Managing and adapting to coastal erosion on the West Coast: Ngakawau & Hector

NIWA Client Report: HAM2007-007
January 2007

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Prepared for

West Coast Regional Council

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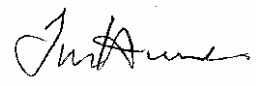

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Executive Summary

This report is one of a number being prepared for West Coast Regional Council (WCRC) to aid the decision-making processes associated with ongoing erosion problems at a number of locations in the region. The advice provided in this report focuses on the villages of Ngakawau and Hector and relates to ongoing coastal erosion issues along the frontage and the increasing proliferation of ad hoc coastal defence structures aimed at protecting residential land and property. At both Hector and Ngakawau, as in most coast areas, the problem is not due to the ongoing changes in the coastline but rather that development historically (and ongoing) has been located too close to the sea to accommodate these natural changes and trends and the resulting impacts now so much more financially significant.

1. Introduction

1.1 Scope of the review

This report is one of a number being prepared for West Coast Regional Council (WCRC) to aid the decision-making processes associated with ongoing erosion problems at a number of locations in the region. The advice provided in this report focuses on the villages of Ngakawau and Hector and relates to ongoing coastal erosion issues along the frontage and the increasing proliferation of ad hoc coastal defence structures aimed at protecting residential land and property.

This study has been supported by the Foundation for Research, Science and Technology Envirolink fund set up to assist Regional Councils in accessing environmental advice from the various Crown Research Institutes. As such these reports do not provide a detailed review, rather they are a summary of the observations made during a number of visits, discussions with West Coast Regional Council staff, various local residents at Ngakawau & Hector, and due consideration to various previous studies of coastal processes at these locations.

Associated with this report is a public awareness brochure on coastal erosion in the West Coast region.

1.2 Visits and background information

Parts of the west coast coastline, including Ngakawau and Hector, have been inspected on a number of occasions over the last year (November 2005, August, October and December 2006) during visits associated with these specific issues and in conjunction with other ongoing work.

Discussions concerning the issues have been held with Chris Ingle, Wayne Moen, Simon Moran and Mary Trayes of WCRC. Mr Wayne Moen has assisted with a number of the site visits and he, and Mary Trayes, have provided much background information associated with the coastal changes in the West Coast region.

During the December 2006 visit a full walkover of the coastline from Lover's Rock at the northern end of Granity to the bach at the northern end of Hector was conducted. The only local resident that was available on the day of the visit, to discuss the issues

with, was Melanie Blundell who owns the property at 37 Main Road, Hector and the adjoining Imagine Café.

A listing of previous studies, which have been reviewed in the context of this report, are included in Section 4.

2. Coastal changes at Ngakawau and Hector

2.1 Why has erosion been occurring recently?

The West Coast region has experienced a number of storm events during the 2006 winter period. These events include:

- 6 May - where a rapidly moving low pressure system south of New Zealand created a train of long-waves. This is known as a Rissaga, or "meteorological tsunami" as the wave conditions exhibit similar characteristics to a small tsunami. Large swell was also occurring that day, which would have produced very confusing seas and surging in and out at the coast. Wave run-up on the beach and overtopping is very sensitive to these long–period waves, with significant overtopping occurring at many locations in the West Coast region and also in Southland during this event.

- 12 June – where large wave conditions coincided with a high spring tide. The consequences, such as overtopping or erosion of the vegetation line at the top of the beach, of a storm event on the coast is highly dependent on storm conditions coinciding with high sea levels.

Occasionally severe storms and events that cause damage to the coastline do occur and are not necessarily indicative of a long-term problem. Of course if such events do become more frequent over a period of time they may be indicative of changes either in the hazard "drivers" (e.g., wave and water level conditions) or a reduction in the level of protection afforded by the beach.

2.2 Why does erosion seem to be worse on some parts of the Ngakawau and Hector coastline than at other locations?

Coastlines adjacent to river mouths tend to be highly dynamic due to the interactions between coastal and river processes, and the resulting impact on sediment movements. The nearshore sand bars that occur at the river mouth are constantly shifting both alongshore and offshore. Whilst these bars can protect the coastline by causing waves to break and dissipate energy further offshore, they can also focus (or disperse) waves approaching the coastline and create wave induced currents, such as rip currents. This results in patterns of coastal change that vary along the coastline, and which also vary with time in response to changes in the position of these offshore bars.

