Appendix H

4Sight Coastal Processes Memo

Memorandum

To: Cassandra Ng

From: Sam Morgan

Date: 21 January 2019

Subject: Tuahine Cres Seawall - Coastal Processes and Impact Assessment

Scope

It is understood that Simon Cave and Anabel Reynolds of 6 and 8 Tuahine Crescent are seeking resource consent to replace an existing seawall at the southern end of Wainui Beach. The preferred option is a timber pile and rock rip-rap hybrid design similar in nature to the existing structure. As a part of the planning and design process this memo seeks to provide an understanding of the potential effects on the surrounding coastal environment. In order to achieve this, an understanding of the wider coastal processes has been obtained from previous research and reporting and supplemented by site observations and analysis of aerial photography.

Site Description and Geomorphic Setting

Wainui Beach is situated approximately 5km east of Gisborne City center on the east coast of the North Island. It is approximately 6km in length being bound by Tuahine Point to the south and Makorori Point to the north. The subject site is located at the southern end of Wainui beach and is the transition point from a beach setting to a cliff setting (**Figure 1**).

Wainui Beach itself is considered to be a rhythmic bar and beach system, which at times will switch to a longshore bar trough system, as per the NIWA beach classifications[1]. This due to the typical series of distinct rip troughs that are separated by detached sub tidal bars that operate along the beach. Sand within the system is somewhat constrained by two southeast trending reef systems situated offshore from the beach and extending from both bounding headlands (**Figure 2**). The seaward extent of the 30m depth contour in comparison to adjoining Makorori Beach indicates that these reef features are effective at retaining sand within the system

There are two streams that discharge out on to the beach, the Hauanatua and Wainui Streams, neither of which are considered larger enough to supply substantial amounts of sand to the beach. Nor are they considered larger enough to influence beach geomorphology apart from within the immediate vicinity of their mouths.

Over the medium to long term there are divided opinions within the various reports published on Wainui Beach over whether the beach is eroding or accreting. Dr. Gibb[2] suggested in his assessment that beach erosion rates where in the order of ~0.15m/yr since 1942, although it is unclear exactly how these figures were obtained and are perhaps based upon post-storm survey data. As verification to these erosion rates if you extrapolate out ~0.15m/yr from 1942 to present day you would expect to see an average of 10m of retreat across the beach. However, this degree of change is not readily apparent from brief analysis of the air photo record or from site observations. In her evidence presented at the council hearing for a larger seawall at this location, Dr. Dunn[3] contends that the beach is accreting

[1] https://www.niwa.co.nz/coasts-and-oceans/nz-coast/learn-about-coastal-environments/beach-types/13-beach-types/intermediate-rhythmic-bar-and-beach

[2] Gibb, J.(2001).Review of the 1995 Wainui Beach Coastal Hazard Zone. Report prepared for Gisborne District Council.

[3] Submission of Dr. Amber Dunn on the Southern Wainui Rock Revetment - February 2018

based upon research she undertook for a Master of Science thesis. Analysis of beach monitoring data was undertaken by Tonkin and Taylor[4] for the previous seawall application. This demonstrated that beach position has fluctuated over time with positive and negative trends noted across the beach. Often the greatest fluctuations appear near the stream mouths, which is not unusual beach behavior. However, there was no assessment of beach volumes presented which would provide great context for the assessment of beach state.

Notwithstanding the gaps in information, Wainui Beach does not appear to be demonstrating a significant erosional or accretionary trend over the period of GDC beach monitoring. This is supported by observations of beach state during site visits by 4Sight on several occasions in 2018 where no substantial signs of erosion were apparent.

