REPORT

Tonkin+Taylor

Options assessment for shoreline erosion - Maketu Surf Club Car Park

Prepared for
Western Bay of Plenty District Council
Prepared by
Tonkin & Taylor Ltd
Date
May 2016
Job Number
851735.220

Exceptional thinking together
www.tonkintaylor.co.nz

Table of contents

1 Introduction and background

The Western Bay of Plenty District Council ("WBOPDC") has commissioned Tonkin & Taylor Ltd ("T+T") to undertake a coastal management options assessment for a segment of the Maketu beachfront adjoining the Maketu Surf Club ("surf club") car park. This segment of beach will be referred to hereafter as "the site" (refer to Figure 1.1 for location plan).

Figure 1.1: Site location plan (source: Bay eXplorer, 2016)

Maketu beach is an important community asset providing access to the coastal marine area ("CMA"), Maketu Estuary ("estuary") and a car park area for locals, tourists and emergency services. A shop and cafe are located adjacent to the site.

The beach and the car park are segregated by a set of concrete steps ("access structure") and a few geosynthetic sand containers ("GSC") (refer Figure 1.2). The access structure and GSC serve two purposes. One purpose is to provide access between the car park and beach. The second purpose is to mitigate the effects of coastal erosion on the assets located behind the structures. We understand that these structures were constructed approximately 13 years ago.

During the annual coastal structures inspections it was noted that coastal erosion at the site was beginning to undermine the access structure, with the gabion basket foundation of the structure partially exposed. A rock revetment was discussed with community representatives as a potential option for addressing the erosion issue and these representatives expressed concern with such a structure being established on site. Therefore, the WBOPDC is considering coastal management options for the site to ensure the beach is preserved and community assets, including the access structure and car park, have a degree of resilience to current and future coastal erosion.

WBODPC 's brief to T+T was to prepare an options assessment to assist it with discussing and agreeing with the community the preferred approach for management of the coastal erosion at the site.

T+T's scope of work included:

1 Desk top study to ascertain the sediment transport mechanism at the site.

2 Development of potential management options, including advantages and disadvantages of each option.

3 Development of rough order costs for each of the nominated potential management options.

4 Providing a sketch of potential management options.

5 Producing a report summarising 1-4 above.

Figure 1.2: The access structure, carpark, GSC and surf club in 2014 and 2016. The area where erosion has been identified by the Community Board is visible at the toe of the access structure in 2014 (see red circle). Source: WBOPDC 2016.

2 Site description

2.1 The car park and beach

The area where there is an issue with coastal erosion periodically undermining the access structure extends for approximately 35 metres between the surf club access ramp and café (refer Figure 2.1).

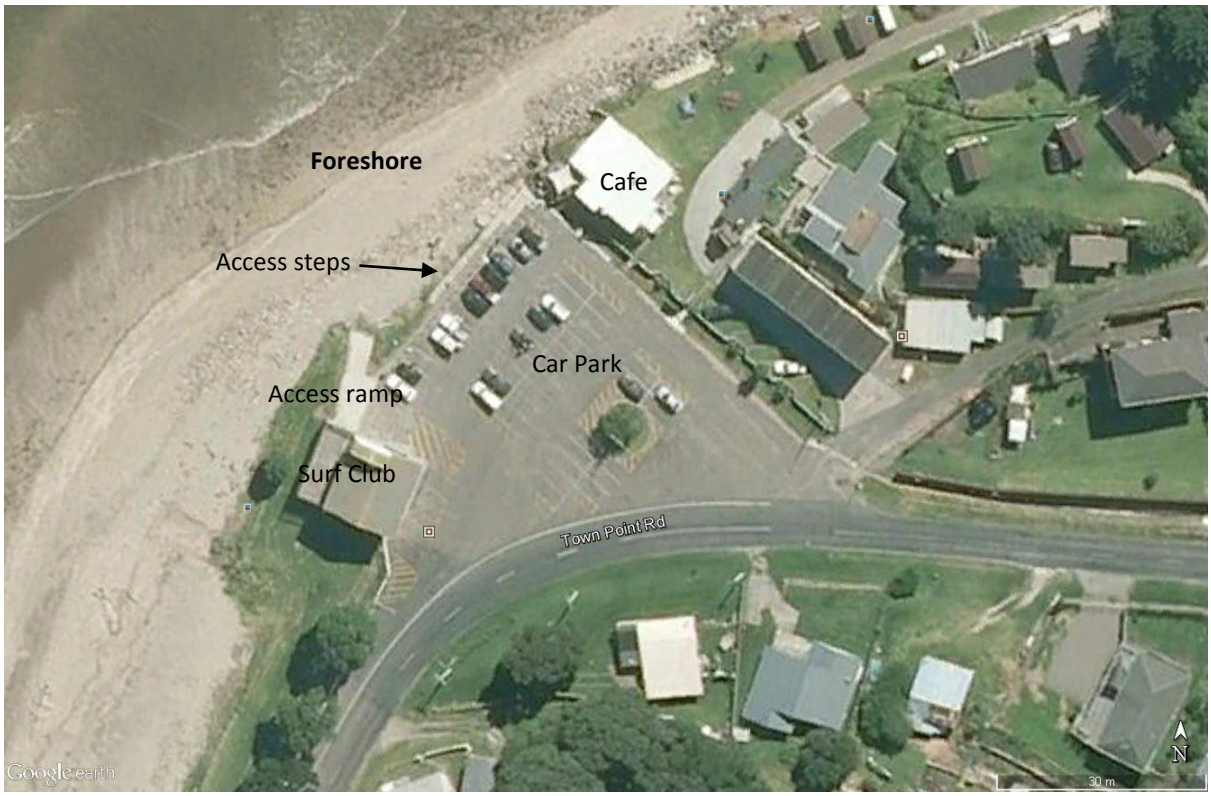


Figure 2.1: The site and key features in 2011. *Source: Google Earth Pro 2016*

Site investigations and a review of aerial photos suggest that during periods when the beach profile has not been eroded by storm events, the beach profile adjacent to the site has a relatively flat sandy high tide beach of approximately 5-7 m wide, fronted by a sloping beach face, which leads down to the intertidal area where cobbles and boulders are located.