The difference in erosion rates and patterns between Ngakawau and Hector is also due to the supply of sediment and hence characteristics of the beaches at the two locations. The Ngakawau coastline is characterised by a gravel barrier system typified by long-term sediment starvation (Figure 1, left), i.e., there is insufficient fresh gravel entering the beach system to maintain its present position. Hence it responds by migrating landwards during storm events by washing gravel from the front face of the upper beach on to and over the beach barrier rest. In contrast the Hector frontage is relatively well nourished at present with sand deposited from the Ngakawau River (Figure 1, right), which provides a wider intertidal beach and protection to the coastal edge, although this protection reduces to the north. However, note this sand cover is not a permanent feature, it can change daily, and overlies a gravel barrier which becomes exposed from time to time (Figure 2).

Figure 1: Upper and intertidal beaches along the Ngakawau (left) and Hector (right) frontages

Furthermore human actions, such as building ad hoc coastal defences (particularly if such defences extend below the Mean High Water Spring mark), the clearing of vegetation from the beach crest, or previous attempts at land reclamation over the foreshore, can also exacerbate localised rates of erosion.

2.3 Is this erosion part of a long term trend?

Patterns of coastal erosion are not constant. Cycles of short to medium term accretion and erosion patterns occur depending on the particular complex interactions between wave climate variability, storm occurrence, storm tracks and how often storms occur (i.e., the impacts due to a particular series of storms), and river flood events (which are the dominant source of sand and gravel supply to the coastline). Landslides in river catchments due to historic earthquakes also have had a significant influence on sediment supplied to the coast on the West Coast.

Figure 2: Hector coastline looking south sometime in the early 1970s when the underlying gravel barrier was exposed (Mangin, 1973)

Some information on erosion and accretion rates based on the position of either Mean High Water Spring line or the vegetation line over the last century are available from previous studies based on analysis of cadastral plans and aerial photographs (Gibb 1978, and DTEC 2003) summarised in Figures 3 and 4 for Ngakawau and Hector respectively.

Given the information sources and errors associated with analysing old cadastral plans and aerial photographs care should be taken in reading too much into the rates of change noted in the Figures 3 and 4. However, the figures do show a number of things:

- Rates of change at the coast tend to be more dynamic closer to the mouth of the Ngakawau River (as would be expected). This is particularly the case along the Hector frontage where the rates of change appear to decrease northwards along the frontage.

- The periods where significant accretion occurred are likely to be related to the Murchison (1929) and Inangahua (1968) earthquakes which caused major landslides within river catchments on the West Coast and hence likely a substantial increase in the amount of sediment being deposited at the coast from the Ngakawau River. It would appear that the sediment reaching the coast due to the latter earthquake mainly benefited Hector, i.e., was

transported north, with little indication of any significant accretion at Ngakawau.

