Hydrosphere Consulting

NSW GOVERNMENT

Marshalls Creek Foreshore Rehabilitation

Options and design report

Acknowledgement of Country:

Hydrosphere Consulting acknowledges the Bundjalung of Byron Bay - Minjungbal people as the Traditional Custodians of the land discussed in this report. We also acknowledge the Tweed Byron Local Aboriginal Land Council and all Aboriginal and Torres Strait Islander people who now reside within the Shire and their continuing connection to Country and culture.

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JOB 25-011: MARSHALLS CREEK FORESHORE REHABILITATION OPTIONS AND DESIGN REPORT

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1. INTRODUCTION

Active erosion and undercutting are occurring on the foreshore area of Marshalls Creek, New Brighton. Recent flooding has also exacerbated erosion at the site. Following an initial baseline assessment undertaken in August 2024, using the Bank Condition Decision Support Tool, this section of the riverbank has been identified as a priority area for rehabilitation.

The Department of Primary Industry and Regional Development – Fisheries (DPIRD - Fisheries) is delivering a bank stabilisation program designed to mitigate flood damage and improve flood and environmental resilience in NSW estuaries. This report provides detailed designs for remediation works for the Marshalls Creek foreshore that facilitate formalised public access, along with best practice living shoreline principles and Connecting with Country principles.

This report documents the site investigations, development of options for foreshore rehabilitation, stakeholder engagement, assessment of planning pathway and design of foreshore rehabilitation works required to progress the on-ground works.

2. STUDY AREA AND FEATURES

The study area encompasses the foreshore area of riverside land at New Brighton adjacent to Marshalls Creek (the northern arm of Brunswick River) along River Street and Casons Road. The site extends from the main grassy area opposite the store/ café on the eastern side of the creek upstream to the end of Casons Road (Figure 1).

Figure 1: Study area

Source: Aerial photo – Nearmap (2024)

Land tenure (Figure 2) within and surrounding the study area includes:

- Council road reserve (New Brighton Road and Casons Road).
- National Parks Estate (Marshalls Creek Nature Reserve.
- Freehold/ private land (lot 1, DP 121484) partly in the waterway (due to migration of the creek). This land has been used as public space for more than 30 years but remains registered in the ownership of a deceased estate. Council is currently considering options for acquisition of this land.

The waterway below mean high water mark (MHWM) is managed by the NSW Department of Planning, Housing and Infrastructure – Crown Lands (DPHI - Crown Lands) and lies within the Cape Byron Marine Park. The adjacent areas of foreshore are part of the Marshalls Creek Nature Reserve, managed by NSW National Parks and Wildlife Service (NPWS).

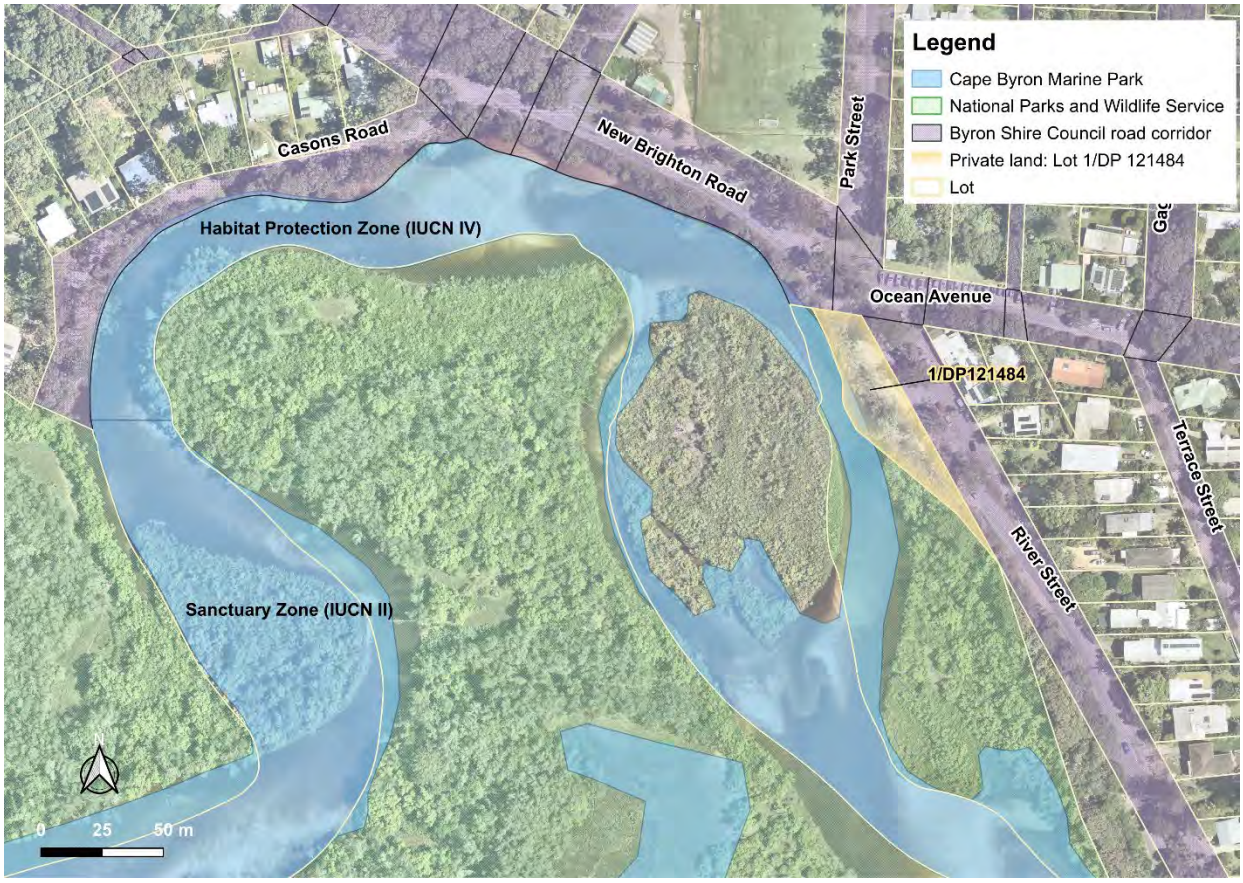


Figure 2: Land tenure

Source: Aerial photo - Nearmap (2024)

Parts of this foreshore area have been used by local community as a space to picnic, gather, and access the creek. Some parts are heavily used by the community and visitors for swimming and passive recreational activities such as kayaking and paddle boarding (Plate 1). The local community is active in supporting management of the area and removing rubbish and weeds and they have a strong commitment to this community space.

Plate 1: Marshalls Creek foreshore (December 2024 - February 2025)

Clockwise from top left: undercutting of foreshore area in front of New Brighton shops, foreshore near New Brighton Road and Casons Road intersection, Casons Road foreshore, rope swings

The study area is in Bundjalung country. The Marshalls Creek foreshore lies in the traditional lands of the Minjungbal People. The local Aboriginal community is represented by the Tweed Byron Local Aboriginal Land Council (TBLALC). The natural landscape is important to the local Aboriginal community, contains discrete sites of particular importance and provides a link between significant sites in adjoining areas. Two areas of shell deposit have been located along the foreshore within the study area.

Council assets in the precinct include stormwater, water, sewer and roads and park assets. Other public assets include power poles and telecommunications (Figure 3).

Figure 3: Public assets along the foreshore

Source: Aerial photo – Nearmap (2024); Public asset locations (approximate) – Dial Before You Dig

Bank erosion from undercutting and scour is threatening the foreshore and public infrastructure with progression towards the adjacent road (refer Section 3.1). There is only a narrow riparian vegetation buffer along the foreshore and there are no formal access points to the creek. Public trampling of the riverbank is having an impact on the stability of the area.

3. BACKGROUND INFORMATION

3.1 Bank Erosion

Surveys undertaken in 2017 by Byron Shire Council (BSC) as part of the development of the draft Coastal Zone Management Plan (CZMP) identified (BSC, 2018):

- Active erosion and significant undercutting of riverbank with public road at risk. Significant public access issues and zero riparian buffer in areas. Area at risk of tidal inundation hazard and bank erosion hazard to public assets. Large precinct in need of works and development of Master Plan for the area is recommended.
- Moderate bank erosion due to hydrodynamic processes and public access. Riparian zone sparsely vegetated and narrow (width 0 - 5m).

The draft CZMP included an On-ground Works Management Strategy including development of a precinct plan, formalised public access and carpark area, riverbank stabilisation works and restoration of riparian vegetation buffer.

The Decision Support Tool (DST) for Bank Erosion Management in NSW estuaries (Hydrosphere, 2020) was field tested for validation purposes in the Brunswick River estuary (including Marshalls Creek) in 2020 prior to the 2022 floods which impacted much of the Northern Rivers area including the Brunswick River estuary.

Fruition Environmental (2024) conducted a comprehensive Bank and Riparian Assessment in 2024. The report provides an updated bank condition mapping dataset using the DST as the basis of the assessment with additional criteria related to erosion processes and riparian vegetation attributes. Key outputs for the relevant bank segments are provided in the following figures. The full report and mapping can be accessed via the NEAP Bank Resilience web page (https://www.dpi.nsw.gov.au/dpi/fishing/estuary-asset-protection-program/riverbank-resilience).

Figure 4: NEAP bank and riparian condition assessment - severity of erosion

Source: Mapped from data provided in Fruition Environmental (2024); Aerial photo – Nearmap (2024)

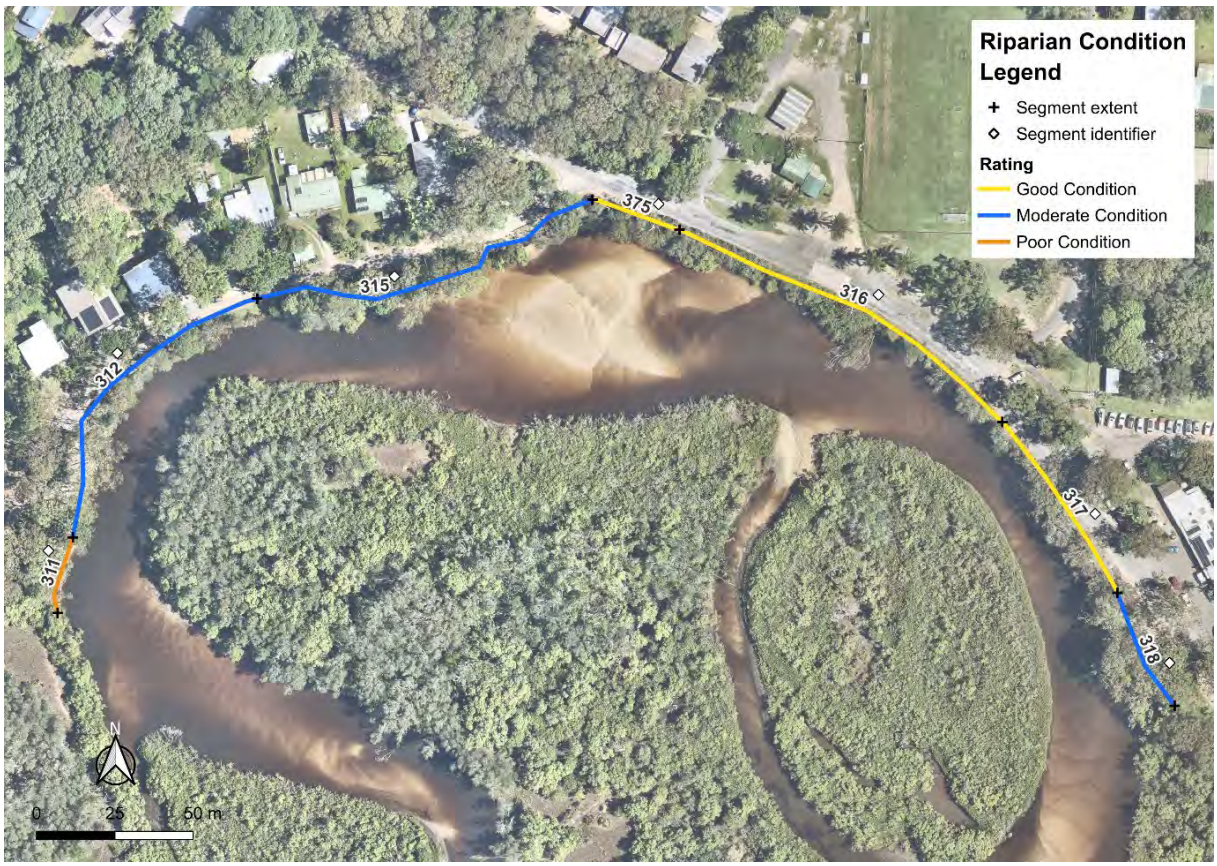


Figure 5: NEAP bank and riparian condition assessment – riparian condition

Source: Mapped from data provided in Fruition Environmental (2024); Aerial photo – Nearmap (2024)

Figure 6: NEAP bank and riparian condition assessment – environmental impact

Source: Mapped from data provided in Fruition Environmental (2024); Aerial photo – Nearmap (2024)

Figure 7: NEAP bank and riparian condition assessment – environmental risk

Source: Mapped from data provided in Fruition Environmental (2024); Aerial photo – Nearmap (2024)

Figure 8: NEAP bank and riparian condition assessment – impact on infrastructure

Source: Mapped from data provided in Fruition Environmental (2024); Aerial photo – Nearmap (2024)

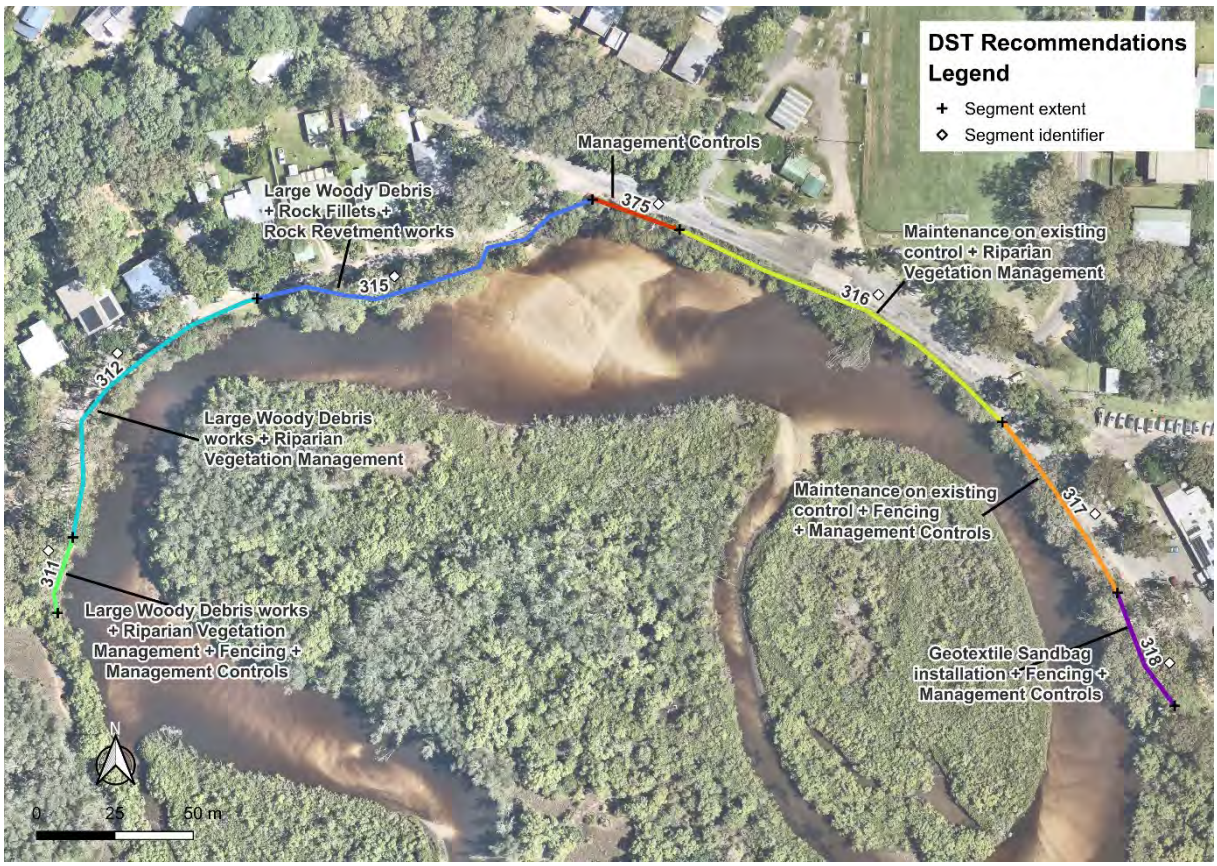


Figure 9: NEAP bank and riparian condition assessment - recommendations

Source: Mapped from data provided in Fruition Environmental (2024); Aerial photo – Nearmap (2024)

These reaches of Marshalls Creek were ranked in the 12 highest priority reaches for management interventions to improve overall bank and riparian condition in the Brunswick River estuary study area (Fruition Environmental, 2024, Table 1). The management objectives for these priority reaches are:

- Improve estuary condition and maintain safe access on public land (reaches 312, 315, 318).
- Maintain safe access on public land, protect high conservation value vegetation in the estuary (reach 311).
- Infrastructure protection and maintenance of public access (reaches 312, 315, 318).

Table 1: Marshalls Creek reach analysis outcomes and priority reaches

Analysis	Description	Reaches
Reaches mapped with “moderate” or “high” erosion severity but also mapped as having “medium” to “high” infrastructure/ commercial or amenity/ safety impact rating.	These are reaches where high erosion severity is causing medium to high level impacts to infrastructure, commercial, amenity or safety values as defined in the DPIRD Fisheries Decision Support Tool for bank erosion management.	312, 315, 318
Reaches mapped with “moderate” or “high” erosion severity and also important for public access.	These are reaches where public access is established but where bank erosion is potentially compromising public safety.	318

Analysis	Description	Reaches
Reaches mapped with high erosion severity and also containing riparian vegetation in moderate condition.	These are reaches where bank remediation measures would protect existing riparian vegetation that has been mapped in moderate condition.	318
Reach containing or immediately adjacent to a mapped coastal wetland and threatened by at least “high” erosion severity.	These are reaches that correspond to the SEPP (Resilience and Hazards) 2021 Coastal Wetlands Area mapping and are threatened by high severity erosion.	311, 318
Reach identified as having “medium” to “high infrastructure/commercial impacts or amenity/safety impacts and also have existing works in ineffective or partially effective condition.	Identifies reaches where failing works are contributing to impacts to infrastructure, commercial, amenity or safety values.	312

Source: Fruition Environmental (2024)

3.2 Existing Bank Features

Ongoing attempts have been made to control the erosion in this area including installation of coir logs, revegetation and rock armouring. Bank protection works consist of rock revetment (varying condition) and informal works (e.g. concrete, tyres) as shown in Figure 10 and Plate 2 to Plate 6.

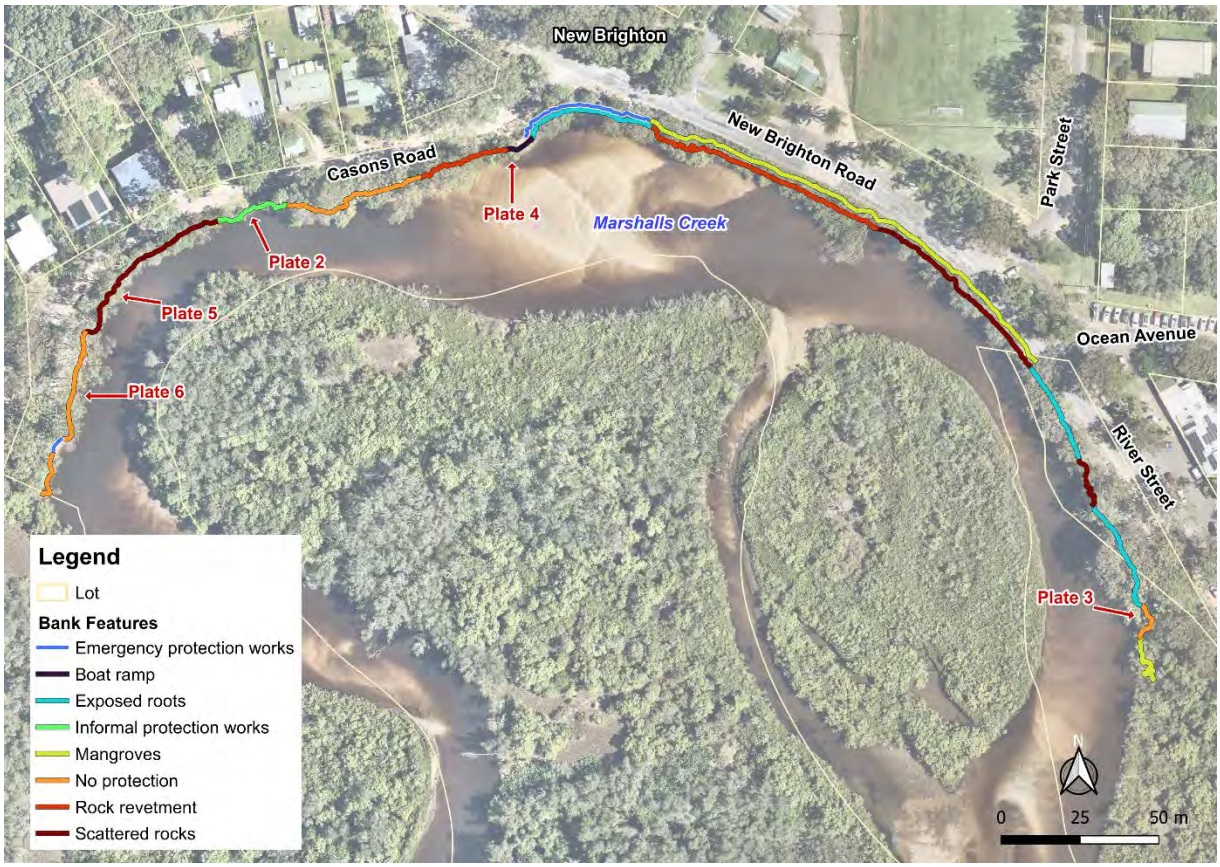


Figure 10: Existing foreshore features showing locations of Plates 2-6

Isolated mangrove stands are also present in some segments
Source: Aerial photo – Nearmap (2024)

Plate 2: Inappropriate use of tyres, brick and concrete for erosion control and waterway access

Plate 3: A range of bank features including mangroves (far right), no protection (centre), and exposed tree roots (left)

Plate 4: Rock revetment (left) and the boat ramp (right)

Plate 5: Scattered rocks along the bank indicating a previous revetment

Plate 6: No protection works with exposed roots on the far left

In December 2024, Byron Shire Council resolved [24-958]:

..to undertake emergency remediation measures to address the significant and accelerating erosion and associated risk to environmental health and public safety and implement as a matter of urgency, options that Council may be able to undertake (e.g. bollards, parking restrictions, signage, communications).

The remediation sites were:

Site 1 - at the end of Casons Lane where a large scour hole exists, with the aim of limiting public access with low impact measures to mitigate further erosion of the bank and protect the road and access to the last house along Casons Lane. The works were not intended to fill the scour hole or aim to completely protect the shell material from tidal wash and turbulence. The works are minor in nature and are intended to be short-lived while further design investigations are commenced. The works are proposed to attempt to protect this section of riverbank from further public trampling through fencing and signage and dissipate flow and reduce further erosion through coir log installation (Plate 7):

- Star picket fencing with shade cloth approximately 1 m from riverbank edge.
- Corflute signage on picket fencing.
- Rock bollards across road to prevent car access to sensitive area at end of Casons Lane.

- Rope swing removed from dead branch on large tree (safety risk to people due to rock/ concrete boulders in the creek and potential fall).
- Placement of coir log to dissipate flow, mitigate further erosion, trap sediment and recruit mangroves - 4 x 3 m length of coir log (seaward) and 3 x 3 m length of coir log (landward).
- Timber stakes for anchoring coir logs.

Plate 7: Site 1 – fencing and coir logs (April 2025)

- Site 2 - the corner of Casons Road and New Brighton Road:
  - Corflute signage on existing timber fence posts, fence repairs and *Lomandra longifolia* plantings in small drainage swale to mitigate stormwater flow from road down riverbank (Plate 8).
  - Dead tree removed from upper riverbank and cut into pieces for placing into holes/ undercut areas of riverbank (Plate 9).
  - Placement of coir log to dissipate flow, mitigate further erosion, trap sediment and recruit mangroves - 3 x 3m length of coir log (downstream of dead tree) and 3 x 3m length of coir log (upstream of dead tree) with timber stakes for anchoring coir logs (Plate 10).

Plate 8: Site 2 - fencing, swale planting and signage (February 2025)

Source: BSC

Plate 9: Site 2 – placement of large woody debris (February 2025)

Source: BSC

Plate 10: Site 2 – coir logs (February 2025)

Source: BSC

- Site 3 - road reserve opposite the post office.
    - Rock bollards to prevent parking along narrow riverbank and 'No parking' signage. Relocating existing rock bollards from picnic area closer to the road to have no parking along the entire riverbank area opposite the shops.
    - Barricading of erosion area along riverbank (Plate 11). Council completed barricading of erosion area along riverbank in January 2025 using orange plastic fencing. This fencing was replaced with star picket fencing and neat signage.
    - Removal of picnic tables and cleaning up the site.

Plate 11: Site 3 – rock barricade and fencing (April 2025)

Council completed barricading of erosion area along riverbank in January 2025 using orange plastic fencing. This fencing was replaced with star picket fencing and neat signage.

3.3 Estuary and Geomorphic Processes

Previous studies have investigated estuary and geomorphic processes and the distribution of bank erosion and vegetation along Marshalls Creek and recommended management strategies. Most recently, a report commissioned under the NSW Estuary Asset Protection Program (NEAP Program), managed by DPIRD – Fisheries provides a bank and riparian condition assessment for the Brunswick River estuary (Fruition Environmental, 2024). That assessment was developed to inform future management actions to improve the stability, resilience, and ecological condition of the estuary. Fruition Environmental (2024) reviews existing knowledge and data, provides detailed information on the current distribution of estuary bank erosion and riparian vegetation condition and lists management priorities for improving bank and riparian condition in the estuary to achieve the main objectives of increasing resilience to flooding, improving asset protection, water quality improvement, and riparian vegetation protection and enhancement.

3.3.1 Geomorphic setting and history

Information on estuary processes in Marshalls Creek from Fruition Environmental (2024) is summarised as:

- Marshalls Creek is mostly dominated by fluvial processes. The influence of tides has been reduced as a result of the construction of the Brunswick River training walls.
- Floods are capable of transporting large volumes of bedload sediments and creating significant scour throughout the estuary.
- Marshalls Creek is nested in a back barrier depression and its planform is controlled by the prominent ridge running east to northeast towards New Brighton. The predominant sediments are reworked marine derived sands and organic rich muds/ silts.
- Fluvial processes dominate erosion processes including bank scour during flooding and bank slumping/ mass failure post-flood. Boat and wind wave-related erosion are less significant issues in this process zone as boat traffic is limited and wind fetches are generally not sufficient to generate significant waves.
- Riparian vegetation is less tolerant of saline conditions and there is an increased dominance of native freshwater riparian vegetation species.

The New Brighton reach of Marshalls Creek is a single, moderately sinuous channel set within an unconfined to partly confined floodplain. Sediments primarily consist of reworked marine derived sands and organic rich mud/silts (Fruition Environmental 2024). Large sand shoals occur within the channel in several locations (visible in Figure 1). Historical aerial photos dating from 1965 (Appendix 1) indicate that sediment accumulation has been a feature of some parts of the study area for at least 60 years with consolidation and increases in area of mid-channel vegetated islands and bars occurring since at least 1965. Bed sediment ripple features indicate both upstream and downstream movements of sediments in this reach in response to incoming and outgoing tides and fluvial processes.

Figure 11 illustrates historical bank transitions between 1970 and 2025, based on digitised aerial imagery from the Historical Imagery Spatial Services. Progressive erosion and channel migration on the northern bank, with clear landward retreat over time, is evident, particularly since the 2022 flooding event. The most significant bank recession is apparent in recent years at the upstream and downstream extent of the works area and near the intersection of Casons Road and New Brighton Road.

Figure 11: Historical bank transitions from 1970-2025

Source: Aerial image - Nearmap (2024), historical data – Nearmap and Historical Imagery Spatial Services, 2025 – Hydrosphere survey.
The mapped bank lines are approximate, as interpretation was limited by the quality of the historical imagery and, in more recent years, by dense tree canopy obscuring the bank edge.

3.3.2 Geomorphic features and processes

There do not appear to be any occurrences of bedrock within the study area. Naturally, the creek channel is loosely confined within the back barrier depression between the coast and the hills of Ocean Shores to the west but is otherwise free to meander within the unconsolidated sediments.

The most notable geomorphic features are as follows:

- A deep (-3.7m AHD) scour hole which occurs offshore at the upstream end of the project area over a length of approximately 150 m. Scour occurs at this location as flows are forced around an almost 90° bend in the channel, with the full-force flood flows directed at the left bank in this area. The area of scour continues downstream around the channel bend, with the narrowest part of the creek being around 15m. This scour hole is shown on Figure 12 with the combined LIDAR and hydrographic survey for the project area provided in Drawing 1 in Appendix 3.

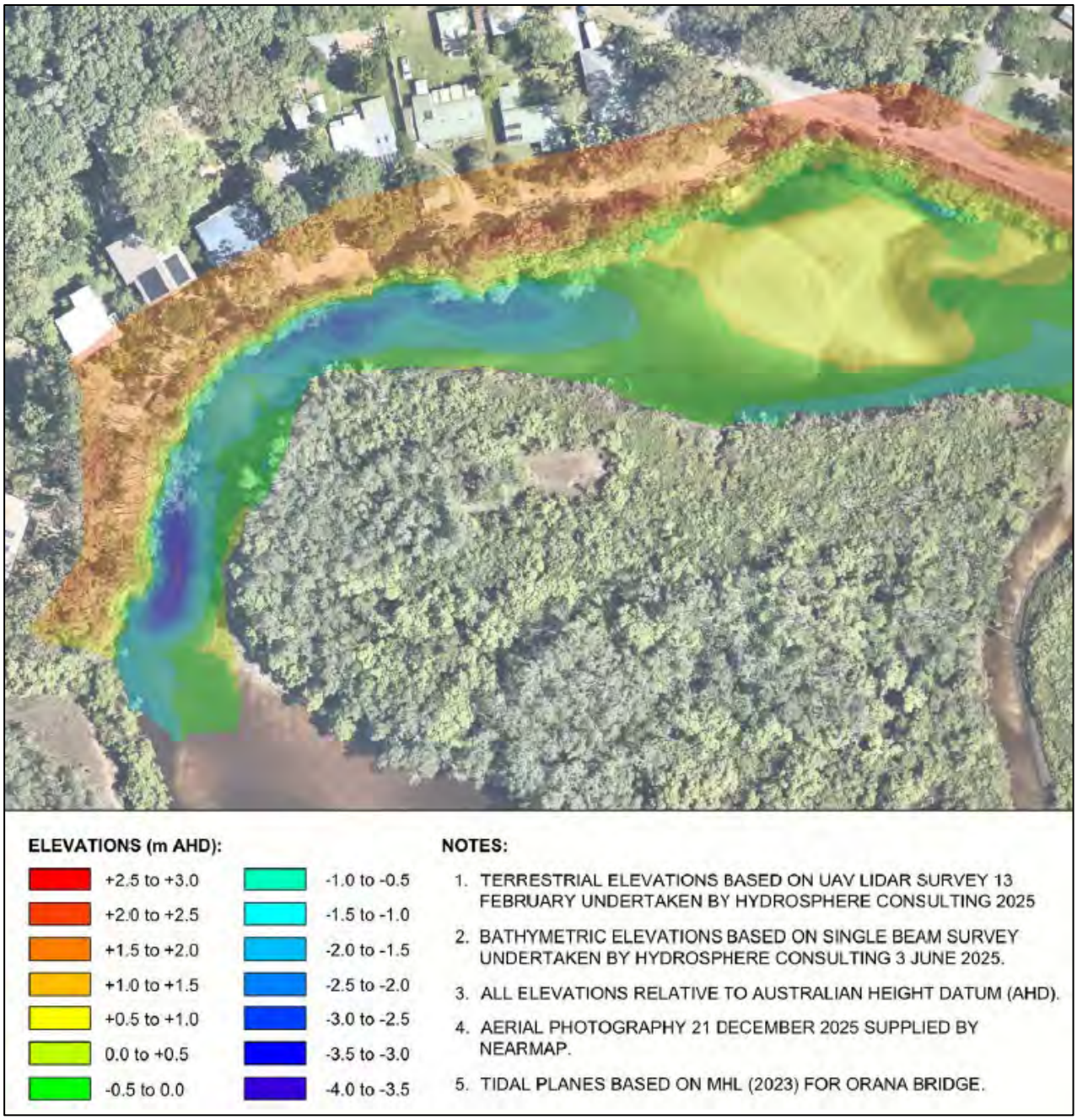


Figure 12: Bathymetric elevations showing scour hole offshore at the upstream end of the project area

- Downstream of the channel bend, the creek width expands significantly to a width of around 65m. At this point much of the mobile sediment is deposited in a large central sand shoal and appears to be pushed by opposing downstream and upstream forces to this point. Although this is clearly an area of sediment deposition, it is notable that erosion still occurs on both banks of this section of the creek. This occurs as flows are effectively split by the central sand shoal, with relatively strong ebb tide currents occurring at the bankside. Similarly, treefall and erosion are evident on the southern (right) bank as the majority of the channel flow is deflected by the shoal into this side of the creek.
- Further downstream, the creek planform constricts again to a relatively narrow (20m) channel, with the thalweg running close to the outer bend, leading to a concentration of scour near the New Brighton shops, with significant erosion and treefall occurring at one of the most visible sections of

Marshalls Creek opposite the Post Office. Downstream of the project area, the channel again begins to widen and flows become more dispersed.