The beach sediment to the north east of the site is typically coarser, with boulders and rock platforms proliferating the coastline up towards Okurei Point.

Based on site observations, the access structure is used by the public as an area to sit and not just for access to the CMA.

The estuary mouth, located immediately to the west of the site, and Okurei Point, located approximately 1.7 km to the north east of the site, both have an influence on the currents, sediment supply, tides and sediment transport (collectively termed “hydrodynamics”) at the site.

2.2 The Maketu Estuary

The estuary is reasonably shallow (average depth is less than 1 m) and covers a total area of approximately 2.3 km^2, with most freshwater inflows sourced from the Kaituna River[1]. The backshore area adjacent to the site is comprised predominantly of residential housing.

An estuary typically has both a flood and ebb tidal delta, often referred to as "sand banks". A flood tidal delta is a deposit of sand formed inside the estuary and an ebb tidal delta is a deposit of sand on the seaward side of the estuary mouth.

Aerial photography from the early 2000s to present day has been analysed and general observations suggest that the shape and location of the ebb tidal delta and the exit channel fluctuate, as expected in these types of systems. It appears that the rounded foreland, which the surf club is situated on, remains constant even with the varying morphology of the estuary and periodic repositioning of the ebb tide delta (see Figure 2.2).

Figure 2.2: Morphology of the Maketu Estuary mouth 2015. Note the location of the ebb and flood tidal delta are indicative only and relate to their location at the time the aerial photography was flown. Source: Google Earth Pro 2016.

The estuary presently receives limited quantities of freshwater from the Kaituna River. The majority of the river flows by pass the estuary and are diverted out to the ocean by way of the Kaituna 'Cut" at Te Tumu, which was completed in 1956. It is proposed to increase the volume of freshwater inflow to the estuary sourced from the Kaituna River in the imminent future, subject to the acquisition of the necessary Resource Consents.

[1] Goodhue, N. D., 2007. Hydrodynamic and water quality modelling of the lower Kaituna River and Maketu Estuary. Masters Thesis. University of Waikato.

2.3 Coastal Processes

2.3.1 Waves

A wave climate assessment has not been undertaken for this project however available literature has been reviewed. Wave modelling undertaken for a recent study of the estuary by DHI suggests that the predominant wave direction offshore from Okurei Point is north east, with directions ranging from north to east[2]. Based on DHI's modelling work, waves from the north east sector appear to refract around Okurei Point with this refraction process reducing their height as they approach the site. DHI's modelling suggests that waves from other sectors, including the north west, are not common. However, it is possible that when waves do approach the site from the north west, the shallow ebb tidal delta located offshore in front of the site, may dissipate a portion of their energy thereby reducing the potential for resultant erosion of the beach.

2.3.2 Current patterns

Hydrodynamic modelling conducted by Goodhue (2007) for the estuary suggests that there is a net seaward flow of water with strong currents occurring near the estuary mouth and that the estuary is ebb tide dominated[3]. This research suggests that "overtides" are present, which mean that the ebb tide persisting for a greater period of time than the flood tide, effecting residual currents[4] and sediment transport. This means that the tidal current potentially moves faster and/or for longer out of the estuary than it does coming into the estuary. When significant rainfall events occurs in the Kaituna River catchment this overtide effect is likely to be more pronounced at the estuary mouth.

There is currently a lack of data or modelling relating to current patterns outside the mouth of the estuary and along the adjacent coast, but it is likely that some form of current does flow along the coastline.

2.3.3 Sediment transport

Coastal beaches typically receive their sediment from either longshore transport (shore parallel, also called littoral transport), or cross-shore (perpendicular to the shore) mechanisms. The dominant sediment transport mechanism will depend on the physical location and setting of the beach, but also weather and wave patterns, and sediment availability within different sources.

Based on our interpretation of the available aerial photography of the site and surrounds, it would appear that the sediment transport mechanism is a longshore one which moves sediments from Okurei Point along the beach in a southwest direction. Waves from the predominant direction at the site refract around Okurei Point and cause waves to break at an acute angle to the shoreline orientation, forcing sediment transport down to the estuary mouth and possibly into the estuary. Our interpretation of aerial imagery is supported by the Maketu Restoration Strategy (1990)[5] and Tortell (1994)[6].

The mechanism of cross-shore transport at the site are not as well documented as longshore transport and difficult to interpret from site visits and aerial imagery. It is likely that in large swells,

[2] DHI, 2014. Kaituna River re-diversion – Numerical modelling. Report prepared for Bay of Plenty Regional Council.
[3] Goodhue, N. D., 2007. Hydrodynamic and water quality modelling of the lower Kaituna River and Maketu Estuary. Masters Thesis. University of Waikato.
[4] Residual current is the mean current over time (i.e. a tidal cycle)
[5] Richmond, C. J and Forbes, S. P., 1990. Maketu Estuary Restoration Strategy: A proposal to central and local Government. Prepared for the Department of Conservation. Technical Report Series No.3.
[6] Tortell, P., (1984). Maketu Estuary: environmental issues and options. Commission for the Environment.

particularly combined with high tides and storm surge, sediment is removed from the site to offshore. It is also possible that sediment deposited on the ebb tidal delta, either from the estuary or from offshore, may gradually move onshore in times of low wave activity. As the positioning of the ebb tidal delta fluctuates, it is possible that the influence of cross-shore sediment transport changes accordingly as more or less protection is given to the beach at the site dependant on the ebb tide delta location.