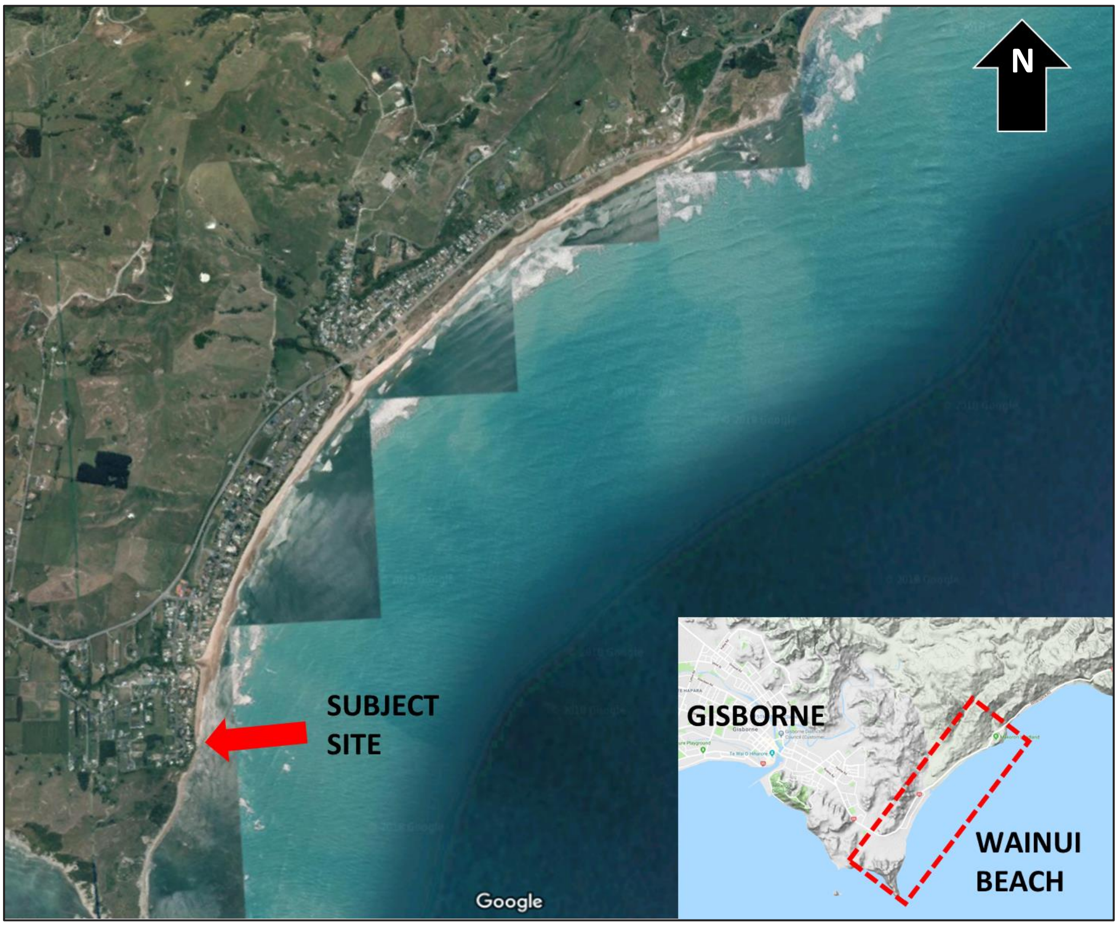

Figure 1: Site location map with subject site marked by red arrow.

It is recognized is that both bounding headlands are actively eroding due to the relatively soft nature of the siltstone cliff face, and is considered to be eroding at a rate of approximately 0.4m/yr[5]. The subject site marks the transition from the sandy beach environment to the abutting cliff. The composition of sand material reflects the nature of backshore parent rock at the subject site, as can be seen in **Figure 3**

[4] . Erosion Protection Works- Wainui Beach - Resource Consent Engineering Design Report. Tonkin and Taylor, July 2017.

[5] Gibb, J.(2001).Review of the 1995 Wainui Beach Coastal Hazard Zone. Report prepared for Gisborne District Council.

below. As illustrated in the image there is an exposure of siltstone formation migrating into an old slip face as you move toward the southern groyne. Beyond the groyne the cliff quickly rises to height in excess of 20m and up toward a peak of approximately 100m. Erosion at the site has been controlled to date by the existing seawall providing protection to the toe of the slope. This has prevented undermining of the rock face and removal of any talus material which ultimately lead to further over steepening of the existing slopes. Sand levels in front of the wall are known to fluctuate depending on climatic conditions, where northeast wind and swell events are thought to deliver sand to this part of the beach, which is then trapped by the southern groyne.

