

18 November 2025

Job No: 1099575-NbS Concept design report

Christchurch City Council
PO Box 237
CHRISTCHURCH 8140

Attention: David Little

Dear David

Southshore Edge Protection – South New Brighton Park Soft Edge Concept Design

Purpose

This letter provides a description of a proposed nature based “soft edge” natural beach extending along (approx.) CH 235 to CH 405 along South New Brighton Park as an alternative to the proposed cobble beach design included in the Jacobs updated engineering consent plans (Document No CN4600003899, Sheet 2004) for the 20-year consent duration.

Setting

The Avon-Heathcote estuary is largely an intertidal estuary with a microtidal tide range. Subsequently tidal currents are only a significant transport mechanism near the inlet, with wind-induced processes dominating throughout the remainder of the estuary (Macpherson, 1978), except in closer proximity to river mouths that discharge into the estuary.

The project site is situated on the western side of the Southshore Spit towards the mouth of the Avon River. The spit and estuary bed is predominantly sand in this area (see Figure 1) which is different to the siltier sediments on the western side of the estuary.

The shoreline at this location is oriented to the west-southwest (around 230° wrt North). Seaward of the existing reno mattress shoreline protection works the seabed level is around 0.1 to 0.2 m RL¹, with slightly higher elevations of sand landward of the unit (around 0.3 m higher). Seabed levels in this area reduced by around 0.3 m as a result of the Canterbury Earthquake Sequence (Jacobs, 2020).

¹ Reduced Level is in terms of New Zealand Vertical Datum 2016 (NZVD16) which is -9.45 m offset from Christchurch Drainage Datum (CDD)

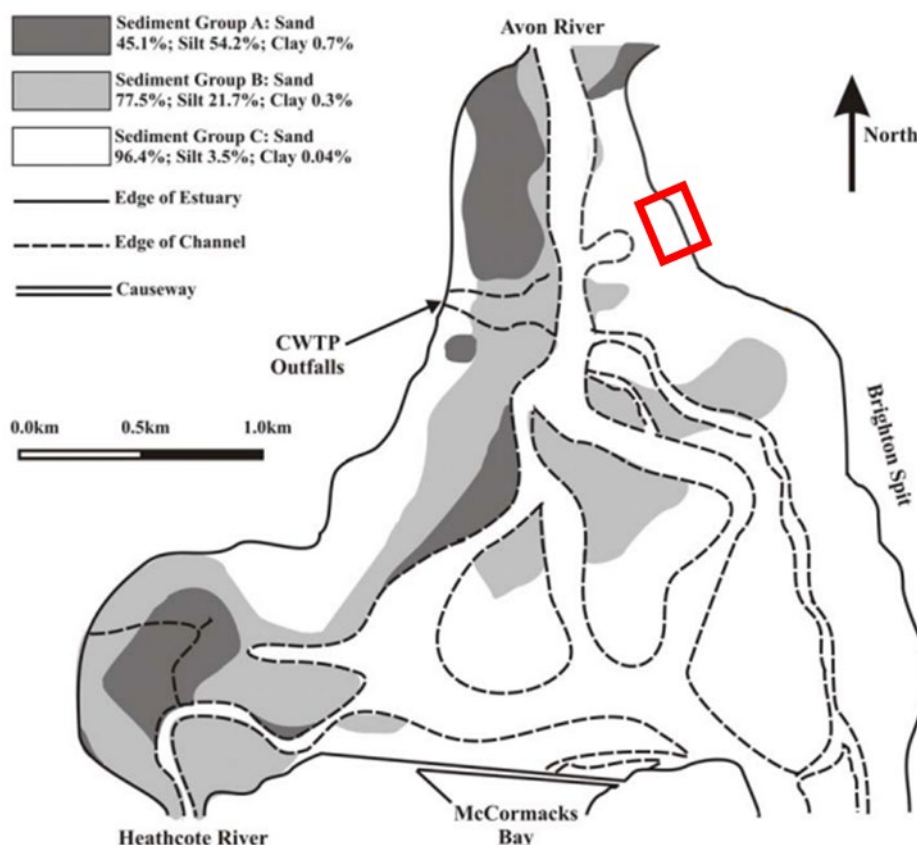


Figure 1: Distribution of sediment in the Avon-Heathcote Estuary with approximate location of the project site shown by the red box (Source: Burge, 2007)

Coastal processes

The main sediment transport mechanism at this relatively shallow location is by wind-generated waves at higher tide levels as well as wind induced counterclockwise circulation around the estuary (Macpherson, 1978). Based on the wind rose from Christchurch Airport (Figure 2) the predominant direction is from the northeast (peak directions ranging from 210° to 240°), which this location is sheltered from, and the second most dominant wind direction is from the southwest.