Based on the available data, it is difficult to draw a conclusion as to the predominant sediment source and transport mechanism at the site. We consider that it is likely both fluvial (estuary) and coastal (beach) processes affect the supply of sediments to the site and influence fluctuations in the beach profile.

2.4 Erosion mechanism

T+T has visited the site on a number of occasions and has reviewed photographs supplied by WBOPDC. Based on our observations of the site we consider that the beach profile in front of the access structure fluctuates and this is likely to be as a result of three possible mechanisms.

During episodic coastal storms when the beach profile is cut down, as a result of elevated water levels and large waves and the shallow ebb tidal delta being less effective in dissipating wave energy, the beach is eroded. In this case sediments are removed from the beach and deposited offshore and the access structure's foundation can become exposed, until such time as sediments on the beach replenish after coastal storm event(s), during calmer periods.

The replenishment of sediments on the beach can take a long time if the coastal storm is a significantly large event and/or there is a succession of storm events over a short period. A high tide beach and elevated beach profile act as a buffer to coastal storms by assisting with the dissipation of wave energy received at the shoreline.

The second erosion mechanism at the site may be from the longshore currents moving sediment from the site and into the estuary during larger wave events, which may cause higher velocity longshore currents and more mobilisation of beach sediments. During calmer conditions this sediment may be moved back to the site during ebb tides or out to and deposited on the ebb delta.

Thirdly, some erosion may occur when large rainfall events in the estuary catchment cause increased water volume and typically higher current velocities exiting the estuary, which may flood over the foreshore on the foreland. This results in a temporary repositioning of the estuary mouth to the east, thereby removing sediment from the site out to and deposited on the ebb tide delta.

Based on the available information, T+T considers that any lowering of the beach profile in front of the car park and consequential potential undermining of the access structure's foundations, is likely to be episodic and related to:

- The frequency of significant coastal storm events.
- The position of the ebb tide delta.
- The quantity of sediment held within the ebb tide delta.
- The effect of the ebb tide delta on incoming waves.
- The effect of the ebb tide delta on the position of the estuary channel adjacent to the beach.

Due to the lack of beach profile monitoring data at the site, it is difficult to determine how often these episodic erosion events are occurring, whether the beach system experiences phases of accretion in between these events, and whether there is a long term trend of beach profile lowering at the site.

2.5 Sediment characteristics

Samples of the sediment at the site were collected and analysed, both visually and within a laboratory for Particle Size Distribution (PSD). The analysis confirms the following:

- The sediments are coarse with shell and wood fragments visible.
- In terms of the Wentworth Scale the sediment is classified as “medium to coarse sand”.

A full PSD report is annexed to this report as Appendix B.

We understand that the boat ramp, situated in the estuary and approximately 400 m south west of the site may require maintenance dredging in the future. WBOPDC is interested as to whether the dredged sediments may be suitable for nourishment of the beach at the site.

Samples of the sediment at the boat ramp were collected and analysed, both visually and within a laboratory for Particle Size Distribution (PSD) and contamination. The constituents analysed were Arsenic, Cadmium, Chromium, Copper, Nickel and Lead. The analysis confirms the sediments are classified as “medium sand” under the Wentworth Scale and well below the contaminant guidelines set out for “Recreation” in the *National Environmental Standard: Guidelines for Assessing and Managing Contaminants in Soil* as well as “Interim Sediment Quality Guideline Value-Low” in the *Australia New Zealand Environment and Conservation Council Australia and New Zealand Guidelines for Fresh and Marine Water Quality Volume 1.* Full PSD and laboratory returns are annexed to this report as Appendix B.

The PSD and contamination testing of the boat ramp sediments has concluded that these sediments would be suitable for nourishment of the beach at the site.

3 Options assessment

The preceding sections of this report set out the most relevant environmental factors in terms of shaping which potential management options are likely to be viable and which option(s) may be the preferred option. Other factors need to be considered in the development, discussion and selection of options for implementation including cost, design life, multiple use potential and aesthetics. An outline of the potential coastal management options available for implementation at the site to address the periodic lowering of the beach profile and exposure of the foundations of the access structure is presented in Table 3.1 below. The drawing contained in Appendix A provides an indicative location and extent of the options.

It should be noted that the options presented are not intended to be an exhaustive list but rather those options which are most likely to be cost effective, practicable and acceptable to the community and WBOPDC.