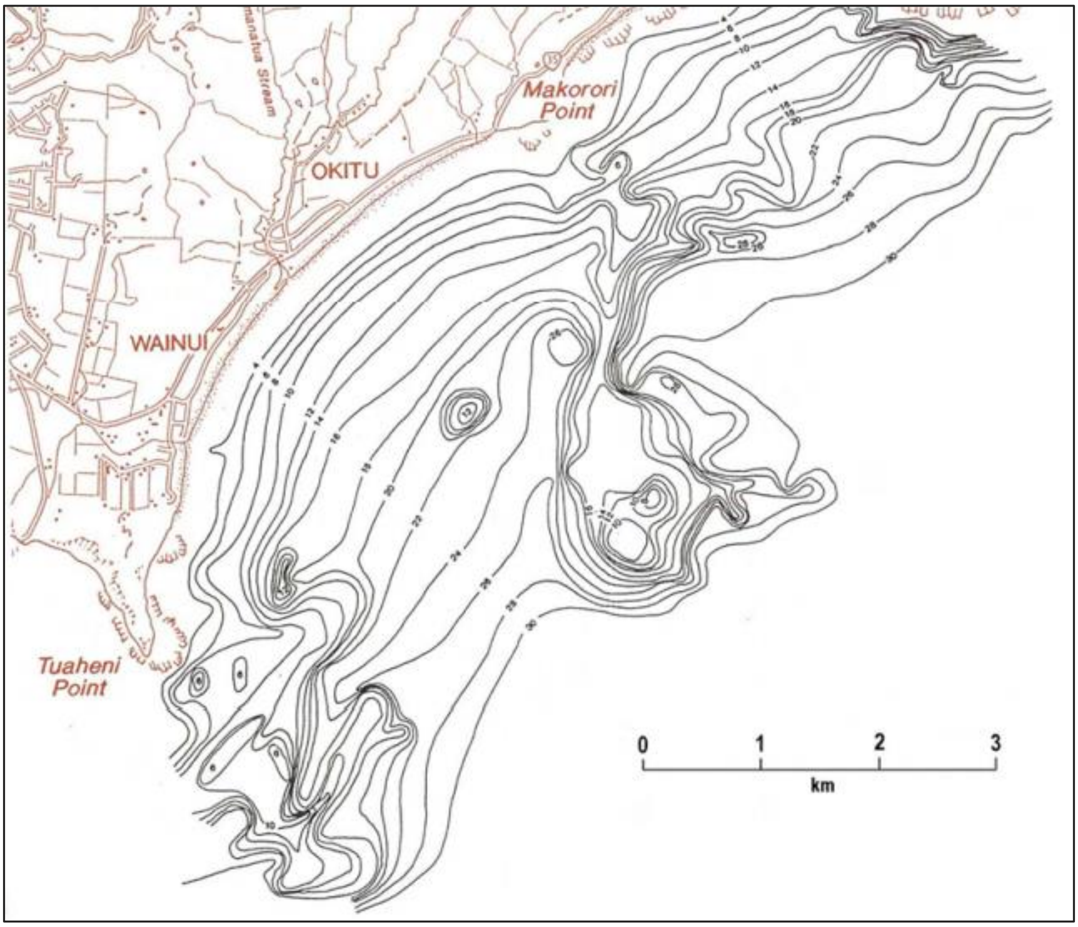

Figure 2: Wainui Beach offshore bathymetry.

