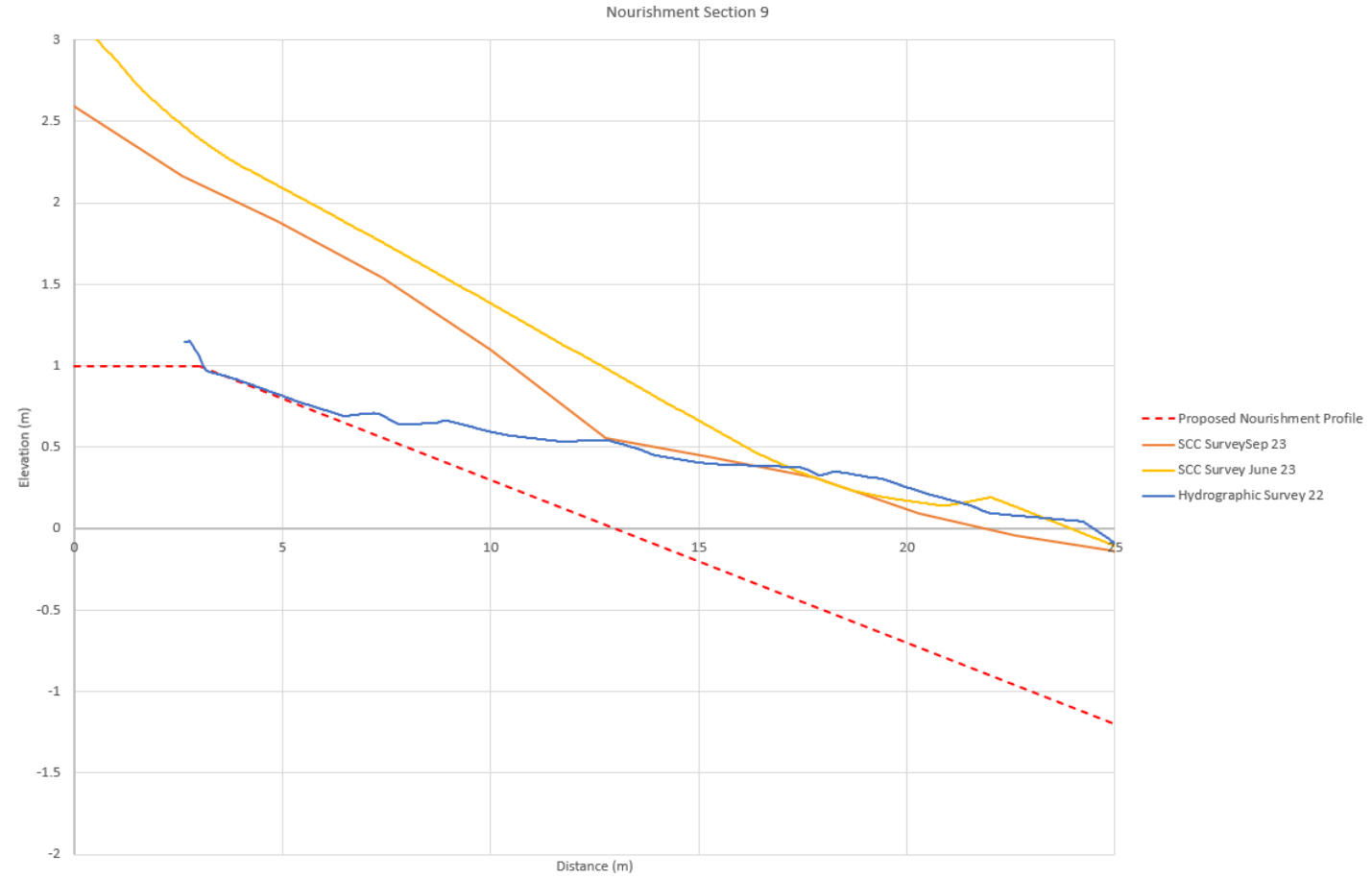

Figure 15-11 Cross Section Nourishment Section 9

SH24.1 - Attachment 1

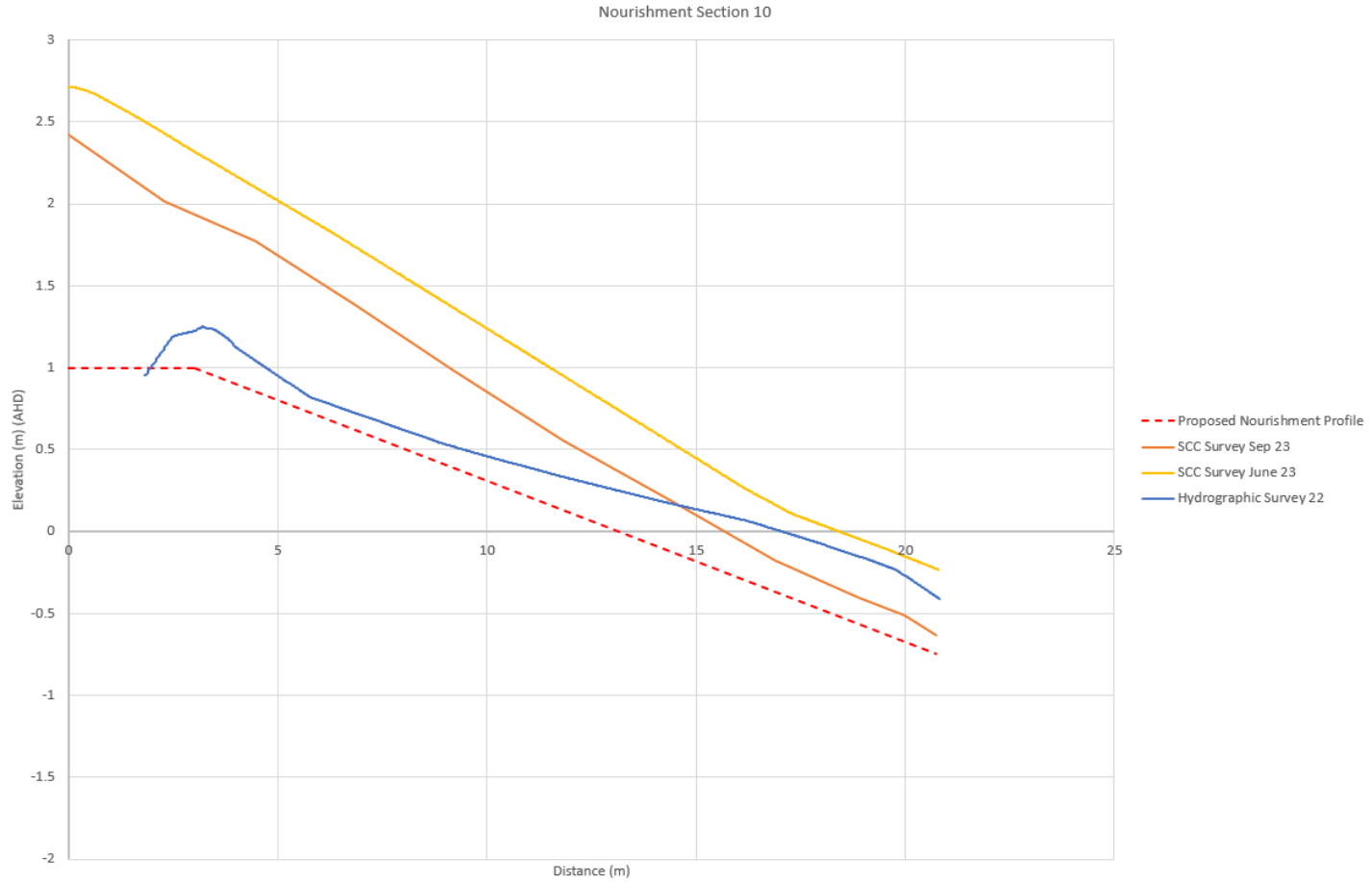

Figure 15-12 Cross Section Nourishment Section 10

SH24.1 - Attachment 1

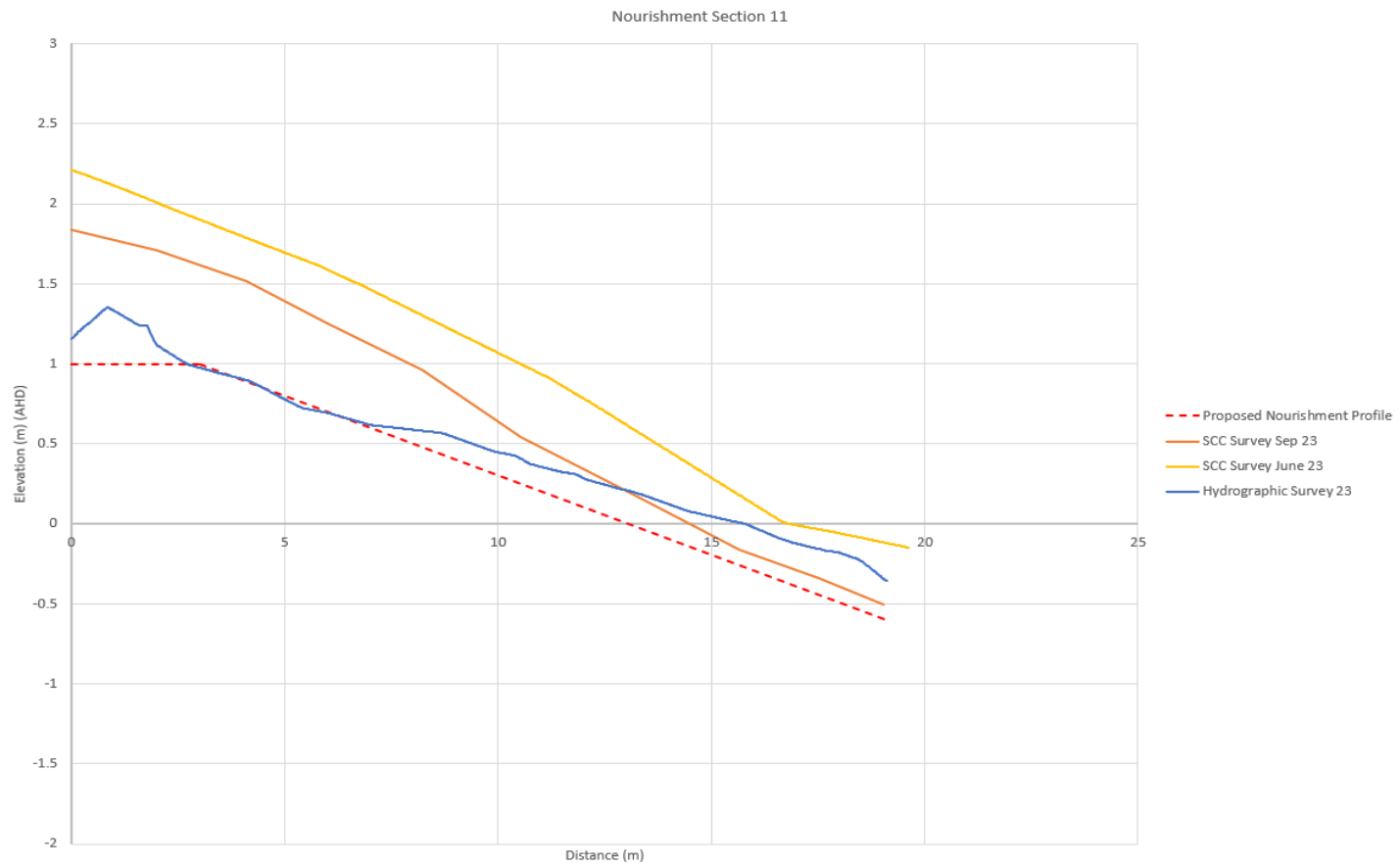

Figure 15-13 Cross Section Nourishment Section 11

SH24.1 - Attachment 1

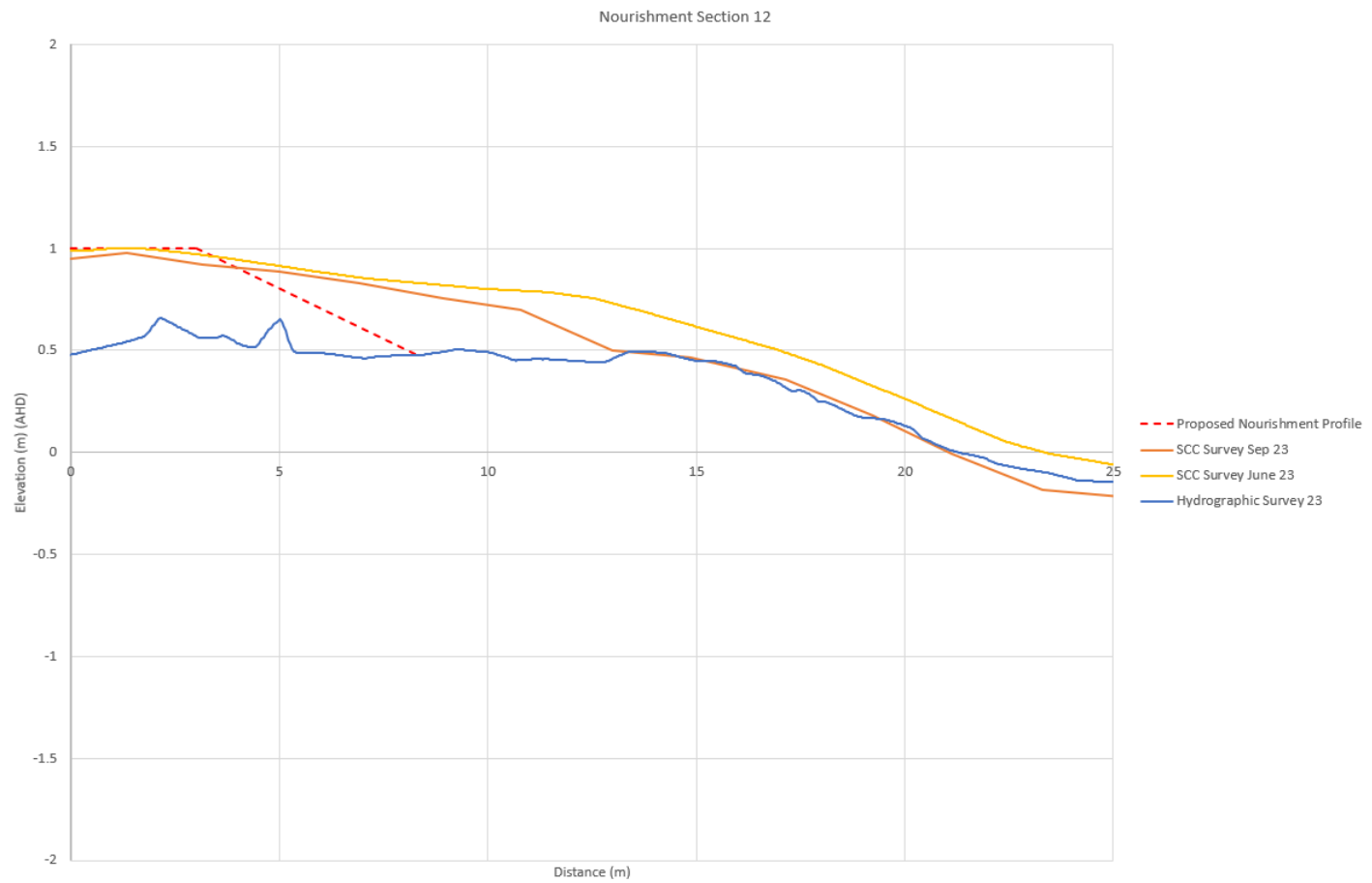

Figure 15-14 Cross Section Nourishment Section 12

SH24.1 - Attachment 1

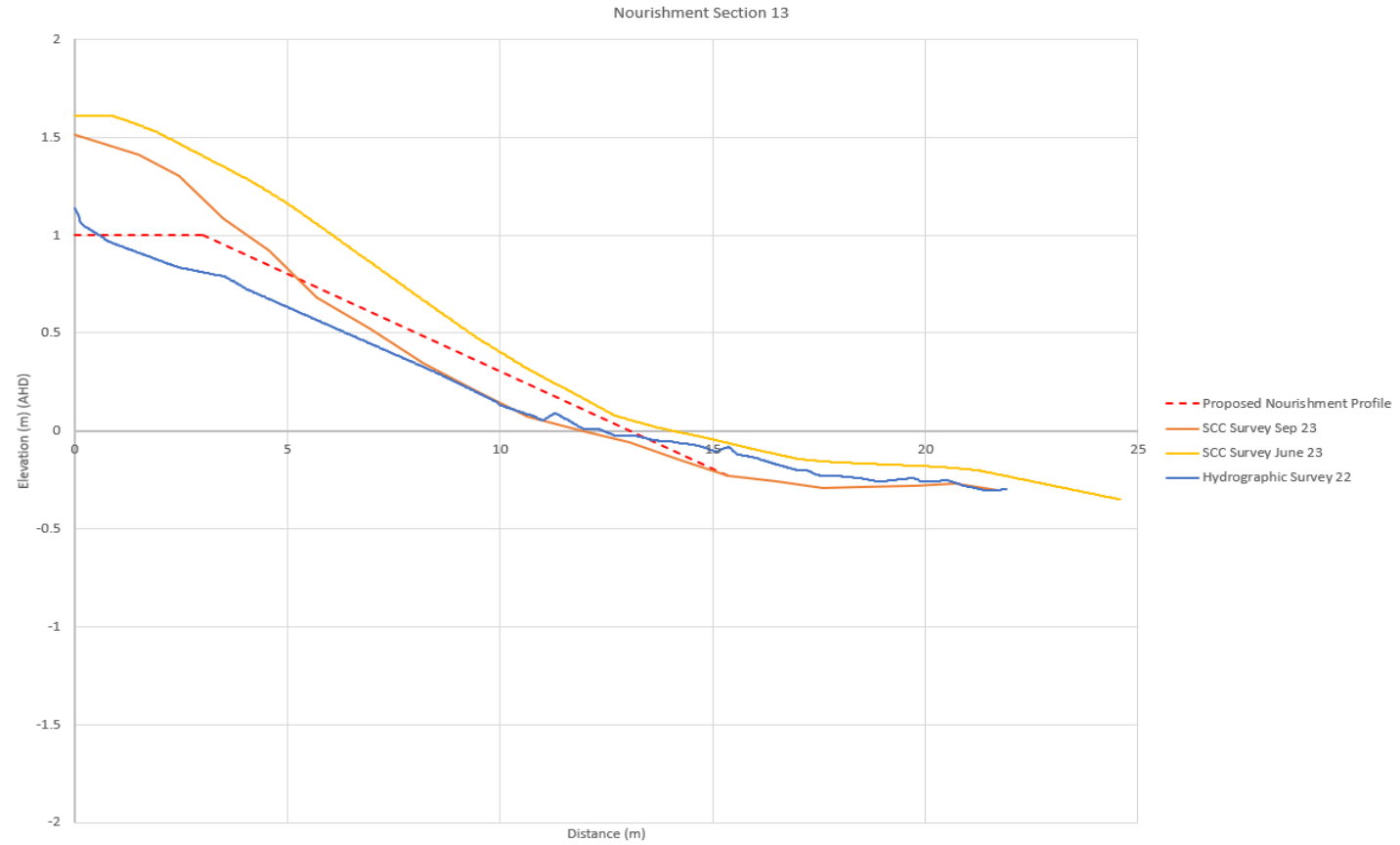

Figure 15-15 Cross Section Nourishment Section 13

SH24.1 - Attachment 1

15.2 Summary of Recent Nourishment Relative to Proposed Concept

Table 15-1 provides a summary of the nourishment cross sections relative to the proposed nourishment concept. There has been a loss of sand since nourishment was completed in June 2023 compared with the recent survey undertaken in September 2023 (likely resultant from natural readjustment). Generally, all cross sections are at or above the proposed nourishment upper beach level (1 m AHD) except between sections 6 and 7 at the Eastern end of the rock revetment works (Figure 15-2). The nourishment sand has typically been placed on a slope (1V:10H) with no flat upper beach level as per the proposed concept option however this is expected to naturally readjust to create an upper flatter beach area.

Table 15-1 Summary of Nourishment Relative to Proposed Nourishment

Cross Section	Discussion relative to proposed nourishment	Meets Proposed Upper Beach Level (1 m AHD)
1	At proposed nourishment level. No bench, slope of 1V:10H.	✓
2	Above proposed nourishment height ~ 0.2 m. No bench, slope of 1V:10H.	✓
3	Above proposed nourishment height ~ 0.2 m. Relatively flat.	✓
4	Below proposed nourishment height ~ 0.5 m. No bench.	X
5	Below proposed nourishment height ~0.2 m. No bench.	X