The process of erosion is a combination of bank undercutting and sediment transport resulting in bank collapse, rock revetment failure and riparian instability (Plate 1). Undercutting is evident even in areas of apparent sediment deposition. In these areas, sub-surface drainage is drawing sand out of the bank below the relatively intact root-bound layers, resulting in extensive void formation below the riparian vegetation (Plate 12). Daily fluctuations in groundwater levels due to tides, as well as sub-surface drainage of rainwater to the creek contribute to this phenomenon.

Unconsolidated sediments are susceptible to scour which is directly correlated with flow velocity. Scour is exaggerated along the concave (i.e. outside) bend of the creek and can be dramatic during flood events. The process is further exacerbated by deposition of mid channel bars that push the thalweg (the location of deepest parts of the channel) toward the outside bend, narrowing the active channel which further increases the flow velocity in these areas.

Once the creek banks become undercut, and/or the sediments supporting the toe of the bank are scoured by high flow velocities, mass failure of the bank face occurs, often exaggerated as large trees lose support and fall, thereby destabilising large areas around the root ball.

Plate 12: Undercut voids extending up to 1.5m into the bank occur along Marshalls Creek

The results of these processes promote continuation of undercutting on concave bends leading to bank collapse and vegetation retreat, increased sediment deposition on convex bends and increasing channel sinuosity (Figure 13). The key geomorphic features of the reach appear to be persistent over time and geomorphic trends are unlikely to change in the foreseeable future. Without intervention it is inevitable that there will be continued erosion of the northern bank of Marshall Creek at New Brighton, including further tree loss and potential threat to bankside infrastructure.

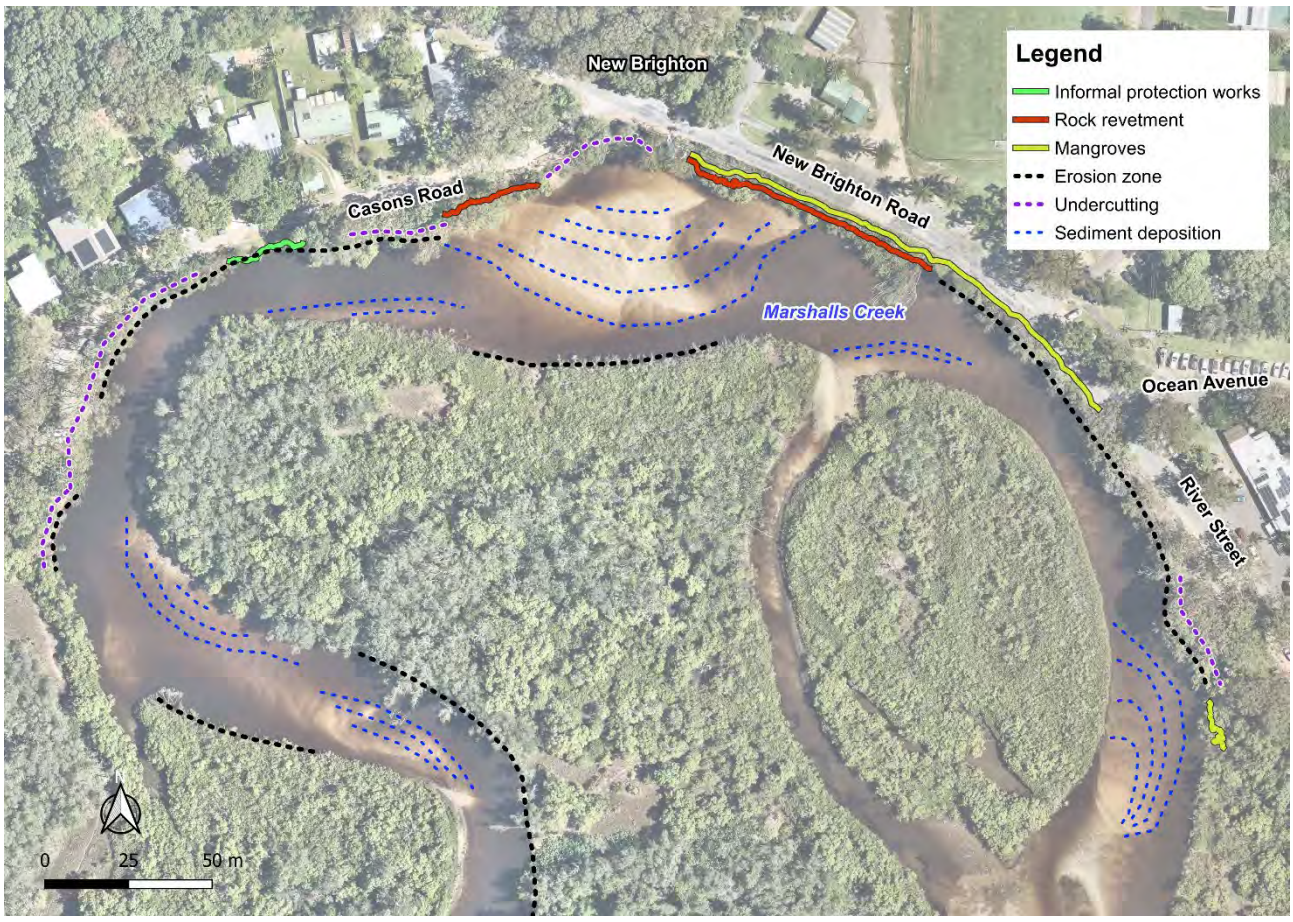


Figure 13: Trajectories for erosion and sediment deposition

Source: Aerial photo – Nearmap (2024)

3.3.3 Flooding

Flood models are useful for assessing erosion impacts from high velocity flows associated with floods. The Tweed Byron Coastal Creeks Flood Study modelled the 100-year Average Recurrence Interval (ARI) peak flood levels for climate change scenarios in 2050 and 2100 (BMT WBM, 2010). The 2050 scenario was based on a 10% increase in rainfall intensity and peak tailwater level of 2.89 m AHD and the 2100 scenario was based on a 30% increase in rainfall intensity and peak tailwater level of 3.49 m AHD. The 100-year ARI peak flood levels for Marshalls Creek at New Brighton for 2050 were predicted to be 0.33 m above the base case scenario set out in the *Marshalls Creek Floodplain Management Plan* (Paterson Consultants, 1997).

A behaviour analysis of the 2022 flood event in the Brunswick River (WMAwater, 2024, provided by BSC) found that the February 2022 flows at Orana Bridge on Marshalls Creek, approximately 4 km downstream of the confluence of Marshalls Creek and Yelgun Creek, were between the 2% and 1% average exceedance probability (AEP, equivalent to the 100-year ARI) flood flows based on flood frequency analysis. The behaviour analysis found that the Marshalls Creek system is characterised by a complicated interaction between Yelgun, Mooball and Marshalls Creeks and the flood may have been a lower AEP in the Marshalls Creek system. Based on this information, the 1% AEP flood velocity has been adopted as the design flood for this project.

Peak velocity and depth relate to the stream power and erosive potential of floodwaters. This ratio is commonly used to evaluate the energy exerted by flowing water on the bed and banks of waterways. The

modelled peak velocity x depth for 2050 for the study area indicates that approximately 60% of the outer bank is subject to medium-high peak flood velocity x depth (i.e. 0.3 - > 1.0 m^2/s) with two hotspots on Casons Road where erosion risk is high. Figure 14 indicates the locations where erosion risk is high, and thus bank rehabilitation methods are required to be robust to ensure protection from future flood events.

Figure 14: Erosion risk based on flood velocity x depth

Source: Data from BMT WBM (2010); Aerial photo – Nearmap (2024)

3.4 Examples of Previous Community Feedback

The New Brighton Village Association (NBVA) provided a submission to BSC in 2024 expressing the community's concern about the condition of the riverbank and lack of action. Key issues raised were river bank erosion and risks to River Street, traffic along Casons Lane contributing to riverbank erosion, undercutting of large trees, and the influence of drainage assets on the scour hole. Retaining the existing native vegetation is important to the NBVA and the group is concerned about the large trees falling into the river. They do not want to lose any more trees with preference that any protection works do not result in tree removal (if possible).

BSC reviewed the drainage in the area (specifically the stormwater pipe opposite the shops, Figure 3) and noted that the stormwater outlet and overland flow are not the main cause of riverbank erosion, which is supported by the findings in Fruition Environmental (2024).

BSC undertook community engagement in 2024/25 as part of the development of the Place Plan for New Brighton, South Golden Beach and Ocean Shores. The community indicated that addressing erosion of

Marshalls Creek in the study area is a key priority. At the time of preparation of this report, BSC has not yet adopted the draft priorities for the New Brighton, South Golden Beach and Ocean Shores Place Plan.

3.5 Previous Concept Designs

Soil Conservation Service (2019) provided a concept plan for stabilisation works at the corner of Casons Road and New Brighton Road (Figure 15 to Figure 17) as part of a Habitat Action Grant application which did not proceed.

Figure 15: Site action plan (2019)

Source: Soil Conservation Service (2019)

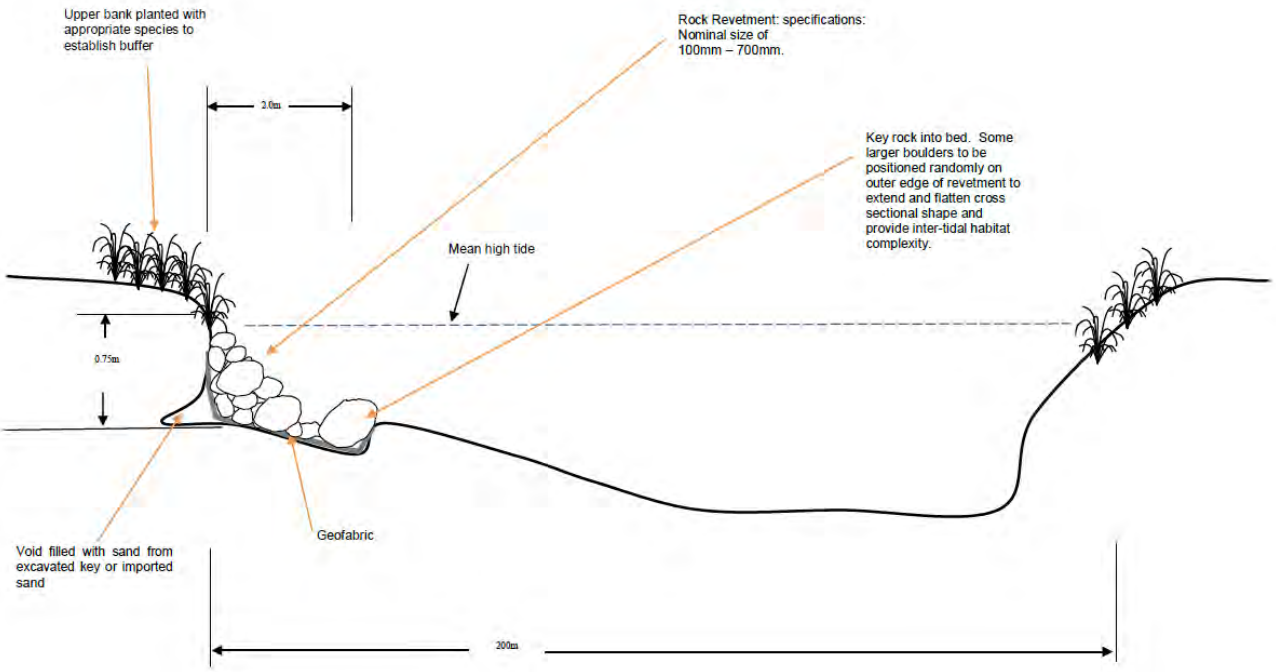


Figure 16: Cross-section – rock revetment

Source: Soil Conservation Service (2019)

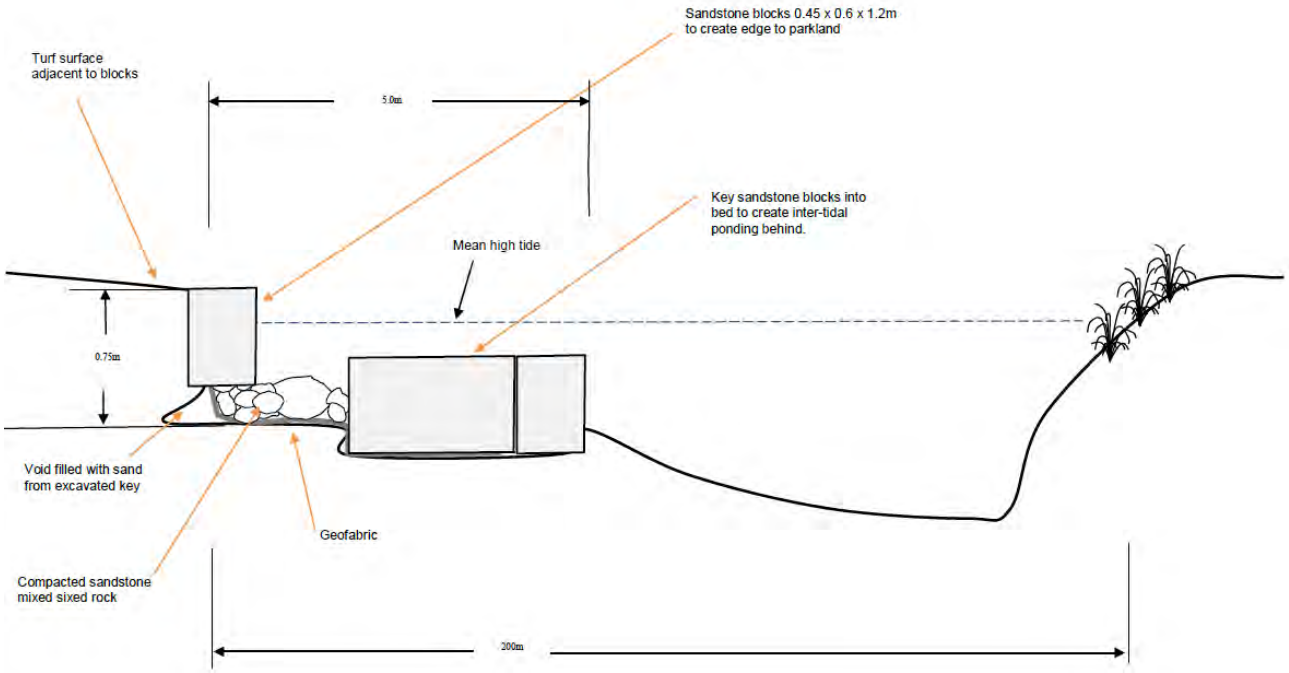


Figure 17: Cross-section – sandstone block stepped gravity wall

Source: Soil Conservation Service (2019)

Council engaged Plummer and Smith (2020) to prepare some landscape concepts to provide images demonstrating how the road reserve and waterway could be repurposed to improve open space public use, amenity and environmental values including (Figure 18).

1. Areas of existing creek edge vegetation to be protected and extended where possible
2. Natural log elements provide informal furniture elements and can be utilised to limit access to particularly vulnerable creek edge areas
3. Existing tree leaning over creek waterhole
4. Proposed new trees as a second 'line of defense' protecting foreshore areas from erosion. This second line of trees assists with the structural integrity of trees along the existing creek bank alignment
5. Existing trees to be retained
6. Natural logs provide casual seating and loosely define garden edges
7. Existing Fig tree to be retained
8. Existing timber fence
9. Private residence
10. Informal (and small) open spaces along the creek edge- mulch and sand surface with small moments of planting where possible
11. Garden areas- weed species to be removed and replaced with appropriate locally native species
12. Stone steppers to assist with creek access
13. Rocks as vehicular barrier
14. Gravel driveway
15. Informal gravel public car park spaces- some garden removal required
16. Existing trees in this zone to be retained
17. Existing creek edge vegetation to be retained and expansion encouraged
18. Existing car park spaces at the end of Casons Road
19. Casons Road cul-de-sac
20. Existing creek edge vegetation

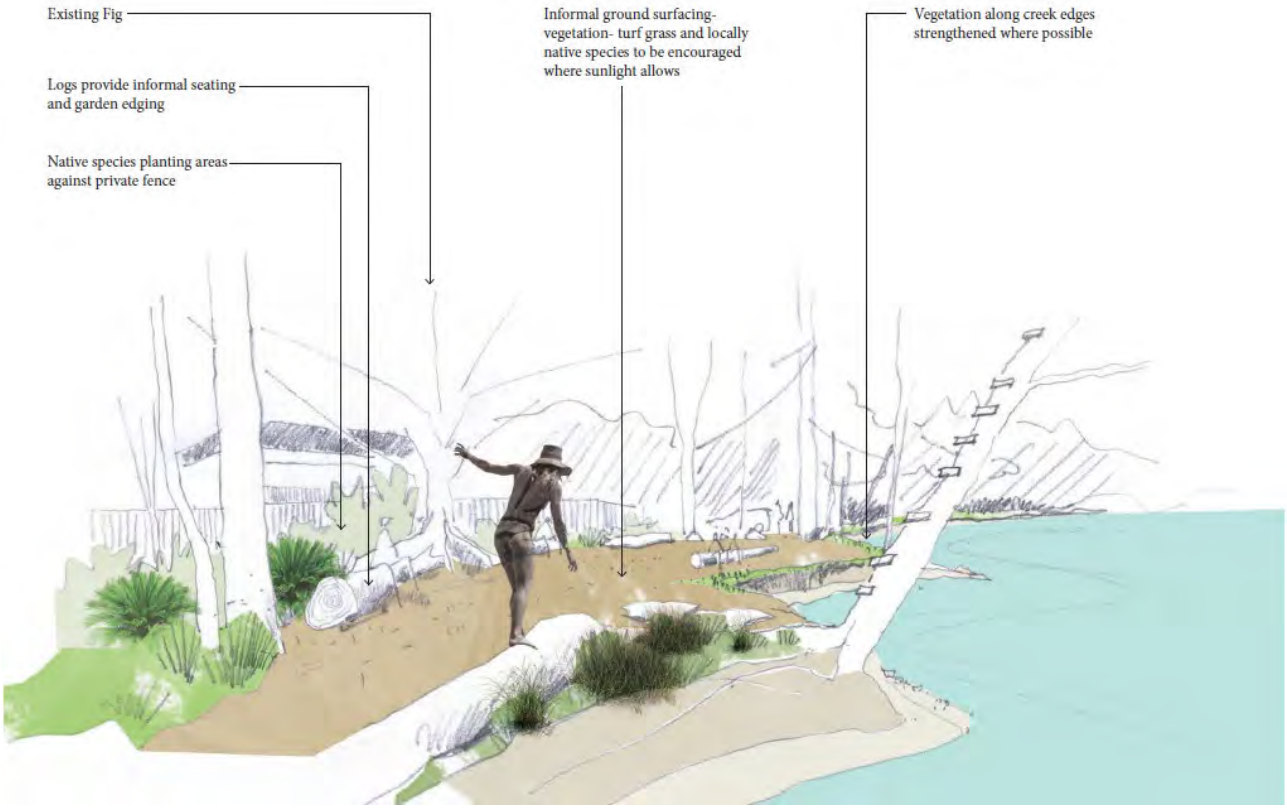


Figure 18: Casons Road sector sketch plan and concept

Source: Plummer & Smith (2020)

4. APPROVALS PATHWAY

A detailed assessment of regulatory requirements for the foreshore rehabilitation works is provided in Appendix 2 and summarised below.

4.1 Potential Foreshore Rehabilitation Works

The foreshore rehabilitation works are likely to consist of a combination of hard stabilisation measures (e.g. rock revetment, geotextile sandbags) for areas where erosion severity is high, the banks are steep or high value assets require protection, as well as softer treatments including woody debris, riparian revegetation, exclusion fencing and sand nourishment.

In accordance with the *Standard Instrument – Principal Local Environmental Plan* dictionary, "environmental protection works" means "*works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works, dune restoration works and the like, but does not include coastal protection works*". Coastal protection works are defined under the *Coastal Management Act 2016* as:

> *(a) beach nourishment activities or works, and*
>
> *(b) activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters, including (but not limited to) seawalls, revetments and groynes.*

Therefore, to assess the approvals pathway, it is considered that:

- Coastal protection works include rock revetment and geotextile sandbags.
- Environmental protection works include riparian revegetation and associated bank management controls such as rock fillets which promote mangrove colonisation and rock sills to protection existing vegetation.

4.2 Summary of Approvals Pathway

The approval pathways under both part 4 and part 5 of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) are discussed in the following sections. The key sections of legislation determining the approval pathway for the foreshore rehabilitation works are (Figure 20):

- Division 25 - Waterway or foreshore management activities of the Infrastructure SEPP for works outside the mapped coastal wetlands. These works could be undertaken under Part 5.
- Division 17, Section 2.110 A of the Infrastructure SEPP for environmental protection works within or adjacent to the road corridor on land mapped as coastal wetlands (Figure 19) that does not require any clearing of native vegetation. These works could be undertaken under Part 5.

Figure 19: Coastal wetlands mapped under the Resilience and Hazards SEPP 2021

Source: Nearmap (2023)

- Section 2.7(1) of the Resilience and Hazards SEPP for coastal protection works within areas mapped as coastal wetlands. Currently, any new coastal protection works will not fulfil any of the conditions in Section 2.16(2)(a) of the Resilience and Hazards SEPP (as they are not identified in a CMP, are not beach nourishment, are not the placing of sandbags for a period of not more than 90 days, or routine maintenance works or repairs to any existing coastal protection work) and therefore would require assessment and development consent under Part 4.
- Section 2.16(1) coastal protection works by a private proponent would require development consent and assessment under Part 4. If any government agency were to acquire the private land (lot 1, DP 121484), the pathways noted above in relation to section 2.110A of the Infrastructure SEPP for environmental protection works and s2.7(1) of the Resilience and Hazards SEPP for coastal protection works could apply.
- Section 2.16 of the Resilience and Hazards SEPP for beach nourishment, the placing of sandbags for a period of not more than 90 days or routine maintenance works or repairs to any existing coastal protection works. These works could be undertaken under Part 5.

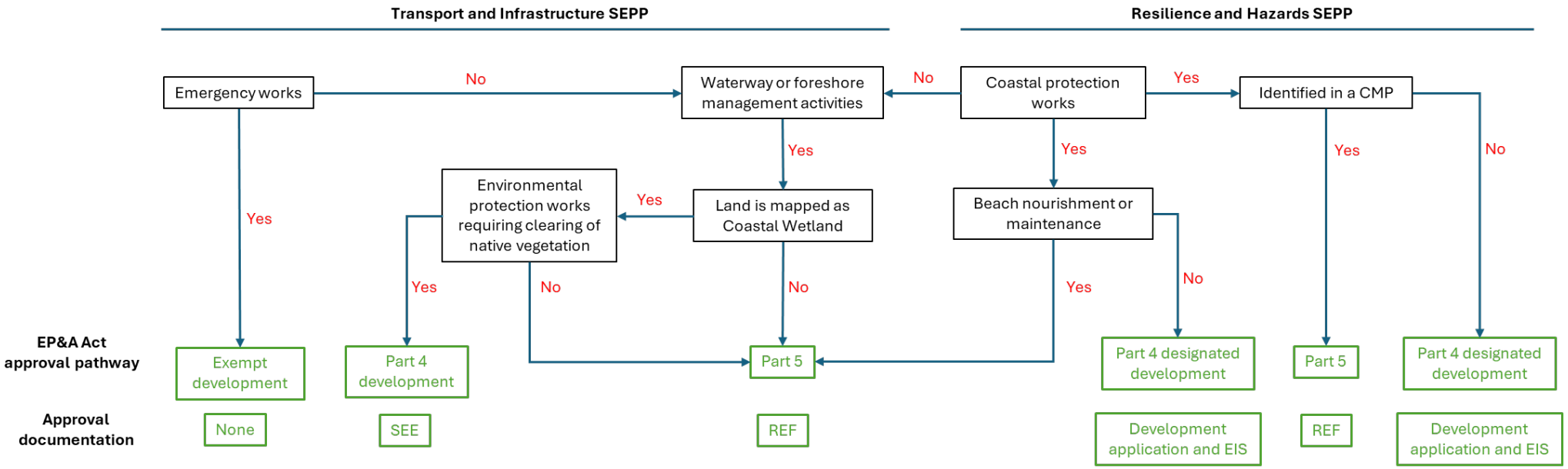


Figure 20: Approval pathway

Waterway or foreshore management activities are (Division 25 – Infrastructure SEPP):
(a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways.
(b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes.
(c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways.

Environmental protection works are (Standard Instrument – Principal Local Environmental Plan dictionary):
Works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works, dune restoration works and the like, but does not include coastal protection works.

Coastal protection works are (*Coastal Management Act 2016*):
(a) beach nourishment activities or works, and
(b) activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters, including (but not limited to) seawalls, revetments and groynes.

4.2.1 Part 5

A part 5 assessment would be required for the works that are waterway or foreshore management activities outside of the mapped coastal wetlands, or environmental protection works within the mapped coastal wetlands, or beach nourishment or maintenance of existing coastal protection works (under Section 2.16(2)a of the Resilience and Hazards SEPP). Under division 5.1 a determining authority (a Minister or a public authority) can assess the environmental impact of certain activities that they are either carrying out themselves or approving. The most likely proponent for these works is a local government authority, however, the planning pathway remains valid if a different government agency is the proponent. Assessment under division 5.1 would require the preparation of a Review of Environmental Factors (REF) prepared in accordance with the *Guidelines for Division 5.1 Assessments* (DPE, 2022). If the proposed works are assessed as likely to have a significant impact on the environment, an Environmental Impact Statement (EIS) would also be required, and that would trigger a requirement for Secretary's Environmental Assessment Requirements (SEARS).

Under Section 2.7(1) of the Resilience and Hazards SEPP, if any proposed new coastal protection works are included in a certified CMP, then that proposal is permitted without consent and therefore assessable under part 5, division 5.1 of the EP&A Act.

The *Review of Coastal Wetland and Littoral Rainforest Mapping within Byron Shire LGA* (EarthScapes, 2023) assesses the existing mapping of coastal wetland (CW) and littoral rainforest (LR) areas in the *Resilience and Hazard SEPP 2021* in the Byron Shire coastal zone. The review identifies potential amendments to the mapping including unmapped areas that meet the criteria for littoral rainforest and coastal wetland mapping, and errors in the existing mapping that impact on Council's operational activities. Council is currently considering shire-wide mapping amendments as part of the development of CMPs. Although the coastal wetland mapping within the New Brighton Road and Casons Road corridor (Figure 29) was not directly identified by EarthScapes (2023) as a mapping amendment, it may meet the criteria for mapping amendments as the existing SEPP mapping overlays a Council road corridor. If the mapping is amended, Division 25 (Waterway or foreshore management activities) of the Infrastructure SEPP would apply and approval under Part 5 would be required.

4.2.2 Part 4

If the proposed works are not included in a certified CMP or SEPP mapping covering this area is not amended, the works would not meet the criteria for Part 5 assessment and any environmental protection works or coastal protection works proposed on land mapped as coastal wetlands would require development consent and approval from Council under part 4 of the EP&A Act. The proposed coastal protection works would be designated development and an EIS would also be required.

Under Section 2.7(4) of the Resilience and Hazards SEPP (Development on certain land within coastal wetlands and littoral rainforests area):

> *A consent authority must not grant consent for development referred to in subsection (1) unless the consent authority is satisfied that sufficient measures have been, or will be, taken to protect, and where possible enhance, the biophysical, hydrological and ecological integrity of the coastal wetland ..*

Section 27 (1) of the *Coastal Management Act 2016* requires a consent authority to be satisfied that:

(a) the works will not, over the life of the works -

(i) unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland, or

(ii) pose or be likely to pose a threat to public safety, and

(b) satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works -

(i) the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works,

(ii) the maintenance of the works.

Any works within the Biodiversity Values Map area (corresponding to the mapped coastal wetlands, Figure 19) would trigger entry into the Biodiversity Offsets Scheme as part of the development application. This would require the application of the Biodiversity Assessment Method and preparation of a Biodiversity Development Assessment Report (BDAR) by an accredited biodiversity assessor. The BDAR will identify biodiversity potentially impacted by the proposal, assess the potential impact of the proposal, outline measures to avoid or minimise impact and identify the type and number of biodiversity credits required to offset any impacts. The preparation of a BDAR may require additional flora and fauna surveys which may have seasonal requirements. The BDAR may be referred to the NSW Government (DPE) for assessment. Impacts on biodiversity are expected to be minimal, however there may be a need for additional costs to offset biodiversity impacts.

4.2.3 Protecting Aboriginal Cultural Heritage

A preliminary due diligence assessment as documented in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW, 2010) is summarised in Table 6 (Appendix 2).

The landscape of the study area is significant to Minjungbal People of the Bundjalung Nation and to the Aboriginal community, and there are sites within the study area of particular importance, some of which are recorded. Further investigations into Aboriginal Cultural Heritage of the study area will be needed and will need to be informed by cultural experts from the Aboriginal community, including through engagement of TBLALC. If the investigations demonstrate that the proposed work would impact Aboriginal objects, and the works cannot be modified to avoid those impacts, then an Aboriginal Cultural Heritage Assessment Report (ACHAR) will need to be prepared to support an application for an Aboriginal Heritage Impact Permit (AHIP). The ACHAR would need to be prepared in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010).

Any works within the waterway will need to comply with the requirements of the *Native Title Act 1993* (Cth).

4.2.4 Other permits and approvals

The following additional permits are likely to be required:

- Marine Park permit for any work within Cape Byron Marine Park.