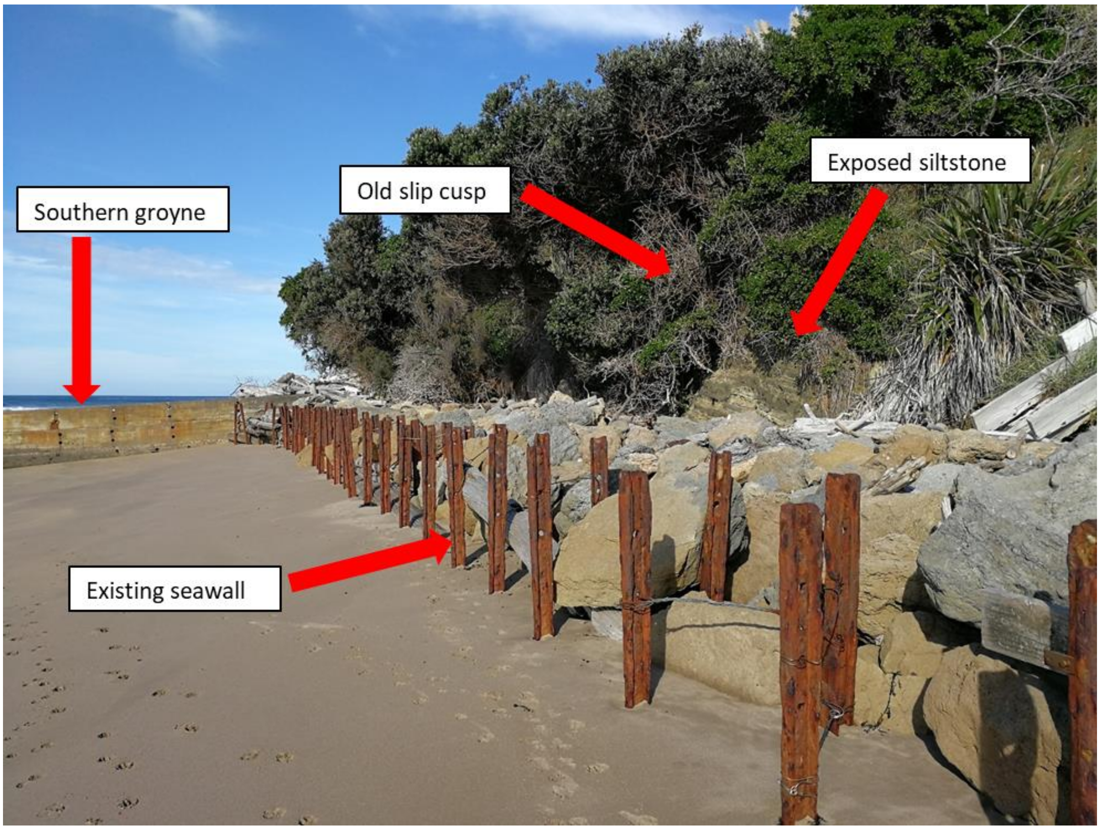

Figure 3: Subject site of proposed new seawall.

Wave Climate

In general, Wainui Beach is considered to be a high-energy environment receiving wave energy from the north-east through to the south. Hindcast wave data from Metocean View[6] indicates that the 100yr significant wave height is in the order 8.8m (**Table 1**) at a water depth of approximately 50m. The predominant wave direction is from the South at this location as can be seen in **Figure 4** below.

Waves directly acting upon the shoreline are expected to be significantly less than 8.8m due to energy decay from movement and breaking over a variety reef and sand bar structures as they move toward the shore. Therefore, waves acting upon the subject shoreline can be expected to be broken and limited in height by water depth. In order to assess this depth limited wave, a factor of 0.55 has been applied to the water depth at the wall during storm events based upon information from previous studies[7]. In this instance, broken wave heights can be expected to be in the order of 1.4m to 1.5m during extreme storm events.

Table 2: Summary of extreme wave heights at 25m Chart Datum.