6	Below proposed nourishment height ~ 0.2 m. No bench.	X
7	Above proposed nourishment height ~0.25 m. 3 m bench and slope of 1V:10H.	✓
8	Above proposed nourishment height ~ 1.5 m. No bench, slope of 1V:10H.	✓
9	Above proposed nourishment height ~ 1.5 m. No bench, very steep.	✓
10	Above proposed nourishment height ~1.5 m No bench	✓
11	Above proposed nourishment height ~ 1.0 m. No bench, slope of 1V:10H.	✓
12	At proposed nourishment level. Flat.	✓

Cross Section	Discussion relative to proposed nourishment	Meets Proposed Upper Beach Level (1 m AHD)
13	Above proposed nourishment height ~ 0.5m No bench	

15.3 Nourishment Sand (Borrow Material) Analysis

15.3.1 Compatibility Analysis

Grain size of both the 'borrow' material and 'native' material is necessary for assessing the feasibility of a beach nourishment project. This provides an opportunity to evaluate the likely performance of borrow material when placed in nourishment (native) areas (i.e. will it stay or be washed away?).

Sampling of the native beach sand was not undertaken however the particle size of the nourishment sand has been reviewed relative to the previous sampling undertaken by ENRS (2022) of the proposed dredge material from within the channel as this would be comparable to the native beach sand. Samples of the dredge material were taken from seven sampling locations as shown in Figure 15-16. Particle size distribution results for the samples are shown in Figure 15-17.

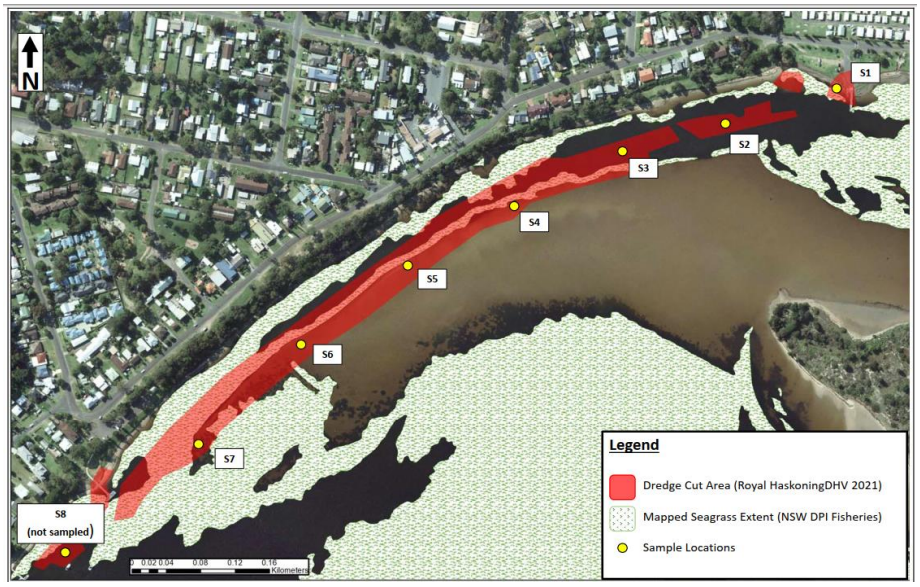

Figure 15-16 Sample Locations of Dredge Material Used for Analysis of Native Beach Sand (ENRS, 2022)

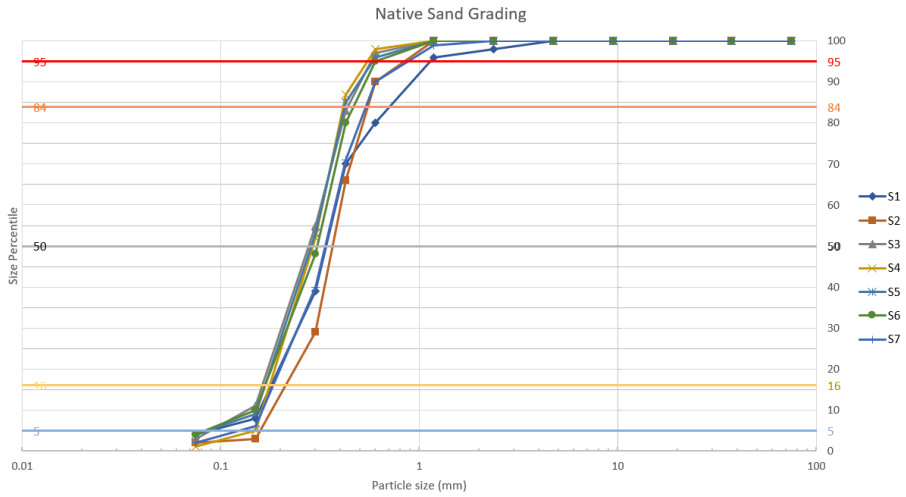

Figure 15-17 Native Beach Sand Grading

The particle size distribution of the borrow material (Figure 15-18) has also been assessed with results shown in Figure 15-19.