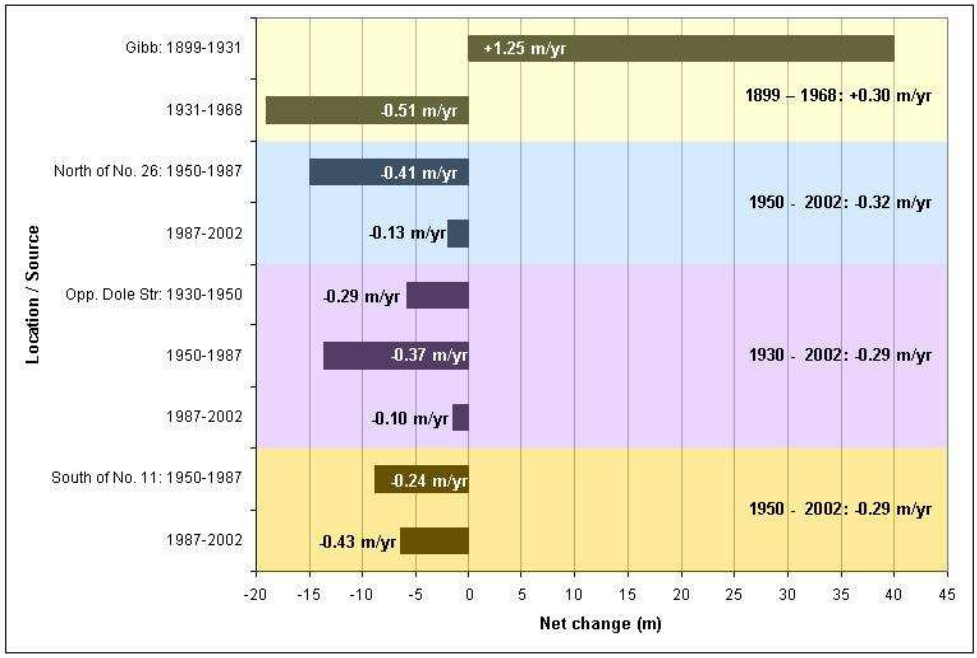

Figure 3: Summary of erosion and accretion net change and average rates at Ngakawau. Note the exact location for the values provided by Gibb (1978) are not known. All other values are from DTEC (2003).

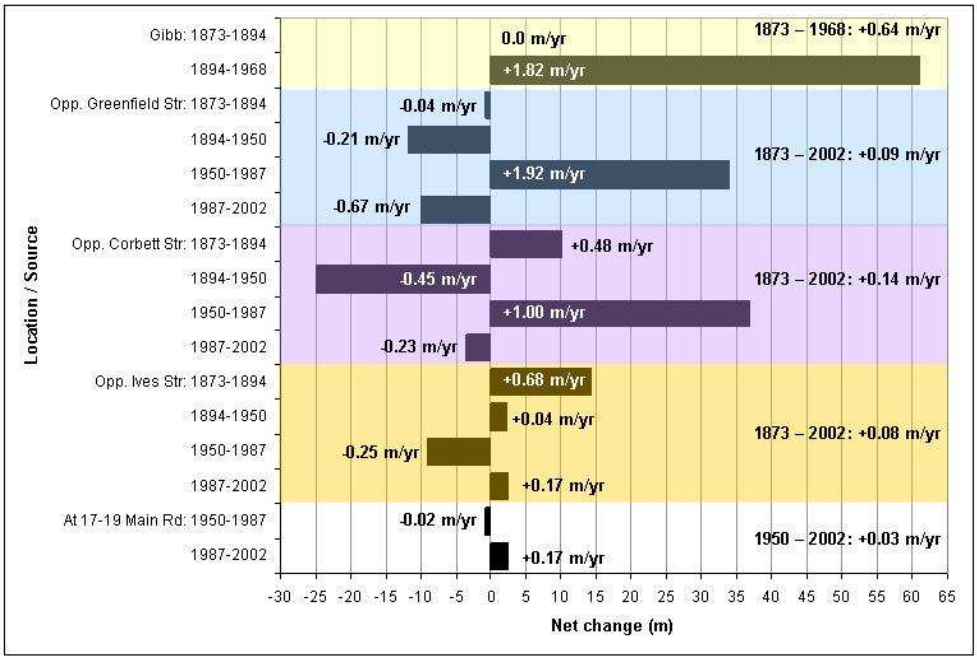

Figure 4: Summary of erosion and accretion net change and average rates at Hector. Note the exact location for the values provided by Gibb (1978) are not known. All other values are from DTEC (2003).

- It would appear that long-term net erosion rates are typically of the order on average of 0.3 - 0.4 m/yr at Ngakawau, and a little more variable along the Hector frontage. This erosion is likely to occur episodically, being primarily caused by storm events. However, over the last couple of decades there appears to have been little net change in the position of the coastline at Hector, and a reduced rate of erosion at Ngakawau. Why this is so, is difficult to say with any degree of confidence without long-term periodic monitoring data.

2.4 Is erosion getting worse?

Changes in the position of the coast are occurring all the time but people tend to become more aware of these changes after a significant storm. There is nothing to suggest that erosion in general is getting worse at Ngakawau and Hector, or indeed at most other locations in New Zealand. As seen in Figures 3 and 4, it can be cyclic, far from regular and rather unpredictable. However, given that erosion rates appear to have been relatively lower over the last few decades relative to the longer-term, it may well be that recent or future erosion rates will be greater than has occurred over the last couple of decades.