Return Period	10yr	100yr	1000yr
Significant Wave Height (m)	7.1	8.8	11.9

[6] https://app.metoceanview.com/hindcast/sites/nz/-38.7/178.25
[7] Nelson, R C (1987), Design wave heights on very mild slopes – an experimental study. Civ. Eng. Trans. Inst. Eng. Aus., CE29(3): 157 – 161

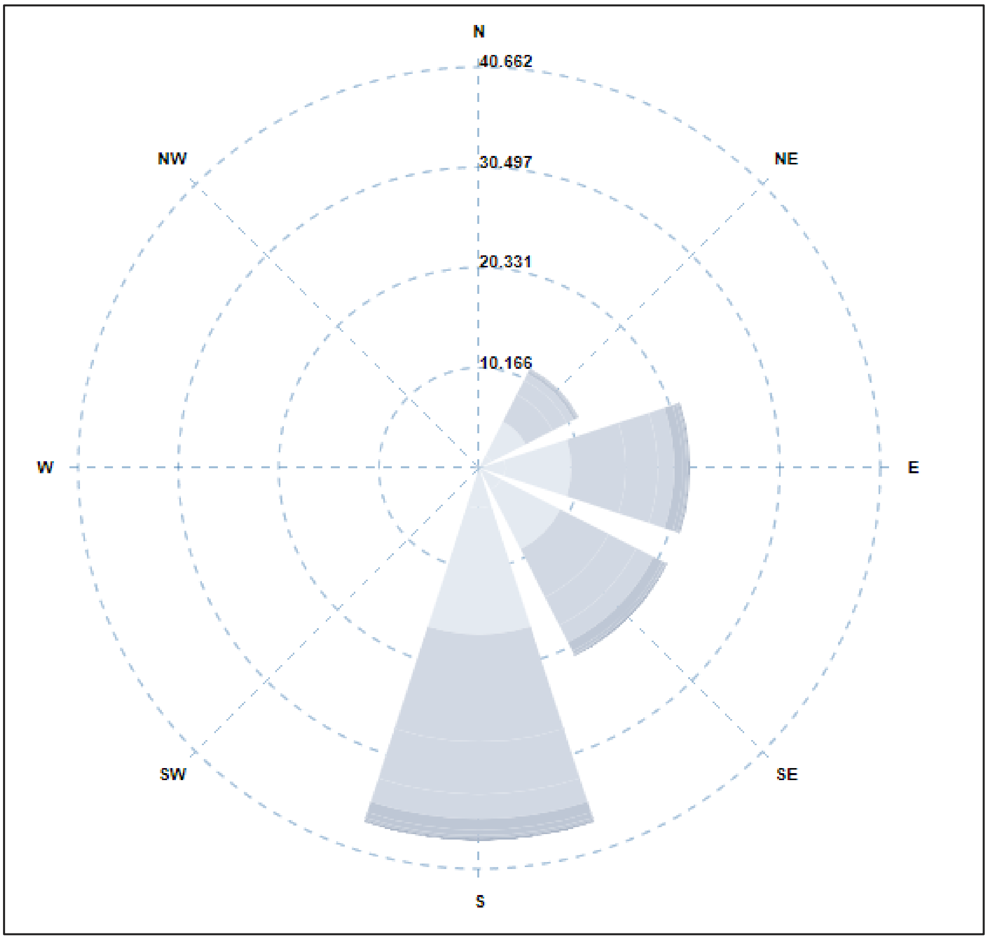

Figure 4: Wave rose for conditions offshore from Wainui Beach.

Inundation Levels

A pragmatic value for Mean High Water Springs (MHWS) for the site has been inferred to be **RL0.97m** taken from LINZ[8] for Eastland Port data situated approximately 5km south of the site. NIWA undertook a study of extreme sea level elevation along the Gisborne coastline and these are summarized for the relevant location in **Table 2** below. Tonkin and Taylor undertook modelling to determine the wave setup in the nearshore environment for the subject site during the design process for the previously proposed structure where they estimated this be approximately 0.9m.

Table 2: Summary of predict storm tide levels (not including wave set up)[9].

Return Period	5yr	10yr	20yr	50yr	100yr
Elevation (RL m)	1.33	1.35	1.37	1.40	1.43

[8] https://www.linz.govt.nz/sea/tides/tide-predictions/standard-port-tidal-levels

[9] Stephens, S., Robison, B. and Gorman, R. (2014). Extreme sea-level elevations from storm tides and waves along the Gisborne District coastline. Report prepared for Gisborne District Council.

