

# Precinct 2 Concept Design: Teralba Rd (Brighton-Le-Sands) to Solander St (Monterey)

## LADY ROBINSONS FORESHORE MANAGEMENT PLAN

Report MHL3034

15 July 2024

Prepared for: Bayside Council





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Final	L. Smith (Arup)	M. Phillips (MHL)	M. Phillips	15 July 2024

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Report No. MHL3034

First published as draft in July 2024



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# Foreword

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In October 2023, NSW government's professional specialist advisor, Manly Hydraulics Laboratory (MHL) in partnership with Arup were commissioned by Bayside Council to undertake the development of concept designs for Precinct 2 (Teralba Rd to Solander St) at Lady Robinsons Beach in accordance with the *Lady Robinsons Foreshore Management Plan* (MHL, 2024). The report was prepared by Matthew Phillips, Edward Couriel, Adrian Turnbull, Megan Liu and Arup.

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# Executive Summary

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This report provides the outcomes of concept design development for coastal protection works and amenity upgrades to Lady Robinsons Beach at Precinct 2 (Teralba Rd to Solander St) in accordance with the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a). Concept designs have been developed for an initial 50 year design planning period and seek to provide:

- Improved and sustainable coastal hazard protection.
- Enhanced foreshore amenity integrated with existing public spaces and facilities.
- Support a thriving foreshore ecology and intertidal environments.

Key design components of the concept designs are summarised in **Figure E.1** and include:

- A new engineered vertical seawall consisting of a contiguous secant piled structure with upper concrete capping/panelling and a pedestrian foreshore boardwalk. Most of the structure other than the upper capping and boardwalk is proposed to be buried beneath existing sand levels as a terminal structure. This structure will extend in a continuous alignment from the southern termination of the existing Brighton-Le-Sands seawall and will transition to a new engineered rock revetment between O’Niell St and President Ave.
- A new piled timber viewing platform and lookout at President Ave combined with a nature-based design intertidal zone and shallow artificial reef to support ecological outcomes.
- A new rock revetment structure with foreshore pedestrian boardwalk extending from President Ave through to Solander St. It includes a waterfront promenade at its crest and a nature-based toe design.
- Accessible intertidal zone, groyne upgrades and improved beach access at Solander St.

Preliminary concept design costings range from \$32M to \$58M with a mid-range estimate of \$45M. Revised costings will be undertaken as part of detailed design with several opportunities to reduce costs and/or to stage the implementation of the works by high to low priority for the Precinct.

A preliminary environmental impact risk assessment was undertaken that identifies a number of additional data and provides recommended next steps for undertaking a Review of Environmental Factors (REF) as part of detailed design. These include further ecological, terrestrial, and marine biodiversity surveys, heritage and First Nations engagement, community/stakeholder consultation and construction impact assessments.

A desktop review of the serviceability of existing structures was also undertaken and identifies a number of recommended serviceability upgrades for existing structures to meet contemporary design standards for Precinct 2 within the planning period. Existing structures considered in the assessment included the southern termination of the Brighton-Le-Sands seawall, ad-hoc rock works, Banks St rock works, Groyne 5 maintenance, President Ave stormwater outlet repairs and provision of temporary coastal protection works (the latter two items having already progressed to detailed design and tender).

Additional recommend considerations for Precinct 2 detailed design are provided below:

- Development of an adaption pathway to future sea level rise and environmental conditions beyond the design life of the structure. Detailed design drawings and specifications are to include explicit triggers and details to cater for sea level rise.
- Refinement of design seawall crest levels considering alongshore variability in design wave exposure, wave runup and overtopping, safety to property and people, adjoining foreshore/dune and/or berm slopes, elevations and crest levels of any adjoining structures. Wave return features may be incorporated in detailed designs to reduce wave overtopping hazards to people and infrastructure. Physical modelling should be used to confirm wave overtopping, design drainage and final design crest levels where adequate factors of safety cannot be demonstrated.
- Review of available geotechnical information and undertake further geotechnical investigations required as part of the seawall design process to confirm, among other things, the extent of existing rock/ad-hoc materials and geotechnical properties of the dune substrate including the geotechnical properties of any bedrock or other ad-hoc mass rubble units present.
- Design and assessment of return flow drainage including wave overtopping return flows, rainfall runoff and interactions with stormwater flows and outlets (President Ave and Kings Lane).
- Assessment of community impacts due to changes to beach access at President Ave (currently closed due to erosion hazards), Teralba Rd (currently also provides vehicular access) and O'Neill Lane. Provision of vehicular beach access is required to be considered as part of detailed design.
- Development of a Maintenance Management Plan for the maintenance of the coastal protection works for the intended design life.

# Concept Design Plan

## Summary



Figure E.1: Overview of Precinct 2 Concept Design Plan

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# 1 Introduction

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## 1.1 Background

Over the last century, the shorelines of Botany Bay (Kamay) have undergone significant modification due to human activities, including the development of Port Botany and Sydney Airport. Studies have found that these changes have disrupted sand transport and wave patterns, leading to areas of persistent erosion along Lady Robinsons Beach (Sydney Ports Corporation, 1993, 1998; Dames & Moore, 1995; Willoughby et al., 1997; Connell Wagner, 1999; MHL2812, 2022).

Initiatives to stabilise the beach and protect the shore date back to the 1930s, yet the shoreline continues to remain unstable in various sections of the beach. In response to this challenge, 1997 and 2004/5 saw the launch of restoration works on Lady Robinsons Beach, including the construction of 13 groynes and the addition of 450,000m<sup>3</sup> of sand.

Despite these major restoration efforts, the shoreline has continued to evolve in response to historic anthropogenic bay modifications. Following completion of these major works in 2005, the shoreline at between Solander Street and President Avenue has retreated by more than 50 meters, resulting in coastal erosion hazards for The Grand Parade, damage to stormwater infrastructure and amenity disruptions to foreshore users.




Studies undertaken in 2014 and 2017 reviewed the existing Lady Robinsons Beach Management Plan and found it was inadequate to stabilise the foreshore from ongoing patterns of erosion and accretion (WorleyParsons, 2014; Advisian, 2017; MHL2720, 2020). As the shoreline continues to shift due to historic man-made disruptions to sand transport and wave propagation (including natural variability within these shifts), options for more sustainable long-term coastal management have recently been investigated by Manly Hydraulics Laboratory (MHL, 2023). Of the management pathways assessed, a targeted foreshore management approach was demonstrated to be most effective and adopted by Council in June 2023.

In 2024, this approach formed the basis of the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a) outlined in **Figure 1.1**. The plan provides strategies to manage shoreline change over the next 50 year period including sea level rise impacts. Targeted strategies are to be developed in different foreshore zones based on how the shoreline is changing. Underpinning the adopted approach is knowledge of the coastal processes causing shoreline change. Management of the foreshore recognises that beach areas prone to erosion are, in some cases, not as cost-effective and feasible to restore and maintain compared with more stable or accreting areas of sandy beaches.

Precinct 2 is located between Teralba Rd (Brighton-Le-Sands) and Solander St (Monterey) as shown in **Figure 1.1** and was identified as a high priority area requiring attention noting immediate erosion hazards threatening loss of public space and placing road infrastructure at risk. This Report provides concept designs for a 50 year design planning period to improve and manage the foreshore at Precinct 2 in accordance with the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a).

Given immediate erosion hazards to the road corridor at Precinct 2, interim protection works comprising sand nourishment, geotextile & re-vegetation will be implemented to temporarily protect The Grand Parade from coastal hazards while the long-term foreshore improvements outlined in this Report are progressed and implemented (MHL, 2024b).



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**Zone A - RESILIENT:** Resilient areas of sandy beach where the shoreline supports ongoing beach recreation. This accounts for approx. 4 km (54%) of shoreline.
- 
**Zone B - RESTORE:** Unstable shorelines that are prone to erosion and require intervention to restore and maintain sandy beach. This accounts for approx. 1 km (14%) of shoreline.
- 
**Zone C - PROTECT:** Unstable and eroded shorelines requiring improved protection through environmentally friendly seawall design and amenity enhancement. This accounts for approximately 2.4 km (32%) of shoreline.

**Figure 1.1: Lady Robinsons Foreshore Management Plan (MHL-Arup, 2024a)**

## 1.2 Study area

The Precinct 2 study area is shown in **Figure 1.2**, located between the southern termination of the existing seawall at Brighton-Le-Sands (just north of Teralba Rd) and Groyne 5 at Solander St, Monterey. The study area is approximately 700m in length. The Precinct is located immediately downdrift of the northern groyne field constructed in 2005/6 with mass sand nourishment of the foreshore following these works. Since this time, the shoreline at Precinct 2 has retreated by more than 50 metres in the vicinity of Banks St and President Ave as shown by the satellite derived shoreline positions in **Figure 1.4**, with average recession rates of approximately 2-5 metres per year (MHL, 2020). Periodic beach nourishment of 55,000 m<sup>3</sup> every ten years was specified in the design of the northern groyne field for this location however re-nourishment has not yet been undertaken since the original works in 2006 (Connell Wagner, 1999).

The present condition of the foreshore is heavily eroded with ad-hoc rock protection once buried in the foredune substrate now exposed and strewn across the active swash zone as seen in **Figure 1.3**. For the past several years beach access along the foreshore at Banks St is inhibited by rock works encroaching into the water's edge with no available sandy beach. Unstable foredune erosion scarps, approximately 2 – 3 m in height, extend from Banks St to O'Neill St. Ongoing erosion is of particular concern near President Ave where hazardous dune erosion scarps have led to the closure of a beach accessway, damaged stormwater infrastructure (**Figure 1.3**) and pose an immediate risk to the shared user pathway and road corridor of The Grand Parade.

At its narrowest point, just north of President Avenue the erosion scarp is situated approximately 12m from the road kerbside (Nearmaps, 2024). Of dune instability hazard, this places the footpath at risk of slope adjustment and roadside at risk of reduced foundation capacity during high wave impact (Nielsen et al. 1992). It is noted that buried historic ad-hoc rock works, placed in the late 1960s (see **Appendix B**) may provide some temporary protection but should not be relied on (non-engineered). A serviceability assessment of these ad-hoc rock works and other existing structures located within Precinct 2 is provided in **Section 5**.

A highly used shared user path (SUP, pedestrian and cycleway) runs along the crest of the foredune, connecting the foreshore at Monterey in the south with the popular urban centre of Brighton-Le-Sands (dining, beach recreation and swimming destination) to the north. The foreshore destination is known to attract locals and regional visitors alike and is highly valued by the Bayside and broader community. The major arterial road of President Avenue provides a prominent East-West connection to the foreshore at Precinct 2.

Environmentally, the foreshores and Bay waters of Precinct 2 provide important intertidal and subtidal ecology. Seagrass beds (*Zostera*) are situated approximately 50-100m offshore of the study area in shallow bay waters (see **Figure 2.1**, DPI Fisheries, 2019). Bay waters also supports rich aquatic and fish biodiversity. A transient vegetated foredune area (artificially placed and vegetated during prior nourishment) in the north of the study site extends toward Brighton-Le-Sands and has eroded in the mid to southern end of the Precinct. There is significant opportunity at the site to support intertidal and nearshore ecology through nature-based design in the south of Precinct 2. A preliminary environmental impact risk assessment register is provided in **Section 4**.



**Precinct 2** stretches from Teralba Road in Brighton-Le-Sands to Solander Street in Monterey. Key elements encompass an inaccessible groyne (Cook Park Rock Jetty), a rock revetment requiring replenishment, a shared pedestrian and biking pathway, deteriorated infrastructure such as inaccessible stairs and exposed stormwater pipes, and restricted pedestrian entry to the beach.

Figure 1.2: Precinct 2 Study Area - Teralba Rd (Brighton-Le-Sands) to Solander St (Monterey)

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Classification: Private



Figure 1.3: Heavily eroded shoreline, foredune scarping and ad-hoc rock at President Avenue

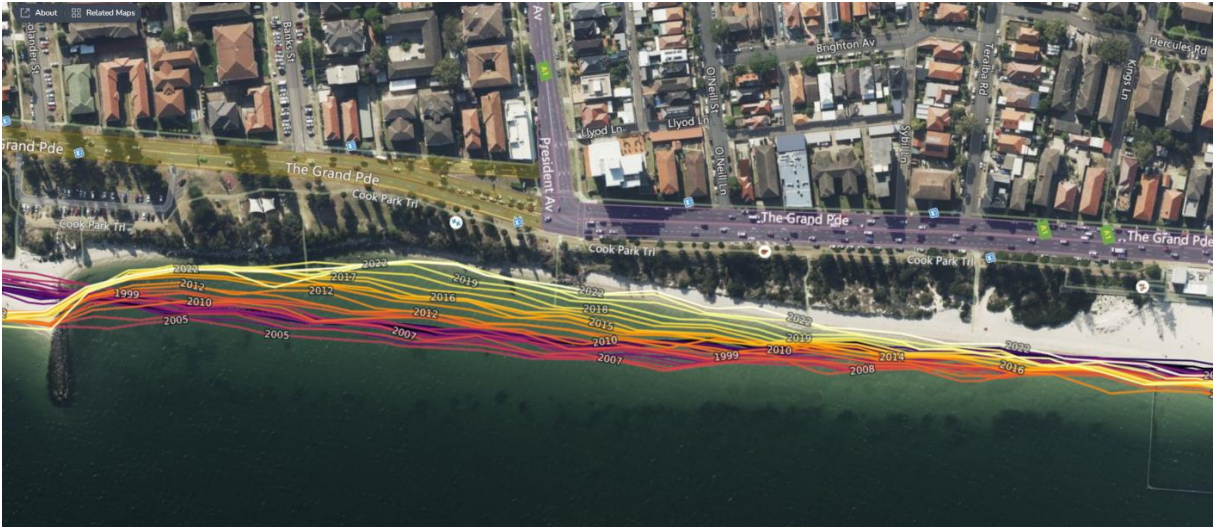


Figure 1.4: Satellite derived shoreline positions at Precinct 2, 2005-2022. Source: Geoscience Australia.

### 1.3 Scope of work and report outline

This report provides outputs for the following scope of work:

- Preparation of brief concept Basis of Design (**Section 2**).
- Concept design development for coastal erosion protection integrated with public space amenity upgrades and nature-based design solutions (**Section 3**).
- Preliminary (desktop) environmental impact risk assessment for concept design (**Section 4**).
- Desktop review and assessment of existing structures for serviceability and structural integration for the design planning period (**Section 5**).
- Recommendation of additional site data required for detailed design and Review of Environmental Factors (REF) including geotechnical and site-specific investigations (**Section 5.7**).

## 2 Basis of design

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### 2.1 Preamble

The following sections outlines the foreshore management, engineering and urban design objectives for developing concept design for Precinct 2 Lady Robinsons Beach. Further information and a visual presentation of the content is provided in **Appendix A**.

### 2.2 Foreshore Management Objectives

#### 2.2.1 Objectives

Key foreshore management objectives are provided in the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a). Objectives relevant to the Precinct 2 study area include:

- Improved and sustainable coastal hazard protection.
- Enhanced foreshore amenity integrated with existing public spaces and facilities.
- Supporting a thriving foreshore ecology and intertidal environments.

Under the Lady Robinsons Foreshore Management Plan (MHL-Arup, 2024a) Precinct 2 is classified as Zone C – Protect, characterised by unstable and eroded shorelines requiring improved protection through environmentally friendly seawall design and amenity enhancement.

Importantly, management of the foreshore in Precinct 2 recognises this area of beach as subject to ongoing erosion that is not cost-effective or practicable to restore and maintain as a sandy beach compared with more stable or accreting areas of the foreshore (such as adjacent beach areas at Brighton-Le-Sands and Monterey; MHL, 2023).

As part of the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a), four vision statements were identified for the overall foreshore, developed in consultation with Bayside Council. These statements are informed by the various visionary statements in relevant local and state-wide strategic documents<sup>1</sup>. The vision for the public realm upgrades is underpinned by a strategic coastal management approach and it is envisaged that the two complement one another. Key vision statements for the foreshore management design include:

- Serving the community
- Culturally inclusive
- Ecological value
- Building a legacy

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<sup>1</sup> Cook Park Masterplan, Bayside Council, 2020. Local Strategic Planning Statement, Bayside Council, 2020. Bayside 2023 Community Strategic Plan, Bayside Council. 2018. Reflect Reconciliation Action Plan, Bayside Council, 2022/23. Better Placed, GANSW, 2023. Connecting with Country, GANS, 2023. Public Open Space Strategy for NSW, NSW Government, 2022. Draft Greener places, GANSW, 2023.

### 2.2.2 Management approach

The *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a) outlines long-term management initiatives for this area including:

- Adaption of the eroded foreshore with a new environmentally-friendly engineered seawall with promenade to provide long-term coastal hazard protection for the adjacent public area and The Grand Parade.
- Upgrade of public space between the road and the foreshore including a new waterfront promenade, viewing platforms and intertidal ecological corridor connecting Monterey with Brighton-Le-Sands beach areas.

Interim sand nourishment, geotextile & re-vegetation will be undertaken to temporarily protect The Grand Parade from coastal hazards until the long-term management solutions provided by the present concept designs are progressed and implemented (MHL, 2024b).

### 2.2.3 Public realm upgrade aspiration

The aspiration around public realm upgrades for Precinct 2 has been discussed with Bayside Council, and the following priorities identified:

- Safeguard public space and parkland adjacent to the foreshore.
- Remove public space pinch points, hazards and barriers to improve access and equity.
- Improve safety for active transport users (primarily pedestrians & cyclists).
- Enhance the user experience, increase comfort (shade, rest, movement) and better connect people with the unique and special foreshore environment.
- Enhance marine and landside biodiversity & ecology to enable thriving flora and fauna.
- Meaningfully integrate First Nations narratives into the design, with appropriate input from local Knowledge Holders. Provide opportunity for communication of Cultural information and storytelling to enrich the foreshore experience and connect the project to Country.

## 2.3 Connecting with Country opportunities

Appropriate consultation and involvement of First Nations stakeholders, knowledge holders and designers is critical to enable a suitable outcome for the project. A range of opportunities have been identified for connecting with Country in the design, which are to be further explored as the design progresses in subsequent stages.

Key themes to be explored with Indigenous designers & representatives include:

- **Intertidal zone:** the changing nature of the foreshore over time.
- **Saltwater dunes:** significance to the community over time as a rich resource.
- **Non-human kin:** consideration of all life supported by the foreshore.
- **First light:** Recognising the Cultural significance of the site's location and orientation towards the rising sun.

## 2.4 Site constraints and opportunities

In Precinct 2, a series of challenges pose concerns, with coastal processes of erosion threatening infrastructure and foreshore amenity. Moreover, the narrowing between the shoreline and road has resulted in a recreation bottleneck, eroding dunes and funneling pedestrians and cyclists through obstacles. Various entries of access to the beach are non-compliant and safety is further compromised by hazards, obstructions and barriers.

Addressing these issues comprehensively is beneficial to preserving Precinct 2's built and natural assets and ensuring equitable access and safety for all stakeholders. Exploring innovative coastal management strategies and enhancing recreational infrastructure present opportunities to not only address existing challenges but also foster ecological sustainable development and community amenity enhancement within Precinct 2.

Noting the heavily eroded condition of the foreshore in Precinct 2, there is significant opportunity to provide engineered coastal erosion protection to enhance the usable public space and safeguard coastal infrastructure.

The parkland (public area and foredune) adjacent to the foreshore varies in width, ranging between 10m and 70m and most narrow at the President Avenue junction. This issue is compounded by the active erosion of the foreshore. In this location, the shared user path is hard up against the road edge, which is not optimal for user safety, experience and comfort. There is significant opportunity through this concept design to improve this issue.

### **Key constraints associated with the present public space include:**

1. Abrupt termination of the boardwalk with shared user path (SUP) at Brighton-Le-Sands.
2. Vehicular access to eroding beach at Teralba Rd.
3. Non-equitable access to eroded beach at O'Neill Ln.
4. Damaged inaccessible beach pathways at President Avenue.
5. SUP presses hard against busy road at President Avenue creating public safety concern with only one pedestrian crossing.
6. Pedestrian access to beach is non-DDA compliant at Solander St.

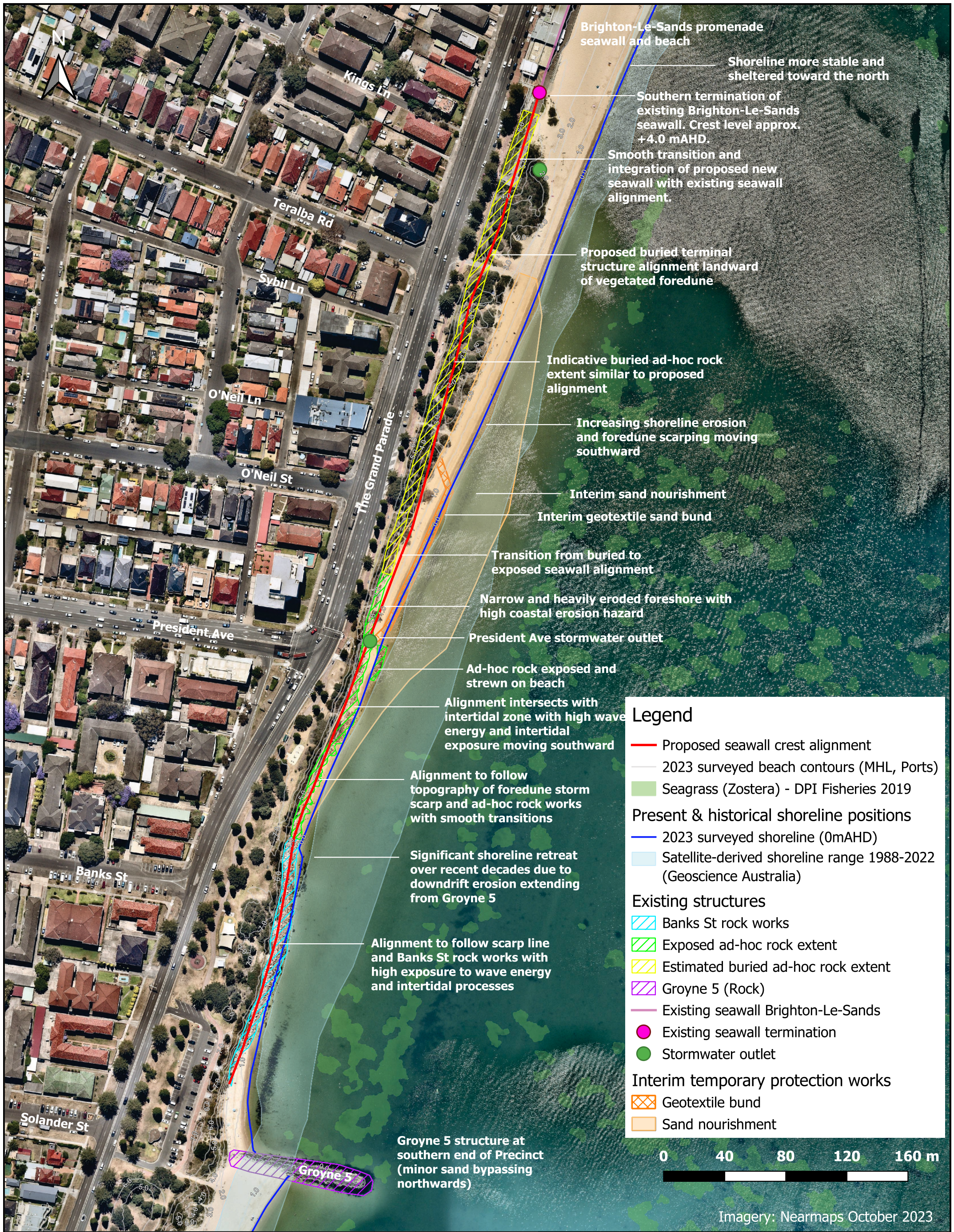
Concept design development also recognises the important ecological value of the foreshore environment including offshore seagrass (*Zostera*), aquatic and intertidal habitat. Significant opportunities to support foreshore ecology and intertidal environments through nature-based coastal design are presented.

Mapping of site constraints and opportunities are provided in **Appendix A**.