However, the awareness of the problem, and the risk and vulnerability are increasing as we have much more development and infrastructure on the coastline. Over the last 50 years there has been rapid development of coastal areas with huge ongoing pressures to continue to develop and occupy the coast - the West Coast, and the Hector / Ngakawau area has not been immune to this. Also what were once baches and cribs are now much more expensive properties with the land also increasing considerably in value. In most coast areas, the problem is not due to the ongoing changes in the coastline but rather that development historically has been located too close to the sea to accommodate these natural changes and trends and the resulting impacts now so much more financially significant. This is largely the problem in Hector and Ngakawau where coastal defences have subsequently been, or are planned to be built.

2.5 What about climate change and sea-level rise?

Global warming has already had an impact on a number of factors which are linked to coastal erosion. This includes sea-level rise. Mean sea levels have been rising in New

Zealand since the mid-1800s, with an average rise of around 16 cm over the last 100 years which is projected to increase by about another 50 cm over the next 100 years.

Sea-level rise is just one component, climate change impacts will also alter rainfall and river flow patterns (which cause a change in sediment supply from the Ngakawau River) and possibly cause changes in storm intensity and wave climate (which affect how beach sediments are moved around within the coastal zone). Assessing how climate change will influence coastal change (either positively or negatively) over and above that caused by natural climate variability is extremely difficult to identify, particularly along the Hector frontage where the complex interaction between river and coastal processes have a significant influence. Along the Ngakawau frontage climate change impacts will most likely exacerbate the erosion problem in the long-term.

2.6 What's likely to happen over the next 10 to 20 years?

Notwithstanding another major earthquake on the west coast, continued retreat of the coastline (primarily due to episodic storm events) will continue in a similar pattern to that occurring in the past (i.e., dominated by natural climate variability not climate change impacts). However, this rate may well be slightly greater than has been experienced over the last couple of decades, particularly given the current phase of climatic conditions we are presently experiencing where it is possible that we will see:

- An increase in the rate of mean sea level rise over the next two decades compared to the last couple (with an average rise in the mean level of the sea of approximately 0.04 m).

- An increased likelihood of short-term positive (sea-level increase) fluctuations (months) in mean sea level of up to +0.25 m.

- An increased likelihood of ex-tropical cyclone and other storms affecting the New Zealand region compared to the last couple of decades. However, this is most likely to impact on the north and eastern facing coastlines.

- More frequent and larger storm-surge events, compared to the last couple of decades. Again this is likely to be more of an issue on the north and eastern coastlines of New Zealand.

3. Managing the impacts of coastal change at Ngakawau and Hector

3.1 Existing approaches to manage coastal erosion

Existing approaches to managing coastal erosion impacts on property and associated infrastructure at Ngakawau and Hector fall in to two categories:

1. Where property has been built back from the beach and a buffer zone of natural vegetation left in place between the beach and the back garden to permit natural changes in the position of the coastline to occur. This is by far the most effective approach in preventing coastal erosion from affecting property or associated infrastructure.

2. Where coastal defences of one form or another have been constructed where housing has been built too close to the coastline. This is mainly along the Ngakawau frontage and the northern part of the Hector frontage, from about 27 Main Road north. Details of the existing coastal defences, their construction and performance are provided in Appendix 1

Gabion baskets (11 Main Road, Ngakawau and 35 Main Road, Hector) are not recommended for coastal defence works on an open coastline where waves can reach them on a regular basis. However, if constructed appropriately, for example as a backstop protection, they are much more preferable to other past attempts at coastal defences, such as dumped building rubble (13, 16 & 17, Main Road Ngakawau and 29 Main Road Hector), old coal wagons or similar (17 Main Road Ngakawau and 29-31 Main Road, Hector), cemented sand bags or beach cobbles (31 Main Road, Hector), or other low cost approaches using waste or dumped material.

Resource consents have recently been submitted for proposed coastal defence works at 13 & 14 Main Road, Ngakawau (to the immediate south of Morris Creek), 16 Main Road, Ngakawau, and at 35 Main Road, Hector. In addition the owner of the property at 37 Main Road Hector and the adjacent Imagine Café are also considering protection options.

