Report on submissions and further submissions on the Proposed Waikato District Plan

Hearing 27D: Coastal Hazards

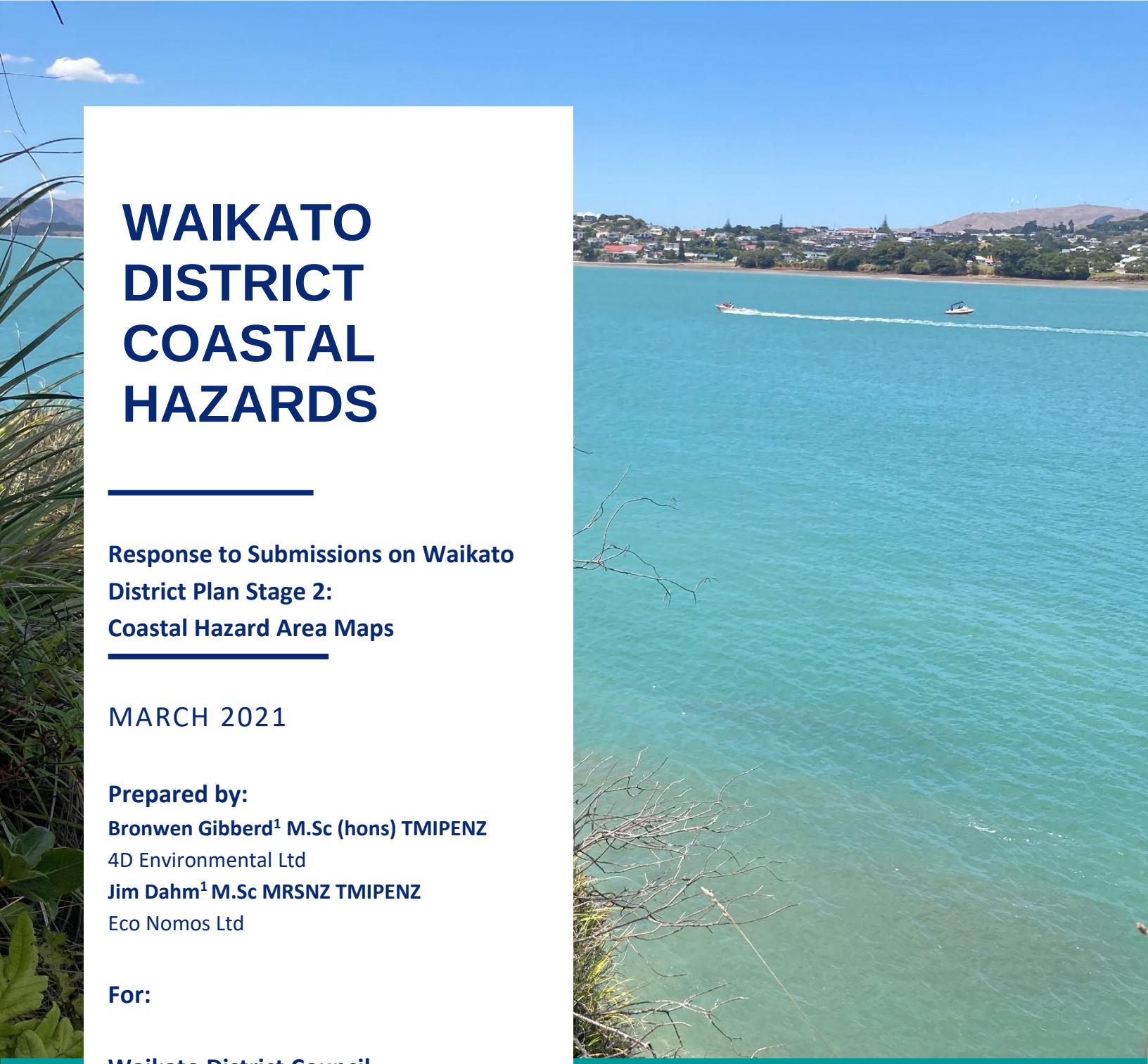
Appendix 4: Technical Reports

Waikato DISTRICT COUNCIL
Te Kaunihera aa Takiwaa o Waikato

Appendix 4 – Technical Reports

WAIKATO DISTRICT COASTAL HAZARDS

Response to Submissions on Waikato District Plan Stage 2: Coastal Hazard Area Maps (March 2021). Prepared by Bronwen Gibberd 4D Environmental Ltd and Jim Dahm Eco Nomos Ltd



WAIKATO DISTRICT COASTAL HAZARDS

Response to Submissions on Waikato District Plan Stage 2: Coastal Hazard Area Maps

MARCH 2021

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1. Purpose and Background

This report provides a discussion and recommended response to submissions received on the notified coastal hazard management areas.

By way of background, a review of coastal erosion and inundation hazards was undertaken as part of the review of the Waikato District Plan (Stage 2 – Natural Hazards). As outputs from this study, coastal erosion and coastal inundation management areas were defined (and notified) along the developed coastlines of Raglan and Port Waikato:

- **High risk coastal hazard area (erosion) and (inundation) -** the areas where there is significant risk from coastal erosion or inundation with existing sea level and coastal processes in the short term (within the lifespan of the District Plan).
- **Coastal sensitivity areas (erosion) and (inundation) -** the areas potentially vulnerable to coastal erosion and inundation over the period to 2120, assuming sea level rise of 1.0 m.

The high risk coastal hazard areas are those areas which, in the absence of existing or future intervention, could be impacted by coastal erosion or flooding within the lifetime of the District Plan (approximately 10-15 years). This does not represent a "worst-case" potential coastal erosion or inundation area over this timeframe but identifies the areas at greatest risk and therefore of highest priority for coastal hazard management.

Coastal erosion and flooding hazard reduce with distance inland and elevation respectively. The uncertainty increases as we project coastal hazards beyond the short term. There is insufficient available information on both existing coastal processes and possible future changes to reliably define the areas vulnerable to coastal erosion over the next 100 years. This is the case whether using traditional deterministic approaches or a probabilistic approach. The Coastal Sensitivity Areas therefore represent the area that we believe could potentially be affected by erosion or inundation in the longer term, including the impact of up to 1.0 m of sea level rise. The coastal sensitivity areas are not defined hazard areas. Some land within coastal sensitivity areas will not be vulnerable to coastal hazards in the short term and/or with current sea level. The sensitivity areas highlight where further investigation, and potentially an adaptable development approach is warranted where significant new development is proposed.

Further and more detailed investigation may indicate that coastal hazards are not of concern in some locations within the Coastal Sensitivity Areas, and we recommend that Council provide for coastal development to occur based on site specific investigations undertaken by a suitably qualified and experienced coastal scientist or engineer. Notwithstanding this, a high level of uncertainty is likely to remain in most areas.

In the rural areas, we have identified a single coastal sensitivity area that identifies the coastal margin that could potentially be impacted by coastal inundation and/or coastal erosion, assuming sea level rise of 1.0 m to

2120. As noted above, these are not defined hazard areas, but simply areas within which any future development (excluding non-habitable farm buildings) will require a site-specific coastal hazard assessment.

2. Coastal Inundation

A number of submissions relate specifically to the High-Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation), at both Port Waikato and Raglan. These submissions generally relate to possible conservatism in the extreme sea level estimates used to define the areas. This section provides some background and discussion of the extreme sea levels applied. Detailed (site-/submission-specific) discussion and recommendations are given in Sections 4-6.

2.1 Coastal Inundation Areas Defined

The elevations used to define the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) are based on work completed by NIWA (Stephens et al. 2015) for the Waikato Regional Council, and supported by field measurements and by observations, and historical data from local land owners and residents. The work by Stephens et al. (2015) included a detailed analysis of data from the Waikato Regional Council's tide gauge in Kawhia Harbour. The analysis considered all the components that make up extreme water level events at the coast, including:

- tides (total storm tide levels are greatly dependent on the correlation with high tide times)
- barometric set-up (raised water levels due to low atmospheric pressure)
- wind set-up (raised water levels due to onshore winds driving water against the shore)
- sea-level "anomaly" (long term variation of sea level due to climate cycles).

For any given storm, the overall storm tide height is heavily dependent on the stage of tide (high/low and spring/neap) when the storm is at its peak. Stephens et al. (2015) calculated a storm tide frequency–magnitude distribution using the Monte Carlo joint-probability technique, which calculates the likelihood of large surges coinciding with high tides. This approach yielded an estimated 1% AEP storm tide of 2.76 m (MVD-53). However, the tide gauge record at Kawhia is relatively

Datums:

Coastal inundation levels are expressed as an elevation above a given datum.

Datums are a sea level "baseline", based on analysis of the mean sea level over a period of time at a particular location.

Moturiki Vertical Datum – 1953 "MVD-53") is commonly used in the Waikato. MVD-53 was determined based on tide gauge measurements from 1949-1953. Due to sea level rise, the present mean sea level is now higher than MVD-53.

New Zealand Vertical Datum 2016 ("NZVD-2016") is based on more up to date sea level records and is the official national vertical datum for New Zealand. NZVD-2016 is 0.25-0.30 m above MVD-53 so values expressed to NZVD-2016 will be smaller.

short (six years), and of the largest recorded events, none occurred due to a coincidence of high storm surge and a high spring tide. More extreme storm surge components are also likely to be measured as the record lengths increase. Ideally storm surge analysis would be undertaken on a much longer dataset to give more certainty about the 1% AEP value.

On the West Coast, storm surges (combination of barometric and wind effects) can be almost double those experienced on the eastern Coromandel Peninsula. In the short Kawhia record, three storm surges greater than 0.7 m were observed. Stephens et al. (2015) comment that it appears that it is likely west-coast estuaries are subject to large wind-driven storm surges that could conceivably reach well over 1.0 m in magnitude.

Given this uncertainty, and the large wind-driven storm surges observed even in the short Kawhia record, Stephens et al. (2015) also calculated an extreme storm tide level based on maximum observed tide, maximum storm surge and maximum sea-level anomaly, during the sea-level measurement period. This approach indicates the potential sea-level elevation expected if a very high tide combined with a large storm surge and a high sea-level anomaly, all at the same time. When combined this yields a possible storm-elevated sea level of approximately 3.1 m relative to Moturiki Datum (Table 1), 0.35 m higher than the 1% AEP storm tide estimate.

The annual exceedance probability (AEP) of the summed sea-level components cannot be calculated due to the short record but is likely to be very low, probably less than 1%. As such, it is probably more accurate to refer to the elevation as the maximum likely storm tide rather than a 1%AEP event. However, observations and measurements made following large storm events in Raglan Harbour indicate that extreme water levels of approximately 3.0 m have occurred (e.g. eCoast, 2020). Therefore, while there is likely to be some conservatism in the estimate, we believe it is not unreasonable.

Table 1: Maximum measured storm surge components at Kawhia.

Storm Surge Component (Maximum) Relative to MSL	Level (MSL)	Level (MVD-53)
Maximum Tide Level	1.94 m	2.07 m
Storm Surge	0.90 m	0.90 m
Sea Level Anomaly	0.16 m	0.16 m
TOTAL:	3.00 m	3.13 m

Given the inadequacies of the existing record (too short to reliably estimate the 1%AEP extreme sea level), and the likelihood that larger surges will occur, we believe it is prudent to estimate the maximum storm tide by summing the various maximum storm surge components. The maximum storm tide elevations for Port Waikato and Raglan were therefore estimated by combining the maximum tide at each location with the maximum storm surge components measured at Kawhia as shown in Table 2. These levels are presented in terms of NZVD-2016 in Table 3.

The Coastal Sensitivity Area (Inundation) represents the same extreme event after 1.0 m of sea level rise. It identifies how this hazard may change over the next 100 years. As such, it defines potential future hazard.

As noted above, there is likely to be some conservatism in these values, they represent the best available information. In defining the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) on maps, this conservatism has been reduced sightly by using a simple 3.0 m and 4.0 m elevation contour as boundaries.

Council is required by national and regional policy to manage future coastal hazard risk and ensure risk is not exacerbated and is reduced to the extent reasonably practicable. As such, it is not intended to prevent future development but rather to ensure that any such development is resilient.

Table 2: Maximum storm tide values for Raglan and Port Waikato (Moturiki Vertical Datum 1953).

	Max Tide	Max Storm Surge (m)	Max SL Anomaly (m)	Max Storm Tide
Raglan	2.10 m	0.90 m	0.16 m	3.16 m
Port Waikato	2.00 m	0.90 m	0.16 m	3.06 m

Table 3: Maximum storm tide values for Raglan and Port Waikato (corrected to New Zealand Vertical Datum (NZVD) 2016).

	Max Storm Tide (MVD-53)	MVD-53 – NZVD-2016 Correction	Max storm (NZVD-2016)
Raglan	3.16 m	0.26 m	2.90 m
Port Waikato	3.06 m	0.29 m	2.77 m

2.2 Assessing Coastal Inundation

Coastal hazard "risk" represents a combination of the likelihood and the consequences of an event. The level chosen to define the proposed High Risk Coastal Hazard Area (Inundation) represents an extreme storm event with a low probability of occurring in any given year (≤1% AEP). The level of risk within the defined areas will vary significantly with ground level, distance from the coast and vulnerability of assets. Obviously, some land within the High Risk Coastal Hazard Area (Inundation) is considerably below this level and is likely to be subject to more frequent inundation. In contrast, areas of higher land, closer to the upper limit storm tide elevation used to define the areas, may only have a low probability of inundation.

Considering the above, we provide the following general comments in regard to the submissions received, and the relatively conservative approach adopted.

Coastal inundation hazard is greatest in areas close to the coast, and particularly where there is exposure to significant wave action. Fortunately, the existing residential areas on the open coast (Port Waikato and Whale Bay) are sufficiently elevated to be away from elevated water levels during storm events, and the potentially damaging impacts of wave overtopping. However, in estuarine environments developed areas are often low-lying and therefore potentially vulnerable to occasional inundation. In many areas, the low-lying margins of

coastal properties may be frequently flooded, but existing development may be located on more elevated land where the probability and consequences of inundation are less.

In our view, land with elevations close to the upper limit used to define the High Risk Coastal Hazard Area (Inundation) (e.g. 2.8-3.0 m MVD-53) currently has a relatively low likelihood of being inundated, and any flooding that may occur would be very shallow. In other areas, where residential land within the High Risk Coastal Hazard Area (Inundation) is very low, land could be flooded relatively frequently, and/or to considerable depth. Other factors such as flooding of road and driveway access can influence the level of consequence for individual properties during a given event. There is currently therefore considerable variability in both the likelihood and consequence (and overall "risk") of coastal inundation within the High Risk Coastal Hazard Area (Inundation).

2.3 Recommendations

While some areas could currently be considered to be relatively "low risk", both the likelihood and severity of inundation will increase over time with future sea level rise. Therefore, while current risk may be relatively low in some parts of the High Risk Coastal Hazard Area (Inundation), this risk is expected to increase over the lifespan of any new development. Considering results of the tide data analysis by Stephens et al. (2015), a storm surge elevation currently associated with a rare event (1% AEP) would have an annual return interval of 10 years following just 0.3 m of future sea level rise.

Based on current data, we recommend that the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) remain as notified.

3. Coastal Erosion

3.1. Coastal Erosion Areas Defined

In our coastal hazard assessment (Focus, 2020) we identified two coastal erosion areas in areas of existing development:

- **High Risk Coastal Hazard Areas (Erosion) -** the areas where there is significant risk from coastal erosion with existing sea level and coastal processes in the short term (within the lifespan of the District Plan). This does not represent a "worst-case" potential coastal erosion or flooding area over this timeframe but simply identifies the areas at greatest risk and therefore of greatest priority for coastal hazard management.
- **Coastal Sensitivity Areas (Erosion) -** the areas potentially vulnerable to coastal erosion over the period to 2120, including consideration of potential sea level rise of 1.0 m. These sensitivity areas are not areas where coastal hazard has been identified with any certainty but are simply areas where further detailed investigation of coastal hazard is recommended prior to any future intensification of land use.

We also recommended that the proposed Waikato District Plan allow for revision of these areas based on site-specific investigation by appropriately qualified scientist or engineer.

3.2. Assessing Coastal Erosion

Beach shorelines are often very dynamic and changeable. The following components need to be considered when estimating the width of coastal erosion hazard areas for any planning period ("t") in a beach setting:

- any long-term trends for permanent erosion or accretion ("LT")
- maximum likely dynamic shoreline fluctuations over the planning period ("ST")
- slope instability associated with collapse of over steepened erosion scarps ("S")
- potential effect of climate change over the planning period, particularly sea level rise ("X")

We have estimated these components for each beach site where necessary using the available information, including field observations and geomorphology, historic aerial photographs and surveys, historic shoreline mapping and community information.

Much of the developed shoreline in the Waikato District is fronted by coastal cliffs, of varied elevation and geology. The nature of coastal erosion hazard in cliff environments is quite different to that on "soft" mobile shorelines such as sandy beaches. Dynamic fluctuations do not occur, but rather erosion is a one-way process. Cliff erosion can occur very slowly at the base ("toe") for a long period of time, resulting in oversteepening of the seaward slope. Weathering and slope instability processes further up can result in occasional, but potentially dramatic and dangerous slope failure (Figure 1). The exact mechanisms of slope failure and potential for erosion vary greatly depending on cliff geology, physical setting, weathering, local bedding and faulting, groundwater levels and vegetation. In many areas, cliffs are composed from multiple rock types with different strengths.

The key factors that need to be considered in erosion hazard assessment for cliff sites are:

- historic long term (i.e. time-averaged) rate of toe erosion
- slope instability arising from the toe erosion (typically assuming failure to a stable slope)
- the potential effect of sea level rise on the above factors (e.g. impact on rate of toe erosion)

In determining appropriate parameters for mapping coastal cliff hazard, we considered shore platform width, field observations, historical photos and shoreline change data to estimate long-term erosion rates. We considered geological and geomorphic information as well as topographic data (Lidar) to estimate a suitable stable slope.

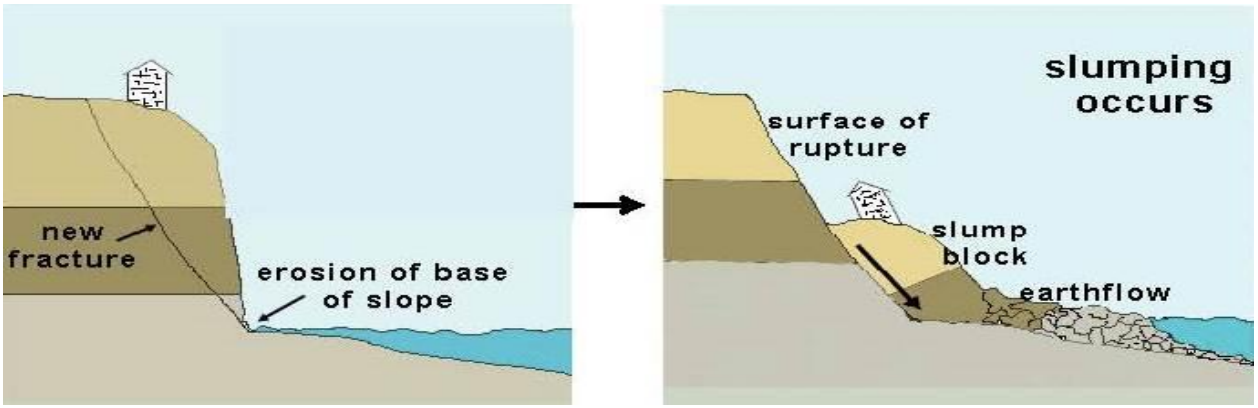


Figure 1: Processes of cliff erosion.

The complexity of the geological setting, the slow and episodic nature of cliff retreat, and limited information makes it very difficult to accurately define appropriate stable slopes for the entire coastline. We have therefore applied a relatively "conservative" slope in defining these coastal erosion areas – particularly for the Coastal Sensitivity Area (Erosion). Site specific geological and/or geotechnical investigations will in some areas confirm that it is possible to safely place development within these areas based on a steeper slope.

These assessments may also be influenced by existing or proposed slope stabilisation works (e.g. retaining walls) on the property. It is important to recognise that the areas identified in the Coastal Hazard Report reflect slope instability that may occur as a direct result of over-steepening due to coastal erosion. We have not considered all possible causes of land instability that may occur due to land-based processes.

In the rural areas, we have identified a single Coastal Sensitivity Area (Erosion). This simply defines an area within which any future development (excluding non-habitable farm buildings) will require consideration of coastal hazards. The Coastal Sensitivity Area (Erosion) is defined in rural areas using a generic distance (100 m on estuarine shorelines, and 200 m on the open coast). In defining a single distance for the rural areas, we have necessarily adopted a relatively conservative approach; to provide for potential coastal hazard in all coastal settings, including high cliffs and erodible shorelines. This area also provides for the likely impact of 1.0 m of sea level rise.

As discussed above, the Coastal Sensitivity Area (Erosion) is not a defined "hazard" area, but simply an area within which coastal erosion hazard should be considered. A site-specific hazard assessment by an appropriately qualified practitioner should accompany any proposal for significant new development or intensification to evaluate potential coastal erosion hazard risk.

3.3. Recommendations

In the following sections we have considered the submissions received and provided further discussion and explanation for the High Risk and Coastal Sensitivity overlays. In some cases, further investigations have been undertaken.

We have recommended an alteration to the methodology for identifying the High Risk Coastal Hazard Area (Erosion) on developed cliff shorelines within Raglan Harbour to reduce conservatism and align more closely with field measurements and the "high risk" definition. This High Risk Coastal Hazard Area (Erosion) does not cover all potential coastal erosion hazard, but represents the area of greatest likelihood of failure based on existing information (including existing slope failures where they occur in an area).

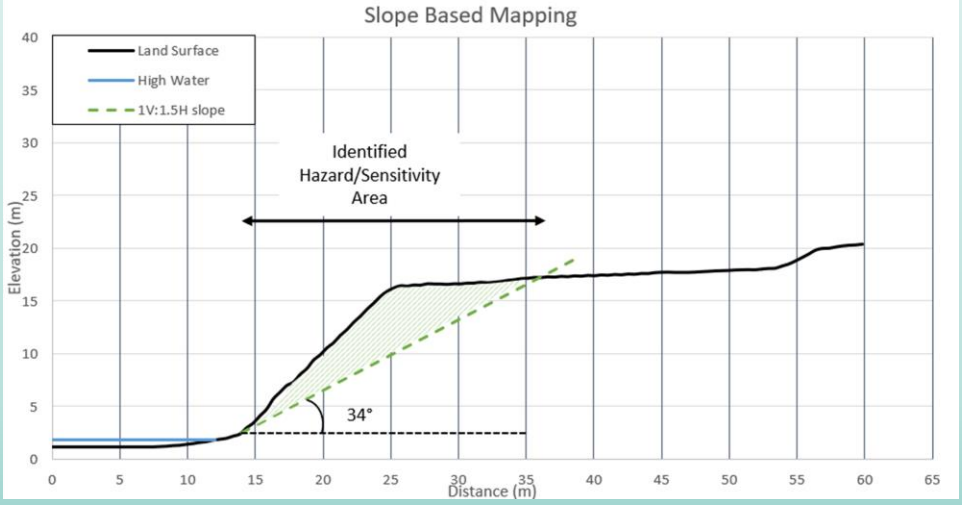
We recommend retaining the Coastal Sensitivity Area (Erosion) as notified on developed cliff shorelines as it is an important "flag" to ensure remaining areas of lesser risk are considered and appropriately managed with any future development.