## 2.5 Alignment constraints and existing structures

Preliminary seawall crest alignment for concept design is shown in **Figure 2.1**. All seawall concept design configurations have been aligned with the crest alignment shown in **Figure 2.1**. Considerations and site constraints relevant to the concept design seawall alignment include:

- Alongshore uniformity and design integration with existing structures. Existing structures are shown in **Figure 2.1** and include the southern termination of the Brighton-Le-Sands seawall, ad-hoc rock works buried/exposed in the beach and dune substrate, stormwater outlets at Kings Ln and President Ave, Banks St rock works, and Groyne 5 to the south. Interim sand nourishment protection works have also been designed to improve an erosion storm buffer until an engineered seawall is implemented. Design integration and serviceability assessment of these existing are discussed in **Section 5**.
- Improving area for public space between the kerbside and seawall particularly at narrow sections near the junction of President Ave and The Grand Parade.
- Minimising impacts to sediment transport and adjacent sandy beach areas at Brighton-Le-Sands. A landward buried seawall alignment (terminal structure) in the northern region of the Precinct is proposed to minimise exposure to wave energy and potential end erosion impacts on adjacent beach areas (**Figure 2.1**). This alignment with a narrow structure footprint (i.e. vertical or tiered vertical seawall) reduces impacts on the transient foredune (vegetated nourishment) that exists in the north. Additional design consideration to improve wave energy dissipation have been considered to minimise structure and beach interactions.
- Contemporary shoreline alignment and historical shoreline changes are shown in **Figure 2.1** and **Figure 1.4**. In the northern region of the Precinct, the proposed seawall crest alignment is located approximately 30-50 m landward of the contemporary shoreline as a buried terminal structure. The alignment meets the present shoreline at between O'Neill St and President Ave where the pre-existing beach is heavily eroded and follows approximately the exposed ad-hoc rock extent moving south towards Banks St. A more dissipative structure configuration with nature-based designed intertidal toe is considered advantageous in these mid to southern regions of the Precinct where the seawall will be most exposed to wave energy. These areas also provide opportunity to support offshore seagrass (*Zostera*) ecology depicted in **Figure 2.1** through nature-based design.
- Historical storm erosion foredune scarp alignment marks the lee of the foreshore and is denoted in **Figure 2.1** by a change in elevation from approximately +3 to +6-8 mAHD. In the north, the proposed alignment deviates slightly seaward of this scarp in order to provide a smooth transition with the termination of the existing Brighton-Le-Sands seawall. In the south, the seawall alignment follows more closely this historic storm erosion scarp, currently lined with ad-hoc rock works.



## 2.6 Engineering design parameters

Engineering design parameters for coastal protection works at Precinct 2 are provided in **Table 2.1**. Engineering design parameters provide guidance for various aspects of concept design of coastal protection works including design life, design ocean conditions, alignment, sea level rise assumptions, overtopping and other design aspects.

**Table 2.1: Preliminary engineering parameters for coastal protection works at Precinct 2**

Item	Design parameter
Primary engineering standards and guideline references for seawall design	<ul style="list-style-type: none"> <li>Coastal Engineering Manual (USACE, 2006)</li> <li>Shore Protection Manual (CERC, 1984)</li> <li>The Rock Manual: The use of rock in hydraulic engineering (CIRIA, 2007)</li> <li>EurOtop: Manual on wave overtopping of sea defences and related structures (Pullen et al., 2018)</li> <li>AS 4997-2005 Guidelines for the design of maritime structures</li> <li>Design of Coastal Revetments, Seawall and Bulkheads (USACE, 1995)</li> <li>The Australian guide to nature-based methods for reducing risk from coastal hazards (Earth Systems and Climate Change Hub, 2021)</li> <li>NCCOE Vol 1 Guidelines for Responding to the Effects of Climate Change, 2017</li> <li>NCCOE Vol 2 Guidelines for working with the Australian coast in an ecologically sustainable way, 2017</li> <li>NCCOE Vol 3 - Climate Change Adaptation Guidelines, 2012</li> </ul>
Potential seawall design configurations	<p>Concept designs shall consider vertical (or tiered vertical) terminal seawall and conventional rock-rubble seawall configurations. Transitions in seawall configurations should be guided by engineering design integration between adjacent structures and should also consider synergies with existing (or enhanced) backshore landscapes and interaction with coastal processes during design conditions</p> <p>The seawall concept designs will include landscaping and materials that blend into the coastal environment and be designed to have a reduced vertical relief following the natural cross section of the foreshore.</p> <p>Nature-based considerations are to be integrated into the seawall concept designs to provide beneficial intertidal and nearshore environmental outcomes and wave energy dissipation following guidance from <i>The Australian guide to nature-based methods for reducing risk from coastal hazards</i> (Earth Systems and Climate Change Hub, 2021) and NCCOE (2017).</p>
Environmental design considerations	<p>Nature-based considerations are to be integrated into the seawall concept designs where practicable to provide beneficial intertidal environmental outcomes following guidance from <i>The Australian guide to nature-based methods for reducing risk from coastal hazards</i> (Earth Systems and Climate Change Hub, 2021) and NCCOE (2017).</p> <p>Concept designs will also provide opportunities for environmental design features to support subtidal nearshore habitats and wave energy dissipation.</p>
Cross-shore positioning	<p>Concept design alignment considerations will include:</p> <ul style="list-style-type: none"> <li>Alongshore uniformity and design integration with existing structures</li> <li>Improving area for public space between the kerbside and seawall particularly at narrow sections near the junction of President Ave and The Grand Parade.</li> <li>Minimising impacts to sediment transport and adjacent sandy beach areas at Brighton-Le-Sands.</li> <li>Contemporary historical shoreline alignment</li> <li>Historical storm erosion foredune scarp alignment</li> </ul>
End-erosion impacts	<p>Concept designs will be located so as to minimise impacts to sediment transport and adjacent sandy beach areas at Brighton-Le-Sands.</p> <p>Where adjacent shoreline areas comprise sandy beach areas classified as Zone 1 under the Lady Robinsons Beach Foreshore Management Plan (2024), further assessment of impacts on adjacent beach areas should be undertaken as part of subsequent detailed design.</p>
Wave energy dissipation	<p>Concept designs will include features to enhance intertidal and nearshore wave energy dissipation in effort to minimise impacts on adjacent beach areas and wave overtopping.</p>
Minimum initial design life	50 years

Item	Design parameter																																										
Design average recurrence interval (ARI)	Initial damage for non-rigid structures: 100–200 year ARI Failure for non-rigid structures or rigid structures: 500–2000 year ARI																																										
Serviceability Criteria	<p>Minimum serviceability criteria of structure including non-structural components as per table below.</p> <table border="1"> <thead> <tr> <th rowspan="2">Average recurrence interval (ARI, years)</th> <th rowspan="2">Encounter probability over 50-year period</th> <th colspan="2">Minimum Maintenance / Serviceability Criteria</th> </tr> <tr> <th>Non-rigid structure</th> <th>Rigid Structure</th> </tr> </thead> <tbody> <tr> <td>≤20</td> <td>≥92%</td> <td>Damage to non-structural components.</td> <td>Damage to non-structural components.</td> </tr> <tr> <td>20-100</td> <td>39-92%</td> <td>Minor maintenance/repairs</td> <td>Minor maintenance /repairs</td> </tr> <tr> <td>100-500</td> <td>10-39%</td> <td>Damage affecting serviceability but not immediate integrity</td> <td>Damage necessitating maintenance /repairs but not affecting immediate integrity</td> </tr> <tr> <td>≥500</td> <td>≤10%</td> <td>Failure of structure</td> <td>Failure of structure</td> </tr> </tbody> </table>	Average recurrence interval (ARI, years)	Encounter probability over 50-year period	Minimum Maintenance / Serviceability Criteria		Non-rigid structure	Rigid Structure	≤20	≥92%	Damage to non-structural components.	Damage to non-structural components.	20-100	39-92%	Minor maintenance/repairs	Minor maintenance /repairs	100-500	10-39%	Damage affecting serviceability but not immediate integrity	Damage necessitating maintenance /repairs but not affecting immediate integrity	≥500	≤10%	Failure of structure	Failure of structure																				
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Concept design ocean conditions	<p>Ocean conditions adopted for seawall concept designs are provided in the table below. Tidal planes (MHL2699,2021) at Fort Denison, Sydney are shown in the table below and are similar to the design location.</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Concept design value</th> </tr> </thead> <tbody> <tr> <td><b>Annual Recurrence Interval (ARI) for initial damage of non-rigid structures and serviceability of rigid structures</b></td> <td><b>100 year Ari<sup>a</sup></b></td> </tr> <tr> <td rowspan="4">Design conditions for initial damage of non-rigid structures</td> <td>Offshore significant wave height for 3h duration (<math>H_{S,0}</math>)</td> <td>8.7 m</td> </tr> <tr> <td>Peak spectral wave period (<math>T_p</math>)</td> <td>13 s <sup>b</sup></td> </tr> <tr> <td>Ocean water level (excluding wave setup &amp; SLR)</td> <td>+1.46 mAHD <sup>d</sup></td> </tr> <tr> <td>Nearshore significant wave height for 3h duration at Precinct 2 (<math>H_s</math>)</td> <td>1.4 m <sup>e</sup></td> </tr> <tr> <td><b>Annual Recurrence Interval (ARI) design failure of rigid and non-rigid structures</b></td> <td><b>500 year ARI<sup>a</sup></b></td> </tr> <tr> <td rowspan="4">Design conditions for failure of non-rigid and rigid structures</td> <td>Offshore significant wave height for 3h duration (<math>H_{S,0}</math>)</td> <td>9.8 m <sup>c</sup></td> </tr> <tr> <td>Peak spectral wave period (<math>T_p</math>)</td> <td>13 s <sup>b</sup></td> </tr> <tr> <td>Ocean water level (excluding wave setup &amp; SLR)</td> <td>+1.51 mAHD <sup>d</sup></td> </tr> <tr> <td>Nearshore significant wave height for 3h duration at Precinct 2 (<math>H_s</math>)</td> <td>1.6 m <sup>e</sup></td> </tr> </tbody> </table> <p><sup>a</sup> Joint probability of adopted wave and water level conditions not considered.  <sup>b</sup> Based on <math>H_s</math>-<math>T_p</math> joint occurrence analysis of Sydney wave buoy data from March 1992 to December 2019  <sup>c</sup> Extrapolated from Fort Denison water level and Sydney wave height exceedance curves.  <sup>d</sup> From <i>Determining Extreme Still Water Levels for Design and Planning Purposes Incorporating Sea Level Rise: Sydney, Australia</i>. (Watson, 2022)  <sup>e</sup> Based on SWAN nearshore wave modelling by Cardno (2013) at location L5, approximately 400m offshore of President Ave in 3.4 m AHD water depth. 500 year ARI conditions extrapolated from Cardno (2013) results. Depth-limited conditions are considered unlikely to occur for design water depths at the toe of the structure.</p> <table border="1"> <thead> <tr> <th>Tidal Plane</th> <th>Water level (m AHD)</th> </tr> </thead> <tbody> <tr> <td>Highest Astronomical Tide (HAT)</td> <td>1.15</td> </tr> <tr> <td>High Water Solstices Springs (HHWSS)</td> <td>1.030</td> </tr> <tr> <td>Mean High Water Springs (MHWS)</td> <td>0.689</td> </tr> <tr> <td>Mean High Water (MHW)</td> <td>0.565</td> </tr> <tr> <td>Mean High Water Neap (MHWN)</td> <td>0.441</td> </tr> <tr> <td>Mean Sea Level (MSL)</td> <td>0.061</td> </tr> <tr> <td>Mean Low Water Neap (MLWN)</td> <td>-0.319</td> </tr> <tr> <td>Mean Low Water (MLW)</td> <td>-0.443</td> </tr> </tbody> </table>	Parameter	Concept design value	<b>Annual Recurrence Interval (ARI) for initial damage of non-rigid structures and serviceability of rigid structures</b>	<b>100 year Ari<sup>a</sup></b>	Design conditions for initial damage of non-rigid structures	Offshore significant wave height for 3h duration ( $H_{S,0}$ )	8.7 m	Peak spectral wave period ( $T_p$ )	13 s <sup>b</sup>	Ocean water level (excluding wave setup & SLR)	+1.46 mAHD <sup>d</sup>	Nearshore significant wave height for 3h duration at Precinct 2 ( $H_s$ )	1.4 m <sup>e</sup>	<b>Annual Recurrence Interval (ARI) design failure of rigid and non-rigid structures</b>	<b>500 year ARI<sup>a</sup></b>	Design conditions for failure of non-rigid and rigid structures	Offshore significant wave height for 3h duration ( $H_{S,0}$ )	9.8 m <sup>c</sup>	Peak spectral wave period ( $T_p$ )	13 s <sup>b</sup>	Ocean water level (excluding wave setup & SLR)	+1.51 mAHD <sup>d</sup>	Nearshore significant wave height for 3h duration at Precinct 2 ( $H_s$ )	1.6 m <sup>e</sup>	Tidal Plane	Water level (m AHD)	Highest Astronomical Tide (HAT)	1.15	High Water Solstices Springs (HHWSS)	1.030	Mean High Water Springs (MHWS)	0.689	Mean High Water (MHW)	0.565	Mean High Water Neap (MHWN)	0.441	Mean Sea Level (MSL)	0.061	Mean Low Water Neap (MLWN)	-0.319	Mean Low Water (MLW)	-0.443
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Criteria for addressing sea level rise (SLR)	<p data-bbox="391 499 1390 571">In the absence of Council having a prescribed sea level rise policy, it is recommended that SSP5-8.5 sea level projections are used for the time horizon of interest from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (Fox-Kemper et al., 2021).</p> <p data-bbox="391 598 1382 669">Considering a 50-year design planning period, 2075 sea level rise projections for Fort Denison under the highest (unmitigated) emissions scenario (RCP 8.5), range between 0.35 m to 0.62 m (relative to the 1995-2014 baseline with range equivalent to 66% confidence limits in projections).</p> <p data-bbox="391 696 1390 792">For the purpose of concept design development, a sea level rise of 0.62 m is adopted for the 50-year design planning period, equivalent to the 2075 upper limit SLR projection for Fort Denison under a high-end (unmitigated) emissions scenario of RCP8.5, and a value similar to projections adopted in the former coastal hazard risk assessment (BMT WBM, 2013).</p> <p data-bbox="391 819 1378 866">Subsequent detailed design stages shall specify an adaption pathway consistent with NCCOE (2012) to future sea level rise and environmental conditions beyond the design life of the structure.</p>																					
Seawall crest level and wave overtopping thresholds.	<p data-bbox="391 896 1353 967">Concept design crest levels will consider at a preliminary level wave runup and overtopping, safety to property and people, adjoining foreshore/dune and/or berm slopes, elevations and crest levels of any adjoining structures.</p> <p data-bbox="391 994 1291 1019">Safe overtopping thresholds for various hazard types are provided below from EurOtop (2018).</p> <table border="1" data-bbox="391 1041 1390 1541"> <thead> <tr> <th>Hazard type</th> <th>Mean overtopping q (l/s per m)</th> <th>Max Volume V<sub>max</sub> (l per m)</th> </tr> </thead> <tbody> <tr> <td>People at structures with possible violent overtopping, mostly vertical structures</td> <td>No access for any predicted overtopping</td> <td>No access for any predicted overtopping</td> </tr> <tr> <td>People at seawall / dike crest. Clear view of the sea. H<sub>m0</sub> = 3 m H<sub>m0</sub> = 2 m H<sub>m0</sub> = 1 m H<sub>m0</sub> &lt; 0.5 m</td> <td>0.3 1 10-20 No limit</td> <td>600 600 600 No limit</td> </tr> <tr> <td>Building structure elements; H<sub>m0</sub> = 1-3 m</td> <td>≤1</td> <td>&lt;1,000</td> </tr> <tr> <td>Damage to equipment set back 5-10m</td> <td>≤1</td> <td>&lt;1,000</td> </tr> <tr> <td>Grass covered crest and landward slope; maintained and closed grass cover; H<sub>m0</sub> = 1 – 3 m</td> <td>5</td> <td>2,000-3,000</td> </tr> <tr> <td>Damage to paved or armoured promenade behind seawall</td> <td>&lt; 200</td> <td>Not provided</td> </tr> </tbody> </table>	Hazard type	Mean overtopping q (l/s per m)	Max Volume V <sub>max</sub> (l per m)	People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping	People at seawall / dike crest. Clear view of the sea. H <sub>m0</sub> = 3 m H <sub>m0</sub> = 2 m H <sub>m0</sub> = 1 m H <sub>m0</sub> < 0.5 m	0.3 1 10-20 No limit	600 600 600 No limit	Building structure elements; H <sub>m0</sub> = 1-3 m	≤1	<1,000	Damage to equipment set back 5-10m	≤1	<1,000	Grass covered crest and landward slope; maintained and closed grass cover; H <sub>m0</sub> = 1 – 3 m	5	2,000-3,000	Damage to paved or armoured promenade behind seawall	< 200	Not provided
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Design scour level	<p data-bbox="391 1597 1374 1693">As a general assumption, a design scour level of -2 m AHD based is adopted for concept design development based on observed and stratigraphic evidence of historical beach scour levels fronting permeable and nonpermeable structures during major storms that impacted the Sydney coastline in the mid-1970s (Foster et al., 1975; Nielsen et al., 1992).</p> <p data-bbox="391 1720 1362 1767">Further assessment of ground conditions and geotechnical investigation is to be undertaken as part of detailed design.</p>																					
Assumed ground conditions	<p data-bbox="391 1798 1385 1895">Ground conditions assumed to be predominantly sandy beach with submerged /exposed ad-hoc rock boulders (between elevations of approximately -1 mAHD and +3 mAHD) located on the seaward edge of the historic storm erosion scarp. Beach sediment is medium grained marine quartz sand with a median grain size, d<sub>50</sub>, of 0.25-0.28 mm (Advisian, 2017).</p> <p data-bbox="391 1921 1378 2018">Bed rock conditions are comprised of Hawkesbury Sandstone, which is a fluvial, quartz rich Triassic sandstone. The Quaternary geologic evidence suggests there is no bedrock at sufficiently shallow depths within the Lady Robinsons Beach Study area to interact with present or future coastal processes (BMT WBM, 2013).</p>																					

Item	Design parameter
	Further assessment and verification of geotechnical conditions of the beach substrate and underlying geology is to be undertaken as part of detailed design.
Ground level assumptions	Ground levels at representative cross-sections have been taken from recent topographic surveys of the study site undertaken by MHL and Port Authority in 2023 combined with subtidal bathymetry collected by NSW OEH in 2018.
Wave overtopping, runoff and stormwater drainage	<p>Concept design shall be informed by a preliminary desktop analysis of wave overtopping during design events.</p> <p>Subsequent detailed design shall account for return flow drainage for design events including wave overtopping return flows assessed by physical modelling, and rainfall runoff and stormwater drainage consideration.</p>
Seawall burial and revegetation	<p>In areas of the beach that are naturally wider with foredunes present, seawall works are to be buried on their seaward side by sand won during excavation and revegetated with native foredune flora.</p> <p>In narrower areas of the beach where maintenance of a buried seawall is not feasible, landscaping and design configuration are to support intertidal ecology and demonstrate synergies with the backshore environment.</p> <p>Re-vegetation is to be undertaken in accordance with Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques (DLWC, 2001).</p>
Public safety	<p>Seawall works shall minimise impacts to user safety during construction and over the serviceable life of the structure.</p> <p>Beach user safety impacts of any proposed seawall structure should be assessed during post-storm eroded and accreted beach conditions. Design of seawall structures shall mitigate safety hazards associated with vertical relief. See <i>Mitigating impacts of vertical relief</i>.</p>
Mitigating impacts of vertical relief	<p>Seawall designs are to mitigate safety and visual amenity impacts associated with vertical relief (i.e., the vertical distance from crest of the structure to the fluctuating natural sand level fronting the seawall).</p> <p>Design considerations to mitigate impacts of vertical relief are to consider the following:</p> <ul style="list-style-type: none"> <li>• Tiering (or cascading) of the seawall.</li> <li>• Composite design incorporating sloped regions (e.g., rock armour, rock bag or Seabee units)</li> <li>• Landscaping / vegetation in the upper portion of the structure above 2 m AHD.</li> <li>• Maintaining a buried seawall by sand and vegetation covering where feasible (particularly in wider beach regions).</li> </ul> <p>Impacts of vertical relief are to be considered for concept design development during design storm conditions.</p>
Landscaping, Aesthetics and Amenity	<p>Landscaping is to be important component of the concept designs to enhance visual amenity and to blend the seawall structure to the natural backshore foredune topography and environment. Seawall designs are to include design components which assist to blend the design into the natural environment.</p> <p>For rigid structures, this should consider design aspects such as seawall geometry, concrete tinting and/or finishes, and features to enhance visual aesthetics.</p> <p>Revegetation will not include species that compromise the seawall integrity, identified as state prohibited species or will have a visual impact to neighbouring properties. Re-vegetation is to be undertaken in accordance with Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques (DLWC, 2001).</p> <p>Seawall designs along existing public accessways are to be designed with the provision where possible of user amenity features such as viewing platforms, seating, separated cycle and pedestrian user pathways, lighting and rubbish disposal.</p>

## 3 Concept design

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### 3.1 Preamble

The following section outlines concept designs for Precinct 2 Lady Robinsons Beach. Further information, plan descriptions and a visual presentation of the concept designs are provided in **Appendix A**.

### 3.2 Concept design plans

**Figure 3.1** provides a plan overview of the concept design for Precinct 2 (Teralba Rd to Solander St) . Key design components of the overall plan are described in **Figure 3.2** to **Figure 3.5**. These include:

- A new engineered vertical seawall consisting of a contiguous secant piled structure with upper concrete capping/panelling and a pedestrian foreshore boardwalk. The majority of the structure other than the upper capping and boardwalk will be buried beneath existing sand levels as a terminal structure (**Figure 3.2**). This structure will extend in a continuous alignment from the southern termination of the existing Brighton-Le-Sands seawall and will transition to a new engineered rock revetment between O’Niell St and President Ave. Existing beach access was will be retained as present at Teralba Rd and O’Neill Ln.
- A new piled timber viewing platform and lookout at President Ave combined with a nature-based intertidal zone and shallow work artificial reef to support ecological outcomes (**Figure 3.3**).
- A new rock revetment structure with foreshore pedestrian boardwalk will extend form President Ave through to Solander St. It includes a waterfront promenade at its crest and a nature-based toe design (**Figure 3.4**)
- Accessible intertidal zone, groyne upgrades and improved beach access at Solander St (**Figure 3.5**). This area also includes the potential opportunity to reconfigure the existing carpark to allow for increased parking spaces (nom.18 spaces) with improved green buffer zone alongside the shared user path, improved accessibility to the public toilets and provision of increased public space (approx. 2500sqm).

Additional plans and diagrams illustrating the concept designs are provided in **Appendix A**.

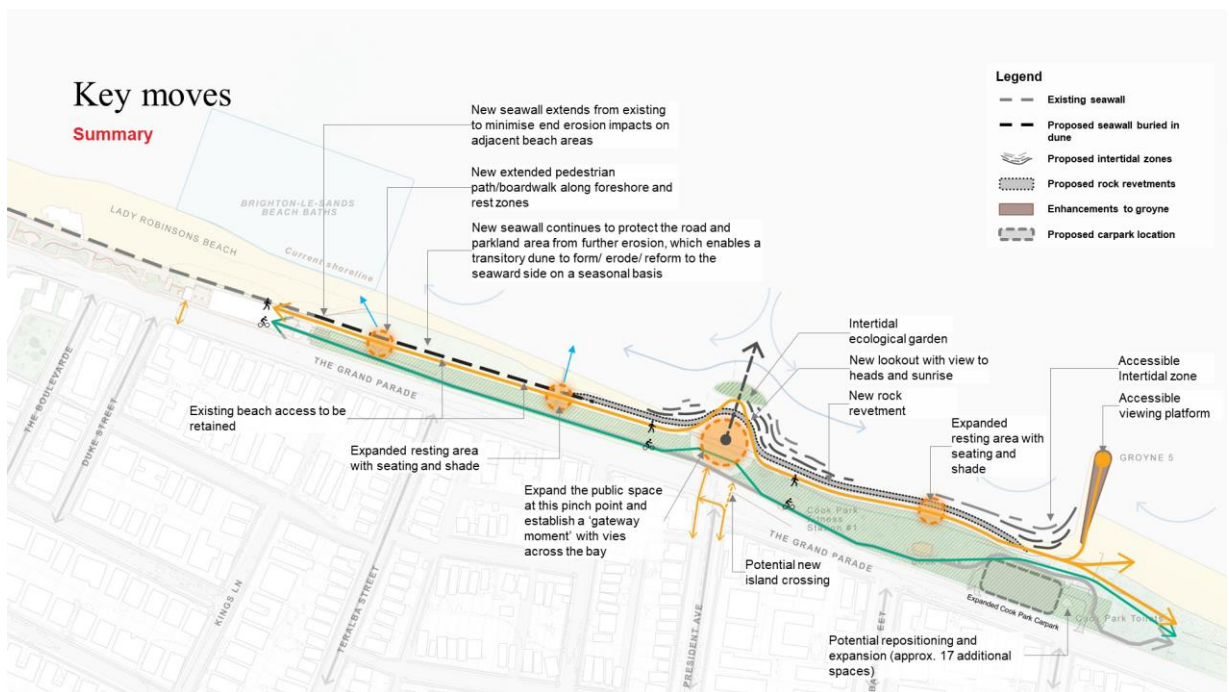


Figure 3.1: Overview concept design plan (top) and summary of key features (bottom)



**Figure 3.2: Northern region at Teralba Rd concept design plan**



**Figure 3.3: Mid region at President Ave concept design plan**

## Rock revetment with boardwalk

- Continued engineering rock revetment with nature-based intertidal zone
- Relocated walking path along foreshore edge
- Opportunity for expanded seating area

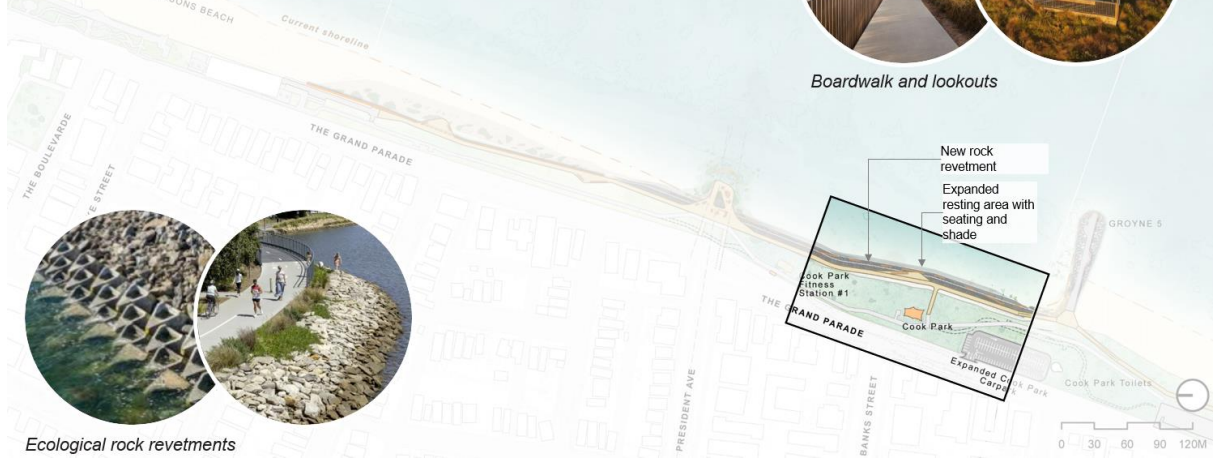


Figure 3.4: Southern region at Bank St concept design plan

## Accessible intertidal zone & groyne upgrades

- Accessible ecological terraces and rockpools
- Provision of equitable access to adjacent beach
- Potential to enable groyne access as lookout
- Groyne repair/ upgrade as part of works
- Carpark modifications



Figure 3.5: Southern region at Groyne 5 concept design plan

### 3.3 Concept design cross-sections

Representative concept design cross-sections are provided in **Figure 3.6** to **Figure 3.8**.

