Case Study
Redlands Coast Living Shorelines (nature-based solutions (NbS) to coastal erosion)
Stage 1: Planning, Design and Permits

Introduction

The Redland City Local Government Area (LGA), also known as Redlands Coast, has approximately 335 kilometres of coastline (Figure 1). The coastal zone extends from Tingalpa Creek at Thorneside, south to the mouth of the Logan River and across the Southern Moreton Bay Islands and North Stradbroke Island (Minjerribah). North Stradbroke Island forms a barrier between the Pacific Ocean and Moreton Bay (Quandamooka). Traditional Owners of much of the Redlands Coast are the Quandamooka People.

Figure 1 – Redlands Coast

The QCoast2100 program is a state-wide initiative of the Queensland State Government and Local Government Association of Queensland (LGAQ) to help Queensland coastal councils proactively plan and manage coastal hazard impacts, from present-day to 2100.
Redland City Council (RCC) has an adopted Coastal Hazard Adaptation Strategy (CHAS) and was awarded funding through the QCoast2100 program to develop two pilot living shorelines projects (nature-based solutions to coastal erosion).

Project Overview

Natural ecosystems contribute to coastal hazard risk reduction through ecosystem processes such as increased bed friction, local shallowing of water, sediment deposition and building of vertical biomass. These processes cause responses such as a change in shore profile and elevation relative to sea level, and wave attenuation, which in turn mitigate coastal hazards. As a living, growing system, nature-based methods are adaptive to a changing climate, and can self-repair after storm events. This contrasts with traditional "hard" structures, which become less effective throughout their design life, and need to be upgraded or replaced with climate change. Shoreline hardening severs the transition between terrestrial and shallow marine ecosystems, resulting in a significant loss of biodiversity as natural habitats are replaced. Nature-based methods, on the other hand, have the capacity to provide several co-benefits in addition to coastal defence, which include supporting biodiversity, fisheries productivity, water filtration, and carbon storage. (Morris et al 2021, pg7)

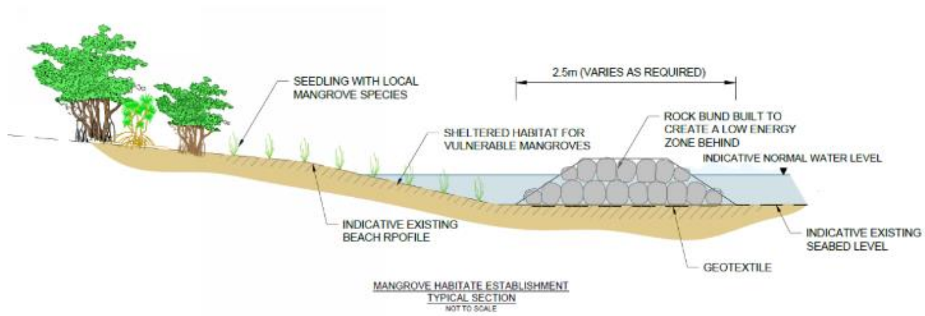


Figure 2 – Example Living Shorelines (Source JBP)

RCC is committed through its CHAS to exploring, testing, and implementing nature-based alternatives to traditional coastal protection structures in areas that are suited to this approach. However, examples of living shorelines projects and proof of concept in Queensland and more locally in a Moreton Bay context are limited and need further development. Prior to RCC considering more broadscale rollout of this Living Shorelines, pilots are required to determine what aspects will and will not work locally.

The purpose of Stage 1 of the project is to develop an understanding of nature-based solutions that may be trialled on the Redlands Coast, and the necessary design and permit documentation for two pilot living shoreline designs. The project will aim to trial/pilot different types of designs, materials, and construction techniques.

Stage 2 of this project involves finalising permits/approvals and then construction of pilots. Stage 3 will involve monitoring, and ongoing maintenance.

Pilot Living Shoreline Sites

Two pilot locations were identified in RCCs CHAS:

1. Oyster Point, Cleveland; and
2. Three Paddocks Park, Birkdale/ Wellington Point.

These locations were selected due to clear evidence of ongoing erosion in areas where natural landscapes have been altered, in addition to evidence of established vegetation in the immediate area. Both locations are visible and accessible to the public while not directly adjoining private land or critical infrastructure. Each site has unique challenges (Three Paddock Park adjoins a modified creek outlet, while Oyster Point is the site of a kayak launch point, shell midden and nearby shorebird roost area). These characteristics will inform potential designs solutions that if deemed successful can be rolled out to other similar sites with similar coastal process and constraints.