In rural areas, the Coastal Sensitivity Area (Erosion) and Coastal Sensitivity Area (Open Coast) have been mapped with a "generic" width of 100 m and 200 m respectively. These two distances reflect criteria defined in our hazard assessment (Focus, 2020), but have been mapped with a fixed distance due to the complexity and logistics of mapping the entire shoreline in detail.

Given the potential conservatism of the Coastal Sensitivity Area (Erosion) in some rural areas, the Council will need to consider applications for future development on a site-specific basis. Our coastal hazard assessment provides discussion and some criteria for assessing likely coastal erosion hazard on the various shoreline types. In some cases, these criteria will provide sufficient guidance to determine whether a location is likely to be subject to coastal erosion hazard. In other locations, additional site-specific data and investigation will be required.

Slopes and Slope Based Mapping

Cliff slopes can be expressed in terms of degrees, or as a slope ratio. For example, 1V:2H refers to a slope where there is 1 m of increase in vertical elevation with every 2 m of horizontal distance. 1V:2H is equivalent to a slope of 26.5 degrees. 1V:1.5H is equivalent to a 34-degree slope.
The figure below illustrates the use of a defined stable slope to identify a coastal hazard area on a cliff shoreline.



4. Port Waikato

4.1. Maunsell Road

Port Waikato			
Maunsell Road			
Malcolm Beattie on behalf of Sunset Heights (Port Waikato) Ltd.	2002	Delete Coastal Sensitivity Area (Open Coast) overlay on properties at 213 and 215 Maunsell Road, Port Waikato as shown on Map 11 Waikato Heads South and Map 11.1 Port Waikato.	Coastal Sensitivity Area (Open Coast)
Glenn & Marion Hunter	2004	Amend Map 11.1 Port Waikato, by deleting the Coastal Sensitivity Area (Open Coast) from 211 Maunsell Road, Port Waikato.	Coastal Sensitivity Area (Open Coast)
Neal Gordon & Teresa Mary Phillips	2010	Amend Map 11.1 Port Waikato by removing the Coastal Sensitivity Area (Open Coast) from the property at 209 Maunsell Road, Port Waikato.	Coastal Sensitivity Area (Open Coast)
Glenn & Marion Hunter	2162	Amend Planning Map 11.1 Port Waikato to remove Coastal Sensitivity Area (Erosion) from the property located at 211 Maunsell Road, Port Waikato.	Coastal Sensitivity Area (Open Coast)

Submission #2002, #2004, #2010, #2162: Maunsell Road, Port Waikato

Submission: That the proposed Coastal Sensitivity Area (Erosion) be removed from several properties at the western (seaward) end of Maunsell Road (Figure 2). These submissions request removal or amendment of the erosion hazard areas that overlay the properties between 209 and 215 Maunsell Road.

Discussion:

The Coastal Sensitivity Area (Open Coast) has been applied with a 200 m width on all rural shorelines along the open coast of the Waikato District. The width of this area provides for the highly varied coastline between Port Waikato and Raglan. In some areas there are high, steep slopes to landward that are potentially vulnerable to slope instability. There are also areas around stream mouths that are subject to significant dynamic fluctuations, and potentially coastal inundation.

209, 211 and 215 Maunsell Road are all within the Residential Zone and are landward of the Port Waikato Coastal Sensitivity Area (Erosion), which applies to the full extent of the sand spit (Figure 3). The Coastal Sensitivity Area (Open Coast) extends inland and overlays portions of these properties. Given these are residential properties (Figure 3), we agree with the submitters that it is appropriate to assess the coastal erosion hazard here in more detail.

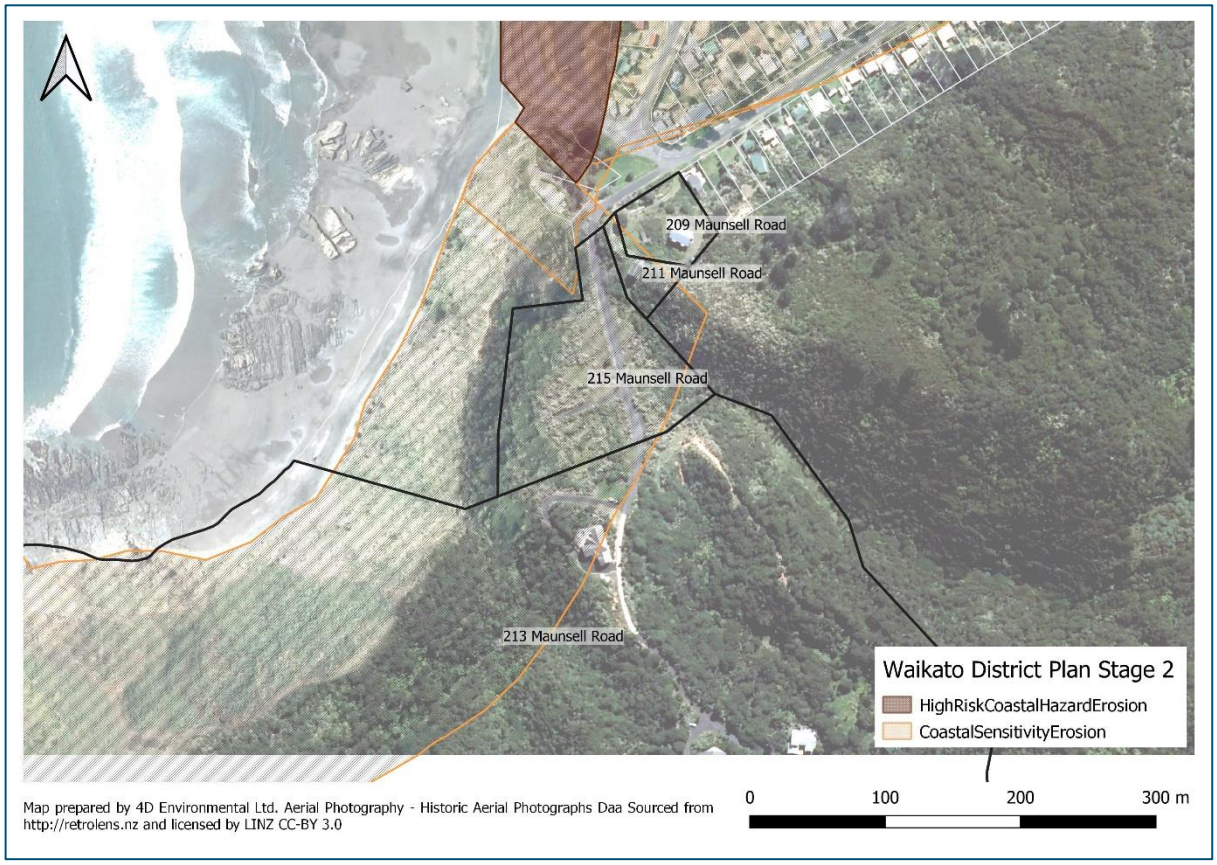


Figure 2: Properties 209-215 Maunsell Road, Port Waikato.

Figure 3: Proposed Waikato District Council Zoning for 209-215 Maunsell Road. Residential areas are shown in yellow, pale areas indicate reserve, grey areas are zoned rural.

The coastline in this area is at the south end of Sunset Beach and is underlain by a shore platform and backed by a steep ridge to landward. This area is underlain by Apotu Group siltstone and consolidated dune sequences, which can be seen exposed in places behind the beach (Figure 4).

Figure 4: Southern end of Port Waikato beach, seaward of the Maunsell Ave properties.

The historical shoreline change data indicates that the shoreline is considerably less dynamic than the sand spit further north and has fluctuated by up to 30 m since the 1940s. Historical photographs show that the area is sometimes fronted by a narrow sand dune, which erodes and rebuilds over natural decadal cycles. Most of the shoreline change observed in the area since the 1940s is associated with erosion and rebuilding of this sand dune. Harder materials to landward are periodically exposed and there is some geomorphic indications of past erosion and land sliding of the steep face, but there is little evidence of significant ongoing erosion over the available historical record (1940s onwards). A more detailed study would be required to accurately determine past erosion rates and slope stability to determine the extent of this seaward ridge likely to be vulnerable to coastal erosion in the next 100 years. It is, however, reasonable to assume that this ridge will remain in some form for the foreseeable future. The properties in question are well landward of any coastal erosion hazard.

Recommendation: We have recommended an adjusted Coastal Sensitivity Area (Open Coast) for this area that is defined by the back of the coastal ridge. The landward edge of the adjusted hazard area follows the stream valley (Figure 5). More detailed investigations (including field inspections) would be necessary to refine this

area further. With regard to 213 Maunsell Road (submission #2002), the adjacent large rural property, we believe it is appropriate to also refine the Coastal Sensitivity Area (Erosion) to the stream valley consistent with the adjacent properties.

It is important to note that the Coastal Sensitivity Area (Open Coast) provides for coastal hazards (inundation and erosion). The elevated nature of the shoreline in this area means that coastal inundation is not of concern. It is possible that there may be further land stability issues that are not related to coastal processes.

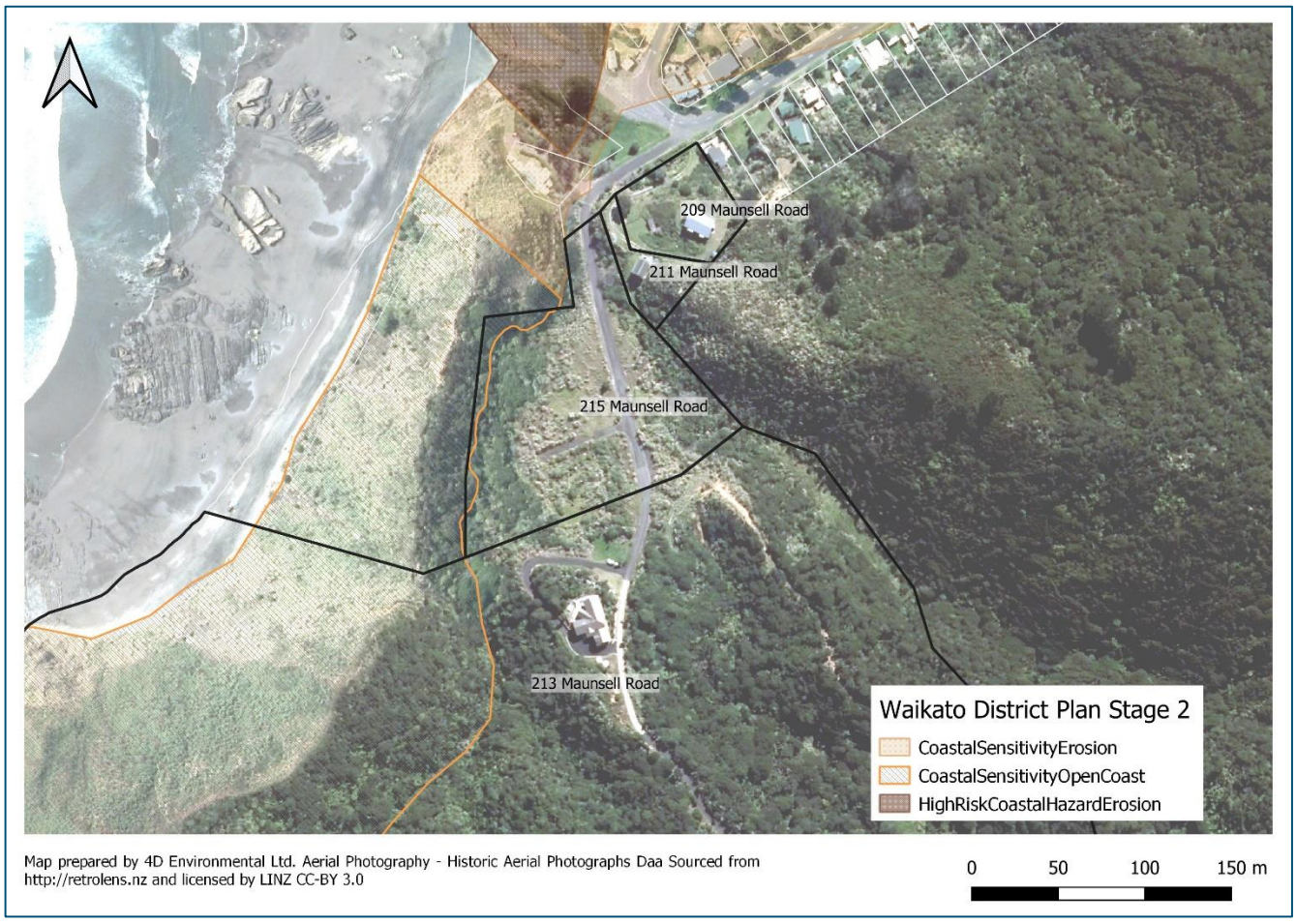


Figure 5: Proposed adjustment to Coastal Sensitivity Area (Open Coast) at Maunsell Road, Port Waikato.

4.2. Tuakau Bridge Road

Port Waikato			
Coastal Erosion and Inundation – Tuakau Bridge Road			
Nicolette Hoete on behalf of Diana Rangipuehu Hoete	2088	Delete the Coastal Sensitivity Area (Inundation) from 2277 Tuakau Bridge-Port Waikato Road, Tuakau and allow the operative regulations to remain. and Delete the Coastal Sensitivity Area (Erosion) from 2277 Tuakau Bridge-Port Waikato Road, Tuakau and allow the operative regulations to remain.	Coastal Sensitivity Area (Erosion) and (Inundation)
Margaret Clough	2006	Delete the Coastal Sensitivity Area (Erosion) and Coastal Sensitivity Area (Inundation) overlays from the property at 2253 Tuakau Bridge Road, Port Waikato.	Coastal Sensitivity Area (Erosion) and (Inundation)

Submission #2006, #2088: Tuakau Bridge Road, Port Waikato

Submission: That the proposed Coastal Sensitivity Area (Erosion) and Coastal Sensitivity Area (Inundation) be removed from properties at Tuakau Bridge Road, Port Waikato (2253 and 2277 Tuakau Bridge Road). The two properties are landward of Tuakau Bridge Road, approximately 2 km upstream (east) of the Port Waikato Township (Figure 6). These submissions have requested the removal of the sensitivity areas on the basis that the properties and dwellings are some distance from the river bank, and there has been no historic flooding or erosion in the area.

Discussion – Coastal Inundation:

These properties are located on the landward side of Tuakau Bridge Road, in the Rural Zone. The properties lie at an elevation of between 3.0 m and 5.0 m above sea level, with the existing dwellings at elevations of approximately 4.0 m or above. The Coastal Sensitivity Area (Inundation) in rural estuarine areas is based on an elevation of 5.0 m (MVD-53). This provides for coastal inundation that may occur during a severe event, after 1.0 m of future sea level rise. An additional allowance of 1.0 m has been added to provide for landward migration of estuarine habitats with future sea level rise. The Coastal Sensitivity Area (Inundation) does not represent a "hazard" zone, but rather a management area within which future development and activities are to have regard to the potential long-term impacts of sea level rise.

The submitters are correct in their observation that there has been no flooding of these properties in the past. This is very unlikely to occur until future sea level rise occurs. Further discussion of the Coastal Sensitivity Area (Inundation) is given in Section 2.

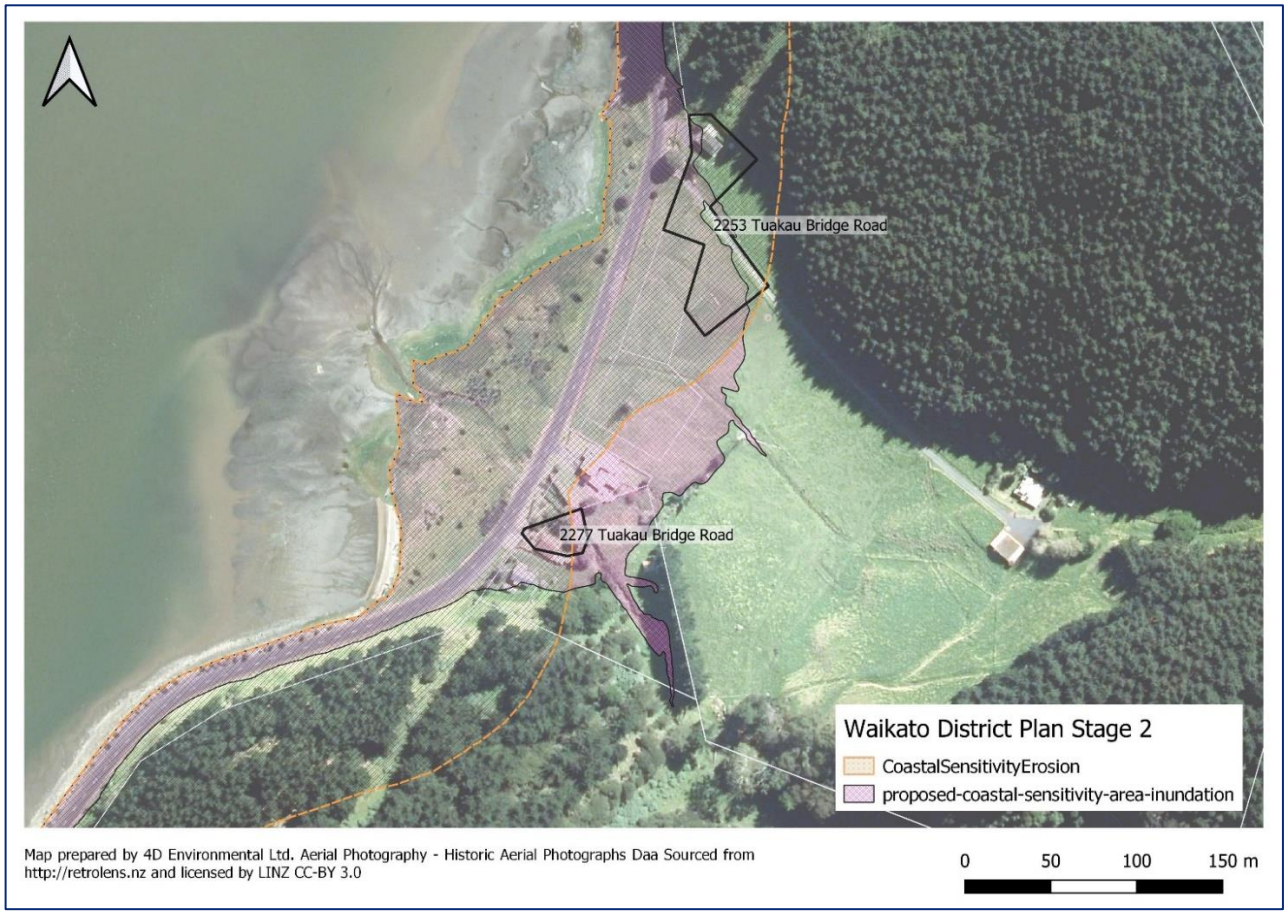


Figure 6: Location of submissions landward of Tuakau Bridge Road, Port Waikato showing the overlay of the proposed Coastal Sensitivity Inundation and Erosion.

Discussion - Coastal Erosion:

The Coastal Sensitivity Area (Erosion) is 100 m wide on rural estuarine shorelines. The properties in question here are landward of Tuakau Bridge Road, and 50-100 m from the bank of the Waikato River. The submitters here feel that this is over conservative and that the properties in question are unlikely to be impacted by coastal erosion even with sea level rise.

The 100 m wide Coastal Sensitivity Area (Erosion) does not a define "hazard" zone but represents an area within which coastal processes and hazards should be considered when new activities are proposed. In this relatively sheltered location, it is likely that the Coastal Sensitivity Area (Erosion) is somewhat conservative, although the long-term impact of 1.0 m of sea level rise is difficult to predict. Notwithstanding this, unlikely that the Council will "abandon" Tuakau Bridge Road as it is the key access to Port Waikato Township. As the Road is located within an estuarine/river environment, it is likely be practicable to maintain the road in the long term, even given future sea level rise. If the Council were to make a clear commitment to protecting this road in the foreseeable future, it would be reasonable to remove the Coastal Sensitivity Area (Erosion) from properties landward of the Road.

This decision is also relevant to properties on the shoreline of Raglan Harbour at Norrie Ave and is discussed in Section 5.3.4.

Recommendations:

We recommend that the Coastal Sensitivity Area (Inundation) remains mapped as it is at present, and that the Council ensures that provisions provide for ongoing appropriate use of land where there is currently little or no risk, while avoiding activities that may increase future risk or prevent landward adjustment of habitats in the future where this may be relevant.

We suggest that if the Council is committed to retaining Tuakau Bridge Road as key access to Port Waikato, the Coastal Sensitivity Area (Erosion) could be limited to the landward side of Tuakau Bridge Road as shown in Figure 7.

We also recommend that Council consider whether, as a consequence of this decision, this approach should be applied to all properties landward of Tuakau Bridge Road. No further submissions were received in this area, so this mapping adjustment has not been proposed at this stage.

Figure 7: Recommended revised Coastal Sensitivity Erosion overlay.

4.3. Port Waikato Beach and Spit

Port Waikato			
Port Waikato Township			
Grant Faulkner	2144	Delete High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Erosion) from map 11.1 for 22 Centreway Road, Port Waikato.	Maps - Coastal multiple
Jade McCormack	2165	**Delete** High Risk Coastal Hazard (Erosion) Area and Coastal Sensitivity Area (Erosion) from Map 11.1 Port Waikato.	Maps - Coastal multiple
Wayne Green	2174	Amend map 11.1 Port Waikato to accurately identify areas subject to the High Risk Coastal Hazard (Erosion) Area, and Coastal Sensitivity Area (Erosion) at Port Waikato, including 9 Ocean View Road.	Maps - Coastal multiple
Jamie Burrows	2008	Delete Coastal Sensitivity Area (Erosion) and High Risk Coastal Hazard (Inundation) Area from 40 Cordyline Road in Port Waikato and review the overlays on properties at 38 and 42 Cordyline Road in Port Waikato.	Maps - Coastal multiple
Julie Roulston	30009.1	The map over lay attributes two potential hazards to our property at 40 Cordyline Road. The altitude of our property in relation to other, close properties is substantially higher. These close and lower altitude properties are not threatened by the same hazards, therefore there are inconsistencies that should be challenged. If our property value drops as a result of these apparently recently discovered hazards, will the Council compensate the property owners?	Maps - Coastal multiple
Hamish Imrie on behalf of Hamish Imrie & Dr. Isabelle Miclette	2007	Amend the High Risk Coastal Hazard (Inundation) Area on 19 Cordyline Road, Port Waikato.	High Risk Coastal Hazard (Inundation) Area
Paul Wood	2051	Delete High Risk Coastal Hazard (inundation) Area on Map 11.1 from 26 Westside Road (Port Waikato). Or Compensate section holders in the Sunset Beach Ltd subdivision for Council's change of opinion on our land.	High Risk Coastal Hazard (Inundation) Area

4.3.1 Coastal Erosion

Submission #2174: Ocean View Road, Port Waikato

Submission: That the proposed Coastal Sensitivity Area (Erosion) be deleted the property at 9 Ocean View Road, Port Waikato.