**Figure 3.6** shows a representative cross-section (AA) for the buried contiguous secant piled vertical seawall with concrete capping and pedestrian boardwalk in its upper portion. The alignment of the seawall will run through the existing foredune area and transition smoothly to the existing concrete gravity seawall structure in the north at Brighton-Le-Sands. The majority of the structure other than the upper capping and boardwalk will be buried beneath existing sand levels as a terminal protection structure. Initial crest levels of the boardwalk (+3.5 mAHD) have been designed to reduce vertical relief from the structure to the existing sand levels and are to be raised in a staged manner in accordance with an adaption plan with triggers for agreed risk thresholds for wave overtopping and sea level rise (to be determined during detailed design).

**Figure 3.7** shows a representative cross-section (BB) for the piled timber lookout at President Ave extending over a nature-based designed intertidal zone to support shallow water ecology and backed with a new rock revetment to protect the shore from ongoing erosion. The viewing platform provides a direct overwater view to the horizon and alleviates the current pedestrian and cycleway pinch point at President Ave. A nature-based designed intertidal zone surrounds the viewing platform and provides wave energy dissipation at this erosion hotspot and help support the establishment of intertidal biodiversity and ecology.

**Figure 3.8** shows a representative cross-section (CC) of the engineered rock revetment with crest level pedestrian boardwalk at the southern end of Precinct 2 near Banks St. The rock revetment is designed with two-layers of randomly placed 0.3-3t (median armour mass,  $M_{50} = 2t$ ) igneous primary armour (1.6m layer thickness) with a 0.1-0.3t ( $M_{50} = 0.2t$ ) rock underlayer (0.75m thickness) and geotextile lining. The structure has a crest level (+4.0m AHD) pedestrian walkway and Dutch toe for scour protection with a nature-based designed intertidal zone. Initial crest levels are to be raised in a staged manner in accordance with an adaption plan with triggers for agreed risk thresholds for wave overtopping and sea level rise.

### 3.4 Preliminary cost estimates

High level cost estimates for the Precinct 2 concept designs are provided in **Table 3.1**. These range from \$32M to \$58M with a mid-range estimate of \$45M. Itemised cost breakdowns are provided for key concept design features. Revised costings will be undertaken as part of detailed design with several opportunities to reduce costs and/or to stage the implementation of the works by high to low priority for the Precinct.

It is noted that preliminary cost estimates are substantially higher than previous estimates undertaken in MHL (2023) which previously focused on coastal protection works and did not consider major upgrades with enhanced amenities, ecology and economic opportunities. The present concept designs are developed to provide a world-class foreshore setting noting Lady Robinsons Beach as a significant local and regional tourism drawcard. These designs could be moderated to reduce costs while maintaining best practise.

# Typical Section AA

Vertical seawall with pedestrian path

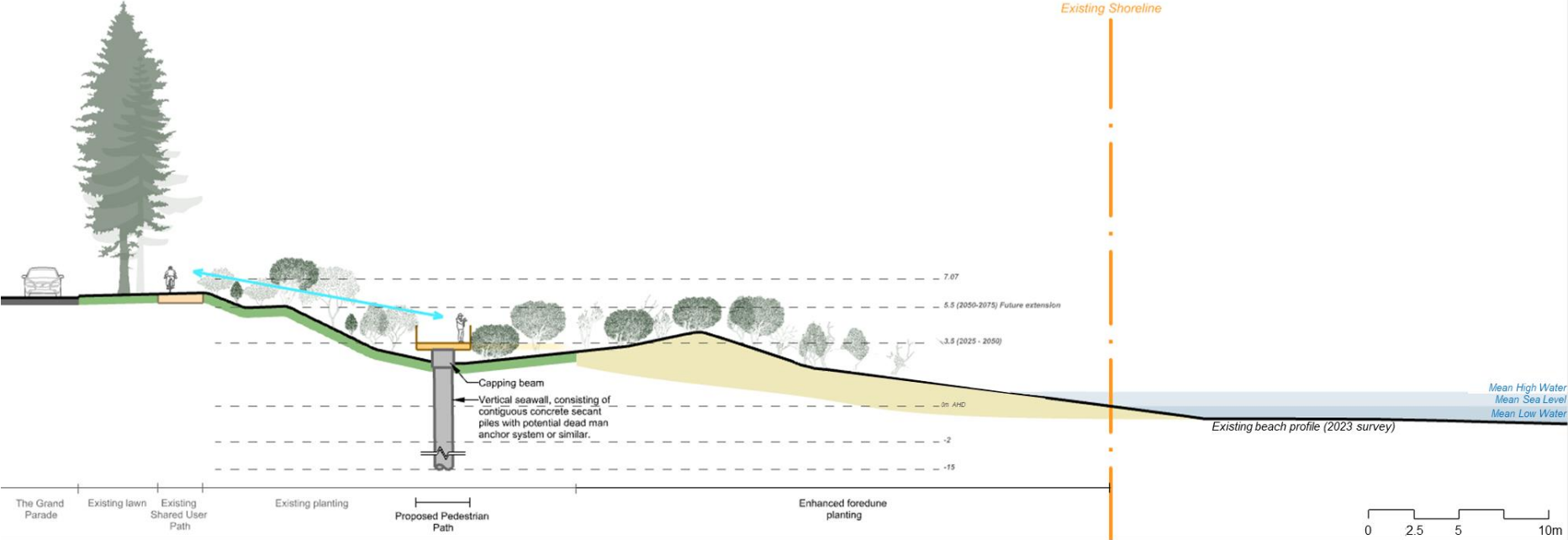


Figure 3.6: Northern region representative cross-section AA at Teralba Rd

# Typical Section BB

Rock revetment wall with lookout at President Avenue

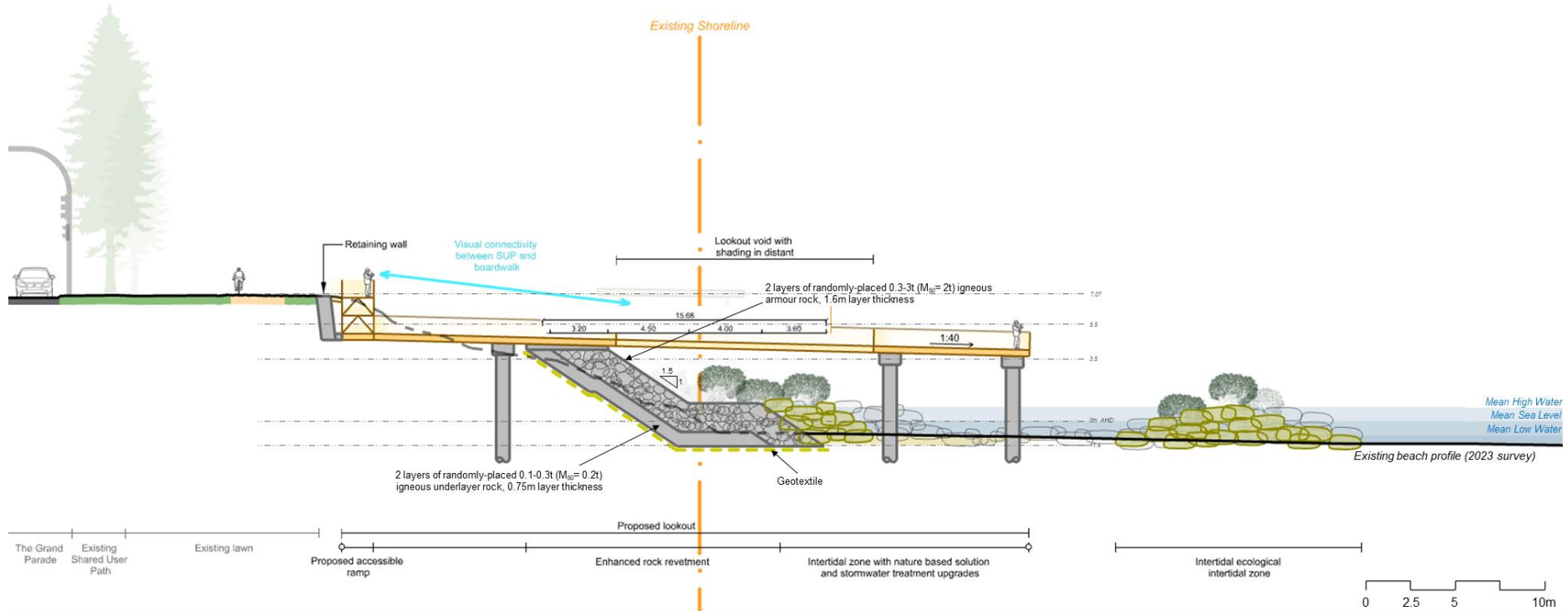


Figure 3.7: Mid region representative cross-section BB at President Ave

MHL3034- 22

Classification: Private

# Typical Section CC

Rock revetment wall with pedestrian path

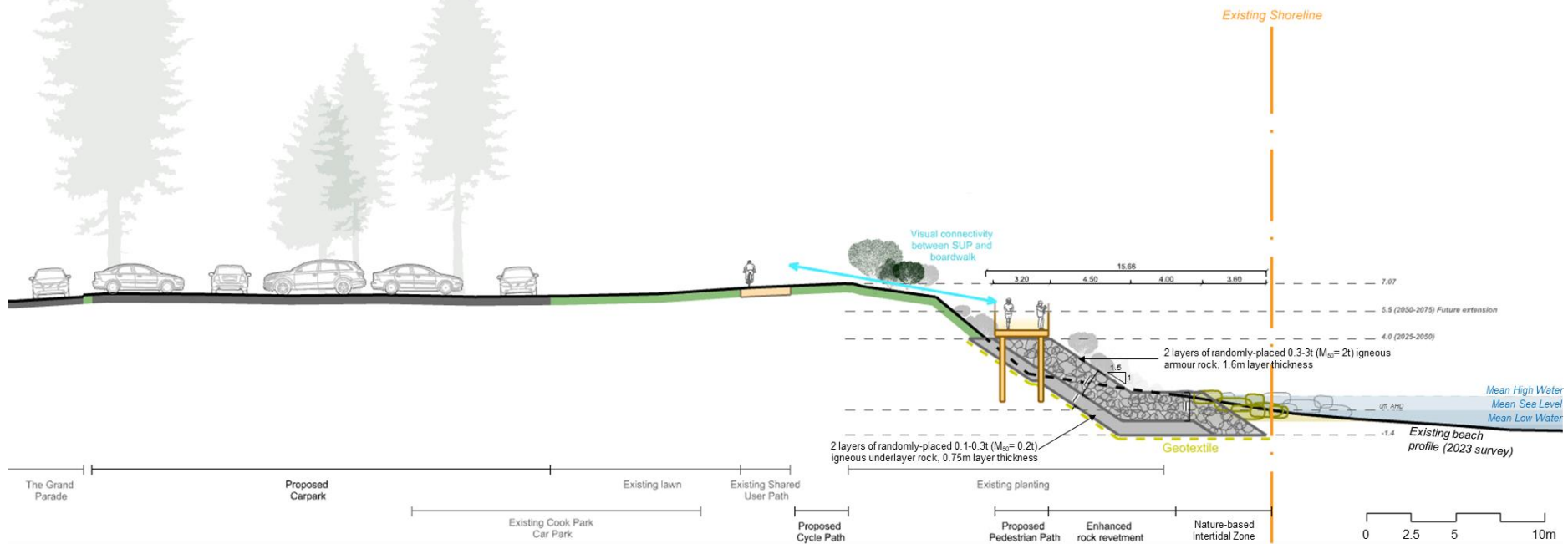


Figure 3.8: Southern region representative cross-section CC just north near Banks St

MHL3034- 23

Classification: Private

**Table 3.1: Preliminary cost estimates**

<b>Lady Robinson Foreshore - Precinct 2 - High Level Cost Estimates 09.07.2024 (Revision 01)</b>	
Assumptions/ Exclusions:	
- Excludes indirect costs such as design and project management fees, investigations, approvals, levies, etc.	
- Order of magnitude cost, QS input required for certainty as design progresses	
- Based on the sketch concept design for Precinct 2	
<b>Line</b>	<b>Description</b>
<b>Vertical Wall</b>	
1	Piled vertical wall system
2	Capping beam
3	Walkway
<b>Subtotal (Lower)</b>	<b>\$ 11,520,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 20,880,000</b>
<b>Rock Revetment (incl. transition)</b>	
4	Recover and process existing rocks on site
5	Ground reprofiling and spreading excavated material along the foreshore
6	Supply and place geotextile
7	Supply new revetment rocks
8	Place existing and new revetment rocks
9	Intertidal zone
10	Rock grouting and walkway
<b>Subtotal (Lower)</b>	<b>\$ 9,280,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 16,820,000</b>
<b>Headland</b>	
11	President Avenue lookout
12	Tiered blockwork intertidal zone
13	Stormwater treatment
<b>Subtotal (Lower)</b>	<b>\$ 1,280,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 2,320,000</b>
<b>Intertidal including groyne</b>	
14	Intertidal zone
15	Groyne repairs
<b>Subtotal (Lower)</b>	<b>\$ 640,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 1,160,000</b>
<b>Architectural/ Landscape items</b>	
16	Balustrade
17	Walkway surfacing
18	Seating
19	Shelters
20	Lighting
21	Landscaping and planting
<b>Subtotal (Lower)</b>	<b>\$ 4,800,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 8,700,000</b>
<b>Preliminary Items (Calculated assuming that the whole scope is delivered)</b>	
22	Site mobilisation, establishment, site office, onsite running cost and demobilisation
23	Plans and permits
24	Traffic management
25	Health & safety and environmental management
<b>Subtotal (Lower)</b>	<b>\$ 4,480,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 8,120,000</b>
<b>Total Construction Cost</b>	
<b>Subtotal (Lower)</b>	<b>\$ 32,000,000</b>
<b>Subtotal (Upper)</b>	<b>\$ 58,000,000</b>
<b>Subtotal (Average)</b>	<b>\$ 45,000,000</b>

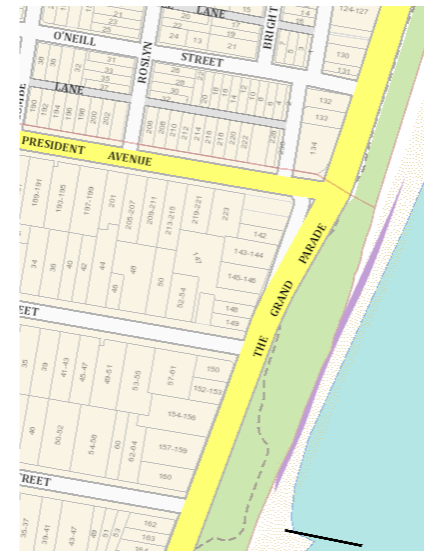

## 4 Preliminary environmental impact risk assessment


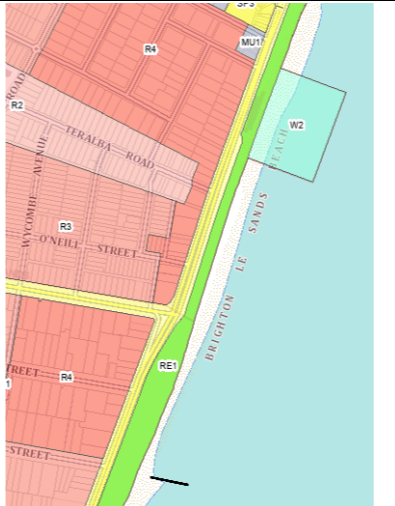
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A preliminary (desktop) environmental impact risk assessment for the Precinct 2 concept designs is provided **Table 4.1**. Potential high environmental and social impact items noted from the assessment include:


- Changes in coastal processes and sediment dynamics – seawall and wave interactions can result in end erosion impacts on adjacent beach areas. Concept design considerations to minimise these impacts include nature-based intertidal wave energy dissipation at exposed seawall sections in the south and mid regions of the Precinct, intertidal shallow water artificial reef at President Ave to dissipate wave energy and deter alongshore currents in shallow waters, and a landward buried seawall alignment in the northern region of the Precinct to minimise exposure to wave energy. However, noting Brighton-Le-Sands beach is classified as Zone 1 under the *Lady Robinsons Beach Foreshore Management Plan* (MHL-Arup, 2024a), further assessment of impacts on adjacent beach areas should be undertaken as part of subsequent detailed design. Following construction, monitoring of adjacent beach areas at Brighton-Le-Sands should be undertaken to confirm if any end-erosion impacts of the design are present.
- Impacts on localised flooding: detailed design shall account for return flow drainage including wave overtopping return flows, rainfall runoff and interactions with stormwater flows and outlets (President Ave and Kings Lane).
- Existing beach access ways at Teralba Rd (including Council vehicular access) and O'Neill Lane are to be retained as present as part of the concept designs. Beach access at President Ave (closed since 2020 due to erosion hazards) will not be reinstated as part of the concept designs as the foreshore is heavily eroded with minimal beach area extending from this location through to Banks St. Due to ongoing erosion processes, it is not considered cost-effective and feasible to restore and maintain sandy beach at this location.
- Noise levels and public disruption due to closure of foreshore public areas during construction will require assessment with construction works designed to mitigate impacts wherever possible.


Table 4.1: Preliminary Environmental Impact Risk Register

Environmental and social risks	Desktop searches	Risk description	Location	Environmental/social impact	Planning approval impact	Recommendation / Next Steps
<b>Biodiversity</b>						
Biodiversity values	Planning portal BV map	There is a section of beach (between President Ave and Solander St) on the BV map (refer to screenshot). Potential to impact		Medium	Medium	Ecology surveys Arborist report Terrestrial biodiversity assessment Marine biodiversity assessment
Key Fish Habitat (KFH)	DPI Fisheries portal	Botany Bay is KFH, potential to impact	Botany Bay	Low	Low	
Seagrass	DPI Fisheries portal	Present along coast of study area (zostera) (refer to screenshot). Potential to impact		Low	Low	
Coastal wetlands	Planning portal - hazard and resilience SEPP	N/A	-			
Threatened species & threatened ecological communities	Bionet PMST	Potential to impact threatened flora and fauna. Numerous records on BioNet and PMST (including MNES) within a 10km radius (and within study area)	Within and around the study area	Medium	Medium	

Environmental and social risks	Desktop searches	Risk description	Location	Environmental/social impact	Planning approval impact	Recommendation / Next Steps
<b>Heritage</b>						
Local heritage	planning portal Heritage estate register	Impacts to heritage items, including Brighton Baths, Row of Acaucaria Trees, Cook Park (refer to screenshot)		Low	Medium	Consult with LALC and other Aboriginal parties/representatives Incorporate historical and First Nations considerations into the design Non-Aboriginal heritage assessment Aboriginal Cultural Heritage Assessment
State	Planning portal	N/A				
National	SEED	Sydney Cultural Crescent Rock Art (potential to be present)	Large area of Sydney (incl. study area)	Medium	High	
Maritime heritage	Maritime heritage register	N/A				
Underwater heritage	Australasian underwater cultural heritage database	N/A				
Aboriginal heritage	SEED - predictive modelling tool, archaeological surveys mapping	Medium-high potential for Aboriginal heritage items/relics/middens to be present. (No record of archaeological surveys being conducted within the study area previously)	Study area	Medium	High	
AHIMS	AHIMS basic search	N/A				
<b>Land use</b>						
Land zoning	Planning portal spatial viewer	Within or adjacent to RE1 - Public recreation, SP2 Classified road (Grande Pde and President Ave), W2 Recreational waterways, as well as R2, R3 and R4 residential		Low	Low	Consultation (e.g. with TfNSW due to classified road) Land use and property assessment

Environmental and social risks	Desktop searches	Risk description	Location	Environmental/social impact	Planning approval impact	Recommendation / Next Steps
Crown land	Planning portal spatial viewer	The RE1 zoned area (all Cook Park?) within the study area is Crown land (owned by Bayside Council)		Low	Medium	
Native Title	SEED, Native title register	N/A				
<b>Coastal processes/dynamics</b>						
Coastal processes / dynamics	Qualitative assessment	Change in coastal processes/dynamics e.g. seawall affecting wave dissipation, removal of vegetation affecting beach/dune system structure/function	Coast	High	Low	Consideration of wave dynamics in design Integration of vegetation considerations into design to support the dune system, etc
<b>Social</b>						
Social	Qualitative assessment	Impacts to sensitive receivers/local businesses/road users, impacts to people's way of life & sense of place, impacts to amenity	Study area and surrounds	Medium	Low	Community consultation Social impact assessment Integration of security and safety considerations into design
User conflict	Qualitative assessment	Conflict between users of both the foreshore and the bay e.g. for fishing and jet skiing	Study area and surrounds	Low	Low	
CPTED / Security / lighting	Qualitative assessment	Risk of fostering an unsafe environment through lack of security and lighting. New lighting may disturb fauna.	Study area	Low	Low	
<b>Landscape and visual</b>						
Visual amenity	Qualitative assessment	Reduced visual amenity during construction, risk of blocking views e.g. planted trees. Improved visual amenity in operation	Study area and surrounds	Medium	Low	LCVIA

Environmental and social risks	Desktop searches	Risk description	Location	Environmental/social impact	Planning approval impact	Recommendation / Next Steps
Landscape character	Qualitative assessment	Impacts to landscape character during construction. Improvements in operation	Study area and surrounds	Low	Low	
<b>Water</b>						
Water quality	Qualitative assessment	Potential for a decline in water quality due to construction water runoff, sedimentation & erosion impacts, impacts during operation, risk of ASS runoff if present	Botany Bay adjacent to site	Medium	Medium	Surface water and flooding assessment
Stormwater management	Qualitative assessment	Stormwater pipes currently exposed, risk of inappropriate/ineffective stormwater management	Study area and surrounds	Medium	Low	
Flooding	Flood prone land - Council mapping	Potential for flooding during times of high rainfall and/or sea level rise		High	Medium	
<b>Soils and contaminants</b>						
Contaminants	EPA register Check google maps for businesses nearby e.g. service station	Potential for contamination to be encountered. Nothing notable nearby in terms of possible contamination sources	Study area	Low	Low	Site investigations for ground truthing Soils and contamination assessment

Environmental and social risks	Desktop searches	Risk description	Location	Environmental/social impact	Planning approval impact	Recommendation / Next Steps
Soils	eSpade/planning portal spatial viewer	Class 4 Acid Sulfate Soils (purple on screenshot) - likely to be found 2m below natural ground surface		Medium	Low	
<b>Air quality</b>						
AQ	Qualitative assessment	Changes to air quality during construction e.g. increase in emissions, dust	Study area and surrounds	Low	Low	Air quality monitoring AQ assessment
<b>Noise</b>						
Noise	Qualitative assessment	Construction noise	Study area and surrounds	High	Low	Noise monitoring Noise assessment
<b>Traffic</b>						
Traffic	Qualitative assessment	Potential disruptions to traffic during construction	Surrounding road network	Medium	Medium	Traffic modelling Traffic and transport assessment
Parking	Qualitative assessment	Potential changes/disruptions to parking during construction. More parking in operation.	Study area and surrounds	Medium	Medium	
<b>Waste</b>						
Waste	Qualitative assessment	Generation and management of waste in construction and operation	Study area	Low	Low	Desktop assessment
<b>Hazards</b>						
Hazards	Qualitative assessment	Use/storage of dangerous or hazardous goods during construction, particularly due to being close to the water's edge	Study area	Low	Low	Incorporate coastal hazards considerations in design Desktop assessment
Coastal hazards	Qualitative assessment	Increase in frequency and severity of storms	Study area	High	Low	

Environmental and social risks	Desktop searches	Risk description	Location	Environmental/social impact	Planning approval impact	Recommendation / Next Steps
<b>Climate change</b>						
Climate change	Qualitative assessment	Site likely to be impacted by sea level rise	Study area	High	Low	Incorporate considerations in design
<b>Sustainability</b>						
Sustainability	Qualitative assessment	Risk of unsustainable construction methods/materials/practices. Less of a risk, more of an opportunity	Study area	Low	Low	Investigating nature based solutions and sustainability considerations e.g. rock revetment options
<b>Aviation</b>						
Aviation	Qualitative assessment	Within Obstacle Limitation Surface (OLS) area of Sydney Airport	Study area	Low	Low	Consider height restrictions and lighting in design

## 5 Review of existing structure serviceability

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### 5.1 Brighton-Le-Sands Seawall at southern termination

The Brighton-Le-Sands is located immediately northward of the Precinct 2 management area, extending approximately 460m in length and situated between Princess St and Kings Lane (**Figure 2.1**). The seawall was constructed in 1936 and is composed of a concrete gravity seawall with timber piling along the toe situated at approximately -0.5 to -1.0 mAHD. Sections of the seawall have been historically exposed to varying degrees of exposure to wave energy, depending on variations in sand accumulation seaward of the structure, size of coastal storm event, etc. In recent decades the seawall has been fronted by a sandy beach berm, typically 40 to 60m in width to the 0 mAHD contour.