- Landowners consent for any works on:
    - Private land (lot 1, DP 121484).
    - Crown land below MHWM (a General Licence from DPHI – Crown Lands for any bank restoration works within the Crown waterway).
- DPIRD – Fisheries (*Fisheries Management Act 1994*):
    - Section 200 (Part 5 works) - under s199 of the FM Act, the Minister for Primary Industries is required to be consulted over any dredging or reclamation works carried out, or proposed to be authorised, by a public authority (other than a local government authority). Therefore approval under the *Crown Land Management Act 2016* will avoid any need for a separate permit under the FM Act.
    - Section 201 (Part 4 works) – a permit will be required for any dredging or reclamation works.
    - Section 205 – permit to harm (cut, remove, injure, destroy, shade etc) marine vegetation (mangroves, saltmarshes, seagrasses and seaweeds).
- Consent from Council for works within the road reserve (unlikely to be required if BSC is the proponent).

Other legislative considerations are discussed in Appendix 2.

5. DESIGN DEVELOPMENT

5.1 Survey

A combined hydrographic, aerial and ground survey was undertaken to provide a topographic model of the site (Appendix 3). Hydrographic survey was undertaken using survey-grade positioning and single-beam echo sounding equipment. The aerial photograph as well as LiDAR scanning was undertaken by drone. Additional infill survey detail of the creek banks was undertaken as necessary to inform the design process utilising RTK GPS. The combination of surveys provides an accurate representation of the bank profiles, contour information for mapping and volume estimation and provided data utilised in the design.

5.2 Site Factors

In this report, the different segments of the foreshore are represented by sections A – S, which are located centrally within each bank segment.

Bank treatments have been developed for each foreshore segment (refer drawings in Appendix 3) based on the site factors discussed in Table 2. All bank segments are located on the outside bend of the estuary and the substrate is generally non-cohesive alluvium, gravels and sands.

Table 2: Site factors for each bank segment

Segment (section)	Current erosion severity[1]	Existing protection	Dominant causes of erosion	Water depth	Constraints, assets and values
A	High	Fallen tree	River/ tidal scour	Deep (>1.5 m)	Borders Nature Reserve and Cape Byron Marine Park Sanctuary Zone, Casons Road
B	High	Coir logs, fencing	River/ tidal scour	Very deep (>3.0 m)	Cultural heritage site (shell deposit), fencing, Casons Road, power poles
C	Moderate	None	River/ tidal scour, public access	Moderate (0.8 – 1.5 m)	Casons Road, power poles
D	Moderate	None	River/ tidal scour, public access	Deep (>1.5 m)	Casons Road, power poles
E	Moderate	Rock revetment (degraded, displaced)	River/ tidal scour	Deep (>2.0 m)	Casons Road, power poles
F	Low	Tyres, bricks, concrete	N/A	Deep (>2.0 m)	Casons Road, power poles

Segment (section)	Current erosion severity[1]	Existing protection	Dominant causes of erosion	Water depth	Constraints, assets and values
G	Moderate	Rock revetment (degraded, displaced)	River/ tidal scour	Deep (>2.0 m)	Casons Road, power poles
H	Moderate	Rock revetment (degraded, displaced)	River/ tidal scour, public access	Deep (>2.0 m)	Casons Road, power poles
I	Moderate	None	River/ tidal scour, public access	Deep (>2.0 m)	Casons Road, power poles
J	Moderate	None	River/ tidal scour, public access	Moderate (0.8 – 1.5 m)	Casons Road, power poles
K	Moderate	None	River/ tidal scour, public access	Shallow (<0.8 m)	Cultural heritage site (shell deposit), Casons Road, fencing, public access area, power poles
L	Moderate	Coir logs, fencing, mangroves	River/ tidal scour, public access	Shallow (<0.8 m)	Casons Road, New Brighton Road, fencing, power poles
M	Negligible	Mangroves	N/A	Shallow (<0.8 m)	New Brighton Road, power poles
N	Negligible	Mangroves	N/A	Shallow (<0.8 m)	New Brighton Road, power poles
O	Negligible	Rock revetment, mangroves	N/A	Moderate (0.8 – 1.5 m)	New Brighton Road, stormwater outlet
P	Moderate	Rock revetment (degraded, displaced)	River/ tidal scour, public access	Moderate (0.8 – 1.5 m)	New Brighton Road, public access area
Q	High	Fallen tree	River/ tidal scour, public access	Moderate (0.8 – 1.5 m)	New Brighton Road
R	High	None	River/ tidal scour, public access, overland stormwater flow	Moderate (0.8 – 1.5 m)	New Brighton Road, public access area, stormwater outlet

Segment (section)	Current erosion severity[1]	Existing protection	Dominant causes of erosion	Water depth	Constraints, assets and values
S	High	None	River/ tidal scour, public access	Moderate (0.8 – 1.5 m)	New Brighton Road, public access area, borders Nature Reserve

1. Figure 4, updated with current condition.

5.3 Potential Bank Treatments

The DPIRD – Fisheries DST Part B report (Hydrosphere Consulting, 2023) provides a review of available estuarine bank erosion treatment methods including the purpose/application, advantages, limitations, environmental benefits and design concepts and consideration of each method. Bank treatment materials and methodologies range from heavily engineered and mechanically intensive 'hard' structures such as rock or concrete walls through to 'soft' approaches such as revegetation. Techniques are often categorised as 'hard', 'soft' or hybrid, or alternatively 'structural' or 'non-structural':

- Soft treatments - riparian vegetation management and fencing. Typically dominated by vegetation or natural materials. Vegetation is typically the dominant element in these approaches and is often supported by natural or biodegrading unobtrusive and complementary elements to facilitate vegetation growth and perform natural processes to provide bank stabilisation. Over time, sites using soft/ green methods return to a natural state with no artificial or hard structures present.
- Hard treatments – various materials. Engineered structures using hard, synthetic and/or imported materials such as rock that harden a bank. These methods are typically armouring type solutions that aim to physically protect a bank from erosion forces.
- Hybrid treatments – e.g. large woody debris (LWD) and rock fillets. These methods use an engineered or built structure to provide bank protection and a biological feature to provide long-term stabilisation. In the long term, hybrid techniques mature to a mostly natural form and function with a site developing into a predominantly natural state.
- Administrative and management controls. Broader management and strategic planning methods can be implemented as 'standalone' methods but are typically most effective when used in conjunction with physical methods. These methods do not provide physical bank protection or remediation of existing erosion but generally address waterway or land uses related to erosion mechanisms or factors. They typically prevent future ongoing erosion rather than reactive responses to directly ameliorate impacts from current erosion. Administrative and management controls have not been considered in this report.
- Complementary techniques. These techniques are not appropriate to be used as standalone/ exclusive techniques but may be used in conjunction with the other techniques to provide further stabilisation or increased environmental benefit.

The preferred approach for Marshalls Creek is to predominately use 'soft' approaches with minimal use of 'hard' elements and only where required. The best approach for each bank segment incorporates elements

of both hard and soft techniques with a combination of methods providing environmental benefits. An assessment of potential bank treatment options is provided in Table 3 including:

- Advantages and limitations – considering effectiveness, ease of implementation, upstream/ downstream erosion potential, space constraints, public safety and access, design life and maintenance requirements, materials (consistency with nearby treatments, sustainability), climate change resilience.
- Environmental outcomes.
- Stakeholder acceptance – based on feedback from TBLALC and NSW government agencies (Section 5.5). Community consultation has not been undertaken as part of the assessment.
- Indicative cost (relative to other potential options).

Table 3: Assessment of potential bank treatment options

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Do nothing	No intervention, allow current processes to continue	Low cost	Only suitable for areas of low erosion risk	Allows natural processes to occur	Likely to be unacceptable to community and stakeholders in areas with erosion	Low	Existing management recommended for segments with low erosion risk (M, N, O). Intervention may be required in future if erosion risk increases.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Soft/ green treatments							
Riparian/ estuarine vegetation management	Native revegetation (active re-establishment, rehabilitation or restoration of native vegetation) and weed management (Plate 13) or active encouragement of mangrove growth	Provides long term bank stability, shade and reduced water/ soil temperature at the shore. Can reduce water velocity at the stream banks and reduce flooding downstream by causing the water to overtop the banks. May filter sediments from overland flows, capturing sediments and nutrients before water enters the stream. Improves aesthetic/ amenity value of an area. Complements other protection measures in the majority of situations. Provides more effective bank stabilisation over time. Native seed source for natural regeneration or future revegetation activities.	Requires effective planning, management and long-term maintenance. Requires an establishment phase before becoming effective. Limited to areas protected from or not eroding and requires additional protection measures. Applicability is reduced where landward space is limited. Can fail if works are not planned and managed effectively.	Increases flora diversity and subsequently fauna diversity. Provides valuable habitat for a wide variety of fauna (e.g. fish, birds, invertebrates). Improves terrestrial, riparian and aquatic habitat. Provides runoff water quality improvement functions (buffer/ filter effect). Can provide ecosystem services to surrounding land uses such as serving as a windbreak, providing habitat for beneficial insects and predators, reduced soil loss. Potential future source of LWD. Sequesters carbon.	Works can involve community/ landholder input, creating a sense of stewardship. Expected to be supported by the broader community. Supported by approval agencies.	Low	Combine with other techniques at bank segments to be managed to provide long term bank stability and improve water quality and the ecological value of the site and increase effectiveness overtime.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Fencing	Exclusion of humans from the foreshore area	Provides long-term protection from human access. Allows for the improvement/ reestablishment of riparian vegetation. Simple to install and inexpensive. Provides numerous indirect environmental benefits.	Potential flood impacts on fencing. Requires maintenance.	Associated benefits of establishment or improvement of a riparian zone.	Potential perception that people are being restricted from 'public' areas.	Low	Existing exclusion fencing to be maintained at section L. temporary exclusion fencing at sections B, Q, R, S to be removed once bank treatments are established. Access to the waterway to be discouraged in all sections except K, P, R.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Hard treatments							
Renourishment	Placement of imported material (usually sand) on a foreshore to replace eroded material.	Provides immediate bank protection. Can restore foreshore to original condition. Improves public access and amenity of foreshore. Potential beneficial reuse of dredged material.	Availability/ cost of suitable material. Longevity of nourishment material remaining on the intended site (generally short unless maintained). Potential for ecological impacts on placement area (e.g. nesting habitat) and surrounding habitats (e.g. smothering rocky areas, seagrass, saltmarsh, mangroves or infilling deeper pools). Does not address the cause of erosion and hence does not arrest erosion. Can be an extensive approvals process (scale dependent).	Potentially improve intertidal sandy habitat. Potentially improve and or increase supratidal sandy habitat. Can improve localised turbidity associated with erosion of finer sediments.	Renourishment with material dredged from Marshalls Creek is not supported by DPIRD.	Low as small volumes required	Importation of small amounts of fill will be required to support revegetation (soil), backfilling of LWD sites (rock and sand, section A, E, J) and backfilling of existing rock revetment (section D, Q). Sand fill at section B is required to protect shell deposits. Sandy beach could be established at section P, initially as a trial to test effectiveness and use.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Cobble	Cobbles are placed on previously eroding banks, mimicking naturally occurring cobble beaches, to provide bank protection from moderate to high energy waves	Simple construction. Natural aesthetic. Flexible (dynamic) under the attack of waves and therefore do not fail as static structures do. Allows and may even improve public access to the water. Maintenance is straightforward and only required after extreme weather events.	Provides less protection than a revetment or seawall. Cobbles and gravel do not provide the same recreational opportunities as a sandy beach. In extreme wave conditions cobbles may be pushed landward. Not suitable for foreshores/ banks with a large tidal range where a substantial area of the foreshore is exposed at low tide due to the vast area which would subsequently need to be covered in cobble.	Erosion protection. May improve water quality as the wrack gets washed onto the foreshore. Improves conditions for seagrass growth.	Likely to be acceptable in less-trafficked areas.	Low	Not suitable for Marshalls Creek as a bank stabilisation measure as alongshore river/ tidal movement is causing the erosion, and tidal range is high. However, cobble would provide erosion controls at the base of trees e.g. sections K, R, Q, S.
Groynes	Narrow structures that extend from the foreshore into a waterway, perpendicular or slightly oblique to the shoreline (Plate 14)	Retain sandy beach and provide bank stabilisation	Bank erosion occurs down drift of groynes. Suitable for a limited range of applications where the sediment movement is unidirectional and alongshore.	Opportunity to improve estuarine habitat if suitable features are incorporated into design.	Unlikely to be acceptable due to impacts on public amenity and navigation.	High	Not suitable for Marshalls Creek foreshore due to narrow channel width and offshore sediment movement.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Timber wall	Vertical structures consisting of horizontal timber or logs attached to vertical piles (Plate 14)	Natural aesthetic. Potential beneficial reuse of unwanted material (logs felled from a development site). Potential beneficial reuse of materials from onsite (logs felled nearby). Applicable where there is limited landward space.	Limited design life – deteriorate over time, submerged timber subject to marine borers. Scouring at the toe. May deteriorate quickly if any gaps form between the logs. Can cause further bank erosion downdrift of the structure. Can result in wave reflection causing bed scour and loss of beach.	Minimal other than arresting erosion.	Unlikely to be acceptable as a standalone feature	Medium	Suitable as bank toe protection to retain substrate/ backfill (sections K, P)

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Rock revetment	Rock strategically placed on an embankment to absorb and disperse erosive forces and to protect the embankment from erosion (Plate 15)	Provides instant bank protection and erosion remediation of the eroded site. Provides long term bank stability at the eroded site. Suitable for high energy (current and wave) environments. Relatively minimal maintenance. Are generally adaptable for protection against rising sea levels and future weather events.	Requires construction machinery access. Poor riparian and aquatic habitat value. Construction often requires the removal of habitat features (riparian vegetation, LWD). Susceptible to weed infestation. Can instigate end-wall erosion. Results in loss of 'beach' offshore from rock wall. Due to the smoothness of rock structures, they encourage high velocities which results in bed scour. This can lead to undermining of wall, or in narrow channels, erosion of opposite bank. Can create public safety issues. Suitable rock can be difficult to source. Rock revetment displaces emergent vegetation mangroves and reeds.	Minimal environmental benefits other than providing instant bank protection and remediation of erosion.	Likely to be acceptable in some areas as it is consistent with existing bank treatments and will provide effective bank protection.	High	Suitable for areas with high value assets at risk (section B – cultural heritage site) and to protect any waterway access structures (proposed deck at section R).

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Vertical seawall	Vertical walls, revetment or retaining walls constructed from concrete, sandstone blocks, limestone blocks, bricks or sheet piling (Plate 16)	Provides long term bank stability. Suitable for high energy (current and wave) environments.	Poor riparian and aquatic habitat value. Construction often requires the removal of habitat features (riparian vegetation, LWD). Often instigates bank erosion downstream of the structure. Requires construction machinery access. Results in loss of 'beach' offshore from vertical seawall. Due to the smoothness of the structure, vertical walls encourage high velocities which result in bed scour. This can lead to undermining of the wall or erosion of the opposite bank in narrow channels.	Minimal environmental benefit although features can be added to enhance marine habitat	Unlikely to be acceptable	High	Not recommended due to risk of bed scour and erosion of opposite bank

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Geotextile sand containers	Revetment constructed of interlocked sand filled geotextile containers/bags (Plate 17)	Wide range of applications. Suitable for emergency and temporary erosion control. Softer and more user friendly than rock in high public use areas.	The soft and flexible nature can create difficulties in designing for stability. Vulnerable to UV exposure. Vulnerable to vandalism, vessel strike, flood debris. Local sand must be used that is compatible with the site. Requires construction machinery access. Temporary stabilisation only as bags will eventually fail. Geotextile material must be removed from site at the end of their use. May be difficult to repair if lower bags fail.	Limited environmental benefits. Can cause downdrift erosion.	Potentially acceptable	High	Potentially suitable in areas requiring waterway access (sections P – S) but more suited to contiguous lengths of banks. Preference is to utilise naturally occurring materials.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Hybrid methods							
Rock fillet	Rock wall structures constructed offshore of an eroding bank built in a general 'j' shape, parallel to the bank and the dominant water flow direction. The upstream end is keyed into the bank with an opening at the downstream end to allow for fauna passage and colonisation of vegetation (Plate 18).	Provides immediate and long-term protection against wind and vessel wave erosion. Once established can provide long term bank stabilisation against fluvial erosion. Generally a straightforward construction process. May be used to improve the habitat value of rock revetment and vertical seawalls.	Can only be applied where a suitable grade bed or bench is present (i.e. not suitable where deep water occurs immediately offshore). Requires construction machinery access. Potential reduction of public access for recreational fishing, navigation and other recreational activities.	Structure provides inter and subtidal aquatic habitat. Creation of intertidal mangrove habitat.	Stakeholder and general community feedback is expected to be positive.	Low - moderate	Suitable for improving aquatic habitat where hard protection is not required e.g. bank sections E, G, J, O.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Large woody debris (LWD)	Whole trees, limbs, branches or logs located either exposed, submerged, or semi-submerged in a waterway (Plate 19)	Ecological benefits. High value beneficial reuse of the material.	Not suitable where public access to the waterway is required or where high value assets are at immediate risk from erosion. Requires construction machinery access. Prone to undermining if not designed properly. Can be difficult to site and anchor. Can impede navigation and cause damage if dislodged during flood event. Prone to decomposition. The wood can dry out and become buoyant if not kept periodically wet.	Provides aquatic habitat for a range of aquatic fauna. Food source for aquatic invertebrates. Provide roosting sites for birds. High value beneficial reuse of the material. Re-introducing habitat features that may have historically been removed.	Expected to be supported by the broader community. Supported by approval agencies.	Medium - high	Suitable for improving aquatic habitat where hard protection and waterway access are not required e.g. bank segments A, C, E, J.

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Complementary techniques							
Submerged sill	Hard structure built parallel to, but offshore of the shoreline and submerged below water level with landward sand nourishment and perched beach	Retains or improves beach access and amenity. No impact on visual amenity. Lengthens renourishment intervals.	Potential navigation hazard. Potential impact on recreational fishing. Potential hazard to swimmers. Only suitable for low energy environments. Storms may still wash sediments offshore over the sill.	Minimal environmental benefits with traditional sills however can provide sub and intertidal habitat. Alternative sills (saltmarsh sills, rock sill) that are conducive to vegetation colonisation improve biodiversity.	Expected to be supported if required to protect nourishment areas	Variable	Recommended for nourishment area/ sandy beach at section P and protection of existing trees (e.g. Section Q, S).
Coir logs	Natural coconut fibre bound together by coir fibre netting and formed into a log shape	Easy to install – light weight and easily installed by hand. Relatively inexpensive. Natural biodegradable material. Natural aesthetic.	Limited design life (~12-36 months). Limited to sites with low rates of erosion, low water velocity, low bank slope and or shallow water depth. Only recommended in conjunction with revegetation as their rapid disintegration requires a long-term stabilisation technique to provide erosion protection at the end of their life cycle.	Natural material	Expected to be supported by the broader community. Supported by approval agencies.	Low - medium	Existing coir logs to be retained at sections B, L and included with other measures at sections C, I to complement LWD

Bank treatment	Description	Advantages	Limitations	Environmental outcomes	Stakeholder acceptance	Indicative cost	Recommendation
Brush bundles/ mattress	Revegetated bank layered with jute or coconut fibre matting which is then covered with a thick blanket of native branches and brush, layered and secured using wire or biodegradable cord	Low-cost material. Easy to install - no heavy machinery required. Provides short term stabilisation while vegetation establishes. No geotextile or metal materials left in the bank, fully biodegradable. Increases scour resistance and increases chance of trapping native seeds.	Short term solution only, 5-10-year design life. Labour intensive to construct. Easily damaged if subject to vandalism. Not suitable for steep banks >3H:1V (33%)	May provide habitat for insects, birds and small mammals. May intercept sediment travelling from overbank areas towards the water	Unknown	Low	Not recommended due to limited supply of brush and steep bank slopes

Source: Adapted from Hydrosphere Consulting (2023)


Plate 13: Examples of riparian revegetation

Source: Hydrosphere Consulting (2023)


Plate 14: Example rock groyne (left) and timber wall (right)

Source: Hydrosphere Consulting (2023)


Plate 15: Example rock revetment

Source: Hydrosphere Consulting (2023)

Plate 16: Example vertical seawall

Source: Hydrosphere Consulting (2023)

Plate 17: Example geotextile sand containers

Source: Hydrosphere Consulting (2023)

Plate 18: Examples of rock fillets

Source: Hydrosphere Consulting (2023)

Plate 19: Examples of large woody debris

Source: Hydrosphere Consulting (2023)

5.4 Concept Design

The foreshore rehabilitation concept has been developed with the following guiding principles:

- Opportunities to incorporate living shoreline approaches and marine habitat enhancement will be incorporated.
- Significant waterway features such as views and biodiversity will be preserved.
- Aboriginal cultural heritage features and values will be preserved and protected.
- Existing foreshore and marine vegetation will be protected and enhanced where possible.
- Hard bank stabilisation works are necessary where erosion severity is high or high value assets require protection. This includes protection of cultural heritage sites, public infrastructure and high value terrestrial vegetation
- Foreshore rehabilitation requirements will consider the wider precinct usage and opportunities including water views, waterway access, shade, public safety, parking available, vessel tie-up and seating.

- Opportunities for improved public access to the waterway will be incorporated at key locations. Based on stakeholder feedback, the existing boat ramp at segment K will be retained for launching of small vessels (canoes, small boats etc.). The existing sandbar offshore from segments K – M is a popular beach area with shallow swimming areas that are easily accessible from the bank. Opportunities for fishing, swimming and canoe launch will also be provided at segments P and R where there are shade trees and seating in close proximity to the New Brighton shops. Similarly, the proposed bank treatments support public use of the area in the upstream segment of bank along Casons Road for seating and fishing.
- Inappropriate existing controls (e.g. Plate 2) will be removed and replaced with suitable materials and designs.

Stakeholder feedback has been incorporated into the concept design (refer Section 5.5 and Appendix 4).

5.5 Stakeholder Engagement

The following stakeholder engagement activities were undertaken as part of this project:

- BSC: site walkover, discussions regarding community feedback and potential bank treatment options, purpose of the project, approvals pathway and potential concepts.
- Approval agencies (DPIRD – Fisheries, DPIRD – Marine Parks, NPWS, DPHI - Crown Lands): ongoing liaison regarding purpose of the project, approvals pathway and potential concepts.
- TBLALC: liaison regarding purpose of the project, shell material present in the riverbank, site walkover.
- Transport for NSW – Maritime: potential concepts and navigation issues.
- Site meeting with agencies and TBLALC to discuss potential bank treatments.
- Online meeting to discuss concept designs.

Notes from the consultation meetings and a summary of stakeholder feedback are provided in Appendix 4. Community consultation has not yet been undertaken.

5.6 Geotechnical Investigation

CMW Geosciences was engaged to investigate substrate stability for locations requiring engineering works (refer Appendix 5). Fieldwork included a walkover survey of the site to assess the general landform, conditions and adjacent infrastructure and nine DCP (Dynamic Cone Penetration) tests advanced to 1m depth (approximate RL -0.3m AHD to RL -0.87m AHD). For investigation purposes, the site was described as two separate sections due to the difference in subsurface consistency/ density. The Zone 1 (Casons Road segments) subsurface was generally very loose to loose material and Zone 2 (River Street segments) subsurface was generally medium dense, with the surficial layer being very loose to loose in the upper 300mm.

An analysis of slope stability was conducted for segment B to calculate the factor of safety of the proposed works. When placing the sand and rock fill at the proposed gradient of 1.5H:1V, instabilities are anticipated to occur due to the weak subgrade. A proposed gradient of 2.5H:1V was recommended to ensure adequate

stability of the remediated bank. However, this is not practical as discussed in Section 5.7.2. An assessment of the stability provided by timber piles at this location was undertaken and design requirements were incorporated (Section 5.7.2).

For the remediation works that are proposed in the south-eastern end of the creek in Zone 2 (segment R), the stability of the bank is anticipated to be satisfactory with the proposed gradient of 1.5H:1V, provided the upper 300 mm of very loose to loose materials are removed or rock fill is sunk through these materials to ensure a sound foundation is formed, subject to confirmation by geotechnical personnel during construction.

5.7 Detailed Design

Detailed designs build on the original concepts presented to stakeholders and the design principles discussed in Section 5.4. Ardill Payne & Partners were engaged to review the concept designs, provide advice on engineering requirements particularly in relation to armouring requirements and minimum rock sizes and evaluate design implications stemming from the geotechnical investigations.

5.7.1 General approach

The designs provided in Appendix 3 are intended to provide reference designs and specifications suitable for construction. As with most bank remediation projects incorporating natural elements, a degree of interpretation and on-site adjustment to designs is required to take account of site factors at the time of construction, take advantage of opportunities (e.g. supply of large woody debris) and respond to unanticipated issues. The designs therefore provide guidance, however engagement of contractors with experience in similar projects and supervision by experienced practitioners will improve final outcomes of the project.

A summary of the recommended bank treatments for each segment, based on the 1% AEP design flood, is provided in Table 4.

Table 4: Recommended bank treatments for each segment

Segment	Treatment	Modelled 1% AEP velocity (m/s)	Recommended rock size (d_{50}, m)
A	Rock Armouring with geotextile backing. Timber entanglement is used should be backfilled around with rock armouring. Existing root ball from fallen tree is recommended to be removed, roots protruding from bank cut back to allow installation of geotextile. Root ball may be placed within combined rock armouring and timber entanglement solution. Armouring is recommended to wrap around the confluence of the drain/creek from the west to the Marshal Creek. the geometry of the upstream creek appears to direct concentrated flows at this point causing potential further scour and erosion if left unprotected.	0.4 m/s. This area is expected to be a pressure point for the water transitioning from upstream to the northern outer bank. Eddy currents and local peak velocities are expected to be higher than modelled.	Note: velocity in modelling is fairly low at locations A and B. experienced velocities are considered to be higher. Recommend larger rock size, say d_{50}=0.35 m.
B	Rock Armouring with geotextile backing. To extend beyond spur with Norfolk Pine.	0.2 m/s. Similar to A this area appears to be a pressure point for the water transitioning from upstream to the northern outer bank. Local peak velocities are expected to be higher than modelled.	Note: velocity in modelling is fairly low at locations A and B. Experienced velocities are considered to be higher. Recommend larger rock size, say d_{50}=0.35 m minimum.
C	Provide backfill against existing bank scarp. Coir logs to prevent tidal migration until establishment of mangrove growth and associated stabilisation. Success of the large woody debris treatment to be monitored. As C transitions toward the north and location D more formal rock armouring similar to D may be required with the armouring turning in to the bank to prevent scouring behind the stabilisation.	0.4 m/s. As C transitions toward the north velocities increase as flow would stabilise with the higher velocity region of the flow being along the northern bank	Transitioning velocities, recommend d_{50}=0.35 m if rock work to be included.
D	Rock armouring proposed	0.9 m/s	d_{50} = 0.35 m

Segment	Treatment	Modelled 1% AEP velocity (m/s)	Recommended rock size (d_{50}, m)
E	Rock armouring with rock fillet and nourishment in front recommended. This area has reasonable velocities, which will be concentrated to the northern bank	1.2 m/s.	d_{50} = 0.35 m
F	Rock armouring.	1.2 m/s.	d_{50} = 0.35 m
G	Maintain rock armouring and incorporate rock sill.	1 m/s.	d_{50} = 0.2 m min.
H	Rock armouring.	1 m/s.	d_{50} = 0.35 m
I	This area is expected to get back eddy and potential accretion once armouring of F to G is completed past the existing spur with the mangrove and gum tree	0.8 m/s. Likely to get back eddy.	N/A
J	Timber entanglements, nourishment and mangrove growth. Potential future rock sill.	0.4 m/s.	d_{50} = 0.15 m for rock sill if required.
K	Timber entanglements, nourishment and mangrove growth	0.2 m/s.	N/A
L	Timber entanglements, nourishment and mangrove growth	0.2 m/s.	N/A
M	Timber entanglements, nourishment and mangrove growth	0.6 m/s.	N/A
N	Replenishment of armouring as required	1.5 m/s.	d_{50} = 0.35 m or size to match existing if larger
O	Replenishment of armouring as required	2.2 m/s.	d_{50} = 0.35 m or size to match existing if larger
P	Rock armouring sill with nourishment behind It is to be noted that public access is the key stakeholder priority and as such solutions may require additional nourishment from time to time	0.6 m/s.	d_{50} = 0.35 m larger may be used to provide stepping/access areas
Q	Rock armouring around spur supporting gum tree.	0.4 m/s.	d_{50} = 0.35 m
R	Structure with armouring under to prevent scour and undermining.	0.6 m/s.	d_{50} = 0.2 m (covered) d_{50} = 0.35 m (exposed)
S	Rock armouring around spur supporting gum tree. Nourishment behind armouring to reinstate sand/soil around tree roots.	0.4 m/s.	d_{50} = 0.35 m

5.7.2 Rock revetments

To avoid excessive sub-surface projection of the rock revetments into the waterway, a design slope of 1(v) in 1.5 (h) was adopted. This slope generally provides a suitable factor of safety for downstream rock work, however the poor geotechnical conditions at Segment B, combined with the depth of Marshalls Creek at this location is problematic as it was determined that there would be an unacceptable risk of failure of the revetment without additional measures. To address substrate instability, a design slope of 1 in 2.5 would be required however, given the slope of the creek bed at this location, the toe of such a revetment would not intersect the creek bed until the approximate mid-point of the creek. In effect, this would mean that half of the creek bed would be rock-lined and this approach was not considered to be consistent with the adopted design principles or in keeping with stakeholder expectations. As an alternative, it is currently proposed that the original concept utilising a 1 in 1.5 revetment be utilised, however additional stability would be provided by driving vertical wooden piles into the lower bank under the revetment face. These piles would intersect the anticipated failure plane, preventing slip of the revetment and would serve to further lock the revetment rockwork in place. The factor of safety for the proposed approach (Appendix 3) is considered to be suitable.

The size of the rock required to resist movement during floods was determined though evaluation of flood modelling results provided by BSC. The median diameter (D_{50}) of rock required in most circumstances is 0.35m. The thickness of the rock armour layer for revetments should be 1.7 x $D_{50,}$ i.e. 0.6m. In structures likely to be utilised by the public, oversized rocks should be incorporated to create ad hoc seating or water access opportunities, improve rock habitat complexity and improve visual appeal. Rocks near public access areas should be sub-angular, to allow effective stabilisation of the rock face while minimising sharp edges. In all cases, a mixture of rock sizes should be utilised to ensure adequate interlocking and stability of rockwork. Basalt or similar rock is recommended for consistency with existing rock on site, hardness and density.

5.7.3 Rock sills (mangrove fillets)

Low level rock sills, designed to facilitate mangrove growth have been incorporated into the design, particularly along Casons Road where mangrove growth is currently limited. The rock sill provides protection of the toe of bank against scour and promotes substrate stability shoreward of the sill. The crest of the sill is designed to be at approximately mean high water (around 0.5m AHD) and runs approximately parallel to the bank. Openings are periodically included through the sill to allow water exchange at lower tide levels and provides a way for mangrove seeds to enter and colonise the substrate behind. Given the significant tracts of mangroves both upstream and downstream of the project area, as well as the observed mass germination of mangroves at BSC's emergency works sites in 2025, it is anticipated that the mangrove fillets will be rapidly colonised. The combination of the lower bank rock sill and likely dense mangrove growth will offer substantial mitigation against bank erosion.

5.7.4 Large woody debris

Large woody debris (LWD) is utilised extensively in the proposed design. Large rot and borer-resistant logs and tree root balls are imported to site and placed along the bank. These elements are interlocked to resist separation and are pinned in place by vertical and diagonal logs driven into the bank and bed of the creek. The incorporation of LWD offers significant fisheries habitat and provides opportunities for mangrove recruitment and sediment entrapment. LWD is not suitable for incorporation near points designated for public

swimming due to the potential for submerged entrapment hazards but provides an effective deterrent against the inappropriate mooring of boats within mangroves or other sensitive areas. The main logs used for LWD should be greater than 0.3m in diameter where available Segments earmarked for LWD installation should also incorporate other habitat features including artificial reef balls, large rock and fallen timber which may need to be removed from other segments during works.