Discussion:
The coastal sand spit at Port Waikato has changed dramatically over the historical record. Between 1942 and 2002, the overall width of the spit increased by up to 300 m and the shoreline of the township built seaward by approximately 100 m. Since 2007 there has been more than 50 m of erosion fronting the Township, and severe erosion of the river shoreline. Sunset Beach shoreline is still seaward of its position in the 1940s, but is continuing to erode, high rates of erosion in the last 5-10 years. As discussed in our coastal hazard assessment

(Focus, 2020) we cannot be sure whether the erosion will continue, or whether the recent erosion is part of complex multi-decadal dynamic shoreline change. It is simply not possible to predict future trends for shoreline change with any certainty. Moreover, given the high erosion rates in recent times we believe a prudent approach is essential.

The average erosion rate over the last 10 years has been approximately 5 m per year. The High Risk Coastal Hazard (Erosion) has therefore been defined to provide a plausible estimate for the most at risk area, based on the continuation of current trends (based on erosion rates over the last 10 years), for the timeline of the District Plan (~10 years).

Recommendation:
As we have outlined in our report, there is considerable uncertainty around future erosion in this area and an adaptive management approach is recommended. While it is quite possible that future erosion may be less or even more severe than shown, we do not believe it is possible to usefully revise the High Risk Coastal Hazard Area (Erosion) based on existing information. Given the rates experienced in recent years, the zone as defined highlights the width of coastal margin that is most likely to be impacted by coastal erosion over the lifetime of this District Plan.

We therefore recommend that the High Risk Coastal Hazard Area (Erosion) is retained as notified.

Submission #2144, #2165: Coastal Spit, Port Waikato

Submission: That the proposed Coastal Sensitivity Area (Erosion) be deleted from properties near the base of the spit at Port Waikato.

Discussion:
The Port Waikato Township is located almost entirely on a sand spit. The spit is a very dynamic feature and has grown northwards over 3 km since the first survey of 1863, with 1.2 km of growth just since the 1940s. There is further historical anecdotal and field data that suggests the landform has been both much larger than at present, and also that the River entrance channel was once hard against the hills on the southern side of the Township. These changes take place over long periods of time, many decades and even centuries.

Given the scale of change that has occurred over the last century and in prior centuries, significant change could be experienced over the next 100 years, particularly with the added complication of future sea level rise. Historical records have demonstrated that this spit is a very dynamic feature over long periods of time. In our view, there is currently no evidence of “hard” material underneath the sand spit, nor any other geological control that would prevent major erosion occurring.

In terms of the 100-year planning timeframe and a sea level rise scenario of 1.0 m, consideration has to be given not just to current erosion rates along the ocean shoreline and parts of the river shoreline but also potential large-scale changes (e.g. possible spit breaches) and the potential sea level rise.

Recommendations:

Given the large changes to the spit over the historical record, we believe caution is warranted until further investigation has more firmly established the dynamics of the spit over century and longer timeframes. We cannot reliably identify which areas of the spit will be affected by such change based on existing information. A precautionary approach is therefore appropriate in defining the Coastal Sensitivity Area (Erosion).
We therefore recommend retaining the Coastal Sensitivity Area (Erosion) as notified. It is important to emphasise that this is not a prediction that the entire spit will be eroded but simply an indication of the high level of long-term uncertainty.

We recommend that the Council continue to work with residents and landowners at Port Waikato to develop an adaptive management strategy that allows ongoing use of Port Waikato properties in a sustainable and resilient way, to reflect the uncertain and long-term nature of the hazard in the Coastal Sensitivity Area (Erosion).

4.3.2 Coastal Inundation

Submission #2007, #2008: Cordyline Road, Port Waikato

Submission: That the proposed High Risk Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) be amended to reflect the elevation of several properties on Cordyline Road, Port Waikato. The submitters note that these properties are significantly elevated in relation to adjacent properties and argue that the inundation mapping does not fairly account for some areas of raised elevation.

Discussion: Further examination of the elevation data indicates that ground levels at 19, 38, 40, 42 and 44 Cordyline Road are largely between 3.0 m and 7.5 m elevation and are therefore above the level that defines the High Risk Coastal Hazard Area (Inundation). Significant areas of these properties also have ground levels above 4.0 m and therefore are above the level that defines the Coastal Sensitivity Area (Inundation).

Recommendation:

We recommend that the mapping be revised to reflect areas within the notified High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) that are elevated above the relevant defined coastal inundation levels.

Submission #2051: 26 Westside Road, Port Waikato

Submission: That the High Risk Coastal Hazard (Inundation) area be amended or be removed from the property at 26 Westside Road, or that the section holders be compensated for the Council's change of opinion on the land.

Discussion:

The High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) are mapped according to ground levels. Ground levels at 26 Westside Road are between 2.3-2.9 m (MVD-53). The property is therefore very much at the upper extent of current coastal inundation risk but is still within the identified coastal inundation area. The risk to the property is currently low, as any coastal storm flooding with current

sea level would be rare and shallow. We have considered the variability in risk within the proposed High Risk Coastal Hazard Area (Inundation) in Section 2 and have recommended that the area be retained, with future development managed to ensure it is resilient and adaptable.

The submission notes that the property at Westside Road is part of a relatively recent (2009) subdivision, and that the coastal inundation overlay represents a "change of opinion" by the Council on this land. At time of the subdivision, an assessment of coastal hazards was undertaken by Tonkin & Taylor Ltd (Tonkin & Taylor, 2007; Tonkin & Taylor, 2009) and reviewed by ASR (2007). Tonkin & Taylor (2007) identified a maximum water level of 3.25 m and recommended a 3.75 m minimum design floor level to provide for coastal inundation. This level was reviewed and supported by ASR (2007) and included 0.5 m of sea level rise and 0.5 m of freeboard.

The coastal hazard assessment by Tonkin & Taylor (2007) noted that "flooding from the estuary/river direction will be mitigated by appropriate floor design levels". While this minimum floor level provides protection to dwellings from potential coastal inundation, land levels in much of Port Waikato Township (including northern and eastern parts of Westside Road) are below 3.0 m and are therefore potentially vulnerable to coastal flooding from the estuary. This was recognised at the time of the Westside Road subdivision and is reflected in the implementation of minimum floor levels.

The Stormwater Catchment Management Plan prepared by the (then Franklin) District Council in 2004 also acknowledged the vulnerability of the low-lying areas within Port Waikato township to stormwater flooding.

Recommendation:

That the proposed High Risk Coastal Hazard Area (Inundation) be retained, with the recommendation that provisions provide for appropriate (adaptable and/or resilient) development as discussed in Section 2, to reflect the variability in risk.

Submission #2144: 22 Centreway Road, Port Waikato

Submission: That the High Risk Coastal Hazard Area (Inundation) be removed from the property at 22 Centreway Road.

Discussion: 22 Centreway Road lies completely within the notified High Risk Coastal Hazard (Inundation) Area. However, examination of elevation data indicates that the building platform on the western portion of the property is elevated (~3.0-3.3 m MVD-53) and above the level used to define the proposed hazard area. The remainder of the property is lower (~2.6-2.8 m MVD-53) and is therefore potentially vulnerable to occasional shallow flooding associated with an extreme storm surge event.

Recommendation:

That the proposed High Risk Coastal Hazard Area (Inundation) be amended to reflect the raised building platform (which will become Coastal Sensitivity Area (Inundation)). That the High Risk Coastal Hazard Area (Inundation) be retained as notified in the remaining areas below 3.0 m (MVD-53), with the recommendation that provisions provide for appropriate (adaptable and/or resilient) development as discussed in Section 2, to reflect the variability in risk.

5. Raglan

5.1. Te Akau South

Te Akau South			
Ian & Desiree McDonald	2001	Amend Coastal Sensitivity Area (Erosion) overlay on 9 Ryan Road, Te Akau South by undertaking detailed investigation and mapping of land based on local soil and rock formations.	Coastal Sensitivity Area (Erosion)
Megan & Stuart Pearson	2020	Delete Coastal Sensitivity Area (Erosion) from 604 Te Akau Wharf Road. And Improve mapping specific to our area.	Coastal Sensitivity Area (Erosion)
Eric Messick	2055	Amend the boundary of the Coastal Sensitivity Area (Erosion) in Horongarara Esplanade on Map 23.3.	Coastal Sensitivity Area (Erosion)
Peter Taylor on behalf of P & M Taylor	2065	Amend Map 23.3 Raglan West to revise the Coastal Sensitivity Area (Erosion) at 11D Ryan Road, Te Akau following a detailed study of the property.	Coastal Sensitivity Area (Erosion)
Andrew Wilson	2066	Amend map to remove Coastal Sensitivity Area (Erosion) from the submitter's property at 2E Ryan Road, Te Akau South. (Note: property address was supplied by submitter on 3.11.20).	Coastal Sensitivity Area (Erosion)
Trish Waugh	2080	Amend Map 23.3 Raglan West by improving the accuracy of the Coastal Sensitivity Area (Erosion) at Ryan Road area, Te Akau South.	Coastal Sensitivity Area (Erosion)
Robin Michael N Hood	2119	Delete the Coastal Sensitivity Area (Erosion) from map 23.3 Raglan West in the vicinity of Horongarara and Ryan Road at Te Akau South.	Coastal Sensitivity Area (Erosion)
Georgina O'Brien	2124	Amend Map 23.3 - Raglan West to remove the Coastal Sensitivity Area (Erosion) from the property at 10D Ryan Road.	Coastal Sensitivity Area (Erosion)
Louise Davis	2182	Amend Map 23.3 Raglan West of the vicinity of Horongarara Te Akau South, so Coastal Sensitivity Area (Inundation) boundaries along Horongarara Esplanade are further seaward and end on WDC esplanade.	Coastal Sensitivity Area (Inundation)
Megan Pearson on behalf of Horongarara Community Group	2021	Amend Map 23.3 Raglan West – Coastal Sensitivity Areas relating to Ryan Road subdivision by individually mapping parcels after a detailed investigation.	Coastal Sensitivity Area (Erosion)
Will Gauntlett for Waikato District Council on behalf of Gavin Ion	2146	Amend the Coastal Sensitivity Area (Erosion) map after undertaking a detailed slope analysis based on local shoreline around Te Akau South residential zoned properties. See attachment 3 of the submission for the location map; AND Any consequential amendments as required; AND Any other change necessary to give effect to the intent of this relief sought and to achieve the purpose of the Resource Management Act 1991.	Coastal Sensitivity Area (Erosion)

Submission #2001, #2020, #2021, #2055, #2065, #2066, #2080, #2119, #2124, #2146: Ryan Road and Te Akau Wharf Road, Te Akau South.

Submission: That a site-specific investigation be undertaken to define a more appropriate Coastal Sensitivity Area (Erosion) for the Te Akau South village area on Horongarara Peninsula.

Discussion:
Ryan Road subdivision is a cliff-top village located on the Horongarara Peninsula, on the northern shore of the Raglan Harbour. The subdivision consists of 37 residential sections, approximately 14 with coastal frontage. The area is elevated (10-40 m above sea level) and fronted by near vertical cliffs of varied height and geology. This area was included in generic 100 m wide Coastal Sensitivity Zone (Erosion), which applies to the rural estuarine shoreline within the District. This sensitivity zone overlays large portions (and in some cases, all) of some properties on Ryan Road, as well as the property at 604 Te Akau Wharf Road. The shoreline is fronted by relatively hard cliffs and it is likely that a more detailed investigation such as that undertaken on the residential shoreline of Raglan Harbour would allow for a reduction of the width of the Coastal Sensitivity Area (Erosion) at least in some areas. Given the higher intensity of development and Village zoning, it is appropriate to consider likely coastal erosion hazard in more detail.

This was recognised early in the Stage 2 notification and submission process, and Council has commissioned a more detailed consideration of an appropriate Coastal Sensitivity Area (Erosion). The outcomes of this investigation are reported in Appendix 2: Review of Coastal Hazards and Coastal Sensitivity Area at Te Akau South.

Recommendation:
We recommend that the Coastal Sensitivity Area (Erosion) be amended to reflect the outcomes and recommendations of Appendix 2: Review of Coastal Hazards and Coastal Sensitivity Area at Te Akau South.

This coastal hazard assessment has identified criteria for the definition of a High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) on the coastal margin of Te Akau south, including 604 Te Akau Wharf Road, and the Village zone area on the Horongarara Peninsula. The revised coastal hazard and sensitivity areas vary in width depending on the geology, elevation and slope of the coastal margin from 20-60 m (High Risk Coastal Hazard) and 30-80 m (Coastal Sensitivity). The area is widest backing the high steep slopes at 2a and 2c Ryan Road and 585 Te Akau Wharf Road (Figure 8).

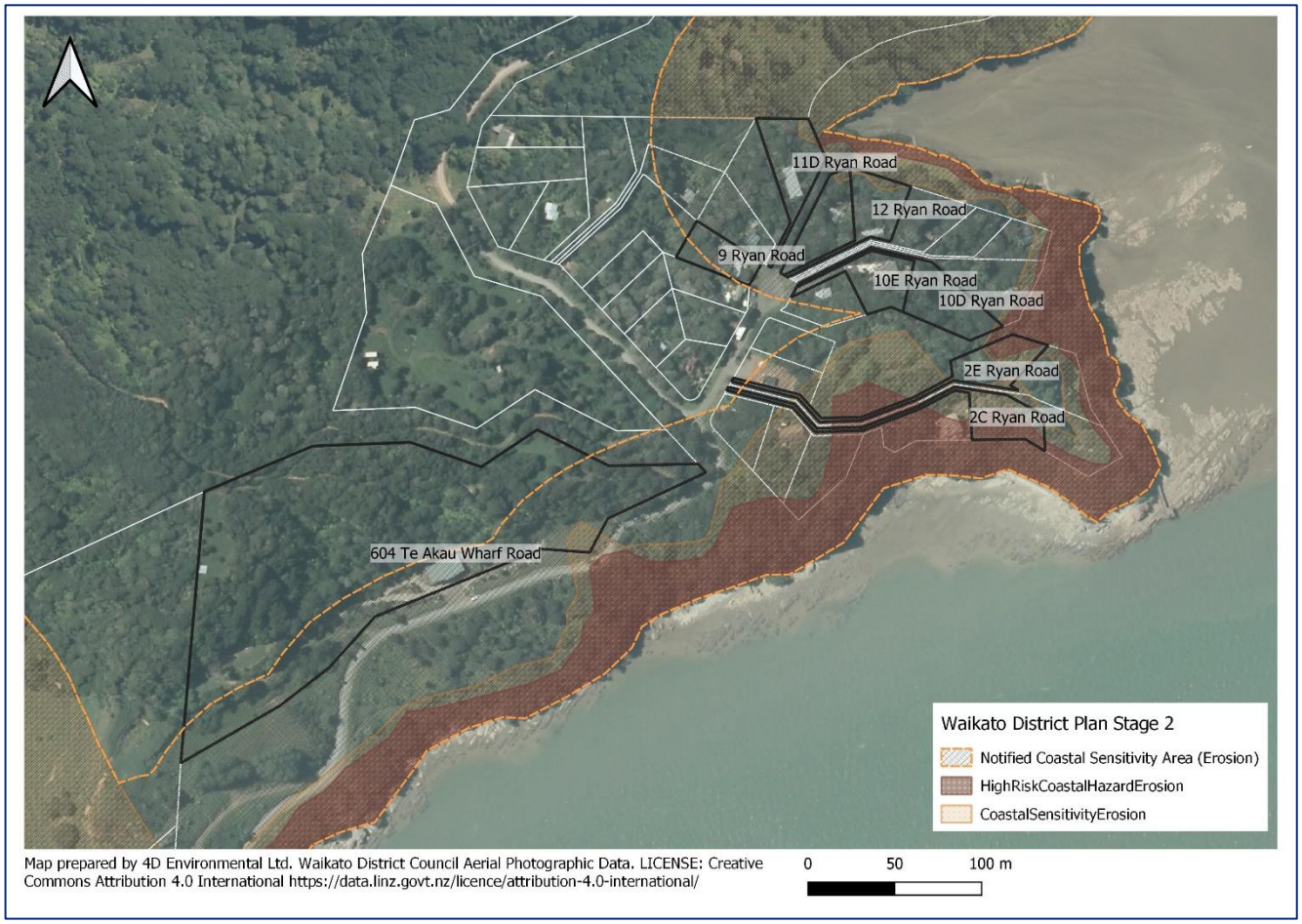


Figure 8: Notified Coastal Sensitivity Area (Erosion) and recommended High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) at Te Akau South.

5.2. Cliff Stability

The Council has received a number of submissions relating to the High-Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) along the shoreline of Cox Bay and Greenslade Road. These areas are fronted by a shore platform and steeply sloping cliffs up to 30 m in height (Figure 9).

Section 3 provides a summary of processes of cliff erosion and a brief outline of the approach that was taken to mapping high risk coastal hazard and coastal sensitivity areas. The available evidence suggests that erosion rates are slow in these areas, so we have assessed the hazard in this area as relating primarily to the risk of slope instability. In general, we adopted a relatively precautionary approach to mapping potential slope instability in our first pass assessment; based observations of the existing slopes in the area. In some areas, existing slopes are close to 1V:2H. Elsewhere along this coast, the cliff face lies at a much steeper angle (1V:1H – 1V:1.5H). With the information available to us, it is not possible to determine with any certainty whether the extent to which steeper, higher areas are "over-steepened" and vulnerable to slope failure. Geological and geotechnical factors that control these failures would need to be established on a site-specific basis.

Blair (1998) highlighted the risk of significant potential cliff slope failure in the Cox Bay area and classified the are as high risk for coastal cliff hazard. The peer review of the hazard report by Tonkin & Taylor encouraged the use of a conservative stable slope value that reflected the occurrence of 1V:2H slopes in some areas.

Given the slow observed toe erosion rates, the proposed High Risk Coastal Hazard Area (Erosion) does not include any allowance for significant toe erosion. This hazard area is instead based on a stable slope from the toe of cliff of 1V:2H. The Coastal Sensitivity Area (Erosion) includes an allowance for 5 m of erosion over the coming 100 years based on a sea level rise of 1.0 m. The High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) are therefore related primarily to slope instability rather than significant coastal retreat at the toe of the cliff. The slope-based technique means that the width of the identified zone is greater in steep elevated areas.

The relevant submissions are summarised and discussed below. We have also provided some recommendations for amendment of the High Risk Coastal Hazard Area (Erosion). Further refinement for individual properties would require more detailed site-specific investigation.

5.2.1 Cox Bay

Cox Bay			
Renald Furer	2059	Amend or delete High Risk Coastal Hazard (Erosion) Area and Coastal Sensitivity Area (Erosion) on Map 23.3 (Raglan West) so that the overlays no longer apply to 27 Lily Street Raglan.	Maps - Coastal multiple
Peter & Kerry Santner	2076	Amend Map 23.4 (Raglan East) by removing the High Risk Coastal Hazard (Erosion) Area and Coastal Sensitivity Area (Erosion) from the property located at 31 Lily Street, Raglan.	Maps - Coastal multiple
Alex Staheli (and Vicki Stokes)	2087	Delete the High-Risk Coastal Hazard (Erosion) Area from 29 Lily Street, Raglan. And Delete the Coastal Sensitivity Area (Erosion) from 29 Lily Street, Raglan.	Maps - Coastal multiple
Terry Yorston	2022	Amend Map 23.3 Raglan West to remove High Risk Coastal (Erosion) Area from 28 Government Road, Raglan. Submitter requests site visit from council engineer or planner.	High Risk Coastal Hazard (Erosion) Area
Dorothy Wray	2012	Submitter requests that council look at reserve next to property at the end of Lily Street 7 Raglan.	
Jane West	2081	Amend Map 23.4 Raglan East, to remove the Coastal Sensitivity Area (Erosion) from the property at 7 Daisy Street, Raglan.	High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion)
Kane Ongley on behalf of Mary-Rose Speakman	2017	Amend High Risk Coastal Hazard Erosion Area as it relates to 31 Bay View Road, Raglan. Submitter requests a site visit.	High Risk Coastal Hazard (Erosion) Area and Coastal

			Sensitivity Area (Erosion)
Ruth Walden on behalf of Ruth & Shane Walden and Jane Lee-Smith	2054	Amend High Risk Coastal Hazard (Erosion) Area on Map 23.4 as shown on the submission to take into account the stabilisation and anti-erosion measures carried out on the property at 39 Bay View Road, Raglan.	High Risk Coastal Hazard (Erosion) Area

Submission #2059, #2076, #2087, #2012, #2022: Lily Street and Government Road, Raglan

Submission #2017, #2054, #2081: Daisy Street and Bay View Road, Raglan

Submissions: That the High Risk Coastal Hazard Area (Erosion) be amended or deleted from the related properties. That the slope used to define the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) is overly conservative and does not represent the actual hazard. That the landslide at the end of Lily Street be inspected. Property owners are concerned about the impact of the High Risk Coastal Hazard Area (Erosion) on insurance and property values.

Discussion:
The cliffs in this area are formed from calcareous siltstone and sandstone (Aotea Formation), which weathers and erodes slowly at the base, with subsequent slope failure. Block failure of sandstone material is evident in the boulders present on the shore platform. Shallow slope failures can be observed at multiple locations along the shoreline (Figure 10).

The properties at 27, 29 and 31 Lily Street are significantly affected by the High-Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion). The properties are fronted by a reserve to seaward and the existing dwellings are located more than 50 m from the shoreline at an elevation of 20-30 m above sea level. The properties at 27 and 29 Lily Street and 28 Government Road are relatively flat, but the reserve to seaward is steeply sloping (approximately 1V:1H) (Figure 11, Figure 12). The property at 31 Lily Street is sloping and fronted by a very steep coastal cliff, which is steeper than 1V:1H. The High Risk and Coastal Sensitivity Areas reflect the potential for failure of these very steep slopes.

Number 7 Daisy Street is elevated, and the existing dwelling is located at approximately 12 m above sea level. The reserve to seaward of the property slopes steeply from the shore to 9-10 m elevation, at a slope of nearly 1V:1H. Further landward, slopes decrease to between 1V:1.5H and 1V:2H. The High-Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) overlay the north eastern corner of the property, seaward of the dwelling. The eastern portion of the property has lower gradients, and therefore the hazard and sensitivity areas are reduced in width in this area (Figure 14).

Figure 9: Coastal cliffs, Cox Bay (fronting Lily Street and Government Road.

Figure 10: Cliff face fronting 27-31 Lily Street, showing active slope instability (February 2021).