Based on both the wind rose and visual observations of the shoreline positions and areas of more sandy deposition made on site by our coastal engineer and coastal scientist, the net alongshore transport is from south to north and the shoreline at this location is out of equilibrium to the net along shore transport trend. This is supported by earlier observations of wave-formed ripple orientation and mean wind direction by Macpherson (1978) at this location (Figure 3).

Wave heights at this location will be both depth and duration limited, with the largest waves occurring with high winds coinciding with high tide conditions. Previous estimates suggest maximum wave heights are in the order of 0.3 to 0.5 m and have relatively short wave periods. As a result alongshore transport rates are likely to be small due to both these low wave heights and the relatively small angle of difference between the main wind direction, that can influence alongshore transport, and the shoreline orientation.

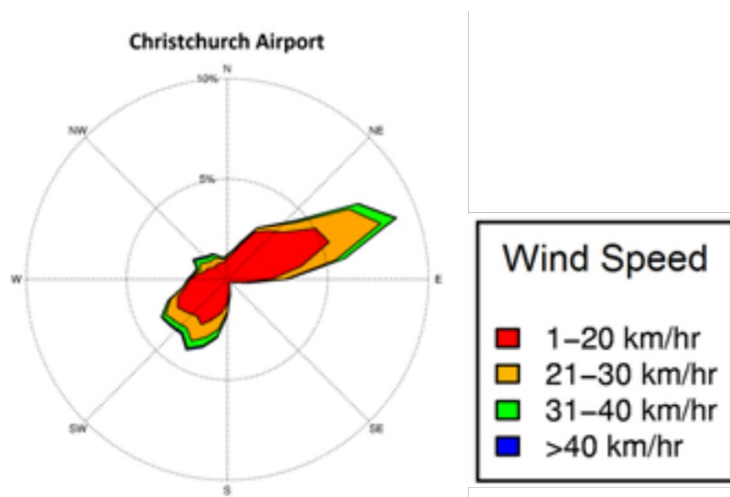


Figure 2: Wind rose at Christchurch Airport showing mean annual frequencies from hourly observations (Source: NIWA, 2016)