Table 3.1 – Potential options for management of coastal erosion at the site

Option	Explanation	Benefits	Barriers	Indicate rough order costs
"Do-nothing" approach	This option sees natural processes currently occurring on site left to continue with no intervention or management at all.	• Natural processes will not be altered and the beach and estuary systems will continue to function as they have done for a long time. • No financial costs and no environmental effects from the implementation of a management option. • Existing landscape and visual values maintained.	• There could be ongoing regression of the shoreline and loss of more Council assets and access to the CMA during erosion events. • The access structure may continue to be undermined until it becomes unsafe and un-usable. The carpark behind the access structure would then also have its functionality compromised. • Would not address erosion adjacent to the site, potentially resulting in loss of the surf club and toilets if future sea level rise exacerbates erosion at the site and/or there is an increase in the frequency and severity of coastal storm events.	No immediate costs. Significant future costs associated with the potential loss of council land and infrastructure and loss of public access to the CMA.
Avoidance	This option involves relocating important Council assets further inland away from the	• May reduce risk to assets if located to a safer location. • Existing coastal processes maintained.	• There could be ongoing regression of the shoreline and loss of more Council assets and access to the CMA during erosion events.	There are likely to be significant costs

Option	Explanation	Benefits	Barriers	Indicate rough order costs
	coastal hazard and then allowing the natural processes occurring onsite to continue without intervention or management.	• Existing landscape and visual values enhanced as the Council assets are moved further away from the coastal environment. • Can provide long-term solution depending on whether the asset is relocated sufficiently landward or above the hazard. This may not always be achievable where topographic and other constraints make it impractical to do so.	• Landscape and visual values may be altered at the site of relocated carpark/assets. • High cost associated with relocating carpark or loss of carpark and/or purchasing land to relocate carpark to if no public land is available or suitable. • Public opposition associated with re-locating, losing or reducing carpark area. • There may not be a suitable site for relocation as any alternative sites in the vicinity may still be susceptible to coastal hazards due to future sea level rise.	associated with asset relocation and land acquisition.
Beach nourishment	This option involves placing sediment won from a local source (re-distribution otherwise known as “push up” or “beach scraping”) or an imported source onto the upper beach face and berm after erosion events, to help the beach recover quicker (essentially speeding up a natural process).	• May reduce risk to assets, if sufficient sediment is placed in front of the access structure as frequently as is required to maintain a beach profile that provides a buffer between the waves received at the shoreline and the access structure. • Provides an opportunity for the beach to build back up more rapidly and provide a buffer against erosion following an erosion event. • Existing coastal processes maintained. • Existing coastal, landscape, visual and recreational values enhanced. • Overall lower environmental impact compared with a structural option/protection structure.	• For redistribution to be viable there needs to be sufficient sediments located on the lower beach profile to be able to transfer onto the upper beach profile. Beaches experiencing a long term erosion trend typically do not have excess sediments available. • If redistribution of in situ sediments is not practical then an offsite sediment source would need to be established. There may not be an offsite source which is cost effective in terms of purchase and transport costs, especially if the frequency of nourishment events is high and/or increases over time because of sea level rise. • Relies on a thorough understanding of the beach profile fluctuation over time. • Sediment placed on the foreshore could quickly and easily be lost in a storm event.	Scrape: $8,000 to $10,000 Import: $35,000 to $45,000

Option	Explanation	Benefits	Barriers	Indicate rough order costs
			• Will not provide protection to access structure or the carpark from large storm events. • Relies on a steady sediment supply and the necessary amount of sediment required may not always be available. • If there is a long term trend of erosion at a site then beach nourishment is unlikely to be effective. • Often requires reactive management after erosion events to maintain a beach profile that provides a buffer to coastal erosion. • May not preclude the need to establish a protection structure in the medium to long term.	
Rock revetment seawall	A sloped rock revetment provides a mechanism to dissipate wave energy received at the shoreline and provides a degree of protection to land and assets located landward of the structure from wave induced erosion. This is a popular coastal erosion management option in coastal environments, particularly open coast beaches with moderate to high wave energy.	• If adequately designed, constructed and maintained will reduce the risk of coastal erosion affecting Council assets. • Relatively long-term design life (i.e. greater than 50 years). • Relatively cost effective solution compared to other protection options. • Slope and voids allow for wave energy dissipation in storm events thereby reducing the potential for the structure to result in lowering of the beach profile and waves to overtop the structure. • Relatively easy to maintain. • Designated access stairs can be incorporated over the structure.	• Could result in beach lowering when waves are interacting with the structure. • Will take up a large portion of the current high tide beach. • Will reduce public access to and along the CMA compared to the current access structure. • May not be well received by the public for aesthetic, loss of public access and cultural reasons (imported rock).	$150,000 to $190,000

Option	Explanation	Benefits	Barriers	Indicate rough order costs
		• The structure can be relatively easily founded on the cobble layer underlying beach sediments at the site.		
Extension of the access structure (seawall)	This option would see new steps constructed below the existing steps.	• If adequately designed, constructed and maintained will reduce the risk of coastal erosion affecting Council assets. • Steps have a multi-use function of providing erosion management, public access to the CMA and also seating. • Relatively long-term design life (i.e. greater than 50 years). • Whilst the steps lack voids contained in a rock revetment, they are sloped so will still allow for some wave energy dissipation in storm events thereby reducing the potential for the structure to result in lowering of the beach profile and waves to overtop the structure. • Existing coastal, landscape, visual and recreational values predominantly maintained. • There is an opportunity for the stair extension to cover up the existing gabion baskets under the existing stairs that are bound to corrode and break open at some point. Given these baskets are under the access structure, it is difficult to ascertain their extent and therefore how practical it is to undertake maintenance and/or removal of the baskets in the future. • The stair extension will occupy a lot less of the beach area at the site than a rock revetment.	• Greater potential for beach lowering when waves are interacting with the structure than sloped rock revetment. • The lack of voids within the access structure is likely to result in increased wave overtopping during storm events than what would be expected for a rock revetment. • Less maintenance is likely to be required compared with a rock revetment but if and when required, any maintenance is likely to be more complex and costly to undertake.	$295,000 to $350,000