Figure 15-18 Sample Location of Borrow Material Along Nourished Foreshore

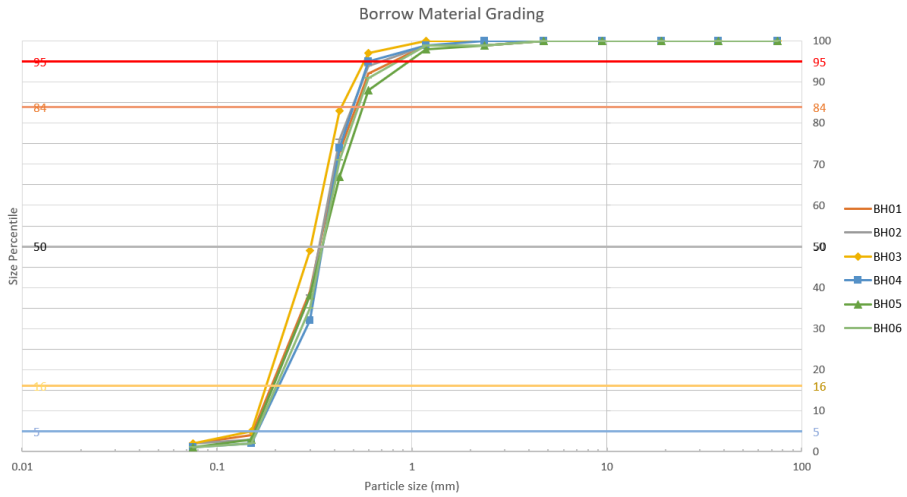

Figure 15-19 Borrow Sand Grading

Grain size grading of the 'native' and 'borrow' material is necessary for assessing the feasibility of a beach nourishment project. The James (1975) model of beach fill behaviour, described in the Shore Protection Manual (CERC, 1984), was adopted for assessing the physical suitability of the various sources of borrow material. The model assumes that the textural properties of the native material (mean grain size and sorting) are the direct response of sand sorting by natural processes (waves) and that these same processes will redistribute borrow material to a similar textural pattern as native material. For instance, fine sands which may be within the borrow material and not the native material, may not be stable in the beach environment and may be moved and lost from the active system.

The Overfill Ration (R_A) is used to predict the volume of borrow material needed to produce a unit volume of stable fill material with the same general grain size as the native beach The Overfill Ratio (R_A) is calculated by comparing the size distribution characteristics of the sand at the beach to be replenished with the characteristics of the sand at the source beach. It includes an adjustment for the percentage of fine grain size sediment in the source area. An overfill factor (R_A) was calculated comparing each borrow sample with each of the native beach sample, with results presented in Table 15-2. An overfill factor (R_A)>1.5 indicates the borrow material would be unstable. Based on the results presented in Table 15-2 borrow sites 3 to 6 should have compatible material, borrow sites 1 and 2 may be unstable. Borrow material deemed unstable would leave the site at a rate deeming the nourishment campaign ineffective.

Table 15-2 Overfill Ratio Borrow Material Relative to Native Sand

Borrow Site	Native Site	Overfill Ratio (R_A)	Comment
BH01	S1	1.75	Unstable
BH02	S2	1.5	Stable

Borrow Site	Native Site	Overfill Ratio (R_A)	Comment
BH03	S3	1.10	Stable
BH04	S4	1.05	Stable
BH05	S5	1.02	Stable
BH06	S6	1.02	Stable

15.3.2 Long Shore Sediment Transport Modelling

Coastal process modelling (Stantec, 2022) to ascertain the longshore sand transport rates of the beach nourishment adopted a sediment size D_{50} of 0.25mm. Recent sediment sampling of the nourishment sand has identified a sediment size D_{50} of 0.33mm (ENRS, 2023).

For comparison purposes the sediment transport rates have been evaluated using the Kamphuis (1991) expression. This expression is based on an extensive series of hydraulic model tests and depends on breaking wave height, wave period, grain size, nearshore beach slope and nearshore wave approach angle. The expression is given by:

$$Q_k = (6.4 \times 10^4) H_{sb}^2 T_{op}^{1.5} m_b^{0.75} D^{-0.25} \sin(2\alpha_b)^{0.6}$$

where

Q_k = sediment transport rate, m^3/year

H_{sb} = breaking wave height

T_{op} = wave period

m_b = nearshore beach gradient (i.e. 1:10 as measured in the beach survey)

D = sediment grain size (i.e. 0.25 mm for modelling and 0.327 mm according to the sand samples taken along the beach)

α_b = angle breaking wave crest makes with the shoreline

Results show that the difference in grain size has a marginal difference on transport rates with the larger grain size leading to a slight reduction in transport rates (Q~5000 m^3/yr (D_{50}=0.25 compared with Q ~4,700 m^3/yr (D_{50}=0.327).

16 Conclusion

This report documents the navigation and dredge feasibility assessment that was undertaken to ascertain any existing constraints in regard to navigation and determine dredge requirements. The extent of the assessment extended from the public jetty opposite Jerry Bailey Road to the boat ramp at the Northeastern extent opposite the Holiday Haven Caravan Park (~1000 m).

Relevant background documentation was reviewed, assessment made of the existing environment and a navigation assessment completed. The navigation assessment determined a minimal amount of dredging would be required if a design vessel of 8 m was selected and this dredging would only be required to achieve adequate depth in storm conditions. The assessment confirmed no dredging would be required if a design vessel of 6 m was selected. Based on the dredge requirements for the 8 m vessel navigating in storm conditions, four concept options were developed that included both dredging, nourishment and a combination of both. Preliminary cost estimates for each concept option were prepared.

The concept options were presented to relevant government authorities in a Stakeholder Consultation session. During the consultation it was established that any dredging of this section of channel was unjustified, given the absence of a navigation/safety risk and the unlikelihood of an 8 m vessel navigating the channel in storm conditions, and thus not supported given the lack of need to dredge and the potential negative impacts on the environment. As such, the direction of the project changed to focus on the beach amenity of the River Road foreshore. The site works undertaken in 2020 to address erosion along this area of foreshore included the construction of a ~240 m rock revetment which altered the beach amenity. SCC has undertaken recent beach nourishment of the River Road Foreshore following revetment rectification works on the eastern end of the rock revetment structure (June 2023). The beach nourishment aimed to increase the existing upper sand level to provide a more substantial sand buffer and to cover the toe of the rock revetment thus providing a wider beach for recreational amenity.

The recent beach nourishment work has been compared with the proposed beach nourishment concepts (Section 8) designed to improve beach amenity. The concepts nominated an upper beach level of 1 m AHD with a flat upper beach section of 3 m width. The assessment found that the recent beach nourishment achieved the proposed upper beach level (1.0 m AHD) along the majority of the foreshore.. The assessment found that the nourishment profiles had a consistent slope to the waterway (~1V:10H) which would likely readjust to a flatter profile with time. Analysis of the change in profiles between June and September 2023 shows a loss of sediment with the beach level reduced by approximately 0.2 m in the three-month period between surveys (likely a result of natural readjustment). A compatibility analysis was undertaken of the borrow material and native beach sand with result showing the nourishment as predominantly stable. Sediment sampling results of the nourishment sand were reviewed and compared with the sediment size adopted for sediment transport modelling. The D_{50}[4] adopted for sediment transport modelling was 0.25 mm compared with the nourishment sand which had a D_{50} of 0.33 mm. This slight increase in sediment size would result in a marginal reduction in the net longshore sediment transport rates.

[4] The median sediment particle size (D50) which is important for understanding and modelling sediment transport.

In conclusions, the study has found a lack of justification for dredging due to the absence of any navigation or safety risk and the potential negative impact it would have on the environment. The assessment of the recent beach nourishment found a significant improvement in beach amenity along the majority of the study foreshore. It should be noted, whilst nourishment has successfully been implemented to achieved a positive outcome, this is not necessarily an ongoing long-term option that the State Government agencies will support. Further assessment of the management of this area is to be via the Lower Shoalhaven River Coastal Management Program (CMP).

17 Bibliography

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Appendix A
Basis of Design

Shoalhaven Heads Dredging Feasibility Review

Basis of Design

Shoalhaven City Council

February 2023

311015-00354

Advisian
Worley Group

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PROJECT 311015-00354 - 311015-00354-MA-BOD-Shoalhaven Heads Dredging Feasibility Review: Shoalhaven Heads Dredging Feasibility Review - Basis of Design

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
A	Issued for Client Review	L.Freeman	B.Morgan	B.Morgan	02.02.23		
B	Final	L.Freeman	B.Morgan	B.Morgan	27.02.23		

-

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1 General Information

1.1 General

The purpose of this Basis of Design (BoD) document is to clearly define the criteria to be adopted for developing and assessing the feasibility of dredging the lower Shoalhaven River at Shoalhaven Heads. The BoD is intended to be a "live" document which is to be updated at appropriate stages in the design development.

1.2 Background

The estuary foreshore adjacent to River Road at Shoalhaven Heads experienced localised significant erosion following a series of storm events that culminated in the June 2016 East Coast Low (ECL). The erosion was a consequence of the estuary entrance being open to the ocean, elevated water levels, large ocean swells that penetrated the entrance and strong winds that generated large swells across the estuary. Ordinarily, the foreshore adjacent to River Road is a relatively sheltered environment.

Various studies and subsequent on-site works have been undertaken to understand the processes occurring in the estuary and address the erosion. On site works undertaken in 2020 have included the construction of a ~270m rock revetment along the foreshore opposite River Road combined with a small quantity of beach nourishment (1,060m^3 over 130m), replacement of beach access stairs at two locations, stormwater outlet improvement works at three locations, decommissioning of one stormwater outlet, clearing of vegetation to facilitate the rock revetment and drainage upgrade works and revegetation works (Figure 1-1ab). The purpose of the beach nourishment works was to raise the existing sand level from 0m AHD to 1.3m AHD in order to provide a more substantial sand buffer and to cover the toe of the rock revetment, thus providing a wider beach for recreational amenity.

Figure 1-1 Rock Revetment Along 270m of River Road Foreshore Shoalhaven Heads. (a) Oblique View of Rock Revetment and (b) Extent of Rock Revetment Relative to Heads Opening.

Shoalhaven City Council (Council) received a NSW Government Boating Access Dredging Program grant from the Maritime Infrastructure delivery Office (MIDO) in 2022. Council has undertaken preliminary studies, as listed in Section 1.8, with the aim of determining the viability of dredging the Lower Shoalhaven River to improve boating safety/navigation (if required) and nourish a section of the foreshore in front of River Road to improve community access and amenity.

1.3 Scope of Works

Advisian has been engaged to undertake the following:

- review existing studies and information to date;
- undertake a preliminary environmental assessment;
- develop and assess the feasibility of navigation dredging options;
- detail the preferred option to a level suitable for progressing to a formal Review of Environmental Factors that includes dredge volumes, drawings and a cost estimate; and,
- outline any information gaps and the next steps to progress the project.

1.4 Scope of BoD

The scope of the BoD applies to the assessment of the existing channel in regard to navigability and subsequent development of a channel dredging option if deemed necessary.

1.5 Units

In general, the SI system of metric units will be used for this Project

1.6 Datums and Grids

The following datums will be used on this project.

- horizontal datum is the Map Grid of Australia (MGA) Zone 56 grid system (GDA2020); and,
- vertical level datum is the Australian Height Datum (AHD).

1.7 Language

All documentation will be in the English language.

1.8 Design Codes, Standards and Guidelines

Wherever possible, the design will comply with relevant Australian Codes and Standards. Where applicable Australian standards do not exist or cannot be applied, other industry recognised international standards and recommended practices may be used.

The precedence applying for use of the Codes, Standards, Specifications and Regulatory requirements for the Project is as follows:

- Regulatory Requirements;
- Australian Standards;
- International Standards; and,
- Nominated Industry Guidelines.

In the event of an inconsistency, conflict or discrepancy between any of the Standards, Guidelines and Regulatory requirements, the most stringent and safest requirement applicable to the Project will prevail to the extent of the inconsistency, conflict or discrepancy. Any inconsistencies critical to the design shall be brought to the attention of the Principal for resolution.

The latest edition of each standard is to be used, unless noted otherwise.

The following codes and standards applicable to the project include but are not limited to:

- Australian Standard AS 3962:2020 Guidelines for the Design of Marinas
- Coastal Engineering Manual prepared by USACE
- National Assessment Guidelines for Dredging (NAGD) prepared by Commonwealth of Australia (2009)
- Site Investigation Requirements for Dredging Works by PIANC

- British Standards - Maritime Structures – Part 5: Code of Practice for Dredging and Land Reclamation
- PIANC (2014), Report No 121, Harbour Approach Channels Design Guidelines

Table 1-1 identifies the project specific documentation reviewed for this engagement.

Table 1-1 Project Documentation Reviewed for Engagement

Document Title	Organisation	Date
Shoalhaven Dredging Project Review of Environmental Factors	Royal HaskoningDHV	20 March 2015
River Road Foreshore, Shoalhaven Heads: Assessment of Coastal Management Options	UNSW Water Research Laboratory	August 2017
Shoalhaven City Council Coastal Management Plan (CMP) Scoping Study	Advisian	August 2020
Shoalhaven Heads – Channel Dredging and Beach Nourishment Stage 1 Tasks	Royal HaskoningDHV	11 May 2021
Shoalhaven River Hydrographic Survey	Hydrographic and Cadastral Survey	21 February 2022
Sediment Sampling and Analysis Plan (SAP) Implementation Report	Environment and Natural Resource Solutions	June 2022
Flora and Fauna Assessment Lower Shoalhaven Dredging Project	Stantec	28 July 2022
Advice Regarding Planning Approval Pathway for Shoalhaven Heads Channel Dredging – Legal Advice	Shaw Reynolds Layers	12 August 2021
Lower Shoalhaven River Tidal Inundation Study	Stantec	30 August 2022
Coastal Process Modelling Shoalhaven Heads Nourishment	Stantec	20 October 2022
Lower Shoalhaven River Coastal Management Program Stage 2 Boating Study	Rhelm	November 2022

2 Site Conditions

2.1 General

Site Conditions means any physical conditions of the Site (including sub-surface conditions, weather conditions or other physical conditions which are a consequence of weather conditions).