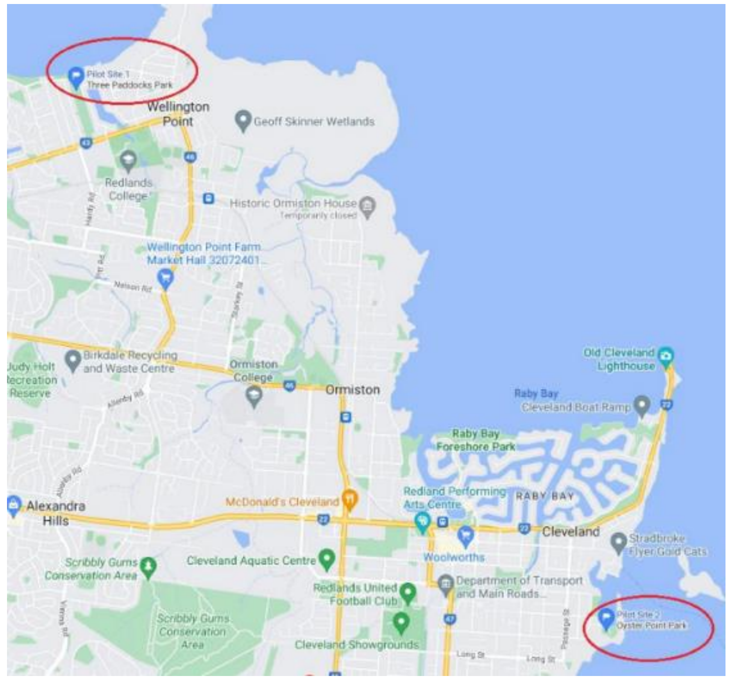


Figure 3 – Site Locations - Site 1: Three Paddocks Park, Birkdale/Wellington Point &Site 2: Oyster Point Park, Cleveland

Figure 4 – Oyster Point Park, Cleveland

Figure 5 – Three Paddocks Park, Birkdale/Wellington Point

Figures 6, 7 & 8 –Oyster Point Park, Cleveland

Figures 9 & 10 –Three Paddocks Park, Birkdale/Wellington Point

Process

RCC utilised the assistance of consultant engineers (JBP Scientists and Engineers), environmental scientists (frc environmental) and cultural heritage experts (Converge Heritage + Community) to progress Stage 1; this involved:

- Background Investigations
  - Existing data review, marine plant surveys, coastal process studies, and living shoreline desktop review.
- Options Analysis
  - Options shortlist, design criteria, multi criteria assessment and preferred option selection.
- Stakeholder Engagement
  - RCC stakeholders, environmental groups, traditional owners.
- Design and Documentation
  - Concept/preliminary/detailed designs, cost estimates, construction methodology indicative maintenance program and costing, asset information, monitoring programme.
- Permits and Approvals
  - Identification of permits, development application (prescribed tidal works), Marine Park permit application.

Background Investigations & Options Analysis

The environmental context and risk level are two key considerations in the decision to use a nature-based method…In general, lower energy environments are more suitable for a soft approach, while hybrid approaches are more diverse and can be used in a larger range of environmental conditions. (Morris et al, 2021).

Marine Plant Assessment

Map the distribution of marine habitats within the vicinity of pilot sites to assist in the design and quantifying impact for permits and approvals.

Coastal Process Studies

Identify drivers for erosion and determine if nature-based options may be appropriate for the sites. Given the relatively low energy wave and tidal processes it was determined that nature-based solutions should minimise the impact of nearshore currents and wind-driven waves on the bank, and promote growth of marine vegetation, in particular existing mangroves, and saltmarsh.

Living Shoreline Desktop Review and Options Appraisal

Six nature-based erosion controls suitable for the Redlands Coast were identified.

1) Vegetation

Vegetation binds existing soils, assists in trapping sediments, reduces wave and storm energy on foreshores. Vegetation has key ecological function in the transition space between terrestrial and marine environments.

Dune vegetation - Native dune grasses and ground covers will be relevant to areas on Stradbroke Island and some exposed sandier coastlines on the mainland and bay islands.

Figure 11 – Dune Vegetation

Mangrove - Occur within low energy, sedimentary shorelines between mean tide and high tide elevations - meaning that nature-based engineering approaches may be required to create calm areas for their establishment.

Figure 12 – Mangroves

Saltmarshes - Consist mainly of low growing, salt-tolerant vegetation. Saltmarshes generally form at the high intertidal zone, at the landward edge of the mangroves in Moreton Bay (and regionally) and are submerged during high spring tides.

Figure 13 – Salt Marsh

2) Minor Bank Works,

Foreshores can be eroded through a variety of mechanisms including lateral retreat, slumping, undercutting, oversteepening, rear side erosion due to overtopping, etc. In these areas, it is beneficial to reduce the slope of the bank back to a stable gradient prior to vegetation establishment.

For bank works to be successful they should be undertaken in conjunction with revegetation. When reshaping the bank, batters of 1:2 (vertical: horizontal) is generally considered stable although recommendations range up to 1:4 for safe maintenance. The need for ongoing maintenance to the reprofiled bank will depend on the success of vegetation establishment and the occurrence of any storms immediately after construction, which is the period with the greatest risk of damage *(JBP, 2022)*.

Figures 13 & 14 – Slope Stabilisation (Source: The Nature Conservancy, 2020)

3) Natural Log Debris

Wooden debris and log jams are a growing approach in riverbank stability. They are not suitable for an open sandy coastline, many parallels can be made between river morphology and the intertidal regions of Moreton Bay, with a log jam considered to be a potential erosion protection option. This protected area would allow silts to accumulate and mangrove propagules to establish, which would act as the primary shoreline defence. This is expected to have similar effect as a small pocket breakwater with lower material costs if the logs can be sourced locally *(JBP, 2022)*.

Figures 15 & 16 – Log jam/debris (Source: City of Gold Coast, 2022)

4) Reefs And Pocket Breakwaters

Reefs and breakwaters protect the shoreline by reducing the wave energy. Offshore submerged reefs are used to attract and sustain a wide diversity of marine life by providing protection from predators, shelter from ocean currents, breeding opportunities and a supply of rich food sources. In a tide-dominated shoreline like the two pilot sites, a pocket breakwater can be designed to provide protection from incoming wave energy, creating stable zones for vegetation and marine plant growth.
A range of emerging materials are being used to create reef habitats, including reef balls, artificial concrete units and oyster bags *(JBP, 2022)*.