5.7.5 Water access structure

Segments Q, R and S near the downstream end of the project area are noteworthy as this area is subject to heavy usage by the public. As continued access to the waterway is a key public expectation it was determined that a water access structure, integrated into the bank protection works would be appropriate in this location. This structure is envisaged to be of fibre-reinforced plastic (FRP) construction. Although not a natural material, FRP structures have been successfully integrated into a wide range of environments such as National Parks and coastal boardwalks and are in keeping with the desired bankside aesthetic. FRP has the advantage of being cost-effective, easy to assemble with minimal impact on site and offers high longevity.

A range of potential configurations for the water access structure were considered. Key constraints in terms of structure are the need to protect the roots of significant trees in this location, many of which are already exposed, and also limit protection of the structure into the waterway. One favoured option including a foreshore deck and water access ramp was considered and presented to stakeholders, however it was determined that the ramp and the required protective rock work would project into National Park and would be inconsistent with the NPWS plan of management. As an alternative, a similar deck arrangement to the original concept was developed as a potential option and is included in the designs. For this option (Figure 21) the ramp was replaced by a series of steps which bridge the exposed tree roots and provide unhindered access to the water. A key advantage of a ground level deck at this location is that there is opportunity to address soil erosion at this location caused by surface runoff.

Other design variations may also be appropriate. Detailed design for this FRP structure was not undertaken and would typically be undertaken by the supplier of the structure at the time of commissioning.

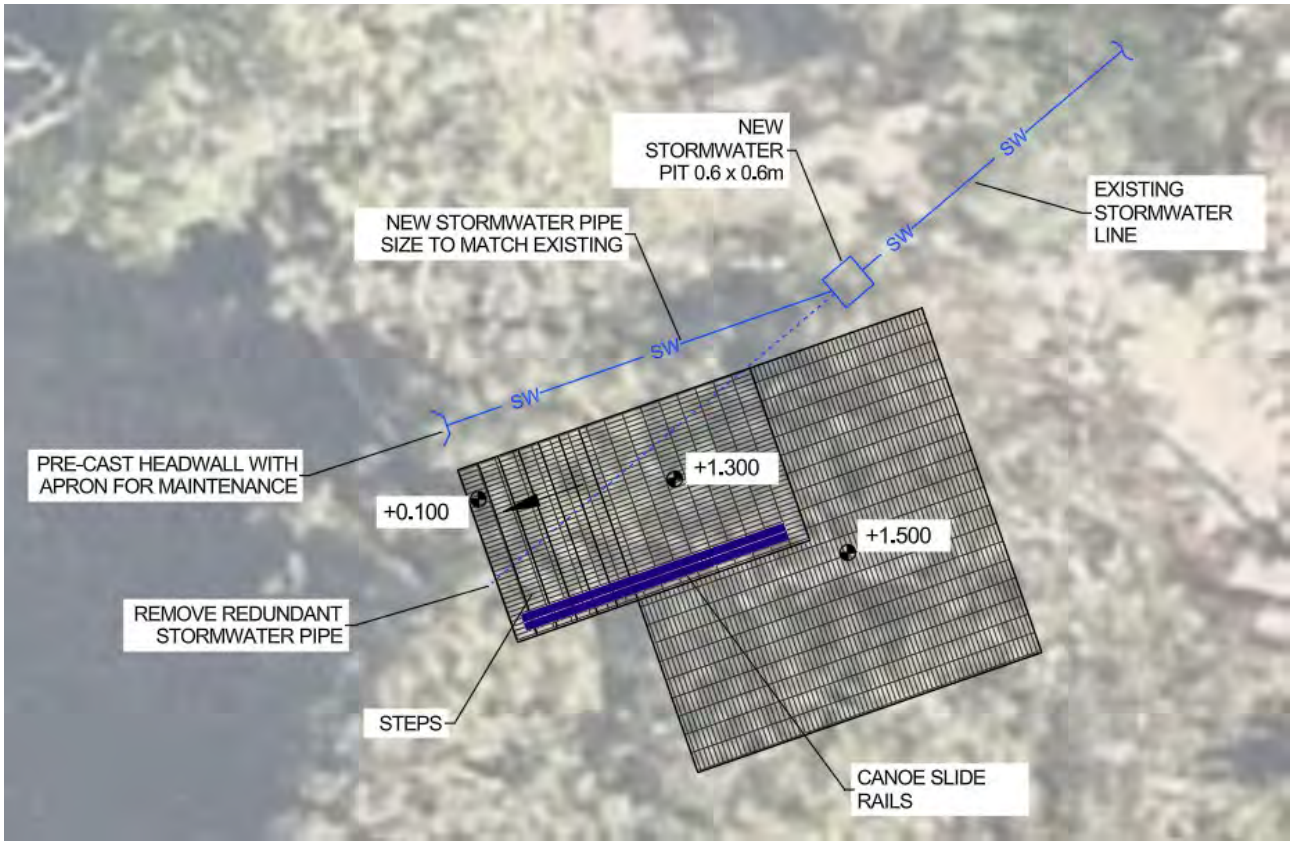


Figure 21: Potential water access structure (deck and steps) layout

6. IMPLEMENTATION PROGRAM

6.1 Confirmation of Approvals Pathway

The proposed foreshore rehabilitation works consist of a combination of rock revetment (classified as coastal protection works) and environmental protection works (softer treatments including woody debris, riparian revegetation, rock sills to protect existing vegetation and rock fillets to promote mangrove colonisation).

The majority of the proposed foreshore rehabilitation measures would be located within the New Brighton Road and Casons Road Council-managed road reserves with some parts extending into the Crown waterway (Figure 22). Segment P (log terrace, sand fill and rock sill), segment Q (rock sill to protect existing trees) and segment R (deck and water access steps) are located on lot 1/ DP121484 (privately owned). The rock sill to protect existing trees would extend into the Marshalls Creek Nature Reserve (segment S) at the downstream extent of the works.

The intertidal components of the proposed foreshore rehabilitation measures are located on land mapped as coastal wetlands (Figure 23). The proposed rock revetment (segment B coastal protection works) is located wholly within the mapped coastal wetlands.

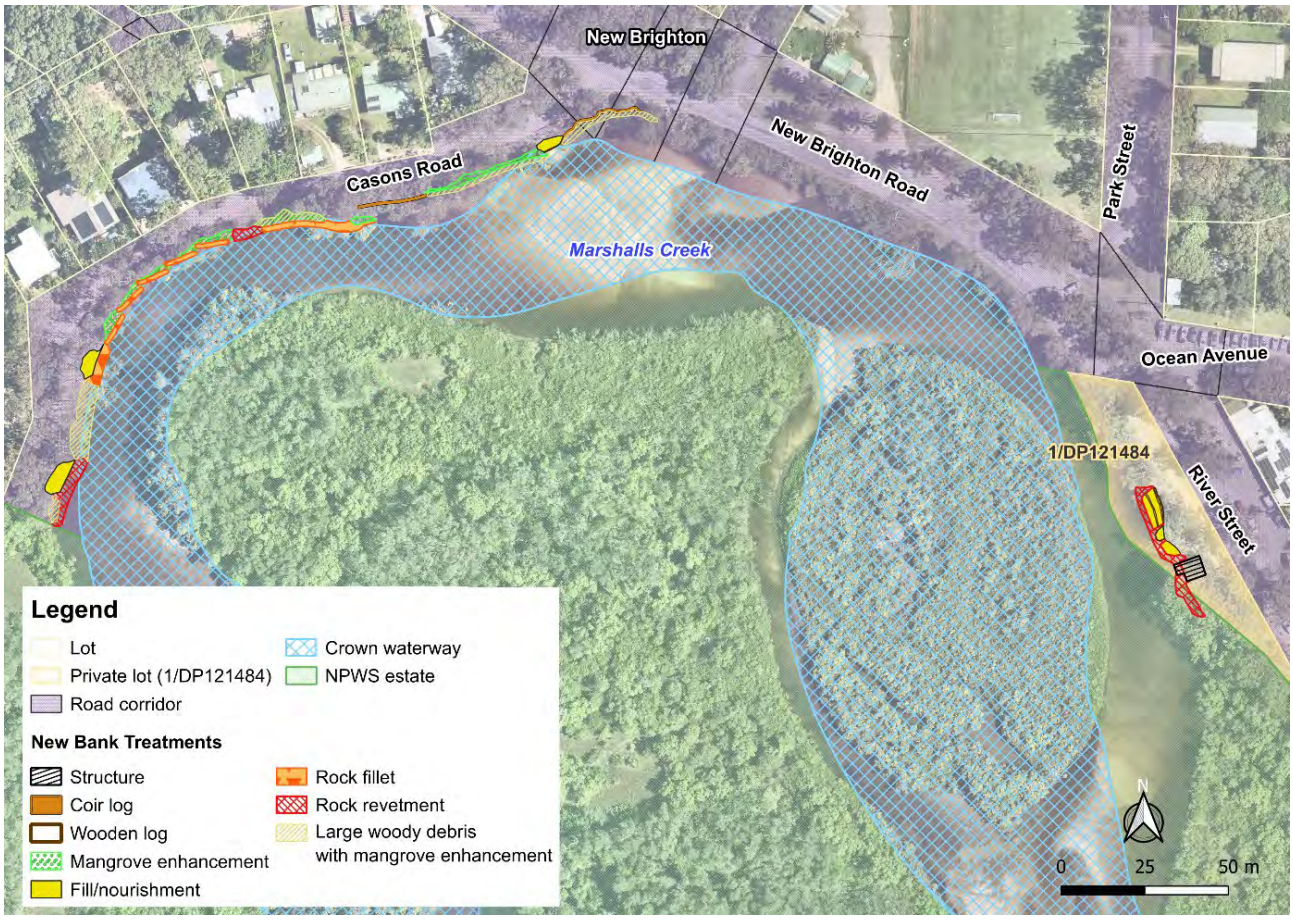


Figure 22: Proposed bank treatment work area and land tenure

Source: NSW Planning Portal; Aerial photo – Nearmap (2024)

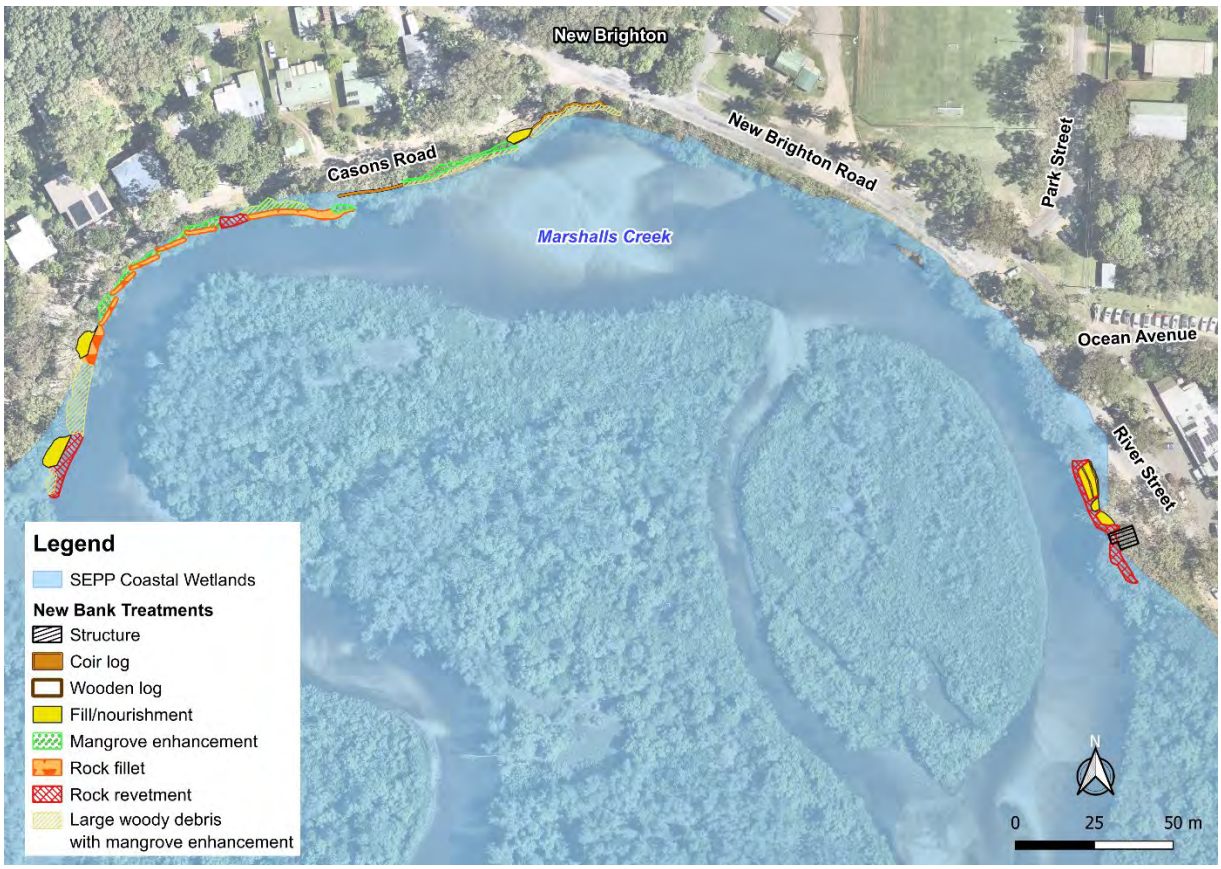


Figure 23: Proposed bank treatment work area and coastal wetlands mapped under the Resilience and Hazards SEPP 2021

Source: NSW Planning Portal; Aerial photo – Nearmap (2024)

The proposed foreshore rehabilitation works are categorised as waterway/ foreshore management activities incorporating environmental protection works and coastal protection works. As parts of the works would be located within the mapped coastal wetlands, development consent under part 4 of the EP&A Act will be required. The proposed works (other than environmental protection works) would be designated development and an EIS would be required. Although the environmental protection works components could be assessed using a Statement of Environmental Effects instead of an EIS, there is no advantage in preparing separate approval documentation.

As the works are located within the Biodiversity Values Map area, the development application and EIS need to include a BDAR prepared by an accredited biodiversity assessor.

The following permits are also required:

- Marine Park permit from DPIRD – Fisheries under Clause 1.16 of the *NSW Marine Estate Management (Management Rules) Regulation 1999* (protection of animals, plants and habitat in habitat protection zone).
- A General Licence from DPHI – Crown Lands for the bank restoration works within the Crown waterway.
- Section 205 permit from DPIRD – Fisheries to harm marine vegetation.

Landowners consent will be required for the lodgement of the development application.

The requirements of the *Native Title Act 1993* (Cth) will need to be satisfied which may include a non-claimant application to the Federal Court, statutory notification and/or statutory compensation processes.

An archaeological survey with TBLALC is required to confirm the management approach for any cultural heritage sites or artefacts. The objectives of the survey are to:

- Inspect and assess any registered Aboriginal sites located within or in close proximity to the project area.
- Consult with the TBLALC regarding archaeological and cultural values identified for the project area as well as any mitigation strategies.
- Provide recommendations and management strategies for any Aboriginal sites or objects potentially impacted by the proposed works.
- Provide guidance to the proponent as to the requirements for any further archaeological assessment or consultation which might be required.

If Aboriginal objects are found an Aboriginal Heritage Impact Permit (AHIP) will be required for permission to harm Aboriginal objects. An Aboriginal Cultural Heritage Assessment Report (ACHAR) would be prepared to support any AHIP application.

6.2 Pre-Construction Phase

The pre-construction tasks include:

- Environmental approvals:
    - Compliance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW*, and if required ACHAR.
    - Request for NSW Department of Planning and Environment (DPE) Secretary's Environmental Assessment Requirements (SEARs).
    - Preparation of the EIS based on the SEARs.
    - Preparation of the BDAR.
    - Permit applications.
- Development application.
- Tender documentation.

Funding will be required to undertake the assessments required to support approval processes and construct the works. Previous grant programs have included:

- NSW Environmental Trust e.g.:
    - Protecting Our Places for NSW Aboriginal community organisations or groups.
    - Environmental Restoration and Rehabilitation grants.
- DPIRD – Fisheries Habitat Action Grants or Flagship Fish Habitat rehabilitation grants.
- Coast and Estuary Grant Programs for actions identified in certified coastal management programs.

6.3 Construction Method

6.3.1 Access

The majority of the Marshalls Creek foreshore is vegetated to varying degrees. To avoid impacts to riparian vegetation, construction of the rock revetment and rockwork for the mangrove fillets will be largely barge-based, supplemented by work from the shore where access is available. Depending on the selected contractor, two barges may be utilised – one as the work platform, the other for material delivery.

Movement of the barge within the waterway will be hindered in shallow water by sand shoals in the system, however the majority of heavy works are required on banks adjacent to deeper sections of the waterway and hence are expected to be fully accessible. Movement of the barge through shallow areas, particularly when fully laden, may need to occur at high tide. As there are strong tidal movements through this section of waterway, the work barge would need to be anchored, typically through the use of 'spuds' lowered into the bed of the creek. An outboard powered workboat would be required to manoeuvre the barge, and ferry light materials and personnel.

Access to the waterway will be at three key locations:

1. End of Casons Road (Figure 24) - loading of construction materials onto the barge is envisaged to occur toward the northern end of the project area, accessed via Casons Road. This location has clear access to the waterway and is immediately adjacent to the turning area at the end of Casons Road, part of which can be utilised for stockpiling of construction materials. Delivery of materials to the stockpile point will need to be via Casons Road, which is a narrow dead-end road in poor condition. This road is the only access to the 12 properties in this location. The road may need to be upgraded to withstand heavy vehicles and traffic control is likely to be required, not only to facilitate safe passage of residents and their vehicles, but also at the junction of Casons and New Brighton Roads which has restricted visibility. As there is limited turnaround area at the end of the road, only body trucks can be utilised for deliveries.
2. Existing 'boat ramp' near the start of Casons Road (Figure 25) – this site is restricted due to the large sand shoal immediately offshore of the ramp. This shoal is likely to limit the use of the site for barge loading and only local work can be conducted from this access point. There is limited space for material stockpiling as through traffic for resident vehicles will need to be maintained. The site also has overhead powerlines approximately 7.5 m above road level which restricts works facilitated by a crane.
3. Works at the southern end of the project area can be undertaken by directly accessing the site from River Street opposite the post office (Figure 26). Access will entail demarcation of a narrow loading area parallel to the road, removal of rock bollards at this location and access across the foreshore reserve area.

Figure 24: Access location 1

Figure 25: Access location 2

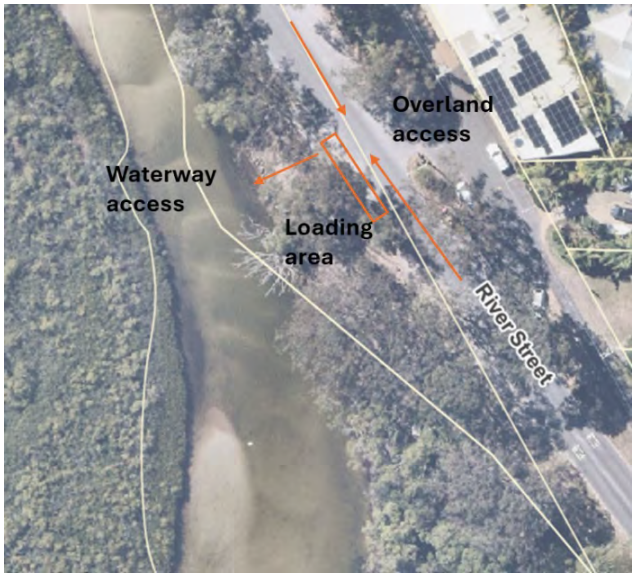


Figure 26: Access location 3

Overland access to the creek bank is possible at the locations listed above. For locations 1 and 3, and to a lesser extent, location 2, there are exposed roots of significant trees which need to be protected. Damage to tree roots and compaction of soil by machinery is to be avoided through a combination of topsoil overfill and boarding. At the completion of bank protection works, boarding would be removed, excess topsoil recontoured and riparian and ground cover vegetation reestablished as appropriate.

6.3.2 Rockwork

Rocks will be placed by excavator, typically from the barge. This will involve the excavation or displacement of bed sediments at the toe of the rock wall, to allow embedment and stabilisation of these foundation rocks. Other clearing of the bank face may be required, including the recovery of existing rocks from previous bank protection works. Where practical, existing features such as large tree root balls or vegetation will be retained and the generalised designs adapted to incorporate these features.

Once the desired working face has been achieved, geofabric will be laid as per design. Typically this will involve laying the fabric starting at the toe of the bank to be pinned by large foundation rocks, progressive backfill of sand/ soil behind the geofabric where required, placement of a small rock underlayer over the geofabric followed by placement of the main armouring boulders. Oversized rock is to be strategically placed on the rock face to facilitate public use of the rocks for sitting, fishing, or waterway access where appropriate. All rockwork is to be manipulated by the excavator to ensure wall stability.

6.3.3 Large woody debris

LWD is to be placed in an interlocked pattern consisting of horizontal, vertical and diagonal logs. The LWD is to be anchored to the bank and bed of the creek by driving vertical or angled logs into the bank. This is usually done utilising a vibratory pile driver on the excavator. Tree root balls, rocks and artificial habitat structures are to be incorporated into the LWD as appropriate. Root balls should be placed with the root ball facing the riverbank, with the trunk angled diagonally downstream, mimicking natural tree fall.

6.3.4 Decking and steps

It is desirable to relocate the stormwater pipe which currently discharges to the planned deck location. This will involve excavation of the new pipe route back from the water's edge to the appropriate bend location, installation of a junction pit and laying of new pipe. To avoid damage to major tree roots, water jetting may be utilised to expose roots and facilitate pipe placement without the need to fully clear the pipe trench. The outlet of the new pipe is to be disguised within new rockwork.

The deck and water access steps are envisaged to be constructed of fibre reinforced plastic (FRP). Construction would involve the installation of a grid of vertical FRP piles into the ground utilising a vibratory pile driver on a small excavator. The excavator would be able to access the site directly from the roadside on New Brighton Road. Piles would be driven until the design resistance is encountered, typically 3 to 6 m below ground level. Once the vertical elements have been installed, the rest of the deck construction can be undertaken by manual handling and hand-held tools.

6.3.5 Vegetation

Vegetation management works will include:

- Import of topsoil to increase root coverage/ backfill roots and cobbles to protect root zones.
- Establishment of riparian vegetation where possible including around trees.

All plantings should be with species endemic to the area. All strata layers (canopy, shrub and ground layers) should be incorporated where space permits and all plantings should guide members of the public to waterway/ bank access points.

6.3.6 Machinery

The machinery required is expected to include:

- Barge(s) (e.g. 12 x 3 m, <1m laden draft).
- Work boat < 7.5 m.
- Barge-based excavator 7-15 tonne.
- Shore-based excavator 15-20 tonne.
- Combination of vibratory piling head, rock grapple and buckets for above excavators.
- Positrack loader (shore-based topsoil contouring etc.).
- Delivery trucks (typically 10 tonne tipper).
- Battery powered hand tools.

6.4 Funding Requirements

Cost estimates have been developed based on other similar projects and/or cost rates obtained from contractors. However, market pricing can change dramatically, particularly if approvals, funding or other delays to works occurs.

The estimated cost of pre-construction, construction and maintenance activities (2 years) is provided in Table 5.

Table 5: Cost estimate (2026$)

Item	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year 2	Year 3
Environmental approvals						
Archaeological survey	$20,000					
Potential ACHAR and AHIP application		$30,000				
TBLALC fees	$5,000					
Request for SEARs	Proponent					
EIS		$80,000				
BDAR[1]		$40,000				
Permit applications		$5,000				
Development application		Proponent				
Tender documentation		$5,000				
Project communication and engagement	$10,000	$10,000				
Construction phase						
Site supervision and professional advice			$15,000			
Site establishment			$70,000			
Construction (incl. materials)			$678,000			
Site restoration			$25,000			
Maintenance phase[2]						
EIS compliance				$10,000		
Vegetation monitoring and management				$5,000	$5,000	$5,000
Subtotals	$35,000	$170,000	$788,000	$15,000	$5,000	$5,000
Contingency (25%)	$8,750	$42,500	$197,000	$3,750	$1,250	$1,250
Totals	$43,750	$212,500	$985,500	$18,750	$6,250	$6,250
Grand total	**$1,272,500**					

1. The value of any offsets required has not been identified. Biodiversity impacts are expected to be limited to the removal of individual mangroves to allow for construction of some parts of the works. Mangrove enhancement is proposed which will partially or fully offset the removal of individual mangroves.
2. Maintenance and topping up of rock armouring has not been included and will depend on the river conditions experienced – refer Section 6.5.

6.5 Maintenance Requirements

Where revegetation is undertaken, monitoring and weed management is required every six months for two to three years (this will depend on species present and site conditions) with the aim to remove weeds and increase coverage of native species.

The condition of the rock revetment segments should be monitored with regular surveys and topping up with appropriately sized armour following any damage if required. Maintenance of the rock revetment segments may require repacking the outer layer of armour, collecting larger rocks that have become dislodged and replacing them in the structure. All repacking should seek to construct a tightly interlocked rock matrix, whereby each rock in the face of the revetment is in firm contact with at least three others in the same layer. If the crest of the rock revetment has lowered, the armouring should be topped-up with similar sized rock to the original design level.

REFERENCES

BMT WBM (2010) *Tweed Byron Coastal Creeks Flood Study – Byron Shire Council Climate Change Assessment*. Report for BSC.

BSC (2018) *Coastal Zone Management Plan for the Brunswick River Estuary*, Issue No. 5.1, April 2018.

BSC (2024) *Place Plan: New Brighton, South Golden Beach & Ocean Shores - Community Consultation Summary Engagement Round 1 (July – October 2024).*

DECCW (2010) *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW.*

DECCW (2011) *Marshalls Creek Nature Reserve Plan of Management.*

DPI Fisheries (2013) *Policy and guidelines for fish habitat conservation and management.*

Fruition Environmental (2024) *Brunswick River Estuary NEAP Bank Erosion and Riparian Condition Assessment Report.* Report produced for Department of Primary Industries and Regional Development – Fisheries, November 2024.

Hydrosphere Consulting (2020) *Development and Validation of a Decision Support Tool for Bank Erosion Management in NSW Estuaries.*

Hydrosphere Consulting (2023) *Development and Validation of a Decision Support Tool for Bank Erosion Management in NSW Estuaries. Part B: Best Management Practice Estuary Bank Treatment Methods.*

Paterson Consultants (1997) *Marshalls Creek Floodplain Management Plan*. Report for BSC.

Plummer & Smith (2020) *Marshalls Creek foreshore – schematic plan.*

NPWS (2020) *Developments adjacent to NPWS lands: Guidelines for consent and planning authorities*, National Parks and Wildlife Service, Department of Planning Industry and Environment, Sydney, NSW.

Soil Conservation Service (2019) *Quotation for riverbank stabilisation works, Marshalls Creek.*

WMAwater (2024) *Post 2022 Event Flood Behaviour Analysis – Brunswick River.*

APPENDIX 1 HISTORICAL AERIAL PHOTOGRAPHY

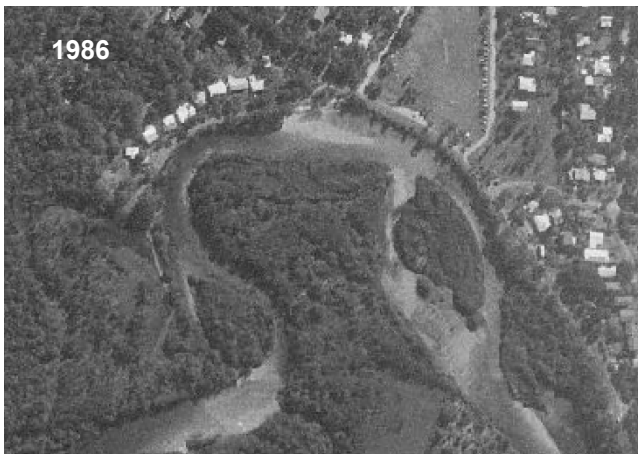


Figure 27: Historical aerial photography

Source: Aerial photos – NSW Historical Images Spatial Services (1965 – 1996) and Nearmap (2015 – 2024)

APPENDIX 2 LEGISLATION AND REGULATORY REQUIREMENTS

Local Environmental Plan

Marshalls Creek is zoned W1 Natural Waterways and the foreshore (BSC road corridor) is zoned Deferred Matter (proposed R2 Low Density Residential Zone, new C Zone Stage 4 planning process) under the *Byron Local Environmental Plan 2014* (LEP). Parts of the private land (lot 1, DP 121484) are zoned C2 Environmental Conservation, C1 National Parks and Reserves and RU2 Rural Landscape. The Marshalls Creek Nature Reserve is zoned C1 National Parks and Reserves.

Environmental protection works are permitted without consent on land zoned W1, R2, RU2 and C2. Uses authorised under the National Parks and Wildlife Act are permitted without consent on land zoned C1. Coastal protection works require consent under the LEP.

Additional local provisions under the LEP relate to management of acid sulfate soils (Figure 28) and development below the MHWM (Figure 28).

Figure 28: Acid sulfate soil risk map

Source: 2024 NSW SEED portal; Aerial photo – Nearmap (2024)

Environmental Planning and Assessment Act 1979 and Regulation

The *Environmental Planning and Assessment Act, 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2021* (EP&A Regulation) provide a framework for environmental planning in NSW. An assessment of the likely impacts of a proposal that may have an impact on the environment is required under the Act before a decision to proceed with the proposal.

The Act imposes requirements for controlling development under different parts:

- Part 4 of the Act controls development that requires consent or is prohibited under an environmental planning instrument.
- Part 5 of the Act imposes requirements for assessing the impact of development that does not require consent under an environmental planning instrument.
- Part 2.2, Division 4 - Exempt development.

The foreshore rehabilitation works would require consent under either Part 4 or Part 5 of the Act.

Other relevant environmental planning instruments that regulate use and development under this legislation are discussed below.

Coastal Management Act 2016

The *Coastal Management Act 2016* aims to manage the coastal environment of NSW in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people of the State. The draft *Coastal Zone Management Plan for the Brunswick Estuary* (BSC, 2018) has been prepared to prioritise and remediate issues occurring with the estuary but was not gazetted. There is no relevant certified Coastal Management Program in place for the location, prepared under Part 3 of the Act. Council is planning to prepare a Coastal Management Program for this area in future.

This area of the Marshalls Creek riverbank is mapped under the *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP) as Coastal Wetland (Figure 29). The management objectives for the coastal wetlands area are as follows (Section 6(2) of the *Coastal Management Act 2016*):

> *(a) to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity,*
>
> *(b) to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests,*
>
> *(c) to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration,*
>
> *(d) to support the social and cultural values of coastal wetlands and littoral rainforests,*
>
> *(e) to promote the objectives of State policies and programs for wetlands or littoral rainforest management.*

Figure 29: Coastal wetlands mapped under the Resilience and Hazards SEPP 2021

Source: 2024 NSW SEED portal

Marshalls Creek and foreshore includes land identified as coastal environmental area under Section 8 of the Act. The management objectives for the coastal environment area are as follows (Section 8(2) of the *Coastal Management Act 2016*):

> *(a) to protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons, and enhance natural character, scenic value, biological diversity and ecosystem integrity,*
>
> *(b) to reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change,*
>
> *(c) to maintain and improve water quality and estuary health,*
>
> *(d) to support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons,*
>
> *(e) to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place,*
>
> *(f) to maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platforms.*

The Marshalls Creek foreshore includes land identified as coastal use area under Section 9 of the Act. The management objectives for the coastal use area are as follows (Section 9(2) of the *Coastal Management Act 2016*):

> *(a) to protect and enhance the scenic, social and cultural values of the coast by ensuring that -*
>
> > *(i) the type, bulk, scale and size of development is appropriate for the location and natural scenic quality of the coast, and*
> >
> > *(ii) adverse impacts of development on cultural and built environment heritage are avoided or mitigated, and*
> >
> > *(iii) urban design, including water sensitive urban design, is supported and incorporated into development activities, and*
> >
> > *(iv) adequate public open space is provided, including for recreational activities and associated infrastructure, and*
> >
> > *(v) the use of the surf zone is considered,*
>
> *(b) to accommodate both urbanised and natural stretches of coastline.*

SEPP (Transport and Infrastructure) 2021

The *State Environmental Planning Policy (Transport and Infrastructure) 2021* (Transport and Infrastructure SEPP) assists in providing infrastructure by modifying planning provisions to improve efficiency and service delivery.