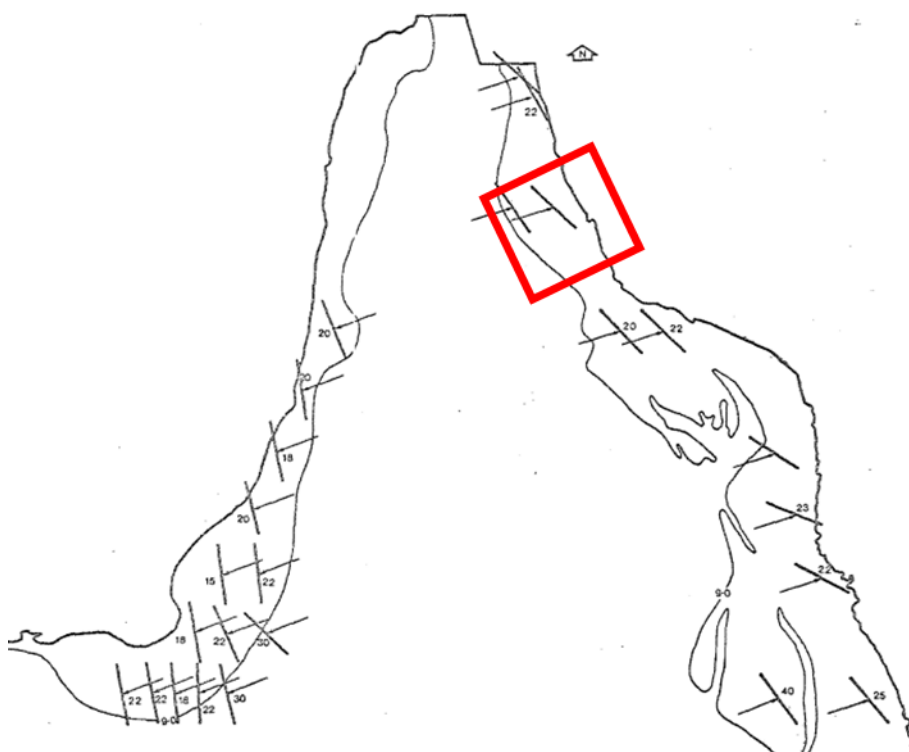


Figure 3: Distribution and orientation of wave formed ripples measured in September 1978 showing mean wave direction (arrows) and the orientation of ripple crest and number of ripples per meter (Source: Macpherson, 1978)

Based on the visual observations made on site and inspections of historic aerial photographs, the evidence of alongshore transport and the ultimate deposition of sand eroded from the foreshore can be seen deposited around the South New Brighton jetty where there is an embayment on the northern side towards South New Brighton Domain. Figure 4 shows the resulting sediment transport pathway from the eroding area of the reserve and the deposition areas around the jetty. At this location shallow sand features can be seen curving around this point extending into the embayment to the north, indicating a reduction in wave energy limiting further progression of transport.

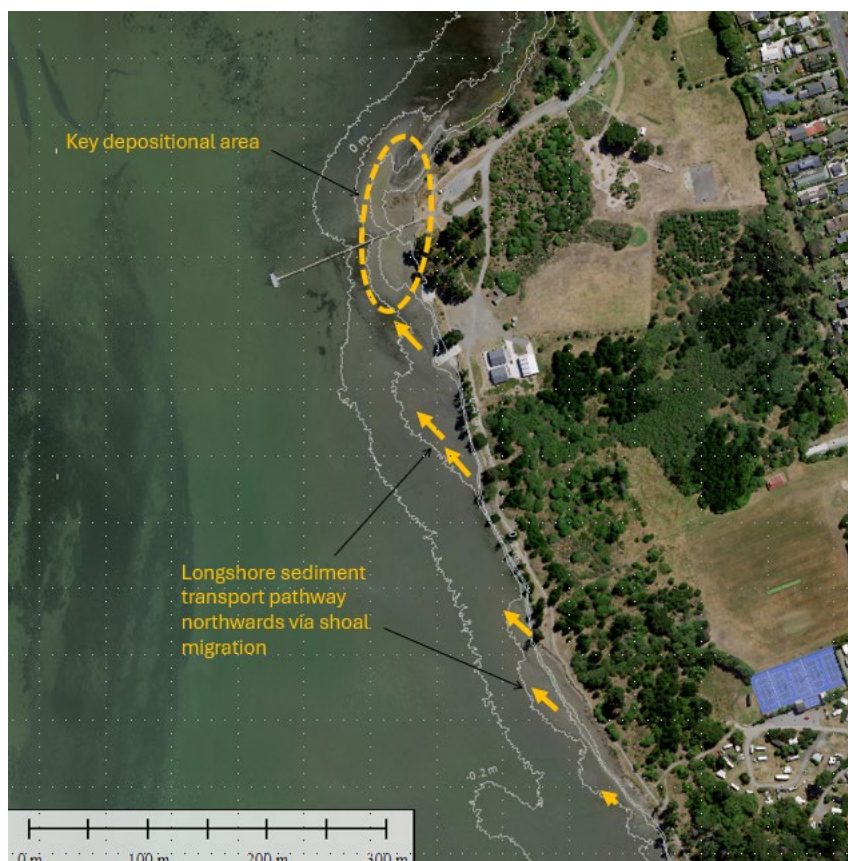


Figure 4: Indication of sediment transport pathways based on observed estuary bed features

Based on observations in other fine sand intertidal estuaries (Dolphin et al. 1995), suspended sediment concentrations over the estuary bed will be significant (10's to 100's of mg/l suspended sediment) during periods of wind generated waves on the fringe of a rising tide. Even with the relatively small waves generated here, and the estuary bed levels will also change locally with the formation and destruction of ripples (Macpherson, 1978). Measurements by Dolphin et al (1995) on sandflats off Wairoa Island (Manukau Harbour) identified ripple movements caused by small waves of less than 0.3 m, mixed with sediments to 0.2 to 2 cm depth at intervals of days to weeks, with storm events mixing sediments to depths of 8 cm or more over time scales of months to decades. Changes of this magnitude can be expected at this location due to similarities in wave climate and sand types.