At both 13 and 14, and 16 Main Road, Ngakawau the proposals are to build a rock revetment over the upper part of the gravel beach. The toe of each of these structures would extend below MHWS. At 16 Main Road, the existing building rubble will be removed as part of the proposal. The proposed designs at both sites do not suggest that the rock structures will be designed and constructed to a sufficient standard to prevent

further landward migration of the upper beach and erosion of the land behind it. Whilst the structures will provide some protection during mild storms they are unlikely to prevent continued erosion during more major events (see for example the performance of a similarly constructed revetment at Rapahoe), and will experience toe scour and crest damage. However, if suitably constructed and extending out over the active beach, then they will most certainly have detrimental impacts on immediately adjacent sections of the coast.

Details of what is proposed at 35 Main Road, Hector is not available but it is thought will most likely involve gabions.

3.2 Specific issues at Ngakawau and Hector to consider for managing the impacts on resident property of future erosion

Coastal defences such as seawalls built to 'hold' or 'advance the line' are often viewed as 'solutions' to coastal erosion problems. Unfortunately such actions tend to be reactive, are rarely the most effective option in the long term, lead to a false sense of security and often further development behind the structures, often lead to other environmental damage and an expectation that such defences will be maintained *in perpertuum* leading to ever increasing financial commitment to maintain and upgrade such defences.

Community constructed coastal defences on this coastline are always going to have a limited lifespan, at best probably around 10 to 20 years, and will not be constructed to a standard to effectively withstand the more significant storm events that occur on the west coast. Furthermore, on a retreating coastline such as this, the effectiveness of such defences is continually being reduced whilst the potential negative impacts caused by the defence often increases. This typical process, over a yearly to decadal timescale, in a general sense, is summarised in Figure 5.

In this situation, **coastal defences should only be used as a last resort where property is at direct risk to 'buy some time' to permit a longer-term approach to reducing the risk to such property.** This longer-term approach is most likely going to need to involve relocation of existing property along the Ngakawau and northern part (north of 27-29 Main Road) of the Hector frontages over the coming decades. Whilst such actions are unlikely to be required in the immediate future (not withstanding a very severe storm event), property owners along these sections of coast should be mindful that the need to relocate property will ultimately be a reality and that planning an exit strategy over the coming decade or so would be advisable.