Emergency and routine maintenance works

Clause 2.7(4) of the Infrastructure SEPP *permits development for the purpose of emergency works or routine maintenance works to be carried out without consent, or that provides that development for that purpose is exempt development, prevails over State Environmental Planning Policy (Resilience and Hazards) 2021, sections 2.7 and 2.8 to the extent of any inconsistency, but only if any adverse effect on the land concerned is restricted to the minimum possible to allow the works to be carried out.*

Section 2.7 and 2.8 of the *State Environmental Planning Policy (Resilience and Hazards) 2021* relate to development on land mapped as coastal wetlands or littoral rainforest (discussed below).

Road infrastructure

Under Division 17 – Roads and traffic, certain development (e.g. the emergency works undertaken by BSC between December 2024 – February 2025) is exempt from approval requirements.

Clause 2.113 Exempt development:

> *(1) Development for any of the following purposes is exempt development if it is carried out by or on behalf of a public authority or the Minister responsible for Crown roads (within the meaning of the Roads Act 1993) in connection with a road or road infrastructure facilities and complies with section 2.20:*
>
> *…*

(c) emergency works to protect a road or road infrastructure facilities, the environment or the public, but only if they involve no greater disturbance to soil or vegetation than necessary,

Clause 2.7 of the Transport and Infrastructure SEPP states that clauses 2.7 and 2.8 (coastal wetlands and littoral rainforest areas) and 2.16 (coastal protection works) in the *State Environmental Planning Policy (Resilience and Hazards) 2021*, discussed below) prevail over the Infrastructure SEPP. The exception is for some public infrastructure including road infrastructure.

Division 17, Section 2.110 A - Development permitted without consent - coastal wetlands and littoral rainforest:

(2) Development for the purposes of roads or road infrastructure facilities may be carried out by or on behalf of a public authority without development consent if -

(a) the development does not involve the clearing of native vegetation from coastal wetlands or littoral rainforest, and

(b) the public authority is satisfied the development -

(i) includes adequate measures to minimise adverse impacts on coastal wetlands or littoral rainforest, and

(ii) is not likely to significantly impact the biophysical, hydrological or ecological integrity of coastal wetlands or littoral rainforest, and

(iii) is not likely to significantly impact the quantity and quality of surface and ground water flows to and from coastal wetlands, and

(c) the development does not involve earthworks other than earthworks that are ancillary to the following development -

(i) geotechnical testing and sampling that involves a drill hole with a diameter of no more than 120mm,

(ii) surveying and the placement of survey marks,

(iii) boring or directional drilling that does not disturb the surface of coastal wetlands or littoral rainforest and that involves a drill hole with a diameter of no more than 1,800mm,

(iv) replacing an electricity pole with a new pole with a diameter of no more than 1,200mm,

(v) installing supporting posts for a gate on an existing fence,

(vi) creating a trench to lay an electricity line to connect 2 connection points that are no more than 100m apart.

Section 2.108 - Interpretation defines road infrastructure:

(2) In sections 2.109, 2.110A and 2.112, a reference to development for the purposes of road infrastructure facilities includes a reference to development for the following purposes if the development is carried out in connection with a road or road infrastructure facilities -

(a) construction works, whether or not in a heritage conservation area, including -

(i) temporary buildings or facilities for the management of construction, if they are in or adjacent to a road corridor, and

(ii) creation of embankments, and

(iii) extraction and stockpiling of extractive materials if -

(A) the extraction and stockpiling are ancillary to road construction, or

(B) the materials are used solely for road construction and the extraction and stockpiling take place in or adjacent to a road corridor, and

(iv) temporary crushing or concrete batching plants, if they are used solely for road construction and are on or adjacent to a road corridor, and

(v) temporary roads that are used solely during road construction,

(b) emergency works or routine maintenance works,

(c) alterations or additions to an existing road, such as widening, narrowing, duplication or reconstruction of lanes and changing the alignment or strengthening of the road,

(d) environmental management works, if the works are in or adjacent to a road corridor.

Section 2.108 - Interpretation defines environmental management works as:

(a) works for the purpose of avoiding, reducing, minimising or managing the environmental effects of development (including effects on water, soil, air, biodiversity, traffic or amenity), and

(b) environmental protection works.

Section 2.110A does not apply to coastal protection works associated with road infrastructure.

Waterway/ foreshore works

Under Division 25 - Waterway or foreshore management activities, development for the purpose of waterway or foreshore management activities may be carried out by or on behalf of a public authority without consent on any land. Waterway or foreshore management activities are:

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

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

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

However, clause 2.7 of the Transport and Infrastructure SEPP states that clauses 2.7 and 2.8 (coastal wetlands and littoral rainforest areas) and 2.16 (coastal protection works) in the *State Environmental Planning Policy (Resilience and Hazards) 2021*, discussed below) prevail over the Infrastructure SEPP.

SEPP (Resilience and Hazards) 2021

The *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP) consolidates and repeals three SEPPs, which assist in supporting an integrated approach to land use planning in the coastal zone. Under Part 2, Division 1, Section 2.7(1), development may only be carried out on land identified as coastal wetlands with development consent. This includes:

(a) the clearing of native vegetation within the meaning of Part 5A of the Local Land Services Act 2013.

(b) the harm of marine vegetation within the meaning of Division 4 of Part 7 of the Fisheries Management Act 1994*.*

(c) the carrying out of any of the following -

(i) earthworks (including the depositing of material on land)

(ii) constructing a levee

(iii) draining the land

(iv) environmental protection works

(d) any other development.

Development for the purpose of environmental protection works on land identified as coastal wetlands or littoral rainforest on the Coastal Wetlands and Littoral Rainforests Area Map *may be carried out by or on behalf of a public authority without development consent if the development is identified in:*

(a) the relevant certified coastal management program, or

(b) a plan of management prepared and adopted under Division 2 of Part 2 of Chapter 6 of the Local Government Act 1993*, or*

(c) a plan of management under Division 3.6 of the Crown Land Management Act 2016*.*

Development (other than environmental protection works) for which consent is required is declared to be designated development under Clause 2.7(2). If development is categorised as designated development, then an Environmental Impact Statement (EIS) must be prepared as part of the development application.

Part 2.3, Section 2.16 of the Resilience and Hazards SEPP (Coastal Protection Works) contains provisions dealing with the granting of development consent to development for the purpose of coastal protection works.

(1) Coastal protection works by person other than public authority. Development for the purpose of coastal protection works may be carried out on land to which this Chapter applies by a person other than a public authority only with development consent.

(2) Coastal protection works by public authority - Development for the purpose of coastal protection works may be carried out on land to which this Chapter applies by or on behalf of a public authority -

(a) without development consent - if the coastal protection works are -

(i) identified in the relevant certified coastal management program, or

(ii) beach nourishment, or

(iii) the placing of sandbags for a period of not more than 90 days, or

(iv) routine maintenance works or repairs to any existing coastal protection works, or

(b) with development consent - in any other case.

..

(3) Emergency coastal protection works by public authority - Development for the purpose of emergency coastal protection works carried out on land to which this Chapter applies is exempt development if it is carried out by or on behalf of a public authority in accordance with a coastal zone emergency action subplan (or a coastal zone management plan under the Coastal Protection Act 1979 *containing an emergency action subplan that continues to have effect under clause 4 of Schedule 3 to the* Coastal Management Act 2016*).*

(4) In this section, emergency coastal protection works means works comprising the placement of sand, or the placing of sandbags for a period of not more than 90 days, on a beach, or a sand dune adjacent to a beach, to mitigate the effects of coastal hazards on land.

Clause 8A of Schedule 7 to *State Environmental Planning Policy (State and Regional Development) 2011*, declares certain development for the purpose of coastal protection works to be regionally significant development for which a regional planning panel is the consent authority.

State Environmental Planning Policy (Planning Systems) 2021

Under clause 2.19 of the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP), development specified in Schedule 6 of the SEPP is declared to be regionally significant development. Schedule 6, part 8(A) includes coastal protection works:

(1) The following development on land within the coastal zone that is directly adjacent to, or is under the waters of, the open ocean, the entrance to an estuary or the entrance to a coastal lake that is open to the ocean -

…

(b) development for the purpose of coastal protection works carried out by or on behalf of a public authority (other than development that may be carried out without development consent under clause 19(2)(a) of State Environmental Planning Policy (Coastal Management) 2018) – now the Resilience and Hazards SEPP.

The proposed works are located within the coastal zone but not directly adjacent to the waters of the open ocean, the estuary entrance or a coastal lake and is therefore not considered to be regionally significant development.

Fisheries Management Act 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. To meet the primary objectives, Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation.

Under the FM Act (Part 7, Division 3) approval is required if the proposed works involve carrying out dredging or reclamation of 'water land' which is defined under the FM Act as land submerged by water either permanently or intermittently. Under the FM Act, dredging work means:

- *"Any work that involves excavating water land, or*
- *any work that involves moving material on water land or removing material from water land that is prescribed by the regulations as being dredging work."*

Section 200 of the Act states that *"a local government authority must not carry out dredging or reclamation work except under the authority of a permit issued by the Minister".* For proposals under Part 5 of the EP&A Act, approval from DPIRD - Fisheries may be required under Section 200 of the FM Act for dredging or reclamation works. Under s199 of the FM Act, the Minister for Primary Industries is required to be consulted over any dredging or reclamation works carried out, or proposed to be authorised, by a public authority (other than a local government authority). Therefore, approval under the *Crown Land Management Act 2016* will avoid any need for a separate permit under the FM Act.

Under Part 4 of the EP&A Act, DPIRD - Fisheries is a determining authority for local development that requires the following permits under the FM Act:

- Section 201 – permit to carry out dredging or reclamation works.
- Section 205 – permit to harm (cut, remove, injure, destroy, shade etc) marine vegetation (mangroves, saltmarshes, seagrasses and seaweeds).

Development requiring consent from the local council and one or more of the above approvals is deemed to be *'integrated development'* under the EP&A Act, which requires the consent authority (BSC) to forward all development applications to DPIRD - Fisheries for assessment.

For proposals under Part 5 of the EP&A Act, approvals from DPIRD - Fisheries may be required as follows:

- Section 199 – the Minister for Primary Industries needs to be consulted if any dredging or reclamation works will be carried out.
- Section 200 – a permit will be required for any dredging or reclamation works.
- Section 205 – permit to harm (cut, remove, injure, destroy, shade etc) marine vegetation (mangroves, saltmarshes, seagrasses and seaweeds).

The FM Act contains schedules of species, populations and ecological communities that have been listed as 'threatened'. Where a proposed development is in the potential range of a listed threatened species, population or ecological community under the FM Act and/or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the area has not been declared a critical habitat, then the preparation of the 'test of significance' on the subject species, population or community is required. The 'test of significance' is used to determine whether the proposed development is likely to significantly affect threatened species, populations or ecological communities. If the determining/consent authority determines that the proposed project will have a significant impact via the 'test of significance', then a SIS is required to be prepared, or the proposal may require modification where possible.

Key fish habitats are aquatic habitats important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations and the survival and recovery of threatened aquatic species (DPI Fisheries, 2013). Based on the DPIRD - Fisheries classification scheme, Marshalls Creek is classified as Class 1 Major key fish habitat (estuarine waterway). Any excavation/ reclamation works within these areas would trigger permit requirements under s200 or S201 of the FM Act.

DPIRD - Fisheries assesses development approvals in relation to the sensitivity of the impacted fish habitat (Figure 30). Based on the key fish habitat and associated sensitivity classification scheme, Type 1 key fish habitat sensitivity due to the presence of marine vegetation, coastal wetlands and the Cape Byron Marine Park. Mangroves are mapped along Marshalls Creek. Any permanent impacts to coastal wetlands may require offsetting in accordance with the DPI Fisheries guidelines (DPI Fisheries, 2013).

Impacts on aquatic biodiversity would need to be considered at the approval stage.

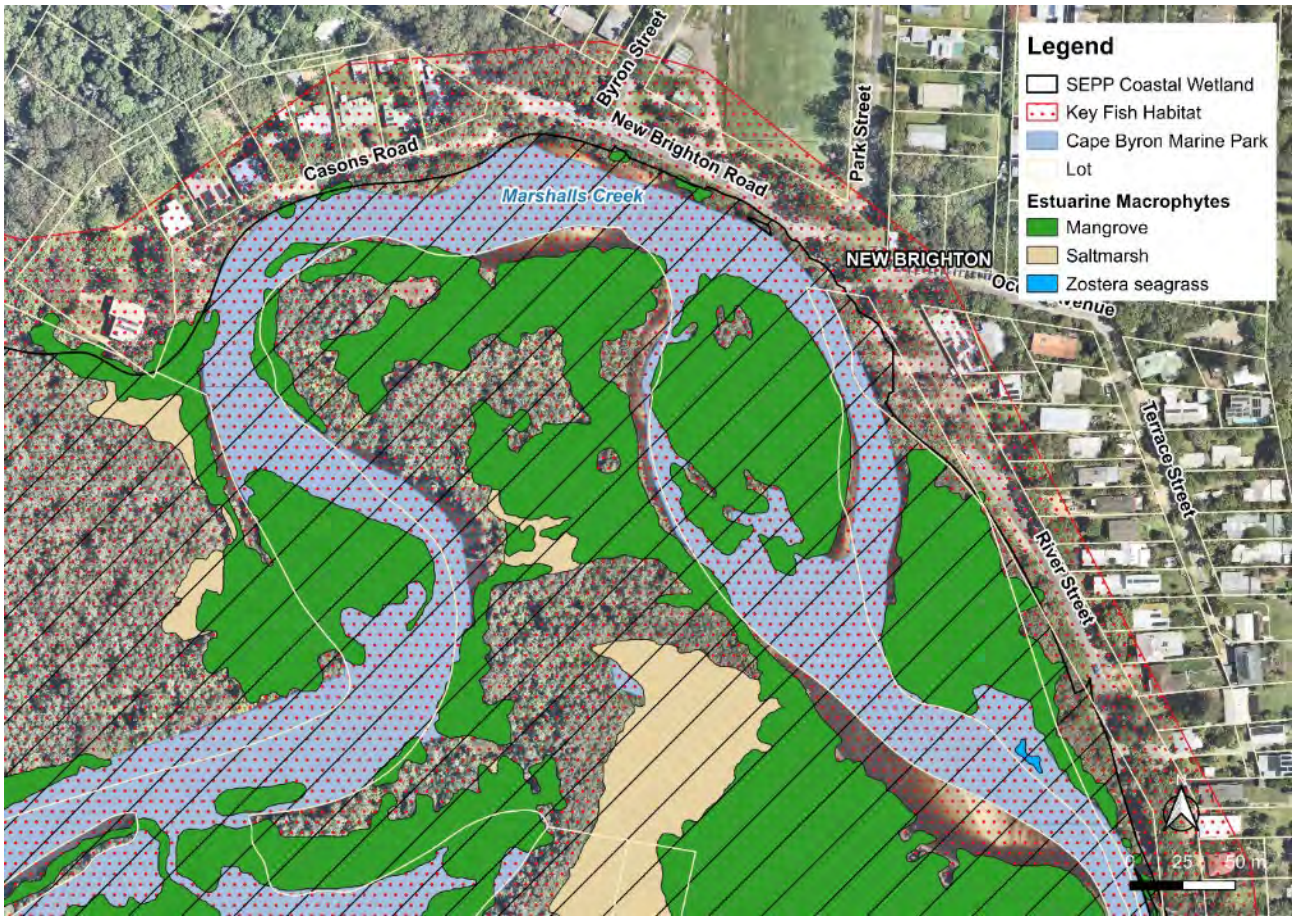


Figure 30: Aquatic habitat

Source: 2024 DPIRD – Fisheries mapping; Aerial photo – Nearmap (2024)

National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* regulates the control and management of all national parks, historic sites, nature reserves and Aboriginal areas. The main aim of the Act is to conserve the natural and cultural heritage of NSW.

Marshalls Creek Nature Reserve

NPWS is directly or jointly responsible for managing lands acquired or reserved under the *National Parks and Wildlife Act 1974*. The *Marshalls Creek Nature Reserve Plan of Management* (PoM, DECCW, 2011) outlines the values of the reserve. Relevant management issues identified in PoM include (DECCW, 2011):

- Soil and water conservation - The reserve is subject to varying degrees of tidal influence, flooding and natural coastal erosion processes. Erosion in the reserve is exacerbated by unauthorised access along sections of the creek banks. Desired outcomes are:
    - Natural hydrological and erosion processes continue with minimal disturbance.
    - Erosion from human induced use is minimised.
    - Water quality and health of Marshalls Creek is improved.
- Aboriginal cultural heritage - Any research into the reserve's Aboriginal cultural heritage values should be undertaken in consultation with the Tweed Byron LALC and Bundjalung Council of Elders and other relevant Aboriginal community organisations. Desired outcomes are:
    - Aboriginal and historic features and values are identified and protected.
    - Aboriginal people are involved in management of the Aboriginal cultural values in the reserve.
    - Understanding of the cultural significance of the reserve is improved.

The reserve experiences low levels of recreational use and there are no recreational facilities within the reserve. Activities include bird watching, canoeing and nature study The PoM allows for low impact self-reliant nature-based use of the reserve such as canoeing, bird watching and nature study.

NPWS has prepared guidelines that identify the key risks to NPWS land and a recommended approach for consideration by planning authorities (NPWS, 2020). Any works that change the hydrology of the creek adjacent to the nature reserve will have potential cross stream and downstream flow on effects within the nature reserve and surrounding environment. These flow on effects will need to be further considered in the environmental assessment phase of the proposed works.

Aboriginal Cultural Heritage

Under part 6, division 2, Section 90 of the Act, an Aboriginal Heritage Impact Permit (AHIP) is required to knowingly destroy, deface or damage a relic or aboriginal place.

There is visible shell material within the riverbank at two locations that has fallen into the river and bed (not recorded AHIMS site but at least one site is well known in the Aboriginal community). In April 2025, shell material was observed near exposed tree roots along the foreshore adjacent to the intersection of New Brighton Road and Casons Road. Advice was obtained from TBLALC regarding management of both sites.

A preliminary due diligence assessment as documented in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW, 2010) is summarised in Table 6.

Table 6: Cultural heritage due diligence process

Item	Response
1. Will the activity disturb the ground surface or any culturally modified trees?	Yes. Disturbance of the ground surface may be required in some foreshore sections depending on the foreshore rehabilitation approach.
2. Are there any: a) relevant confirmed site records or other associated landscape feature information on AHIMS? and/or b) any other sources of information of which a person is already aware? and/or c) landscape features that are likely to indicate presence of Aboriginal objects?	Yes. A search of the AHIMS database found no recorded Aboriginal sites or Aboriginal Places in the study area or immediate surrounds. However, shell material is visible within the riverbank at the end of Casons Road and some shell has fallen into the river and bed. Shell material was also observed near exposed tree roots along the foreshore adjacent to the intersection of New Brighton Road and Casons Road. BSC obtained advice from TBLALC regarding the emergency remediation works and cultural heritage management requirements. Maurice Gannon from TBLALC provided the following advice to BSC: *1. There is clear evidence of midden material in the highly eroded creek bank. The visible lens of mature sized yugari (pipi) shells close to the surface and the scatter of more weathered yugari shells on the creek bed and in the tidal waters are all definitive of Aboriginal midden material. Yugari is an abundant salt-water bivalve, it doesn't live in fresh water. They need deep sand and strong surf action to survive. So, for a lens of large yugari to be present in the banks of Marshall Creek they must have been collected on the beach and brought to this location. Some of the shells are 'intertwined' with the roots of the fig tree growing nearby, which is also indicative of the age of the midden material (the tree grew after the deeper shell deposit, at least). It is possible that the midden extends beneath the road, however it has also obviously been virtually obliterated by the ongoing erosion of the creek bank. It should also be noted that there is some broken ceramic crockery in the remaining lens of shell material which is evidence of the near-surface layer having been disturbed, or deposited, at some time in the relatively recent past.* *2. Whilst the local Aboriginal community has been aware of the midden site it has never been registered on AHIMS.* Another location of shell deposit was observed in May 2025 along Casons Road. Both deposits have some of the key characteristics of midden material (size of shells, mixture of species) but lack some of the other defining features (depth of the deposits, age weathering). Given the fact that the sites have been heavily eroded it is very possible that they are actually the residual, recent layers of larger deposits that have been eroded. There may be additional sites or Aboriginal objects within the study area.

Item	Response
3. Can harm to Aboriginal objects listed on AHIMS or identified by other sources of information and/or can the carrying out of the activity at the relevant landscape features be avoided?	Unknown. Maurice Gannon from TBLALC provided the following advice to BSC (in relation to the emergency remediation works): *Erosion control measures can be undertaken to protect the site from further harm without disturbing or causing any additional harm to the remaining midden material.* *TBLALC would prefer to repair the site as immediately as possible and we anticipate that Arakwal (if it is consulted / engaged in the project) would agree.* *Basically the eroded section needs to be filled (note: not cut or reshaped). The fill should be placed in such a way as to cover the remaining midden material and to completely protect it from the tidal wash and turbulence that is the cause of the erosion. My recommendation would be a rock wall (basalt 'boulders'). These can be 'laid-up' onto the creek bank in such a way that the midden material will not be impacted at all.* However, trampling, filling and compaction of a site can be a form of harm as defined under the *National Parks and Wildlife Act 1974.* Whether the shell deposits are of Aboriginal cultural heritage (ACH) origin or not is a moot point because the scale of the proposed works basically dictates that the most cautious approach should be taken. Mr Gannon therefore recommends that a licensed archaeologist be engaged to complete an Aboriginal Cultural Heritage Assessment Report (ACHAR), which necessarily will entail Aboriginal community consultation in preparation for impacts to ACH and, if necessary, subsurface testing within the confines of the appropriate regulatory authorisations and approvals. There may also be consideration given to seeking approval for non-impacting erosion control works at the two midden sites. He suggests that consideration should be given to including the whole length of the proposed creek bank rehab / engineering works under the ACHAR simply because (i) it is a contiguous natural and cultural environment, and (ii) this would not equate to any significant widening of the scope of the ACHAR.

Based on the advice from TBLALC representatives and given the uncertainty whether the shell is a confirmed cultural site and there is the potential for harm depending on the adopted rehabilitation approach, further consultation and a formal due diligence assessment and site survey will be undertaken with TBLALC. This will ascertain whether an ACHAR and Aboriginal heritage Impact Permit (AHIP) or other management measures are required.

Suitably qualified cultural monitors should also observe and/or participate in the remediation works. If any Aboriginal objects are found, work should cease and the LALC and Heritage NSW should be notified.

Marine Estate Management Act 2014

DPIRD - Fisheries manages Cape Byron Marine Park under the *Marine Estate Management Act 2014*. Marshalls Creek within the study area is mapped as a Cape Byron Marine Park Habitat Protection Zone. The upstream river reach is mapped as a Sanctuary Zone.

The objects of the habitat protection zone are -

(a) to provide a high level of protection for biological diversity, habitat, ecological processes, natural features and cultural features (both Aboriginal and non-Aboriginal) in the zone, and

(b) where consistent with paragraph (a), to provide opportunities for recreational and commercial activities (including fishing), scientific research, educational activities and other activities, so long as they are ecologically sustainable and do not have a significant impact on any fish populations or on any other animals, plants or habitats.

Part 5 of the Act specifies how a development that occurs within a marine park should be addressed. Under a Part 4 or Part 5 development application, the authority (DPIRD - Fisheries) needs to be consulted before the final determination of the application. If the consent authority determines the proposed development is likely to impact animals or plants within the marine park, the proponent must consult with DPIRD - Fisheries.

Figure 31: Cape Bryon Marine Park zoning

Source: 2024 NSW SEED portal

Consent for damage or interference with habitat is only given:

(a) for research, environmental protection, public health, traditional use or public safety purposes, or

(b) for the purposes of an ecologically sustainable use that does not have a significant impact on fish populations within the zone or on any other animals, plants or habitats.

In granting any permission due consideration would also be given to any concerns raised during the required Native Title notification processes.

Crown Land Management Act 2016

Crown land is land set aside on behalf of the community for a wide range of public purposes including environmental and heritage protection, recreation and sport, open space and government services. The *Crown Lands Management Act 2016* governs the management of Crown land which includes the bed of Marshalls Creek below MHWM. A Crown land lease, licence, permit or right of way to occupy and/or use Crown land is required for certain works on Crown land. Written consent from DPHI – Crown Lands is required for development on Crown land under Section 23 of the *Environmental Planning and Assessment Regulation 2021.* Written support is required for applications for grant funding for projects occurring on Crown Land.

DPHI – Crown Lands has prepared guidelines for the administration of Crown land within the coastal zone under the *Crown Lands Management Act 2016*. The guidelines define the principles for the management and administration of coastal Crown land and the provision of approvals for activities and development. Relevant principles are:

- Principle 3. Coastal protection works on coastal Crown land on the open coast, should be low impact or non-structural, where feasible or practicable.
- Principle 4. Private structural coastal protection works on the open coast should be wholly located within the boundaries of the property the works are intended to protect.

DPHI – Crown lands has confirmed that these principles do not apply to coastal protection works within estuaries. However, feedback from stakeholders indicates that there is a desire to focus on “soft’ options such as fencing, revegetation and the use of coir or LWD which are preferred to rock revetment (refer Appendix 4).

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides provisions for the protection of threatened or protected animal and plant species, threatened ecological communities and areas of outstanding biodiversity value.

Under the BC Act, the Biodiversity Offsets Scheme (BOS) provides a framework to assess the impacts of a project on biodiversity. The BOS applies to local development (assessed under Part 4 of the EP&A Act) that triggers the BOS threshold. The BOS threshold is a test used to determine when it is necessary to engage an accredited assessor to apply the Biodiversity Assessment Method (BAM) to assess the impacts of a proposal as set out in the *Biodiversity Conservation Regulation 2017*. A development exceeds the BOS threshold if it involves the clearing of native vegetation of an area exceeding a threshold area or impacts land included on the Biodiversity Values Map or is likely to significantly affect threatened species. A proponent of a Part 5 activity can also voluntarily opt in it to the BOS.

The BC Act also sets out the assessment framework for threatened species and ecological communities for activities and approvals under Part 5 of the EP&A Act. To determine whether the proposed activity is likely to significantly affect threatened species or ecological communities or their habitats, a test of significance must be applied. If it is found that the proposed activity is likely to significantly affect threatened species or will be carried out in a declared area of outstanding biodiversity value, the proponent must either apply the BOS or prepare a Species Impact Statement (SIS).

If the BOS applies, a Biodiversity Development Assessment Report (BDAR) would need to be prepared, which sets out how the proponent has applied steps to avoid and minimise impacts on biodiversity and sets out the number and type of ecosystem and species credits required to offset residual impacts of the activity on biodiversity ('credit obligation'). The BDAR would accompany the development application (Part 4 development) or environmental assessment (Part 5 development) and would be assessed by the consent authority. If the consent authority approves the application, the credit obligation (and any other required actions) would be included as conditions of the relevant approval or consent. The proponent must satisfy all credit obligations before proceeding with the proposed works.

Vegetation along the foreshore consists of the following plant community types (PCTs) included in the NSW State vegetation type map (DPE, 2022):

- Far North Swamp Oak-Tuckeroo Swamp Fringe Forest.
- Far North Ranges Red Gum Grassy Forest.
- Grey Mangrove-River Mangrove Forest.
- Unclassified vegetation.

BSC's online mapping tool (2023 EEC mapping) indicates the presence of Subtropical Coastal Floodplain Forest endangered ecological community (EEC) along the foreshore with an area of Swamp Oak Floodplain Forest EEC between Ocean Avenue and Park Street, New Brighton (Figure 32). The foreshore is also mapped as High Environmental Value vegetation (Coastal Floodplain Wetlands and Mangrove Swamps) and wildlife corridor, and parts of the foreshore are mapped as Koala habitat (BSC Koala Plan of Management). Marshalls Creek is included on the Biodiversity Values Map (corresponding to the mapped coastal wetlands, Figure 29).

Impacts on terrestrial biodiversity would need to be considered at the approval stage.

Figure 32: Endangered ecological communities mapped within the study area

Light purple: Subtropical Coastal Floodplain Forest, Dark purple: Swamp Oak Floodplain Forest
Source: BSC online mapping

Environmental Protection Biodiversity Conservation Act 1999 (Commonwealth)

The Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined as matters of national environmental significance.

Under the EPBC Act, if an action has, will have or is likely to have a significant impact on a matter of national environmental significance (MNES), approval from the Minister will be required. To determine whether an action is likely to have a significant impact, an assessment of significance on relevant matters is undertaken and a referral to the Minister may be required.

The proposed works are unlikely to impact any MNES and a referral to the federal government under the EPBC Act is not expected to be required.

Native Title Act 1993

The *Native Title Act 1993* provides a legal process for recognising the rights and interests of Aboriginal and Torres Strait Islander people in land and waters. The Tweed River Bundjalung People Native Title Claim (NC2020/002) covers the land and water in this area however, the claim was not accepted for registration.