Expected future changes with a do-nothing approach

At the project site, the evidence of the alongshore transport means that left unprotected the shoreline will continue to erode with sediment transported northwards and ending up on the intertidal areas north of the jetty at the northern end of the reserve.

Left to natural processes this ongoing erosion is likely to result in eventual failure of the reno mattress (due in part to corrosion of the wire basket) and rapid erosion/lowering of the built-up seabed landward of the reno mattress (between the basket and the existing shoreline). As the unprotected shoreline attempts to realign to a more stable position, there is likely to be further shoreline retreat. This is estimated to be some 15 m to 20 m at the northern end and up to 50 m at the southern end of this coastal stretch. The resulting erosion would also likely erode landward of the proposed shoreline protection works to the north of the site, requiring additional armouring of the exposed coastal edge to prevent failure of the protection works.

Design rationale

A nature-based solution needs to work with existing coastal processes and at this location it is recognising that the wave climate is from wind driven waves at higher stages of the tide and the existing alignment of the reno mattress is out of equilibrium from the incident wave climate.

The proposed design solution also needs to be landward of the existing reno mattress and to minimise occupation of the existing seabed between the reno mattress and the shoreline.

Preliminary concept design

This preliminary concept design has been done based on observations made during a site inspection by our Technical Director: Coastal Engineering, Richard Reinen-Hamill and his experience on designing nature-based solutions. It is sufficient for indicative extents and layouts as well as general plan forms but will require additional design to refine. We have also relied on design work carried out by Jacobs for rock armour sizing.

The preliminary concept design is to align the shoreline as close as possible to the incident wave direction between the proposed rock armour at the north and the existing stormwater outlet to the south. Based on observed shoreline alignments in more sheltered pockets of the shoreline, this appears to be at an alignment perpendicular to 220°.

As part of this work, it is assumed that the existing reno mattress will be removed and that cobbles will be stockpiled for reuse as part of the proposed soft shore works. Existing cobbles on the foreshore will also be collected for further use. The removal of the mattress will result in some erosion of the accumulated sand unless the proposed control structures are constructed in tandem with the reno mattress removal.

A key requirement for establishing a beach at this location is to anchor the headland and the northern (updrift end) where there is a change in coast alignment. This is done in the form of a rock armour groyne that is integrated into the proposed armour to the north and reinforces this point. The seaward extent is at the seaward extent of the existing reno mattress. The beach orientation is then along an alignment of around 130° with the toe extending from around the tip of the groyne to the southeast. To limit the extent of land loss there will need to be intermediate shoreline controls in the form of groynes and we have included three additional groynes and the beach ends at the existing stormwater outlet.

A sketch of the proposed design is shown in Figure 5 with a typical cross section sketches through the beach and through the groyne shown in Figure 6 and Figure 7. Levels referred to in these sketches are in NZVD-2016.

The rock groynes are situated on the original foreshore level and the rock armour, sized based on the revetment design armour size by Jacobs, is placed on a geotextile filter fabric to reduce differential settlement. The crest of the groynes are some 0.7 m above Mean High Water Springs (MWHS) to reduce sand overtopping and the length of the groynes are to reduce alongshore transport during typical conditions.

The typical section shows the approach is to grade back the existing land, extending much of the upper beach areas into the reserve area. This will include areas which will be cut back. The organic material will be removed but all sand and gravel will be retained to form the subgrade of the beach to a more favourable orientation and to reduce the requirement for importing additional sand. The slope of the subgrade is expected to be around 10(H):1(V) which is observed to be a relatively stable slope for the wave climate at this location. A vegetated area is proposed at the landward extent of the beach and an informal backshore armoring between the beach and planting utilises the recycled cobbles from the reno mattresses. Gaps in the vegetation are proposed to enable future sand top ups to occur if required (refer later section on monitoring and future management for details).

As part of the capital works we have allowed for beach nourishment of around 0.5 m thick over the project area to complete the soft edge design. This volume will be refined during detailed design informed by the cut/fill balance of the existing shore edge reshaping.