Figure 17 - Reef ball breakwater (Source: Sacred Heart University, 2019)

Figure 18 - Reef balls before/after (Source: Reef innovations, n.d)

Figure 19 – Oyster reef breakwater (Source: Chesapeake Bay Foundation, 2023)

5) Rock Fillets

Rock fillets are designed to dissipate energy from wave and currents and allow vegetation to re-establish adjacent to an eroding bank.

They are typically oriented parallel to the shoreline, connected at one end where the dominant energy originates (either due to waves or currents), and constructed using loose placed rock. The crest level of the rock is relatively low level, e.g. positioned at mean sea level, and is not considered the primary shoreline defence - instead being designed to absorb wave action and create an area of calm water between the fillet and the eroding bank. This area encourages the accumulation of sediment and provides a habitat that is suitable for the natural regeneration of mangroves or reeds *(JBP, 2022)*.

Figures 20 & 21– Rock fillet before/after (Source: NSW Government, 2017)

6) Planted Revetments.

A planted revetment uses a sloped rock or concrete honeycombed base with vegetation strategically planted onto the structure. The application of a vegetated revetment is considered suitable in the following areas:

3. Where an eroding shoreline is threatening valuable assets or infrastructure.
4. Where additional environmental benefit is desired however the primary defence requires engineering certification *(JBP, 2022)*.

Figures 22 & 23 – Planted Revetments (Source: JBP, 2022 & NSW Government, 2017)

Design Requirements

- Provide measurable shoreline protection against erosion
- Have increased ecological and social benefits
- Provide continued public access to enjoyment of the foreshore
- Have design and specifications capable of being documented (and potentially certified)
- Minimise capital costs and ongoing maintenance requirements
- Minimise construction and disturbance areas
- Minimise design, construction, operation, and maintenance risks *(JBP, 2022)*.

Design Life

The ultimate intent for a Living Shoreline solution is for it provide foreshore erosion protection whilst becoming part of the local environment with limited requirement for ongoing Council maintenance. However, there is limited guidance available on the standard of protection offered by nature-based designs. The Living Shoreline concept is considered suitable for low wave energy environments, with some damage expected during extreme storms - as is the case for any coastal ecosystem. Thus, the concept of a design event is not as straightforward as conventional engineering structures.

Parts of the Living Shoreline, such as temporary structures consist of rocks, logs, or oyster bags etc, do have a design life. A design life of 5 to 10 years is considered appropriate for temporary structures, with the requirement on structure performance lowered towards the end of design life with gradual restoration of nature taking over as chief form of foreshore protection. Within the design life, the structure may still require maintenance to maintain its design level, particularly following adverse weather conditions, occasional damage, dilapidation, or significant toe scour.

RCC guidelines and the State Coastal Protection and Management Regulation (2017) gives provision for the design of structures to withstand a minimum 2% Annual Exceedance Probability (AEP) design storm event. Given the foreshore protection works are not protecting critical infrastructure assets directly and if failure occurs it is unlikely to cause immediate danger to life, the minimum criteria is considered appropriate.

Designs have considered storms over several return periods and adopted a 2% AEP storm event, occurring at the end of expected asset life of 10 years *(JBP, 2022).*

Stakeholder Engagement

Traditional Owners- Quandamooka Yoolooburrabee Aboriginal Corporation (QYAC)

QYAC was consulted regarding the cultural heritage risks at both pilot sites. Three Paddocks Park has moderate risk however conventional design could proceed. Oyster Point Park does have some subsurface shell midden visible in the erosion scarp. Council undertook a Due Diligence Assessment and in consultation with cultural heritage experts were able to determine that a no-dig or zero excavation design could allow Council to progress the project and ensure Council met its duty of care to Aboriginal cultural heritage.