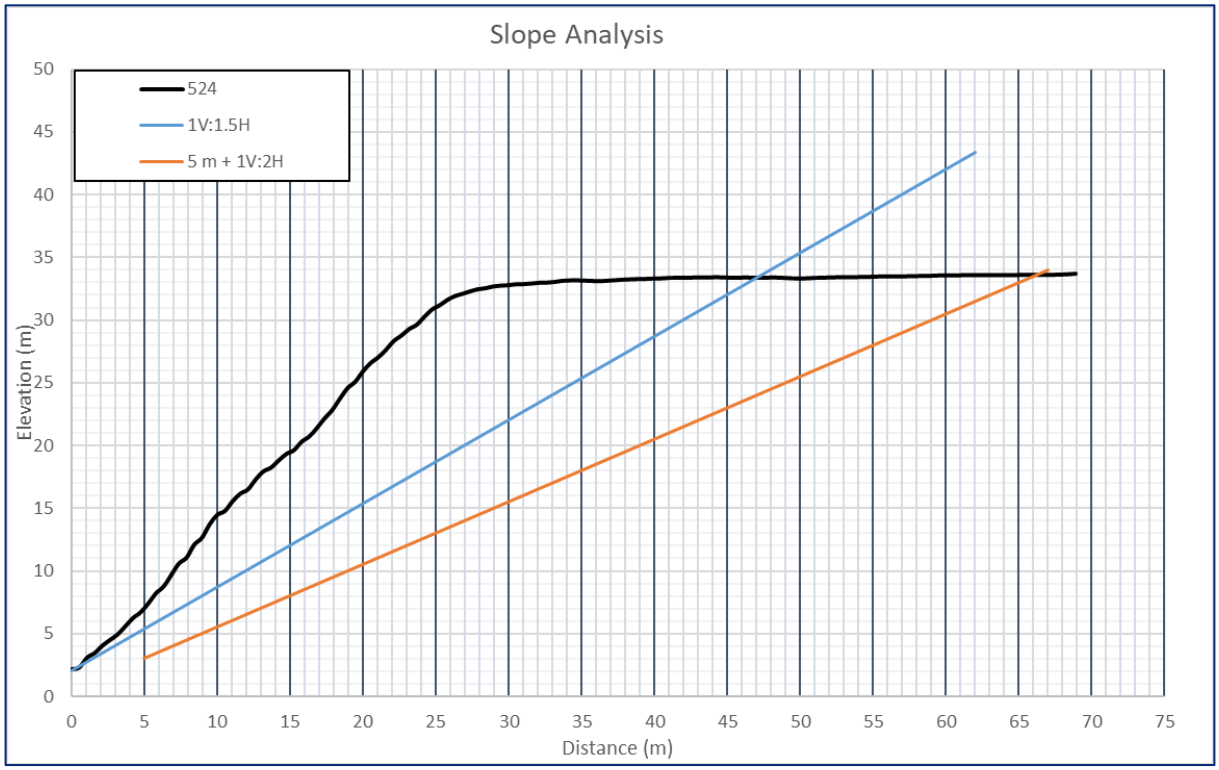


Figure 11: Cross shore profile at 27 Lily Street, illustrating steep elevated topography.

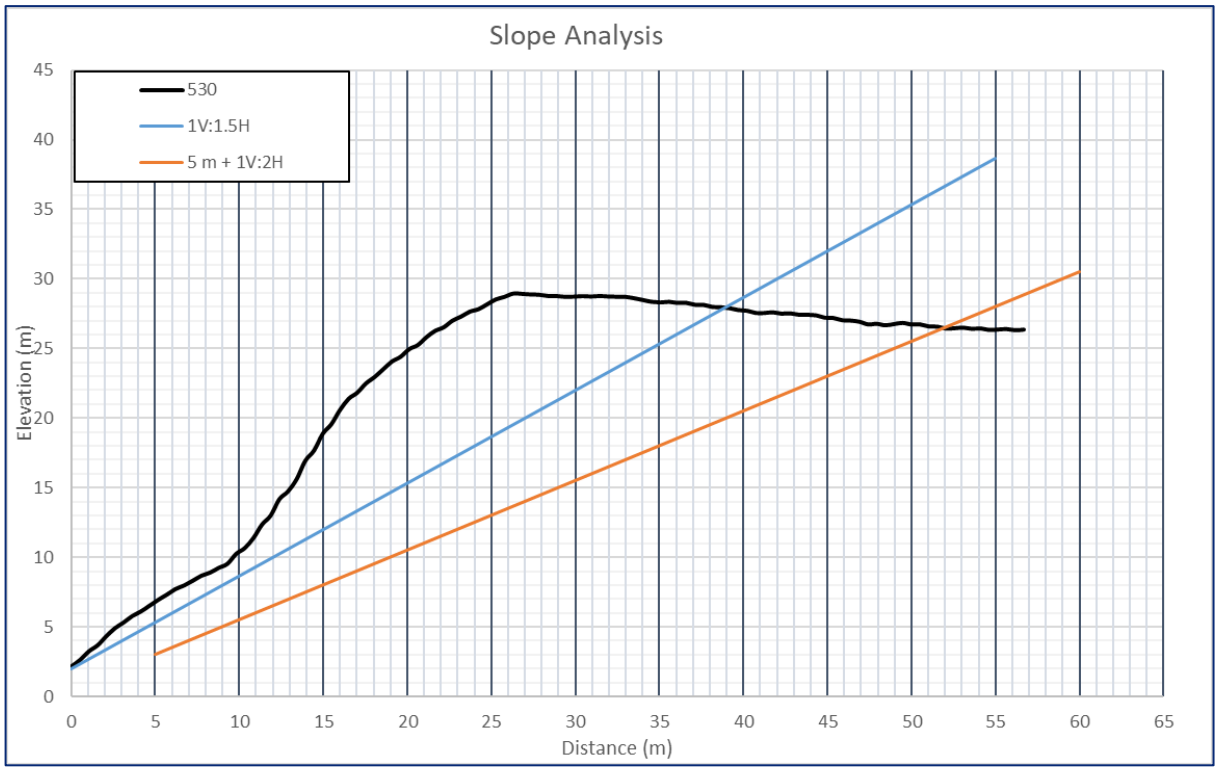


Figure 12: Cross shore profile at the eastern boundary of 28 Government Road.

Two submissions have been received that relate to the High-Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion), which overlay significant portions of the properties at the seaward end of Bayview Road. 31 and 39 Bayview Road are both deep, elevated properties (>20 m elevation) northwest of Lorenzen Bay. Both properties are fronted by high coastal cliffs with slopes of approximately 1V:1H.

Site visits were undertaken at 31 and 39 Bay View Road, to gather further site-specific information and a field inspection was also completed to gather up to date information about the state of the shoreline and existing instability. During a site visit to 31 Bay View Road, observations were made of the top edge of a recent landslide on the neighbouring property. This provided useful insight into the potential failure slopes in the area. Based on the location of the landward edge of the land slide allowed an estimation of the gradient of the slip (Figure 13). These measurements and other observations of local cliff slopes suggests that most failures are within a 1V:1H – 1V:1.5H slope. Accordingly, we believe that the High Risk Coastal Hazard Area (Erosion) can be amended to reflect a steeper stable slope of 1V:1.5H.

Nonetheless, given variability in geology and a lack of information about the depth and nature of potential slope failure, we cannot be confident that failures to a lower gradient won't occur occasionally in localised areas. The Coastal Sensitivity Area (Erosion) provides for this uncertainty.

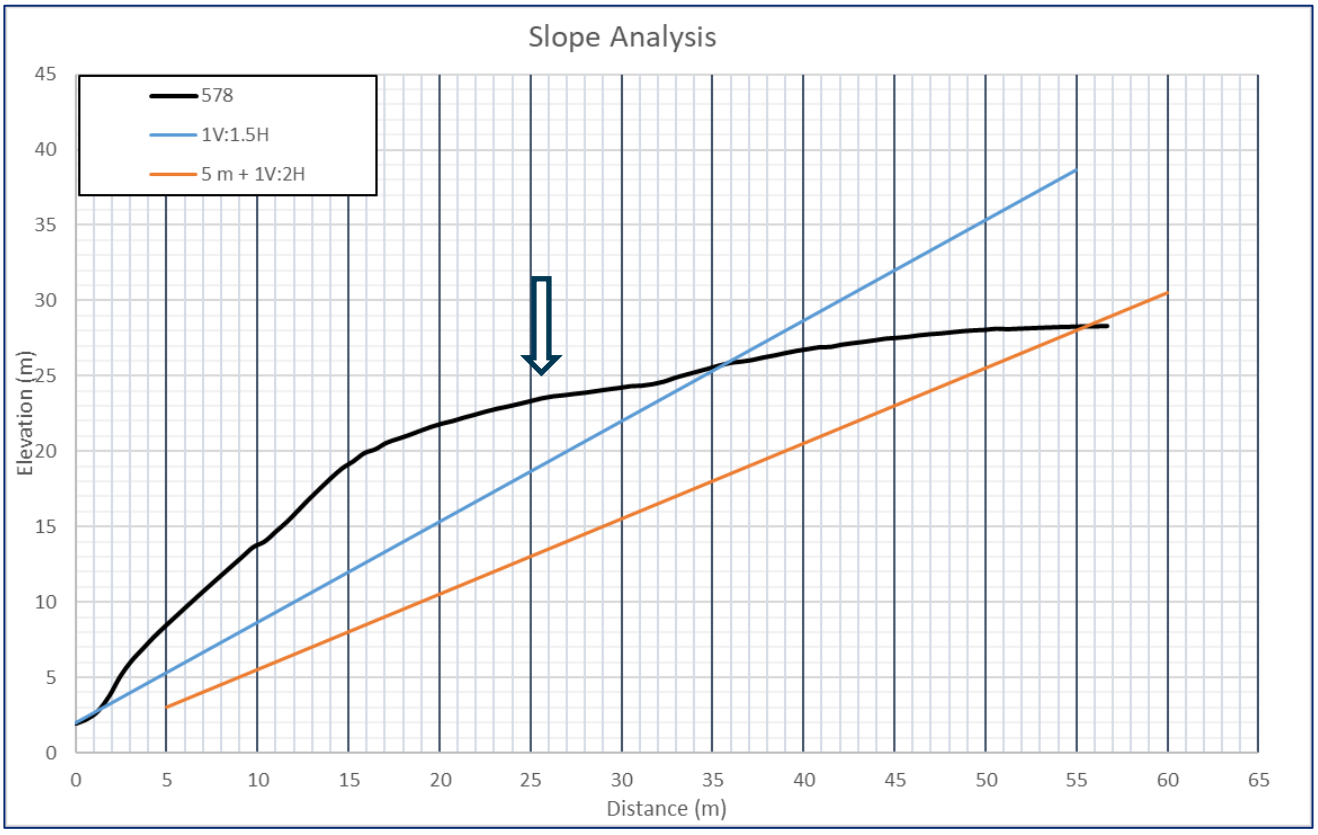


Figure 13: Cross section at location of recent land slip on Bay View Road. Elevation data represents pre-slip profile. Blue arrow indicates approximate location of landward slip edge.

Recommendation:

We recommend that the High Risk Coastal Hazard Area (Erosion) be amended to reflect a steeper stable slope (1V:1.5H) (Figure 14 & Figure 15). This slope is consistent with observed failures in the area.

More significant land instability cannot be ruled out based on current information, so we recommend retaining the Coastal Sensitivity Area (Erosion) as notified, to ensure consideration is given to the extent of site-specific coastal hazard. As discussed in Section 3, this Sensitivity Area is not a defined "hazard" area, but simply a recognition of the need for coastal processes and hazards to be considered.

Figure 14: Recommended refinement of High Risk Coastal Hazard Area (Erosion) at Lily Street and Government Road. The darker shaded area indicates the refined high risk area.

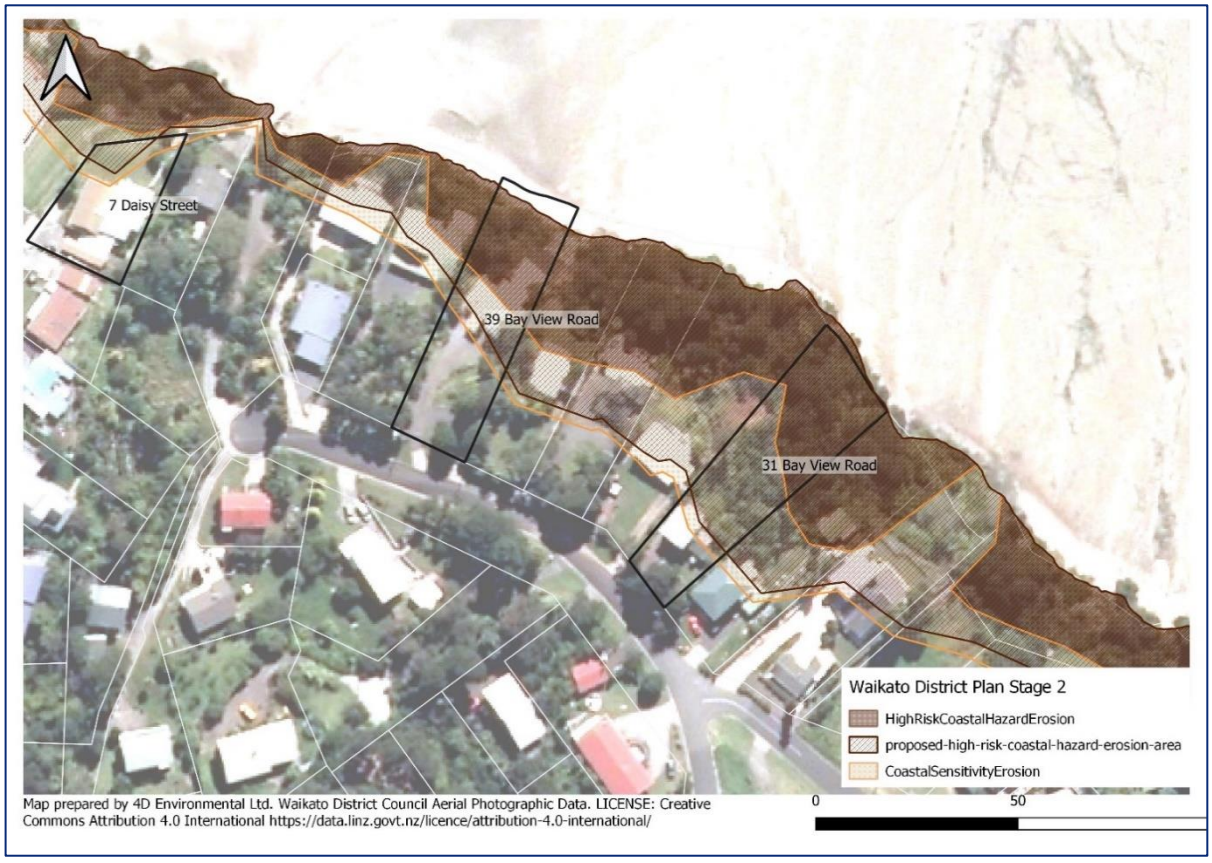


Figure 15: Recommended refinement of High Risk Coastal Hazard Area (Erosion) at Daisy Street and Bay View Road. The darker shaded area indicates the refined high risk area.

5.2.2 Greenslade Road

Greenslade Road/Sandy Bay			
Peter Scott on behalf of P & T Boyle, R Youmans, P & S Scott, W Sutton, I Farrelly	2163	Amend Planning Map 23.4 to remove High Risk Coastal Hazard (Erosion) Area from the properties located at 104C, 104B, 106G, 106H, 106J Greenslade Road, Raglan OR amend Area to a more realistic and less encroaching estimation in line with a 1:1 gradient.	High Risk Coastal Hazard (Erosion) Area

Submission #2163: Greenslade Road, Raglan

Submission: Received on behalf of a group of residents at Greenslade Road, requesting that the High Risk Coastal Hazard Area (Erosion) be removed from the properties, or that a more realistic stable slope be applied (1V:1H).

Discussion:
A meeting was held on site with representatives of the submitter group. The primary concern of the group is that they feel the area is backed by naturally very steep slopes that are relatively stable when managed well. Much of the length of the cliff is fronted by seawalls to prevent toe erosion. Residents have commissioned

geotechnical advice and undertaken a planting and vegetation management programme to aid in preventing further failures. The group felt that the 1V:2H stable slope applied in the definition of the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) was excessive and encroached unreasonably and unrealistically into the properties. Current slopes in most areas are approximately 1V:1H.

Further field observations were made, with particular attention to a relatively recent (July 2017) slope failure in the Council reserve fronting 104c Greenslade Road (Figure 16). Field measurements and analysis of the DEM data indicates that the slope of this failure is close to 1V:1.5H (Figure 17). This provided useful insight into the potential failure slopes in the area. It is possible that site specific investigations (combined with careful management) may confirm that steeper slopes can be maintained safely, at least in some areas. However, we do not have sufficient data to apply a steeper slope broadly across the area.

The geology underlying the Greenslade Road area is mapped as volcanic sediments (Okete Volcanic Formation) (Waterhouse & White, 1994). East of 104c Greenslade Road, the shore is backed by a basaltic cobble beach and shore platform (background of Figure 16) but the embayment and high steep slopes fronting the focus area suggest a change in underlying geology. Shoreline protection works at the base of the slopes limit exposures at the shoreline and make it difficult to evaluate. Visible material consists primarily of slipped surface soils.

Figure 16: Coastline fronting Greenslade Road properties. Location of recent slope failure marked with white arrow.

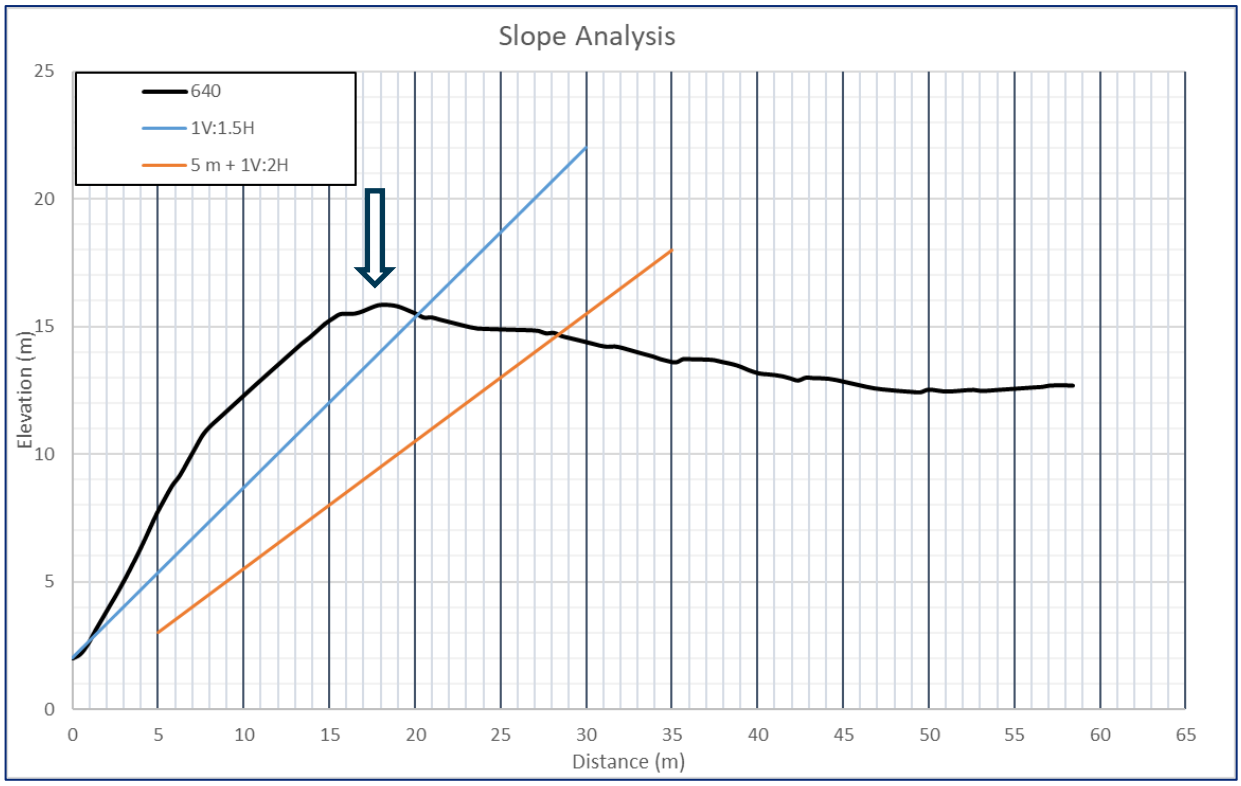


Figure 17: Cross section through coastal reserve seaward of 104c Greenslade Road. Elevation data pre-dates slip event. Blue arrow marks the approximate location of top of slope failure.

Recommendations:

We recommend that the High Risk Coastal Hazard Area (Erosion) be amended to reflect a steeper stable slope (1V:1.5H) (shown in Figure 18). While most existing slopes are steeper than 1V:1.5H, this slope provides for failures such as that observed at 104c Greenslade Road. While ongoing management of the cliffs will help to prevent such failures, with current knowledge it is not possible to assume that such actions can limit all future failure to slopes of 1V:1H or steeper.

We therefore recommend retaining the Coastal Sensitivity Area (Erosion) as notified, to ensure full consideration is given to the extent of site-specific coastal hazard when new development is proposed. As discussed in Section 3, this Sensitivity Area is not a defined "hazard" area, but simply recognition of the need for coastal processes and hazards to be considered at the time of any significant new development or intensification.

There is a group of property owners who are invested in preserving slope stability and maintaining this area as a high value recreational space. We would recommend that Council work with this community to establish a plan for the management of the shoreline. This plan should consider the management of slope instability in both private property and Council reserve. We note that as part of this process, an agreed approach to the use of shoreline armouring works and/or retaining structures is required, which considers the benefits and potential impacts of various approaches.