A visual inspection and condition assessment were undertaken of the Brighton-Le-Sands seawall by Manly Hydraulics Laboratory in December 2019, reported within the *Lady Robinsons Beach – Investigation and Design Study Stage 1: Review and Assessment of Coastal Processes report* (MHL, 2020). The inspection and assessment were undertaken of all visible surfaces of the seawall not buried by sand. As a result, assessment of the lower face of the seawall and toe was not able to be undertaken in most locations.

The overall condition of the seawall was assessed as “fair” with the asset functioning safely at an adequate level of service. Isolated deterioration evident (cracking, concrete spalling and damaged edges) was noted in a number of locations to the north of the beachside restaurants requiring repair works within the next 5-10 years (low priority). Failure of the seawall due to wave energy exposure is currently considered to be unlikely given the seawall is fronted by a relatively wide sandy beach berm (MHL, 2020). Continued structure condition monitoring, particularly after storms that expose the seawall to wave energy, is warranted given the age of the structure.

The estimated spatial extent of the Brighton-Le-Sands seawall relevant to the proposed works within Precinct 2 is the southern termination of the seawall, in the lee of the curved, semi-circular stairs at the southern extent of the beachside restaurants (see **Figure 2.1**, **Figure 5.1**). No defects of the existing seawall were noted in the MHL 2019 inspection at this termination end (MHL, 2020), however access for inspection is poor due to high relative levels of sand preventing direct observation, as well as the termination of the seawall being covered by the promenade decking constructed in 2006, preventing a contemporary condition assessment being undertaken.

The capping of southern termination of the seawall was adapted with the upper section (including the wave return) removed during promenade upgrade works in 2006 (DEM Aust, 2006) shown in **Figure 5.2**. Available documentation does not indicate that the 2006 works identified significant issues of concern with the condition of the seawall when adapting the existing structure. The current crest level of the seawall at the southern termination point is approximately +4.0 mAHD, progressively reducing in height towards the north, being measured at under +3.5 mAHD adjacent to Duke St, to just above +3.0 mAHD near Princess Street (MHL, 2020). Crest levels of the existing seawall at the southern termination point are to be confirmed by a registered surveyor during detailed design.

The crest of the concept design seawall for Precinct 2 varies between +4.0 mAHD to +3.5 mAHD, with the section immediately south of the termination point at +3.5 mAHD. It is anticipated that the detailed design of the new works will include a gradual increase in crest level prior to termination in a contiguous form with the existing structure at approximately +4.0 mAHD. Future crest adaption with sea-level-rise of the proposed seawall should be considered in-conjunction with the pre-existing seawall at Brighton-Le-Sands to maintain a congruent transition between the two structures.

It is anticipated that cross-shore alignment between the existing seawall and the new structure will be achieved through a smooth transition to provide a consistent visual and physical transition between old works (concrete gravity seawall) and new works (vertical contiguous piled seawall with upper concrete capping beam). The methodology for joining the structures so as to ensure a permanent 'bind' and mitigate gaps will be developed during detailed design for construction purposes guided by engineering design integration. Construction works for the proposed new seawall will require removal and redesign of the existing timber decking which currently covers the seawall (**Figure 5.1**).

Given burial in recent decades, the seawall condition is likely to have benefited from reduced exposure to coastal processes, nor the chemical and physical processes of general weathering. However, it is noted that the structural integrity of the existing seawall is subject to confirmation either prior to the Precinct 2 works being undertaken (through mechanical removal of sand/vegetation and/or coring and sampling of the concrete structure), or during the permanent works, when the current structure will be exposed and can be visually and/or structurally assessed for adequacy. This is noted to be particularly important given the age of the structure.

While the condition of the existing seawall structure is highly relevant as a point of connection / tie-in for proposed coastal protection works, it is noted that the majority of the structure is located within Precinct 1 of the Lady Robinsons Foreshore Management Plan (MHL, 2024). Maintenance of the existing structure and/or potential plans to amend the current configuration are outside the scope of this Report, though will be addressed within proposed management works for Precinct 1 in due course.



Figure 5.1: Southern termination of Brighton-Le-Sands seawall

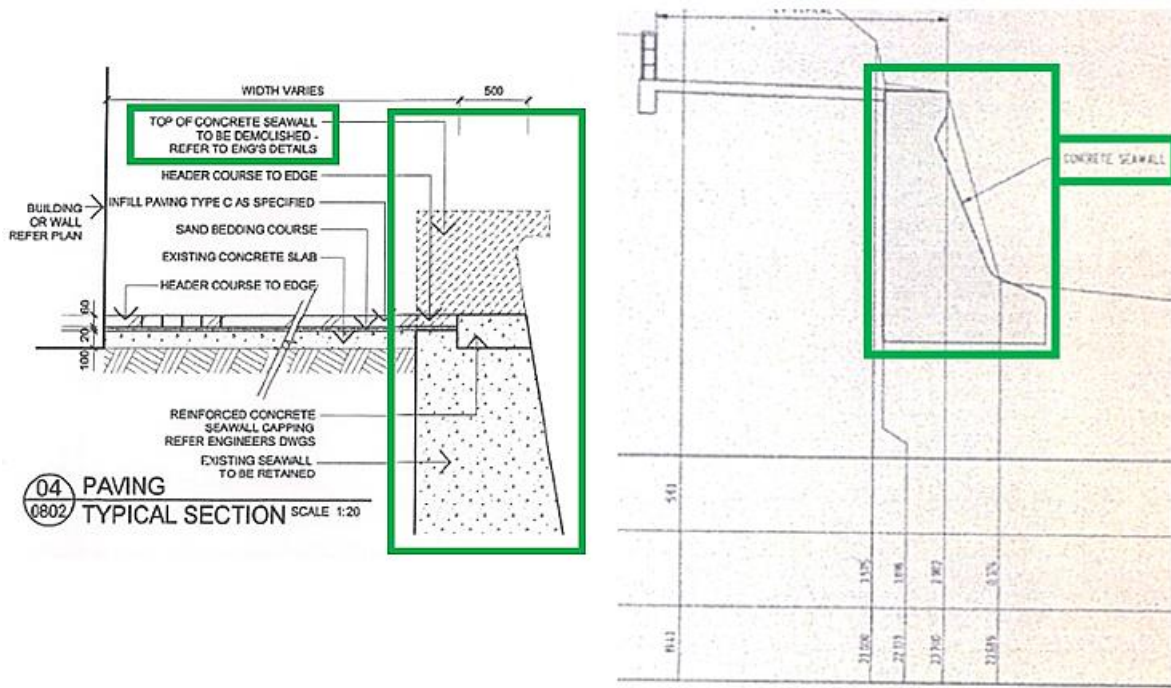


Figure 5.2: Amendments to the southern termination end of the Brighton-Le-Sands seawall undertaken in 2006 shown on left (DEM Aust, 2006) with former indicative cross section on right (Arup, 1996).

## 5.2 Ad-hoc rock works (Bank St to Brighton-Le-Sands)

Ad-hoc emergency rock works were constructed along the toe of an erosion scarp between Bank St to Brighton Baths in the late 1960's as shown in the historical images provided by Council in **Appendix B**. The images show the rock works extending to the southern extent of Precinct 2 (possibly further), and to the northern extent of Precinct 2, at Brighton-Le-Sands beach facilities and swimming enclosure. The estimated cross-shore buried and exposed extent of the ad-hoc rock protection is shown in **Figure 2.1**.

Interpretation of the historical images depicting ad-hoc rock protection works provides the following information:

- The diameter of the rocks is estimated to range in size from 0.3m to 1.0m, though because the rock type is not identifiable, the mass of each is unknown.
- The maximum crest of the rock revetment appears to be approximately +3.0 to 4.0 mAHD, which is lower than the dune crest (approx. +5.0 to 6.0 mAHD). The toe of the rock works is at a scoured beach level approximately 0.0 to +1.0 mAHD.
- It is expected that over time the rock armour will have slumped due to movement of the rocks through direct wave action as well as “settling” because of the rock mass displacing sandy sediments at the toe (base) of the works.

The area has received additional rock-placement as erosion/recession mitigation since the 1960's. More recently in 2019, additional ad-hoc rock protection (approx. 15m length) was placed to protect the beach access walkway and stormwater outlet at President Ave (**Figure 2.1**). The beach in this location has continued to erode despite the placement of this rock, resulting in closure of the beach accessway, damage to stormwater infrastructure and leaving ad-hoc rock strewn within the intertidal zone and beach substrate (**Figure 1.3**). Adjacent sections of ad-hoc rock are increasingly being exposed due to ongoing recession, with 1-3 m erosion scarps above the rock works cutting into the vegetated transient foredune (previously nourished and vegetated during the late 1960s and early 1970s).

The overall condition of exposed sections of ad-hoc rock was assessed by MHL in 2019 as “poor” with the structure failing to protect the foredune from progressively eroding, failing to protect stormwater infrastructure and resulting in unsafe beach access (MHL, 2020). The inspection raised concerns regarding the stability of the ad-hoc rock works with ongoing wave exposure and retreat of the foredune scarp. Unsafe accessways were closed as a high priority action from the inspection. Failure of the ad-hoc works has occurred in some sections (e.g. President Avenue beach accessway rock protection) and will continue to worsen with increased wave exposure particularly during high wave energy events into the immediate future.

The ad-hoc rock protection works placed on the foreshore (tipped from the dune crest onto the beach) would not meet contemporary coastal engineering standards, due to a range of factors including (but not limited to):

- There is no geotextile (or similar) material on the scarp face to prevent loss of sediment and undermining of the terrestrial area behind the revetment,
- The ad-hoc rock protection has not been provided a “toe” of rocks at scour depth to prevent undermining and failure of the structure,

- The rocks appear to be undersized and underweight by contemporary coastal engineering standards,
- The rock works do not have engineered overtopping design protection and drainage, and it is likely that events causing overtopping of the crest of the ad-hoc rock will continue to erode the foredune,
- The rocks have been 'dumped' rather than pattern placed to ensure interlocking, and
- There appears to be a single 'layer' of rock size, rather than a secondary layer of smaller rocks, overlain by a primary layer of larger rocks.

While not designed to engineering standards, ad-hoc rock protection of such nature provides a temporary form of protection, typically able to withstand 1-2 year ARI conditions with a likely chance of damage and failure during large events. Replacement of the ad-hoc rock works with an engineered structure is considered necessary for protection of adjacent infrastructure and assets (including the road corridor of The Grand Parade) against immediate and future coastal erosion hazards.

Proposed to replace the ad-hoc rock works is the construction of a new engineered seawall with a minimum initial design life 50 years with design failure for non-rigid and rigid structures of 500–2000 year ARI and including design for a 50 year high-end sea level rise projection. Interim temporary protection works have been designed to provide an additional protection buffer until a new engineered seawall is constructed (see [Section 5.6](#))

Further geotechnical investigation (as a minimum excavation of three test pits along the proposed seawall alignment) is required during detailed design to confirm the spatial extent of ad-hoc rock protection in the vicinity of the proposed new construction works. If ad-hoc rock is encountered, it is considered likely that the rocks will not be suitable for re-use as primary armour, however may be able to be re-used within the secondary layer of rocks, subject to assessment of suitability (including rock type, density, quality, size, etc). Where deemed suitable by a qualified engineer, other re-purposing of these rocks could include design of nature-based intertidal and nearshore habitat, fill landward of seawall works, topping up of depleted groyne structures and/or reuse as toe protection of existing seawall structures. Any materials encountered that are considered unsuitable should be removed from the foreshore and re-used/disposed of appropriately.

### 5.3 Banks St rock works

Rock works at Banks St (approx. 140m in length) provide temporary (non-engineered) shore protection for the adjacent public recreation area (playground) and road corridor shown in **Figure 2.1**. For the last approximately 10 years, the rock works at Banks Ave have protruded into the water line cutting off pedestrian access along the beach with frequent exposure of wave energy on the structure. Sand elevations at the toe of the structure at the time of the MHL 2019 inspection were measured between 0 and -0.5 m AHD and there is currently little to no access along this section of beach even during low tide. Dune crests along the top of the works are situated at approximately +6.0 to 7.5 mAHD.

A desktop review of available survey and condition information of the Banks St rock works was collated from various sources (MHL, 2020; MHL, 2023; OEH Marine Lidar, 2018; Nearnmaps). Rock diameters are visually estimated to range in size from 0.4m to 1.2m, with sandstone being the primary rock type (estimated dry density of 2.35 t per m<sup>3</sup>). The structural slope of the rock works between +0.6 mAHD (approx. Mean High Water) and +2.0 mAHD was calculated every 10m along the structure utilising 2018 Marine Lidar point cloud elevation data (OEH, 2018). Structure slopes ranged from 1V:1.3H to 1V:2.6H with a median slope of 1V:1.7H. In some locations, a number of rocks have dislodged from the rock works, and are positioned within the swash zone of the foreshore, resulting in a flatter structure slope at lower intertidal elevations. It is expected that over time the rock revetment will have slumped due to movement of the rocks through direct wave action as well as “settling” because of the rock mass displacing sandy sediments at the toe (base) of the revetment. The maximum crest of the rock revetment is estimated to be approximately +2.0 to +3.5 mAHD, which is notably lower than the dune crest.

The overall condition of exposed sections of ad-hoc rock was assessed by MHL in 2019 as “fair” with the asset providing a temporary level of non-engineered protection with minor structure slumping and rock displacement (MHL, 2020). A preliminary structure stability assessment using Hudson’s formula for rock armour stability, undertaken in the present study, indicates that the rock is undersized and underweight to provide a required design level of coastal protection (initial damage at 100yr ARI conditions) for the 50 years design planning period. It is noted that the Bank St rock works is frequently exposed to wave energy with no dry sandy beach fronting the structure for several years. During this time, it has withstood with minor damage, wave attack of events ranging up to approximately a 1 in 10 year ARI nearshore wave conditions. This value is consistent with preliminary analytical stability analysis of the existing structure, with initial to intermediate rock armour damage expected for 1 in 5 year to 1 in 10 year nearshore wave conditions at the structure.

The rock works are ad-hoc by nature and do not meet contemporary engineering standards noting:

- There is no geotextile (or similar) material on the scarp face to prevent loss of sediment and undermining of the terrestrial area behind the revetment,
- The rock works do not been provided a “toe” of rocks at scour depth to prevent undermining and failure of the structure,
- The rock works do not have engineered overtopping design protection and drainage, and it is likely that events causing overtopping of the crest of the rock works will

continue to erode the foredune,

- While there appears to be some degree of intended connectivity between rocks, in general the rocks have been “dumped” rather than pattern placed to ensure interlocking, and
- There appears to be a single ‘layer’ of rock size, rather than a secondary layer of smaller rocks, overlain by a primary layer of larger rock armour

The asset would likely require structure upgrades or replacement within the next 10 years to maintain serviceability to design specifications. As a minimum the structure requires:

- Topping up with an additional layer of 2t ( $M_{50}$ ) rock armour at a design slope no steeper than 1V:1.5H and crest height of +4.0 mAHD
- Design adaption of the lower portion of the structure to incorporate a Dutch toe (2t armour) to accommodate scour protection to a design level of -2.0 mAHD. Toe design would also benefit from nature-based design adaption noting high exposure to intertidal processes.

Alternatively, concept designs in the present study have included the replacement of the Banks St rock works with a new engineered sloped rock revetment with a minimum initial design life 50 years with design failure for 500–2000 year ARI conditions, initial damage for 100–200 year ARI conditions and design for a 50 year high-end sea level rise projection. Concept design also incorporate a crest level promenade and nature based toe.

As shown in **Figure 2.1**, the alignment of the proposed new rock revetment will likely intersect with the varying alignment of the existing Banks St rock works, with some of the current rock works likely to be landward and other sections seaward of the proposed new seawall. When encountered during construction of the new seawall, it is considered likely that the rocks will not be suitable for re-use as primary armour, however may be able to be re-used within the secondary layer of rocks, subject to assessment of suitability (including rock type, density, quality, size, etc). Where deemed suitable by a qualified engineer, other re-purposing of these rocks could include design of nature-based intertidal and nearshore habitat, fill landward of seawall works, topping up of depleted groyne structures and/or reuse as toe protection of existing seawall structures. Any materials encountered that are considered unsuitable should be removed from the foreshore and re-used/disposed of appropriately.



**Figure 5.3: Banks St rock works in 2019.**

## 5.4 Groyne 5 (Solander St)

Groyne 5 is one of five groynes situated between Florence St (Ramsgate) and Solander St (Monterey) constructed as part of northern groyne field Lady Robinsons Beach protection works in 2004-5 (**Figure 2.1**). The groynes were designed with the follow specifications (Connell Wagner, 1999), with the overall dimensions of Groyne 5 described in **Table 5.1**:

- spacing of 220-360 m
- minimum crest height of 2.3 m LAT (1.4 m AHD)
- minimum crest width of 2.5 m
- toe level of -1.5 m LAT (-2.4 m AHD)
- 1:1.5 slope at the root of the groyne and 1:2 slope at the head

**Table 5.1: Details of Groyne 5 (adapted from Connell Wagner, 1999, cited in MHL, 2019)**

Groyne	Design Length (m)	Design Orientation (° TN)	Compartment Length (m)
5	96	101	360 (4 to 5)

Connell Wagner (1999) reported a design primary basalt rock armour with median armour size (d50) of 900mm (2 Tons) and rock core with d50 of 225mm (20kg). However, observed primary armour was notably smaller than this during the condition survey, with rock diameters ranging from 400 – 1000mm with an estimated d50 of approximately 700mm. The observed values are closer to rock sizes specified during concept design stages by Sydney Ports Corporation (1996) (MHL, 2020).

More recent reviews of the Lady Robinsons Beach Groyne Scheme have investigated the potential lengthening of the groyne structures in effort to improve sand retention (WorleyParsons 2014, Advisian 2017, MHL 2020, and MHL, 2023). WorleyParsons (2014) noted the potential lengthening of Groyne 5 by 10-25m as low priority action, however this

was later not included in management options assessed by Advisian (2017). More recently, investigation of coastal processes by MHL (2023) quantified sand accretion on average of +700 m<sup>3</sup> per year in the Groyne 4 and 5 compartment between 2006 and 2018. Based on these results, adaption or lengthening of Groyne 5 is not recommended to improve shoreline stability under the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a).

Results of condition assessment and survey of the structure by MHL in 2019 are shown in **Figure 5.4** and **Figure 5.5** (MHL, 2020). The overall condition of Groyne 5 was found to be *fair*, with defect observations and RTK-GPS surveys indicating that the primary rock armour layer was notably depleted at the head of the structure near the navigation post up to approximately 0.8m below the design crest level of 1.4m AHD, and equivalent to approximately a single layer of primary rock armour (rather than a double layer). The rocks have likely been displaced during large swell conditions and deposited at lower elevations (MHL, 2020).

Displacement of primary armour at the midway and shore survey sections was less significant. Undermining of the navigation post concrete footing was observed and corrosion at the base of the post itself. Hairline and fine cracks (<0.3mm) were noted in most rock armour units with slightly larger cracking (0.3 - 0.5mm) in some larger units (MHL, 2020).

It is noted that since the survey in 2019 there have been several moderate coastal storm events, notably during 2020 and 2022, that may have caused additional impact on the condition of Groyne 5.

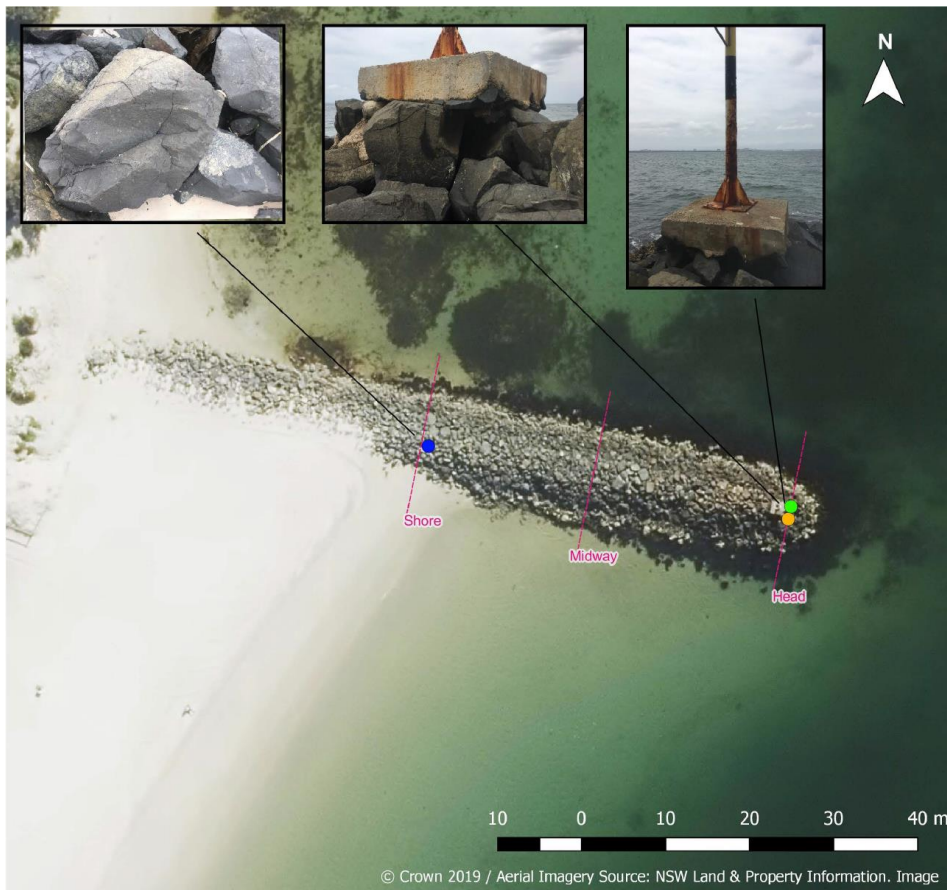
The concept design for Precinct 2 in the present study include a provisional design option for a platform constructed atop Groyne 5, to provide accessibility along the length of the groyne for viewing purposes, while also providing foreshore access in the landward corner to a constructed intertidal platform (Arup, 2024).

Noting the existing condition of Groyne 5 is substandard to the design life of 50 years (Connell-Wagner, 1999), and that the design life of proposed Precinct 2 works is required to be a minimum of 50 years, Groyne 5 will require reassessment of current condition, and to be reconstructed to meet contemporary coastal engineering standards. This will include (at minimum) the recommended actions noted by MHL (2020):

- Topping up of groyne head with slightly larger primary larger rock armour (i.e. basalt rock armour d50 ≈ 900mm, 2t) to design crest level of 1.4 mAHD (low priority)
- Replacement of the navigation post (low priority)
- Replacement of cracked primary rock armour (low priority)

Should the concept design option that includes a walkway atop the groyne be progressed, consideration should be given to:

- Design and construction of a larger groyne structure that is able to support a walkway and associated viewing platform without deformation (within tolerance).
- Construction of an 'independent' walkway (e.g. on piles) that does not rely on the groyne as the primary means of support.
- Provision of measures to prevent unauthorised access to the groyne structure.