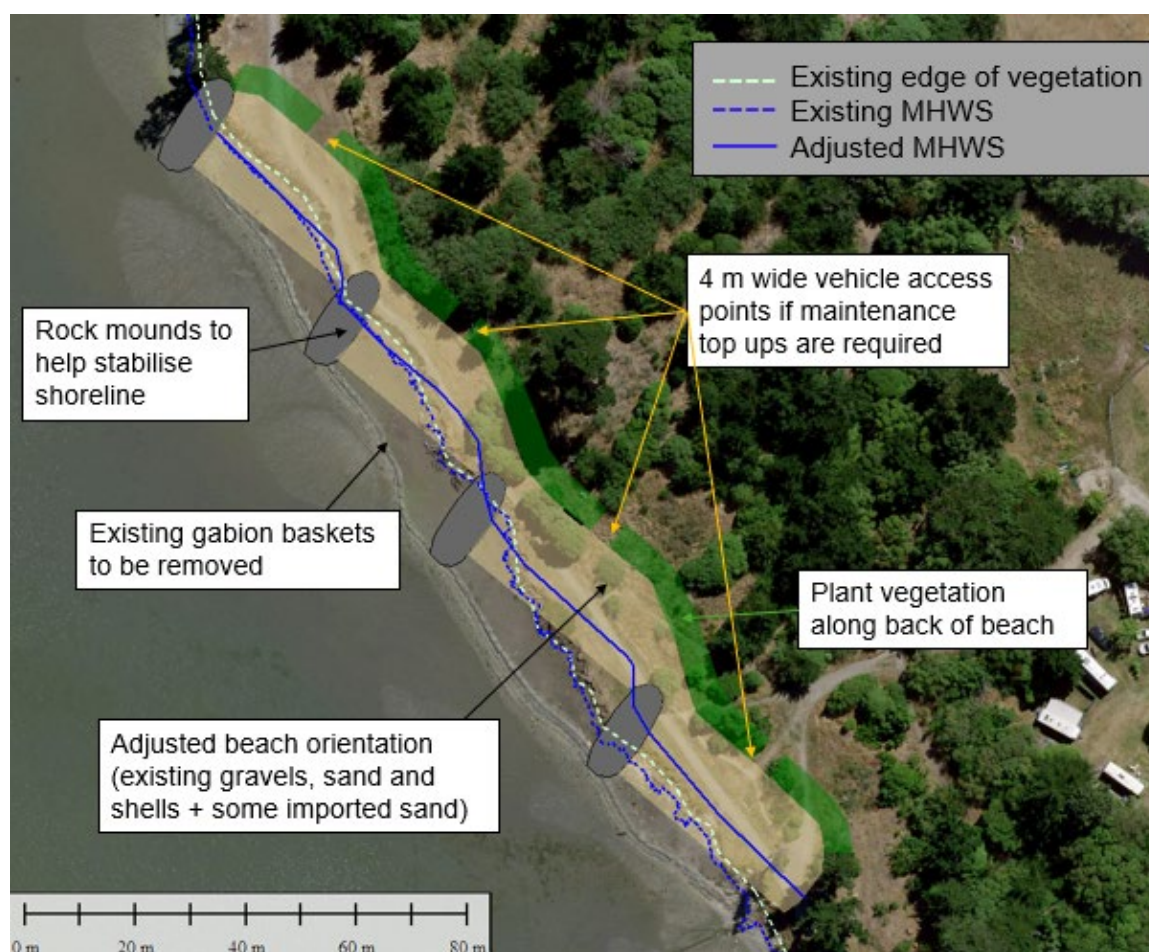


Figure 5: Plan view of the concept sketch (not to scale) for a nature based soft shore showing the existing and expected future MHWS location and the existing coastal edge