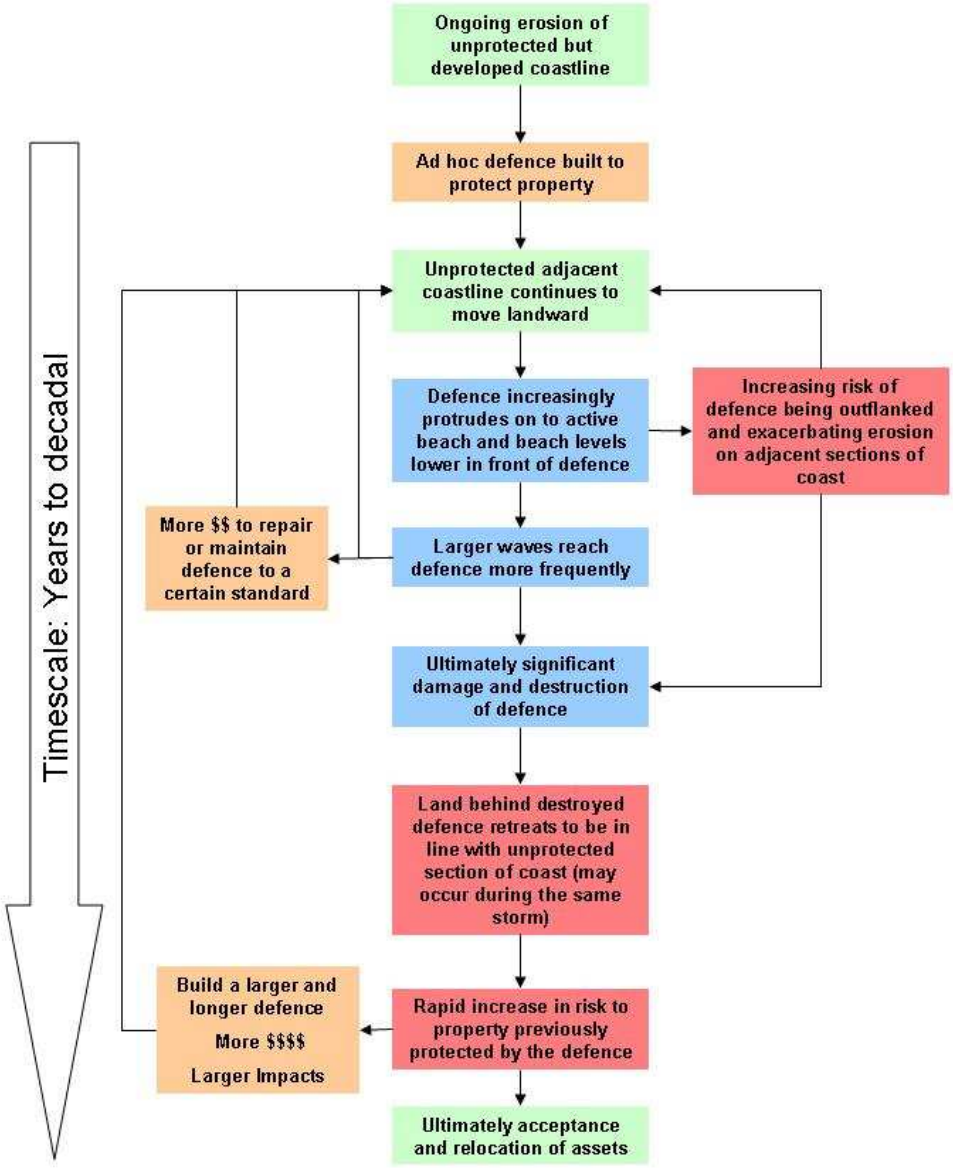

Figure 5: Typical timeline of the protection provided by, and effects of, ad hoc coastal defences on an eroding coastline.

Whilst it is likely that further coastal defences will be permitted to be constructed, (and some suggestions are provided in the following section as to potential appropriate methods), outlined below are a number of supporting recommendations that may need to be considered by both Buller District and West Coast Regional Councils associated with any such consents, longer-term planning, and also by the Ngakawau and Hector residents themselves:

- It is important that both Council and landowners are aware that further residential construction seaward of SH 6 along any part of the Ngakawau or Hector frontages will be impacted by coastal erosion during the lifetime of the property. For example at present a new property is being constructed between 25 and 27 Main Road, Hector. It is being built close to the coastline and all vegetation has been cleared right up to the coast. It is anticipated that this owner will have erosion concerns in the near future. Construction of further coastal defences is not going to be a way of mitigating this risk.

- Whilst it is appreciated that some form of coastal defence structures will be permitted to try to increase the level of protection to property along parts of the frontage, such structures should only be a consideration along the sections of coast backed by property between the coast and SH 6:

    - Along the Ngakawau frontage.

    - Between 27 and 37 Main Road, Hector.

  All other sections along the Hector frontage have sufficient buffer zones at present to avoid the need for any such structures.

- All back gardens need to be treated as buffer zones:

    - A zone of at least 10 m width (the more the better) of natural coastal vegetation, such as flax or bamboo clumps as commonly found along the coastline of the West coast is recommended.

    - Much of the benefit of such zones are lost if this vegetation is replaced by gardens or decking out to the coast (e.g., 16 Main Road, Ngakawau).

    - Buffer zones are still required if coastal defences have been built (as wave overtopping and occasional failure of such defences will still occur). Extending gardens or decks right up to the coastal defence will reduce much of the overall effectiveness.

    - Where there is little space to accommodate a buffer zone between the coast and property, thick cover vegetation, e.g., bamboo clumps is recommended. This can be routinely trimmed to around a metre high

to still remain effective but not spoil sea views (as is being done at 37 Main Road, Hector).

3.3 Guidelines for appropriate defence design

As outlined above, the negative impacts of ad hoc coast protection works are well known and great care needs to be taken, particularly with linear type defences, such as seawalls and revetments built along the coast to ensure that such impacts do not occur. However, where such structures are built appropriately they can provide an effective short-medium term option in increasing the standard of protection afforded to a coastal property (which does not necessarily include back gardens) by acting in conjunction with the existing beach.