**Figure A.3**  
**Condition Inspection**  
**Groyne 5**

**Legend**

Defect Type

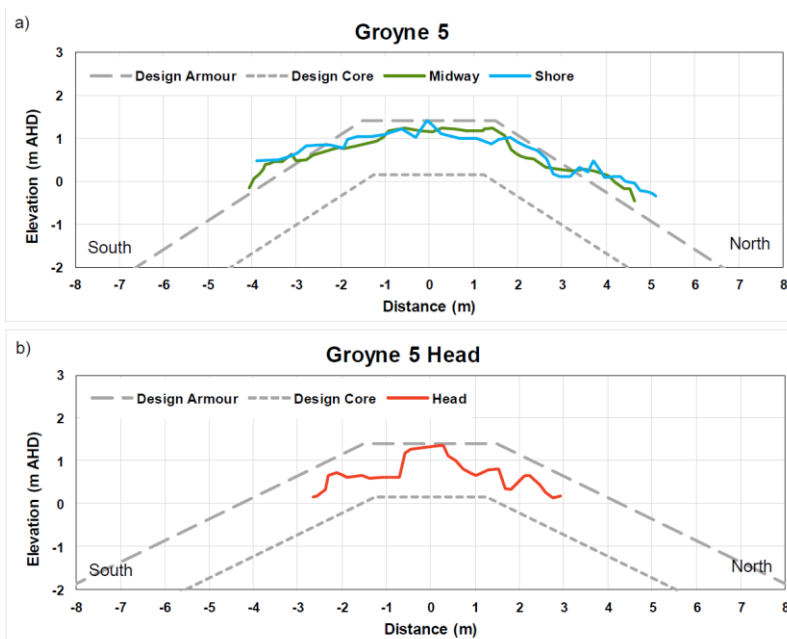
- Breach
- Core Exposure
- Displaced Rock Armour
- Rock Armour Cracking
- Structural Voids
- Public Safety Concern
- Damage/Corrosion to Navigation Posts
- Other

--- RTK-GPS Survey Lines

Report MHL2720  
 Lady Robinsons Beach -  
 Investigation & Design Study  
 Stage 1: Review and Assessment  
 of Coastal Processes



**Figure 5.4: Aerial image of Groyne 5 with assessment notes (From MHL, 2020)**



**Figure 5.5: RTK-GPS survey of Groyne 5 compared with design parameters (MHL, 2020)**

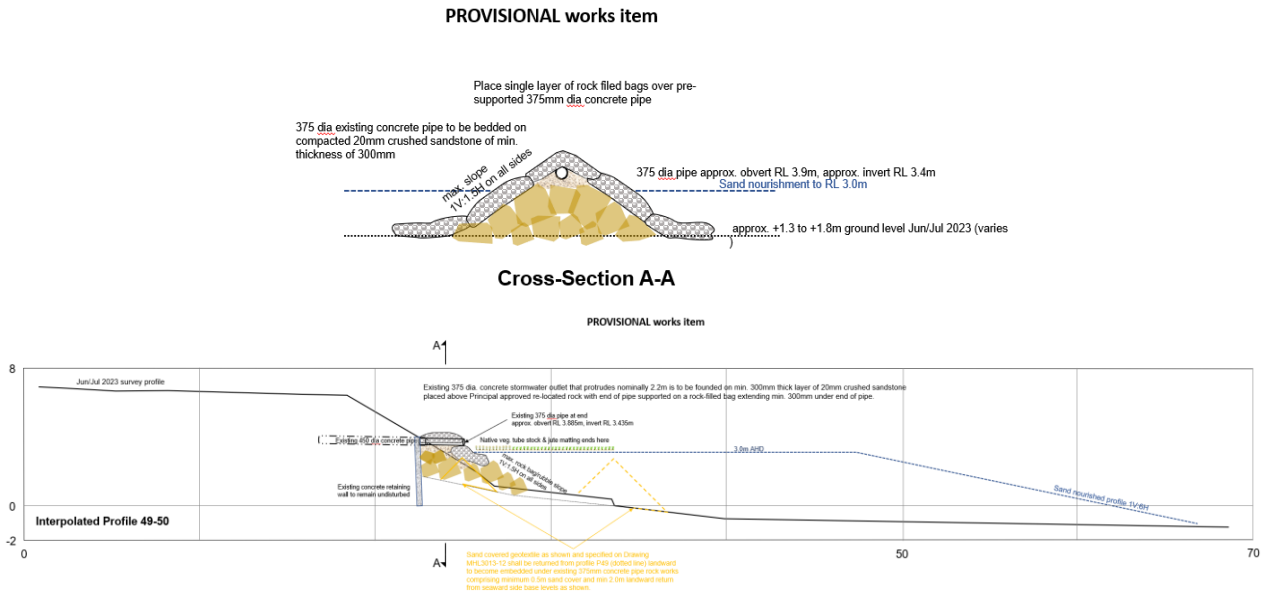
## 5.5 President Ave Stormwater Outlet

The stormwater outlet at President Avenue has been noted as a site requiring specific actions to address ongoing issues of localised erosion and scour of the foreshore (**Figure 1.3**). In addition to general ad-hoc rock placement for coastal protection within this section of shoreline, the stormwater pipe has been propped up by placement of a significant volume of additional rock / concrete material in an effort to stabilise the outlet.

In 2019, MHL assessed the condition of the stormwater outlet as poor noting ongoing erosion issues to support structures with a priority action to initiate repair works (MHL, 2020). In recent years following this assessment, ad-hoc works to stabilise the outlet have failed due to a lack of engineering design and ongoing shoreline retreat that undermined and displaced the ad-hoc outlet supports and resulted in failure of the outlet pipe (shown in **Figure 1.3**). In 2024, provisional works were designed to provide temporary repairs to the supportive structure for the stormwater outlet which includes the use of 4-tonne Kyowa rock bags shown in **Figure 5.6** (MHL, 2024b). These works are considered to provide a stable interim structure until engineered integration with provision of a new seawall at this location is constructed which will provide longer-term stability to the outlet.

It is noted that the concept design for Precinct 2 includes an over-water cantilevered platform constructed immediately to the south of the stormwater outlet, to provide a viewing platform and increase amenity of the foreshore at President Ave. This provides an opportunity to improve the form and function of the stormwater outlet. Subject to an assessment of the existing stormwater network, including the water quality of liquid flowing through the outlet, volume and type of potential pollutants etc., options for improvement may include in-line or off-line stormwater quality treatment devices, flow attenuation devices (e.g. “duck-billed valves”), energy dissipators, or other devices that improve the quality and/or amenity of the stormwater outlet.

Subject to confirmation of the concept design, it is anticipated that the current stormwater outlet location is seaward of the proposed Precinct 2 seawall, reinforcing the opportunity/requirement to undertake works at this location. From visual observation, it is considered likely that some of the in-situ rocks will be appropriate for re-use within the secondary armour layer of rocks, subject to assessment of suitability (including rock type, density, quality, size, etc). Any materials encountered that are considered unsuitable should be removed from the foreshore and re-used/disposed of appropriately.



**Figure 5.6: Provisional temporary support structure for President Avenue stormwater outlet (MHL, 2024)**

## 5.6 Temporary sand nourishment protection works

Due to prevailing erosion issues at President Avenue, there remains an immediate need for temporary remedial measures to be implemented by Bayside Council, while strategic long-term solutions are concurrently designed and implemented in accordance with the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a)

As noted in **Section 5.5**, in addition to this project, MHL have undertaken detailed design of temporary restoration works for the area of beach between President Ave and Teralba Rd (MHL, 2024b). Sand nourishment is utilised in the interim restoration works providing a temporary buffer against recession.

The proposed temporary beach restoration works comprise the placement of nominally 30,000m<sup>3</sup> of sand sourced from the beach south of the Cooks River to provide a temporary buffer to erosion at Precinct 2 at locations between President Ave and Teralba Rd as shown in **Figure 2.1**. The nourishment will be placed to form an embankment along the eastern side of Cooks Park (nominally 300m long x 10m wide) to achieve a nominal 1 in 4 batter, and be covered with jute matting, fertiliser and 9,000 (nominally) tube stock dune plants for temporary vegetation cover. The proposed sand nourishment works incorporates the provision for buried geotextile fabric protection between President Ave and O'Neill St (**Figure 2.1**). The nourishment program is designed to be delivered in stages, resulting in a planned increase in subaerial (and eventual sub-aqueous) foreshore width.

Based on an understanding of long-term average erosion trends for the placement location (MHL, 2023), the nourishment could be expected to last between 2 and 5 years. It is noted however that large or consecutive storm events could remove the entire nourished volume in

a matter of hours or days. Scarping in the nourishment following local wave events, is expected to develop particularly in the southern region near President Avenue within a few months. Given the erosion trends at this location it is unlikely re-vegetation would sufficiently establish prior to future scarping and erosion. The proposed re-vegetation therefore has been designed to incorporate jute matting with tolerant native root stock located landward of the geotextile protected berm crest only. Nourishment placed closer to Brighton-Le-Sands at the northern end of the location is expected to be more stable with a slower erosion response and therefore excludes geotextile fabric.

Unless nourishment works are undertaken on a regular basis any beach restoration works are expected to be limited and temporary. One-off nourishment works provide an interim and time-limited measure until a longer-term solution is implemented. The proposed temporary beach restoration works are intended, and have been designed as such, to be complimentary to the development of strategic long-term management solutions for Precinct 2 noted in the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a).

In particular, an increased volume of sand along the foreshore of Precinct 2 provides enough material with which to compile sand bunds during construction work of permanent structures, without resorting to use of external materials such as sheet piling etc., reducing construction costs as well as loss of amenity. The proposed geotextile fabric scarps are intentionally located close to, or being, seaward of the anticipated cross-shore position of the permanent seawall. This is intended to provide additional benefit during proposed permanent works, as it may enable use of this geofabric material and/or the “temporary” works battered slope as the underlayer for the permanent coastal protection works, which are to be installed in this location.

## 5.7 Summary

A summary of recommended serviceability upgrades for existing structures to meet design specifications for Precinct 2 are listed in **Table 5.2**. Also shown in recommended further investigations as part of detailed design to confirm structural integrity and characteristics to inform Precinct 2 design implementation.

**Table 5.2: Summary of recommended serviceability upgrades for existing structures**

<b>Existing structure</b>	<b>Recommended serviceability upgrades to meet design specifications</b>	<b>Indicative costing</b>	<b>Further investigations as part of detailed design</b>
Southern termination of Brighton-Le-Sands seawall	Smooth and contiguous transition and structural tie in with proposed new seawall at Precinct 2.	Included in preliminary costings Section 3.4.	Concrete core samples to be taken along the structure and examined at an accredited laboratory to assess for concrete content and determine remaining life of key structural elements. Visual structure assessment and inspection when exposed.
Ad-hoc rock works (Banks St to Brighton-Le-Sands)	Removal or reuse, and replacement with new engineered seawall	Included in preliminary costings Section 3.4.	Geotechnical investigation to confirm estimated rock extent. Engineering suitability assessment for potential reuse as part of proposed design.
Banks St rock works	Removal or reuse, and replacement with new engineered seawall, Or Topping up with an additional layer of 2t (M <sub>50</sub> ) rock armour at a design slope no steeper than 1V:1.5H and crest height of +4.0 mAHD. Design adaptation of rock toe to improve scour protection and support intertidal ecology.	Included in preliminary costings Section 3.4.	Engineering suitability assessment for potential reuse as part of proposed design.
Groyne 5	Topping up of groyne head with slightly larger primary larger rock armour (i.e. basalt rock armour d50 ≈ 900mm, 2t) to design crest level of 1.4 mAHD. Replacement of the navigation post. Replacement of cracked primary rock armour.	Included in preliminary costings Section 3.4.	Rock armour sourcing and availability.
President Ave stormwater outlet	Temporary works as per MHL2988 (2024b). Long-term design integration with coastal protection structure and stormwater improvements	Included in preliminary costings Section 3.4.	Detailed design integration of President avenue stormwater outlet with coastal protection structure.
Temporary sand nourishment protection works	Proposed works as per MHL2988 (2024b).	\$700,000-800,000	N/a

## 6 Summary and recommendations

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This Report provides the outcomes of concept design development for coastal protection works and amenity upgrades to Lady Robinsons Beach at Precinct 2 (Teralba Rd to Solander St) in accordance with the *Lady Robinsons Foreshore Management Plan* (MHL-Arup, 2024a). Concept designs have been developed for an initial 50 year design planning period and seek to provide:

- Improved and sustainable coastal hazard protection.
- Enhanced foreshore amenity integrated with existing public spaces and facilities.
- Support a thriving foreshore ecology and intertidal environments.

Key design components of the concept designs include:

- A new engineered vertical seawall consisting of a contiguous secant piled structure with upper concrete capping/panelling and a pedestrian foreshore boardwalk. The majority of the structure other than the upper capping and boardwalk as proposed to be buried beneath existing sand levels as a terminal structure. This structure will extend in a continuous alignment from the southern termination of the existing Brighton-Le-Sands seawall and will transition to a new engineered rock revetment between O’Niell St and President Ave.
- A new piled timber viewing platform and lookout at President Ave combined with a nature-based designed intertidal zone and shallow work artificial reef to support ecological outcomes.
- A new rock revetment structure with foreshore pedestrian boardwalk extending from President Ave through to Solander St. It includes a waterfront promenade at its crest and a nature-based toe design.
- Accessible intertidal zone, groyne upgrades and improved beach access at Solander St.

Preliminary concept design costings range from \$32M to \$58M with a mid-range estimate of \$45M. Revised costings will be undertaken as part of detailed design with several opportunities to reduce costs and/or to stage the implementation of the works by high to low priority for the Precinct.

A preliminary environmental impact risk assessment was undertaken identifies several additional data and provides recommended next steps for undertaking a Review of Environmental Factors (REF) as part of detailed design. These include further ecological, terrestrial and marine biodiversity surveys, heritage and First Nations engagement, community/stakeholder consultation and construction impact assessments.

A desktop review of the serviceability of existing structures was also undertaken and identifies a number of recommended serviceability upgrades for existing structures to meet design specifications for Precinct 2 for the design planning period. Existing structures considered in the assessment included the southern termination of the Brighton-Le-Sands seawall, ad-hoc rock works, Banks St rock works, Groyne 5, President Ave stormwater outlet and provision of temporary protection works.

Additional recommended considerations for Precinct 2 detailed design are provided below:

- Development of an adaption pathway to future sea level rise and environmental conditions beyond the design life of the structure. Detailed design drawings and specifications are to include explicit triggers and details to cater for sea level rise.
- Refinement of design seawall crest levels considering alongshore variability in design wave exposure, wave runup and overtopping, safety to property and people, adjoining foreshore/dune and/or berm slopes, elevations and crest levels of any adjoining structures. Wave return features may be incorporated in detailed designs to reduce wave overtopping hazards to people and infrastructure. Physical modelling should be used to confirm wave overtopping, design drainage and final design crest levels where adequate factors of safety cannot be demonstrated.
- Review of available geotechnical information and undertake further geotechnical investigations required as part of the seawall design process to confirm, among other things, the extent of existing rock/ad-hoc materials and geotechnical properties of the dune substrate including the geotechnical properties of any bedrock units present.
- Design and assessment of return flow drainage including wave overtopping return flows, rainfall runoff and interactions with stormwater flows and outlets (President Ave and Kings Lane).
- Assessment of community impacts due to changes to beach access at President Ave (currently closed due to erosion hazards), Teralba Rd (currently also provides vehicular access) and O'Neill Lane. Provision of vehicular beach access is required to be considered as part of detailed design.
- Development of a Maintenance Management Plan for the maintenance of the coastal protection works for the intended design life.

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# Appendix A Concept design development

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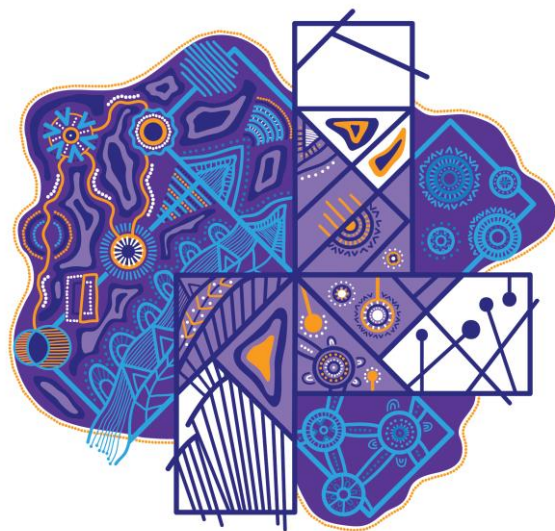
# Lady Robinsons Beach

Precinct 2 | Teralba Rd (Brighton-Le-Sands) to Solander St (Monterey)

Preliminary Concept Design

<b>Prepared for</b>	<b>Manly Hydraulics Laboratory</b>
Prepared by	Arup Pty Ltd Gadigal Country Barrack Place 151 Clarence Street Sydney, NSW 2000
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Reviewed by	David Dack

<b>Version</b>	<b>Notes</b>	<b>Date</b>
01	Draft Preliminary Concept Design Issued for Review	19.06.2024
02	Final Preliminary Concept Design	09.07.2024



## Acknowledgement of Country

In the spirit of reconciliation, we acknowledge the Traditional Custodians of Country throughout Australia and their connections to land, sea and community. We pay our respect to their Elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples.

We recognise that this project is on the land of the Gwegal, Gadigal and Bidjigal peoples.

Image: 'Continuing to Shift to shape an even better world' original artwork by Tarni O'Shea of Gilimbaa and updated by David Williams of Gilimbaa.

# Contents

## Precinct 2 – Basis of Design & Concept Design Development

1	Introduction & Context	5
2	Basis of Design – foreshore management plan & public amenity aspiration	9
3	Constraints & Opportunities	14
4	Concept Design Development Response	18

# Introduction & Context

Over the last century, the shorelines of Botany Bay (Kamay) have undergone significant modification due to human activities, including the development of Port Botany and Sydney Airport. These changes have disrupted sand transport and wave patterns, leading to areas of persistent erosion along Lady Robinsons Beach. In response to these present challenges and future challenges with climate change, the *Lady Robinsons Foreshore Management Plan* was developed in 2024, providing tailored strategies to sustainably adapt to the impacts of ongoing shoreline change over the next 50-years, considering factors like sea level rise.

Precinct 2 has been identified as a priority area of foreshore requiring enhancements in placemaking, coastal hazard protection, and environmental improvements. This study presents the preliminary concept design for Precinct 2 developed in consultation with Bayside Council.

# The Foreshore

## Management zones

The *Lady Robinsons Foreshore Management Plan (2024)* identifies targeted strategies for different management zones based on how the shoreline is changing, beach user behavior and environmental consideration. Each foreshore precinct along Lady Robinsons Beach is classified as one of the following management zone:



**Zone A - RESILIENT:** Resilient areas of sandy beach where the shoreline supports ongoing beach recreation. This accounts for approx. 4 km (54%) of shoreline.



**Zone B | RESTORE:** Unstable shorelines that are prone to erosion and require intervention to restore and maintain sandy beach. This accounts for approx. 1 km (14%) of shoreline.



**Zone C | PROTECT:** Unstable and eroded shorelines requiring improved protection through environmentally friendly seawall design and amenity enhancement. This accounts for approximately 2.4 km (32%) of shoreline.



# The Foreshore

## A unified vision for the foreshore - Building on prior work

Four vision statements were identified for the overall foreshore, in consultation with Bayside Council. These statements are informed by the various visionary statements in relevant local and state-wide strategic documents<sup>1</sup>. The vision for the public realm upgrades are underpinned by the proposed coastal management strategies, and it is envisaged that the two compliment one another.

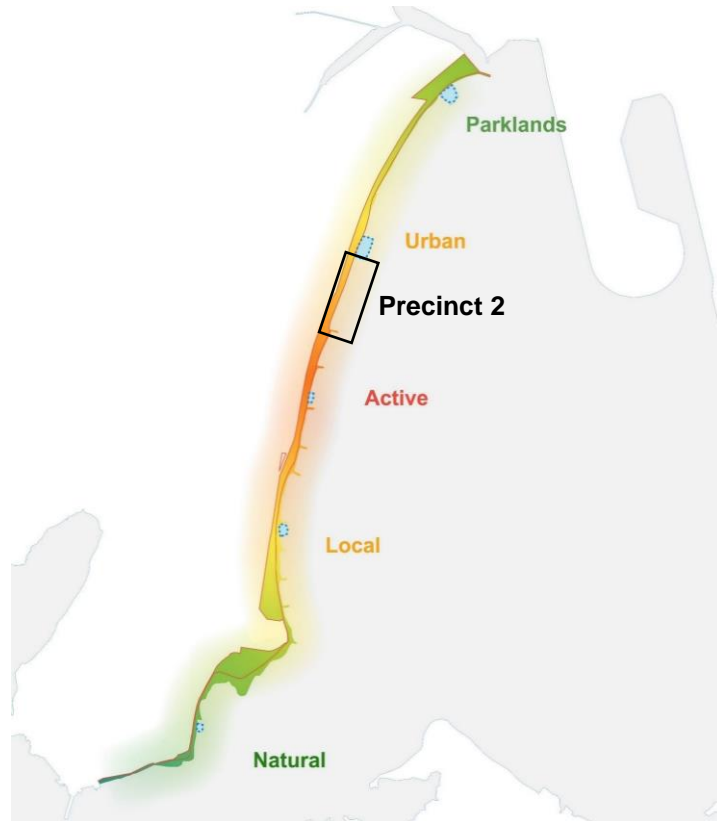


## Foreshore Management Plan

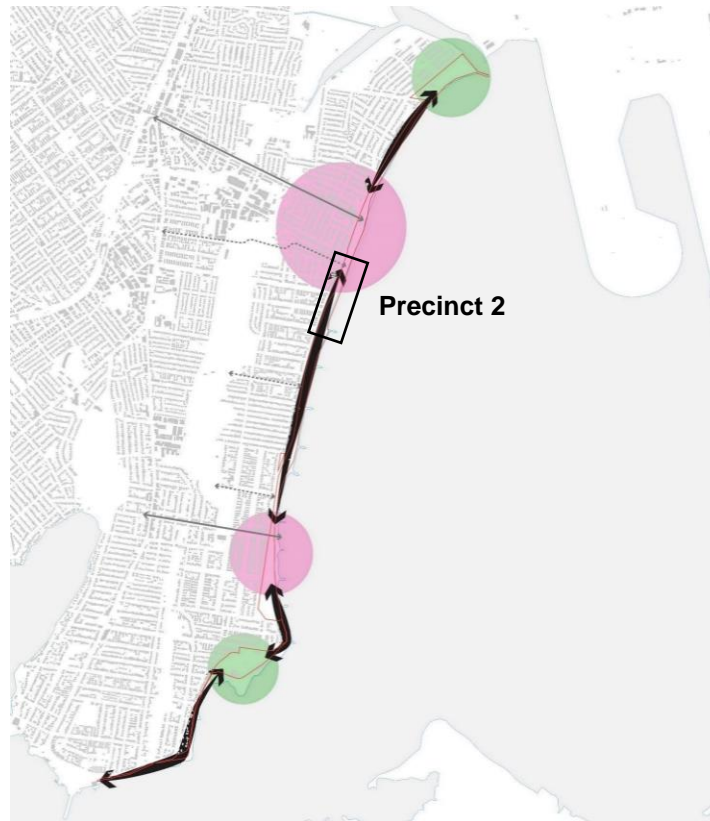
<sup>1</sup> Cook Park Masterplan, Bayside Council, 2010. Local Strategic Planning Statement, Bayside Council, 2020. Bayside 2023 Community Strategic Plan, Bayside Council. 2018. Reflect Reconciliation Action Plan, Bayside Council, 2022/23. Better Placed, GANSW, 2023. Connecting with Country, GANS, 2023. Public Open Space Strategy for NSW, NSW Government, 2022. Draft Greener places, GANSW, 2023.