2.2 Location

The study area is located within the Shoalhaven Local Government Area (LGA) on the South Coast of NSW at Shoalhaven Heads (Figure 2-1). The extent of the navigation assessment is as shown in Figure 2-2, extending from the public Jetty opposite Jerry Bailey Road to the boat ramp at the Northeastern extent opposite the Holiday Haven Caravan Park.

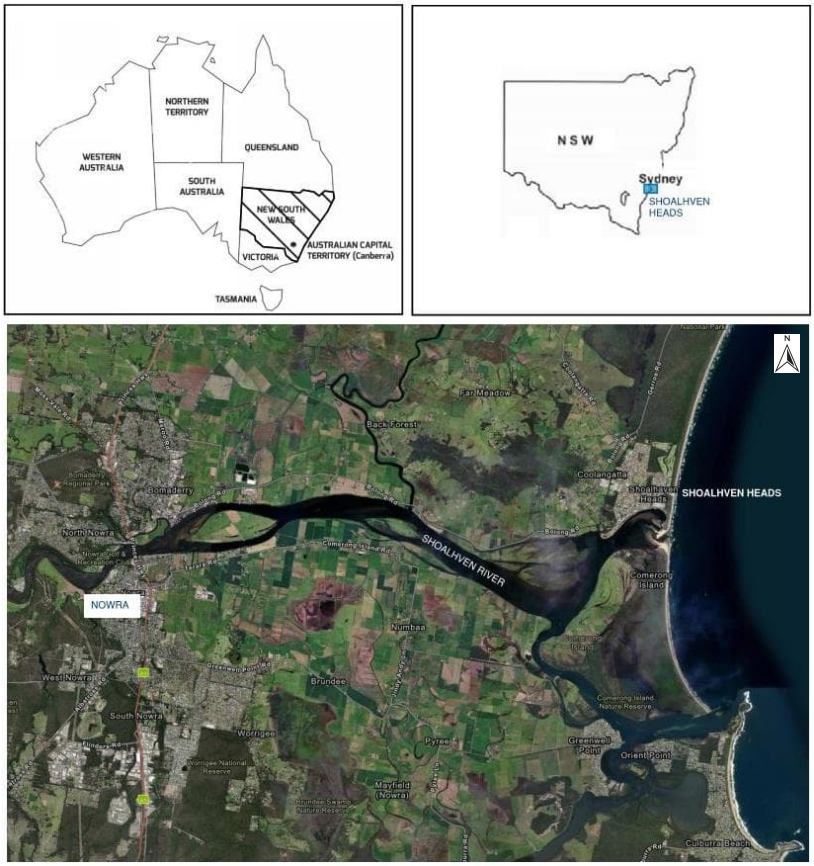


Figure 2-1 Location of Study Area

Figure 2-2 Extent of Study Area Shown by White Dashed Line

The foreshore running parallel with River Rd is typically sheltered with exposure to low energy wind seas and tidal currents. If the estuary entrance is open to the ocean, usually as a result of a flood event (also an erosive force), the foreshore can be exposed to long period ocean swells of more energetic and erosive nature however it would require a combination of factors including:

- elevated estuary water levels;
- estuary entrance to be open; and,
- large ocean waves or strong winds blowing across the estuary.

2.3 Bathymetry

Bathymetry is required to describe the level of the channel bed over the extent of the study area. Channel depth is one of the key dimensions for assessing the adequacy of the navigation channel for the nominated design vessel measured below a particular reference water level.

Figure 2-3 depicts the bathymetry of the navigation channel based on survey obtained in 2022 and reference in Table 1-1. Random cross-sectional profiles taken at various transects along the navigation channel are provided in Appendix A. Typical depths at the centreline of the channel are approximately -2m AHD. Channel width varies with the narrowest section approximately 20m wide.

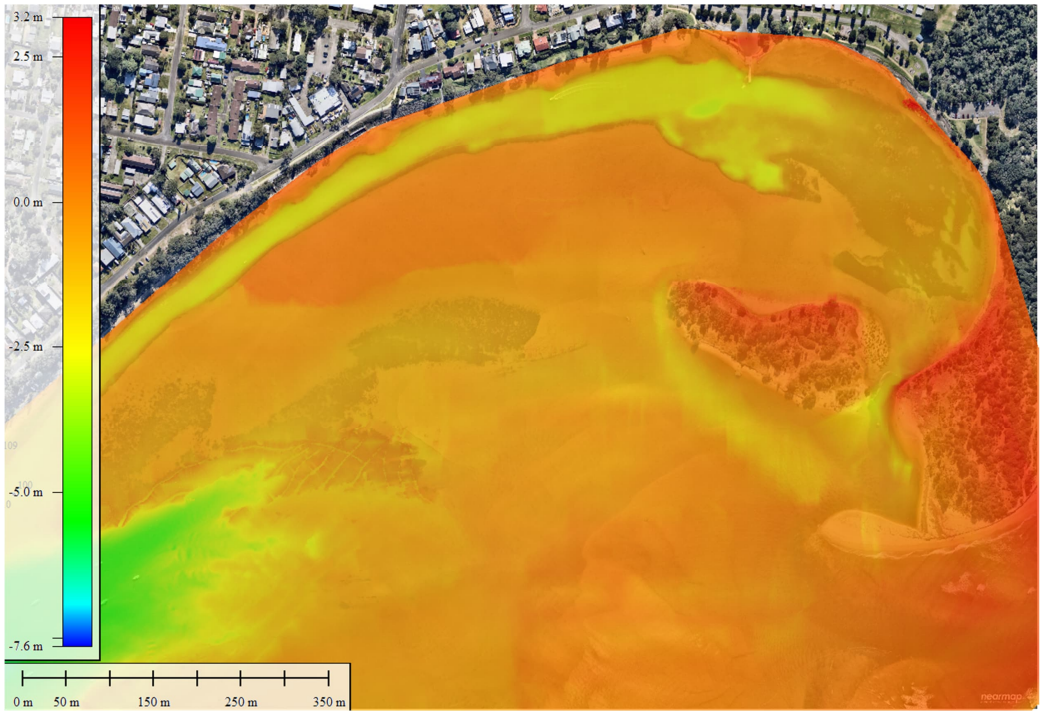


Figure 2-3 Bathymetry of Navigation Channel Based on Survey Obtained in 2022

2.4 Water Levels

Water levels at Shoalhaven Heads are dominated by the astronomical tides. Tidal planes for the study area, taken from the tidal recording station at Shoalhaven Heads, are provided in Table 2-1. The location and a photo of the tide gauge is shown in Figure 2-4. An entrance open scenario will be adopted for the navigation assessment based on MLWS (-0.415m AHD).

Table 2-1 Tidal Planes for Shoalhaven Heads (WRL, 2017)

Tidal Plane	Level m (AHD)	
	Entrance Closed	Entrance Open
High High Water Solstices Springs (HHWSS)	0.738	0.947
Mean High Water Springs (MHWS)	0.434	0.594
Mean High Water (MHW)	0.375	0.502
Mean High Water Neaps (MHWN)	0.315	0.410
Mean Sea Level (MSL)	0.067	0.090
Mean Low Water Neaps (MLWN)	-0.181	-0.231
Mean Low Water (MLW)	-0.240	-0.323
Mean Low Water Springs (MLWS)	-0.299	-0.415
Indian Spring Low Water (ISLW)	-0.516	-0.667

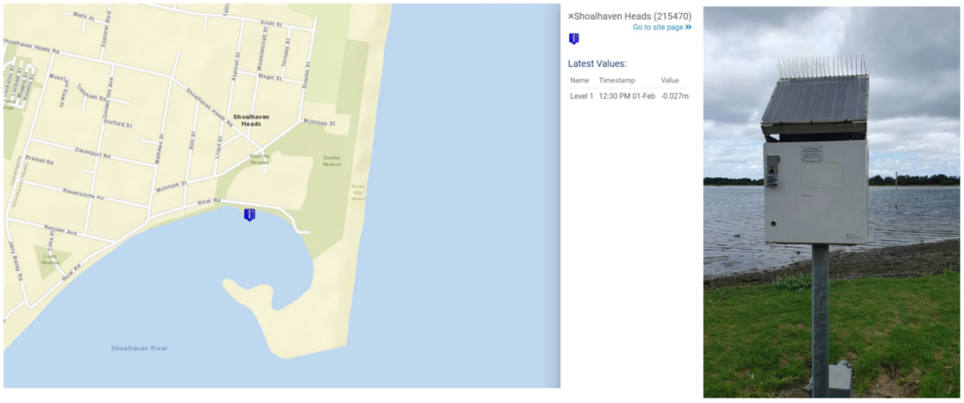


Figure 2-4 Location of MHL Tide Gauge at Shoalhaven Heads

During storms, coastal water levels may be further elevated by the effects of wind setup, barometric setup and wave setup. Elevated water levels including astronomical tide, wind and barometric setup (collectively referred to as storm surge), but not wave setup, for the NSW Coast (m AHD), for a range of Average Recurrence Intervals (ARIs), are listed below (Manly Hydraulics Laboratory, 2018):

- 25 yr ARI 1.4 AHD (+SLR)
- 50 yr ARI 1.45 AHD (+SLR)
- 100 yr ARI 1.5 AHD (+SLR)

Shoalhaven Council's Sea level rise projections are stated in Section 2.5.

2.5 Sea Level Rise

Shoalhaven Council have adopted sea level rise projections for planning purposes of 0.1 m by 2030, 0.23 m by 2050 and 0.36 m by 2100. The IPCC has recently released its 6th Assessment Report and has published sea level rise projections for selected locations throughout the world, including at Jervis Bay. For Jervis Bay, the sea level rise projections are given in Figure 2-5 (source https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool?psmsl_id=2312) based on a "high" Greenhouse gas emissions scenario. For a 25-year design life, we would therefore adopt a sea level rise of 0.4 m based on a precautionary approach.

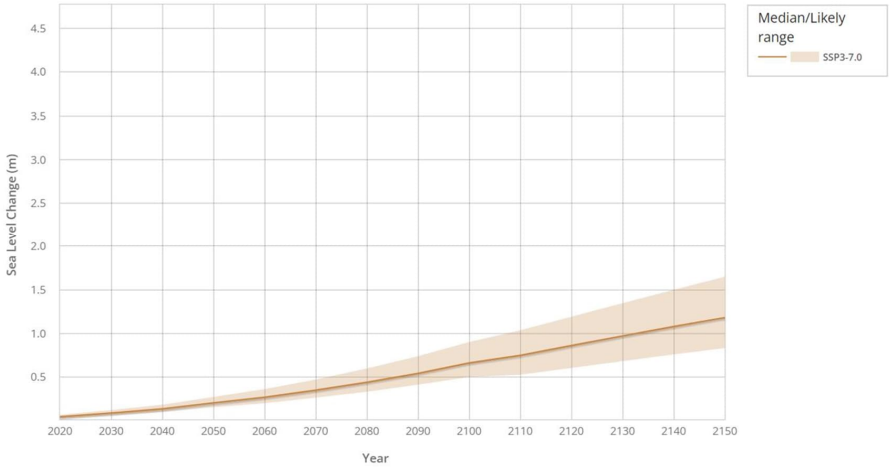


Figure 2-5 Jervis Bay Sea Level Rise Projections

2.6 Wave Climate

The condition of Shoalhaven Heads entrance influences the wave climate. If the entrance is closed the site is only exposed to short period, local wind waves. If the entrance is opened by flood, the site may be exposed to diffracted, long period swell waves following the freshwater flood. The area is most vulnerable to wave attack immediately following a flood as ambient wave energy will narrow and close the entrance over time. Based on historical records over the period 1936 to 2016, the entrance was predominantly open, approximately 67% compared with 33% closed (WRL, 2017).

2.6.1 Boat Wake

Boat wakes are generated by passing vessels travelling the inlet. The height of the wave at the site caused by passing vessels is a function of the speed of travel, displacement and hull shape of the vessel and distance to the facility from the vessel's sailing line.

Based on experience and considering the speed limits within the channel a significant wave height of 0.3m can be assumed for boat wake.

2.6.2 Wind Waves

With a closed entrance the greatest exposure to wave attack is from wind waves generated from the South West (upstream). Adopting a 20 year ARI the wave conditions are (WRL, 2017):

- Significant Wave Height (H_S) = 0.67m; and
- Peak Spectral Wave Period (T_P) = 2.9s

2.6.3 Swell Waves

WRL (2017) determined the design wave conditions at the inner foreshore for both a small entrance opening (160m) and large entrance opening (600m) as shown in Figure 2-6 and Figure 2-7.

For a small entrance opening a diffraction coefficient of 0.4 was adopted with a corresponding significant wave height of 0.66m at the inner foreshores and a peak spectral wave period of 12.2s (20yr ARI). For a large entrance opening a diffraction coefficient of 0.85 was adopted and a corresponding significant wave height of 1.82m at the inner foreshore. This was further reduced to account for depth limitation with a depth limited significant wave height of 1.25m adopted with a peak spectral wave period of 12.2s (20yr ARI).