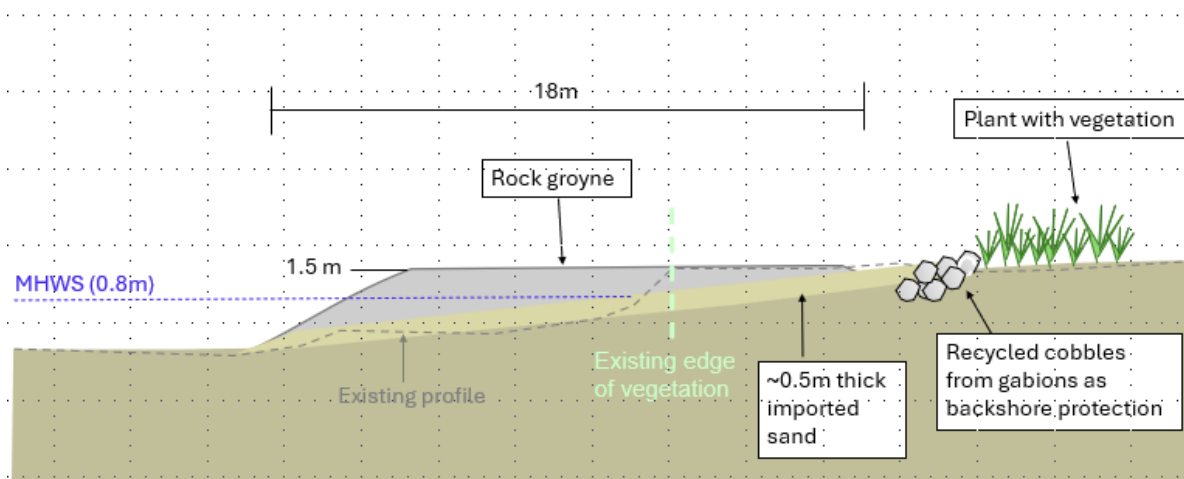


Figure 6: Typical section showing existing and proposed topographies and a section through the rock groyne (not to scale)

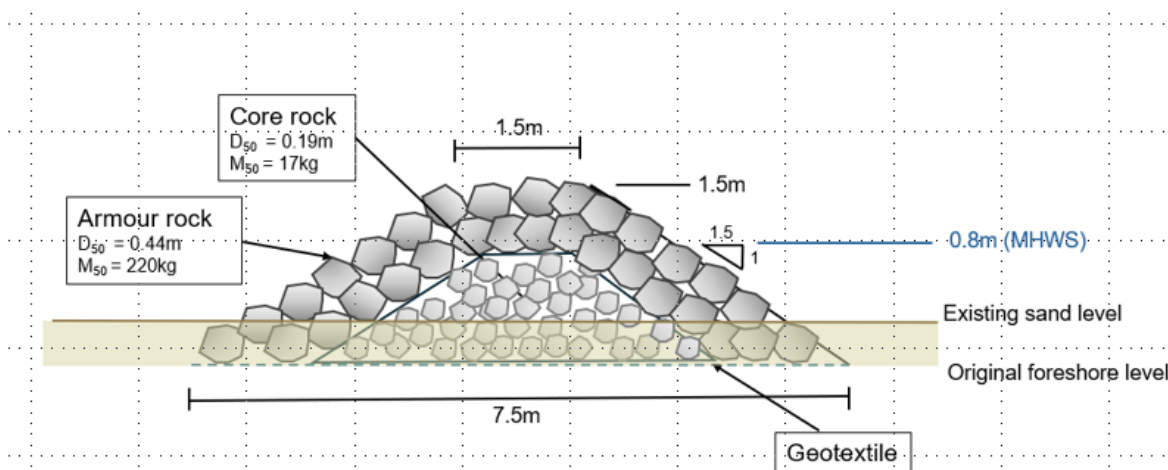


Figure 7: Typical section through the proposed rock groyne (not to scale)

Ongoing monitoring and management

As is typical for all nature-based projects, there will need to be monitoring and adaptive management over time to take into account the potential for shoreline adjustments and changes.

The groynes would be expected to be stable with only minor repairs involving replacement of dislodged rock units following a significant storm.

The sand beach orientation is expected to limit alongshore drift but there is the potential for storms to move sand offshore and then alongshore during significant events. Subsequently, there is a potential for some ongoing loss of sand to the north that could be managed by either ongoing top ups of sand and/or allowing more landward adjustments of the beach crest.

We recommend a monitoring programme based on annual visual inspections and after significant storms or reported damage from users of the reserve, and provision for top ups to replace lost sand when required. This would involve trucking in sand and placing it above the MHWS line, allowing natural processes to redistribute the sand down the beach profile. For budgeting purposes, we recommend allowing for 200 m³ every 5 years, but the actual frequency and volume will be dependent on the outcomes of the monitoring.

Expected construction works

The expected construction sequencing is to establish a stockpile area on land close to the proposed construction and establish diversions for the existing walkways to separate construction effects on users of the reserve.