# The Foreshore

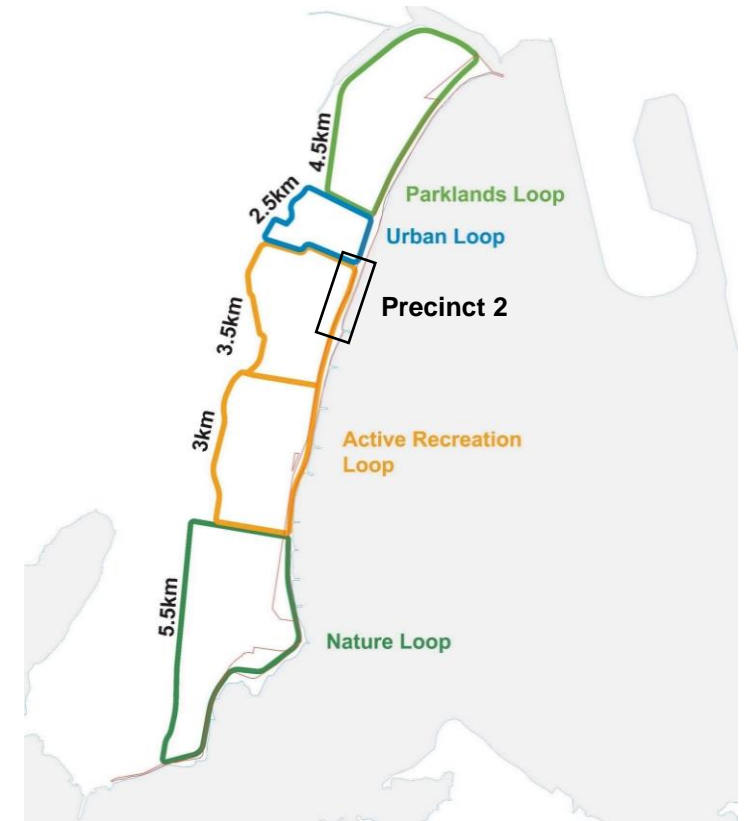
Function, character & identity



A spectrum of experiences  
Precinct 2: Urban to active



Hierarchy of amenity  
Precinct 2: Destination & connection



Connected into wider precinct  
Precinct 2: Active recreation

# Basis of Design | Coastal management strategy & public amenity aspiration

Refer to Basis of design report for further detail



Major stormwater outlet

Stair Access

Vehicular foreshore access

Brighton-Le-Sands Baths

Stair Access (Closed due to erosion)

Rock revetment

Cook Park Playground

Cook Park Carpark

Cook Park Rock Jetty Groyne 5

Sandy beach

**Precinct 2** stretches from Teralba Road in Brighton-Le-Sands to Solander Street in Monterey. Key elements encompass an inaccessible groyne (Cook Park Rock Jetty), a rock revetment requiring replenishment, a shared pedestrian and biking pathway, deteriorated infrastructure such as inaccessible stairs and exposed stormwater pipes, and restricted pedestrian entry to the beach.

# Basis of Design

## Foreshore management - Precinct 2

### Current condition:

The foreshore at Precinct 2 between Teralba Rd and Solander St is unstable and eroded with limited beach area. This area is characterised by narrow rocky foreshores & eroded foredunes where ongoing shoreline retreat has resulted in a number of hazards to beach users, public infrastructure and The Grand Parade road corridor near President Avenue. Sandy beach at this location is not cost-effective & feasible to restore and maintain.

### Approach to management:

- Management of this area to include initiatives to protect the shore with a new promenade seawall with nature-based design integration, removal of shoreline hazards, upgrades of public space between the road and the foreshore, and improved long-term coastal hazard protection for The Grand Parade.
- Interim sand nourishment, geotextile & re-vegetation will be undertaken to temporarily protect The Grand Parade from coastal hazards until a long-term solution is implemented.



# Basis of Design

## Public realm upgrade aspiration

The aspiration around public realm upgrades for Precinct 2 has been discussed with Bayside Council, and the following priorities identified:

- Safeguard public space and parkland adjacent to the foreshore
- Remove public space pinch points, hazards and barriers to improve access and equity
- Improve safety for active transport users (primarily pedestrians & cyclists)
- Enhance the user experience, increase comfort (shade, rest, movement) and better connect people with the unique and special foreshore environment
- Enhance marine and landside biodiversity & ecology to enable thriving flora and fauna
- Meaningfully integrate First Nations narratives into the design, with appropriate input from local Knowledge Holders. Provide opportunity for communication of Cultural information and storytelling to enrich the foreshore experience and connect the project to Country



**Improved open space and active transport links enhancing experience, equity and safety**



**Ecological enhancements through environmental seawalls & intertidal zones**



**Enhanced the user experiences and connect people to the Bay**



**Interwoven Country-centric design**

# Connecting with Country Opportunities

## Key themes to be explored with Indigenous designers & representatives

Appropriate consultation and involvement of First Nations stakeholders, knowledge holders and designers is critical to enable a suitable outcome for the project. A range of opportunities have been identified for connecting with Country in the design, which are to be further explored as the design progresses in subsequent stages.



### Intertidal zone

The changing nature of the foreshore over time



### Saltwater dunes

Significance to the community over time as a rich resource



### Non-human kin

Consideration of all life supported by the foreshore



### First light

Recognising the Cultural significance of the site's location and orientation towards the rising sun

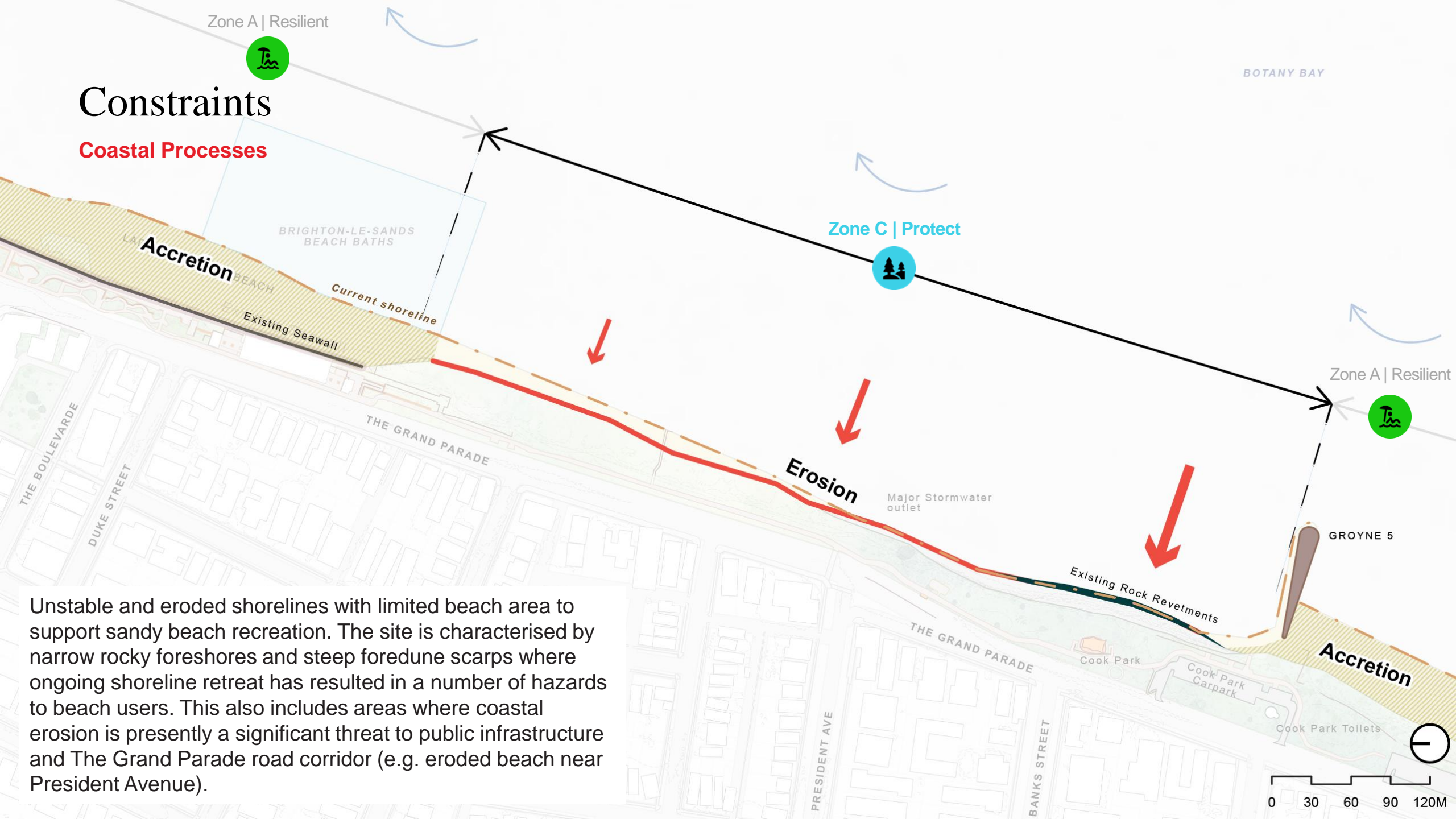
# Constraints & Opportunities

In ***Precinct 2***, a series of challenges of poses concerns, with coastal processes of *erosion* threatening infrastructure and foreshore amenity. Moreover, the narrowing between the shoreline and road has resulted in a *recreation bottleneck*, eroding dunes and funneling pedestrians and cyclists through obstacles. Various entries of access to the beach are *non-compliant* and safety is further compromised by hazards, obstructions and barriers.

Addressing these issues comprehensively is beneficial to preserving Precinct 2's built and natural assets and ensuring equitable access and safety for all stakeholders. Exploring innovative coastal management strategies and enhancing recreational infrastructure present opportunities to not only address existing challenges but also foster ecological sustainable development and community benefit within Precinct 2.

# Constraints

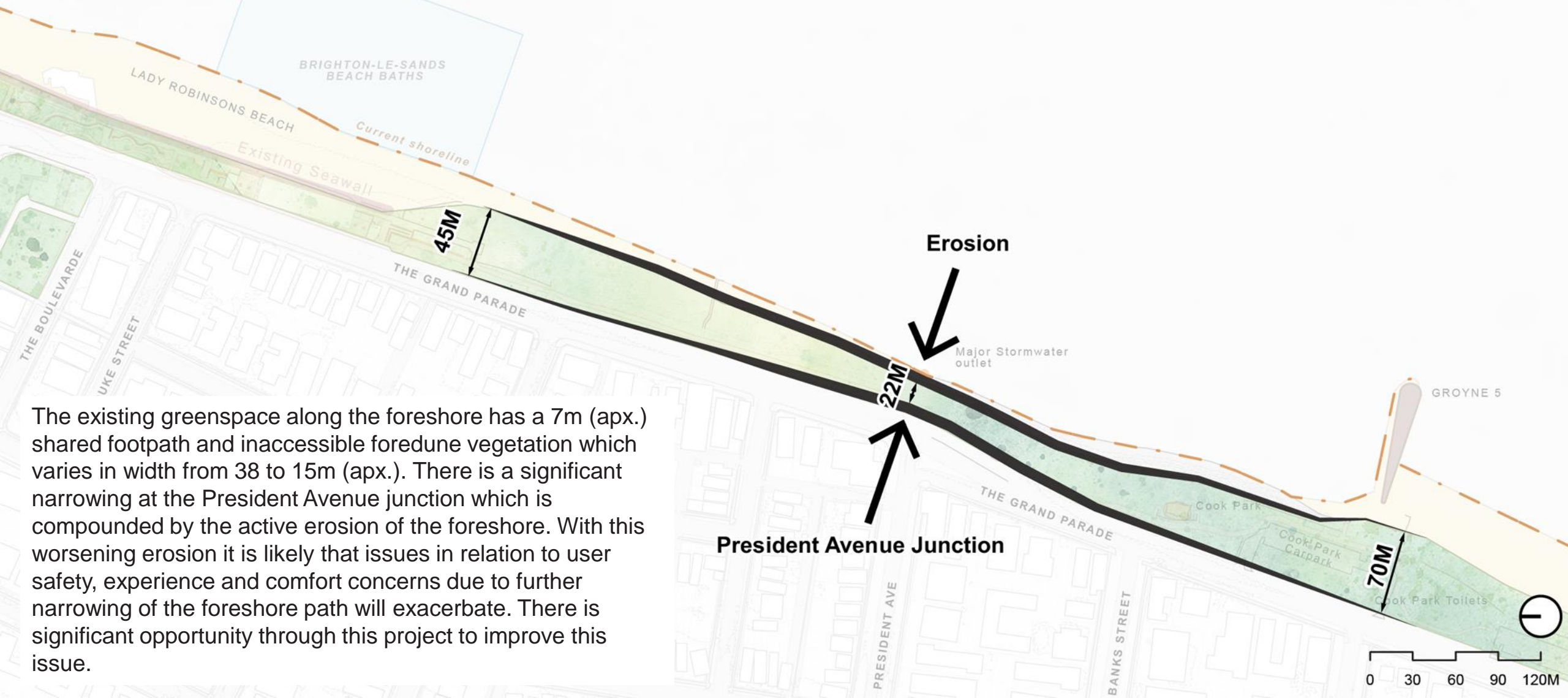
## Coastal Processes



Unstable and eroded shorelines with limited beach area to support sandy beach recreation. The site is characterised by narrow rocky foreshores and steep foredune scarps where ongoing shoreline retreat has resulted in a number of hazards to beach users. This also includes areas where coastal erosion is presently a significant threat to public infrastructure and The Grand Parade road corridor (e.g. eroded beach near President Avenue).

# Constraints

## Greenspace bottleneck



The existing greenspace along the foreshore has a 7m (apx.) shared footpath and inaccessible foredune vegetation which varies in width from 38 to 15m (apx.). There is a significant narrowing at the President Avenue junction which is compounded by the active erosion of the foreshore. With this worsening erosion it is likely that issues in relation to user safety, experience and comfort concerns due to further narrowing of the foreshore path will exacerbate. There is significant opportunity through this project to improve this issue.

45M

22M

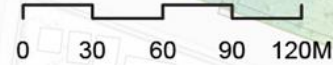
70M

Erosion

President Avenue Junction

Major Stormwater outlet

GROYNE 5



# Constraints

## Current foreshore access and accessibility issues



3. Non-equitable access leads to eroded beach



4. Damaged inaccessible stair



6. SUP abrupt cornering



7. Pedestrian access to beach (non-DDA compliant)



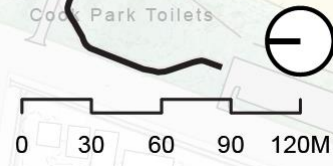
1. Boardwalk terminates abruptly



2. Vehicular access to eroding beach



5. SUP hard against busy road and only 1 pedestrian crossing

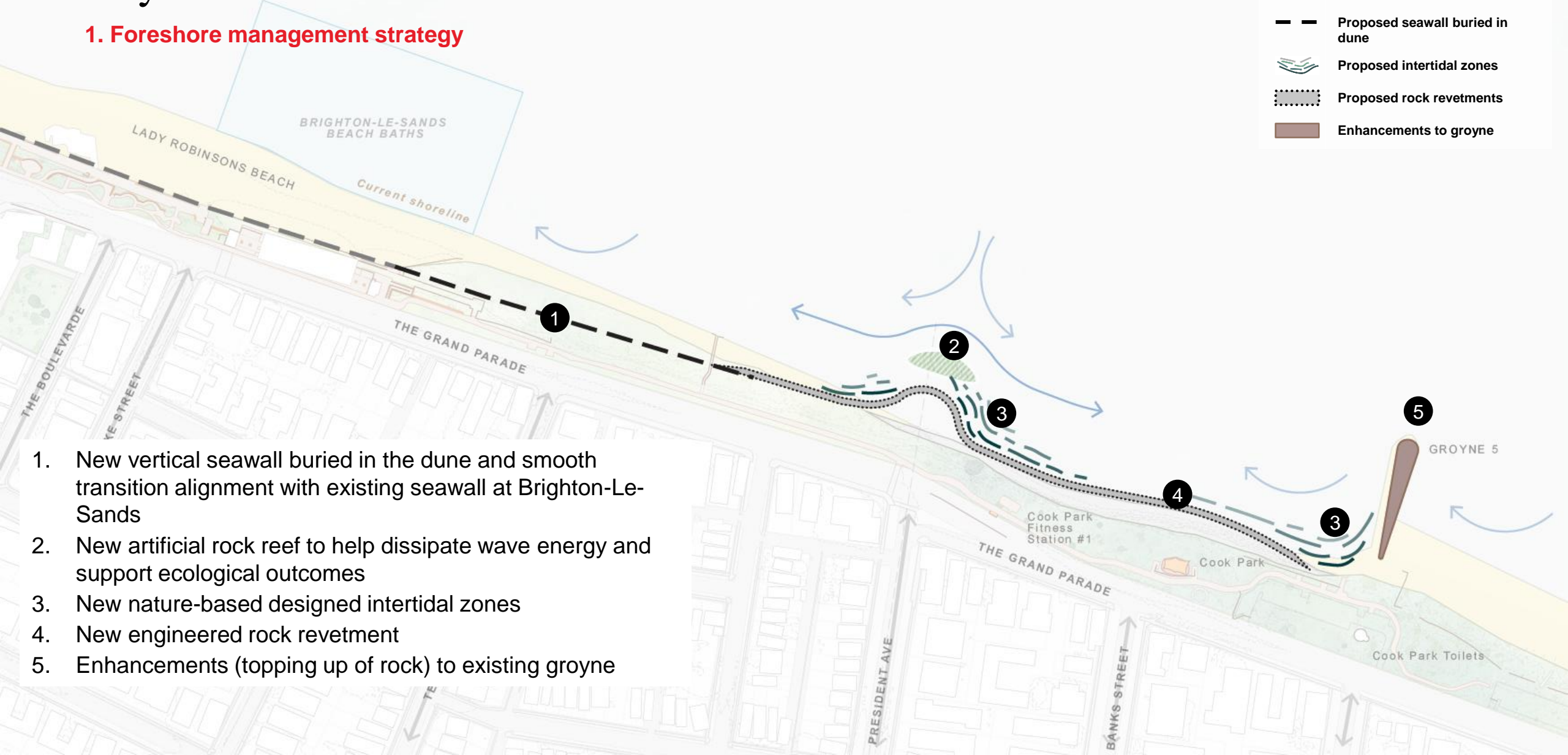


# Response

Key design moves

# Key moves

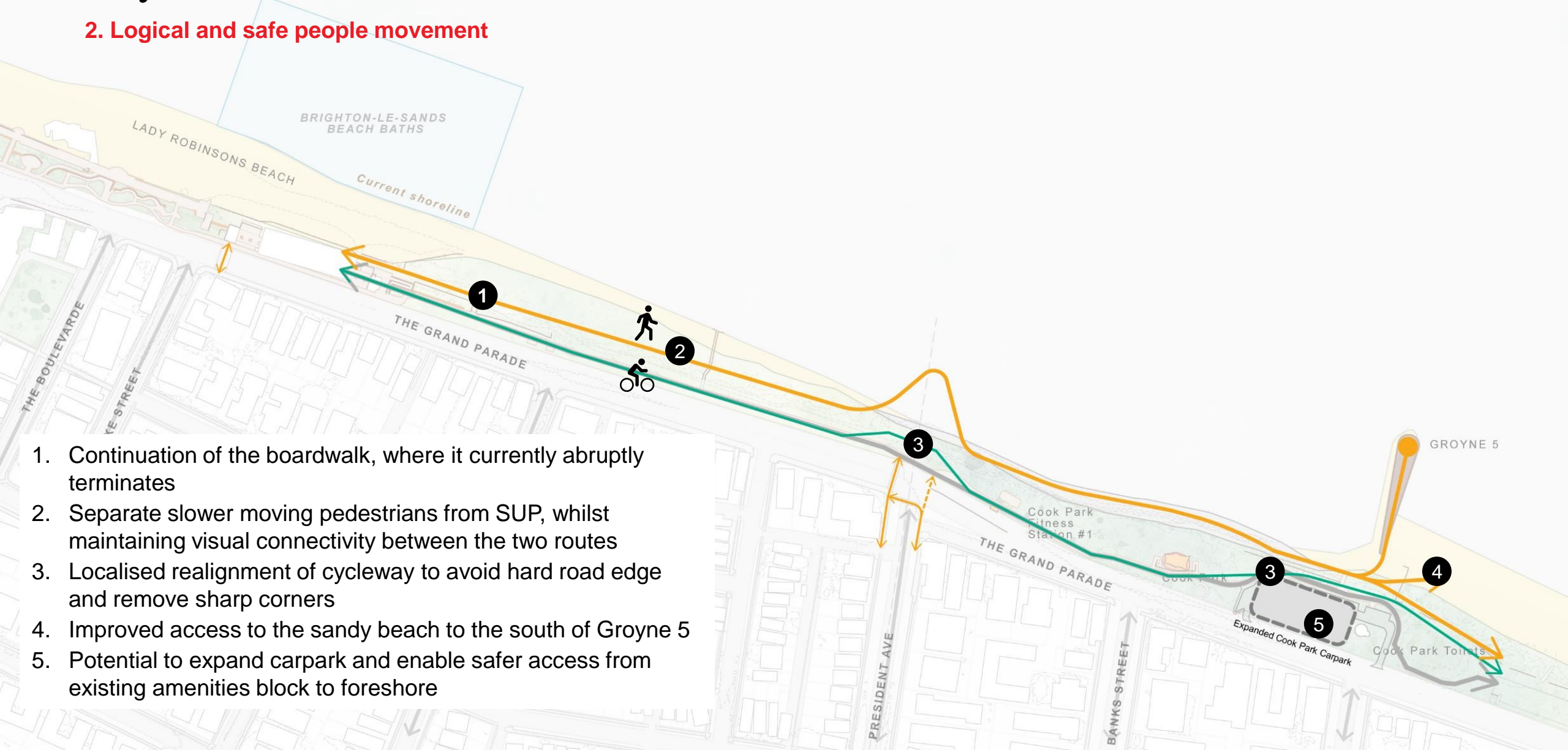
## 1. Foreshore management strategy



1. New vertical seawall buried in the dune and smooth transition alignment with existing seawall at Brighton-Le-Sands
2. New artificial rock reef to help dissipate wave energy and support ecological outcomes
3. New nature-based designed intertidal zones
4. New engineered rock revetment
5. Enhancements (topping up of rock) to existing groyne

# Key moves

## 2. Logical and safe people movement

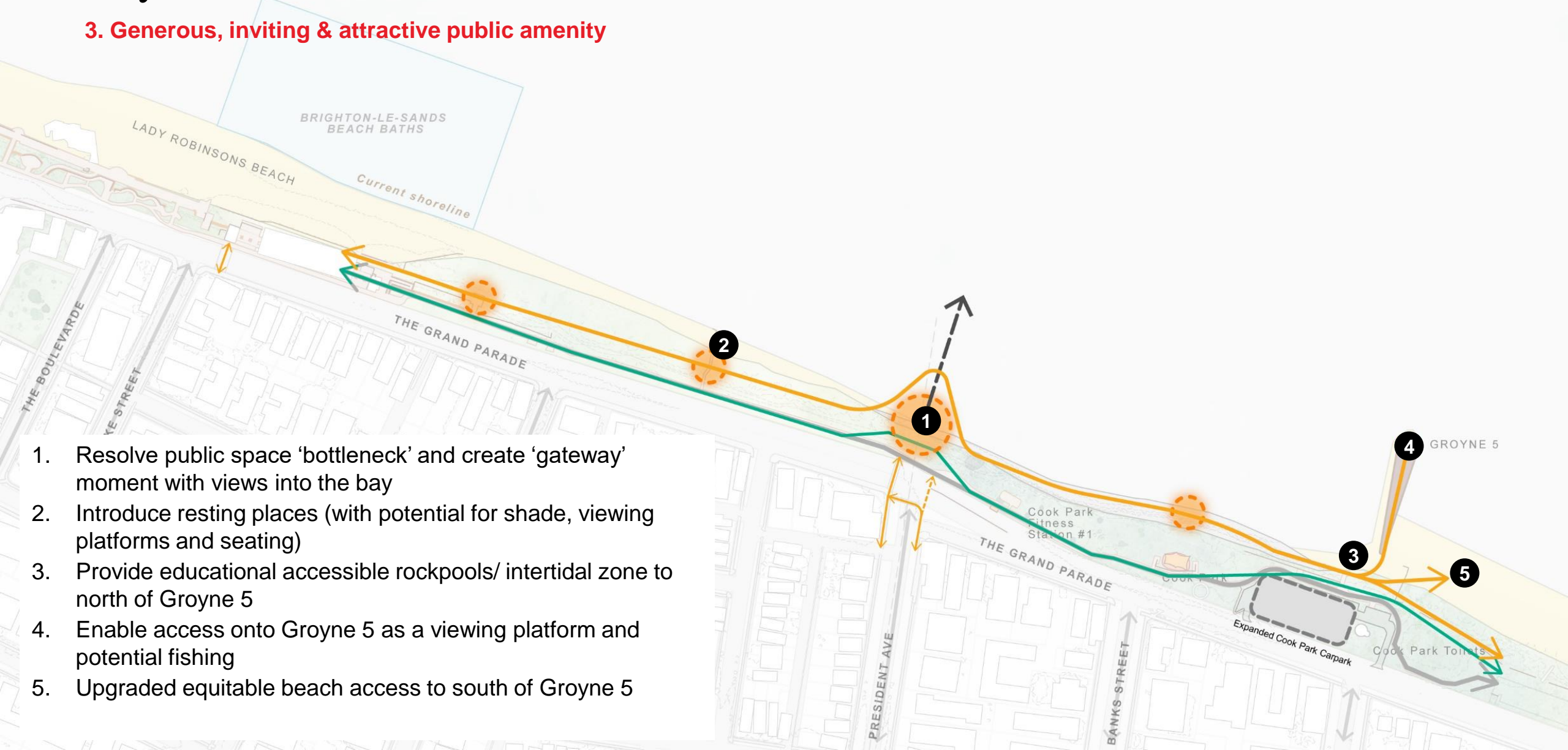


1. Continuation of the boardwalk, where it currently abruptly terminates
2. Separate slower moving pedestrians from SUP, whilst maintaining visual connectivity between the two routes
3. Localised realignment of cycleway to avoid hard road edge and remove sharp corners
4. Improved access to the sandy beach to the south of Groyne 5
5. Potential to expand carpark and enable safer access from existing amenities block to foreshore