4SIGHT CONSULTING

Near Shore Currents

Due to the nature of the beach (i.e. a rhythmic bar and beach system) and the form of offshore structures no net current regime is apparent from site observations and aerial photo analysis. It is instead expected that currents along Wainui Beach will be largely dictated by changing wind and swell conditions. During significant storm or swell events, a longshore trough system may form in response to the respective wind and swell direction.

Currents at the subject site are thought to be influenced to some degree by the existing groyne. The groyne will interrupt the flow of currents originating from the southerly quarter and will likely cause back eddy's during periods of northerly current flow. It is important to note this will only occur within the high tide period as the seaward extent of the groyne is situated above the low water mark.

Sediment Transport Regime

Sediment transport along Wainui Beach is thought to largely correspond with changes in wind and swell conditions. Typically, large wave and storm events will mobilise sand stored in the upper beach margin, with the associated rip and current regimes depositing this material in offshore bar systems. These storm deposits are normally then transported back onshore by fair weather conditions and long period swells.

As mentioned above, greater short-term variability in sediment transportation can be expected around the two stream mouths situated along the beach as the variation in stream flows adds greater complexity to the beach dynamics.

Due to the nature of the offshore reef structures Wainui Beach is considered to be a largely closed system, with only a narrow window of opportunity to the southeast available for sand to be delivered to the beach given it loosely aligns with the predominant swell direction.

At the site itself sand levels are known to fluctuate, presumably in response to changing weather, swell and corresponding current regimes. **Figure 5** shows lower sand levels at the site on the 10th of August 2018 that followed a 5 day period of northeast swell activity. Conversely **Figure 6** shows relatively high sand levels on the 20th of November 2018 following during a long period of relatively small east swell that was preceded by period of calm conditions. Details of swell conditions for these periods are contained within **Appendix A**.

Figure 5: Sand levels at the site on 10.08.2018.

Figure 6: Sand levels at the site on 20.11.2018

Proposed Design Solution

Due to the cliff nature of the site there is an ongoing progressive erosion problem and a coastal protection structure is required in order to maintain the future integrity of the respective properties. The proposed coastal protection structure is hybrid solution with a vertical face located in the front of the wall to restrict the seaward extent of the wall toe and allow for rip-rap behind the wall to be built up to desired design heights. The timber piles are prescribed at Ø300mm spaced at 900mm centers to avoid loss of rock between individual piles. The larger rock would be placed along the seaward face and along the top of the rip-rap wall to create a stable platform to construct the remainder of the wall. The size of the rock has been determined using the rock sizing equations of Hudson[10] and Van der Meer[11] with allowance made to reuse the existing rock on site.

The rock wall will dissipate the energy approaching the base of the cliff to avoid any further erosion. It will act in a similar manner to the existing structure with the most significant difference being an increased crest height to allow for future sea-level rise. At RL4m, the crest height of the structure proposed here is lower than the previously proposed at a height of RL4.8m. While this height reduction will mean an increased risk of overtopping. Incorporating a future sea-level rise of 1m, the new design provides 700mm of freeboard above the 1%AEP storm surge event and wave setup water level. This height should provide sufficient protection from overtopping under present day conditions and enable time for salt tolerant planting to be established above the structure. This planting should be able to absorb the relatively minor and infrequent overtopping that is expected.

Coastal Processes Impact Assessment

The degree to which a coastal protection structure will impact on local coastal processes is often related to the size and type of structure, the beach type and behaviour, relative energy of coastal processes at the site and the position of structure within the tidal cycle[12][13][14]. In general, it is considered that vertical impermeable structures situated at low tide or below on a high energy beach steep beach with net directional sediment transport regime will have greatest effect on local beach conditions. Conversely a permeable and sloped structure that is only affected by coastal processes under extreme events on a generally low energy beach is likely to have less long-term effects on the beach and coastal process at a particular site.

Due to the nature of local conditions and scale of the proposed structure, it is unlikely that the structure will have any impact upon the local wave climate, local current regimes, sediment transport or inundation level at Wainui Beach.