Figure 2-6 Irregular Wave Diffraction Coefficients and Significant Wave Heigh for a Small Entrance Opening (Aerial Photo 5 July 2013) (Source: WRL, 2017)

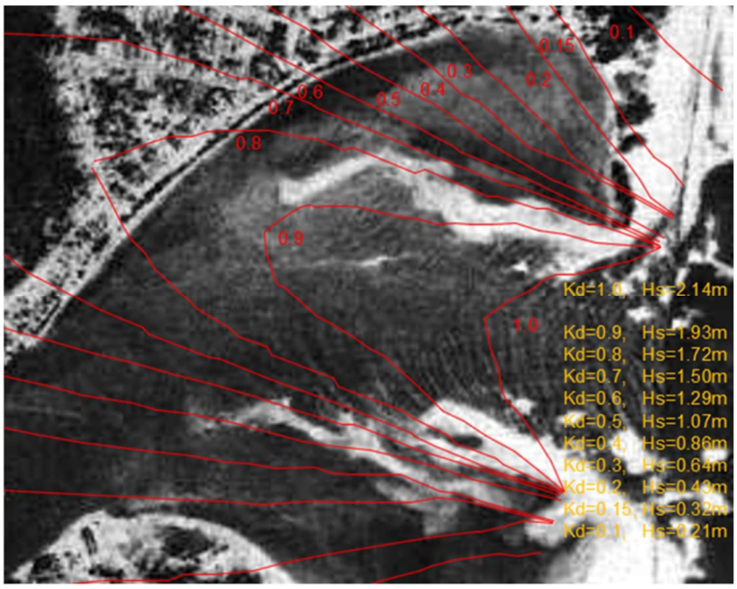


Figure 2-7 Irregular Wave Diffraction Coefficients and Significant Wave Heigh for a Large Entrance Opening (Aerial Photo 29 December 1974) (Source: WRL, 2017)

2.7 Sediment Data

Environment and Natural Resource Solutions (ENRS, 2022) took sediment samples from seven sampling points within the navigation channel (Figure 2-8). In total 21 samples were collected (3 from each sample site) to a total core depth of 2.0m below riverbed. The composition of the sediment samples collected from the proposed dredge area were dominated by fine/medium grained sand, with minor components of silt, clay and gravel. No clear spatial or stratigraphic trends were identified. Sediment was largely reported as yellow to light brown sand with minor shell and shell grit. The particle size distribution percentages from the samples is shown in Table 2-2.

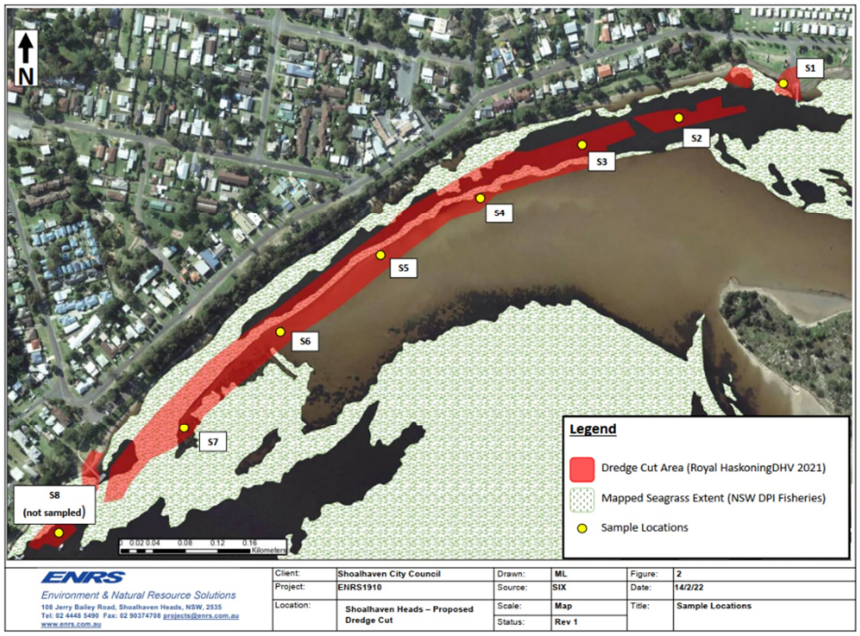


Figure 2-8 ENRS Sediment Sampling Locations and Royal Haskoning DHV Proposed Dredge Cut Area (Source: ENRS 2022)

Table 2-2 Particle Size Distribution Percentages from Representative Depths (Source: ENRS, 2022)

Core/depth	Fines (<60 µm)	Sand (60 µm - 2mm)	Gravel (>2mm)
S1/0-0.5	4	93	3
S2/0-0.5	2	98	<1
S3/0-0.5	3	97	<1
S4/0-0.5	1	99	<1
S5/0-0.5	3	97	<1
S6/0-0.5	4	96	<1
S7/0-0.5	2	97	1
S1/0.5-1.0	5	88	7
S2/0.5-1.0	2	97	1
S3/0.5-1.0	17	82	1
S4/0.5-1.0	2	98	<1
S5/0.5-1.0	4	96	<1
S6/0.5-1.0	5	95	<1
S7/0.5-1.0	3	96	1
S1/1.0-2.0	2	97	1
S2/1.0-2.0	2	93	5
S3/1.0-2.0	22	78	<1
S4/1.0-2.0	3	97	<1
S5/1.0-2.0	4	96	<1
S6/1.0-2.0	9	91	<1
S7/1.0-2.0	8	89	3

For the purpose of risk-based assessment for potential terrestrial reuse of dredged sediment within the project area, the National Environment Protection Measure (NEPM) Health Investigation Levels (HILs) 'A' were applied. The analytes/contaminants tested included 15 metals, BTEXN, TRH, PAH, Organotins, OC/OP Pesticides, PFAS, TOC, PCBs and PSD. Metal concentrations in the sediments were identified to be homogenous laterally and vertically throughout the investigation area. For all the metals tested, the calculated 95% UCL values were below the respective NAGD and NEPM criteria. Within surface sediments (0 – 0.5m), organic compounds, pesticides and PFAS/PFOA were all present at concentrations below the assessment criteria, with most analytes not present at detectable levels. Acid sulphate screening results generally returned very low or no acidity or indications of potential acid sulphate material in sediment samples. The reported laboratory results supported the sediment being suitable for onshore reuse.

2.8 Ecology

A Flora and Fauna Assessment (Stantec, 2022) identified no areas of Outstanding Biodiversity Value (OBD), critical habitats (as listed under the NSW BC Act, FM Act or EPBC Act) and no marine parks within the study area. The assessment identified extensive amounts of Zostera within the project footprint. Small areas of Mangrove and saltmarsh are present to the south and west of the project study area (Figure 2-9 and Figure 2-10). The Lower Shoalhaven River is classed as a Class 1: Major Fish Habitat i.e., a marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'. The Lower Shoalhaven River is considered to be the second most important wetland for shorebirds on the NSW Coast and at various times it supports over sixty species of shorebirds (Stantec, 2022). The sand shoals adjacent to the study area provide important habitat for numerous species of shore birds and waders for foraging and roosting.

Figure 2-9 Ground-Truthed Map of Marine Vegetation in the Project Footprint (Source: Stantec, 2022).

Figure 2-10 Medium to High Density Zostera Along Foreshore of Project Footprint (Source: Stantec, 2022)

3 Design Requirements

3.1 Geometric Constraints

The Project is to consider the following geometric constraints:

- existing infrastructure (public jetty at Jerry Bailey Road and Boat Ramp at Holiday Haven Caravan Park) and channel operations;
- water depth and channel width;
- ecological sensitive areas (eg. Seagrass, shorebirds); and,
- the existing foreshore.

3.2 Design Vessels

3.2.1 Vessel Data

The Boating Demand Study (Rhelm, 2022) identified that the type of boats used on the lower Shoalhaven River are predominantly small power boats (4 – 6m at 40% and 6 – 8m at 14%) accounting for approximately 60% of all boat users. As such for channel design purposes the design vessel will be taken conservatively as an 8m long power boat.

As per AS3962:2020 Marina Design, an 8m long power boat has the following parameters relevant to channel design:

- 0.9m draft; and,
- 3.4m beam.

3.2.2 Design Vessel Specification

The following design vessel data will be used for the assessment of the navigation channel.

Table 3-1 Design Vessel Specification

Vessel Type	Length (m)	Beam (m)	Draught (m)
Trailerable Power Boat	8	3.4	0.9

3.3 Environment

Where possible, the design will look to minimise impacts on the environment during both construction and operation phases of the Projects.

3.4 Safety

The design will be in accordance with the relevant Australian Standards & Guidelines, and the provisions of the *Work Health and Safety Act*, 2011.

3.5 Navigation

The navigation requirements (channel width and depth) will be developed in accordance with AS3962:2020 Marina Design. The principals from the PIANC document Harbour Approach Channels Design Guidelines would also be considered where applicable as this document generally relates to larger vessels such as container vessels and bulk carriers. Even though the site is not a marina, parallels can be drawn regarding vessel navigation principals.

AS 3962:2020 states that for an entrance channel, the minimum width should be the greatest of:

(a) 20m;

(b) (L + 2)m, where L is the overall length of the longest boat, therefore 8m + 2m = 10m; or

(c) 5B m, where B is the beam of the broadest mono-hull boat, therefore 5 x 3.4m = 17m.

Based on the above, a channel width of 20m has been adopted for navigation channel assessment purposes.

The depth in the entrance channel will take into account the following assumptions:

- draft of the design vessel – 0.9m;
- minimum design tidal level for used by the design vessels
    - a design tidal level of MLWS (-0.415 AHD) adopting the worst-case scenario of the entrance being open
- half of the design wave height for navigation – ½ of 0.67 = 0.34m;
- under keel clearance – 0.3m for soft material; and,
- an allowance for siltation taken nominally as 200mm.

3.6 Channel Augmentation Design and Strategy

The augmentation design footprint and profile will include the channel width, batter slopes, channel alignments and design depth (including augmentation tolerance).

The works strategy will be influenced by the following:

- site observations and initial discussion with stakeholders (Department of Planning and Environment (DPE) and Maritime Infrastructure delivery Office (MIDO);
- review of coastal processes;
- philosophy of 'working with nature';
- acknowledgement of the value of the area;
- nature and quantity of material being dredged and disposed; and,
- beneficial reuse options available (e.g. beach nourishment).

Determine plant and equipment options suited to specific areas to be augmented. Factors to be considered include:

- site conditions;
- time of the year the work would be undertaken;
- required augmentation depth and footprint;
- nature and quantity of material to be excavated;
- rate of excavation;
- disposal of excavated material; and,
- mobilisation requirements.

Develop disposal methods for excavated material that consider the following:

- beneficial reuse (e.g. to address bank erosion, increase beach amenity etc.); and,
- need for and type of Approval (and potential conditions).

4 References

ENRS. (2022). *Sediment Sampling and Analysis Plan (SAP) Implementation Report.*

Manly Hydraulics Laboratory. (2018). *NSW Extreme Ocean Water Levels.*

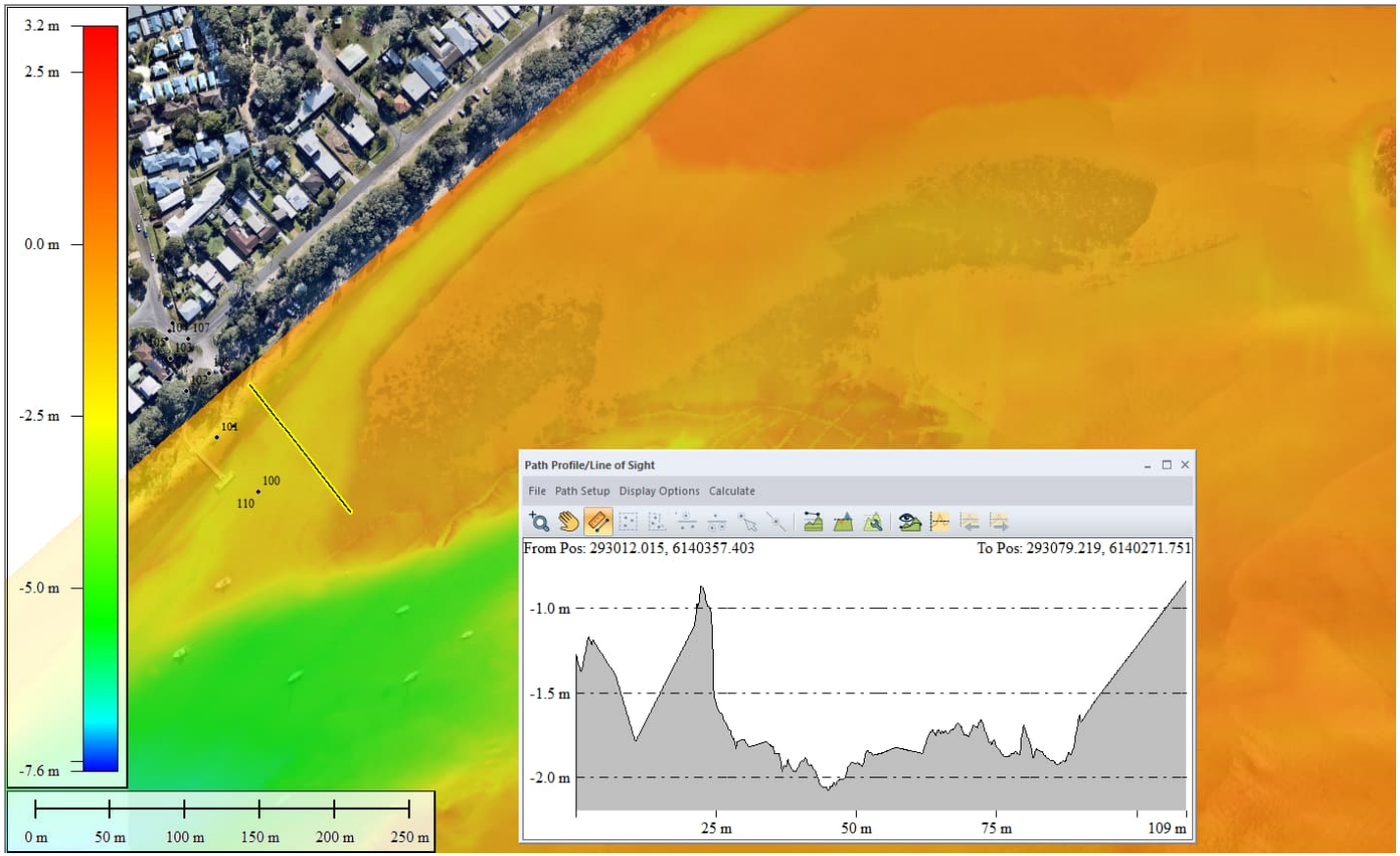
Rhelm. (2022). *Lower Shoalhaven River Coastal Management Program Stage 2: Boating Study.*