Option	Explanation	Benefits	Barriers	Indicate rough order costs
		• The structure can be relatively easily founded on the cobble layer underlying beach sediments at the site. • The access structure's crest already integrates into the car park to ensure waves overtopping the structure do not erode the sands and soils landward of the structure.		
Groyne	A short 25 m groyne could be built somewhere near the surf club on the upper beach face, to the south west of the site. This groyne may retain sediments moving alongshore from Okurei Point towards the estuary.	• May potentially assist with reducing the alongshore movement of sediments from the site into the estuary, which could be causing or contributing to erosion of the beach at the site. • A small scale groyne constructed of timber could be trialled initially and monitored to understand if this type of structure could provide any benefits at the site. Depending on the trial results the timber groyne could be removed or more permanent or alternatively configured groyne structure or structures could be constructed.	• A groyne is typically a preferred option in circumstances where alongshore movement of sediment more dominant than onshore-offshore sediment transport. At this site it is our preliminary view that the longshore movements of sediments is not having a significant effect on the beach in terms of sediment removal and erosion. Therefore the structure is unlikely to prevent erosion of the beach and the transport of sediments offshore from cross-shore processes. • Provides no protection to the Council assets. • Because a groyne traps sediments as they move along the shoreline they can result in the depletion of sediments which would, without the structure being in place, be deposited on the beach on the downdrift side of structure. • Due to its shore perpendicular nature, the groyne is likely to restrict public access along the upper portion of the beach profile and also be visually intrusive.	$45,000 to $55,000

Notes to Table 3.1:

- The rough order cost estimates provided above are for construction only and do not include Resource Consent, design, construction supervision or maintenance costs.
- The rough order cost estimates provided above contain an allowance for preliminary and general costs and also a 40% contingency and exclude GST.
- The volume of sediment required for a nourishment event has been calculated at 500 m^3.
- Cost assigned to beach nourishment ("scrape") are the rough order cost per scrape event. This nourishment could need to occur multiple times over the course of a year.
- Cost assigned to beach nourishment ("import") are the rough order costs per event and assume sediment is sourced from the boat ramp. This nourishment could need to occur multiple times over the course of a year.
- A groyne could be constructed out of rock, geo synthetic sand containers or timber poles and lagging. Therefore the costs can vary significantly. For the purposes of this high level options report, we have assumed that a trial groyne is constructed of timber lagging and poles as the materials. It is important to note that without site investigation data and a detailed design we are not certain that the timber poles would be able to be used at the site should the cobble layer near the access structure extend further to the west. This cobble layer would prevent the driving of timber piles into the beach.

4 Summary and discussion of options

The do nothing and avoidance options are unlikely to be acceptable and practical at the site because the car park, access structure and toilet are strategic and significant assets to the community in terms of providing access to the popular beach adjacent to the surf club. There is no alternative site nearby owned by WBOPDC which the car park and toilets could be relocated to and the cost of rebuilding these assets would be significant.

The beach nourishment option is likely to be acceptable and practical at the site. If there is a suitable quantity of sediment available on the lower beach face at the site then this could be "pushed up" or "scraped" onto the upper beach face and berm in front of the access structure. This method is relatively cost effective and uncomplicated. If there is insufficient sediment available on the lower beach face at the site then sediment would need to be imported to be placed on the upper beach face and berm to achieve an appropriate profile. Sediments won from undertaking maintenance dredging of the boat ramp 400 m south west of the site are likely to suitable for nourishment of the beach at the site. To date no analysis has been undertaken as to whether a sufficient sediment volume can be won from maintenance dredging of the boat ramp and surrounds to nourish the entire site. Nourishment could be achieved by way of a combination of "scraping" at the site and importing sediments from the boat ramp. There is a higher cost associated with moving sediment from the boat ramp to the site than redistributing sediment from the lower beach face at the site.

Larger scale dune enhancement and revegetation with native sand binding vegetation has been discounted at this site. This is because the access structure is utilised for access to the CMA and also seating, and the public would need to be excluded from any dune to protect vegetation from damage. Further, given the elevation of the beach and the wave energy received at the shoreline at the site, it is likely dune vegetation would be lost during a significant coastal storm.

At present there is lack of knowledge regarding historic beach profile fluctuations at the site. Without profile monitoring data it is difficult to gauge both the likely success of beach nourishment and cost effectiveness as a stand-alone option for mitigating the coastal erosion effects on Council assets at the site. Monitoring and reporting would therefore be required and it would be prudent, especially in the case of the imported sediment scenario, to trial small scale nourishment before committing to larger scale and cost nourishment.

If WBOPDC and the community want to ensure the existing car park and access structure have some resilience to coastal erosion at the site then a seawall constructed in front of the access structure, but as far landward as possible, is a practical option. It is our preliminary view that an extension of the access structure is a superior option to a rock revetment due to its multi-use function and

significantly smaller footprint. We also note that there is an opportunity to remove the footpath in front of the bollards which segregate the car park from the access structure. The access structure could then be reconstructed more landward and more beach area would be able to form in front of the access structure through nourishment or accretion phases. Pedestrian access between the café and surf club could still be provided along the top step of the access structure. A geosynthetic sand container seawall has been discounted as it is unlikely to tolerate the wave energy experienced at the site, has a shorter design life, higher costs, requires more maintenance, and will result in more adverse effects in terms of lowering of the beach profile and wave overtopping.

Not enough information exists at present in relation to the sediment transport mechanism at the site to confirm whether a groyne is likely to be beneficial at the site. Our preliminary view is that it is likely that the lowering of the beach at the site is primarily due to wave action and therefore the groyne is unlikely to provide benefits. There would be negative consequences of its establishment in terms of restricting public access along the beach and visual effects.