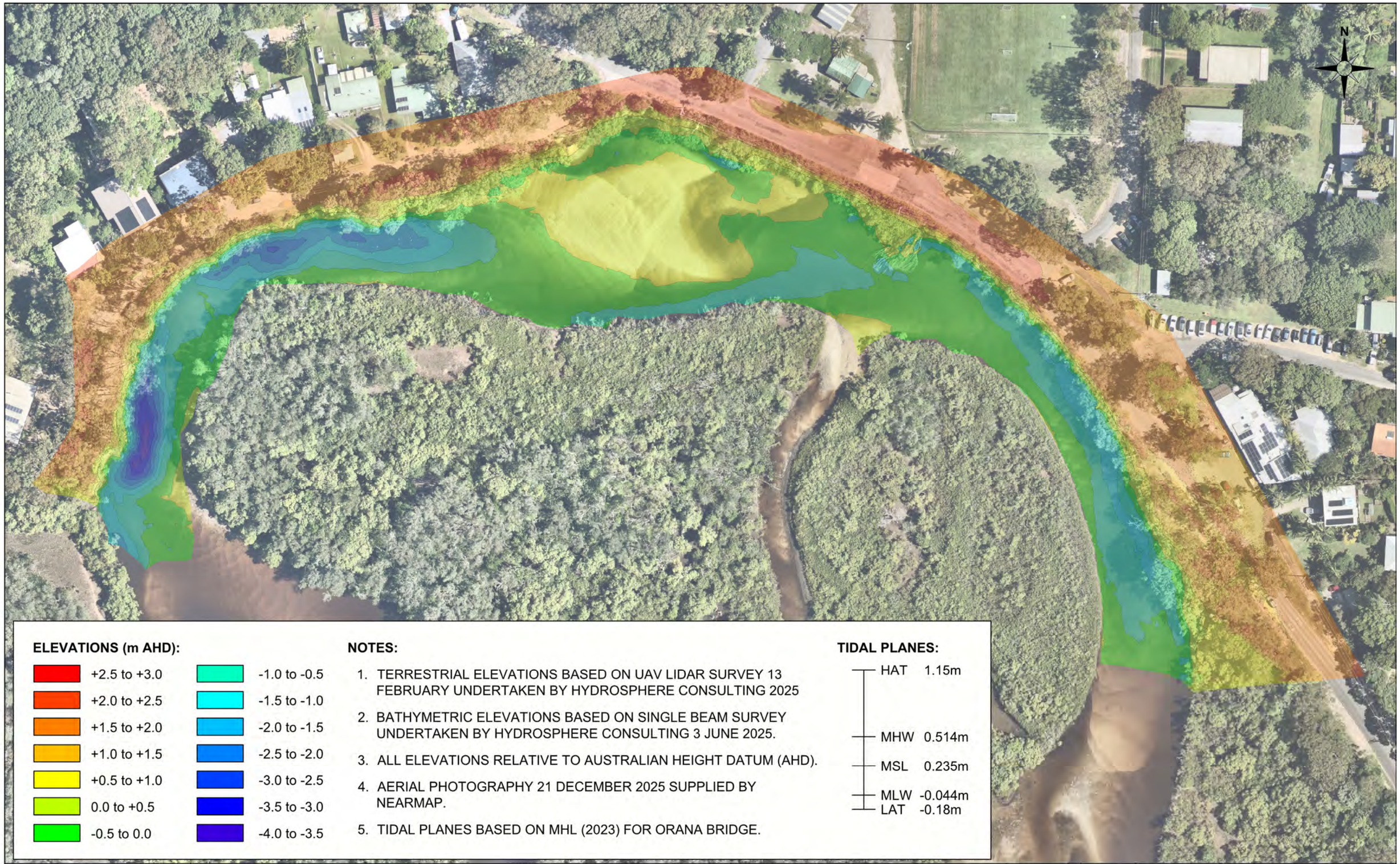
All Crown land is subject to native title rights unless the native title is extinguished (i.e., by granting freehold estate, mining leases, etc.). Any activity impacting native title is considered a 'future act' (specific proposals to deal with land in a way that affects native title and interests) under the *Native Title Act 1993*. Future act

activities require a notice to be forwarded to the native title claimants' representative body for consultation and feedback.

Roads Act

The *Roads Act 1993* regulates the carrying out of various activities on public roads. Consent from BSC may be required for works within the Council road corridor undertaken by other public authorities.

APPENDIX 3 DESIGN DRAWINGS



ELEVATIONS (m AHD):

+2.5 to +3.0	-1.0 to -0.5
+2.0 to +2.5	-1.5 to -1.0
+1.5 to +2.0	-2.0 to -1.5
+1.0 to +1.5	-2.5 to -2.0
+0.5 to +1.0	-3.0 to -2.5
0.0 to +0.5	-3.5 to -3.0
-0.5 to 0.0	-4.0 to -3.5

NOTES:

1. TERRESTRIAL ELEVATIONS BASED ON UAV LIDAR SURVEY 13 FEBRUARY UNDERTAKEN BY HYDROSPHERE CONSULTING 2025
2. BATHYMETRIC ELEVATIONS BASED ON SINGLE BEAM SURVEY UNDERTAKEN BY HYDROSPHERE CONSULTING 3 JUNE 2025.
3. ALL ELEVATIONS RELATIVE TO AUSTRALIAN HEIGHT DATUM (AHD).
4. AERIAL PHOTOGRAPHY 21 DECEMBER 2025 SUPPLIED BY NEARMAP.
5. TIDAL PLANES BASED ON MHL (2023) FOR ORANA BRIDGE.

TIDAL PLANES:

HAT	1.15m
MHW	0.514m
MSL	0.235m
MLW	-0.044m
LAT	-0.18m

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MARSHALLS CREEK ELEVATIONS
COMBINED LIDAR & HYDROSURVEY

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	2025-06-11	REV3	MH

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DRAWING 1

SHEET 1 OF 1

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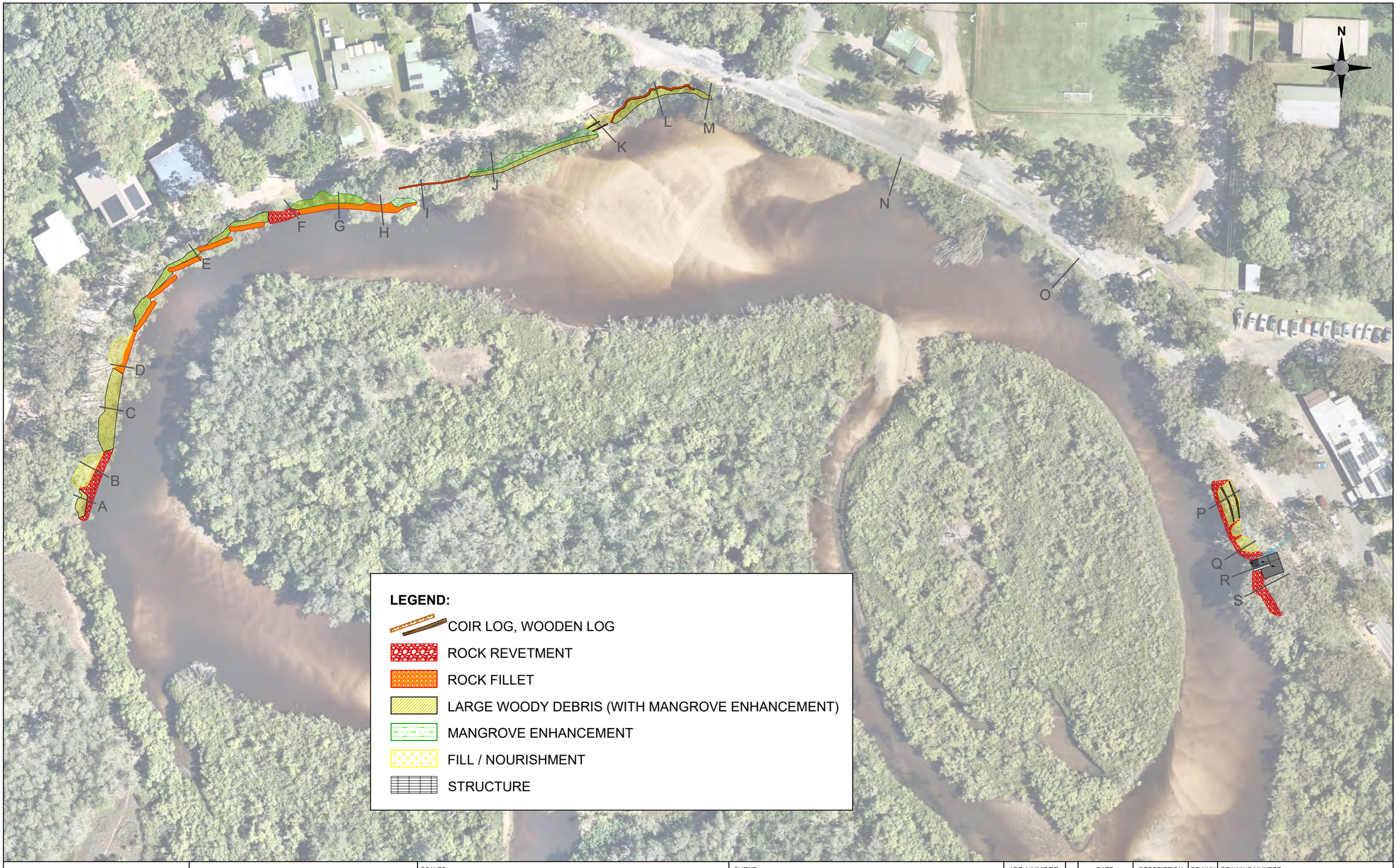

Y:\25-011 Marshalls Creek Foreshore Rehabilitation\Drawings\New Brighton Overview Bank Treatments.dwg

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MARSHALLS CREEK EROSION
OVERVIEW OF NEW BANK TREATMENTS

REVISION	DATE	DESCRIPTION	DRAWN
	2025-06-11	REV3	MH

DRAWING NUMBER

DRAWING 2

SHEET 1 OF 1

GENERAL NOTES

Geotechnical and ground preparation

1. Earthworks construction should be undertaken in general accordance with a project specific specification. Where no such specification exists, a reasonable alternative might be AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.
2. Tamping and compaction should be undertaken for loose to very loose soils above water level prior to placement of geotextile to reduce the rate of settlement after rock placement.
3. General guidelines relating to earthworks for access roads and support of ground slabs include:
    - Remove topsoil and vegetation.
    - Remove any loose materials within Zone 2 where the proposed slope gradient of 1V:1.5H relies on competent subgrade for stability.
    - Fill for structural purposes should be placed in layers not exceeding 250mm loose thickness and be compacted to the required standard and level before placing the next layer. Thinner layers may be required for smaller compaction equipment.

Rock

4. All rock shall be clean, hard, dense, durable, free from overburden, spoil, shale and organic matter. Rock that is laminated, fractured, porous, with discontinuities or otherwise physically weak, shall not be used.
5. The breadth or thickness of a single stone shall be not less than one-third its length.
6. Armouring rock in areas likely to be regularly encountered by members of the public shall be sub-angular without fractured edges.
7. Median rock size (D50) is to be 0.35m unless otherwise specified with a minimum revetment armour thickness of 1.7 x D50. This will vary from 0.34 - 0.6m thickness for 0.2m and 0.35m D50 size respectively.
8. Rock to be placed to provide an interlocking armouring layer with variation in rock size to ensure close fit. Rock grading to be such that size distribution D50/D90 to be 0.75 and D25/D50 to be 0.45

Geotextile

9. The area on which the geotextile is to be placed shall be prepared by clearing and grading and all sharp objects and large protruding stones shall be removed, smoothed or covered with suitable fill material. Cut trees and shrubs shall not protrude above the ground surface. The topsoil and vegetation mat may remain unless otherwise specified. Where necessary, localised excavations shall be carried out to permit installation of geotextiles.
10. Texcel 600R is proposed as geotextile underlay for armouring and revetments areas due to its specific gravity of 1.35 - 1.4 allowing easier installation in water.
11. Geotextiles shall be placed just ahead of associated advancing construction work. Geotextiles placed shall be covered by relevant construction materials or suitable protective sheeting as soon as practical. If time between placement and coverage exceeds 48 hours, the geotextile is to be carefully inspected for degradation prior to coverage.
12. Any punctures in the geotextiles shall be repaired to the satisfaction of the Principal.

Placement

13. Rock armouring and timber entanglement material is to be placed carefully with a maximum drop height of 2m for rock armouring and 1m for timber entanglement exceeding 400kg. Armouring elements greater than 1,000kg are to be limited to <0.5m drop height.
14. All rock, wood and other construction element are to be placed in a way to ensure long-term stability. Placed rocks are to be checked for stability at the time of placement and readjusted if necessary.

Cultural heritage

15. Protection of Aboriginal cultural heritage sites or artefacts is to be in accordance with agreed management strategies (to be developed).

Environmental protection

16. Damage to tree roots and soil disturbance is to be minimised as much as possible. Roots are to be protected by placement of top soil to minimum 0.2m cover and boarding or similar when to be traversed by vehicles or machinery.
17. Sediment and erosion control measures are to be implemented in accordance with the Blue Book.
18. Any works requiring the trimming or destruction of marine vegetation (mangroves) is only to be undertaken in accordance with a permit to harm marine vegetation issued by DPIRD - Fisheries.
19. Any trimming of terrestrial tree branches or roots if required is only to be undertaken with permission from Byron Shire Council and is to be undertaken by a qualified arborist.

Habitat enhancement

20. Provision is to be made for riparian vegetation enhancement wherever possible.
21. All plantings should be with native species endemic to the area.
22. Public access points should provide for public movement while maximising vegetative cover through the use of planting islands and low bushes which maintain visual connection with the waterway.
23. Where appropriate, artificial habitat structures (e.g. reef balls) should be incorporated into rock revetments to increase aquatic habitat complexity.
24. Exposed roots are to be backfilled and protected.

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MARSHALLS CREEK EROSION
GENERAL NOTES

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	2025-06-11	REV3	MH

DRAWING NUMBER

DRAWING 3

SHEET 1 OF 1

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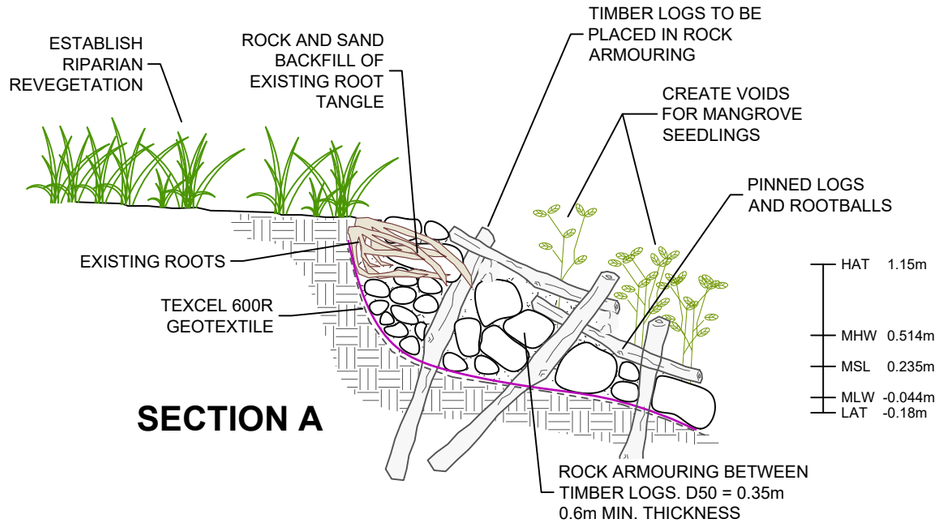

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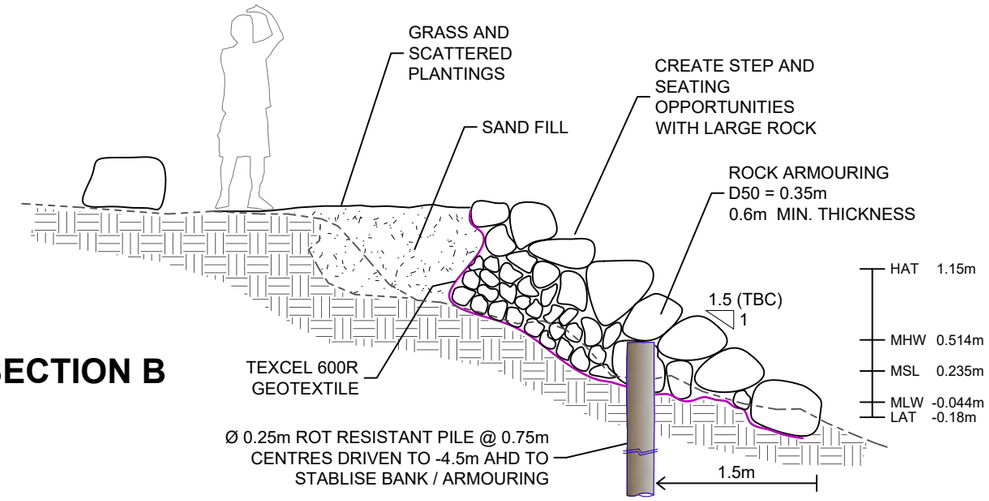

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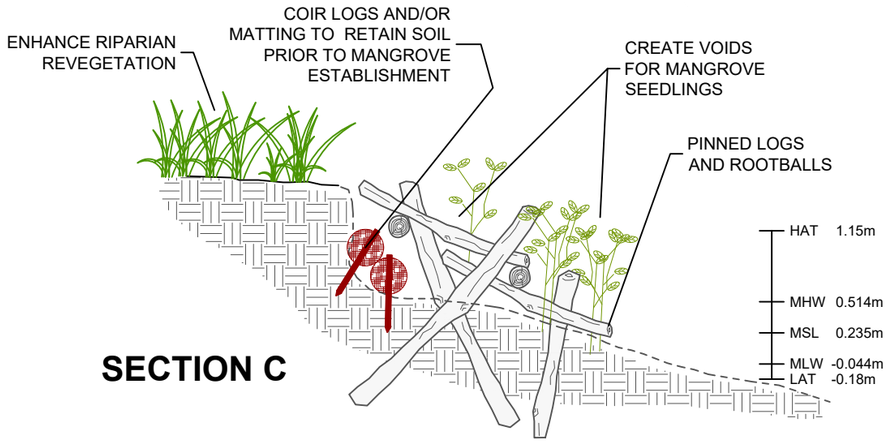

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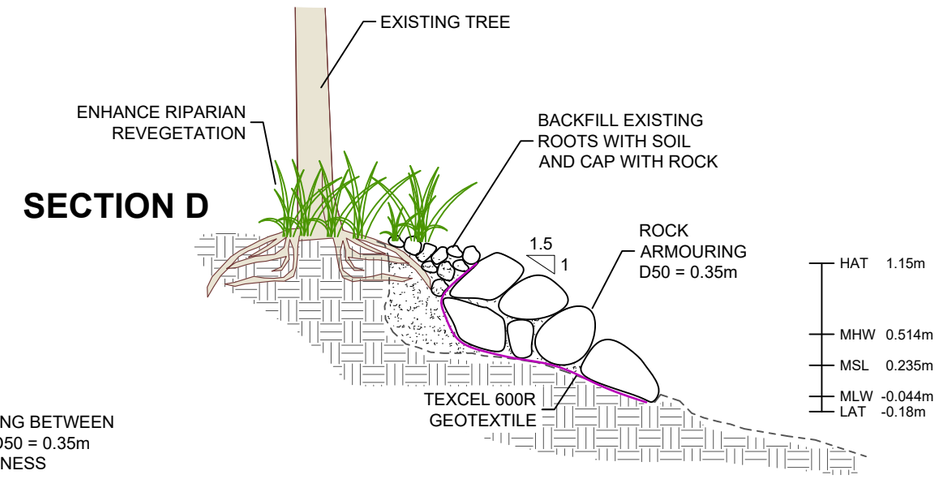

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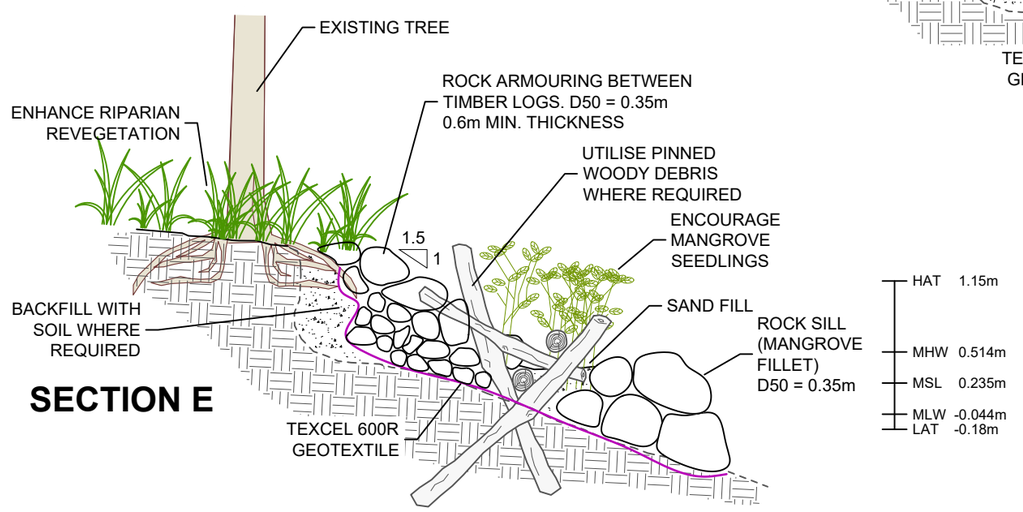

SECTION E

NOTES

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MARSHALLS CREEK EROSION CONCEPT DIAGRAMS A - E

REVISION	DATE	DESCRIPTION	DRAWN
	2025-06-11	REV3	MH

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DRAWING 4

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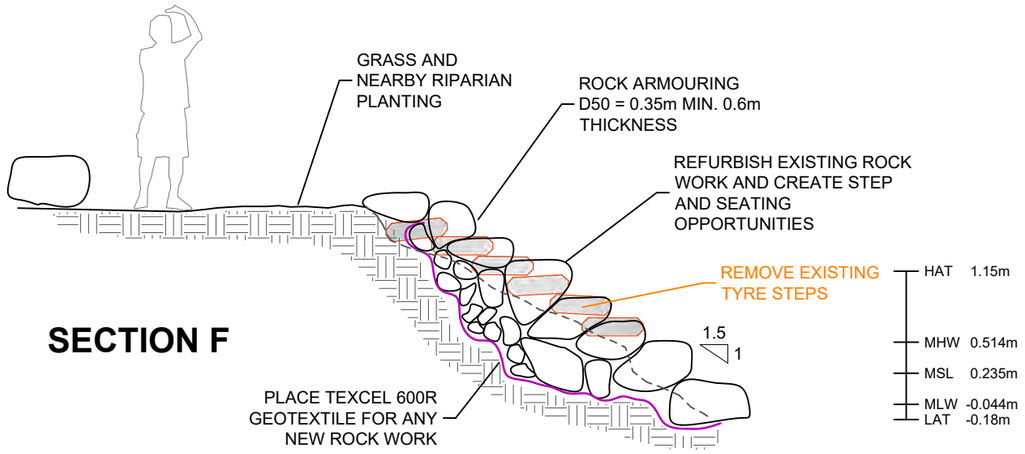

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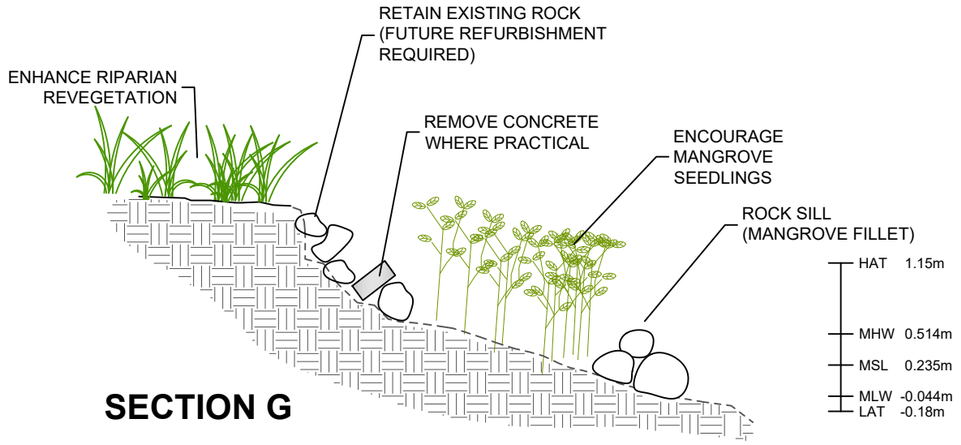

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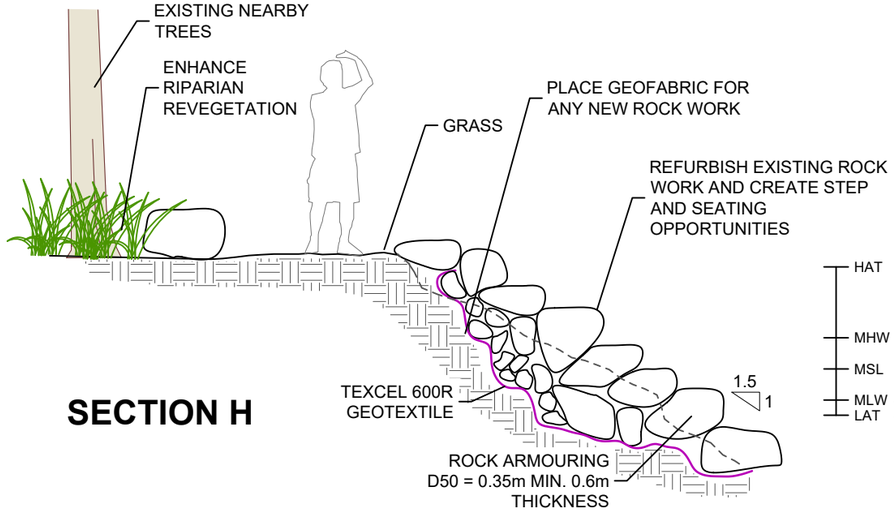

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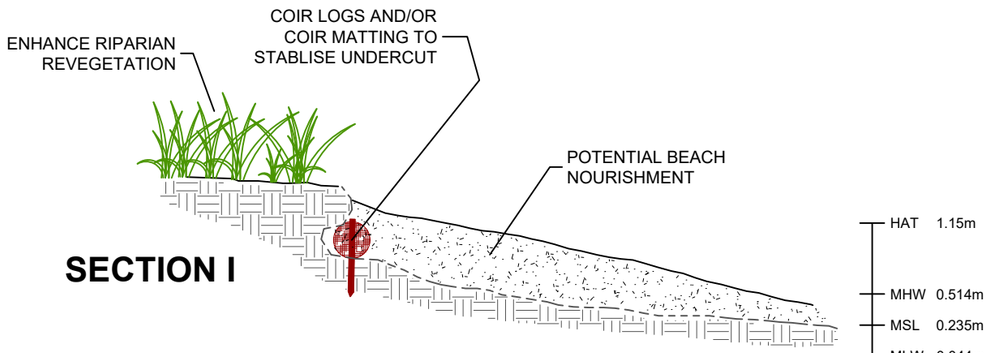

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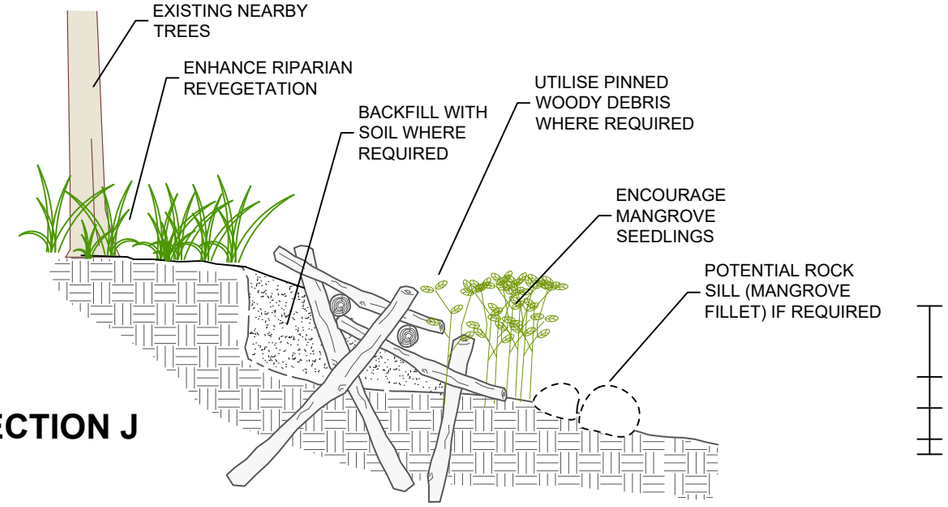

SECTION J

NOTES

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MARSHALLS CREEK EROSION CONCEPT DIAGRAMS F - J

REVISION	DATE	DESCRIPTION	DRAWN
	2025-06-11	REV3	MH

DRAWING NUMBER

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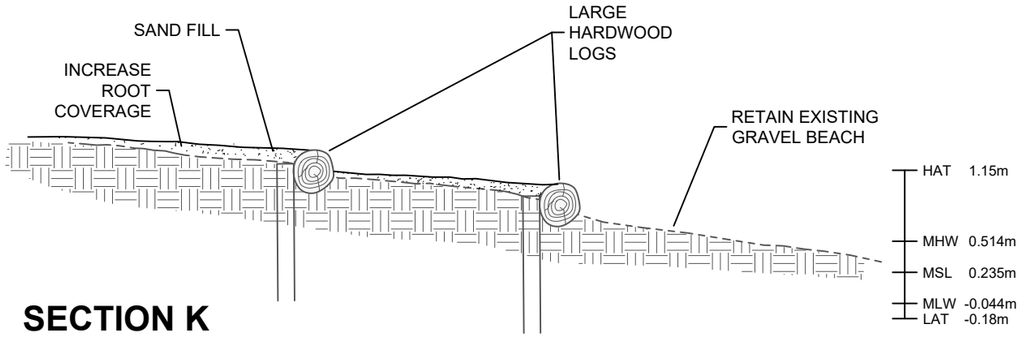
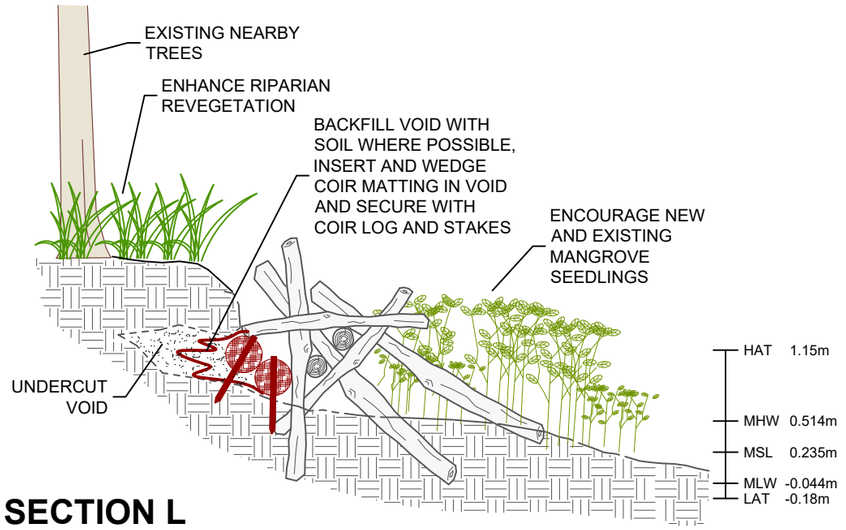


SECTION K

Retain existing vehicle barrier. Existing imported soil/gravel is slowly eroding and exposing roots, however public access location should be maintained. Exposed roots at margins of access to be reburied with soil and barrier planting e.g. Lomandra to stabilise.



SECTION L

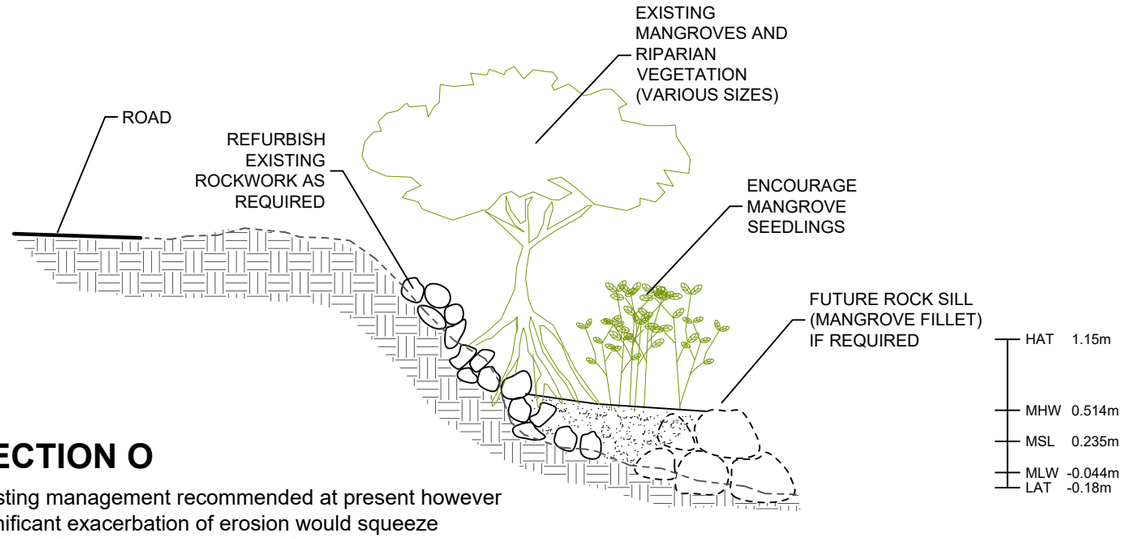
Note: Continued undercut of bank accompanied by failure of mangrove recruitment will warrant backfilling with sand and installation of woody debris and/or mangrove fillet (not drawn).