Royal HaskoningDHV. (2021). *Shoalhaven Heads Channel Dredging and Beach Nourishment.*

Stantec. (2022). *Flora and Fauna Assessment Lower Shoalhaven Dredging Project.*

WRL. (2017). *River Road Foreshore, Shoalhaven Heads: Assessment of Coastal Management Options.*

Appendix A
Bathymetry Cross Sections



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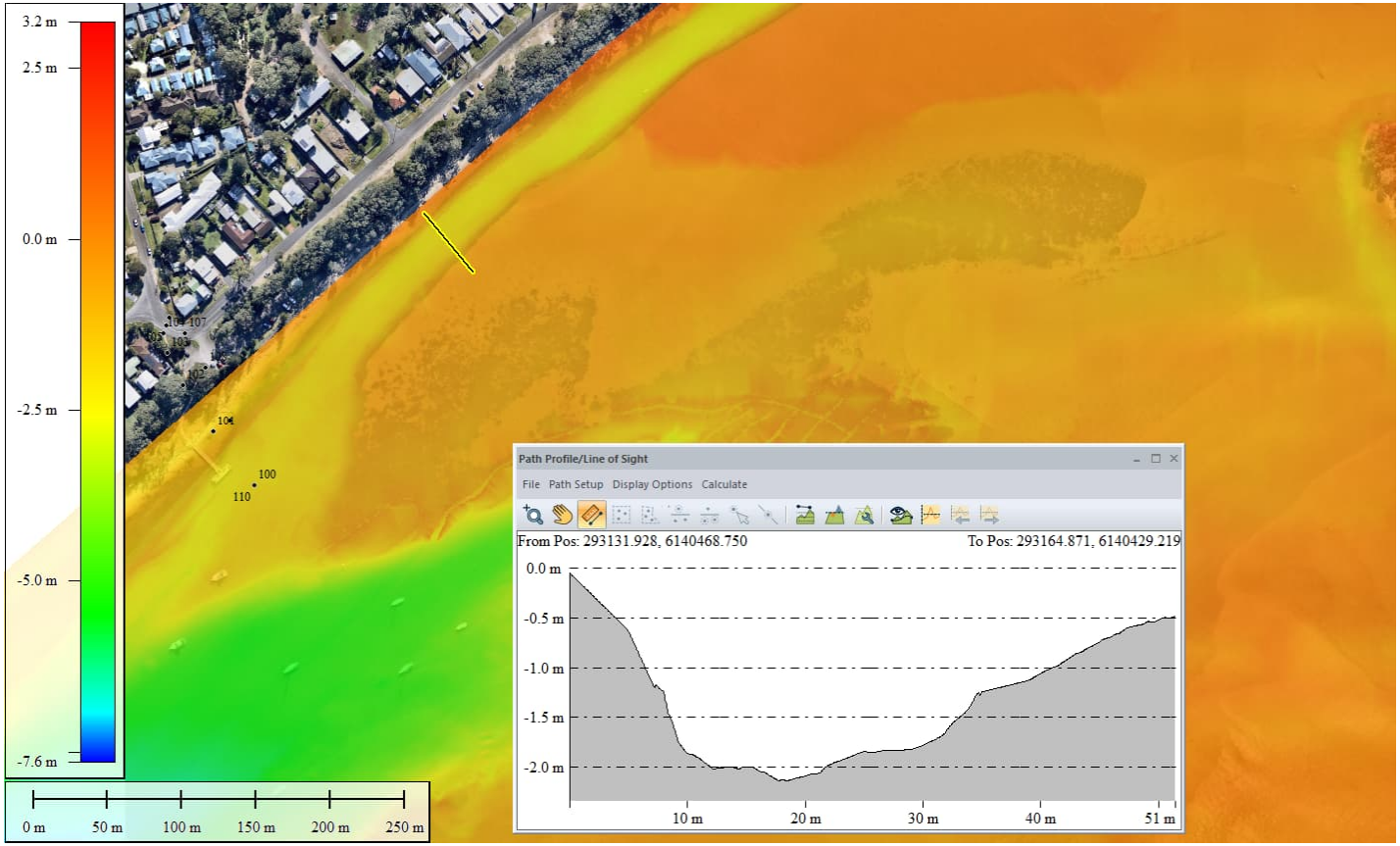

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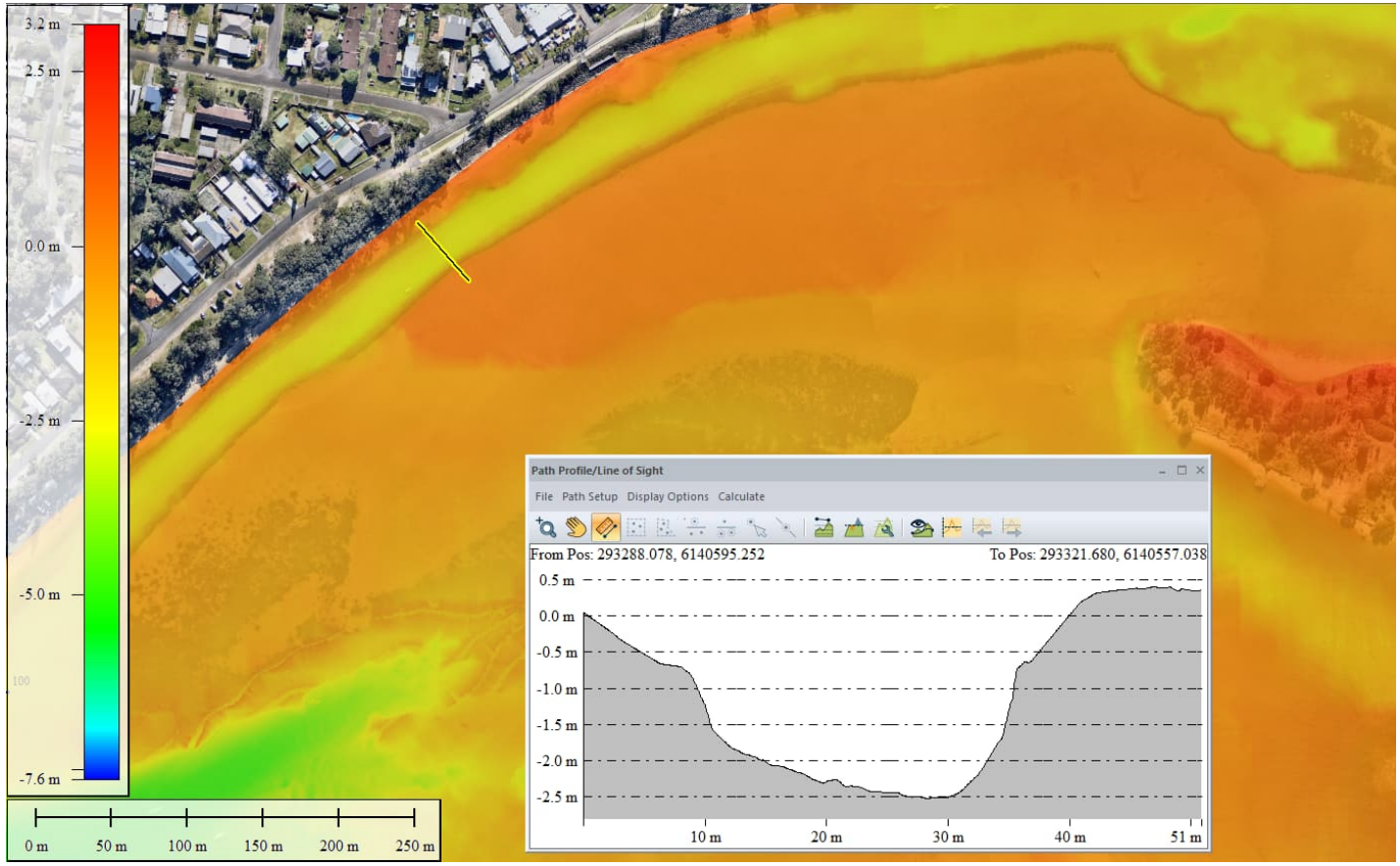

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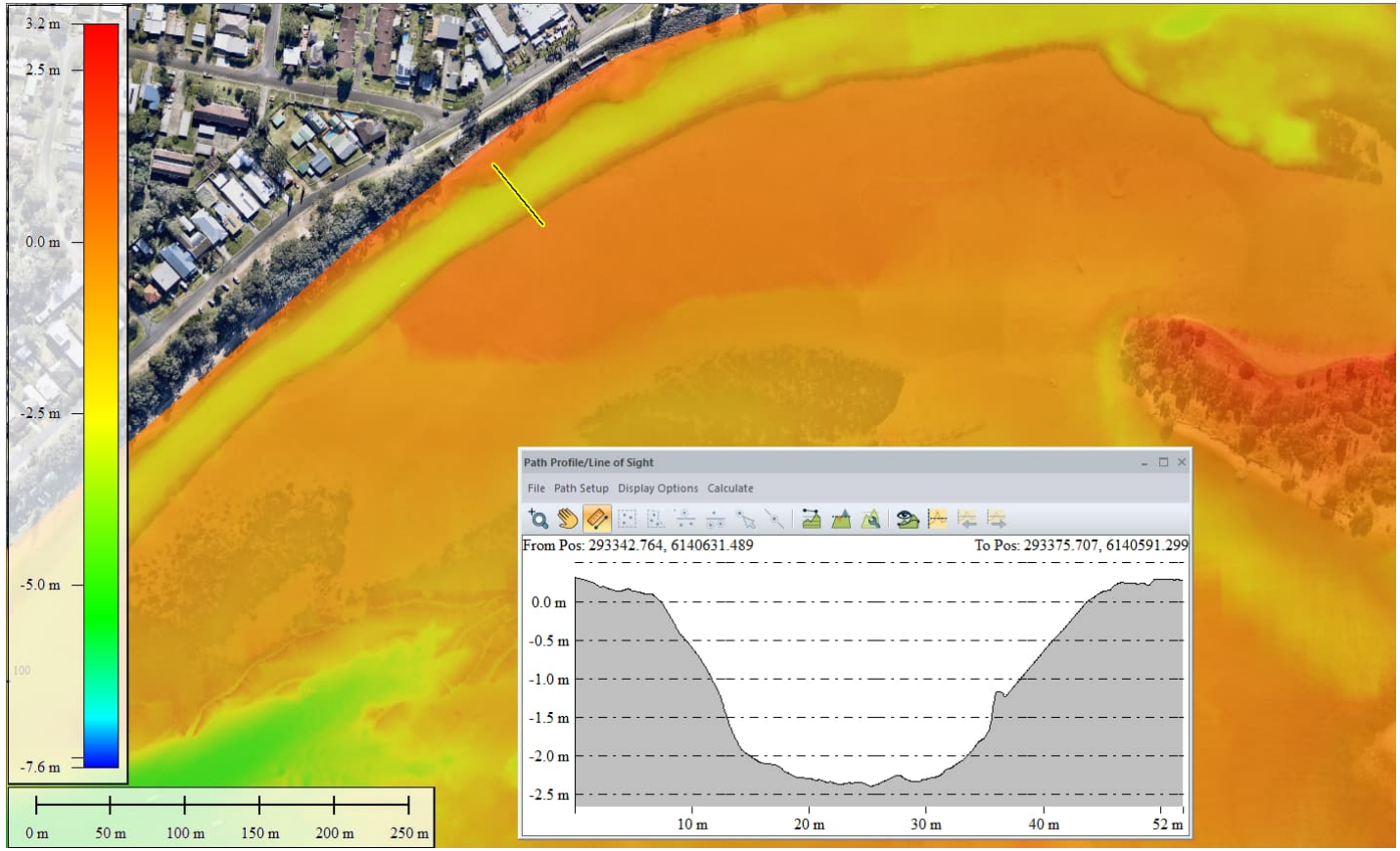

