

Erosion Protection Works

Wainui Beach

Introduction

The Gisborne District Council (GDC) is seeking resource consent to replace an existing protection structure and ongoing beach scraping on Wainui Beach, and a retrospective consent for an emergency structure at 21 Wairere Rd. The work is intended to be consistent with the Wainui Beach Erosion Management Strategy (WBEMS) established in 2014.

This report addresses the following aspects:

1. Identification of any gaps in information or assessment that may compromise GDC's ability to fully assess the effects of coastal erosion and the mitigation measures proposed;
2. Review the applicant's assessment/conclusions regarding coastal processes and whether the conclusions reached in the application are reasonable and reliable; and
3. Comment on the proposed works and mitigation measures including their effectiveness in addressing coastal processes.

Gaps in information or assessment

Wainui Beach is a pocket beach, so there is negligible exchange of beach sediment with other beaches along the coast to the north or south. This has been demonstrated by an analysis of the characteristics of the beach sediment compared to the offshore sediments and those of adjacent beaches (Gibb, 1981, 2001; Dunn, 2001). The sediment forming Wainui Beach is sourced from large eruptions within the Taupo Volcanic Zone, in situ biogenic material, and erosion of headlands flanking the beach. The Hamanatua Stream and Wainui Stream catchments are not considered to be a major source of sediment at present.

Wainui Beach is subject to episodic storm-induced erosion, followed by longer periods of accretion during fair weather conditions. These cycles of erosion and accretion appear to involve recycling of the same sediment within the Wainui Beach system. This may involve beach rotation, whereby the eroded sediment is primarily transported along the shore towards to north or south depending on the wave approach direction, or diabathic (onshore/offshore) sediment transport, whereby the eroded sediment is moved offshore during storms conditions and onshore during fair weather conditions.

There is evidence of some beach rotation occurring in response to variations in the dominant direction of wave approach angles over interannual time scales. However, the onshore/offshore exchange of sediment appears to be the most important sediment exchange for Wainui Beach. Dunn (2001) mapped the offshore area using side-scan sonar and sediment sampling (Figure 1). Her results showed extensive areas of shallow reefs extending from Tuahene and Makarori Points and separated by a channel containing fine sand. Patches of medium sand and shell occurred on top of the reefs, and the offshore sand was significantly finer than the sand found on Wainui Beach

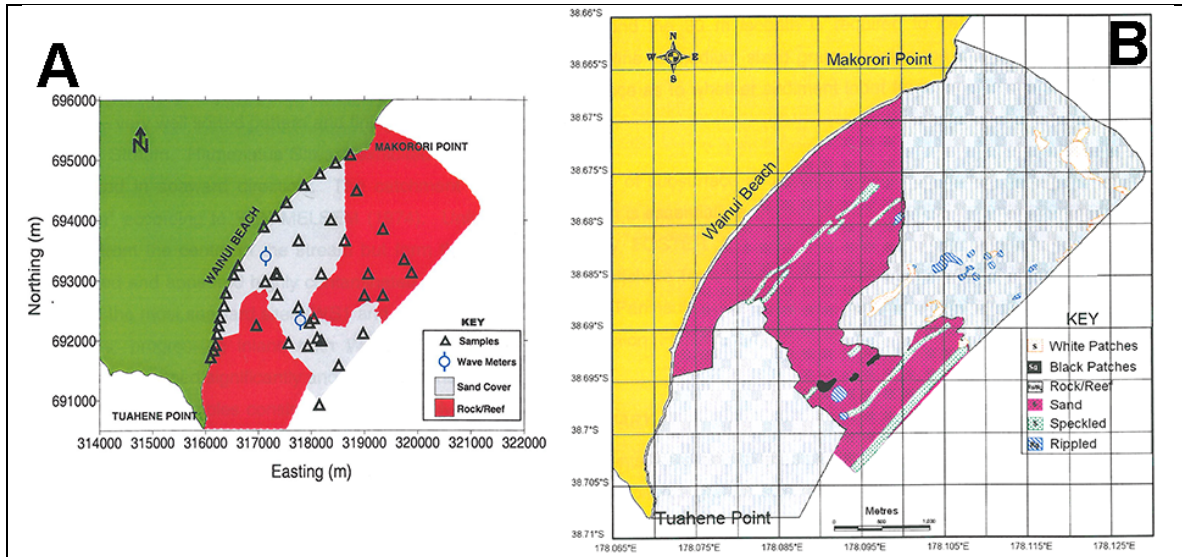


Figure 1 – (A) Sediment sampling sites and location of InterOcean S4 Wave recorders, and (B) sonofacies identified by a side-scan sonar survey undertaken offshore from Wainui Beach for MSc thesis research in 2000 (Dunn, 2001).