Figure 24 – Close up of shell layer

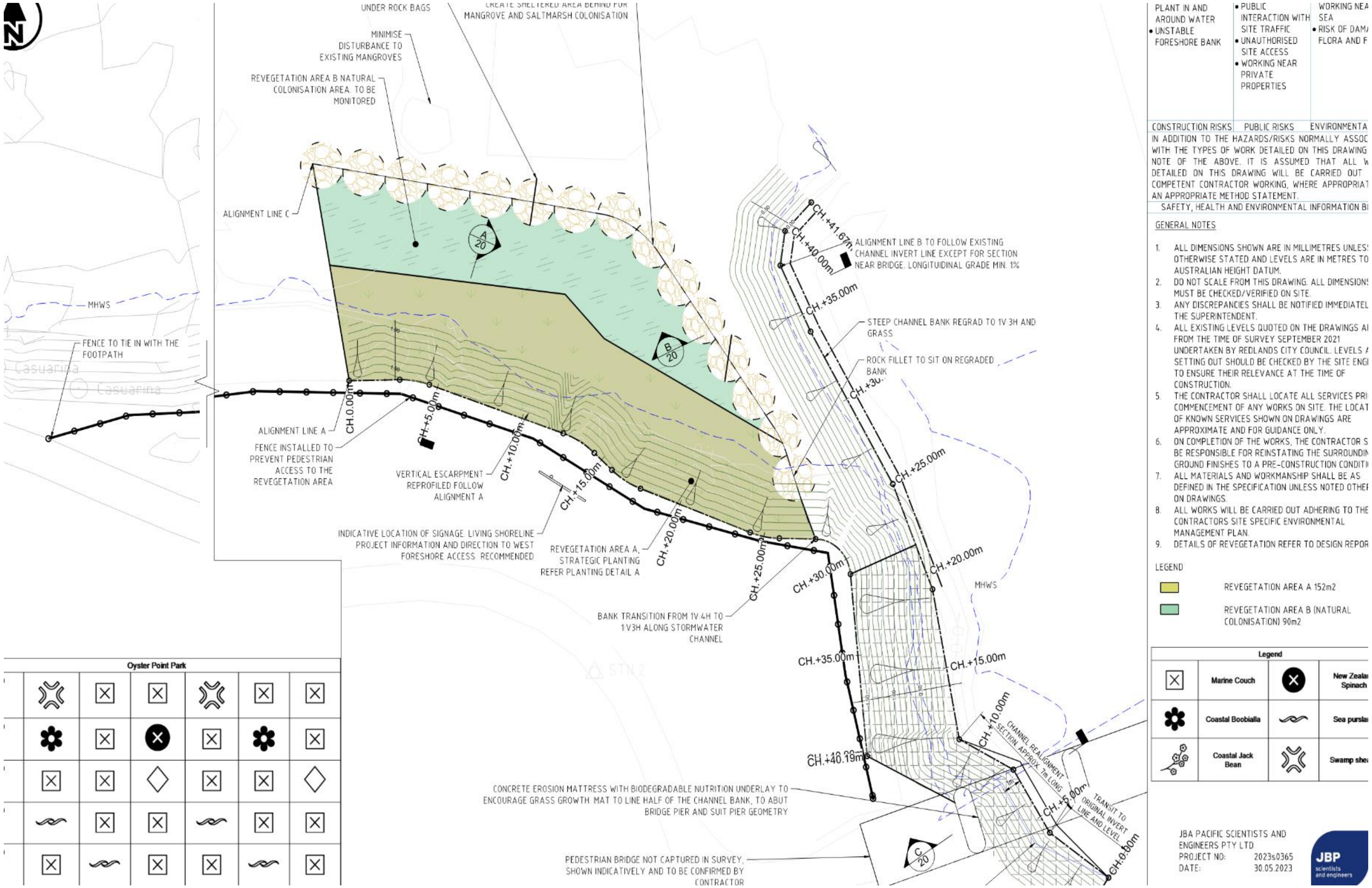
Environmental Groups

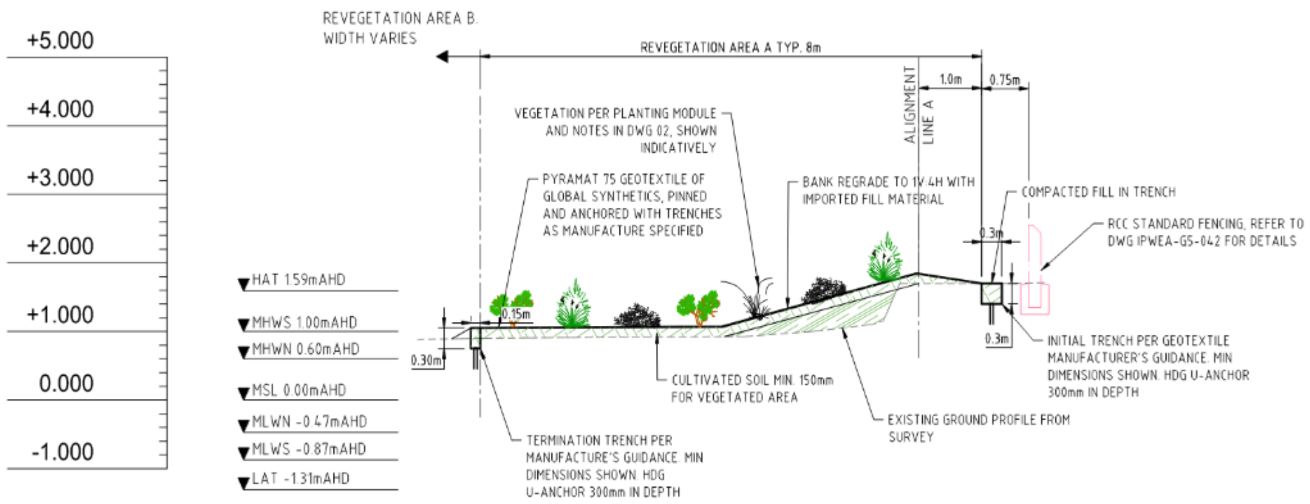
Healthy Land and Water, and the QLD Wader Study Group were consulted regarding the concept designs. In early stages the designs involved breakwaters at a significant offset to the foreshore to allow for a shadow effect or large calm area behind the breakwaters. This would in turn facilitate a more stable environment for mangrove encroachment as a form of foreshore stabilaistion. This could however change the habitat characteristics of Oyster Point Park and was not supported due to the impacts on shorebirds. The breakwaters were subsequently moved to sit just off the foreshore and the plant palate to be utilised will focus on groundcover species to avoid impact to shorebirds.