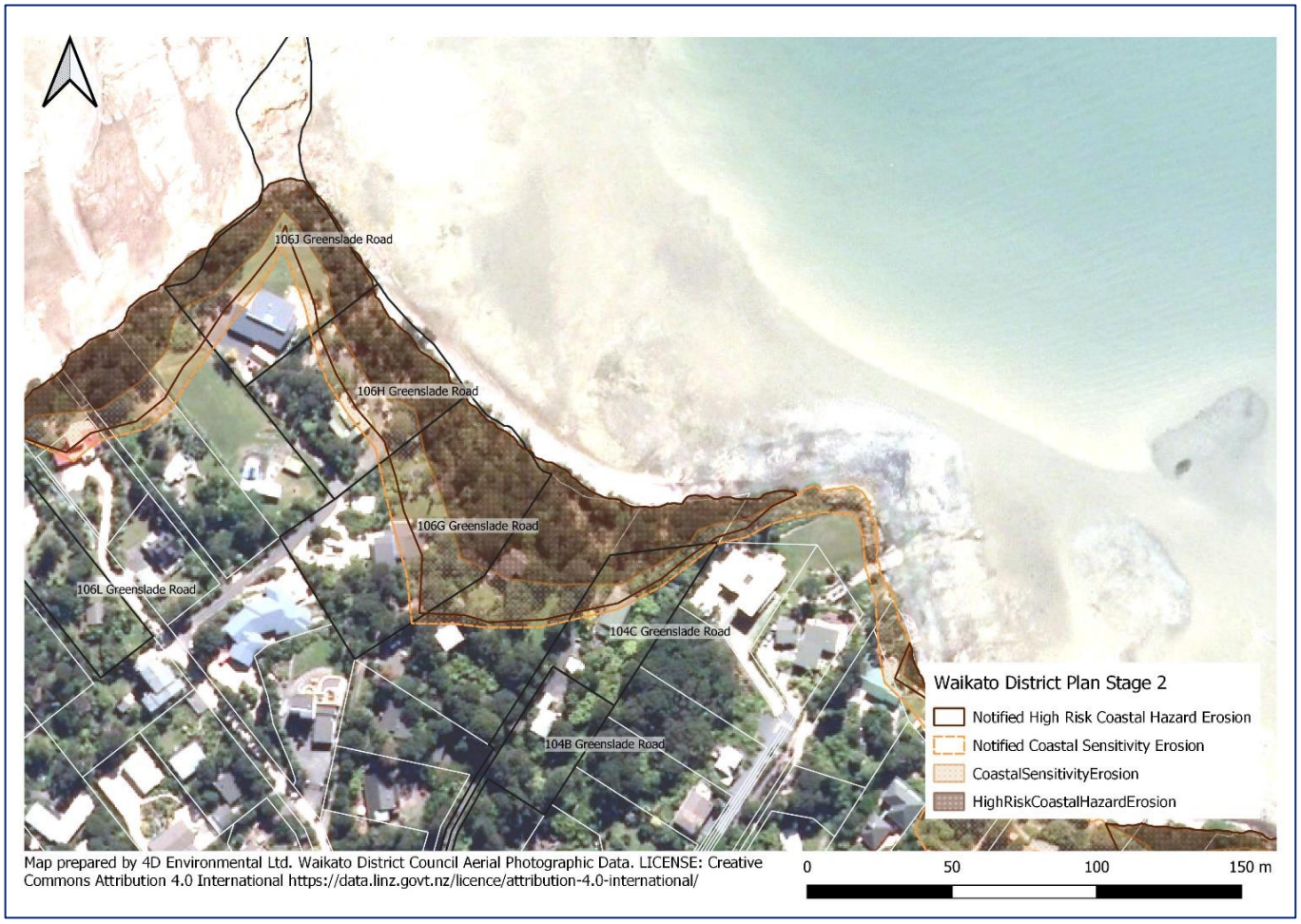


Figure 18: Recommended refinement of High Risk Coastal Hazard Area (Erosion) at Greenslade Road

5.3 Raglan Township Shoreline

Raglan Township				
Lorenzen Bay				
Christopher John Mitchell	2098		Amend Map 23.4 (Raglan East), to remove High Risk Coastal Hazard and Coastal Sensitivity Areas (Erosion & Inundation) from 95 Lorenzen Bay Road, Raglan.	Maps - Coastal multiple
Pauline & Matthew Davies on behalf of Barratt Davies Family Trust	2067		Delete High Risk Coastal Hazard (Erosion) Area, Coastal Sensitivity Area (Erosion), High Risk Coastal Hazard (Inundation) Area and Coastal Sensitivity Area (Inundation) from 95B Lorenzen Bay Road, Raglan.	Maps - Coastal multiple
Raymond Brown	2014		Delete Coastal Sensitivity Area (Erosion), Coastal Sensitivity Area (Inundation), High Risk Coastal Hazard (Erosion) Area and High Risk Coastal (Inundation) Area from 106L Greenslade Road, Raglan. Submitter suggested Council visit the property and meet with the owner.	Maps - Coastal multiple
Wallis Street				
Grant Brady on behalf of Grant & Ros Brady	2141		Amend Map 23.3 Raglan West to remove the Coastal Sensitivity Area (Inundation) from 68 Wallis Street, Raglan.	Coastal Sensitivity Area (Inundation)
Nihinihi Ave Area				
Brett Curle	2069		Delete the High-Risk Coastal Hazard (Inundation) Area from 6 Nihinihi Avenue, Raglan as shown on Map 23.3 Raglan West.	High Risk Coastal Hazard (Inundation) Area
Sue Wood	2137		Amend Planning Map 23.3 Raglan West Coastal Sensitivity Area (Inundation) line on 10 Pokohui Avenue, Raglan to a lower level, more in line with the risk assessment and survey information provided.	Coastal Sensitivity Area (Inundation)
Norrie Ave				
Jason & Kim Borich & Osborne	2003		Amend the Coastal Sensitivity Area (Erosion) overlay to remove it from all properties along Norrie Ave, Raglan, in particular number 24 Norrie Ave. **Amend** the High Risk Coastal Hazard (Erosion) Area overlay to remove the overlay from all properties along Norrie Ave, Raglan, in particular number 24 Norrie Ave.	High Risk Coastal Hazard (Erosion) and Coastal Sensitivity (Erosion)
Michelle & John Major for Jadam Trust	2009		Amend Map 23.45 Raglan Town Centre, to remove the Coastal Sensitivity Area (Erosion) overlay from properties at 22, 24 and 26 Norrie Ave Raglan as shown on the map provided in our submission. Amend Map 23.5 Raglan Town Centre to remove the High Risk Coastal Hazard (Erosion) Area overlay from properties at 22, 24 and 26 Norrie Ave Raglan as shown on the map provided in our submission.	High Risk and Coastal Sensitivity (Erosion)

5.3.1 Lorenzen Bay

Submission #2098, #2067, #2014: Lorenzen Bay, Raglan

Submissions: Request removal of the overlay of both the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) at Lorenzen Bay. Also requesting removal of the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion).

Figure 19 and Figure 20 illustrate the extent to which the Coastal Inundation and Coastal Erosion overlays affect the properties at Lorenzen Bay. Submitters at Lorenzen Bay have objected to the High Risk Coastal Hazard Areas and Coastal Sensitivity Areas on the basis that the properties in question have not been inundated in the past, and are protected by long established seawalls, and that these seawalls have not been breached in the past. Concern is expressed over the significance of the overlays and the potential impact on property values and insurability.

Figure 19: Coastal erosion overlays at Lorenzen Bay.

Figure 20: Coastal inundation overlays at Lorenzen Bay.

Discussion – Coastal Erosion:

The properties in question are located on a low-lying terrace on the eastern side of Lorenzen Bay. This terrace is naturally formed from estuarine and terrestrial sands, silts and conglomerate. Since the early 20th century this area (which would have been naturally susceptible to coastal erosion) has been highly modified with fill and protection structures.

At Lorenzen Bay, coastal protection works have been in place since aerial photographic records began, making it very difficult to assess natural erosion rates or shoreline fluctuations. The shoreline has also been artificially reclaimed in some areas so the seawalls may be backed by readily erodible fill rather than natural sediments. In Focus (2020) we have recommended the establishment of an adaptive management plan for the site to determine the long-term management of the shoreline and establish the location and role of any shoreline protection works.

As an interim measure, we have defined a High-Risk Coastal Hazard Area (Erosion) of 10 m relative to our adopted baseline that represents an approximate natural shoreline alignment. This represents the area at greatest risk from coastal erosion with current sea level. More detailed investigations, including subsurface data, would be required to further refine this area. The High Risk Coastal Hazard Area (Erosion) primarily

extends across the low lying terrace seaward of the existing dwelling at 95 Lorenzen Bay and 106L Lorenzen Bay Road (Figure 19).

In the longer term, sea level rise of 1.0 m may drive shoreline retreat of approximately 15 m (in the absence of engineered protection); based on slopes typical of local estuarine beaches. Accordingly, the coastal erosion sensitivity area has assumed a total erosion of 25 m. The width of this Coastal Sensitivity Area (Erosion) is limited at 106L Greenslade Road by the elevated "hard" volcanic sediments landward of the coastal terrace.

It is relevant to note here that coastal erosion (in terms of both the high risk and sensitivity areas) has been assessed without regard to existing or future alternative coastal protection works. It seems likely that coastal protection of some sort will be part of any agreed long term adaptive management strategy but note that such works may or not include all existing structures. Hard coastal structures are a last resort under existing national coastal policy and quite stringent standards will likely need to be met for any structures that are part of a long-term solution, including environmental matters related to public access and amenity and to the natural and the landscape character of the shoreline. If coastal structures (either the existing or alternative works) or alternative protection are agreed to as part of a long-term adaptive management plan for the area, the management areas may be modified accordingly. These coastal hazard management areas cannot simply be modified on the basis of existing works as these works have not been consented as long-term solutions to erosion in this area.

Discussion – Coastal Inundation

The property at 95 Lorenzen Bay Road is very low-lying, with most of the land at approximately 2.5 m (MVD-53). The most seaward portion of the property at 95b Lorenzen Bay Road lies at approximately 2.8 m (MVD-53) (Figure 21). Both properties are therefore potentially vulnerable to minor flooding in an extreme event with current sea level. Even a minor amount of future sea level rise would greatly increase the frequency and severity of flooding events.

The seaward portion of the property at 106L Greenslade Road is relatively low lying (~3.0 m MVD-53) and rises to landward. The High-Risk Coastal Hazard (Inundation) and Coastal Sensitivity Area (Inundation) overlay just the lowest lying areas of the seaward terrace, seaward of the dwelling. During a site visit, the owner confirmed that in extreme events, storm tide levels extend onto the most seaward edge of the lawn above the top of the sea wall.

The coastal inundation level adopted is based on the maximum likely coastal flood event as assessed by NIWA (Stephens et al. 2015) and knowledge gathered during our coastal hazard assessment (Focus, 2020). As discussed in Section 2, this may be slightly conservative, but this is required given the limitations of existing information. The conservatism has also been slightly reduced by the rounding down we adopted, as discussed in Section 2. While there is no confirmed record of such an event in the last 50 years, that does not exclude potential for such an event. Information presented in ECoast (2020) also suggests that the coastal flood level adopted (RL 3 m MVD-53) is not unreasonable. In our opinion, it is neither reasonably practicable nor prudent to adjust these coastal inundation areas based on current data.

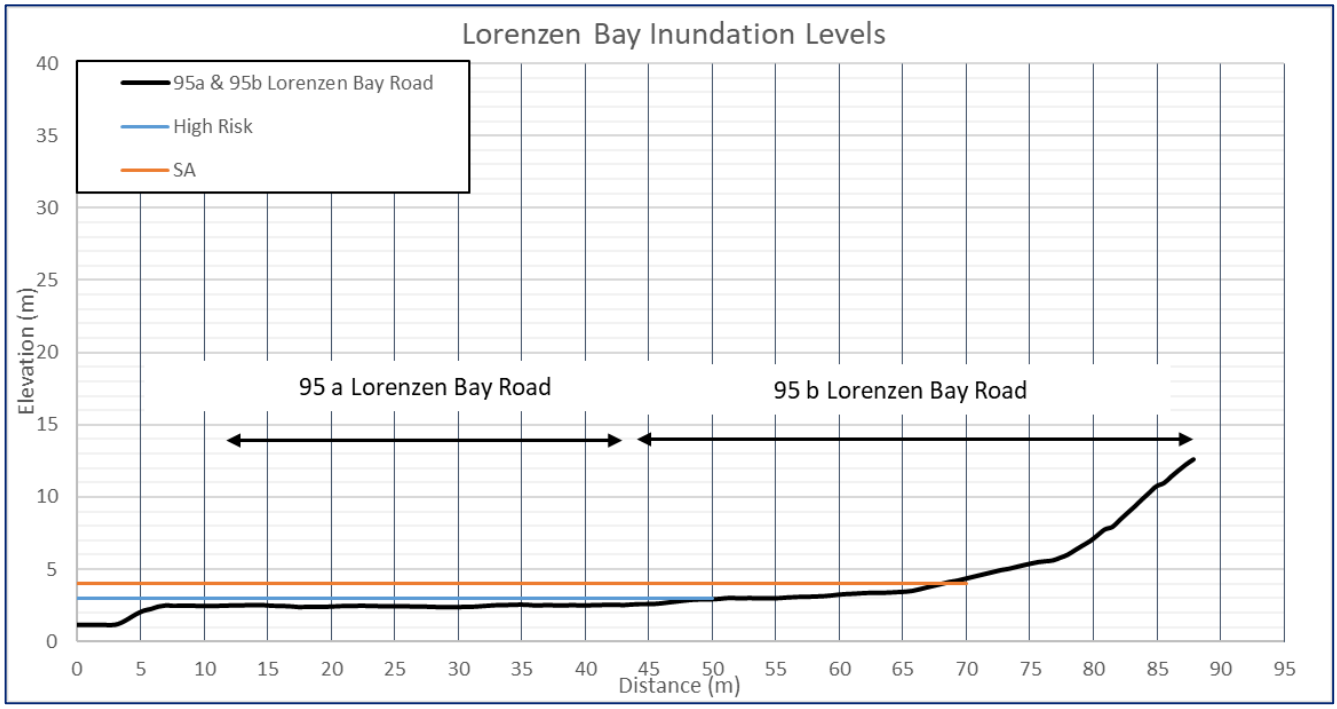


Figure 21: Cross section of 95a and 95b Lorenzen Bay Road, showing an overlay of the ground levels with the defined flood elevations.

The purpose of identifying coastal inundation areas is to ensure that future development is adaptable and floor levels are such that dwellings and other important assets and infrastructure are resilient to flooding. In terms of insurability, planning measures such as those proposed are critical to ensure that development in the area will be insurable in the future. Insurance companies are businesses and will provide cover where coastal hazards are well managed. An adaptive management plan will address this and other issues for Lorenzon Bay. It is not viable in the long term to continue to the ad hoc approach of the past.

Recommendations:

We recommend that the existing High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) remain at Lorenzen Bay as interim measures to avoid increasing the risk from coastal erosion. We also recommend that the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) remain as notified to ensure future development in the area is resilient.

As outlined in Focus (2020), we believe that the complexities at this site will require an adaptive management plan. Once such a plan is established, it may be appropriate to modify coastal hazard overlays. We recommend that Council works with the residents and landowners of the area to develop an adaptive management plan to manage coastal hazards. In our view, Lorenzon Bay is a priority area for an adaptive management plan.

5.3.2 Wallis Street

Submission #2141: Wallis Street, Raglan

Submission: Request removal of the Coastal Sensitivity Area (Inundation) overlay from the property at 68 Wallis Street, as the property is sufficiently elevated and protected to not be vulnerable over the next 100 years.

Discussion:
This property is fronted by a high vertical concrete seawall on the seaward side, with the landward boundary adjacent to Wallis Road. The submitter has provided photographs of the property, and the seawall protecting the property frontage. The High Risk Coastal Hazard Area (Inundation) overlays the very seaward edge of the property (Figure 22).

Figure 22: Coastal Inundation overlays at 68 Wallis Street.

The Coastal Sensitivity Area affects the seaward portion (approximately half) of the property (Figure 22). Examination of existing Lidar data indicates that the section is has elevations of approximately 3.9-4.0 m (MVD-53), elevations marginally below the flood elevation used to define the Coastal Sensitivity Area (Figure 23). This means that the lower area of the section may be subject to minor and very occasional flooding during an extreme storm event after 1.0 m of sea level rise. With current sea level, there is coastal inundation hazard is not likely to affect the property, except for a very small area at the most seaward edge.

Given the shallow nature of coastal inundation likely in the next 100 years, coastal inundation hazard is likely to have little effect on the ongoing use of this property. However, it is relevant to note that the elevations used to define the coastal inundation areas do not include wave effects. Areas very close to the shore may be exposed to wave overtopping during extreme events, to an elevation higher than the static storm tide level. The presence of the Coastal Sensitivity Area (Inundation) overlay will ensure these factors are considered when planning future development.

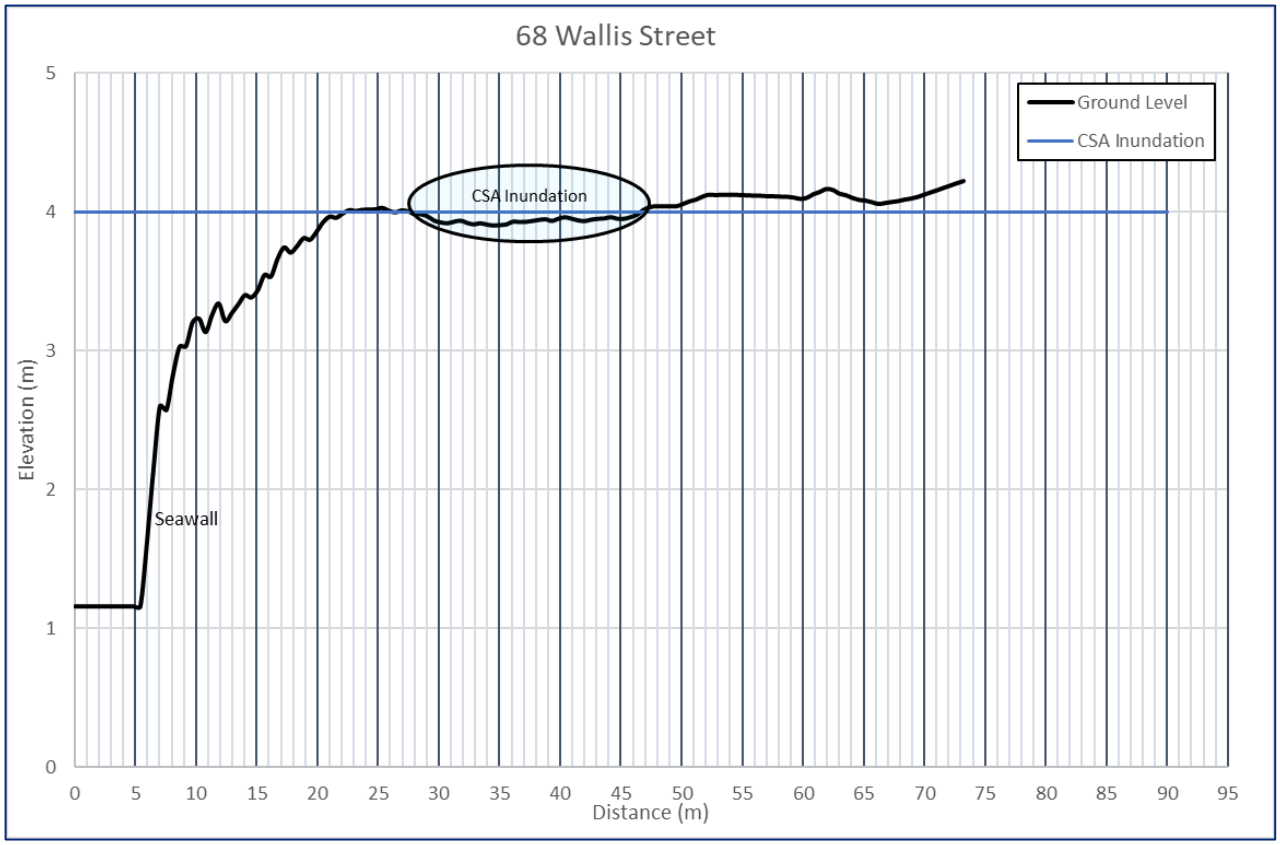


Figure 23: Cross section of 68 Wallis Street, showing an overlay of the ground levels with the defined flood elevations.

Recommendation:

That the Coastal Sensitivity Area (Inundation) remain as proposed. That the Council ensure related provisions provide for ongoing use and development within the Coastal Sensitivity Area while appropriately managing potential future coastal hazard risk.

5.3.3 Nihinihi Avenue Area

Submission #2069: Nihinihi Avenue, Raglan

Submission: Request removal of the High Risk Coastal Hazard Area (Inundation) from the property at 6 Nihinihi Avenue. That the drain on the property be a covered culvert to lessen the risk of flooding from the sea.

Discussion:

The property at 6 Nihinihi Ave lies on the landward side of Marine Parade and Nihinihi Avenue. Ground levels at this property, the adjacent properties, and a portion of Marine Parade are all mostly in the range of 3.0-3.5 m (MVD-53). Within 6 Nihinihi Avenue, there is a low-lying area between the existing dwellings and the road (2.0-2.8 m MVD-53). This area is therefore within the High Risk Coastal Hazard Area (Inundation) (Figure 24).

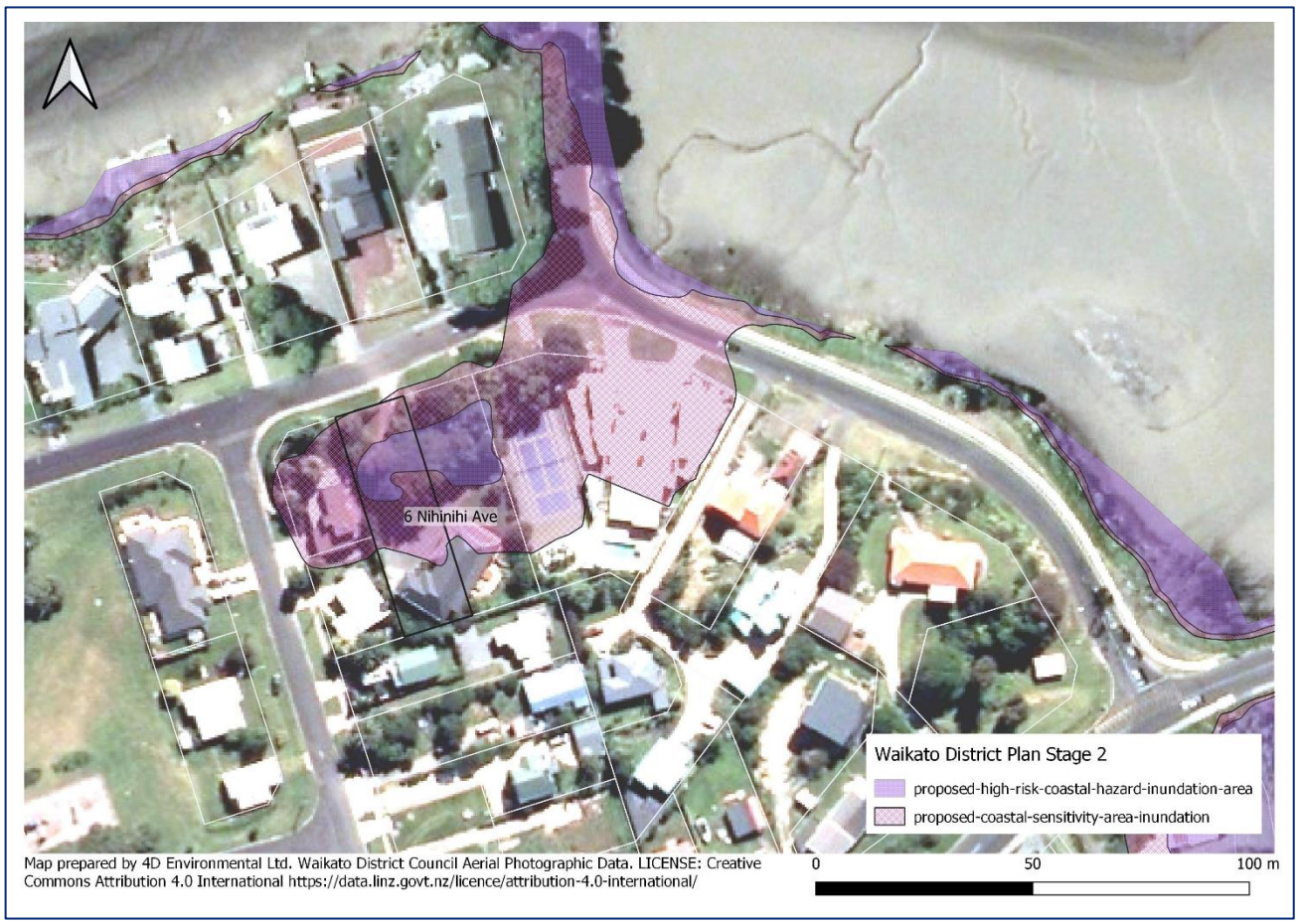


Figure 24: High Risk Coastal Hazard Area (Inundation), and Coastal Sensitivity Area (Inundation) at 6 Nihinihi Avenue.