Therefore, it is most likely that sand eroded from the beach is deposited as offshore sand bars in shallow water close to the beach, where they overly reefs at the northern and southern ends of the beach, and fine sands in the central region. This is consistent with the pattern of surf breaks along Wainui Beach (Figure 2). Wave refraction analysis (Dunn, 2001) suggests that the offshore reefs tend to concentrate wave energy in zones along the beach, the final characteristics of the surf are determined by the offshore bars.

The beach profile data presented in support of the resource consent application consists of envelopes of the maximum and minimum elevation, and average elevation with distance across the beach (Appendix C: Beach profile analysis). The profiles do not extend sufficiently far offshore to capture any offshore bars present, although they do show the presence of sand berms associated with the maximum elevations. The analysis presented is not particularly useful for assessing the behavior of the beach system in response to episodic erosion events as it only includes the subaerial sand storage component and omits the submarine component. In this particular case, the submarine component is also likely to play an important role in determining the surf characteristics for the beach. Given that the consent application includes beach scraping that is intended to modify the beach

profile, consideration of the impact on the offshore bars should be included in the assessment of the effects.

The resource consent application also involves the construction of protective structures that will be exposed to wave processes during storms. Nearshore wave data for Wainui Beach are sparse. Dunn (2001) deployed two wave recorders (Figure 1), with one located at 25 m depth between the two main reefs, and the other closer to the shore at 6 m depth. The data were collected for 1 month (Oct-Nov 2000), and included a combination of fair weather and mild storm conditions. A comparison of the data between the two measurement sites indicates a reduction in wave height with decreasing water depth: significant wave height at the deep site ranged from 0.34-2.32 m, with a mean of 1.18 m; while at the shallow site it ranged from 0.27-2.00 m, with a mean of 1.09 m. Although the reduction in wave height was relatively small, the effect was most pronounced for the largest waves, and is probably due to wave breaking.

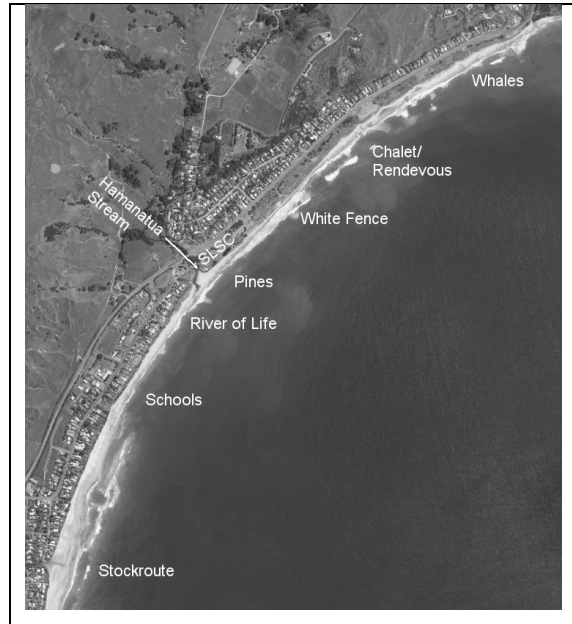


Figure 2 – Surf breaks along Wainui Beach identified by local surfers. Some of these have been defined as surf breaks of national significance within the NZ Coastal Policy Statement (2010)

Refraction analysis further indicated that there is a significant variation in wave height along Wainui Beach (Dunn, 2001). The analysis of wave conditions undertaken for the consent application is predominantly based on a hindcast of the offshore deep-water wave climate undertaken by MetOcean. It is not evident what the actual location was for the analysis, but I assume that it was further offshore than the “deep” site of Dunn (2001), which would involve more shoaling transformations of the waves than those measured by Dunn. The design report correctly notes that the deep-water waves are likely to have broken before reaching the shoreline, and SBEACH was used to estimate the effect that broken waves would have on raising the mean water level at the shoreline (wave set up). However, the effect on wave height does not appear to have been considered. It is also not clear if the hard-bottom version of SBEACH (Larson and Kraus, 1989) was employed for the areas of Wainui Beach that do have underlying reefs.