Resource Consents are likely to be required from the Bay of Plenty Regional Council and possibly WBOPDC to implement all options with the exception of the "do nothing" option. A detailed site investigation and design process will also be necessary in terms of finalising and implementing the preferred option.

5 Conclusions

WBOPDC commissioned T+T to undertake a coastal management options assessment for a 35 m section of shoreline at Maketu which T+T considers to be at times affected by coastal erosion. The beach at the site, the access structure, toilets and car park are all strategic and significant assets to the community. The coastal erosion at times results in the foundation of the access structure becoming exposed and a loss of the high tide beach at the site.

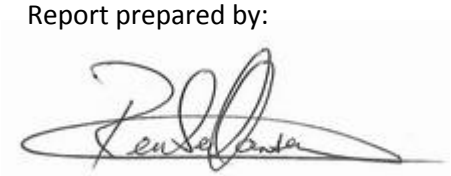
Due to a lack of beach profile monitoring data it is difficult to say whether the beach at the site experiences periods of erosion and accretion, but in a long term context is generally stable in terms sediment quantity and beach elevation, or alternatively the beach is experiencing a long term trend of erosion. It is therefore recommended that WBOPDC initiate a monitoring immediately to begin to understand the changes in the beach elevation onsite over time. This will provide for more informed future decision making in relation to management options. Future sea level rise is likely to result in the need for more intervention and management of the coastal erosion at the site.

Following a review of all options presented in Table 3.1 and considering multi criteria such as short and long term financial costs, certainty/effectiveness, effects on coastal processes, public access and amenity it is considered that WBOPDC and the community could consider either undertaking trial nourishment of the beach at the site only, or construct an extension to the access structure and nourish the beach at the site as well. The decision whether to implement nourishment only versus a combination of nourishment and an extension to the access structure will be influenced by the extent to which WBOPDC and the community require certainty in terms of providing a car park and access structure which has some resilience to coastal erosion. That is, we do not consider the nourishment option is likely to provide long term benefits in terms of protecting WBOPDC's assets form coastal erosion. The nourishment option is likely to provide enhanced recreational and visual amenity value, provided the site is replenished with new sediments each time they are lost as a result of an erosion event. Irrespective of whether nourishment is implemented in isolation of the access structure extension or not, it would be prudent to trial nourishment at first and then upscale it if deemed successful.

6 Applicability

This report has been prepared for the exclusive use of our client Western Bay of Plenty District 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.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
.....	.....
Reuben Hansen	Glen Nicholson
Principal Environmental Management Specialist	Project Director

RCH
t:\tauranga\projects\851735\851735.2200\issueddocuments\160524.rch.options assessment.docx

Appendix A: Concept plan of the proposed options

A3 SCALE 1:250

0 5 10 15 (m)

ORIGINAL IN COLOUR

DRAWING STATUS: CLIENT REVIEW ISSUE

REVISION	DESCRIPTION	BY	DATE
1	Client Review		

DESIGNED :	LPS	May. 16
DRAWN :	KAH	May. 16
DESIGN CHECKED :		
DRAFTING CHECKED :		

CADFILE : \\851735.2200-01.dwg

APPROVED :

NOT FOR CONSTRUCTION

This drawing is not to be used for construction purposes unless signed as approved

NOTES :

1. All dimensions are in millimetres unless noted otherwise.
2. Aerial photo Copyright 2002–2005 Terralink International Limited and its licensors.

REFERENCE :

Tonkin+Taylor
Level 1, 525 Cameron Road, Tauranga
Tel. (07) 571 7360 Fax. (09) 307 0265
www.tonkintaylor.co.nz

CLIENT, PROJECT

WESTERN BAY OF PLENTY DISTRICT COUNCIL

MAKETU SURF CLUB CAR PARK COASTAL EROSION

TITLE

POTENTIAL MANAGEMENT OPTIONS

Layout Plan

SCALES (AT A3 SIZE)	DWG. No.	REV.
1:250	851735.2200-01	1

Appendix B: Sediment analysis results

GEOTECHNICS
15c Amber Crescent,
Judea
Tauranga 3110
New Zealand
p. +64 7 571 0280