# Key moves

## 3. Generous, inviting & attractive public amenity

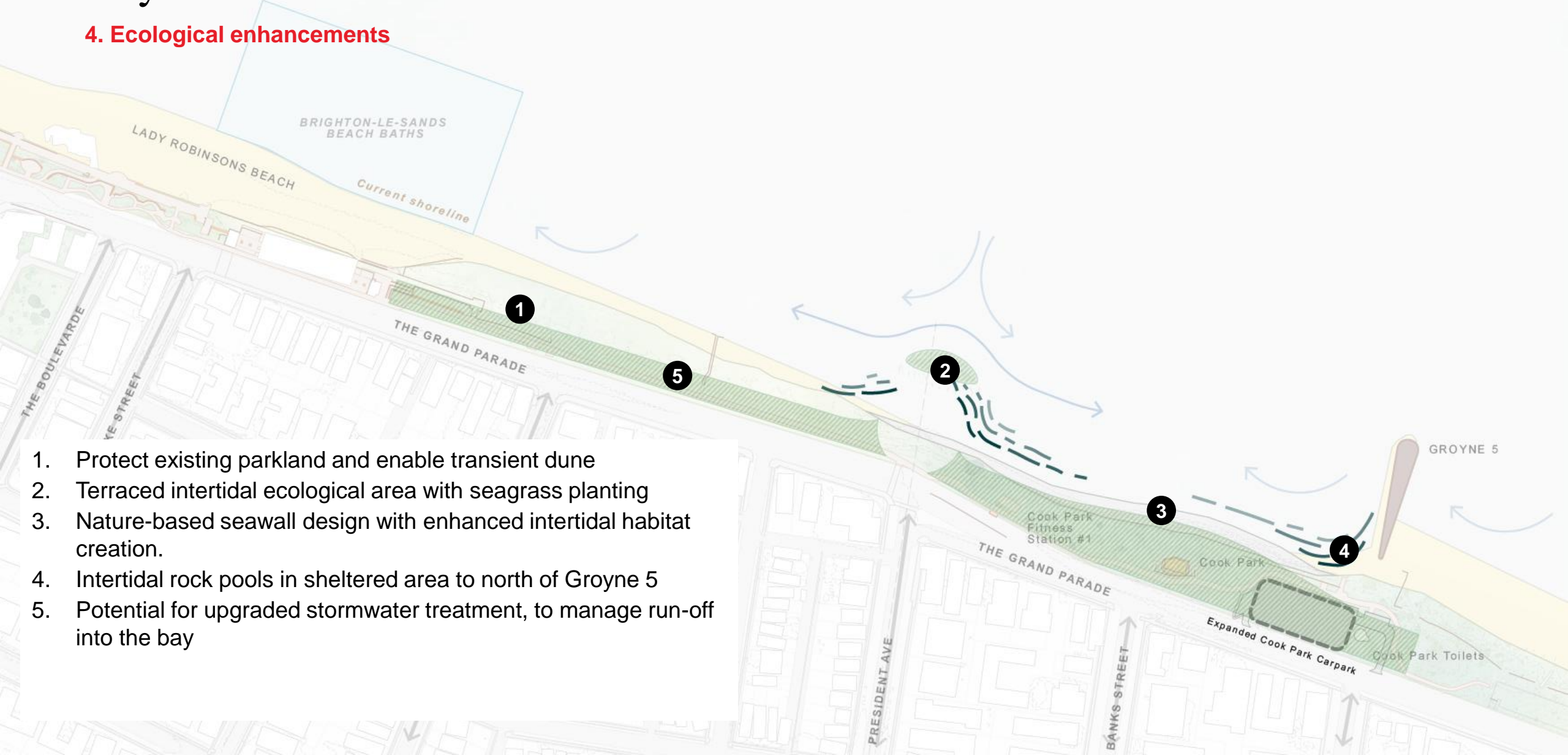
1. Resolve public space 'bottleneck' and create 'gateway' moment with views into the bay
2. Introduce resting places (with potential for shade, viewing platforms and seating)
3. Provide educational accessible rockpools/ intertidal zone to north of Groyne 5
4. Enable access onto Groyne 5 as a viewing platform and potential fishing
5. Upgraded equitable beach access to south of Groyne 5



# Key moves

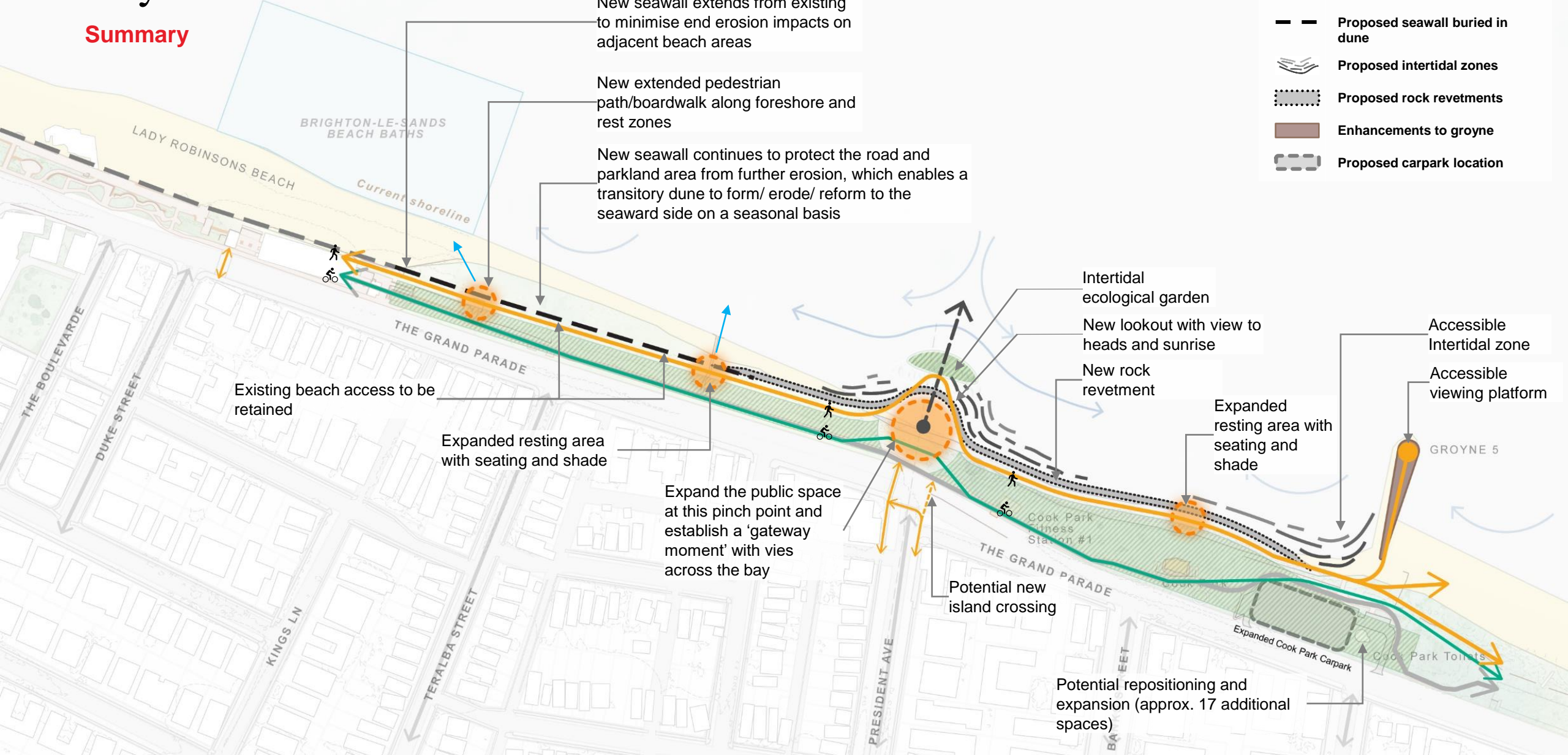
## 4. Ecological enhancements

1. Protect existing parkland and enable transient dune
2. Terraced intertidal ecological area with seagrass planting
3. Nature-based seawall design with enhanced intertidal habitat creation.
4. Intertidal rock pools in sheltered area to north of Groyne 5
5. Potential for upgraded stormwater treatment, to manage run-off into the bay



# Key moves

## Summary



# Seawall and boardwalk extension

- New vertical, buried in the dune seawall extends from the existing seawall at Brighton-Le-Sands
- Seawall alignment located to minimise end erosion impacts on adjacent beach areas

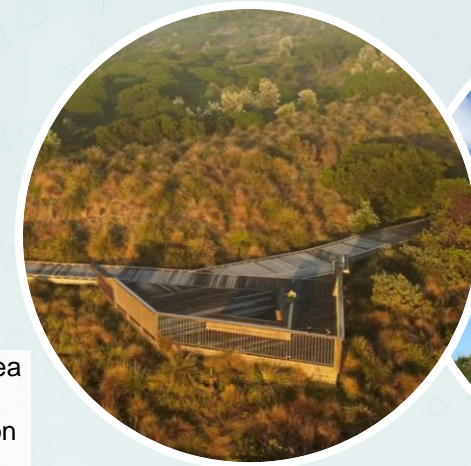
New seawall extends from existing to minimise end erosion impacts on adjacent beach areas

New extended pedestrian path/boardwalk along foreshore and rest zones

New seawall continues to protect the parkland area from further erosion, which enables a transitory dune to form/ erode/ reform to the seaward side on a seasonal basis

Existing beach access to be retained

Expanded resting area with seating and shade



Lookouts and rest areas



Boardwalk



# President Avenue 'Gateway'

- Expanded public realm at current 'bottle-neck'
- Foreshore realignment at President Avenue to dissipate wave energy in most exposed/ at-risk area
- Introduce an intertidal aquatic reef and terracing to promote marine biodiversity, and enable public viewing (inaccessible)
- New look-out structure at President Avenue with views over bay, out towards heads and sunrise
- Realignment of shared user path (SUP) to pull back from hard road edge



*Cantilevered lookout structure*



*Intertidal aquatic reef*



# Rock revetment with boardwalk

- Continued engineering rock revetment with nature-based intertidal zone
- Relocated walking path along foreshore edge
- Opportunity for expanded seating area



Boardwalk and lookouts



Ecological rock revetments



# Accessible intertidal zone & groyne upgrades

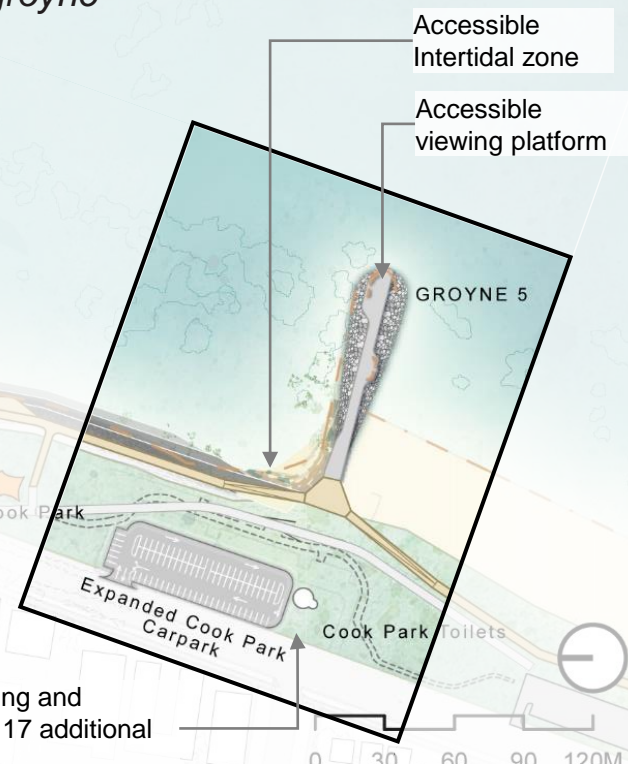
- Accessible ecological terraces and rockpools
- Provision of equitable access to adjacent beach
- Potential to enable groyne access as lookout
- Groyne repair/upgrade as part of works
- Carpark modifications



Accessible groyne



Accessible rock pools



Potential repositioning and expansion (approx. 17 additional spaces)

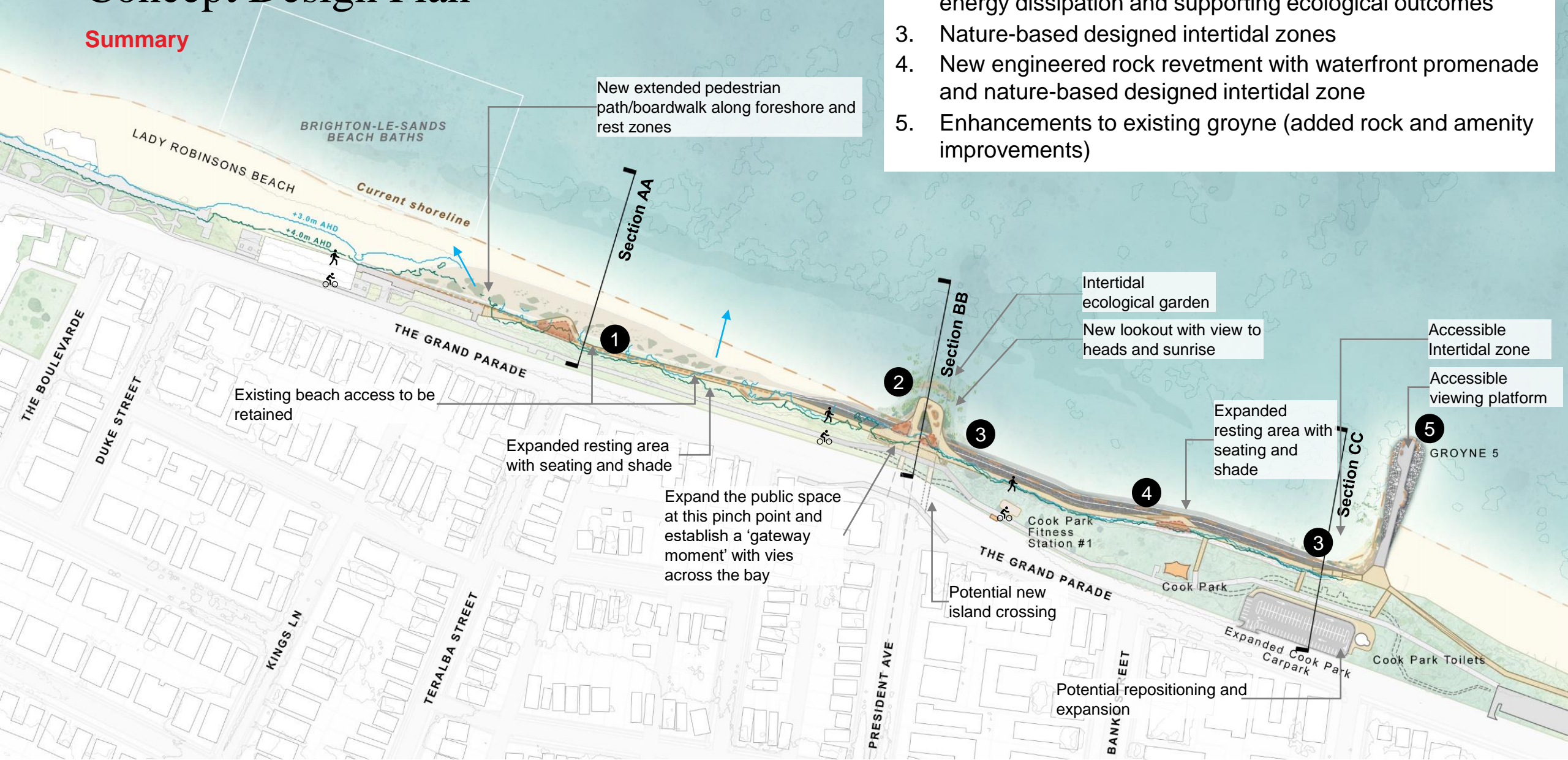
# Concept Design Plan



# Concept Design Plan

## Summary

1. New buried vertical seawall with foreshore boardwalk terminating at existing seawall at Brighton-Le-Sands
2. New lookout platform and artificial rock reef providing wave energy dissipation and supporting ecological outcomes
3. Nature-based designed intertidal zones
4. New engineered rock revetment with waterfront promenade and nature-based designed intertidal zone
5. Enhancements to existing groyne (added rock and amenity improvements)



# Parking

## Potential future enhancements

As part of the foreshore upgrade works, there is an opportunity to reconfigure the existing carpark. As part of this study, a preliminary testing has been undertaken (see plan right). To confirm this approach, further design work is required in the next stage. The preliminary option (right) demonstrates the following benefits:

- Increased parking spaces (nom.18 spaces)
- Green buffer zone alongside the shared user path
- Improved accessibility to the public toilets and provision of increased public space (approx. 2500sqm)
- Rationalisation of vehicular access points to singular crossover



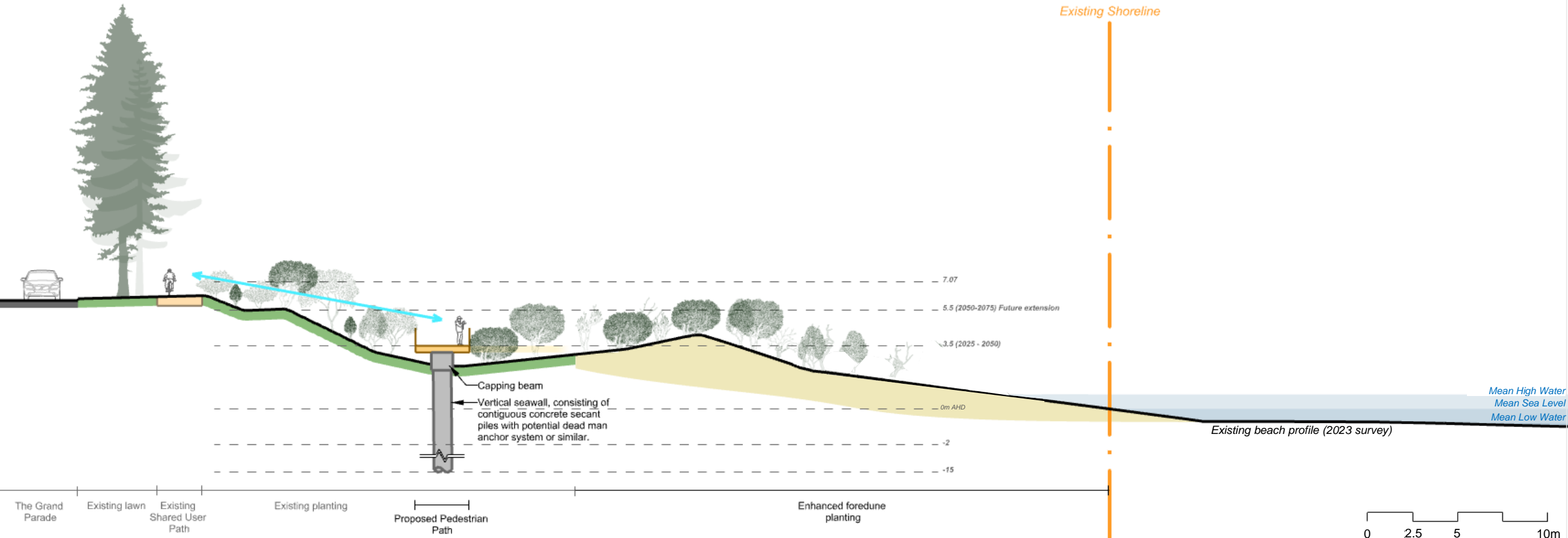
Existing configuration: approx. 59 spaces (approx.):  
Reconfigured design: 76 Spaces (73 Standard; 3 DDA)

### Considerations:

- Arborist report and tree survey to understand impact on existing Norfolk Island Pines
- Transport study to confirm reconfigured in/out from Grand Parade

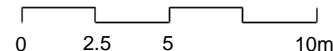
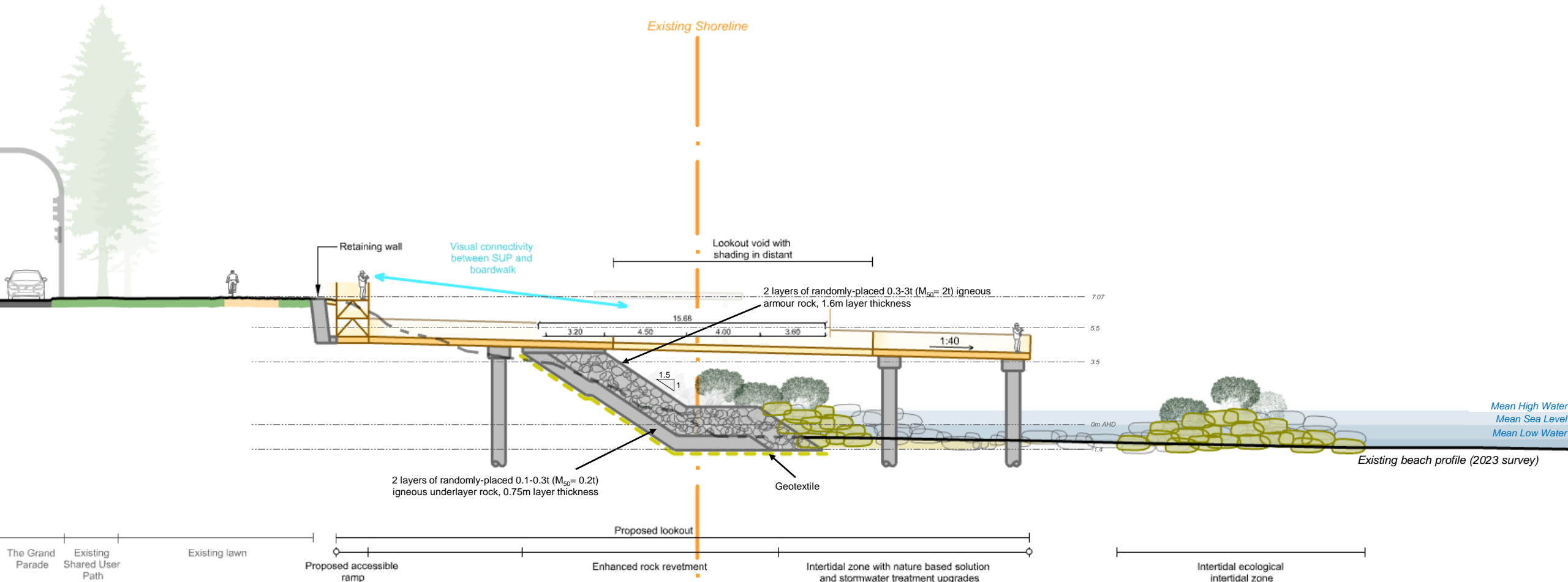
# Typical Section AA