Figure 25 – Shorebirds at Oyster Point

Design Three Paddocks Park

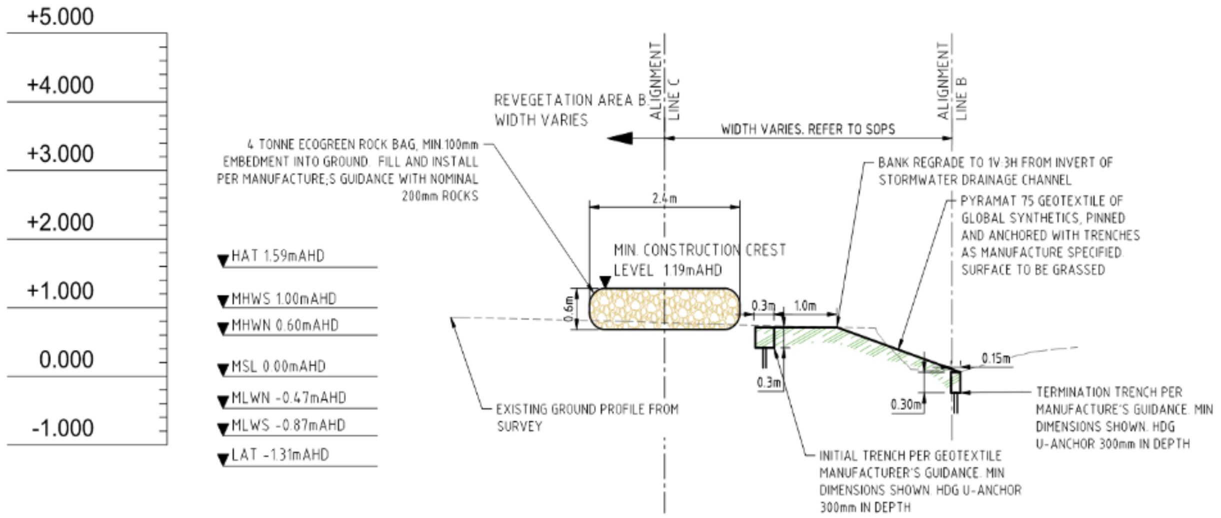
The design at Three Paddocks Park aims to accommodate coastal processes from Moreton Bay and a nearby stormwater channel that are causing foreshore erosion. The design utilises rock fillets to create a calm zone for natural and planted revegetation.