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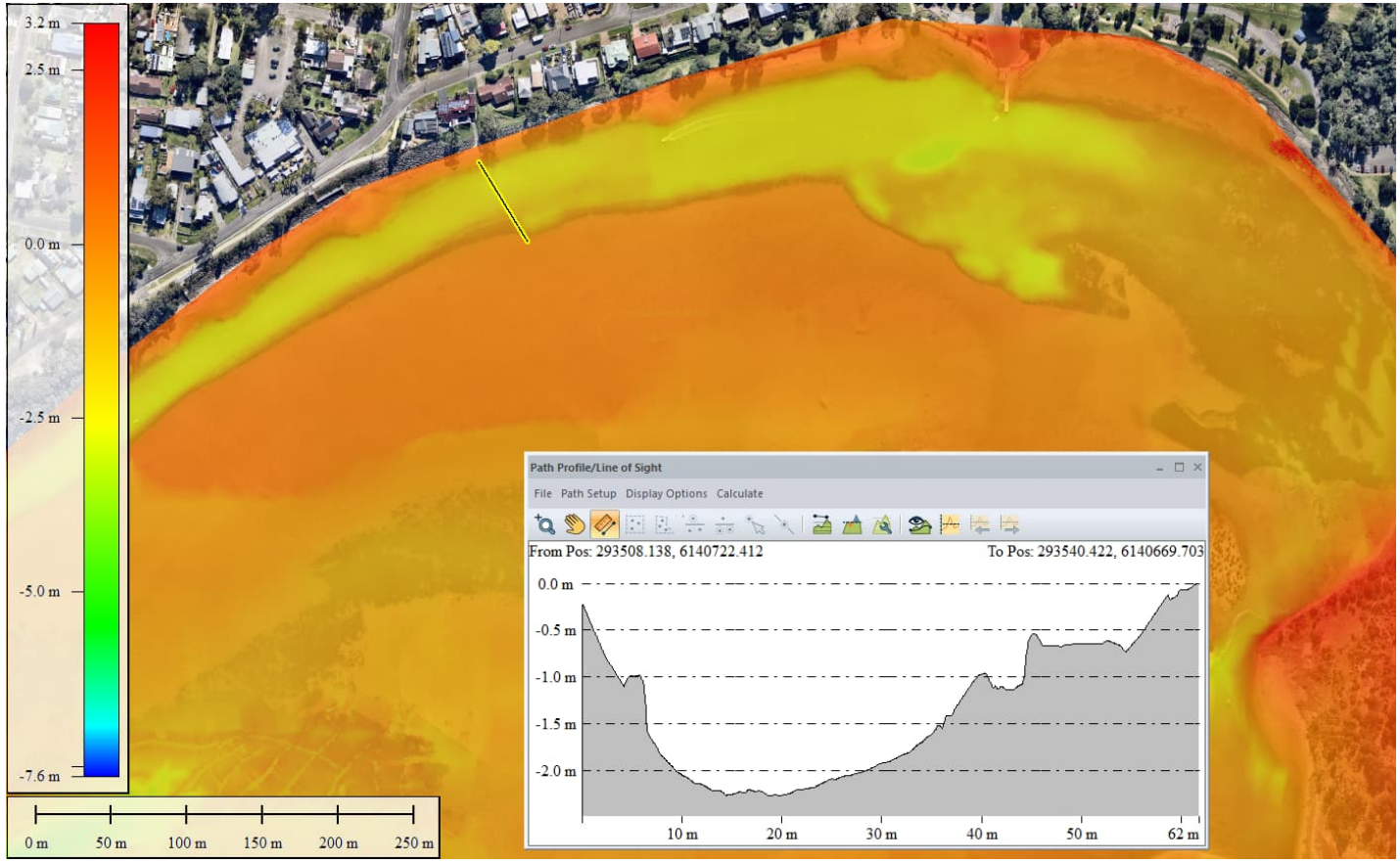

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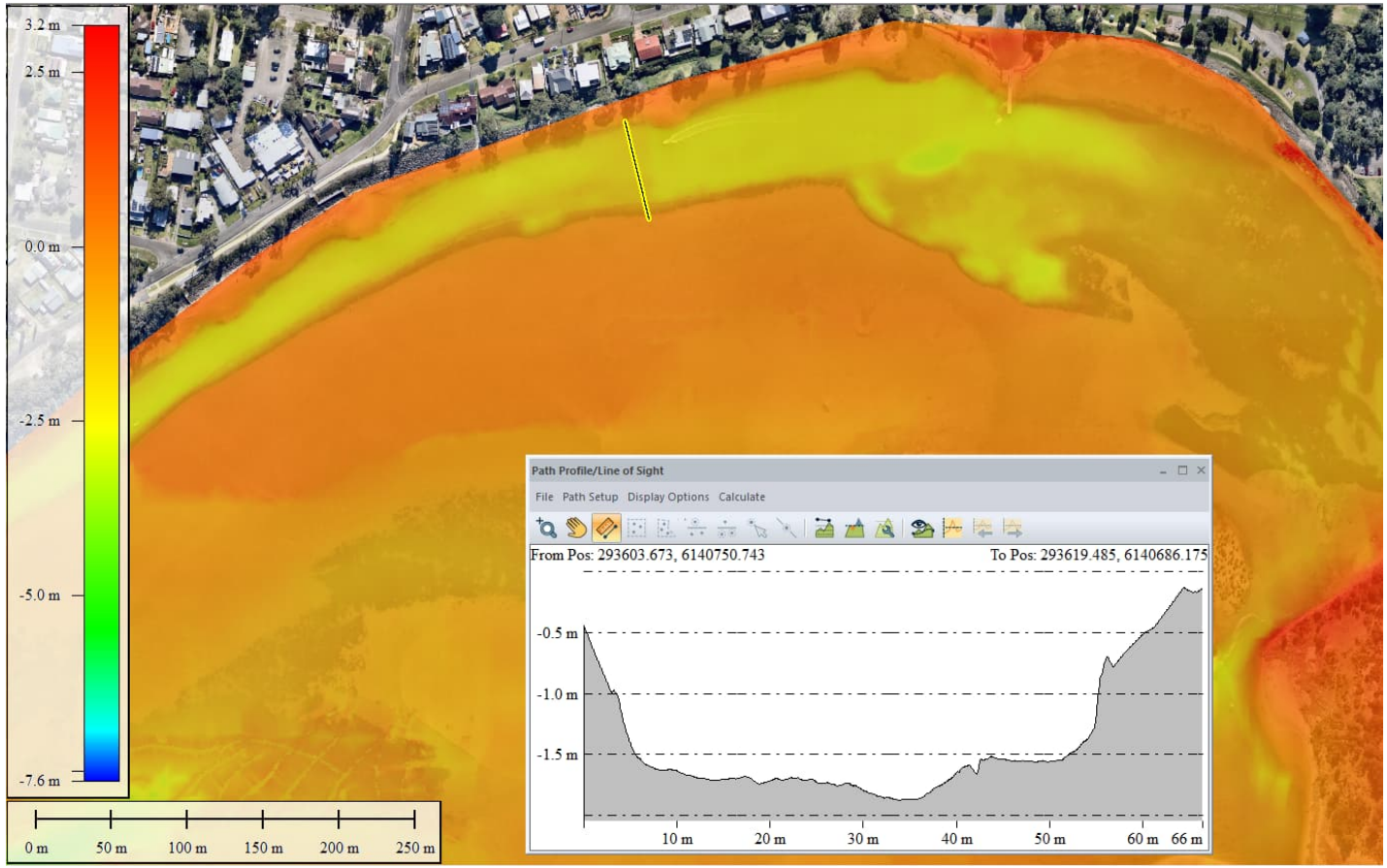

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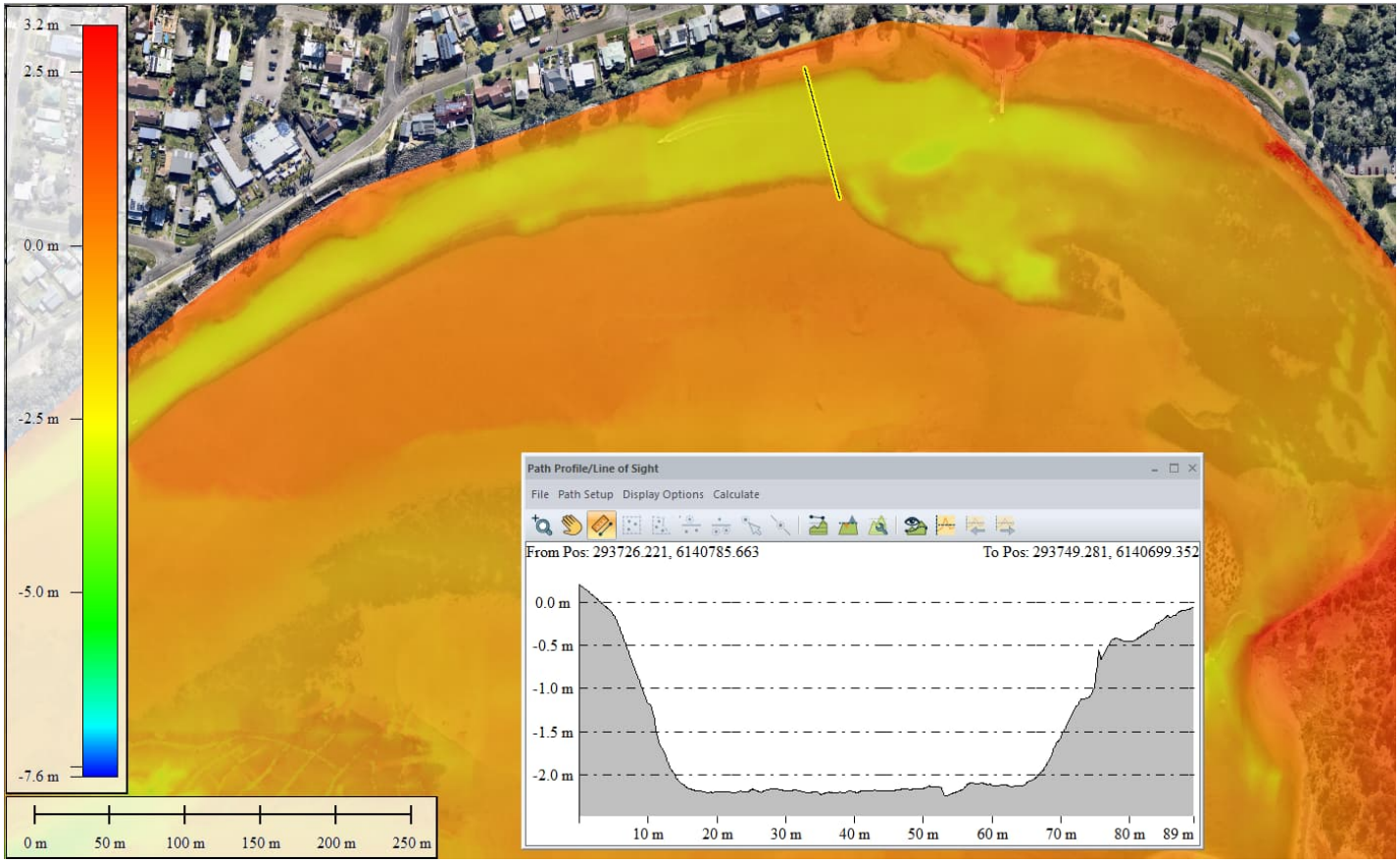

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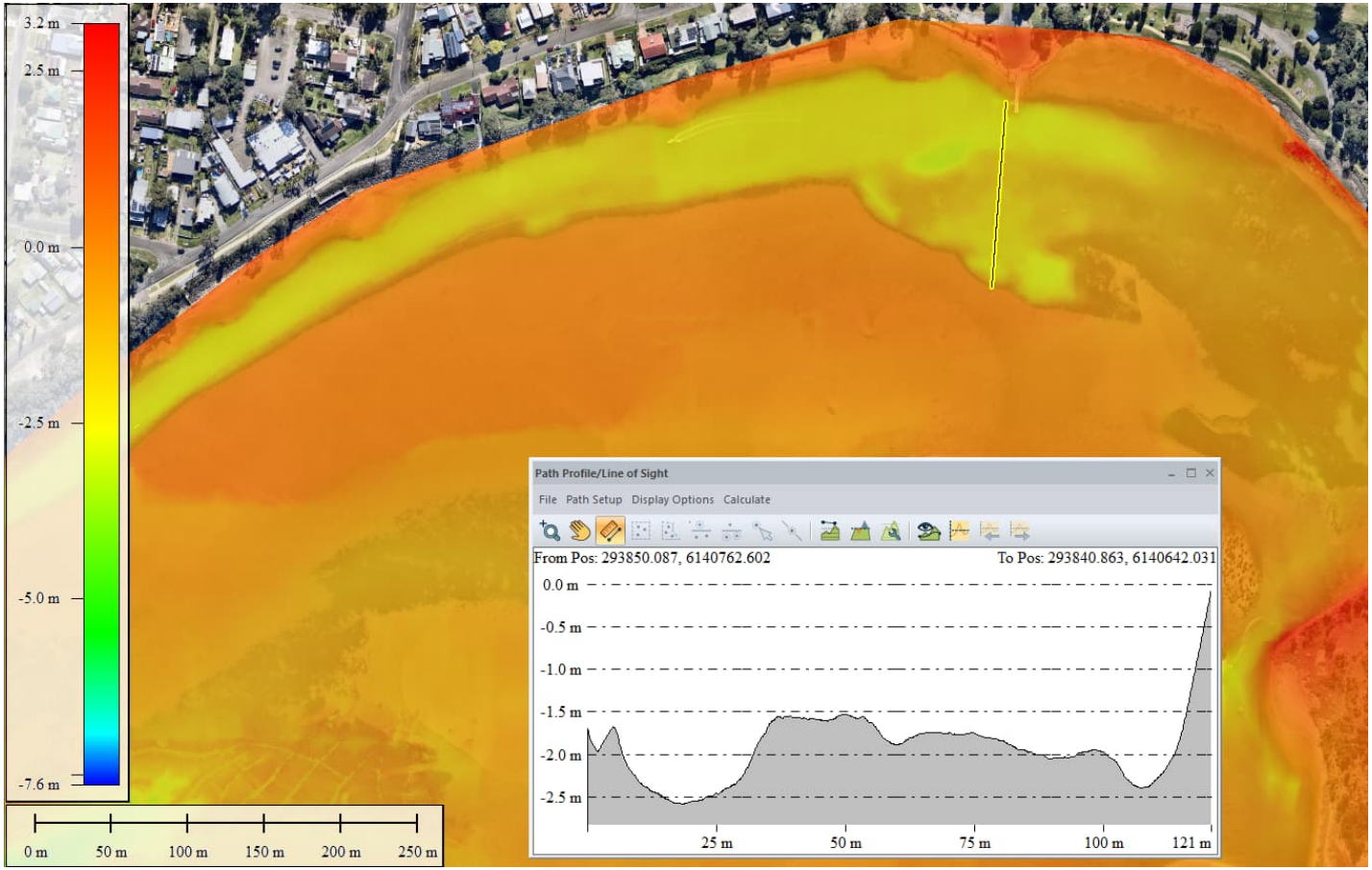