In terms of the form of further coastal defence work, the following general recommendations are suggested:

- Any further defence structure should be located landward of the present active beach, with the interface of the beach and structure well above present day high tide levels (i.e., the present beach is left in front of the defence).

- Where there is scope, i.e., more space between the coastline and any property, consideration should be given to a backstop defence rather than a defence located right behind the beach. This will provide a higher level of protection to a property for a longer length of time.

- Where defences are planned along a number of sections, the location and profile of the defence should be consistent and continuous.

- Whilst still far from ideal it is suggested that a gabion revetment may be a more suitable option than a rock revetment, particularly along the Hector frontage, Figures 6, 7 and 8.

- The front face of all gabion structures should ideally be sloping, (less appropriate is a stepped profile) but not vertical.

- It is suggested that two layers of 0.5 m high gabion baskets are used (rather than the more typical 1 m square type. The smaller gabions tend to keep their shape better, provide more structural support and experience less stone movement. In a sloping revetment having two layers of 0.5 m thick gabion

baskets rather than one 1 m thick layer ensures the bottom layer remains intact even if the top layer becomes damaged, and is easier and less expensive to repair.

Figure 6: Example of a sloping gabion revetment which tends to have less impact and are more stable than a vertically constructed gabion wall. Blown sand (e.g., along the Hector frontage) is also able to accumulate on such revetments, softening their appearance (Photo: Scottish Natural Heritage, 2000).

- It is suggested that PVC and zinc coated gabion baskets be used. In a marine environment these last longer than the more normal (and less expensive) galvanised baskets without the PVC coating.

- The toe of the defence should extend at least 1 – 1.5 m below the present beach level and below the level of Mean High Water Springs.

- The crest of any gabion structure should not extend significantly higher than the level of the land behind it, with a crest width of at least 2 m wide.

- Rock fill for any gabions should be sourced from an external source and not filled with cobbles removed from the adjacent beach.

- A suitable geotextile (e.g., Bidim A64) or filter layer should be placed between the gabion and underlying substrate.

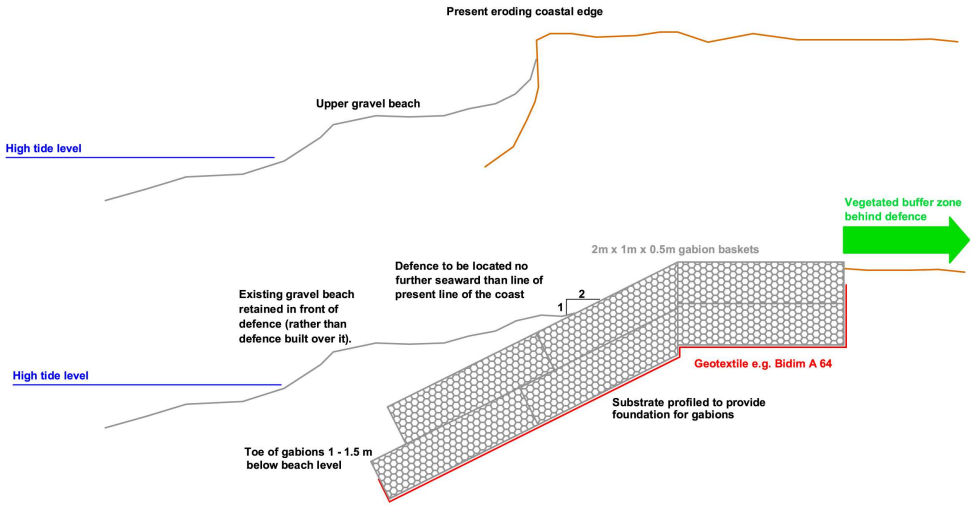

Figure 7: Outline design for a potential sloping revetment along the Ngakawau frontage showing the maximum seaward position of the defence relative to the present day coast. It is vital that the present gravel beach is maintained in front of the defence. Rock armour may also be used but should follow a similar design profile as above. The design is indicative only and will need to be developed for any particular location.