SECTION M

Not drawn. Existing management recommended, however if undercutting of bank progresses, the management approach is to initially follow coir matting/log treatment as for Section L. Installation of woody debris at southern end of this bank segment would increase protection of mangroves from human activities.

SECTION N

Not drawn. Existing management recommended.



SECTION O

Existing management recommended at present however significant exacerbation of erosion would squeeze estuarine/riparian vegetation out of existence. Future works may require refurbishment of the existing revetment. This should be taken as the opportunity to widen the riparian strip through the use of a mangrove fillet immediately offshore of the current revetment.

NOTES

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MARSHALLS CREEK EROSION
CONCEPT DIAGRAMS K - O

REVISION	DATE	DESCRIPTION	DRAWN
	2025-06-11	REV3	MH

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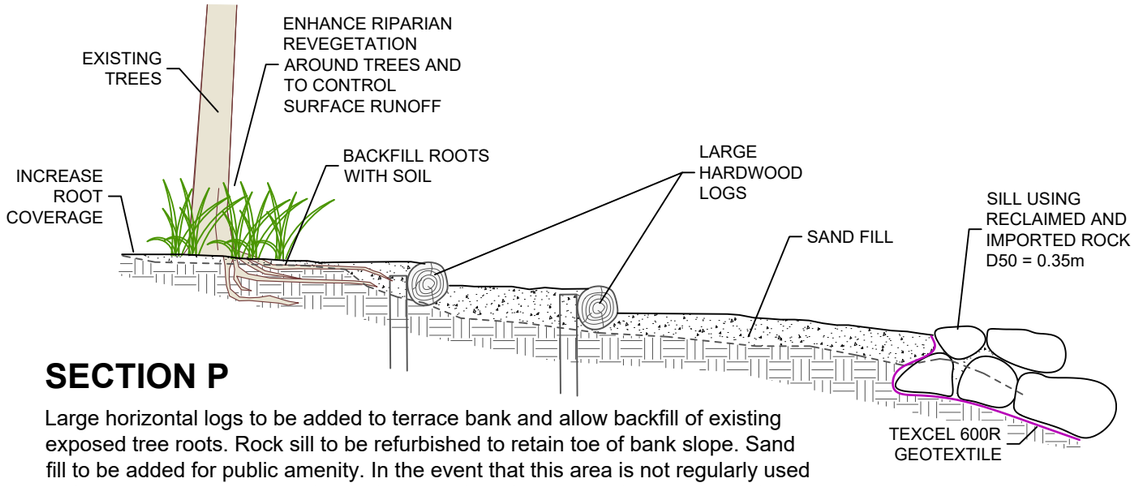
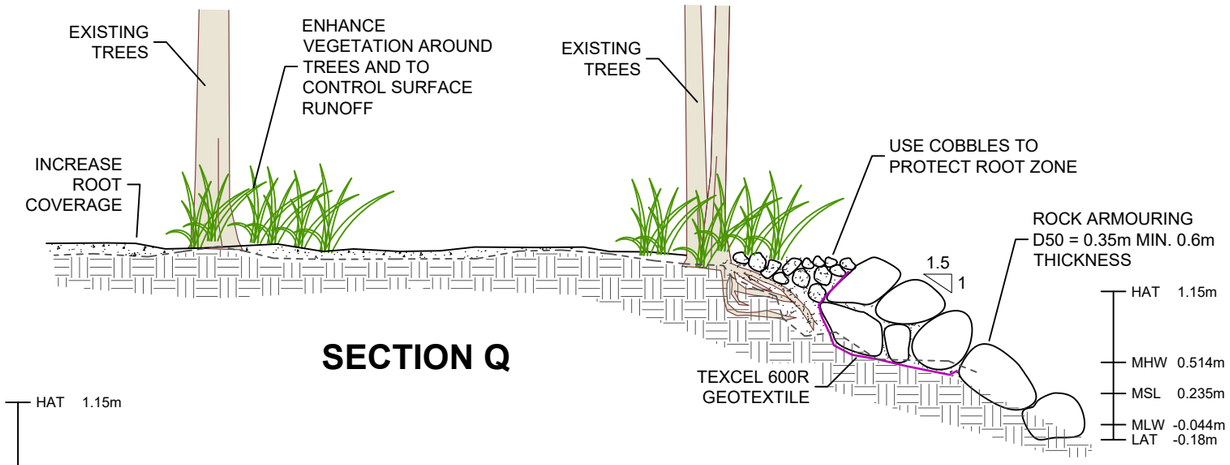


SECTION P

Large horizontal logs to be added to terrace bank and allow backfill of existing exposed tree roots. Rock sill to be refurbished to retain toe of bank slope. Sand fill to be added for public amenity. In the event that this area is not regularly used by the public, or erosion continues to occur, then this area is to be revegetated.



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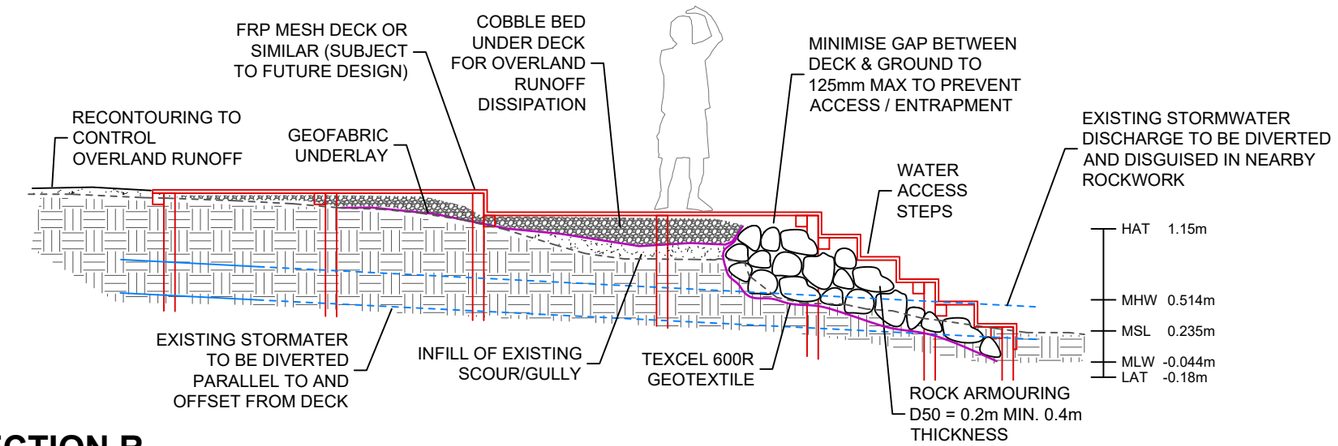
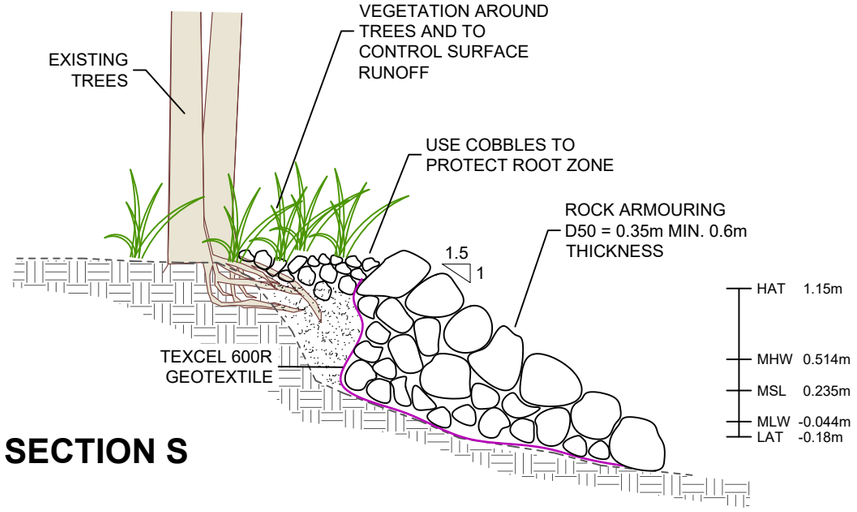


SECTION R

Deck and water access step design is indicative and is subject to future design by others. Existing stormwater pipe is to be diverted to run parallel to deck and discharge to nearby rockwork. Exposed roots to be backfilled and protective geofrabric and cobble layer added to dissipate overland stormwater flows.



SECTION S

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MARSHALLS CREEK EROSION
CONCEPT DIAGRAMS P - S

REVISION	DATE	DESCRIPTION	DRAWN
	2025-06-11	REV3	MH

DRAWING NUMBER
DRAWING 7
SHEET 1 OF 1

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APPENDIX 4 STAKEHOLDER FEEDBACK

Summary of meetings with Approval Agencies and TBLALC (attached).

Table 7: Stakeholder feedback

Summary of feedback	Response
Chloe Dowsett, Coastal & Biodiversity Coordinator and other staff, BSC	
Consideration of reef balls or marine habitat enhancement features would be beneficial.	Marine habitat enhancement features have been incorporated.
Locals store dinghies or other watercraft along Casons Road section. Agree with the intention of the rock sill/ mangrove fillet which aims to trap sediment and recolonise mangroves behind the fillet. Continued public access and deployment of tinnies at this location are likely to be counter-productive to mangrove recruitment. It would be good to try to limit vessel deployment at this location and promote deployment of vessels further downstream at the boat ramp area. LWD to be considered for installation to prevent access and tinnies/dinghy's being tied to trees. This fits in with objective to project to formalise access at certain points and limit areas between these access sites.	Vessel deployment to be concentrated at existing boat ramp, segment K. LWD has been included to discourage tinnies/ dinghies being tied to trees or launched from other areas.
Potential beach nourishment areas - preference is to source local material from within the system rather than importation.	DPIRD- Marine Parks does not support dredging of the river for sand nourishment. Material to be sourced from local quarry.
Existing informal boat ramp on Casons Road - consider improvements to this area to promote deployment of tinnies and/or watercraft. Vehicle barrier to be retained but could be amended slightly to promote vessel deployment area. Gravel is angular and known to cut / scratch feet. Improvement of access to creek to be considered through stepped access and/or improvement of substrate.	Existing boat ramp to be stabilised with log terrace. Exposed roots at margins of access to be reburied with soil and barrier planting e.g. Lomandra to stabilise.
Bank in front of shops – this area is highly used by the public. Aim to hold the line of erosion while allowing public access at this central location. Enhance riparian area adjacent. Small beach area may consider sand fill / beach nourishment.	Concept design includes public access at this location (segment R) with deck structure. Sandy beach to be established at segment P with log terracing and sand fill initially as a trial to confirm suitable erosion control and public use of the area.
Key critical environmental assets for protection are the large Eucalyptus trees being undercut along the river. Rock protection is supported around trees.	Noted.

Summary of feedback	Response
DST recommended geobags, however these are not in fitting with area and are unsightly, can be slippery and can tear. Natural materials including LWD and rock preferred.	Noted. The concept design includes natural rock consistent with existing features where required for increased bank stabilisation.
Concern with rock protection on creek side of the water access ramp due to public safety risk (diving off ramp etc.). Key area for public access and use by kids, swimming and fishing. Consideration to be given to potential cantilever approach of ramp over rock sill or removal of rock sill altogether.	Discussed further in meeting 5 May 2025 (refer attached meeting notes).
Supportive of proposed concept plans. Realisation of this project will assist greatly in both restoring community confidence and in protecting this sensitive area whilst ensuring sustainable access.	Noted.
Proposed bank works all look very natural and will be in keeping with the local character. Three access points are well considered (at end of Casons Road, start of Casons Road and opposite the shops.	Noted.
Ben Grant, Senior Planner, BSC	
The project will likely be characterised as “coastal protection works incorporating ancillary waterway or foreshore management activities”, due to the extent of hard protection structures adopted in the design. Any coastal protection works occurring within the mapped coastal wetlands area under the Resilience and Hazards SEPP will require consent under Part 4 of the EP&A Act. The development application would be classified as designated development requiring an EIS. Works occurring outside the mapped coastal wetlands area can be undertaken without development consent as “waterway or foreshore management activities” pursuant to Div 25 of the Transport and Infrastructure SEPP. The proponent would need to prepare an REF and consider the potential environmental impacts of the works under Part 5 of the Act. If any native vegetation is to be removed within the Biodiversity Mapped area (under the *Biodiversity Conservation Act 2016*), then a BDAR needs to be prepared and submitted with the DA. Currently, the BV Map corresponds to the Coastal Wetlands Map, which is generally delineated along the edge of the riverbank.	Noted. Approvals pathway is discussed in Appendix 2.
Dave Maguire – Acting Manager, Cape Byron Marine Park, DPIRD – Marine Parks	
The waters of the creek at this location are part of the CBMP, zoned as Habitat Protection and have significant stretches of Sanctuary Zone adjacent.	Objectives and approval requirements are discussed in Appendix 2.

Summary of feedback	Response
In general terms, DPIRD – Marine Parks position is that the natural and other values of the creek should be protected to the greatest degree possible. Where possible treatments focussed on "soft' options such as fencing, revegetation and the use of coir or LWD are preferred to rock revetment. Where rock revetment is the only option, works are to be done around existing vegetation e.g. mangroves and complemented with rock fillets or other treatments designed to enhance mangrove recruitment and survival.	The preferred approach for Marshalls Creek is to predominately use 'soft' approaches with minimal use of 'hard' elements and only where required. The best approach for each bank segment incorporates elements of both hard and soft techniques with a combination of methods providing environmental benefits.
DPIRD – Marine Parks does not support dredging/ realignment of sandbars. Beach nourishment of the creek foreshore (for sandy beaches without protection) is not encouraged or seen as long-term solution.	Sandy beach to be established at segment P with log terracing and sand fill initially as a trial to confirm suitable erosion control and public use of the area.
Supportive of facilitating access to waterway with a deck/ ramp. The width of the structure and associated intrusion into the creek (including rock revetment, approx. 6 m) needs review and consideration by Transport for NSW.	Concept designs were provided to NSW Maritime for feedback.
Downstream effects of deck/ ramp and associated rock revetment causing further intrusion into the shoreline and existing mangroves warrant consideration.	Noted. The design has been modified to reduce the intrusion into the waterway. The rockwork upstream and downstream of the structure will include roughness elements to reduce nearshore current velocities.
In consultation with the Tweed LALC recommend consideration to protect midden/area of shell scatter – it may be appropriate to consider discouraging access along the creek foreshore to this point (i.e. to protect the midden and reduce trampling allowing mangrove recruitment and growth).	Concept design includes rock revetment and backfill of shell deposit at segment B with general agreement from TBLALC. Mangrove recruitment and growth will be encouraged upstream and downstream of these works.
Areas of undercut bank provide important refuge/ fish habitat – suggest if possible minimal intervention where there are no safety or infrastructure concerns.	LWD is proposed along most of the bank to support fish habitat e.g. segment C, E, J, L and upstream/ downstream of rock revetment. Backfill and coir logs are proposed at some locations to rehabilitate the banks and provide stability.

Summary of feedback	Response
Supports existing public access locations and soft options to manage degradation and protect/ enhance adjacent vegetation as required.	Noted.
Areas of informal bank protection works are challenging. Focus needs to be on enhancing/ retaining natural values.	Inappropriate existing controls will be removed and replaced with suitable materials and designs.
Supports measures to protect cultural heritage values guided by TBLALC. For example LWD in the vicinity of and upstream of the shell deposits configured to reduce further scouring/ exposure would be supported.	Noted.

Summary of feedback	Response
Management of fallen trees: The 'removal of LWD from NSW rivers and streams' is listed as a key threatening process under the FM Act. As such, the general preference is as follows: • Retention is prioritised, as LWD/ snags provide critical habitat and play a key role in maintaining healthy fish populations. • Removal should be avoided, except where necessary for navigation safety, flood risk management, or infrastructure protection. Under the *Policy and Guidelines for Fish Habitat Conservation and Management* (2013 Update) (DPIRD Fisheries P&G) for fallen trees may be classified as LWD/ snags they must be: • Greater than 10 cm in diameter and at least 1 metre in length. • Can include entire fallen trees, large branches, root wads, or logs. Accordingly, the removal of certain fallen trees will trigger the dredging/ reclamation provisions of the FM Act and require a permit under s200/ 201 or consultation under s199 (for a Public Authority). In practice, there is a preference towards retention of native species when compared to exotics, as they support local ecological functions and degrade naturally in a way that benefits habitat structure. Exotic species may not be considered suitable for retention due to different decay rates, potential toxicity (e.g. camphor laurels), or lack of ecological compatibility with native aquatic species. Other considerations for removal vs. retention of fallen timber includes the impact the fallen trees are having on bank stability (e.g. if they are protecting, or alternatively if they are contributing to erosion, etc. through impacts to water flow and sedimentation). Re-use on site, in terms of relocating or realigning snags where retention is not possible, is something that is supported under the DPIRD Fisheries P&G. Additionally at this location (CBMP Habitat Protection Zone), the following clause from the *Marine Estate Management (Management Rules) Regulation 1999* applies to habitat disturbance: (2) Consent is only to be given under subclause (1) - (a) for research, environmental protection, public health, traditional use or public safety purposes, or (b) for the purposes of an ecologically sustainable use that does not have a significant impact on fish populations within the zone or on any other animals, plants or habitats.	Fallen trees will be retained where there are no concerns for safety of waterway users. All snags/ fallen trees will be utilised as LWD for bank treatments. A dredging and reclamation permit will be required as discussed in Section 4.2.3.

Summary of feedback	Response
Danny Bucher, Project Officer Marine Estate, DPHI – Crown Lands	
Crown Lands' interests in the project area are limited to the mapped waterway of Marshalls Creek below the deed Mean High Water Mark. There are some sections where erosion has shifted the bank away from the mapped deed MHWM. Where bank restoration works do not extend into the mapped waterway area then no authorisation would be required from DPHI - Crown Lands. An identification survey is recommended to ascertain the position of the waterway.	Waterway boundaries are mapped in Figure 2.
A General licence would be required for a deck/ jetty located within the mapped waterway. In other areas a short-term licence would be the most appropriate form of authorisation for bank restoration works below the mapped MHWM.	Noted, refer Section 4.2.3.
Crown Lands supports in principle the strategic approach to the area, particularly the attempts to use non-structural methods where appropriate while recognising that some areas of high public use and facilitated access are also required.	Noted.
Emma Kirsner and Shey Smith, Ranger, Tweed Byron Area, NPWS	
Very supportive of the concepts and the use of materials that already occur in the environment and not introducing new materials to help preserve the existing creek bank, mangroves, and trees	Noted.
Proposed rehabilitation footprint is located outside of NPWS tenure but directly adjacent to Marshalls Creek Nature Reserve however note that any works that change the hydrology of the creek adjacent to the nature reserve will have potential cross stream and downstream flow on effects within the nature reserve and surrounding environment. These flow on effects will need to be further considered in the environmental assessment phase of these proposed works.	Proposed bank treatment works are consistent with the Plan of Management for the Nature Reserve, particularly: • Consultation and involvement of the TBLALC in the management of Aboriginal sites, places and values, including interpretation of places or values. • No recreational facilities within the reserve. • Low impact self-reliant nature-based use of the reserve such as canoeing, bird watching and nature study. Rock revetment to protect trees within the Nature Reserve from erosion is consistent with the PoM.

Summary of feedback	Response
Project aim is to restore the foreshore but increasing biodiversity should be included. All strata layers should be incorporated – Canopy, ground layer, shrub layer which could help in guiding members of the public to access points.	All strata layers have been included in detailed designs for riparian revegetation.
Maurice Gannon, Conservation Planning Officer, TBLALC	
The Brunswick Heads region has not been researched either extensively or intensively by archaeologists. There are few sites registered on the Aboriginal Heritage Information Management System (AHIMS) database, particularly in the hinterland (on the western side of the Pacific Motorway). It is reasonable to state that this is almost certainly a function of the lack of research, given that there is an abundance of sites all along the NSW north coast and inland in the Tweed Valley. However, included in the few sites that have been registered around Brunswick are some extremely culturally important ones.	Noted. Information provided has been included in the due diligence assessment (Appendix 2).
There are two locations of shell deposits in the Marshalls Creek bank along Casons Road. Both deposits have some of the key characteristics of midden material (size of shells, mixture of species) but lack some of the other defining features (depth of the deposits, age weathering). Given the fact that the sites have been heavily eroded it is very possible that they are actually the residual, recent layers of larger deposits that have been eroded.	Noted. Information provided has been included in the due diligence assessment (Appendix 2).
Whether the shell deposits are of Aboriginal cultural heritage (ACH) origin or not is a moot point because the scale of the proposed works basically dictates that the most cautious approach should be taken. I therefore recommend that a licensed archaeologist be engaged to complete an Aboriginal Cultural Heritage Assessment Report (ACHAR), which necessarily will entail Aboriginal community consultation in preparation for impacts to ACH and, if necessary, subsurface testing within the confines of the appropriate regulatory authorisations and approvals. There may also be consideration given to seeking approval for non-impacting erosion control works at the two midden sites. I suggest also that consideration should be given to including the whole length of the proposed creek bank rehab / engineering works under the ACHAR simply because (i) it is a contiguous natural and cultural environment, and (ii) this would not equate to any significant widening of the scope of the ACHAR.	Noted. Information provided has been included in the due diligence assessment (Appendix 2).
Other than funding, there are no operational reasons to delay the ACHAR pending the final specification and funding of the full project. In other words, the archaeological assessment and any related field work could be undertaken at any time and, in fact, the earlier the better, given that the locations are subject to active erosion.	Noted.

Summary of feedback	Response
Todd Adamson – Waterway Operations Officer North – NSW Maritime	
No objections to the overall concept, considering safety and navigation. Marshalls Creek has a high level of interest/use by passive craft such as canoes and kayaks.	Noted.
To improve design safety and sustainability, consider ramp access rather than steps at section R, to improve access for all abilities and formalize the launching and retrieval of canoes/kayaks.	A ramp has been considered at that location, constraints include the available space and grade, adjoining Nature Reserve, exposed tree roots and narrow creek width in this location. In addition, there is minimal parking and no all ability access to this area. There is also the boat ramp along Casons Rd which was planned to be the main canoe launch area. There still may be opportunity to consider variations to the deck and waterway access during the construction phase.

Marshalls Creek site meeting 7/4/25 10am – 12.30pm

Attendance:

Hydrosphere – Mick, Robyn

BSC – Chloe Dowsett, Ben Grant (Senior Planner)

NPWS – Emma Kirsner, Shey Smith

DPIRD – Marine Parks – Dave Maguire, Karen Ellis

TBLALC – Maurice Gannon

DPHI – Crown Lands – Danny Bucher

Discussion

Section A:

Within Sanctuary zone, different approval process to other sections.

Section B:

Maurice sees more evidence of midden material (since TC Alfred) so now believes it is a midden site and should be registered on AHIMS. Suggests test pits may be required with salvage of material. He will advise if funding may be available through "Protecting Our Places" grants.

Chloe – Sandstone here? – e.g. double row of blocks over top of rock revetment

No need for picnic tables here – isolated seating only.

Section G:

Dave and Emma – concerned about actively diverting flows to other side of river and impacts.

Section I:

Dave suggested may not be appropriate to provide water access just for residents. Purpose is for river rehab and the other rec access may be enough?

Do we want to encourage tinny access here?

Do we need rocks instead of coir logs here?

Section K:

Do we need dinghy controls here?

Chloe – should we repair boat ramp, resurface/ regrade?

Section L:

Coir logs have been effective.

Maurice – shells exposed here too (possible midden).

Potential dredging from sandbar in river – Maurice advised this would be preferable to importing fill. Island is a popular beach area plus it protects shallow swim area near bank so may not be preferred by community. Dave has some concerns about dredging.

Section P:

Chloe – use sandstone here instead of logs?

Where does sand come from?

Keep water access/sand fill compact/ narrow with natural outer areas e.g. root balls.

Reveg with endemic species. Match with PCT preferred by NPWS if possible

Section R:

Potential disabled parking and canoe drop off area?

Danny – CL requires consideration of soft protection works instead of hard if on Crown waterway (below MHWM).

Section S:

Check NPWS Reserve PoM – need to be consistent with that.

TfNSW should be consulted about navigational issues.

Chloe concerned about safety of submerged rocks.

Potential cantilever decking over rocks?

General

Construction would be by barge.

Discussion of NPWS, CL, private boundaries to be resolved.

Need to consider downdrift end effects of hard protection.

Marshalls Creek concept design meeting

5/5/25 2pm – 4pm

Attendance:

Hydrosphere – Mick, Robyn

DPIRD – Fisheries – Jillian Reynolds

BSC – Chloe Dowsett, Phil Holloway, Matt Meir

NPWS – Lori Cameron

DPIRD – Marine Parks – Dave Maguire, Karen Ellis

TBLALC – Maurice Gannon

DPHI – Crown Lands – Danny Bucher, Jacky Wiblin

Apologies:

DPIRD – Fisheries – Jonathan Yantsch, Fletcher Mingramm

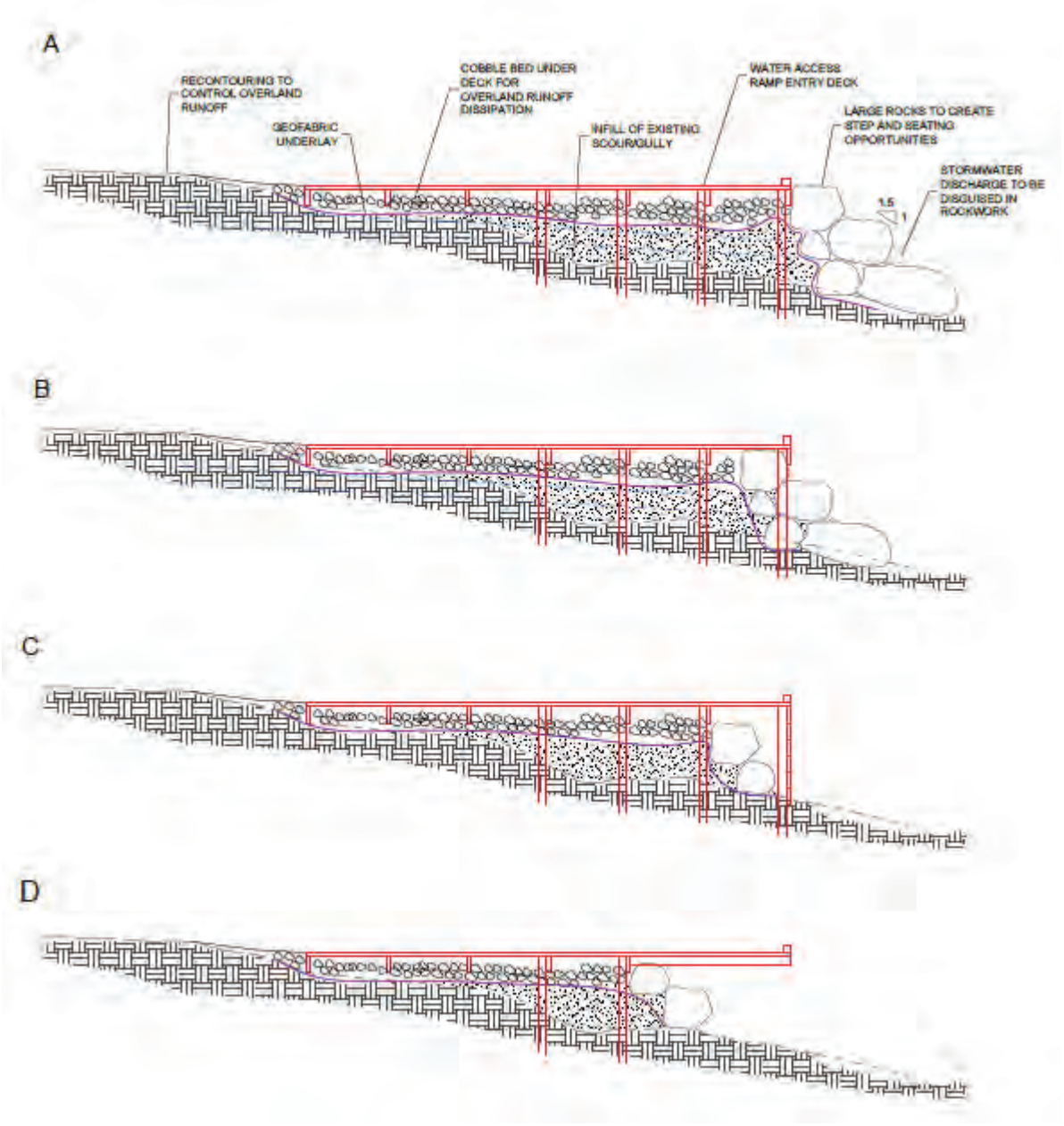
NPWS – Emma Kirsner, Shey Smith, Cameron Townend

DPHI – Crown Lands – Grant Nelson

Discussion

Hydrosphere presented figures showing site overview and elevations from LIDAR survey, bank treatment plan, concept sections A-S, design options for the deck and ramp, and administrative boundaries.

- Height of rock walls – rock revetment will be above high tide level with any backfill protected from floods (e.g. Section B, F, R, S). Rock fillet (e.g. Section D, E, G, H) will be below MHWM and open to tidal inflow at downstream end to promote mangrove enhancement.
- Options for rock protection around deck and ramp (Sections R, S) – see below. Option A is preferred as rocks will be visible above tide level, increasing safety and minimizing danger from jumping off deck. Rocks in option B will not be visible at higher tides, dark coloured water. Smooth wall in option C may increase erosion downstream and on opposite bank. Option D deck would need to be designed to prevent dislodgement of deck during flood.



- Shell/ midden areas – rock revetment and fill proposed for Section B to protect shell deposits. Maurice confirmed erosion at shell deposit in exposed tree roots at Section L does not require rock protection as material is already heavily impacted by erosion. It is appropriate to undertake an archaeological survey and potentially apply for an Aboriginal Heritage Impact Permit for the bank treatments.
- Section K boat ramp will be the main point of waterway access for small watercraft. Treatment at Sections L-M to be large woody debris for mangrove protection, fish habitat and road/powerline protection, discouraging pedestrian access. Coir logs to remain.
- Fill area P-Q to be sandy beach initially as a trial. May require revegetation in future if fill erodes or not utilised as a beach area.
- Rock revetment at Section A-B will be placed to reinstate the original planform/ eroded bank. Revetment to marry-in with downstream remaining rock. Rock

revetment to protect midden is acceptable to DPIRD-Fisheries. Large woody debris will be placed up stream and downstream to absorb eddying/ turbulence and offset impacts of hard protection.

- Rock revetment at Section P-S will be placed to reinstate the original planform/ eroded bank.
- The majority of the proposed bank treatments with rock revetment A-J and P-S will be within mapped coastal wetlands. Part 4 development application and EIS will be required.
- NPWS confirmed that the Nature Reserve Plan of Management does not permit new developments including recreational features/ public access structures. Works other than habitat protection works would require amendment to the PoM and Ministerial approval. Deck and ramp structure with associated rock revetment to be outside NR. Rock revetment to protect trees within NR from erosion would be consistent with the PoM. Boundary of the NR is the mean low water mark. Any works in the NR would require assessment which could be undertaken as part of project EIS.
- Crown waterway – the waterway boundary is the cadastral boundary mapped with last survey of the MWHM. Proposed structures at Sections R-S would be within private land, outside of the Crown waterway and would not require a Crown land licence. Bank treatments including rock works within Crown waterway would require a short-term occupation licence for construction phase from Crown lands.
- Community consultation – Council, DPIRD-Fisheries and Hydrosphere to discuss potential community engagement.
- Funding – Hydrosphere will prepare an implementation plan with costing to inform future funding opportunities and grants. Council is likely to be lead with agencies and TBLALC as project partners although funding has not yet been identified.