The degree of exposure of the proposed structure will ultimately depend on climatic conditions and sand levels in front of the structure at any given time. A conservative estimate would be that the structure is exposed to coastal processes for an average of 3 hours either side of high tide. However, due to its position within the tidal cycle there is the potential for the structure to have a localised impact on the beach via reflection and end-effect processes. Therefore, consideration of the potential impacts are discussed in further detail below.

---

[10] CERC (1984) Shore Protection Manual. CERC Dept. of the Army, U.S. Army Corps of Engineers, Washington.

[11] The Rock Manual (2007) “The Use of Rock in Hydraulic Engineering”, CIRIA-CUR-CETMEF (C683)

[12] Dean, R. G. 1987. Coastal armoring: effects, principles and mitigation. Proceedings of the 20th Coastal Engineering Conference, ASCE, pp 1843-1857

[13] Weggel, J. (1988). Seawalls: The Need for Research, Dimensional Considerations and a Suggested Classification. Journal of Coastal Research, 29-39.

[14] Griggs, G., & Tait, J. (1988). The Effects of Coastal Protection Structures on Beaches Along Northern Monterey Bay, California. Journal of Coastal Research, 93-111.

Reflection
It is recognised that the seaward face of the structure is vertical in nature which can increase the amount of energy reflection because the approaching wave is not able to dissipate up a sloped surface. In response, the seaward face will be permeable in nature allowing water movement through the structure to dissipate some of the wave energy. For this reason, the proposed structure will act in similar manner to the existing structure in terms of reflection.

As observed in **Figures 5 & 6** wave reflection currently does not appear to be significantly impacting the site. The impact of existing (and proposed) structural wave reflection is complicated by the adjoining groyne which is much more likely to have a substantive impact on sand retention at this part of the beach. This is due to the shore perpendicular orientation of the groyne and its solid-state nature.

Reflection is known to be a more significant issue during periods of increased wave activity[15] and potentially impact the founding of the structure by creating undermining of foundations. Piling the proposed structure will ensure that it is unable to be undermined, whilst the rip rap will be able to settle and adjust to changing sand levels. Further, bedrock material is less than 1m below average sand levels therefore there is a limit to the amount of scour associated with reflection that can occur.

Overall the potential effects to arise from wave energy reflection off the proposed new structure are considered to be undetectable in the context of the existing situation.

End-Effects

Seawalls are often known to cause ‘end effects’ or erosion to the adjoining softer shore lines. The exact nature of the root cause of end effects is not well understood but the simplest way of explaining it is as the release of potential energy built up due to the interaction of waves with hard ‘reflective’ structures and shifting that energy on to the adjoining shoreline. What has been commonly observed is that the further a structure is within the tidal prism the greater the effects and these effects are often worse on the downstream side of a structure.

Currently there are existing structures on either side of the proposed which are capable of absorbing the potential impact of end effects. The structure has been designed in order to minimise the potential end effects by “tying off” into these existing structures. This is intended to be achieved by reducing the slope on the northern end of the structure to allow for a reduction in the amount of “reflected energy” as it migrates into the existing structure to the north. However, the structure moving north is considered to be in poor condition so considered is given below to the potential effects should the structure no longer be in place.

In order to assess the potential risk to the adjoining areas from end effects guidance has been sought from Komar[16] who estimated that the adjoining downstream coast is affected by approximately 70% of the length of the structure. In this instance end effects to the north of the structure are considered to be a higher risk than those to the south because of the existing groyne and seawall structures to the south. South-east swell events are thought to the biggest risk to the northern end due to the predominance of swell from the direction and the subsequent currents they create. As shown in **Figure** 7 the groyne does provide some shelter from these events which essentially reduces the effective

---

[15] Carley, J., Flocard, F., Coghlan, I, Cox, R and Shand, Tom. (2015). Establishing the Design Scour Level for Seawalls. Proceedings of the Australasian Coasts & Ports Conference 2015. 15 - 18 September 2015, Auckland, New Zealand
[16] Komar, Paul D., 1998. Beach Processes and Sedimentation . 2nd edition, Prentice Hall, Upper Saddle River (New Jersey), x + 544 p.

length of the structure. The wall area terminates at a siltstone interface which provides some degree of resistance to the reflected energy, but the adjoining area by the access stairs is considered to be at risk should the existing wall be removed.