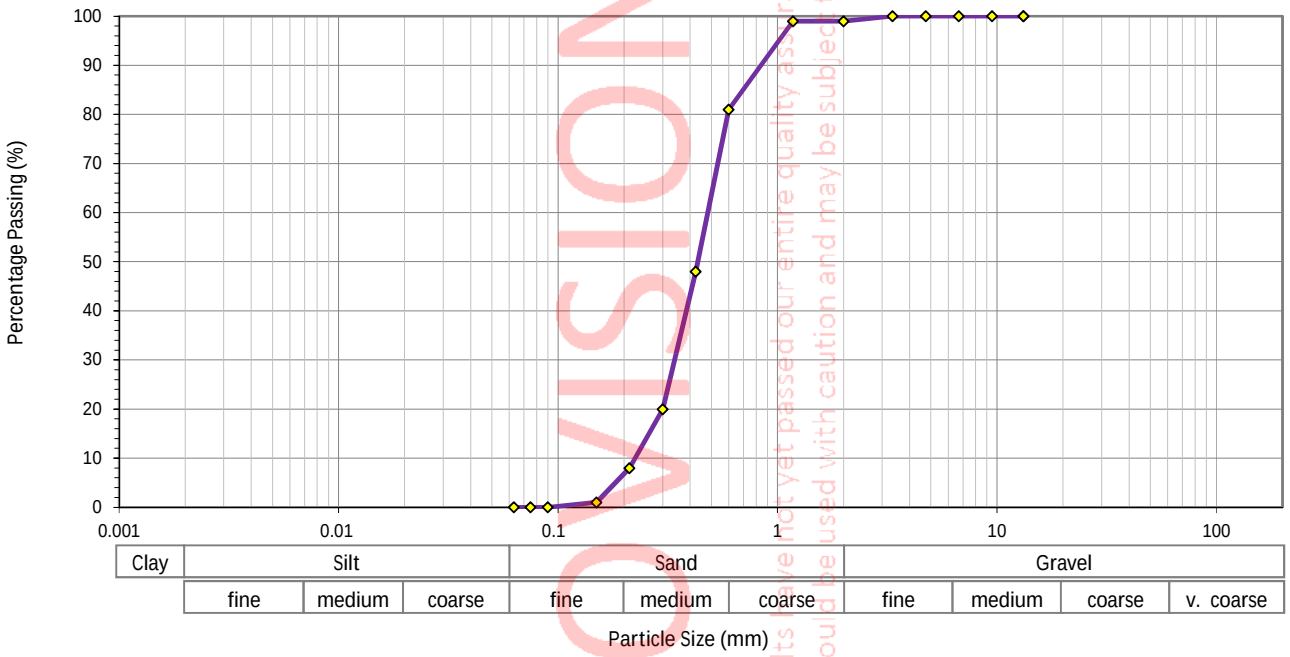
Geotechnics Project ID	651354
Customer Project ID	851735.22
Customer Project Name	WBPS Maketu Sea Wall

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	ID	Maketu		
	Description	N/A		
	Data	N/A		
SAMPLE	Geotechnics ID	GEOT201605090	Date Received	5/05/2016
	Reference	S1	Depth	0.00m
	Description	Fine to coarse SAND, trace shells; grey. Dry.		
SPECIMEN	Reference	1	Depth	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	-	4.75	100	0.300	20
100	-	19.0	-	3.35	100	0.212	8
75.0	-	16.0	-	2.00	99	0.150	1
63.0	-	13.2	100	1.18	99	0.090	0
53.0	-	9.50	100	0.600	81	0.075	0
37.5	-	6.70	100	0.425	48	0.063	0

TEST REMARKS

• The material used for testing was natural, whole soil. • The percentage passing the <0.063mm was obtained by difference.

This test result is not IANZ accredited.

Approved By Date

GEOTECHNICS
15c Amber Crescent,
Judea
Tauranga 3110
New Zealand
p. +64 7 571 0280

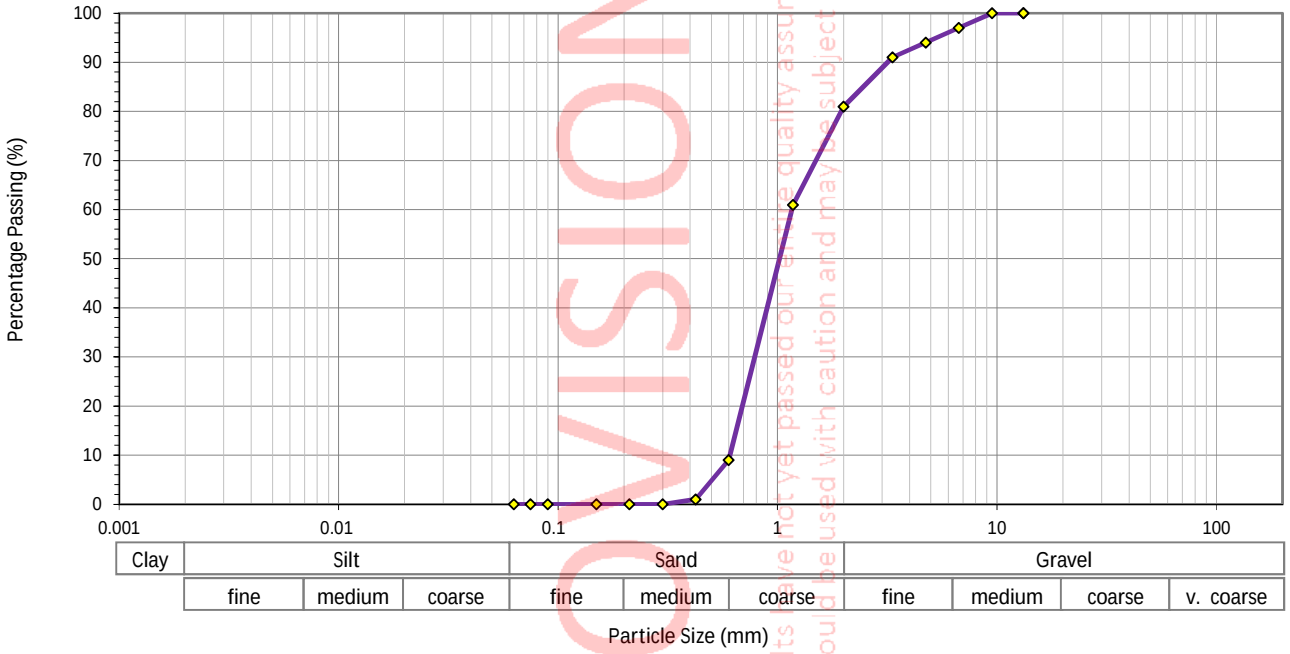
Geotechnics Project ID	651354
Customer Project ID	851735.22
Customer Project Name	WBPS Maketu Sea Wall

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	ID	Maketu		
	Description	N/A		
	Data	N/A		
SAMPLE	Geotechnics ID	GEOT201605091	Date Received	5/05/2016
	Reference	S2	Depth	0.00m
	Description	Medium to coarse SAND, trace shells; dark brown. Moist.		
SPECIMEN	Reference	1	Depth	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	-	4.75	94	0.300	0
100	-	19.0	-	3.35	91	0.212	0
75.0	-	16.0	-	2.00	81	0.150	0
63.0	-	13.2	100	1.18	61	0.090	0
53.0	-	9.50	100	0.600	9	0.075	0
37.5	-	6.70	97	0.425	1	0.063	0

TEST REMARKS

• The material used for testing was natural, whole soil. • The percentage passing the <0.063mm was obtained by difference.