As noted in the submission, the low area includes an open drain and culvert, which provides a hydraulic connection to the property (Figure 25). Future drainage works or changes to ground levels may alter this hazard vulnerability, but any significant future sea level rise (as little as 0.2 m) would result in potential overtopping of the road during extreme events, and a direct hydraulic connection to the properties to landward. The potential for more extensive flooding following future sea level rise is acknowledged in the Coastal Sensitivity Area (Inundation), which extends across the front portion of the property.

Figure 25: Open drain at 6 Nihinihi Ave.

Recommendation: That the High Risk Coastal Hazard Area (Inundation) is retained as proposed. The map identifies an area that is low lying and flood prone. The hazard designation can only be removed if effective hazard mitigation is identified and implemented.

Submission #2137: Pokohui Avenue, Raglan

Submission: Amend the Coastal Sensitivity Area (Inundation) to a lower level at 10 Pokohui Avenue, to reflect a site-specific risk assessment and survey information provided.

Discussion: The property at 10 Pokohui Avenue lies on the southern bank of the Wainui Stream. The section is relatively low lying (3.5-5.0 m (MVD-53)). The Coastal Sensitivity Area (Inundation) overlays a portion of the property (Figure 26). The Coastal Sensitivity Area (Inundation) represents land levels below 4.0 m (MVD-53).

The site-specific assessment provided by the submitter (Wainui Environmental, 2019) provides survey data and a discussion of appropriate floor levels to provide for a 1% AEP storm event. The survey data provided is consistent with the Lidar data used to map the Coastal Sensitivity Area (Inundation).

Figure 26: Coastal Sensitivity Area (Inundation) overlay at 10 Pokohui Avenue.

The report acknowledges that using the Waikato Regional Council's coastal inundation tool, the property could be subject to flooding during an extreme event following 1.0 m of sea level rise (4.1 m MVD). The report also indicates that the proposed dwelling has a floor level of 4.60 m (MVD-53) and confirms that this represents a 0.48 m freeboard above the future upper storm tide estimate with 1.0 m of sea level rise. This assessment has considered the same storm tide levels as those recommended in our coastal hazard assessment (Focus, 2020) and used to define the Coastal Sensitivity Area (Inundation).

It is relevant to note here that the Coastal Sensitivity Area (Inundation) is defined based on ground levels, and there may be dwellings within the mapped sensitivity area that have floor levels adequate for current and/or future inundation. The primary focus for managing new development in a Coastal Sensitivity Area (Inundation) is to ensure adequate floor level elevation and mitigation of coastal inundation risk.

Recommendation:

The report provided indicates that the floor level of the new dwelling provides adequate protection from a 1%AEP coastal inundation event, including with 1.0 m sea level rise. However, there is currently no data available than can be used to alter ground levels significantly and therefore the map indicates that portions of the property remain vulnerable to flooding. It is therefore not possible to alter the Coastal Sensitivity Area (Inundation) map on the basis of this data. We therefore recommend retaining the Coastal Sensitivity Area

(Inundation) map as notified. As discussed above, this overlay does not mean that the dwelling is vulnerable to coastal inundation.

5.3.4 Norrie Avenue

Submission #2003 & #2009: Norrie Avenue, Raglan

Submission: Remove the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) from the properties at 22, 24 and 26 Norrie Ave, Raglan. Given the elevation and distance from the sea, the submitters argue that these properties are unlikely to be impacted by erosion and have been unfairly "singled out".

Discussion:
The properties in question are located on the landward side of Wainui Road, south of Raglan town centre. The High Risk Coastal Hazard Area (Erosion) has been defined here based on the application of a 1V:2H stable slope. The steeply sloping seaward face of the properties, and high elevation means that the High Risk Coastal Hazard Area (Erosion) is wider in this area when compared with nearby, lower lying sections (Figure 27).

Figure 27: High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) as notified.

Given our observations of nearby shorelines around Raglan Harbour coastline, and in consideration of the submissions received, we have recommended to the Council that the High Risk Coastal Hazard Area (Erosion) be amended to reflect a 1V:1.5H slope from the toe of cliff (as discussed in Section 5.2). This amendment will result in a reduction in the width of the High Risk Coastal Hazard Area (Erosion) fronting 22-24 Norrie Ave and the overlay will no longer affect the properties (see Figure 28).

The Coastal Sensitivity Area (Erosion) on these properties reflects the potential for a slope failure to occur following erosion of the cliff toe over the next 100 years, including the effect of 1.0 m of sea level rise. These sensitivity areas have been drafted with no assumptions made about future shoreline protection works. However, given the properties are landward of a major access Road (Wainui Road), it seems unlikely that they will be directly influenced by coastal erosion in the foreseeable future.

Recommendations:
We recommend that the High Risk Coastal Hazard Area (Erosion) be amended to reflect a steeper stable slope as discussed above, and shown in (Figure 28) below.

If the Council were to make a clear commitment to protecting this road in the foreseeable future, it would be reasonable to remove the Coastal Sensitivity Area (Erosion) from properties landward of the Road. This same decision will also impact properties at Port Waikato (Tuakau Bridge Road) and is discussed in Section 4.2. This potential adjustment is also show in Figure 28 below.

Figure 28: High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) with proposed amendments.

5.4 Rangitahi Peninsula

Rangitahi Peninsula			
Rangitahi Peninsula	2115	Amend Planning Maps 23 and 23.3 so that it accurately maps erosion hazard risk on the Rangitahi Peninsula using the existing geotechnical information from the structure plan, resource consents and development.	High Risk Coastal Hazard & Coastal Sensitivity Areas (Erosion)
Ian & Karen McLeay	2121	Amend Map 23.3 - Raglan West relating to the Rangitahi Peninsula, taking into account the information from the CMW Geotechnical Completion Report dated 8th May 2020.	Coastal Sensitivity Area (Erosion)
Tyrone Murphy	2071	Amend Map 23.3 (Raglan West) - Coastal Sensitivity Area (Erosion) Overlay on to accurately reflect the risk at 10 Mara Kai lane, Rangitahi Peninsula, Raglan.	High Risk and Coastal Sensitivity Areas (Erosion)
Geoff Hutchison	2126	Delete Policy 15.2.1.17 - Setbacks from the coast. And Amend the Coastal Sensitivity Area (Erosion) - Map 23.3 - Raglan West, to remove the area from the property at 2 Mara Kai Lane Raglan.	15.2.1.17 And Maps - Coastal multiple
Matt Connor	2015	Amend High Risk Coastal Hazard (Erosion) Area and Coastal Sensitivity Area on Map 23.3 Raglan West, in so far as it affects the submitter's property and Rangitahi Road.	High Risk Coastal Hazard (Erosion) Area

5.4.1 Rangitahi Development

Submission #2115, #2121, #2015: Rangitahi Development, Raglan

Submission:
That the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) be amended to reflect the existing geotechnical information that was collected and analysed during the consenting process for the Rangitahi Peninsula Development.

Discussion:
The creation of the Rangitahi Peninsula Zone, and the subsequent subdivision of Precincts A, B and D of the Rangitahi Peninsula Development (Figure 29) have occurred somewhat in parallel with the coastal hazard assessment and Waikato District Plan Stage 2 process.

The coastal processes assessment undertaken by Focus (2020) has applied slope-based criteria to define High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) overlays to guide development near the coastline. These were based on a broad knowledge of the coastal geology and geomorphology and a relatively conservative approach, particularly with regard to slope stability. This is prudent given the limitations of existing knowledge.

The proposed Coastal Sensitivity and High-Risk Coastal Hazard areas at Rangitahi were mapped using the same criteria applied elsewhere on developed cliffs within Raglan Harbour. These hazard areas use a consistent slope-based approach to highlight where development may be vulnerable to slope instability associated with

oversteepening due to coastal erosion. As discussed in Section 3, the notified High-Risk Coastal Hazard Area (Erosion) is based on a stable slope of 1V:2H, measured from the toe of the coastal cliff. The Coastal Sensitivity Area (Erosion), provides for and additional long term slow erosion of the foreshore (5 m) over the next 100 years in association with a sea level rise of 1.0 m. In some areas, the specific topography means that this additional erosion, while modest, could potentially expose a relatively wide coastal zone to slope instability[2].

In some areas, the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) overlap recently subdivided lots. This is particularly significant on the eastern shore of Rangitahi Peninsula in the first stage (Precinct A) of the Rangitahi development (Figure 29).

The Rangitahi Peninsula is fronted predominantly by coastal cliffs, some as high as 15 m. In other areas, there is no scarped coastal edge, and the topography slopes landward. The peninsula is predominantly sloping topography and has recently been significantly modified by coastal subdivision and development. The geology of the shoreline is varied, and there is little detailed information available about long term shoreline change rates, except that they appear to be relatively slow.

In response to the submission, we have reviewed a number of geotechnical reports have been provided by Rangitahi Ltd, which were prepared as part of the subdivision of Precincts A-D of the Rangitahi development.

[2] The analysis undertaken by Focus (2020) and for the purpose of this advice is based on available digital elevation model (~ 2009). Earthworks and engineering structures have been completed since this time which may have altered elevation and slope in some areas.

Figure 29: Broad overview of current precincts and future extent of development at Rangitahi Peninsula. Proposed High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) are also shown.

We have reviewed these reports to consider whether the geotechnical investigation and current building restrictions imposed within the Rangitahi development address coastal erosion and associated potential slope instability, including the potential effects of sea level rise over the next 100 years.

The Geotechnical Assessment reports (CMW Geosciences, 2017; CMW Geosciences, 2018; HD Geo, 2020) describe a range of geotechnical investigations undertaken as part of the preparation for the Rangitahi Peninsula development. The investigations included site investigations of geomorphology, slope stability and ground conditions, fieldwork to assess ground conditions and geomorphological plans and cross sections.

26 geological exposures were logged along the coastline of Precincts A-D.

The CMW and HD Geo geotechinical investigations identified that one of the primary identified geotechnical hazards was slope instability that could occur in relation to regression and oversteepening of coastal cliffs. CMW (2018) observed some evidence of cliff instability in Precinct B, including a significant slip below lots 194-195. CMW (2018) also reports estimated coastal regression of 5-10 m fronting Precinct B over the last 73 years (based on analysis of historical aerial photography).

The studies identify "Specific Design Zones" that identify areas within residential properties that may be subject to land stability that could impact future development. CMW (2017, 2018) provided recommendations for building setbacks from coastal cliff areas and steep zones, and/or zones that require specific foundations designs.

The review of the available reports indicates that two types of design zones have been applied that overlay the coastal lots relevant to this submission (i.e. those properties that are overlain by high-risk and coastal sensitivity erosion areas)

- In precinct A - Specific Design Zone (Slope): No building construction and no earthworks to be undertaken unless endorsed by a Chartered Professional Engineer (experienced in geomechanics and the contents of the completion report).
- In precinct B - Specific Design Zone (Coastal Cliff): No building development to be undertaken due to the allowance for coastal erosion and coastal regression.

These two specific design zones extend over many of the same areas as the proposed High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion). While the reports outline detailed investigations, it is difficult determine from the reports whether coastal processes and future sea level rise have been incorporated into the calculations. The consent notice requiring an engineer's report within the specific design zones gives clear consideration of several factors that may influence site stability but does not specifically refer to coastal processes and coastal erosion (including the impacts of sea level rise).

At the time of writing this, we have not yet received requested digital copies of the design zones, or information about the proposed coastal hazard management for Precinct D (or subsequent areas of the future development).

Recommendations:

The specific design zones are applied via consent notice against property titles. The zones overlap significantly with the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) overlays in the proposed District Plan. However, to date we have been unable to obtain sufficient information to determine whether the Rangitahi specific design zones could be applied to manage coastal hazards in the future in place of the proposed High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion). We would need to be confident that coastal erosion hazard has been adequately provided for in these zones. This approach would need to include a mechanism to ensure development within these zones explicitly takes into consideration coastal hazards (including the effect of sea level rise).

We therefore recommend that based on the available information at the time of this report, the Council retain the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion), as applied to other developed cliff shorelines in the District. This would include an amended High Risk Coastal Hazard Area (Erosion) based on a stable slope of 1V:1.5H from the toe of slope (see Section 5.2). The Coastal Sensitivity Area (Erosion) would remain as notified.

5.4.2 Mara Kai Lane

Two submissions have been received that relate directly to properties on Mara Kai Lane, on the northern tip of the Rangitahi Peninsula. These dwellings have been in place since for over 50 years, with the first building visible in aerial photography from 1944 (2 Mara Kai Lane).

Submission #2071, #2126: Mara Kai Lane, Rangitahi Peninsula, Raglan

Submissions:
That the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) be removed, or amended to more accurately reflect the coastal erosion risk at Mara Kai Lane, Rangitahi Peninsula.

Discussion:
This area is characterised by a steep cliff face approximately 15 m high, with typical slopes of approximately 1V:1H. There is no evidence in historical aerial photography of measurable rates of shoreline retreat, but in many areas, there is an exposed (active) cliff face indicating periodic erosion.

The High-Risk and Coastal Sensitivity Areas both extend across the seaward portion of the property at 2 Mara Kai Lane, including across a part of the existing dwelling (Figure 30). At 10 Mara Kai Lane, the property is only marginally affected by the proposed coastal hazard management areas.

The geotechnical investigation undertaken by CMW Geosciences for the Rangitahi subdivision did not include any observations or data collection in the existing subdivision at Mara Kai Lane. The owner of 2 Mara Kai Lane provided a geotechnical report prepared in 2017, which provided a preliminary assessment of the stability of the site and indicated a building setback 7.0 m from the cliff top to provide for instability that may be caused by undercutting of the cliffs by coastal erosion; though the basis for this setback is not provided. The report also does not appear to have considered the long-term impact of sea level rise on cliff stability. The 7 m recommended building setback line is located between the revised High Risk Coastal Hazard Area (Erosion) and the Coastal Sensitivity Area (Erosion).

Recommendation:
As discussed further in Section 3, we have considered the level of conservatism applied in defining the High Risk Coastal Hazard Area (Erosion), and recommend that the High Risk area be refined to reflect a steeper 1V:1.5H slope (Figure 30). This slope is consistent with observed slopes, and recent landslides in similar settings within Raglan Harbour and represents the area of greatest risk for slope instability.

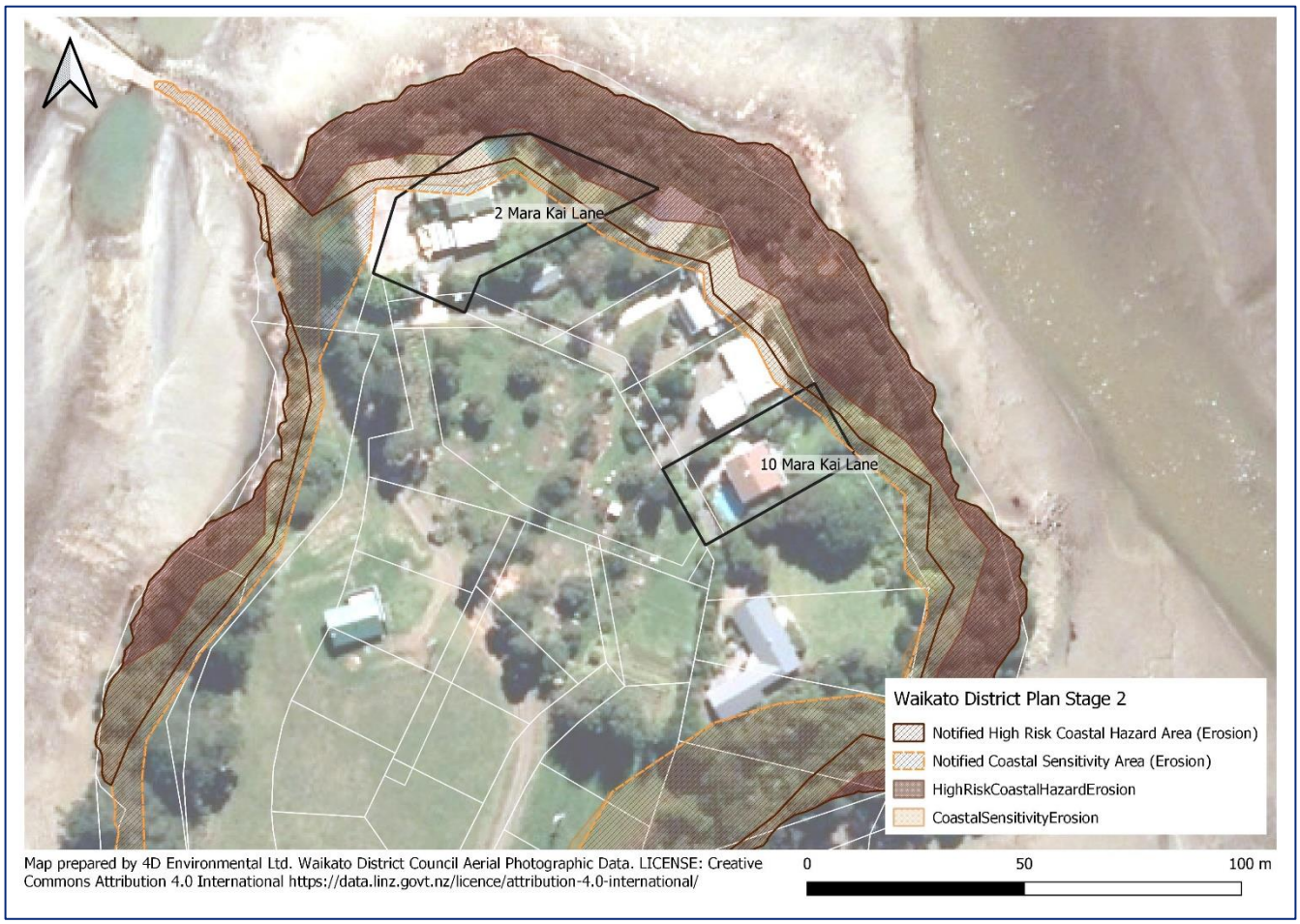


Figure 30: Properties at Mara Kai Lane, Rangitahi Peninsula, showing notified and revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion).

More significant land instability cannot be disregarded based on current information, so we recommend retaining the Coastal Sensitivity Area (Erosion) as notified, to ensure full consideration is given to the extent of site-specific coastal hazard. As discussed in Section 3, this Sensitivity Area is not a defined "hazard" area, but simply a recognition of the need for coastal processes and hazards to be considered. Some existing dwellings on Mara Kai Lane are located within this Coastal Sensitivity Area (Erosion).

5.5 Te Kopua

Raglan -Te Kopua			
Darcel Rickard on behalf of Te Kopua Trust & Te Kopua 2b3 Incorporation	2175	Provide further site-specific investigation in Planning Map 23.3 Raglan West for Te Kopua on the Coastal Sensitivity Area (Erosion) and Coastal Sensitivity Area (Inundation) mapped areas	Maps - Coastal multiple

Submission 2175: Te Kopua Spit

Submission: That further site-specific investigation be undertaken to refine the Coastal Sensitivity Area (Erosion) and Coastal Sensitivity Area (Inundation), as the current mapped hazard areas impose restrictions now over a 100-year planning horizon, based on a high level of uncertainty.

Discussion:
As noted in the coastal hazard assessment (Focus, 2020), the Coastal Sensitivity Areas identify areas potentially vulnerable to coastal erosion or flooding over the period to 2020. With predicting shoreline change and coastal hazards into the future, uncertainty increases with increasing timeframes. Given the uncertainties around the various drivers of shoreline change at this site, as well future sea level rise and shoreline response it is not possible to predict the extent of coastal hazard areas with precision and certainty over 100 years. Scientists and managers must instead base the definition of coastal hazard areas on what is known about the geology and geomorphology of the site, past trends, current and future human risk and impacts, and predictions for sea level rise and climate change.

A number of coastal hazard investigations have focussed on the Te Kopua area in the last decade, including Environment Waikato (2008), Dahm & Gibberd (2010), Focus (2020) & ECoast (2020), as well as internal Waikato Regional Council reports. These studies have considered local geomorphology and processes and gathered and examined the available historical shoreline change data and local knowledge. Lidar data provides detailed information about the elevation of the area.

Earlier studies are summarised in Focus (2020), and more recently the Waikato Regional Council commissioned a further comprehensive review of coastal processes and coastal hazards from Ngarunui Beach to Te Kopua (ECoast, 2020). All of these investigations have reviewed available historical data and highlighted the potential vulnerability of the Te Kopua Spit area to coastal erosion and coastal inundation.

Coastal Erosion:

The Te Kopua area lies adjacent to the entrance area of Raglan (Whaingaroa) Harbour and is subject to significant dynamic shoreline fluctuations over periods of several decades. Shoreline change analysis based on aerial photographs and historical surveys (Dahm & Gibberd, 2010; Focus, 2020; ECoast, 2020) has revealed a complex and varied pattern of shoreline change over time.

The northern shoreline of the Te Kopua spit experiences multi-decadal to century scale dynamic shoreline fluctuations, with no clear long-term trend for erosion or accretion. These fluctuations (periods of erosion and accretion) have exceeded 100 m at the western end, decreasing eastwards to at least 50-60 m towards the eastern end. The eastern end of the spit appears to be slowly accreting over time, gradually extending further to the northeast. The landward margin adjacent to Wainui Stream is largely stable, apart isolated areas of very minor erosion on the outside of bends in tidal channel. Over the last 10-15 years, the trend has been for erosion near the harbour entrance, some accretion of central areas of the spit, and continued stability along the frontage of the campground.

In defining the Coastal Sensitivity Area (Erosion), the long-term effects of sea level rise must be evaluated. Sea level rise of 1.0 m could have substantial impacts on the morphology of the spit. Based on current knowledge, this entire area is made from sand, and is therefore readily erodible by natural coastal processes, and would be increasingly vulnerable to coastal erosion with any future sea level rise. As described in Focus (2020) and ECoast (2020), the spit is intricately linked with the harbour entrance and tidal processes, which will be influenced by future sea level rise. It is not possible to quantify the response of the spit shoreline with any certainty in this complex environment. At Te Kopua, the Coastal Sensitivity Area (Erosion) therefore identifies the area of potential coastal erosion hazard as the entire sand spit between the end of Rerea Kereopa Drive and Putoetoe Point.

As acknowledged in the report by Focus (2020), it is possible that landward areas of the Coastal Sensitivity Area (erosion) are underlain by more erosion resistant materials and will be less vulnerable to coastal erosion than assumed. However, any future modification of the landward boundary of the Coastal Sensitivity Area (Erosion) would require more definitive data about the exact elevation and seaward extent of any underlying resistant geology in relation to any proposed development.