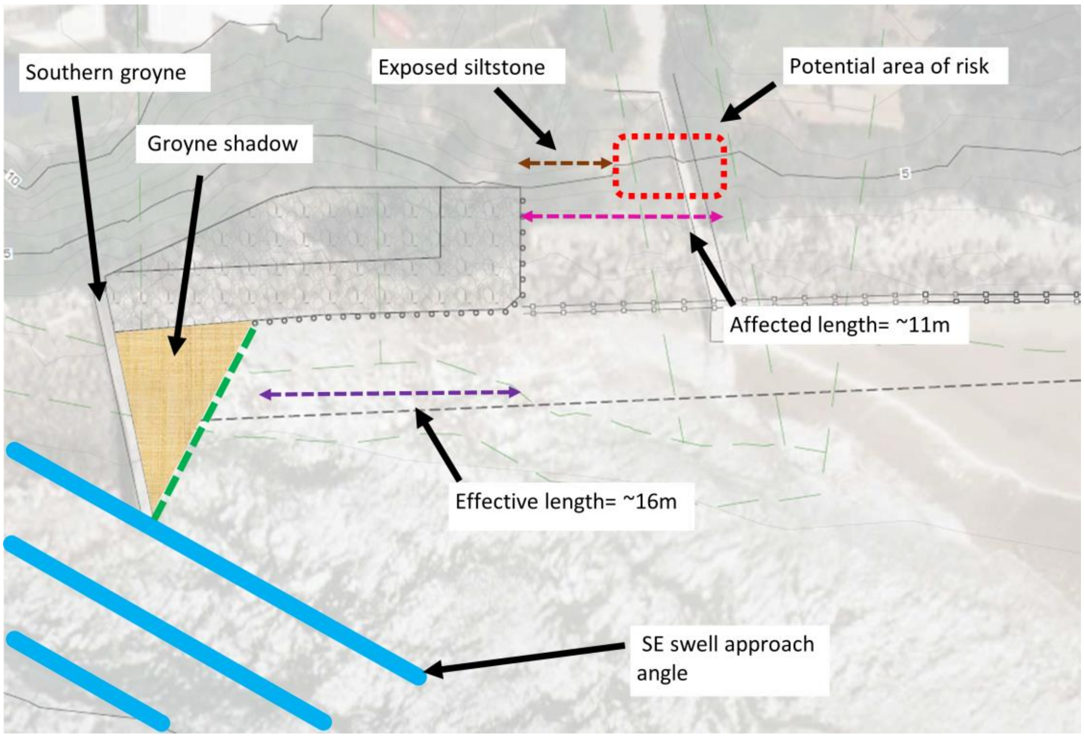

Figure 7: A schematic diagram showing the potential for end effects at the site.

Conclusion

Investigations into coastal processes and hazards at the site confirm that a coastal protection structure in and along sections of the subject coastline is required to avoid impacts upon the landward infrastructure. The structures will be designed to handle the local coastal processes and allow for future sea-level rise.

Due to the scale and location of the proposed structure it appears unlikely that there will be any discernible change to the larger coastal processes operating on Wainui Beach. Reflection from the proposed wall is thought to similar to the existing situation to which the beach does not appear to be impacted by.

Should the existing wall be removed in the future there is a small area that will potentially be impacted by end effects created by the new structure. However, this is should be able to be managed by appropriate design of a new access structure, as it is likely the existing structure will need to be replaced during the removal of the existing seawall. It is noted that should the existing seawall be removed the associated backshore margins are likely to undergo varying degrees of erosion as they adjust to the new energy regime.

Therefore, any effects on local coastal processes to arise from the proposed are not considered to be significant.

Appendix A- Corresponding swell conditions