Works would be carried out from north to south, with the first activity being partial removal of the reno mattress and recovery of cobbles and the construction of the northern headland groyne and its integration into the protection works to the north.

The groyne construction will require excavators operating on the foreshore and CMA to prepare the subgrade, place the filter fabric and then place the rock armour. Construction plant could be expected to work within 10 m of the toe of the rock groynes and along the foreshore landward of the existing reno mattress both for the removal of the mattress and recycling of the cobbles and the grading and reshaping of the existing land area. It is anticipated that collection of the cobbles and debris seaward of the reno mattresses would be done manually.

This will be followed by removal of the reno mattress in the vicinity in the next groyne to the south and the construction of this groyne. Excavated material would be stockpiled with organics and debris removed and sands and gravels retained for reuse.

The cell between the two groynes would be shaped to form the required subgrade slope that will require a mix of cut and filling to achieve the required slope and elevations. Filled areas will need some level of compaction.

This process will be repeated for the remaining two groynes and the beach cells between them and the stormwater outlet to the south. There may also be a requirement to armour the stormwater outlet, but this will need to be determined during detailed design.

Once the general plan form has been completed the bund and the cobble back shore will be formed and sand imported and placed. A conservative estimate of sand requirements is 1600 m³, but this will be dependent on the cut fill balance and the availability of existing sand and gravel on the foreshore and backshore. No compaction of the sand is proposed as tide and wave action will effectively do this over a period of weeks.

Assessment of effects on physical system and coastal processes

There is an initial effect of the change in occupation of the foreshore and land areas within the project footprint and then ongoing coastal processes effects.

Figure 5 shows the location of the existing edge of vegetation that represents the present coastal edge along with the existing MHWS and the proposed MHWS on completion of the works. This figure shows that the proposed MHWS is generally landward of the existing MHWS and in the southern part of the beach more landward than the present shoreline.

Table 1 shows the occupation of key elements of the existing situation and the proposed design. The existing reno mattresses occupy some 331 m² of the CMA and this compared to around 300 m² of occupation of the rock groynes (i.e. a net reduction of rock armour in the CMA). There is presently around 1450 m² of seabed between the reno and the current coastal edge, and some 400 m² of this will have additional sand placed on it. Some 2500 m² of existing land will be graded and formed into beach with the mound occupying an additional 930 m² of land and 583 m² of land will be converted to CMA.

Table 1: Occupation areas of the key elements of the conceptual design

Key feature	Area (m ²)
Reno mattress	331
Seabed landward of reno	1450
Total CMA occupation of works	700
Sand CMA occupation	400
Rock CMA occupation	300
Land converted to beach	2500
Land converted to CMA	583

Expected performance of the proposal

The design is expected to increase shoreline stability due to the change in orientation, but some sand losses and shoreline adjustment can be expected over the next 20 years. Within the project site this may manifest in adjustments to the MHWS location and movement of the sand within the cells, adjusting to the incident wind-wave climate. There is the potential for cross-shore sand losses during more significant events, and sand lost from the beach is expected to be thinly dispersed on the seabed seaward of the beach to the north, and potentially ending up on the estuary bed to the north of the wharf. The depth and rate of loss and transport will be a function of the wave energy, and it is anticipated to replicate the existing sediment transport processes and extents of estuary bed where sediment transport and wave and wind induced estuary bed changes have been observed.

Applicability

This report has been prepared for the exclusive use of our client Christchurch City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Canterbury Regional Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:

Authorised for Tonkin & Taylor Ltd by:

.....

Richard Reinen-Hamill
Rebekah Haughey

.....

Mike Jacka
Project Director

21-Nov-25

\\ttgroup.local\corporate\christchurch\tt projects\1099575\issueddocuments\r20251023.nbs_concept design report.final.v3.docx

References

Burge, P.I. (2007) Sedimentation in the Avon-Heathcote Estuary/Ihutai – an analysis of past and present studies

Dolphin, T.J., T. M. Hume, K.E. Parnell (1995) Oceanographic processes and sediment mixing on a sand flat in an enclosed sea. Manuaku Harbour, New Zealand. *Marine Geology* 128: 169-181

Macpherson, J.M. (1978) Environmental geology of the Avon-Heathcote Estuary. Doctoral Thesis, University of Canterbury, Christchurch, New Zealand