Figure 31: Coastal Erosion overlays at Te Kopua, showing proposed High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion).

Coastal Inundation:

The Te Kopua spit is a sand feature built by modern coastal processes. Ground elevations are generally below 4.0 m (MVD-53) and are below 3.0 m (MVD-53) in the campground area and the upstream western margin of the Wainui Stream. The majority of the area has therefore been identified as Coastal Sensitivity Area (Inundation), potentially vulnerable to coastal inundation during an extreme event following 1.0 m of sea level rise. While the current risk is low in in many areas, this overlay highlights the need to consider hazard resilience when undertaking new development.

As discussed in Section 2, the levels applied to define these areas are based on the best available information and are supported by local knowledge and observations of past events. While the High Risk Coastal Hazard Area (Inundation) is limited to the campground, the remainder of the spit is relatively low lying and could also be flooded during extreme storm events even after relatively small amount of sea level rise.

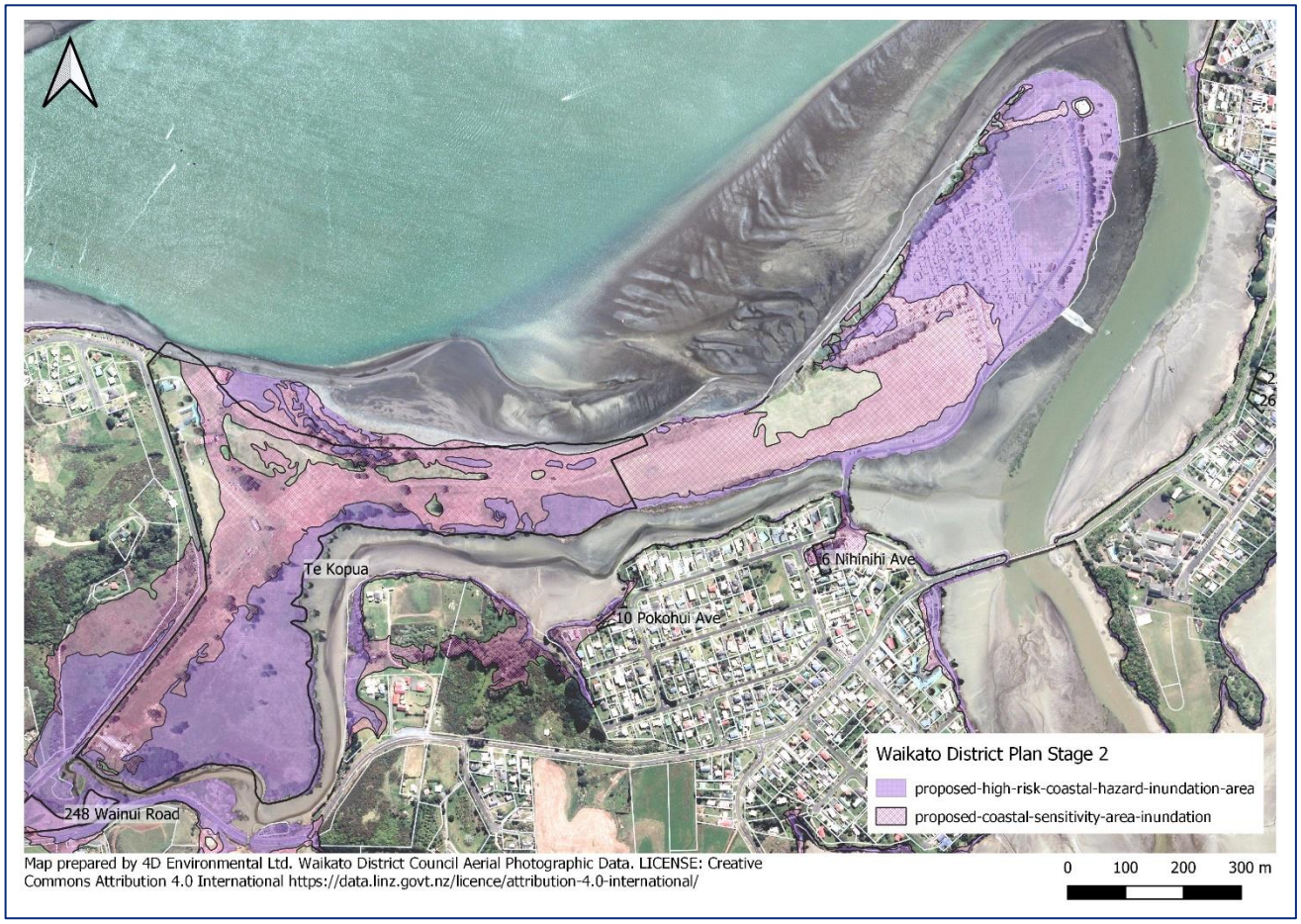


Figure 32: Coastal inundation overlays at Te Kopua, showing proposed High Risk Coastal Hazard Area (Inundation), and Coastal Sensitivity Area (Inundation).

Recommendations:

We recommend that the Coastal Sensitivity Area (Erosion) is retained as notified in the absence of data that confirms the landward boundary of erodible sediments. Future investigation of sub-surface materials may provide a basis for adjustment of the landward boundary of the Coastal Sensitivity Area (Erosion).

We also recommend that the Coastal Sensitivity Area (Inundation) is also retained as notified. As discussed in previous sections, we recommend that the Council provide for adaptable and/or resilient development within these areas where risk can be mitigated.

It is important to emphasise that the defined areas and associated uncertainties do not preclude future development but will require an adaptive management approach to ensure that any development can remain resilient over time.

5.6 Raglan Rural Coastline

Raglan Harbour Rural Coastline				
N.L Van Der Voorden	2041		Amend Map 24 so that both the Coastal Sensitive Area (Erosion) and Coastal Sensitivity Area (Inundation) do not apply to the properties located at 209 and 201 Ohautira Road.	Maps - Coastal multiple
Lorraine Webber on behalf of Lorraine Webber, John Lenihan, Michael Rodger, Alex KirbyLo	2157		Amend Map 23.4 Raglan East to remove current mapping of Coastal Sensitivity Area (Erosion), and Coastal Sensitivity Area (Inundation), at 4316 State Highway 23, Raglan.	Maps - Coastal multiple

Submission #2041: Ohautira Road

Submission: Amend Coastal Sensitivity Area (Erosion), Coastal Sensitivity Area (Inundation) so that they do not apply to the property at 209 and 201 Ohautira Road, Raglan Harbour. There is no history of erosion or flooding on the property.

Discussion:

The Coastal Sensitivity Area (Inundation) covers the low-lying portions of the property at 201 and 209 Ohautira Road, adjacent to Waitetuna River (Figure 33). The mapped extent of this sensitivity area represents an area that is potentially vulnerable to the effects of extreme water levels and coastal inundation including inundation that may occur during an extreme event after sea level rise over the next 100 years.

Most of the property is at an elevation of over 10 m and is not vulnerable to coastal flooding, even with future sea level rise. There are, however, lower flat areas of the property with ground levels of 3-5 m, which are identified as within the Coastal Sensitivity Area (Inundation). Only very small areas on the property are at an elevation below the extreme coastal storm tide level of 3.1 m (MVD-53), so we would not expect there to be a history of coastal inundation on the property. As noted by the submitter, all buildings on the property are elevated well above the flood hazard area. These areas are not included in the Coastal Sensitivity Area (Inundation) overlay and will not be subject to the associated provisions.

The coastal hazard assessment (Focus, 2020) recommends that the Council manages future development in low-lying areas provide for restoration of coastal wetlands where these features have been lost historically and for landward expansion and migration of wetland habitats in response to sea level rise of at least 1.36 m (i.e. RCP8.5+). These habitats provide critical ecosystem services including protection against coastal flooding and erosion. This is consistent with National Policy. In these rural areas, the Coastal Sensitivity Area (Inundation) therefore includes these low-lying areas so that future intensification of development considers these long-term impacts.

The Coastal Sensitivity Area (Erosion) in this area (rural estuarine shoreline) is defined by a 100 m buffer from the shoreline and is present over the full width of the property. This is not a defined “hazard” area but highlights that coastal processes and hazards should be considered. The width of the zone reflects the variability in shoreline geology and topography around Raglan Harbour. This is discussed further in Section 3.

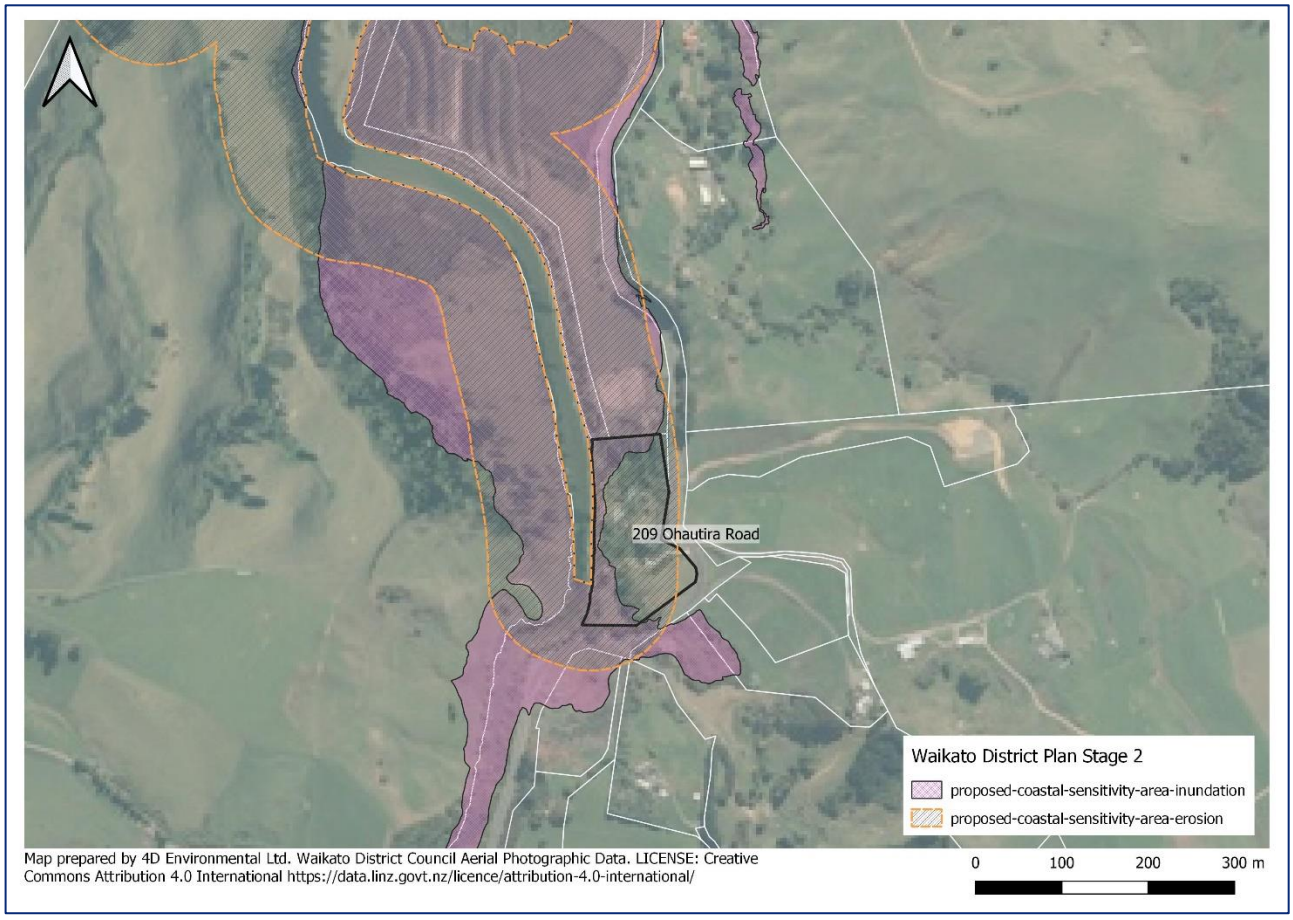


Figure 33: Extent of Coastal Sensitivity Area (Inundation) and Coastal Sensitivity Area (Erosion) overlays at 201-209 Ohautira Road.

Recommendation:

We recommend that the mapped Coastal Sensitivity Area (Inundation) remain as notified, while ensuring the provisions of the Plan provide for use and development that is resilient to coastal inundation now and in the future.

In some areas the 100 m wide Coastal Sensitivity Area (Erosion) will include areas that are not subject to coastal hazards, depending on the local setting. Given the sheltered upper harbour setting, this is likely to be the case here. The coastal hazard assessment by Focus (2020) provides guidance on the broad criteria that can be used to define coastal erosion hazard on different types of shoreline. Any future proposed development should be considered in light of these factors in a context specific to the site and the proposed activity.

Submission #2157: State Highway 23, Raglan

Submission: Co-owners of the rural property at 4316 State Highway 23, southeast of Raglan Township express concerns about the generic 100 m Coastal Sensitivity Area (Erosion). Request a more detailed investigation of coastal hazards be undertaken, to provide an equivalent level of consideration to that given to residential properties in Raglan Township.

Discussion:

The Coastal Sensitivity Area (Erosion) is defined by a 100 m buffer from the shoreline in this area (rural estuarine shoreline) and is present over the full width of the property. This is not a defined "hazard" area but highlights that coastal processes and hazards should be considered. The width of the zone reflects the variability in shoreline geology and topography around Raglan Harbour. This is discussed further in Section 3.

The property at 4316 State Highway 23 has a coastal frontage of approximately 350 m. The shoreline is variable, with some areas fronted by 20 m high steep cliffs (steeper than 1V:1H). A valley runs through the property and this includes areas that are relatively low lying with a gently sloping shoreline.

The hazard assessment undertaken by Focus (2020) applied a slope-based approach to identifying the Coastal Sensitivity Area (Erosion) along cliffed shorelines. The 100 m rural Coastal Sensitivity Area (Erosion) was based partly on the maximum likely width of this area if this approach were applied around Raglan Harbour.

We agree that undertaking a more detailed hazard mapping exercise around the entire rural coast of Raglan Harbour would improve definition of the coastal sensitivity area. However, this would be a time consuming and expensive exercise for Council and is not warranted given the low level of development pressure on the coast. We note that should further development be proposed in the sensitivity area, the plan provides for development to occur based on a site-specific assessment of hazards.

Recommendation:

We recommend that the Coastal Sensitivity Area (Erosion) remains as notified, with provisions in the District Plan providing for site specific consideration of coastal erosion hazard for future development.

5.7 Coastal Inundation Areas

Raglan Coastal Inundation			
Coastal Inundation – Raglan Township			
Hayden Vink	2168	Amend section 15.10 – High Risk Coastal Hazard (Inundation) – so that there are sub-categories within each overlay, with different rules based on actual risk, e.g.: High-Risk Coastal Hazard (Inundation) Area – Open Coast'; High Risk Coastal Hazard (Inundation) Area – Harbour"; High Risk Coastal Hazard (Inundation) Area – Tidal Inlet.	High Risk and Coastal Sensitivity Areas (Inundation)
Jason Vink	2169	5 Aroaro Lane Amend section 15.10 – High Risk Coastal Hazard (Inundation) – so that there are sub-categories within each overlay, with different rules based on actual risk, e.g.: High-Risk Coastal Hazard (Inundation) Area – Open Coast'; High Risk Coastal Hazard (Inundation) Area – Harbour"; High Risk Coastal Hazard (Inundation) Area – Tidal Inlet.	High Risk Coastal Hazard Area (Inundation)
Nicol Beeby	2039	**Amend** the High Risk Coastal Hazard (Inundation) Area and Coastal Sensitivity Area (Inundation) on Map 23.3 Raglan West to reflect the actual contour at 27 Primrose St, Raglan, as shown on plan attached to submission.	Maps - Coastal multiple

Andrew & Karen Lovelock	2058	Amend Coastal Sensitivity Area (Inundation) on Map 23.3 (Raglan West) so that high water mark is removed from the property located at 3B Lily Street, Raglan.	Coastal Sensitivity Area (Erosion)
David Wharmby	2116	Amend Map 23.3 - Coastal Sensitivity Area (Inundation) so that the Coastal Sensitivity Area runs outside the property boundary at 25 Robertson Street Raglan.	Coastal Sensitivity Area (Inundation)

Submission #2168: Wainui Road, Raglan

Submission: That the High Risk Coastal Hazard Area (Inundation) be amended so that there are sub-categories of high risk inundation overlays to reflect the physical environment. The property at 248 Wainui Road is currently used for commercial premises. Now has High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) overlays. Building design and floor levels have provided for flooding and sea level rise as necessary. Location is low energy, not subject to waves or swell. The High Risk Coastal Hazard Area (Inundation) is based on a high level of uncertainty and a long time frame.

Discussion:
The property at 248 Wainui Road lies on the corner of Wainui Road and Riria Kereopa Memorial Drive, adjacent to the upper reaches of the Wainui Stream arm of the estuary. Numerous activities are operating on the site, with buildings located on the more elevated areas of the property. The property is relatively low lying, with the majority of the land below 2.5 m (MVD-53) and is zoned "Business". The High Risk Coastal Hazard Area (Inundation) reflects these low lying areas on the property, which are potentially vulnerable to elevated water levels during an extreme event, and with current sea level, the depth of inundation could be as much as 1.0 m in places.

This submission has requested that the High Risk Coastal Hazard (Inundation) be refined to have sub-categories with different rules, which apply depending on geographic location (harbour, open coast etc). As the location of the property in question is adjacent to the upper reaches of the estuary, the coastal inundation hazard relates to static water levels associated with a storm tide. As discussed further in Section 2, the coastal storm tide levels used to map the High Risk Coastal Hazard Area (Inundation) are based on analysis of the available tide record and observations of previous storm events. There is no allowance within these levels for effects such as wave overtopping. The proposed High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) are not applied on the open coast, as we acknowledge there are much more significant and complex issues relating to wave effects. Potentially vulnerable areas of coastal margin are encapsulated in the Coastal Sensitivity Area (Open Coast).

The submission notes that the coastal hazard assessment (Focus, 2020) acknowledges the uncertainty associated with defining the Coastal Sensitivity Area (Inundation). As discussed in Section 2 and Section 3, the sensitivity areas are not confirmed "hazard" areas but identify the potential for hazard to increase over the next 100 years with sea level rise and other climate change effects. For this reason, the Council has drafted provisions that provide for adaptive management approach that ensures future development has considered these effects and is resilient.

Recommendation:
We recommend that the proposed High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) are retained as notified. As discussed in Section 2, we also recommend that Council consider the provisions that relate to coastal development within the High Risk Coastal Hazard Area (Inundation) to ensure they provide for resilient development where appropriate.

Submission #2169: 5 Aro Aro Inlet

Submission: That the High Risk Coastal Hazard Area (Inundation) be amended so that there are sub-categories of high risk inundation overlays to reflect the physical environment. The property at 5 Aroaro Lane is adjacent to an extensive wetland system and adjacent to drained land that is managed as grazing. There is a flap gate on the culvert and there are multiple drains evident through the historical wetland. Building design and floor levels have provided for flooding and sea level rise as necessary. The High Risk Coastal Hazard Area (Inundation) is based on a high level of uncertainty and a long time frame.

Discussion:
The western half of the property at 5 Aroaro Lane varies in elevation (2-5 m MVD-53) and is therefore partly within the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) overlays (Figure 34).

In terms of providing for different physical environments, the High Risk Coastal Hazard (Inundation) and Coastal Sensitivity Area (Inundation) apply within the estuarine environments of Port Waikato and Raglan. These extreme water levels do not include any allowance for wave overtopping effects such as may be experienced in exposed locations. The proposed High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) are not applied on the open coast, as we acknowledge there are much more significant and complex issues relating to wave effects. Potentially vulnerable areas of coastal margin are encapsulated in the Coastal Sensitivity Area (Open Coast).

The High Risk Coastal Hazard (Inundation) and Coastal Sensitivity Area (Inundation) do not include any allowance for modification of extreme sea level by flood control structures. As highlighted in our report (Focus, 2020), there are significant issues that need to be worked through regarding the future of the Aro Aro Inlet and considerable uncertainty as to how this area will be managed in the longer term. If a future adaptive management plan confirms that the existing water level control structures or alternative approaches are appropriate in the long-term, the proposed Plan provides for development within the defined areas based on a suitable site-specific investigation. However, until the long-term management of this area has been agreed and an appropriate adaptive management strategy developed, we believe it would be inappropriate to modify the hazard areas based on control structures that may or may not be part of long-term management.

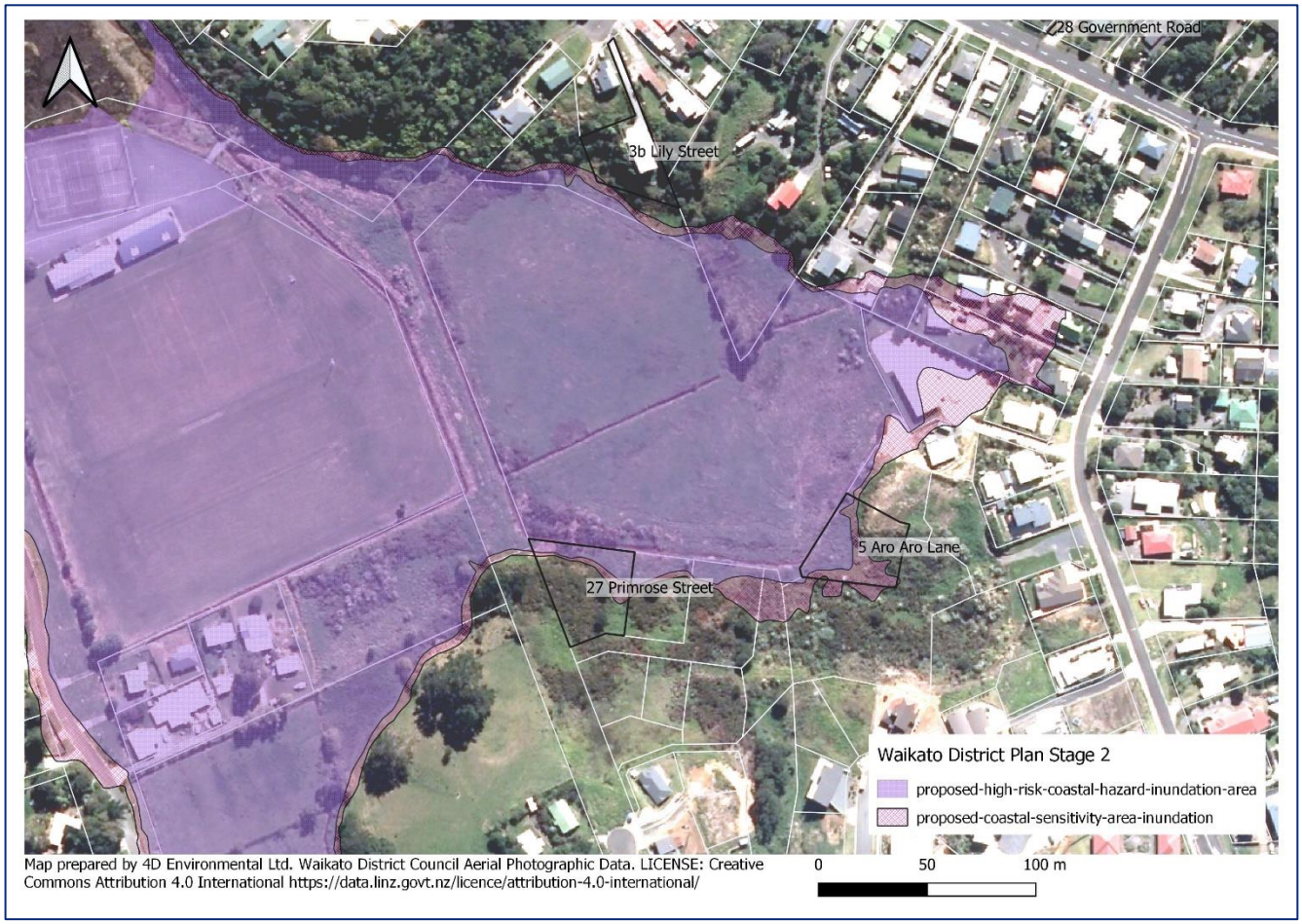


Figure 34: Location of properties at 5 Aroaro Lane, 27 Primrose Street and 3b Lily Street. Coastal Inundations overlays are shown.