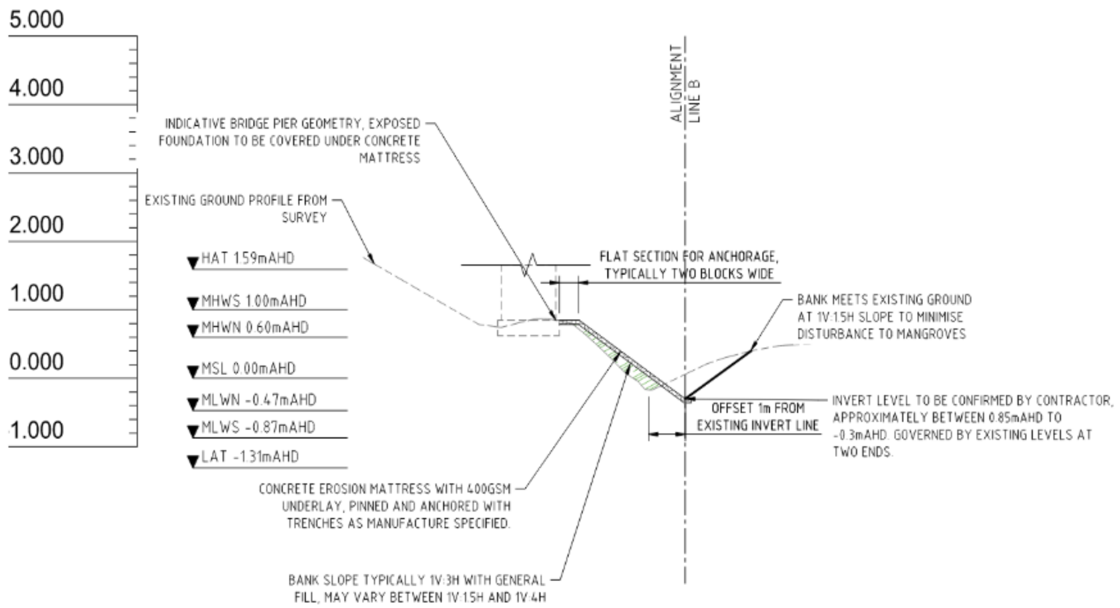




TYPICAL SECTION A

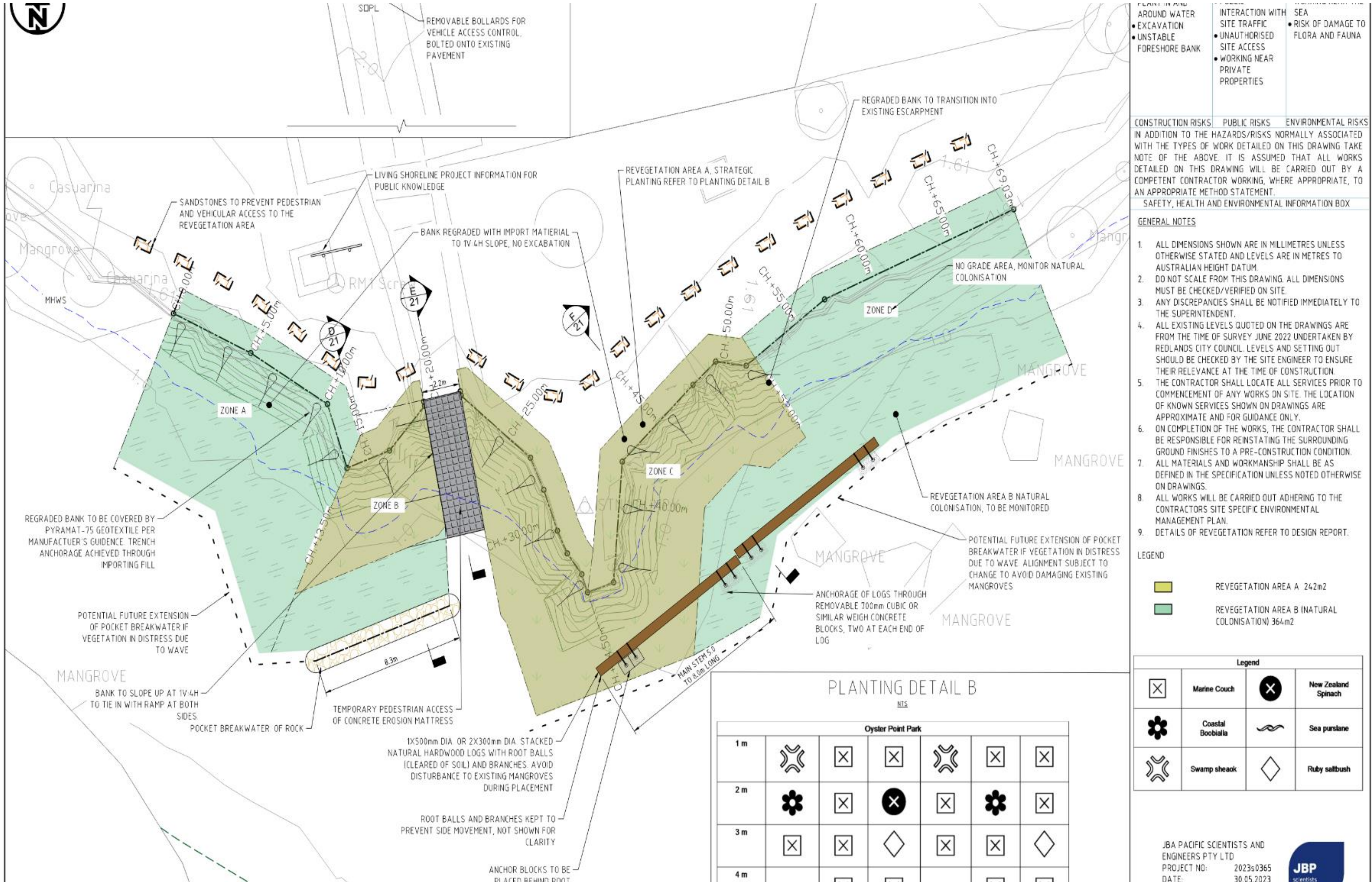
SCALE 1:50

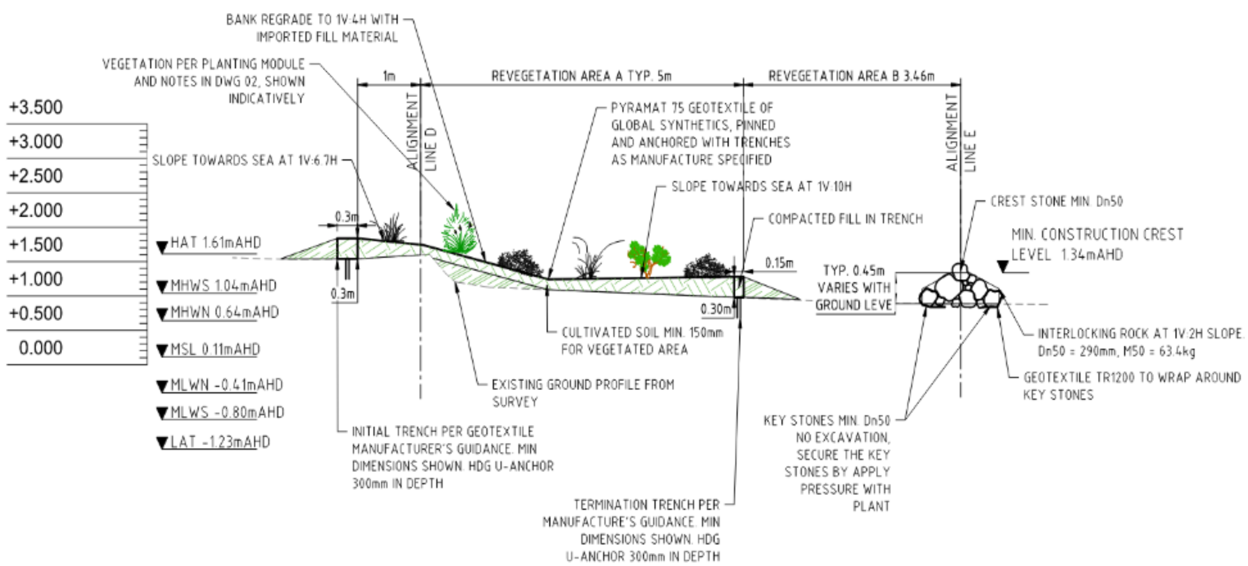




Design Oyster Point Park

The design at Oyster Point Park intends to trial 4 different zones of intervention. All zones are intended to have minimal excavation to meet cultural heritage duty of care. Zone A = regrading and natural vegetation colonisation, Zone B = rock fillet breakwater and revegetation, Zone C = revegetation and log breakwater, Zone D = no grading and natural colonisation.