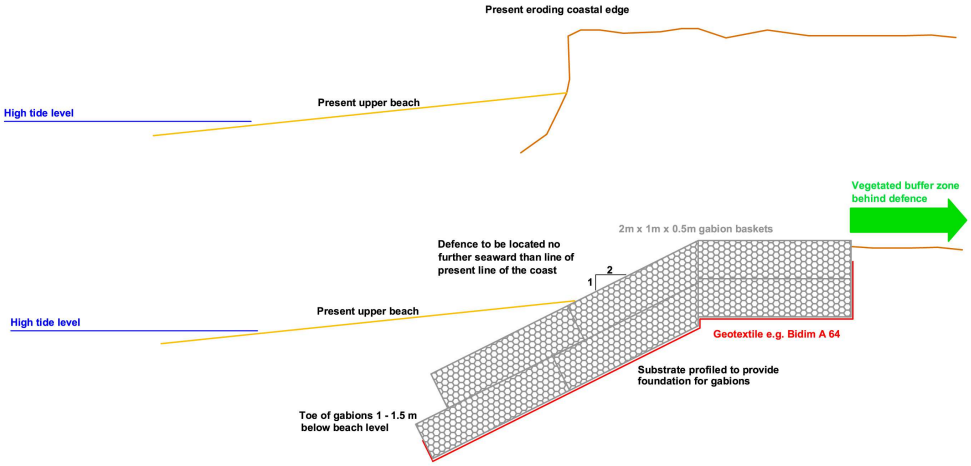

Figure 8: Outline design for a potential sloping revetment along the Hector frontage showing the maximum seaward position of the defence relative to the present day coast. The design is indicative only and will need to be developed for any particular location.

- The ends of any structure needs to curve back in to the land behind, or that wing walls, i.e., gabions extending back landward perpendicular to the seaward face of the structure are included to prevent outflanking.

- Any further defences that are built still need to include as wide a vegetated buffer behind it as possible (as outlined above). For a number of sections (e.g., 16 Main Road, Ngakawau) this may require relocation of garden decking and shedding from immediately behind the coastline. At this location there is not enough space to accommodate an appropriate coastal defence seaward of the existing decking and shed.

If a rock structure is used along the Ngakawau frontage, in addition to the comments above for a gabion revetment in terms of location, slope etc. the revetment should:

- Consist of two layers of well placed (rather than dumped), evenly sized interlocking rock with a geotextile or appropriate filter layer between the rock and the underlying substrata.

- Be constructed such that the largest rock be placed at the toe of the structure which should be at least 1.5 m below the level of the present beach.

- Have a width at the crest of the revetment of at least three rocks wide to prevent scouring behind the crest due to run-up and overtopping.

4. References

DTEC Consulting Ltd (2002). Evaluation of the effect of stone removal North of Westport. Report for West Coast Regional Council, May 2002. 17 pp.

Gibb, J.G. (1978). Rates of coastal erosion and accretion in New Zealand. *New Zealand Journal of Marine & Freshwater Research, v. 12, No. 4*: 429-456.

Mangin, C.M. (1973). Coastal processes and development in the southern Karamea Bight. MA Thesis, Geography Department, University of Canterbury.

Scottish Natural Heritage (2000). A guide to managing coastal erosion in beach/dune systems. October 2000, pp 128.

5. Appendix 1: Existing coastal defence work along the Ngakawau and Hector frontages

Figure 9: Gabion revetment at 11 Main Road, Ngakawau. The wall is not aligned with the coastline and is likely to suffer outflanking at the southern end. Also by not maintaining the upper gravel beach in front of the defence also makes it more prone to damage and undermining and less effective in preventing overtopping.

Figure 10: Dumped rubble at and to the north of 16 Main Road, Ngakawau.

Figure 11: Rubble fill tipped over the upper beach at 29 Main Road, Hector which will be eroded away the next time waves reach the fill material.

Figure 12: Old coal wagons at 31 Main Road Hector, Again these will do little to prevent ongoing erosion during storm events.

Figure 13: Concrete filled bag revetment at 31 Main Road Hector. This shows the results of an inadequate construction including inappropriate construction material, lack of proper foundation, underlayer and end design. This wall is unlikely to survive much longer.

Figure 14: Gabion wall at 35 Main Road Hector. The wall has been built over the upper beach making it more prone to damage and outflanking.