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Appendix B
Cost Estimate

Shoalhaven Heads Navigation Channel
PRELIMINARY COST ESTIMATE - WORKS
Option 2 - Backhoe Dredger

Excavator on flat top barge used to dredge and place material into hopper barges. Hopper barges unloaded with another excvator and reworked with a dozer. All material sourced from within navigation channel

Item	Description	Unit	Quantity	Rate	Amount	Item Total
1	**Site Establishment**					**$135,000**
1.1	Mobilisation of Plant and equipment	Lump Sum			$ 100,000	
1.2	Establishment including installation and maintenance of fencing, compound, signage, environmental controls, liaison with authorities.	Lump Sum			$ 20,000	
1.3	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program				$ 15,000	
2	**Dredging and Onshore Placement**					**$143,000**
2.1	Pre- and post- dredging surveys	Item	2	$10,000	$ 20,000	
2.2	Dredging insitu material from the navigation channel with an excavtor on a barge	m^3	3,000	$ 20	$ 60,000	
2.3	Barging dredged material to shore, dewatering and unloading with an excavator	m^3	3,000	$ 15	$ 45,000	
2.4	Reworking dredged material onshore with a dozer	m^3	3,000	$ 5	$ 15,000	
2.5	Authorised down-time rate up to 5 days	Days	2	$ 2,000	$ 3,000	
3	**Site Disestablishment and Clean up**	Lump Sum				**$50,000**
	CONSTRUCTION COSTS (Items 1 - 3)			***SUB TOTAL***		**$328,000**
				SUB TOTAL : CONSTRUCTION COST		**$328,000**
Add	Design, Planning Approval and Contractor Procurement	Lump Sum				$100,000
Add	Construction Management	10%				$32,800
Add	Continegncy	25%				**$92,160**
				COST ESTIMATE		**$552,960**

Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practising professional engineers familiar with the construction industry. The quantities have been estimated from the design report dated June 2023. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies, and should not be relied upon

Shoalhaven Heads Navigation Channel
PRELIMINARY COST ESTIMATE - WORKS
Option 2 - Cutter Suction Dredger

Cutter Suction Dredge pumping material onshore, dewatered and reworked with a dozer. All material sourced from within navigation channel

Item	Description	Unit	Quantity	Rate	Amount	Item Total
1	**Site Establishment**					**$335,000**
1.1	Mobilisation of Plant and equipment	Lump Sum			$300,000	
1.2	Establishment including installation and maintenance of fencing, compound, signage, environmental controls, liaison with authorities.	Lump Sum			$20,000	
1.3	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program				$15,000	
2	**Dredging and Onshore Placement**					**$95,900**
2.1	Pre- and post- dredging surveys	Item	2	$10,000	$20,000	
2.2	Dredging insitu material from the navigation channel with a cutter suction dredger and pumping to shore	m^3	3,000	$15	$45,000	
2.3	Dewatering material using settling ponds	m^3	3,000	$5	$15,000	
2.4	Reworking dredged material onshore with a dozer	m^3	3,000	$5	$15,000	
2.5	Authorised down-time rate up to 5 days	Days	1	$1,500	$900	
3	**Site Disestablishment and Clean up**	Lump Sum				**$150,000**
	CONSTRUCTION COSTS (Items 1 - 3)			***SUB TOTAL***		**$580,900**
				SUB TOTAL : CONSTRUCTION COST		**$580,900**
Add	Design, Planning Approval and Contractor Procurement	Lump Sum				$100,000
Add	Construction Management	10%				$58,090
Add	Continegncy	25%				**$147,798**
				COST ESTIMATE		**$886,788**

Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practising professional engineers familiar with the construction industry. The quantities have been estimated from the design report dated June 2023. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies, and should not be relied upon

Shoalhaven Heads Navigation Channel
PRELIMINARY COST ESTIMATE - WORKS
Option 3a - Backhoe Dredger

Excavator on flat top barge used to dredge and place material into hopper barges. Hopper barges unloaded with another excvator and reworked with a dozer. Material sourced from within navigation channel and as a result of its widening in areas.

Item	Description	Unit	Quantity	Rate	Amount	Item Total
1	**Site Establishment**					**$135,000**
1.1	Mobilisation of Plant and equipment	Lump Sum			$ 100,000	
1.2	Establishment including installation and maintenance of fencing, compound, signage, environmental controls, liaison with authorities.	Lump Sum			$ 20,000	
1.3	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program				$ 15,000	
2	**Dredging and Onshore Placement**					**$286,500**
2.1	Pre- and post- dredging surveys	Item	2	$10,000	$ 20,000	
2.2	Dredging insitu material from the navigation channel with an excavtor on a barge	m^3	6,500	$ 20	$ 130,000	
2.3	Barging dredged material to shore, dewatering and unloading with an excavator	m^3	6,500	$ 15	$ 97,500	
2.4	Reworking dredged material onshore with a dozer	m^3	6,500	$ 5	$ 32,500	
2.5	Authorised down-time rate up to 5 days	Days	3	$ 2,000	$ 6,500	
3	**Site Disestablishment and Clean up**	Lump Sum				**$50,000**
	CONSTRUCTION COSTS (Items 1 - 3)			***SUB TOTAL***		**$471,500**
				SUB TOTAL : CONSTRUCTION COST		**$471,500**
Add	Design, Planning Approval and Contractor Procurement	Lump Sum				$100,000
Add	Construction Management	10%				$47,150
Add	Continegncy	25%				**$123,730**
				COST ESTIMATE		**$742,380**

Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practising professional engineers familiar with the construction industry. The quantities have been estimated from the design report dated June 2023. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies, and should not be relied upon

https://worleyparsons.sharepoint.com/sites/ShoalhavenDredgeStudy/Shared Documents/3.0 Engineering/Cost Estimate/Construction Cost Estimate Shoalhaven Heads 290623

SH24.1 - Attachment 1

Shoalhaven Heads Navigation Channel
PRELIMINARY COST ESTIMATE - WORKS
Option 3a - Cutter Suction Dredger

Cutter Suction Dredge pumping material onshore, dewatered and reworked with a dozer. Material sourced from within navigation channel and as a result of its widening in areas.

Item	Description	Unit	Quantity	Rate	Amount	Item Total
1	**Site Establishment**					**$335,000**
1.1	Mobilisation of Plant and equipment	Lump Sum			$300,000	
1.2	Establishment including installation and maintenance of fencing, compound, signage, environmental controls, liaison with authorities.	Lump Sum			$20,000	
1.3	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program				$15,000	
2	**Dredging and Onshore Placement**					**$184,450**
2.1	Pre- and post- dredging surveys	Item	2	$10,000	$20,000	
2.2	Dredging insitu material from the navigation channel with a cutter suction dredger and pumping to shore	m^3	6,500	$15	$97,500	
2.3	Dewatering material using settling ponds	m^3	6,500	$5	$32,500	
2.4	Reworking dredged material onshore with a dozer	m^3	6,500	$5	$32,500	
2.5	Authorised down-time rate up to 5 days	Days	1	$1,500	$1,950	
3	**Site Disestablishment and Clean up**	Lump Sum				**$150,000**
	CONSTRUCTION COSTS (Items 1 - 3)			***SUB TOTAL***		**$669,450**
				SUB TOTAL : CONSTRUCTION COST		**$669,450**
Add	Design, Planning Approval and Contractor Procurement	Lump Sum				$100,000
Add	Construction Management	10%				$66,945
Add	Continegncy	25%				**$167,279**
				COST ESTIMATE		**$1,003,674**

Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practising professional engineers familiar with the construction industry. The quantities have been estimated from the design report dated June 2023. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies, and should not be relied upon

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Shoalhaven Heads Navigation Channel
PRELIMINARY COST ESTIMATE - WORKS
Option 3b - Backhoe Dredger

Excavator on flat top barge used to dredge and place material into hopper barges. Hopper barges unloaded with another excvator and reworked with a dozer. Material sourced from within navigation channel and as a result of its widening in areas.

Item	Description	Unit	Quantity	Rate	Amount	Item Total
1	**Site Establishment**					**$135,000**
1.1	Mobilisation of Plant and equipment	Lump Sum			$ 100,000	
1.2	Establishment including installation and maintenance of fencing, compound, signage, environmental controls, liaison with authorities.	Lump Sum			$ 20,000	
1.3	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program				$ 15,000	
2	**Dredging and Onshore Placement**					**$471,000**
2.1	Pre- and post- dredging surveys	Item	2	$10,000	$ 20,000	
2.2	Dredging insitu material from the navigation channel with an excavtor on a barge	m^3	11,000	$ 20	$ 220,000	
2.3	Barging dredged material to shore, dewatering and unloading with an excavator	m^3	11,000	$ 15	$ 165,000	
2.4	Reworking dredged material onshore with a dozer	m^3	11,000	$ 5	$ 55,000	
2.5	Authorised down-time rate up to 5 days	Days	6	$ 2,000	$ 11,000	
3	**Site Disestablishment and Clean up**	Lump Sum				**$50,000**
	CONSTRUCTION COSTS (Items 1 - 3)			***SUB TOTAL***		**$656,000**
				SUB TOTAL : CONSTRUCTION COST		**$656,000**
Add	Design, Planning Approval and Contractor Procurement	Lump Sum				$100,000
Add	Construction Management	10%				$65,600
Add	Continegncy	25%				**$164,320**
				COST ESTIMATE		**$985,920**

Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practising professional engineers familiar with the construction industry. The quantities have been estimated from the design report dated June 2023. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies, and should not be relied upon

Shoalhaven Heads Navigation Channel
PRELIMINARY COST ESTIMATE - WORKS
Option 3b - Cutter Suction Dredger

Cutter Suction Dredge pumping material onshore, dewatered and reworked with a dozer. Material sourced from within navigation channel and as a result of its widening in areas.

Item	Description	Unit	Quantity	Rate	Amount	Item Total
1	**Site Establishment**					**$335,000**
1.1	Mobilisation of Plant and equipment	Lump Sum			$300,000	
1.2	Establishment including installation and maintenance of fencing, compound, signage, environmental controls, liaison with authorities.	Lump Sum			$20,000	
1.3	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program				$15,000	
2	**Dredging and Onshore Placement**					**$298,300**
2.1	Pre- and post- dredging surveys	Item	2	$10,000	$20,000	
2.2	Dredging insitu material from the navigation channel with a cutter suction dredger and pumping to shore	m^3	11,000	$15	$165,000	
2.3	Dewatering material using settling ponds	m^3	11,000	$5	$55,000	
2.4	Reworking dredged material onshore with a dozer	m^3	11,000	$5	$55,000	
2.5	Authorised down-time rate up to 5 days	Days	2	$1,500	$3,300	
3	**Site Disestablishment and Clean up**	Lump Sum				**$150,000**
	CONSTRUCTION COSTS (Items 1 - 3)			***SUB TOTAL***		**$783,300**
				SUB TOTAL : CONSTRUCTION COST		**$783,300**
Add	Design, Planning Approval and Contractor Procurement	Lump Sum				$100,000
Add	Construction Management	10%				$78,330
Add	Continegncy	25%				**$192,326**
				COST ESTIMATE		**$1,153,956**

Disclaimer: This cost estimates include construction cost and contingency allowance. The estimate is based on Advisian's experience and judgement as a firm of practising professional engineers familiar with the construction industry. The quantities have been estimated from the design report dated June 2023. The construction cost estimate assumes a +/- 50% accuracy and can NOT be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. This is a preliminary cost estimate is to be used for comparing project options and dredging methodologies, and should not be relied upon

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