TYPICAL SECTION D

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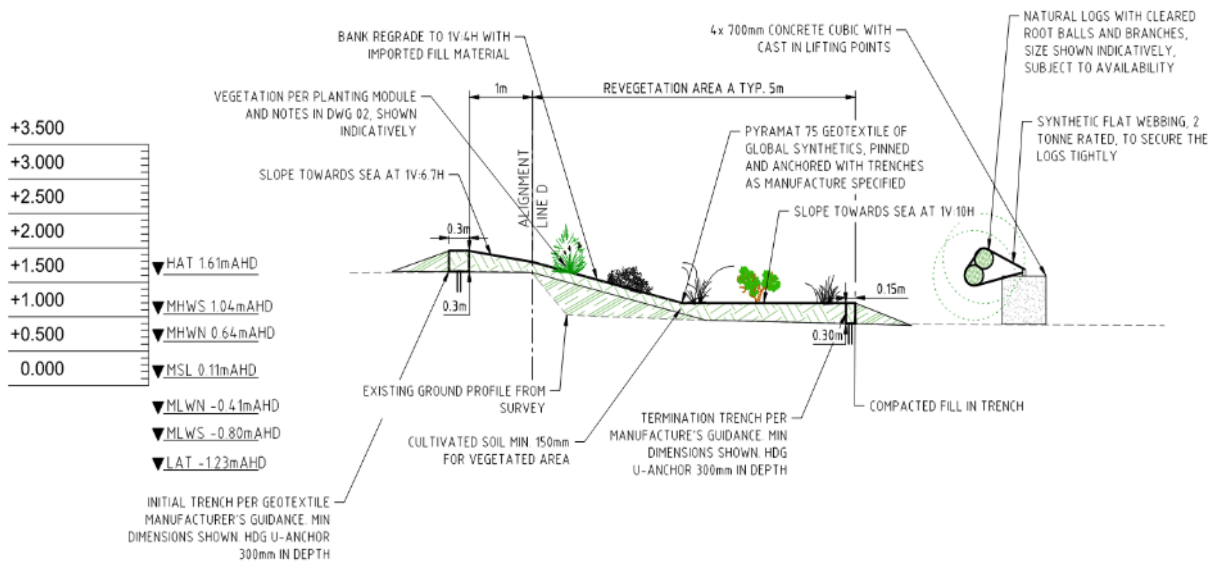

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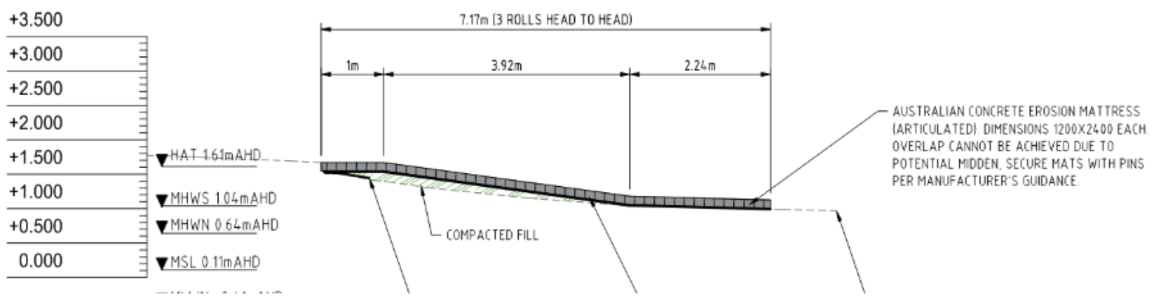

Permits and Approvals

Stage 1 of this project intent is to identify the planning approvals and permits pathway for Living Shorelines.

Operational Works

Council undertook a prelodgement meeting with State Assessment and Referral Agency (SARA). It was determined that the proposed works require:

- Development permit for operational works for tidal works, including prescribed tidal works (i.e. works in local government tidal waters), or works within the Coastal Management District.
    - Referral to SARA required to address *State code 8: Coastal development and tidal works*
- Development permit for Operational works for the removal, destruction or impacts on marine plants.
    - Referral to SARA required to address *State code 11: Removal, destruction or damage of marine plants*
- Owners' consent for development applications were required from the State for Oyster Point Park due to the reserve having ambulatory boundaries.

It was generally acknowledged that the current State Codes are geared towards development and not towards revegetation or nature-based solutions where protection of foreshore land is proactive prior to critical infrastructure or property being impacted. Thus, some responses to performance outcomes in the State Codes were tailored to meet the overall purpose of the code instead as per example below.

Performance Outcome	Response
PO10 Erosion control structures (excluding revetments) are only constructed where there is an **imminent threat** to **significant buildings or infrastructure**, and there is no feasible option for either: 1. **beach nourishment**; or 2. relocation or abandonment of structures.	<u>Alternative response addressing Purpose of Code.</u> The proposed coastal protection works are required to protect Council assets from substantial coastal erosion. Oyster Point Park is community infrastructure which has been subject to progressive erosion, which will be the focus of the nature-based designs. The coastal protection works comply with the purpose of this code by ensuring that works are designed and located to: 1. protect infrastructure from the impacts of coastal erosion. 2. maintain coastal processes by restoring the growth and spread of plants and succession of plant communities, that have a specific role in trapping sediment and building landforms and stabilising sediments against erosion. 3. conserving coastal resources including; • the beach and dune system, • habitat, plant and animal diversity • and cultural resources and sites. 4. maintaining appropriate public use of, and access to and along, State coastal land. 5. accounting for the projected impacts of climate change – the proposed works are a recommendation of Councils Coastal Hazard Adaptation Strategy; this pilot project is intended to build understanding of the solutions that will be adaptable to the impact of climate change. 6. & 7. – The projects provide net environmental benefit.

Table 1 – Example State code 8: Coastal development and tidal works performance outcome response

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

The *EPBC Act 1999* provides the legislative framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places, which are defined in the *EPBC Act 1999* as matters of national environmental significance (MNES). Works are intended to reinstate vegetation close to the eroding foreshore and are unlikely to impact on EPBC species.