APPENDIX 5 GEOTECHNICAL INVESTIGATION REPORT

CMW Geosciences
Great People | Practical Solutions

20 June 2025

River Street, New Brighton Road and Casons Road

GEOTECHNICAL INVESTIGATION REPORT

Hydrosphere Consulting

Job No. BAL2025-0008AC | Version 2

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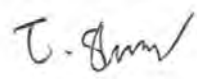
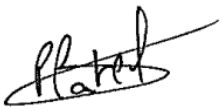
Version Control

Document version information	
Job number	BAL2025-0008AC
Prepared by	Tom Strawbridge, Engineering Geologist 
Reviewed by	Chris Lowe, Associate Geotechnical Engineer 
Authorised by	Thomas Platel, Principal Geotechnical Engineer 

Review and Update History

Revision	Date	Comments
A	4/06/2025	Initial draft for internal review
0	10/06/2025	Issue to client
B	11/06/2025	Final for internal review
1	11/06/2025	Final issue to client
C	19/06/2025	Additional DCP testing and slope stabilising pile analysis
2	20/06/2025	Final issue to client

Appendices

Figures

1.0

1.0 INTRODUCTION

CMW Geosciences (CMW) was engaged by Hydrosphere Consulting to carry out a geotechnical investigation of the site located at River Street, New Brighton Road and Casons Road, which is being considered for remediation work of the Marshalls Creek bank due to erosion.

The purpose of this report is to summarise the investigation findings which cover the cross sections from 'A' to 'I' and 'P to S' in the drawings provided by Hydrosphere Consulting, job number 25-011, dated 04/05/2025. The initial Dynamic Cone Penetrometer (DCP) investigation, comprising of DCP01 to DCP09, was undertaken on 30/05/2025 to assess the shallow subsurface conditions. Additional DCP investigations, denoted as DCP-A to DCP-H, were undertaken on 18/06/2025 to assess the deeper subsurface conditions at key locations. The purpose of the additional DCP's is to inform the design of slope stabilising piles where weak subgrade was found in the initial investigation campaign.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal email reference, BAL2025-0008AB dated 28/05/2025 & 16/06/2025.

2.0 PROPOSED DEVELOPMENT

Drawings provided by Hydrosphere Consulting indicate the development involves the construction of several bank stability remediations. The extent of remediation work is shown on Figure 1 labelled A through to S in the drawings provided. Figure 4 to Figure 7 in the supplied drawings show the concept design diagrams for each location labelled on Figure 1 below.

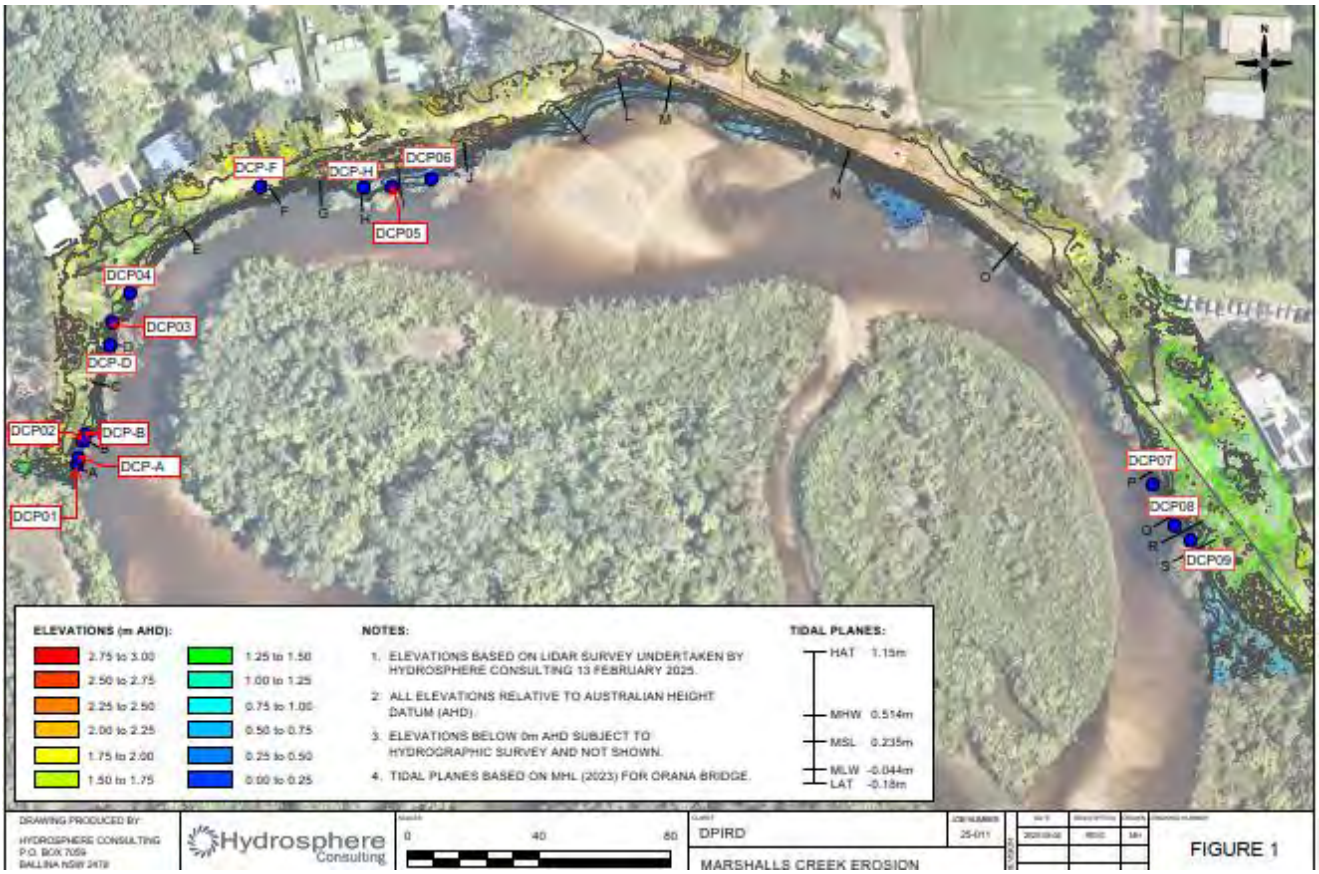


Figure 1: Site Plan with location of remediation work (A – S) and DCP locations overlain

3.0 SITE DESCRIPTION

Figure 2 below illustrates the site is located a 5 - minute drive from Ocean Shores and a 10-minute drive from Brunswick Heads. The area of interest (shown in Figure 1) is an extent of the Marshalls Creek which is fed from the Brunswick River.

Figure 2: Site Location

4.0 GEOLOGICAL SETTING

The published geological map for the area presented in Figure 3 shows the geology along the water edge comprises of Estuarine deposits which includes sand, silt, clay, shells and gravel. From site observations sand and silt was observed from the water edge, hence it is consistent with the published geology.

Figure 3: Geological Map

5.0 FIELD INVESTIGATION

5.1 Scope of Field Investigation

All fieldwork was coordinated by CMW and carried out in general accordance with AS1726 (2017), Geotechnical Site Investigation, on the 30/05/2025 and 18/06/2025. The fieldwork completed comprised of:

- A walkover survey of the site to assess the general landform, conditions and adjacent infrastructure.
- 9 DCP tests were advanced to 1m depth (approximately RL-0.7m AHD to RL-0.9m AHD)
- 5 DCP tests were advanced to 3.9m to 4.9m depth (approximately RL-3.5m AHD to RL-4.7m AHD)

DCP results are included in Appendix A.

5.2 Subsurface Conditions

From the DCP results (see Appendix A), the site can be split into two separate sections referred to as Zone 1 from DCP01 to DCP06 and Zone 2 from DCP07 to DCP09 due to the difference in subsurface consistency/density. Zone 1 subsurface conditions were generally very loose to loose materials. It can be observed in DCP04 the density of soil was medium dense to dense at 0.5 and 0.7m, it should be noted that from site observations, the DCP may have been advanced through coarser materials at these depths and this could be interpreted as an anomaly within the Zone 1 data. Zone 2 subsurface conditions were generally medium dense, with surficial layer being very loose to loose in the upper 300mm.

DCP-A & DCP-B in Zone 1 show the ground conditions are very loose to loose for the first 2m and become medium dense to dense to 2.6m. From this depth the subsurface becomes very dense to 3.9m where refusal took place.

At DCP-D the subsurface is very loose to loose to 1.7m where it becomes medium dense to dense until 3.0m. From 3.0m to 3.7m, the ground is dense to very dense. From 3.7m onwards it becomes very dense to 3.9m where refusal took place.

Note: DCP-D results indicate the first 200mm is dense to very dense. This can be assumed to be fill from observing rockfill while attending site.

DCP-F indicates the subsurface is very loose to loose for the first 2.2m. From 2.2m to 4.2m, it becomes medium dense. Between 4.2m and 4.7m, the ground is dense and becomes very dense from 4.7m.

Note: DCP-F results indicate pockets of ground are medium dense to dense between 0.3 to 1.1m. However, since there are underlying very loose to loose sands, it is conservative to assume the upper 2.2m of soil profile is very loose to loose.

DCP-H establishes the ground is very loose to loose for the first 2.3m and becomes medium dense to dense until 3.8m. The subsurface becomes very dense from 3.8m onwards.

The site conditions at the time of investigation are illustrated in Figure 4 and Figure 5 below.

Figure 4: Site Conditions **at P – S on Figure 1 on the drawings provided**

Figure 5: Site Conditions at **A and B on Figure 1 on the drawings provided**

6.0 GEOTECHNICAL RECOMMENDATIONS

6.1 Slope Stability Analysis

Using slope stability software (Slope/W), an analysis was conducted on section B as per location given in Figure 1. The analysis was undertaken utilising data provided by Hydrosphere Consulting to calculate the factor of safety (FoS) of the proposed remediation works. Figure 6 below establishes the calculated FoS is 0.93 considering the mean high water level (MHW at RL0.514m AHD).

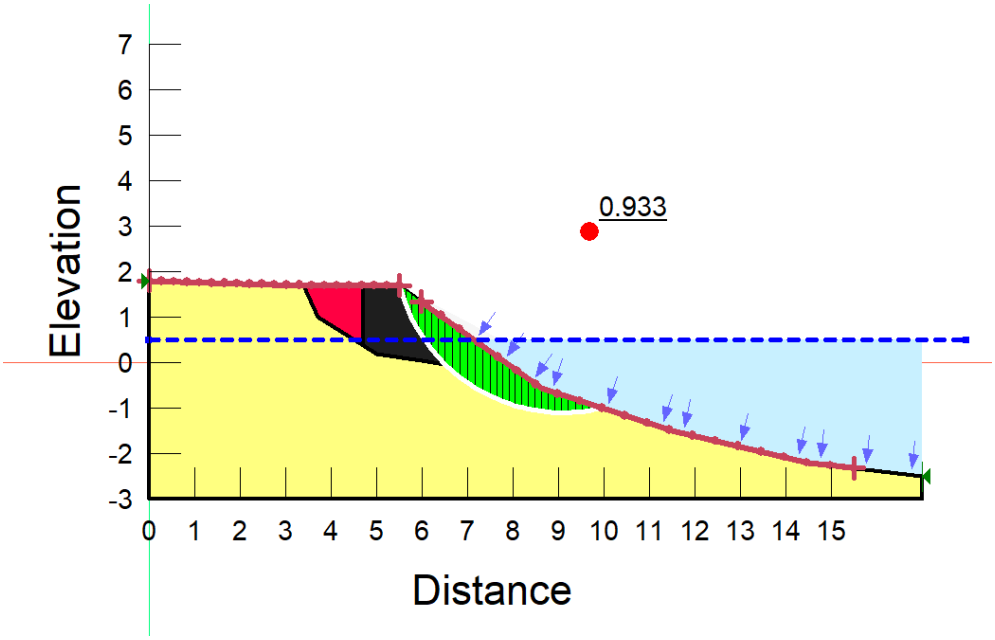


Figure 6: Slope Stability Analysis -Section B (1.5H:1V batter slope)

In Zone 1, when placing the sand and rock fill at the proposed gradient of 1.5H:1V, instabilities are anticipated to occur due to weak subgrade. It was initially recommended to have a 2.5H:1V batter to ensure adequate stability of the remediated bank. Figure 7 below establishes the calculated FoS is in excess of 1.2 considering this adjusted geometry and the mean high water level (MHW at RL0.514m AHD).

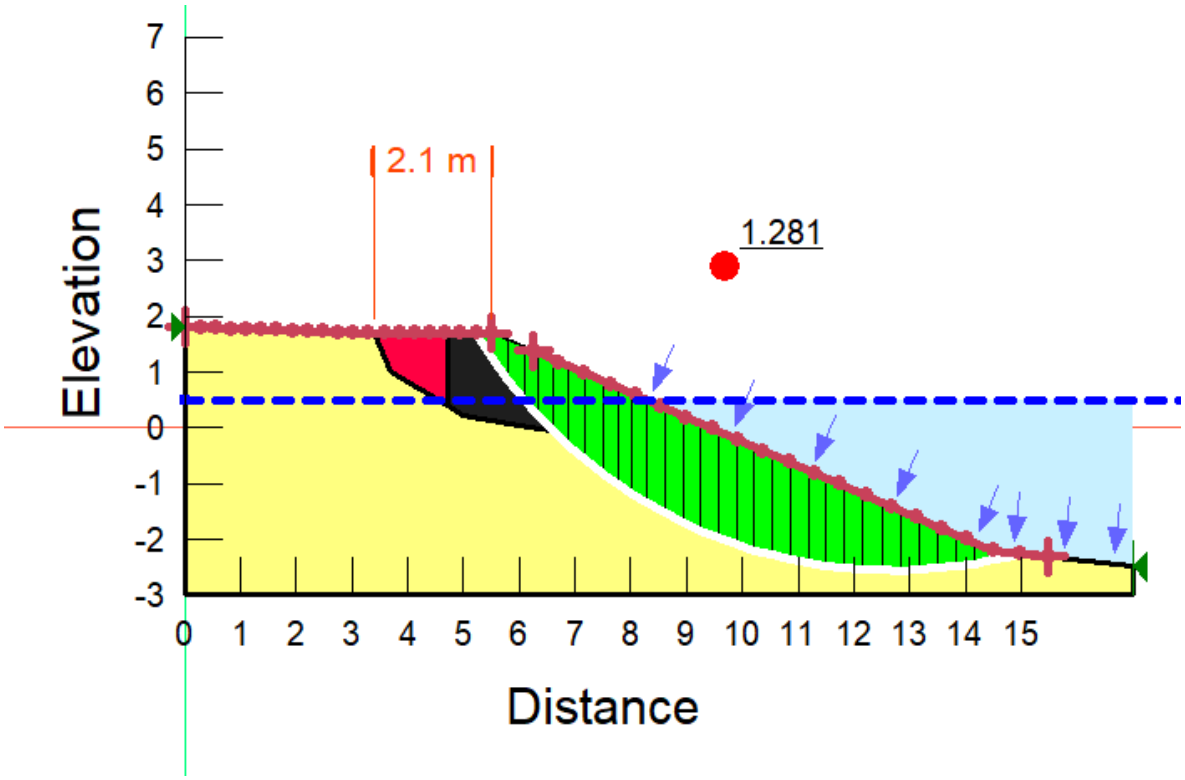


Figure 7: Slope Stability Analysis -Section B (2.5H:1V batter slope)

Through correspondences with Hydrosphere Consulting, it is understood that a 2.5H:1V batter is not practical. Therefore, CMW was requested to assess the benefits of using timber piles to reinforce the slope. Timber pile shear capacities of 90kN, 140kN and 200kN for piles diameters of 250mm, 300mm and 350mm were provided as an input to CMW.

Slope/W modelling was undertaken considering 250mm diameter piles at 0.75m spacing (i.e. three times the pile diameter). The piles were modelled at 1.5m offset from the toe of the rock revetment. It was found that this arrangement would provide suitable factor of safety in excess of 1.3. A pile toe RL of -4.5m AHD is required to ensure sufficient lateral resistance of the pile, as assessed in design software RSPile, using the concept of p-y curves to model the pile-soil interaction. Based on available DCP results, the pile embedment material comprises of medium dense to dense sands (or better) below RL-2m AHD.

The proposed arrangement is shown in the figure below.

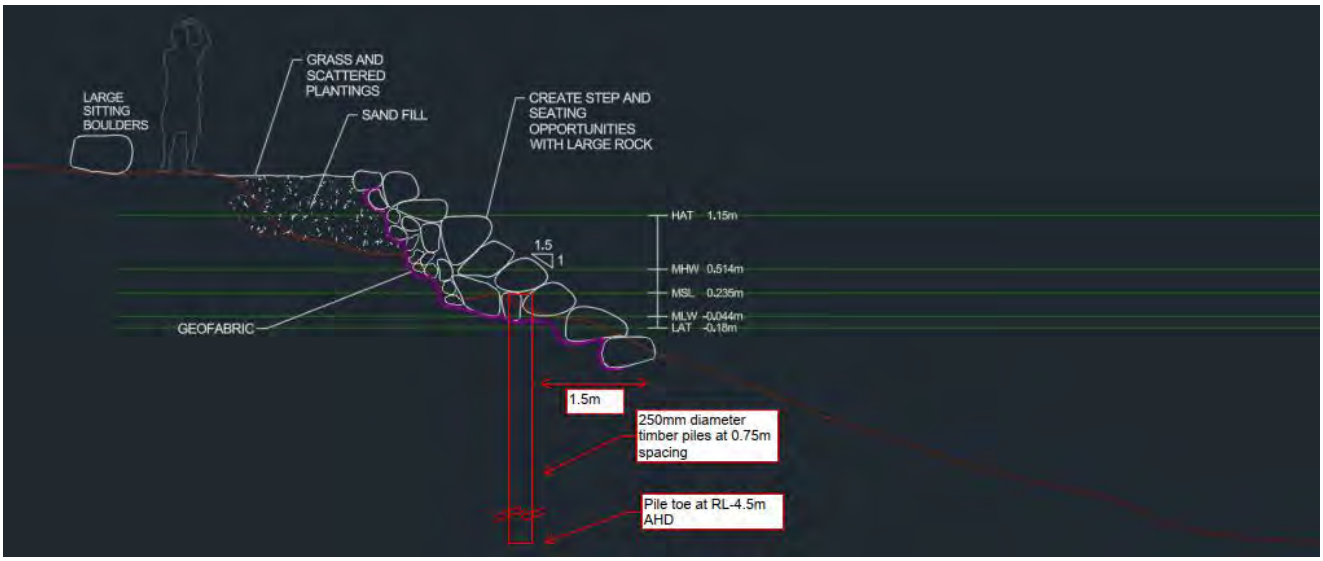


Figure 8: Slope Reinforcement Pile Concept Sketch

For the remediation works that are being proposed in the southeastern end of the creek in Zone 2, when placing the sand and rock fill at the proposed gradient of 1.5H:1V, the stability of the bank is anticipated to be satisfactory provided the upper 300mm of very loose to loose materials are removed or rock fill is sunk through these materials to ensure a sound foundation is formed, subject to confirmation by geotechnical personnel during construction.

Due to the anticipated nature of ground (i.e. inferred sands), vertical settlement of the rock revetment is expected to occur during construction.

6.2 Excavation Conditions

Excavation up to a depth of around 1.5m below ground level are expected to be readily undertaken using conventional plant such as a 20T excavator. Inflow of water into excavations will occur due to close proximity of the creek.

6.3 Site Preparation and Earthworks

Earthworks construction should be undertaken in general accordance with a project specific specification. Where no such specification exists, a reasonable alternative might be AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.

It is recommended that when placing the sand and rock fill, it is compacted/tampered to reduce the rate of subsidence in the very loose to loose sand. This can be done for the first rock layer, prior to placing a separation geotextile. The separation geotextile shall be selected to prevent damage considering the particle size distribution of imported materials and the proposed construction methodology.

In Zone 1, to mitigate risks associated with the vertical settlement of the rock revetment, construction measures such as monitoring of settlement of the finished level of the rock revetment is recommended to be implemented. Allowance shall be made for topping up the rock revetment during construction, however this is expected to be minimal based on the inferred presence of medium dense to dense materials at depths of 1.7m to 2.3m and minimal additional surcharge of approximately 1m of rock revetment material which the natural ground will experience.

Vehicle/plant movement across 'wet' subgrades during and following inclement weather would be expected to result in some damage to the exposed subgrade (i.e. local rutting due to machinery tracks and the like).

General guidelines relating to earthworks for access roads and support of ground slabs include:

- Remove topsoil and vegetation.
- Remove any loose materials within Zone 2 where the proposed slope gradient of 1.5H:1V relies on competent subgrade for stability.
- Fill should be placed in layers not exceeding 250mm loose thickness and be compacted to the required standard and level before placing the next layer. Thinner layers may be required for smaller compaction equipment.

7.0 SAFETY IN DESIGN

The design landform requires site excavations that may include geotechnical works such as steep fills over very to moderately weak subgrade as specified in the Geotechnical report(s) and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect). The CMW designs/ specifications for undercuts have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

8.0 CLOSURE

This report has been prepared for use by Hydrosphere Consulting in relation to the, River Street, New Brighton Road and Casons Road project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Hydrosphere Consulting seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental matters are not covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

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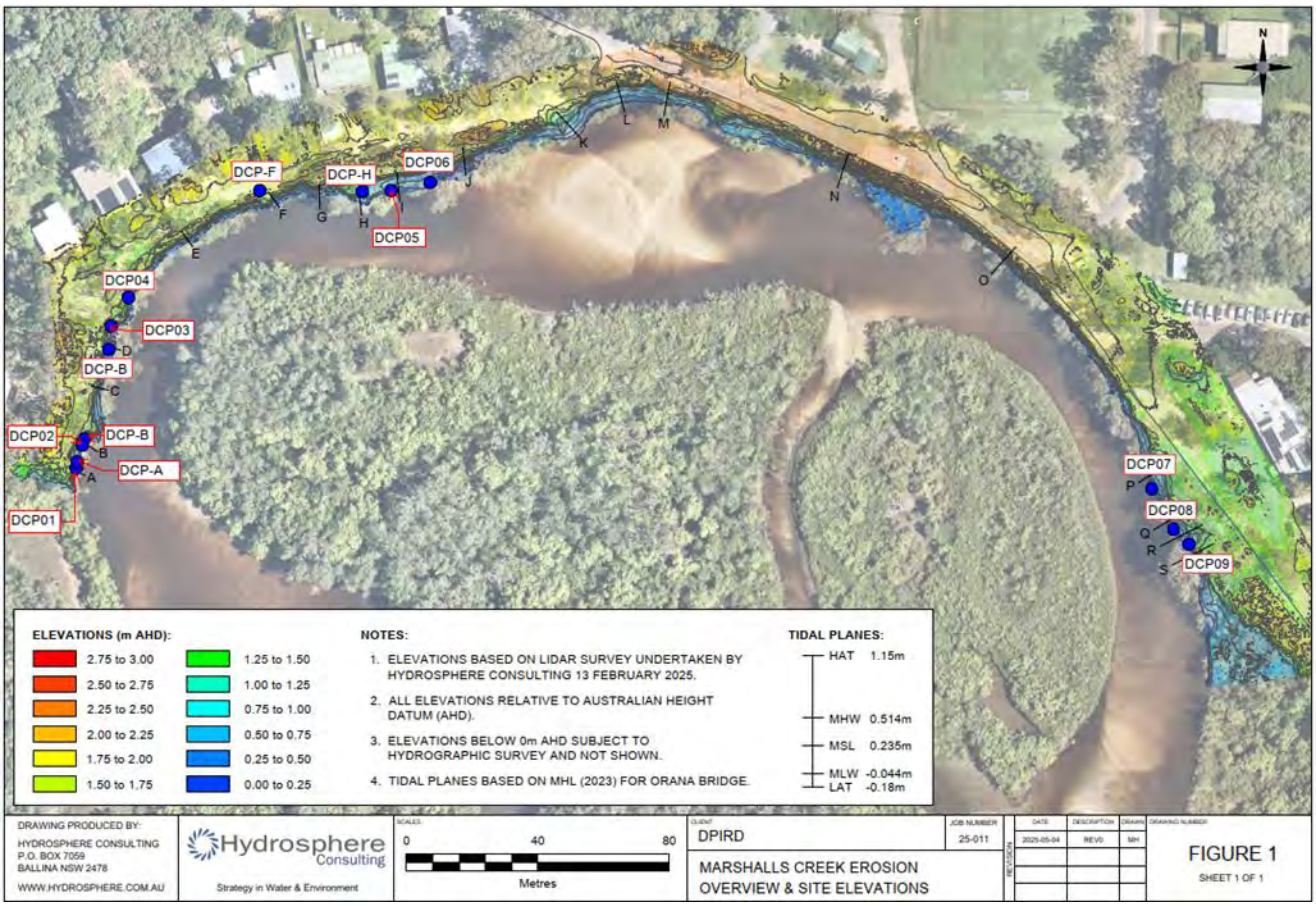
APPENDIX A

DCP Results & Site Plan


N
DCP-F
DCP-H
DCP06
DCP05
DCP04
DCP03
DCP-B
DCP02
DCP-B
DCP-A
DCP01
DCP07
DCP08
DCP09
A
B
C
D
E
F
G
H
J
K
L
M
N
O
P
Q
R
S
ELEVATIONS (m AHD):
2.75 to 3.00
2.50 to 2.75
2.25 to 2.50
2.00 to 2.25
1.75 to 2.00
1.50 to 1.75
1.25 to 1.50
1.00 to 1.25
0.75 to 1.00
0.50 to 0.75
0.25 to 0.50
0.00 to 0.25
NOTES:
1. ELEVATIONS BASED ON LIDAR SURVEY UNDERTAKEN BY HYDROSPHERE CONSULTING 13 FEBRUARY 2025.
2. ALL ELEVATIONS RELATIVE TO AUSTRALIAN HEIGHT DATUM (AHD).
3. ELEVATIONS BELOW 0m AHD SUBJECT TO HYDROGRAPHIC SURVEY AND NOT SHOWN.
4. TIDAL PLANES BASED ON MHL (2023) FOR ORANA BRIDGE.
TIDAL PLANES:
HAT 1.15m
MHW 0.514m
MSL 0.235m
MLW -0.044m
LAT -0.18m
DRAWING PRODUCED BY:
HYDROSPHERE CONSULTING
P.O. BOX 7059
BALLINA NSW 2478
WWW.HYDROSPHERE.COM.AU
Hydrosphere Consulting
Strategy in Water & Environment
SCALES:
0
40
80
Metres
CLIENT
DPIRD
JOB NUMBER
25-011
MARSHALLS CREEK EROSION
OVERVIEW & SITE ELEVATIONS
REVISIONS
DATE
DESCRIPTION
DRAWN
DRAWING NUMBER
2025-05-04
REV0
MH
FIGURE 1
SHEET 1 OF 1

DYNAMIC CONE PENETROMETER
AS1289.6.3.2 – 1997

Client:	Hydrosphere Consulting	**Date:**	30/05/2025
Project Name:	New Brighton Bank Erosion	**Tested By:**	Tom Strawbridge
Project No:	BAL2025-0008	**Equipment ID No:**	DCP01
Location:	River Street, New Brighton Road, Casons Road	**Hammer Weight:**	9 kg
Soil Type:	Sand (based on visual observations of material at the ground surface)	**Hammer Drop Height:**	510 mm

Test Location	DCP01	DCP02	DCP03	DCP04	DCP05	DCP06	DCP07	DCP08	DCP09
Ground Level (m AHD, approximate)	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.1	0.2

Test Depth (m)	**Blows/100mm**								
0.00-0.10	1	1	0	1	1	1	1	0	2
0.10-0.20	2	0	2	3	3	0	2	0	2
0.20-0.30	2	0	1	0	3	2	3	1	2
0.30-0.40	2	0	1	1	2	1	3	3	2
0.40-0.50	1	0	0	2	1	2	3	2	3
0.50-0.60	1	0	0	4	2	1	3	2	2
0.60-0.70	1	0	1	7	1	2	4	2	3
0.70-0.80	1	1	1	1	2	1	3	2	3
0.80-0.90	1	1	1	3	1	1	4	2	2
0.90-1.00	1	1	2	2	2	2	3	1	2
1.00-1.10									
1.10-1.20									
1.20-1.30									
1.30-1.40									
1.40-1.50									
1.50-1.60									
1.60-1.70									
1.70-1.80									
1.80-1.90									
1.90-2.00									
2.00-2.10									
2.10-2.20									
2.20-2.30									
2.30-2.40									
2.40-2.50									
2.50-2.60									
2.60-2.70									
2.70-2.80									
2.80-2.90									
2.90-3.00									

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DYNAMIC CONE PENETROMETER
AS1289.6.3.2 – 1997

Client:	Hydrosphere Consulting	**Date:**	18/06/2025
Project Name:	New Brighton Bank Erosion	**Tested By:**	Tom Strawbridge
Project No:	BAL2025-0008	**Equipment ID No:**	DCP01
Location:	River Street, New Brighton Road, Casons Road	**Hammer Weight:**	9 kg
Soil Type:	Sand (based on visual observations of material at the ground surface)	**Hammer Drop Height:**	510 mm

Test Location	DCP-A	DCP-B	DCP0-D	DCP-F	DCP-H				
Ground Level (m AHD, approximate)	0.4	0.2	0.2	0.2	0.3				

Test Depth (m)	**Blows/100mm**								
0.00-0.10	2	1	10	1	0				
0.10-0.20	2	1	7	0	1				
0.20-0.30	2	1	0	1	2				
0.30-0.40	1	1	0	4	2				
0.40-0.50	1	1	0	5	0				
0.50-0.60	1	1	0	4	4				
0.60-0.70	1	1	0	4	0				
0.70-0.80	1	0	1	4	1				
0.80-0.90	1	1	0	6	1				
0.90-1.00	1	1	2	6	1				
1.00-1.10	1	0	2	3	1				
1.10-1.20	1	1	2	1	2				
1.20-1.30	2	1	2	1	1				
1.30-1.40	1	3	1	2	1				
1.40-1.50	1	2	2	1	1				
1.50-1.60	1	1	1	0	1				
1.60-1.70	2	1	2	2	2				
1.70-1.80	2	2	3	1	2				
1.80-1.90	2	2	4	2	2				
1.90-2.00	3	4	4	2	2				
2.00-2.10	4	4	4	1	1				
2.10-2.20	4	5	5	2	2				
2.20-2.30	5	5	4	3	2				
2.30-2.40	6	5	4	3	3				
2.40-2.50	6	5	6	2	2				
2.50-2.60	6	5	6	3	3				
2.60-2.70	9	10	6	2	4				
2.70-2.80	10	12	5	3	5				
2.80-2.90	14	15	5	2	5				
2.90-3.00	12	15	10	2	6				

3.00-3.10	11	15	6	3	7				
3.10-3.20	14	14	8	3	6				
3.20-3.30	18	16	9	3	6				
3.30-3.40	17	15	10	3	6				
3.40-3.50	18	16	9	2	8				
3.50-3.60	18	14	8	3	9				
3.60-3.70	17	14	10	4	8				
3.70-3.80	18	18	17	3	9				
3.80-3.90	20	20	20	4	13				
3.90-4.00				4					
4.00-4.10				5					
4.10-4.20				5					
4.20-4.30				6					
4.30-4.40				6					
4.40-4.50				9					
4.50-4.60				9					
4.60-4.70				9					
4.70-4.80				10					
4.80-4.90				13					

Ballina

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