This test result is not IANZ accredited.

Approved By Date

GEOTECHNICS
15c Amber Crescent,
Judea
Tauranga 3110
New Zealand
p. +64 7 571 0280

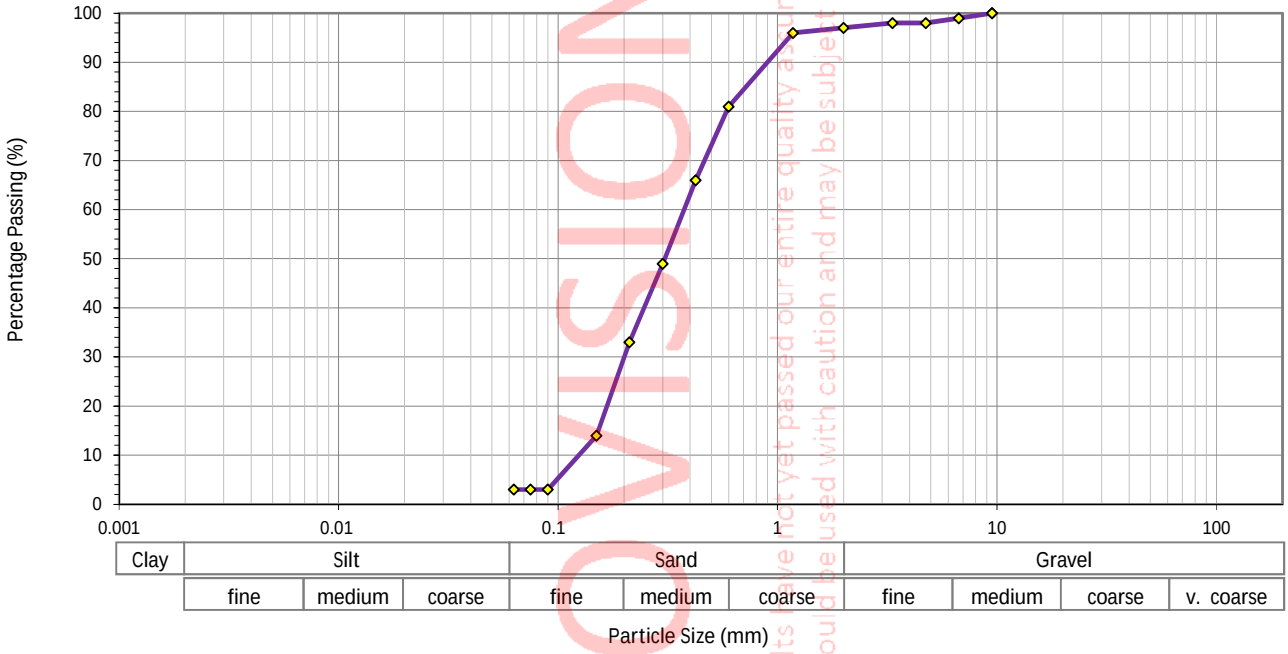
Geotechnics Project ID	651354
Customer Project ID	851735.22
Customer Project Name	WBPS Maketu Sea Wall

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION - NZS 4402:1986 - Test 2.8.1 (Wet Sieve)

TEST DETAILS

LOCATION	ID	Maketu		
	Description	N/A		
	Data	N/A		
SAMPLE	Geotechnics ID	GEOT201605092	Date Received	5/05/2016
	Reference	S3	Depth	0.00m
	Description	Fine to coarse SAND, trace shells; dark grey. Wet.		
SPECIMEN	Reference	1	Depth	N/A
	Description	N/A		

TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	-	4.75	98	0.300	49
100	-	19.0	-	3.35	98	0.212	33
75.0	-	16.0	-	2.00	97	0.150	14
63.0	-	13.2	-	1.18	96	0.090	3
53.0	-	9.50	100	0.600	81	0.075	3
37.5	-	6.70	99	0.425	66	0.063	3

TEST REMARKS

• The material used for testing was natural, whole soil. • The percentage passing the <0.063mm was obtained by difference.

This test result is not IANZ accredited.

Approved By Date

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1575485	SPv1
Contact:	Lauren Schick	**Date Registered:**	29-Apr-2016	
	C/- Tonkin & Taylor	**Date Reported:**	06-May-2016	
	PO Box 317	**Quote No:**	72182	
	Tauranga 3140	**Order No:**	851735.2200	
		Client Reference:	851735.2200	
		Submitted By:	Lauren Schick	

Sample Type: Sediment

Sample Name:		R1 Maketu Boat Ramp 28-Apr-2016 2:40 pm				
Lab Number:		1575485.1				
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	3	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	3	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	< 2	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	3.9	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	< 2	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	22	-	-	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

www.tonkintaylor.co.nz