For the design calculations, specifically the height of the structure, the design report used a significant wave height of 1.54 m for current conditions. There does not appear to be any explanation of how this value was derived, and why it is considered appropriate. The Eurotop Manual, which the design report indicates was followed for the analysis, also requires definition of the design wave period or wavelength, as wave steepness is considered an important factor. The design report does not specify what wave period was used for the analysis.

Conclusions about coastal processes

In terms of coastal processes, there are two key aspects to the consent application: the construction or removal of “structures” along the dune or cliff along the landward margin of the beach; and the redistribution of sediment within the beach profile by beach scraping. There has been a long history of modification of the landward margin of the beach system at Wainui Beach, which started with the replacement of the native dune vegetation with marram and other introduction species. The establishment of marram oversteepened and increased the height of the frontal dunes, and arguably had an adverse impact on the way the system responded to storm events.

Subsequently various coastal protection structures have been installed in response to erosion. The application involves replacement and partial removal of existing structures. It is very unlikely that the proposed coastal protection structures will fundamentally affect beach processes in a manner that differs from the existing structures. Therefore, while this aspect of the consent application is unlikely to improve the beach system at Wainui Beach, it is also unlikely to have adverse effects beyond those that currently exist.

It is unclear why the design analysis is based on time periods that exceed the consent period? The WBEMS makes it clear that the long-term strategy is replace coastal protection structures, although it is not clear what alternative is considered viable at this stage. The resource consent application also indicates that the longest consent period being requested is 25 years to align the consent with the end date of the longest existing consent that expires in AD 2042. Given this, it seems unnecessary to design the structures for estimated conditions in AD 2066.

The beach scraping proposed within the consent application appears to be inconsistent with the WBEMS. Note that the application refers to this work as sand push-ups. In my opinion this is misleading, as the work does not consist of merely pushing sand inland from the lower part of the profile. The proposal indicates that sand will be extracted from a length of beach and used to form an artificial berm providing an area of dry sand at high tide.

The analysis of the beach scraping impacts includes an unusual interpretation of the beach morphodynamics (interactions between processes and beach shape) on page 28 of the Design Report (Appendix D), where it states:

“The theory here is that because flatter profiles promote accretion, whereas steeper profiles are more prone to erosion (Smutz et al, 1980), moving moderate amounts of sand from the littoral system to dunes above the wave run-up limit not only aids in providing a buffer against storm erosion but also accelerates accretion of the littoral beach because of the manufactured flatter nearshore profile”.

The paper by Smutz *et al* (1980) indicates that the key factors determining if a beach will accrete or erode are: the availability of sediment; the steepness of the waves (H/L); the ratio between settling velocity and the period of the waves (Dean’s parameter); and the beach slope. These are well known factors influencing beaches, and, apart from sediment availability, can be combined into dimensionless

parameters such as the Iribarren Number to predict beach state or morphodynamics.

In the study discussed by the paper, all factors except beach slope and wave steepness were kept constant in a medium scale physical model. By varying the beach slope (3 slopes) and applying storm or swell wave conditions, they then demonstrated that *under conditions where accretion would be expected*, increasing the accommodation space by lowering the beach slope resulted in more accumulation. Further, *under conditions where erosion would be expected*, erosion was faster if the beach slope was increased. This is not the same as showing that flat profiles promote accretion and steep profiles promote erosion. If this were true, then the expected outcome of the proposed beach scraping would be to increase the erosion rate for the upper part of the beach. The consensus view is that the beach slope is primarily a consequence of beach state, although it is also affected to a degree by sediment grain size (or settling velocity).

This means the beach response is primarily a consequence of wave steepness and sediment availability. In general, storm waves tend to be steep (larger wave height and shorter period than fair weather swell), and tend to transport sediment offshore producing a flatter beach. Less steep waves after the storm tend to transport sediment onshore, resulting ultimately in a steeper beach profile (as illustrated by the differences in the minimum and maximum elevation profiles for Wainui Beach). This behavior is dependent on the sediment availability. For pocket beaches, particularly those where there is a veneer of sand overlying a harder substrate, as at Wainui Beach, there is a limit to the amount of sediment that can be moved onshore, resulting in flatter beaches than would occur if more sediment was available.