## Vertical seawall with pedestrian path



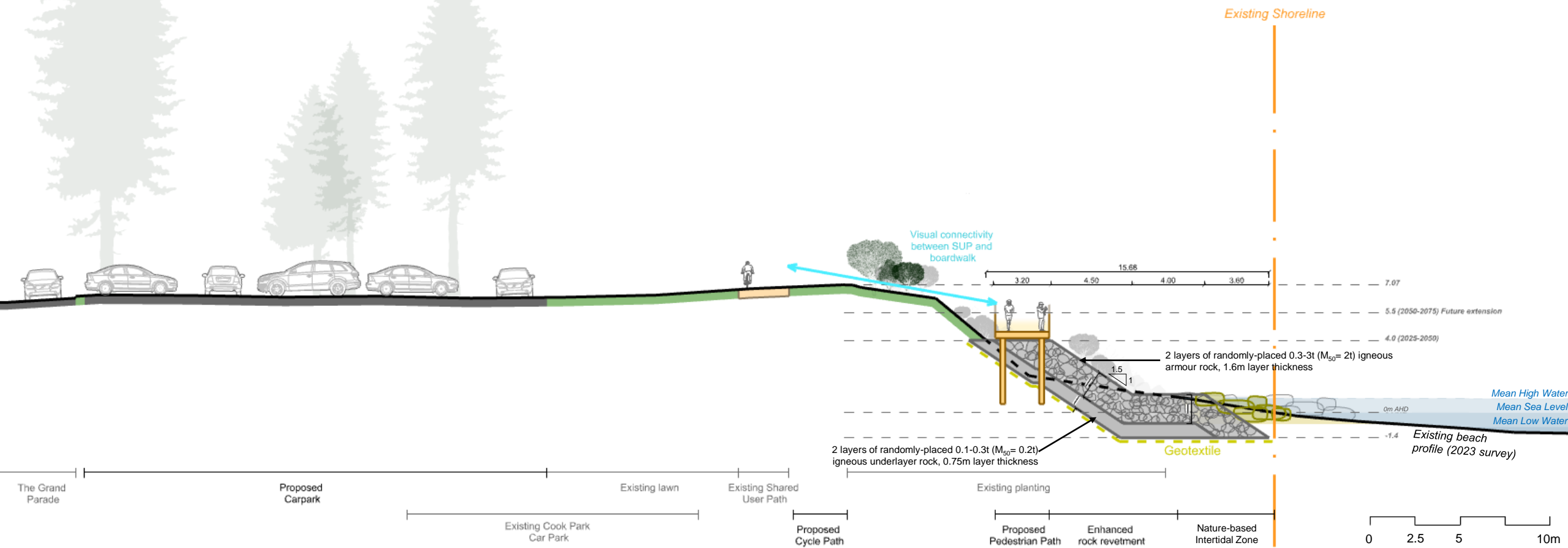
# Typical Section BB

## Rock revetment wall with lookout at President Avenue

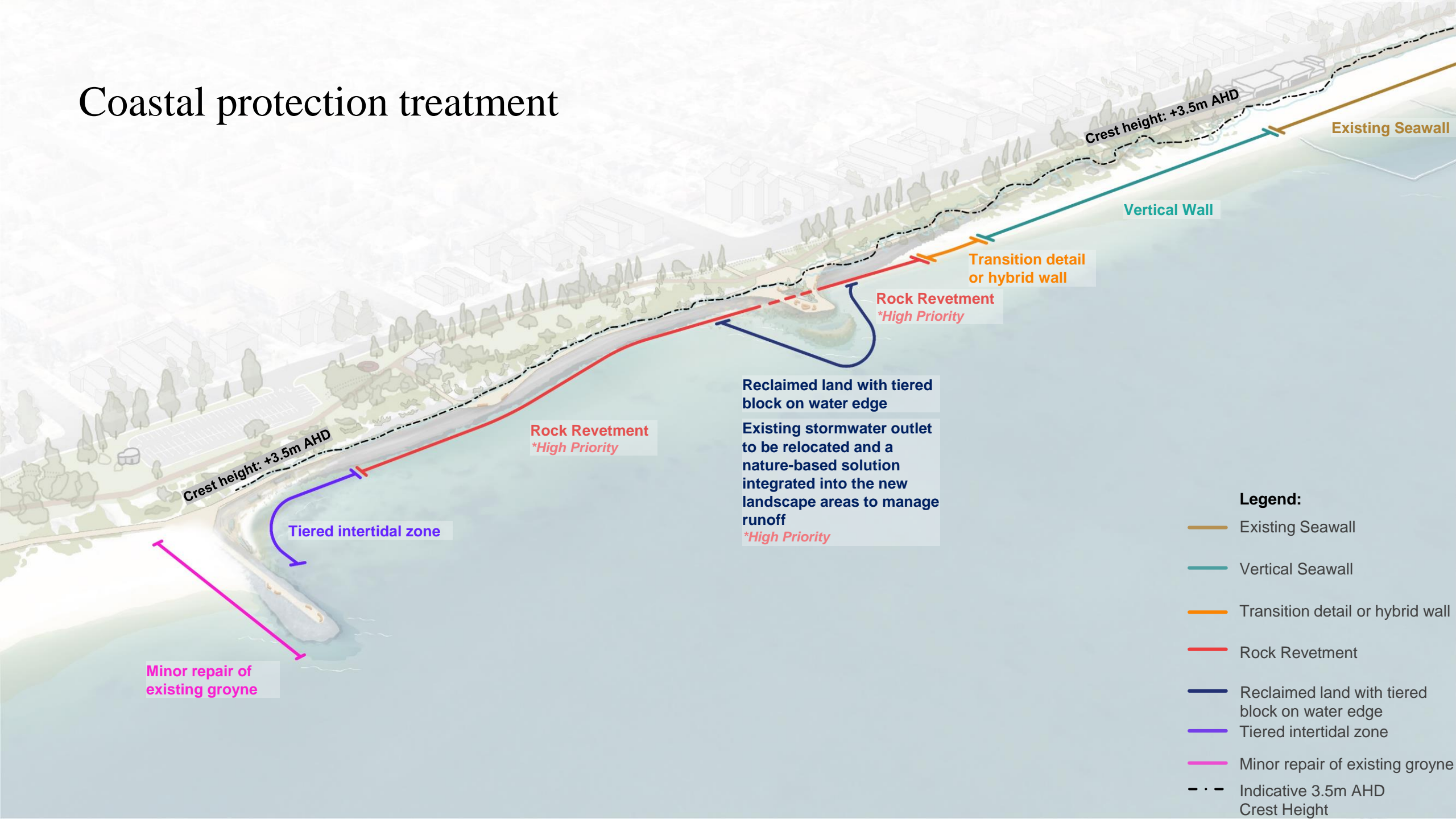


# Typical Section CC

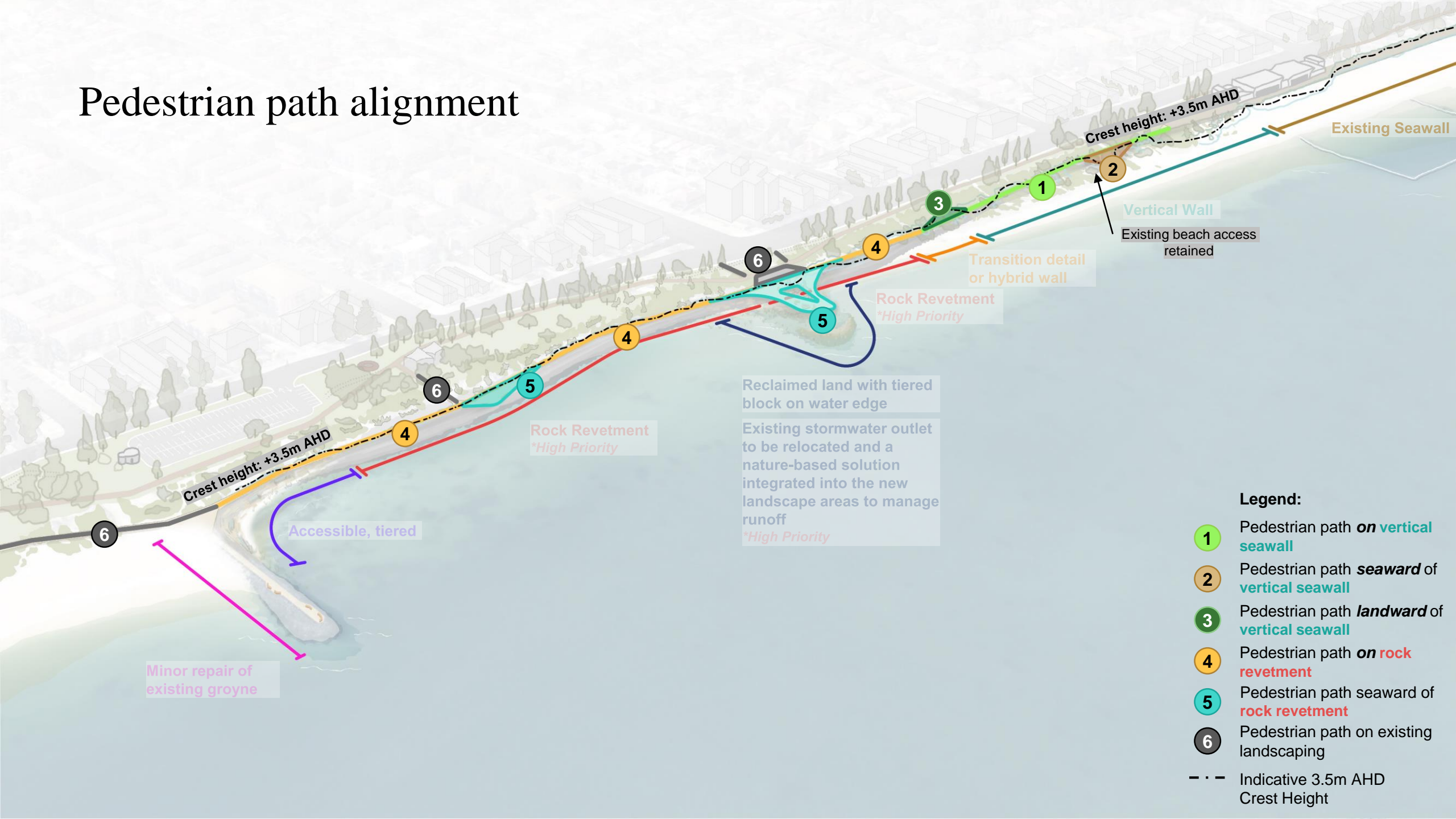
## Rock revetment wall with pedestrian path



# Coastal protection treatment



# Pedestrian path alignment

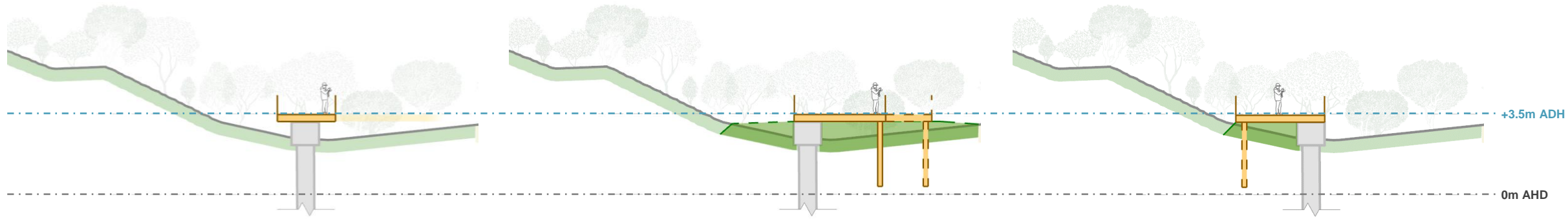


**Legend:**

- 1 Pedestrian path **on vertical seawall**
- 2 Pedestrian path **seaward of vertical seawall**
- 3 Pedestrian path **landward of vertical seawall**
- 4 Pedestrian path **on rock revetment**
- 5 Pedestrian path seaward of **rock revetment**
- 6 Pedestrian path on existing landscaping
- - - Indicative 3.5m AHD Crest Height

# Pedestrian alignment on vertical sea wall

Typical Section AA | Crest height: +3.5m AHD



## 1 Pedestrian path *on* vertical seawall

- Path sits on top of sea wall
- Landscape infilling is optional

## 2 Pedestrian path *seaward* of vertical seawall

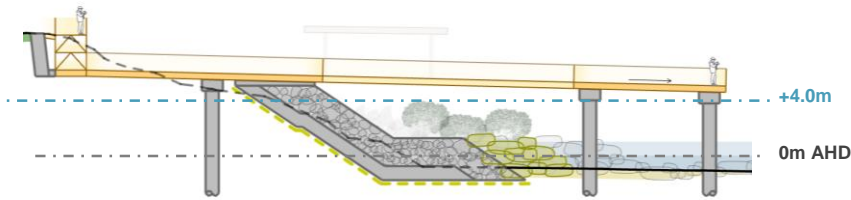
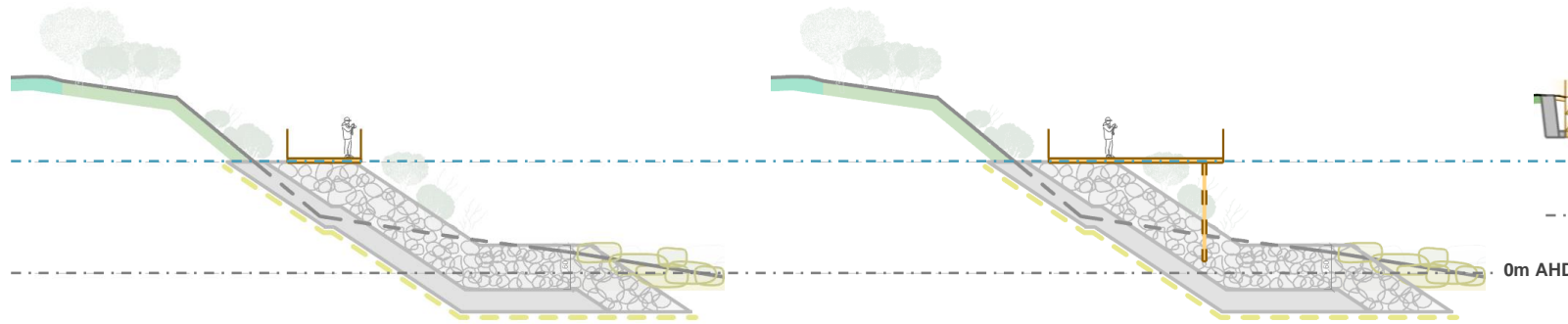
- *Option 1:* Piled path (separate structure)
- *Option 2:* On-top of reshape landscaping and/or supported by vertical seawall
- Landscape infill may be required

## 3 Pedestrian path *landward* of vertical seawall

- *Option 1:* Piled path (separate structure)
- *Option 2:* On-top of reshaped landscaping and/or supported by vertical seawall
- Landscape infill may be required

# Pedestrian alignment on rock revetment

Typical Section CC | Crest height: +4.0m AHD



## 4 Pedestrian path on rock revetment

- Path sits on top of sea wall

## 5 Pedestrian path seaward of rock revetment

- **Position: On Sea Wall**
- Option 1: Path sits on-top of both reshaped landscaping and supported by wall

## 2 Pedestrian lookout at President Avenue (Section BB)

- **Position: Seaward**
- DDA accessible ramp from street level to lookout
- Path sits on existing landscaping
- Piling and excavation will be required



ARUP

## Appendix B Historical photographs of ad-hoc rock placement Bank St to Brighton-Le-Sands

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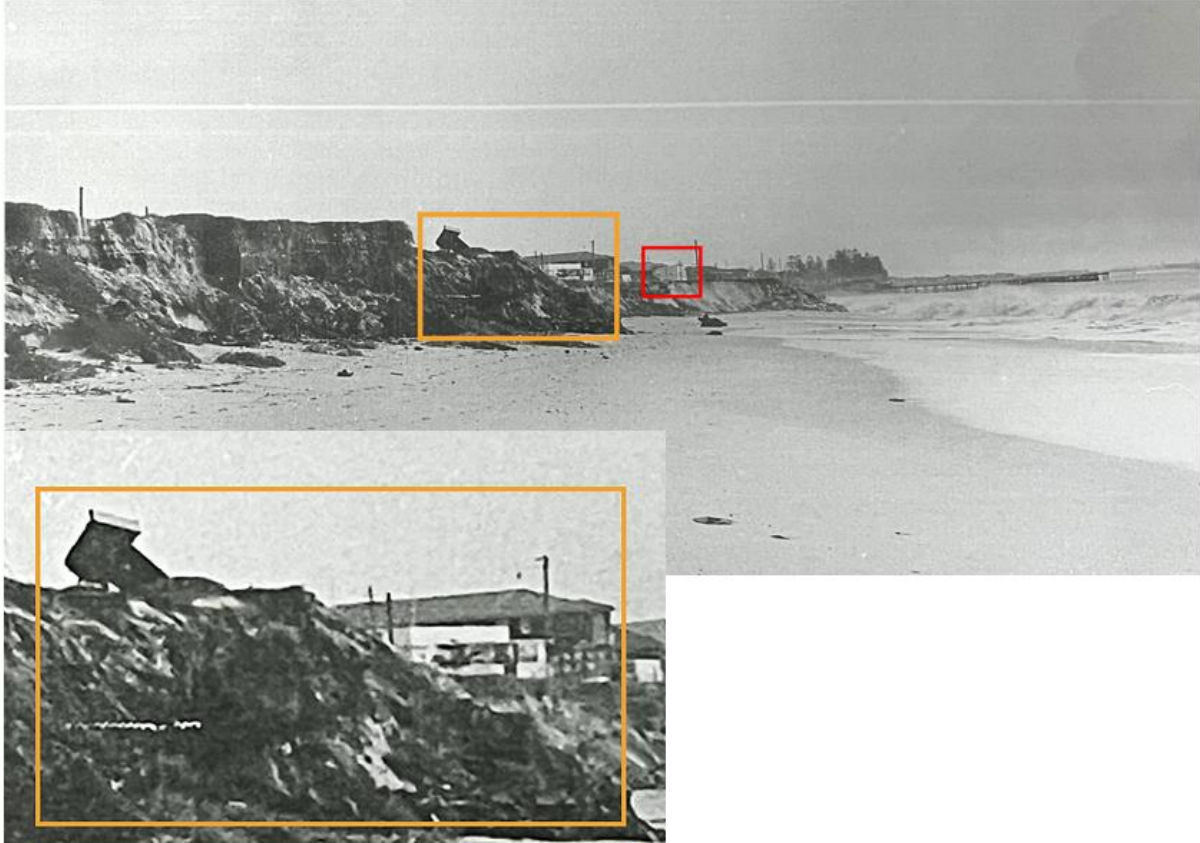
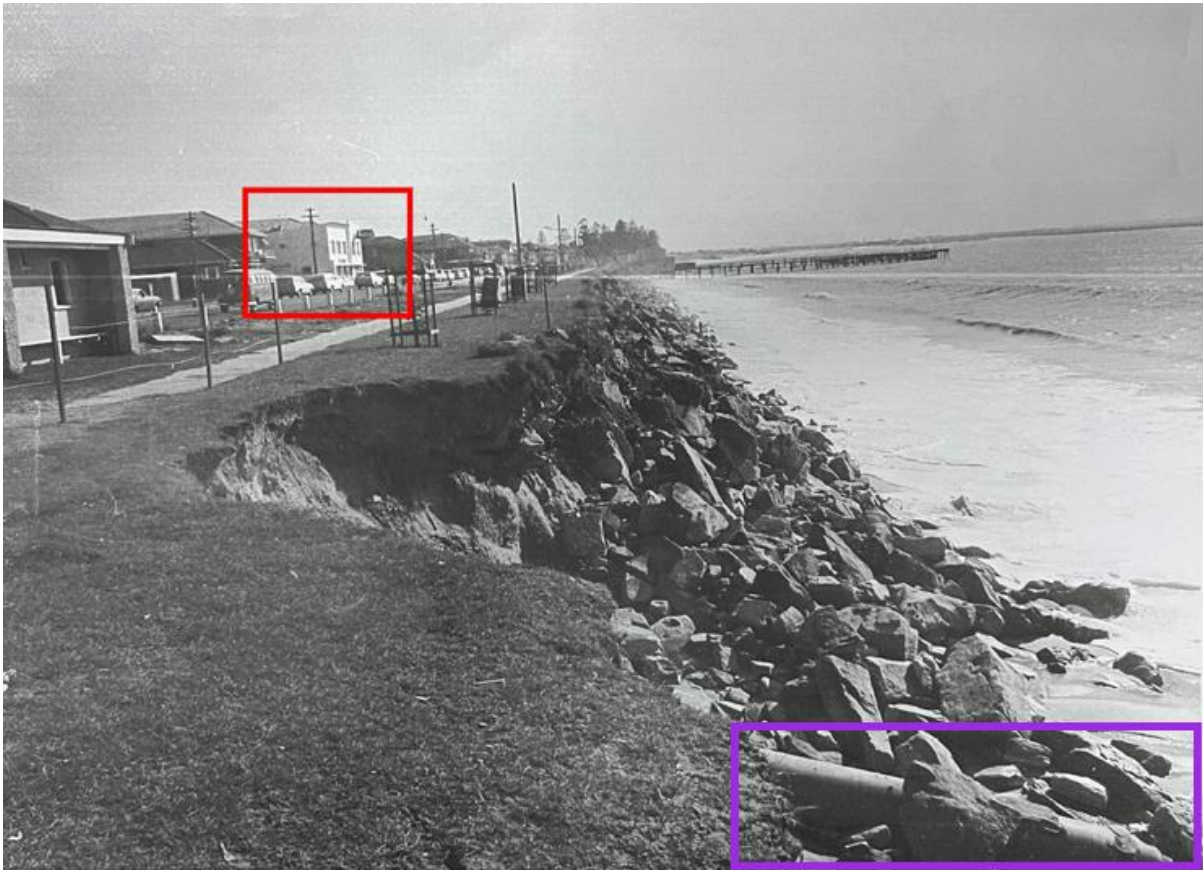
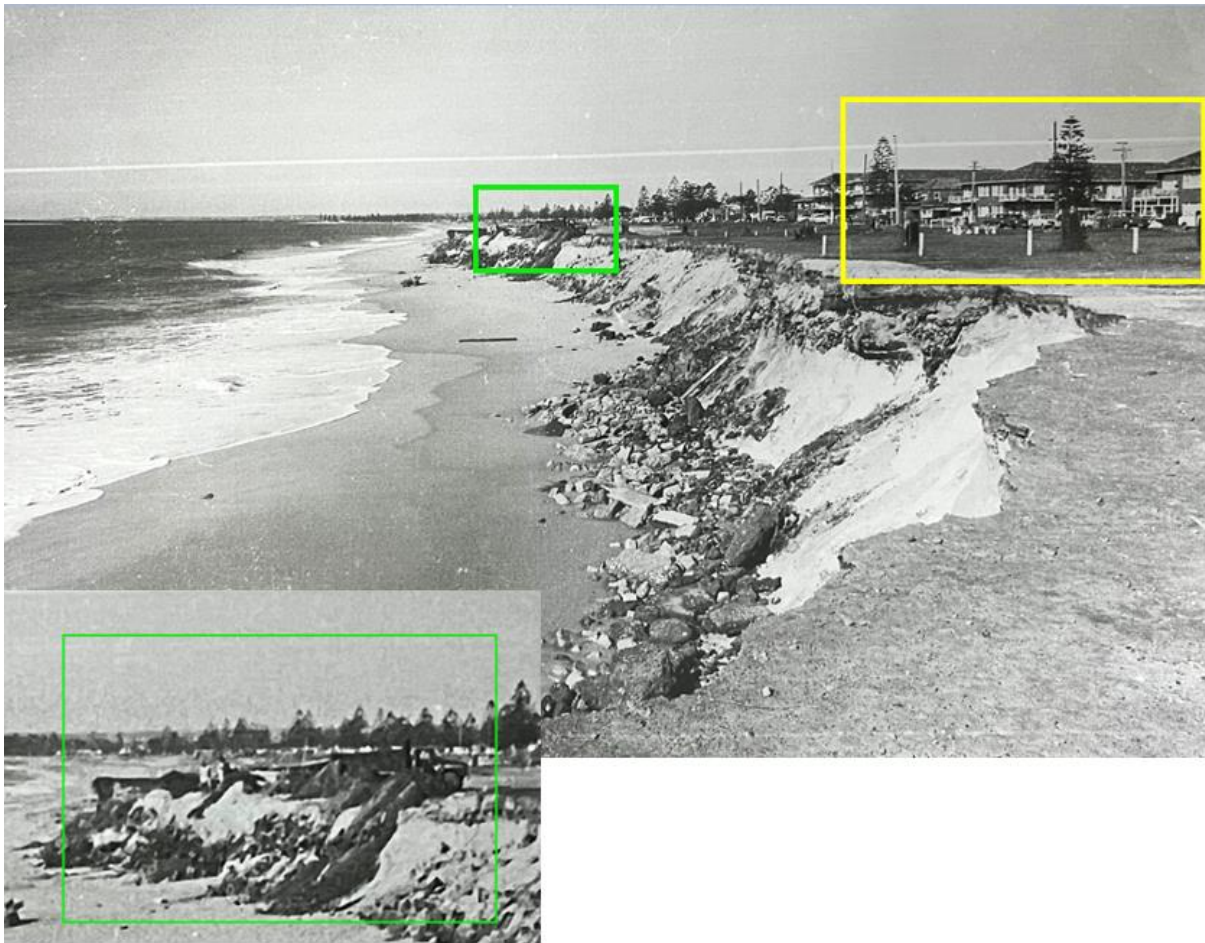


Figure B.0.1: Significant erosion of Lady Robinson Beach circa 1967. Note the presence of tipper truck demarcated in orange, likely 'placing' rock along the foreshore as a form of ad-hoc coastal protection works. Note also prominent building on The Grand Parade demarcated in red. Image source: Council



**Figure B.0.2: Rock ‘placed’ along the foreshore at Lady Robinsons Beach as ad-hoc coastal protection works circa 1967, with broken stormwater pipe demarcated in purple. Note prominent building on The Grand Parade demarcated in red. (Image source: Council, provided to MHL, 2024)**



**Figure B.0.3: Erosion of Lady Robinson Beach circa 1967, view towards the south. Note the presence of a truck at the dune scarp demarcated in green within the primary image, as well as the magnified image (inset), and residential properties demarcated in yellow, providing a reference point for estimated spatial placement of rocks as ad-hoc coastal protection works circa 1967 (source: Council, provided to MHL, 2024)**



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