Moreton Bay Marine Park Act 2004

The subject site adjoins the Moreton Bay Marine Park and is protected under the *Marine Parks (Moreton Bay) Zoning Plan 2019*. Both sites are within the habitat protection zone and are mangrove/intertidal habitat and require application to the Department of Environment and Science for a Marine Park Permit.

Native Title

The proposed works fall within the Native Title area of a Quandamooka Coast Claim. Native title matters must be addressed in areas where native title may still exist, even if native title decisions have not been determined at the time an activity is to proceed. The project team worked with Council's Legal services to ensure designs were able to comply.

Cultural Heritage

Consultation with QYAC determined for Three Paddocks Park works can proceed without specific management plans, provided activities likely to cause ground disturbance have a QYAC monitor present. For Oyster Point Park a management plan that meets duty of care guidelines for Aboriginal Cultural Heritage was undertaken. Key outcomes are:

- Works that do not involve excavation are not expected to pose a risk of causing harm to cultural material.
- Utilise geofabric against profiles of the eroding foreshore to remove the risk of any further damage to the profiles and any cultural material they contain.
- Utilise existing disturbed surfaces such as the road or existing concrete slab to install signage and other infrastructure.
- Laying erosion controls directly onto the surface without excavation.
- Screw bollards to the road rather than excavating the ground to install them.
- Utilise temporary construction fencing or stone blocks laid on the surface to demarcate work sites and control vehicle access.
- Avoiding utilising heavy machinery near the edge of erosion areas.

Should the project successfully develop and implement measures that enable it to avoid causing additional ground disturbance, then it is expected that the Project will have no or minimal risk of causing harm to cultural heritage *(Converge, 2022).*

Problems / Challenges / Learnings

Cultural Heritage Duty of Care

Foreshore protection works that minimise surface disturbance are relatively unutilised by Council barring emergency works for coastal protection. Piloting a minimal surface disturbance “no-dig” design has resulted in utilising the self-weight or anchoring mechanisms to be undertaken for harder elements. Monitoring the effectiveness of this will be important as the sites establish.

Shorebird habitat

A balance needs to be met between alterations that will assist with foreshore stabilisation but minimise negative impacts to endangered or at-risk flora and fauna of that site. There is consensus in environmental advice that mangroves are crowding out saltmarsh habitat within Moreton Bay, so designs need to be mindful of the adjacent habitat values.

Asset capture of project and class of work

Due to the nature of this pilot project, in that Living Shorelines assets are broadly untested, this class of work will be treated as operational within Council with no capital assets captured at this time. Ongoing monitoring and proof of concept will be required.

Stakeholder engagement and complexity

It is identified that for broader implementation of Living Shorelines within the Redlands Coast there will need to be consideration given to managing community expectations around mosquito habitat and choosing appropriate sites and designs that with regards to sightlines/views to the bay. Site selection, different plant palates and site-specific interventions that consider the impact to sightlines/views will be very important for long term success of nature-based solutions.

Planning framework and approvals

Project works trigger operational works approvals. The planning justifications and costs required to prepare and lodge development applications are not insignificant (approximately $40-45K per an application). Alternatively, for example, if Council were to undertake beach nourishment this could be undertaken at no cost from a planning application and lodgement perspective as these works are considered to not meet a threshold of impact and are therefore *excluded works* or *accepted development.*

Ultimately if the state were able to move towards making nature-based solutions to coastal erosion either *excluded works* or *accepted development* with respect to the *Planning Act,* then this would provide significant cost savings and assist in broad scale implementation.

Technical Guidelines

As this is a new solution to erosion mitigation that is not broadly implemented within the mainstream in Australia, industry experience and ability to design and deliver on proposals will be gradual. Ultimately creating industry standards and guidelines that are widely adopted and can be considered off-the-shelf solutions will be important for broad scale implementation of nature-based solutions.

Outcomes / Conclusions

The objectives of Stage 1 were to determine suitable nature-based solutions for foreshore erosion in the Redlands Coast, this involved:

- Gaining information on the types of nature-based solutions, and more specifically the design, construction and implementation of different approaches, materials, and construction methods that could apply locally,
- Understand planning/permits/approvals requirements,
- Understand the need for engineering certification,
- Further develop an understanding of stakeholder and community expectations and concerns.

A combination of harder structures that facilitate calmer areas for softer options to establish over time are the basis for the Living Shorelines options determined by Redland City Council. These include vegetation, minor bank works, natural log debris, reek and pocket break waters, rock fillets, and planted revetements.

It is anticipated nature-based solutions will have the following benefits:

- Adapt to climate change (as opposed to traditional hard infrastructure),
- Have lower capital and ongoing maintenance costs,
- Have higher cost/benefit ratio, particularly when considering the biodiversity creation and carbon sequestration,
- Assist fisheries,
- Improve water quality,
- Assist cultural heritage preservation,
- Provide natural landscape aesthetics to foreshores *(Morris et al, 2021)*.

The next stage of the project is to:

- Finalise permits and approvals,
- Finalise for-construction documentation,
- Construct the pilot projects,
- Track construction and maintenance costs,
- Monitor the different interventions and their effectiveness,
- Build an evidence base of the degree of erosion protection offered by different approaches,
- Identify the best performing designs for future implementation.

The ultimate intent is for nature-based solutions to become part of the local ecosystem, providing the a similar or better level of foreshore protection as established natural areas.

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