It is not clear if beach scraping will occur if the beach profile is less than 0.5 m above the minimum historic elevation. However, if it is allowed to occur, the volume of sediment recovered will be less than assumed in the analysis. It is questionable whether undertaking beach scraping when the beach is recovering from a storm event (sediment moving onshore from the offshore bar) is beneficial, since it only speeds up the natural process and doesn't contribute additional sediment. The effect of the beach scraping is to also deepen the lower part of the beach profile, potentially allowing larger waves to approach closer to the shoreline at high tide.

The SBEACH model was primarily developed to assess the evolution of a beach profile from the dune to the offshore bar in response to storm conditions (Larson and Kraus, 1989). However, it can also be used to assess the effects of modifications such as beach nourishment and hence beach scraping. Given that an SBEACH model was applied to estimate the protective structure height required to minimize overtopping, presumably the model could also have been used to assess the effects of beach scraping.

However, it is difficult to assess the overall impact of the beach scraping without beach profiles that incorporate the offshore bars. Of particular concern is the possibility that under conditions of low sediment availability (limited volume within

the offshore bars), the creation of increased accommodation space in the lower beach profile by beach scraping may lead to the loss or significant depletion of the offshore bar. This would have an impact on the surf characteristics in the area of beach scraping, which would be contrary to one of the key principles of the WBEMS. In contrast, providing a dry beach at high tide does not appear to be an important focus of the WBEMS.

Beach scraping will impact any beach fauna present through the excavation and burial of organisms in the affected parts of the beach as noted in the application. The data used to assess the ecological impact was derived primarily from other sites and appears to be based on dredging activities (Wellington, Tauranga and Lyttelton) and not beach scraping. Are the data relevant to Wainui Beach, and is the estimated recovery time (1-3 years) sufficiently fast to prevent cumulative degradation with repeated beach scraping in combination with the direct effects of storm events?

Finally, it should be noted that it is widely accepted that beach scraping is a short-term response to coastal erosion, and in my opinion, a largely cosmetic one. Beach scraping can be combined with dune restoration to provide a longer-term response. However, this requires more beach width than is available at Wainui Beach in order to produce a morphology that is appropriate for native vegetation. Planting native vegetation on slopes steeper than those that naturally form with the same vegetation appears to be ineffectual.

Effectiveness of proposed works

There has been a long history of protective structures at Wainui Beach, and these appear to have been reasonably effective at limiting landward erosion in the areas where they have been constructed. The proposed protection structures are similar to existing structures, albeit they are to be constructed to a higher standard. It is very likely that the new structures will be at least as effective during the requested consent period.

Beach scraping is generally intended to be a short-term response to a coastal erosion event, and unless it is combined with other measures to stabilize the artificial profile, or introduce additional sediment volume, in my opinion it is predominantly cosmetic. The maximum 5 m width of the berm created from the scraped sand, which is proposed for the upper beach profile, is insufficient to allow for the establishment of a functional dune system with native species. The excavation of sand from the lower beach profile has the potential to impact on the sand volume in the offshore bar. Since the offshore bars along Wainui Beach contribute to the nationally significant surf breaks located along the beach, there should be an assessment of the impact of beach scraping on the surf breaks. Insufficient data have been provided with the consent application to allow this to be assessed. In my opinion, beach scraping should not be consented until the benefits and impacts of the activity have been fully assessed.

Summary

Overall the proposed replacement and modification of existing coastal protection structures on Wainui Beach is not likely to result in greater adverse impacts than those resulting from the existing structures. However, some aspects of the design parameters used for the application have not been fully explained, and the proposed design may be over-designed for the duration of the resource consent.

The proposed relocation of sediment within the Wainui Beach system (beach scraping; also referred to as sand pushups in the application) does not appear to have clear medium to long-term benefits and has the potential to adversely impact beach processes. In particular, the relocation of sand from the lower beach may affect the volume of sand in offshore bars along Wainui Beach, impacting on surf breaks of national significance. Further assessment of the impact of beach scraping should be undertaken before consent is granted.

References

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