Recommendation:

The High Risk Coastal Hazard Area (Inundation) reflects the low lying areas on the property. These areas are potentially vulnerable to elevated water levels during an extreme event. Management of the wider area with flood gates and drainage may influence flood hazard vulnerability in the long term but would need to be part of a wider management strategy, which balances the ecological impacts of drainage. Potential options for managing the area are discussed in Focus (2020).

We therefore recommend that the proposed High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) are retained as notified.

Submission #2039: Primrose Street, Raglan

Submission: That the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) be amended to reflect earthworks that have occurred on the property since the Lidar data was collected.

Discussion:
The available Lidar data indicates that most of the property at 27 Primrose Street is well above the level of any foreseeable coastal inundation hazard. The building platform lies at approximately 5.5-6.5 m MVD-53. The northern boundary of the property is adjacent to the same drained wetland as discussed above (submission #2169) (Figure 34).

The submitter has provided a drawing proposing amended boundaries for the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation), at 27 Primrose Street and two adjacent properties. This information indicates that the landowner has undertaken retaining and infilling activities in association with developing the site. The submitter was not however able to provide any recorded data of ground levels after the earthworks.

Recommendation:
Based on current data, we recommend that the High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) remain as notified. If the owner/submitter can provide clear records post-works ground levels (e.g. surveyed ground levels), the coastal inundation areas could potentially be adjusted to reflect this.

Submission #2058: Lily Street, Raglan

Submission: That the Coastal Sensitivity Area (Inundation) be amended to seaward of the property at 3b Lily Street, Raglan. The coastal inundation levels and maps are based on a "model based" approach which has significant uncertainty.

Discussion:
Almost all of the property at 3b Lily Street is well above the level of any foreseeable coastal inundation hazard. The building platform lies at approximately 15 m MVD-53. The southern boundary of the property is adjacent to the same drained wetland as discussed above (submission #2169 & #2039). The Coastal Sensitivity Area (Inundation) overlay is limited to a very small corner of the property (approximately 7 m^2) (Figure 34). Provisions that relate to this overlay will only apply within this very small area and do not affect the remainder of the property.

The submission raises concerns about a "model based" approach to coastal inundation mapping. It is most likely that this refers to the use of a "bathtub model", which simply means we have identified all areas below a given elevation (the elevation of likely extreme storm tide levels) and have not undertaken detailed numerical modelling of flood flows. As discussed in Section 2, the storm tide elevations applied are based on analysis of tide gauge data and field observations during storm events rather than any modelled simulations.

Moreover, as noted above, the flood elevation has been assessed without any regard to existing water level control measures. Establishment of an agreed adaptive management plan for the area would provide for sustainable development in these areas.

Recommendation: We recommend that the Coastal Sensitivity Area (Inundation) remain as notified.

Submission #2116: Roberston Street, Raglan

Submission: Amend the maps so that the Coastal Sensitivity Area (Inundation) runs outside the property boundary at 25 Robertson Street. Lidar data indicates property is above the flood level. Property is already subject to restrictions relating to sewer and stormwater system. Wetlands and mangroves in Kaitoke Creek provide storm surge attenuation.

Discussion: The property at 25 Roberston Street is located adjacent to Kaitoke Creek, on the southern shore of Raglan Town. The property lies below the road and is fronted by a coastal wetland reserve. The Coastal Sensitivity Area (Inundation) overlaps a very small area of the most seaward edge of the property (Figure 35). Review of the elevation data confirms that the most seaward edge of the property is below 4.0 m (MVD-53) and is therefore correctly included in the Coastal Sensitivity Area (Inundation). The property slopes upwards to approximately 8.5 m (MVD-53) at the road boundary. Almost all of the property is elevated well above current extreme storm tide levels and will remain above expected coastal inundation levels after 1.0 m of sea level rise.

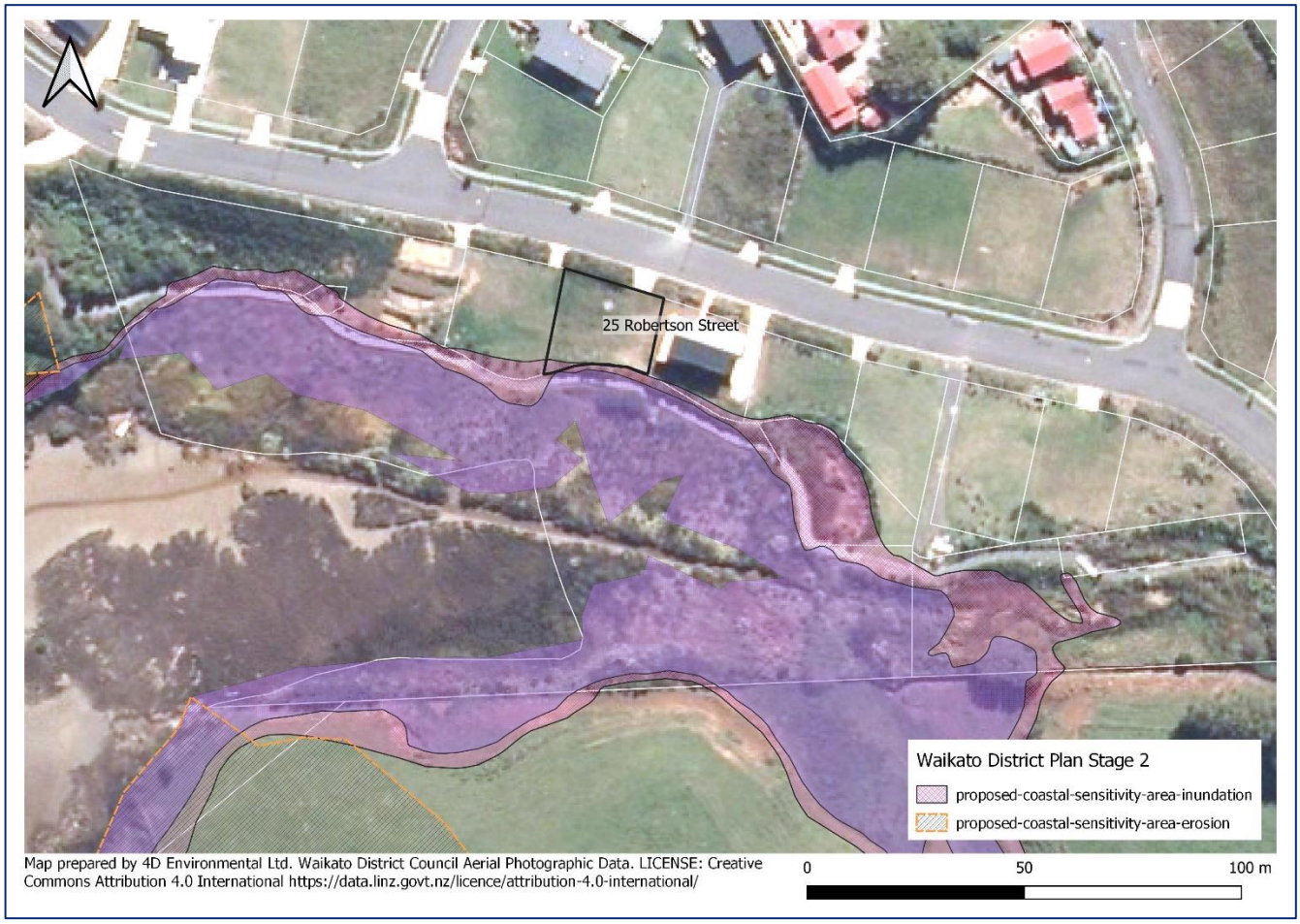


Figure 35: The extent of the Coastal Sensitivity Area (Inundation) overlay at 25 Robertson Street.

Recommendation: We recommend retaining the Coastal Sensitivity Area (Inundation) as notified.

6. Raglan South Open Coast

Raglan South Open Coast				
Whale Bay				
Tyler Barry	2031		Amend the Coastal Sensitivity Area (Open Coast) on Map 23.1 Manu Bay to accurately reflect the risk at 9 Tohora Close, Whale Bay.	Coastal Sensitivity Area (Open Coast)
Tyler Barry	2031		Amend High Risk Coastal Hazard (Erosion) area on Map 23.1 Manu Bay to accurately reflect the risk at 9 Tohora Close, Whale Bay.	High Risk Coastal Hazard (Erosion) Area
Ngarunui Beach and Whaanga Coast				
Helen Ritchie	2070		Amend Map 23 Raglan Coast to have a consistent width of Coastal Sensitivity Area (Open Coast) between Manu/Whale Bay and Whaanga Coast.	Coastal Sensitivity Area (Open Coast)
Mark Mathers	2187		Amend Section 15.7 Coastal Sensitivity area (Erosion) and Coastal Sensitivity Area (Open Coast). Provide more in-depth reasoning for the placement of this overlay.	Coastal Sensitivity Area (Open Coast)

6.1. Whale Bay

Submission #2031: Tohora Close, Whale Bay

Submission: To amend the Coastal Sensitivity Area (Open Coast) overlay from the property at 9 Tohora Close to reflect the risk more accurately.

Discussion: Submission 2031 relates to the High Risk Coastal Hazard (Erosion) and Coastal Sensitivity Area (Erosion) at Whale Bay (Figure 36). This area was subject to a local hazard assessment and is reported in Focus (2020).

Investigation of shoreline change from historical aerial photographs was difficult due to limitations in rectifying the old photographs and erosion rates could not be determined with this method. Qualitative analysis of the photographs suggests that the any shoreline erosion at Whale Bay has been very slow.

The field visit and reports from residents indicate that there is periodic bank erosion in some areas during severe storms and there is a vertical scarp along the seaward edge of the reserve, further indicating that while erosion is slow, it does occur. The eroding bank is composed largely of natural materials, including colluvium and in some places fill material. Existing slopes along the settlement are between 1V:1.5H and 1V:2H, and in

slightly lower lying areas, slopes are closer to 1V:3H. Geological maps indicate that the Whale Bay settlement is located on an area of terrace deposits (river and stream alluvium and swamp deposits). The area is underlain by volcanic materials which are seen at beach level.

The High Risk Coastal Hazard Area (Erosion) provides for just 2.0 m toe erosion, together with failure to a relatively steep stable slope (1V:1.5H). This High Risk Coastal Hazard Area (Erosion) is limited to the reserve seaward of the residential properties (Figure 36).

The Coastal Sensitivity Area (Erosion) provides for landward migration (10 m) of the boulder beach and bank as a result of sea level rise of up to 1.0 m over the next 100 years, and for failure to a slightly gentler stable slope (1V:2H). This sensitivity area provides for potential slope failure that may occur given the limited information available regarding the depth of various underlying substrates. As discussed in Focus (2020), the Coastal Sensitivity Area (Erosion) is not a defined "hazard" zone, but an area within which it is desirable to consider the potential for coastal processes to threaten a proposed activity. This area overlies the seaward portions of the beachfront properties at Tohora Close, predominantly seaward of the existing dwellings (Figure 36).

Figure 36: Proposed High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) at Whale Bay.

While the area is underlain with hard volcanic sediments, there remains the potential for erosion of the overlying terrace deposits and landward and upward migration of the boulder beach. The Coastal Sensitivity Area (Erosion) also provides for potential subsequent failure of sediments to a stable slope. Without detailed information about the depth and exact characteristics of the overlying terrace deposits, it is prudent to require a site-specific assessment within the area of possible failure prior to the construction of any permanent dwelling or any intensification of development.

A further field visit was completed, and a meeting held with the property owner of 9 Tohora Close. The calculations and profile shape at 9 Tohora Place were checked and it was confirmed the mapping could not be further refined using the current methods.

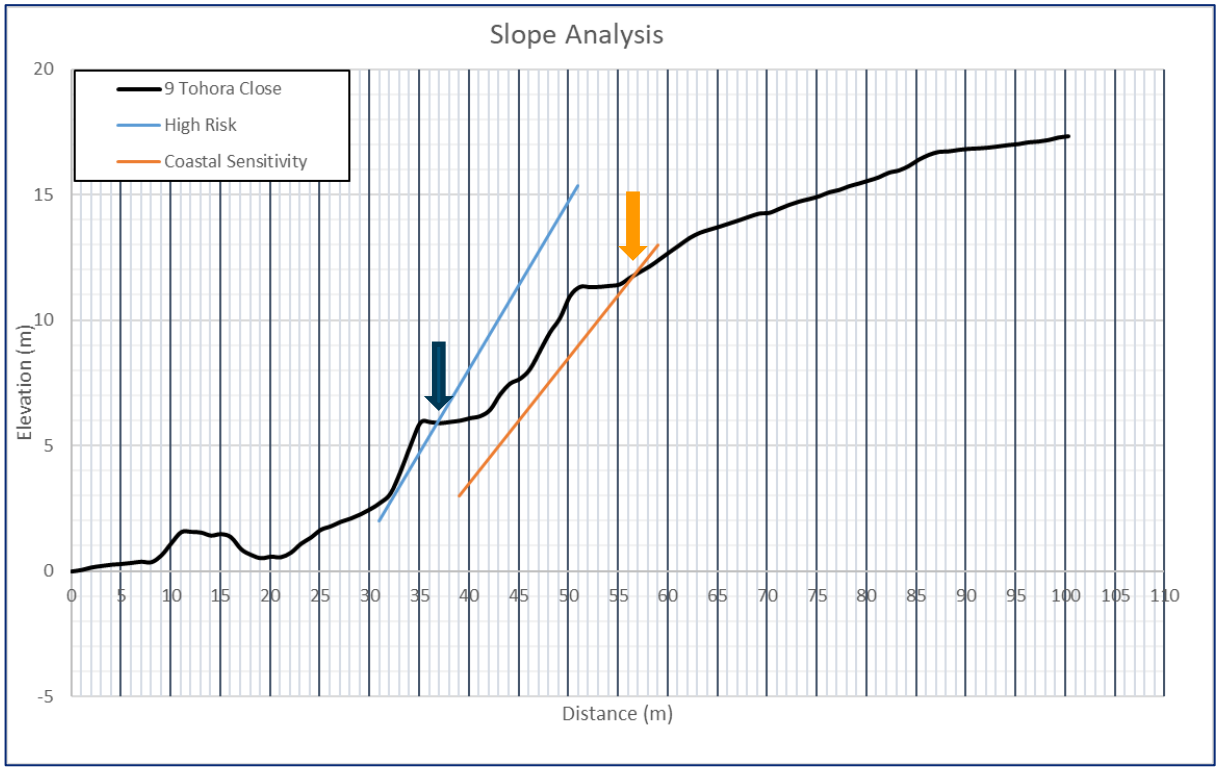


Figure 37: Cross section at 9 Tohora Close, Whale Bay. Blue line and arrow illustrates definition of High Risk Coastal Hazard Area (Erosion), orange line and arrow indicates definition of Coastal Sensitivity Area (Erosion).

Recommendation: The current proposed Coastal Sensitivity Area (Erosion) cannot be revised further without more detailed geotechnical investigations to determine the depth and physical characteristics of terrace deposits and the depth of volcanic materials underneath the surface.

We therefore recommend retaining the existing proposed High Risk Coastal Hazard (Erosion) and Coastal Sensitivity Area (Erosion) at Whale Bay. We also recommend (as we have for all defined Coastal Sensitivity Areas) that provisions in the District Plan provide for activities and/or future development within these areas when supported by site specific investigations and data (provided by an appropriately qualified expert).

6.2. Ngarunui Beach

Submission #2187: 536 Wainui Road

Submission: Lack of justification for the 200 m wide Coastal Sensitivity Area (Open Coast). Concern over the implications of the overlay for future development.

Discussion:
The property in question is located at the southern end of Ngarunui Beach (Figure 38). The coastline is backed by steep vegetated slopes (approximately 30-45 m high), with gradients of approximately 1V:1H in the vicinity of 536 Wainui Road (Figure 39). Further north on Ngarunui Beach, active modern sand dunes separate the beach from the cliffs. There are currently no sand dunes at the southern end of the beach, where there appears to be slow erosion of cliff toe. An existing dwelling on the property is located at the top of the coastal cliff, approximately 100 m landward from the beach. This area is within the proposed 200 m wide Coastal Sensitivity Area (Open Coast).

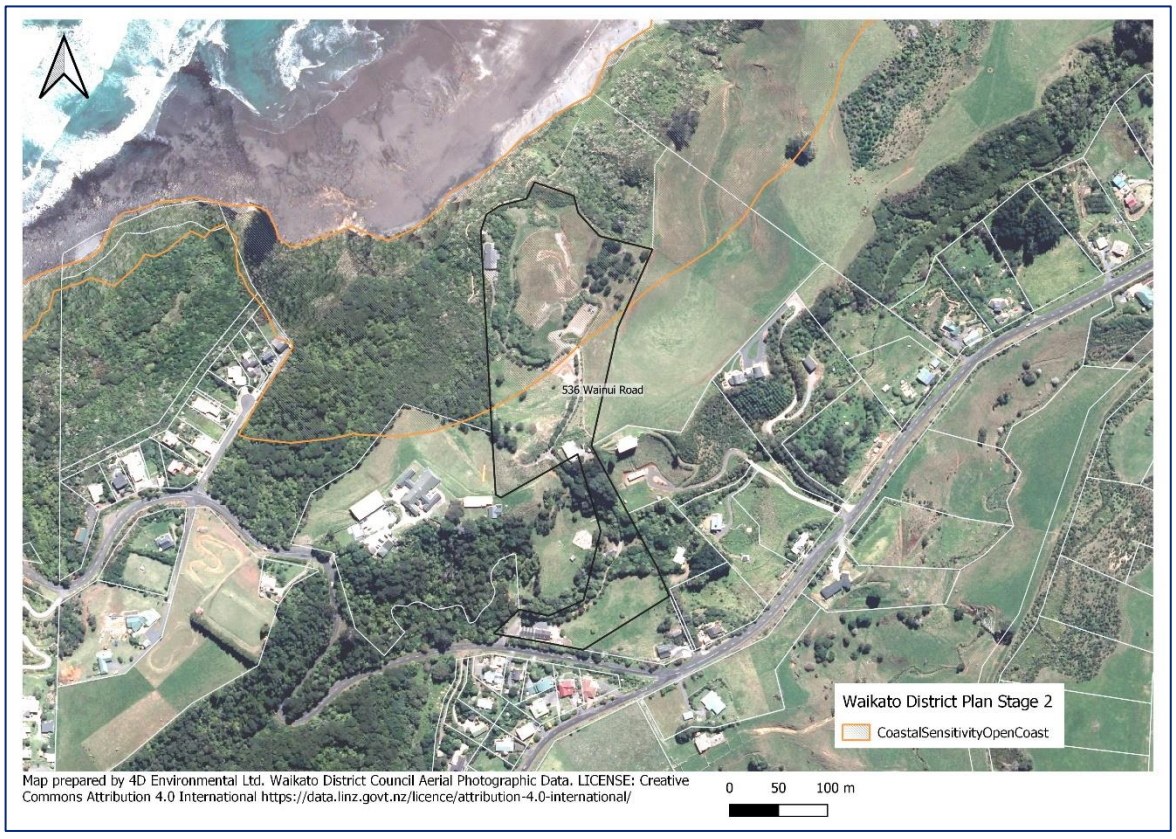


Figure 38: Proposed Coastal Sensitivity Area (Open Coast) at 536 Wainui Road.

The 200 m wide Coastal Sensitivity Area (Open Coast) has been defined with sufficient width to encompass potential long term coastal erosion hazard along the rural open coast of the Waikato District. This width needs

to be sufficient to provide for erodible shorelines and high sloping cliffs. This area identifies the coastal margin that may be vulnerable to coastal erosion hazard, including the effects of 1.0 m of sea level rise.

Figure 39: Coastline at the southern end of Wainui Beach, fronting 536 Wainui Road.

The slope based Coastal Sensitivity Area (Open Coast) mapped along the adjacent Whaanga Coast and Whale Bay and Manu Bay reflects the hard underlying volcanic geology (boulder beaches, basaltic rock platforms and steep rocky slopes), and therefore limited potential for significant shoreline retreat or deep slope failure.

The property in question lies landward of Ngarunui Beach and is therefore fronted by a dynamic sandy shoreline. The high sea cliffs landward of Ngarunui Beach are formed from consolidated materials of various nature (volcanic ash and lahar deposits and Pleistocene sands) with complex topography. With the existing beach to seaward, active erosion is occurring but appears to be slow.

However, as discussed in our report (2020) there is evidence that:

- Banks/cliffs composed of Pleistocene sands could erode quite rapidly if exposed to more frequent and severe wave attack as is likely to occur with projected sea level rise
- there is considerable uncertainty how the low gradient beaches will respond to projected sea level rise, but there is potential for quite significant erosion

Given the combination of these factors at this site and the high coastal slopes, there is potential for quite significant erosion and slope instability, particularly with future sea level rise. Accordingly, we believe it would not be prudent to revise the sensitivity area without more detailed study.

Figure 40: Coastline at the southern end of Wainui Beach, fronting 536 Wainui Road.

Recommendation:
That the proposed 200 m wide Coastal Sensitivity Area (Erosion) be retained as notified. This is not a defined "hazard" area, but simply indicates the potential for coastal hazards to influence the site in the long term, particularly with the effects of sea level rise.

The Coastal Sensitivity Area (Open Coast) will include some areas that are not subject to coastal hazards, depending on the local setting. The coastal hazard assessment by Focus (2020) provides guidance on the broad criteria that can be used to define coastal erosion hazard on different types of shoreline along the open west coast. Any future proposed development should be considered in a context specific to the site and the proposed activity.

Given the exposed and dynamic nature of sandy shorelines on the West Coast and potential vulnerability to sea level rise effects, these criteria would still identify a wide area of coastal margin at locations such as this one.

6.3. Whaanga Coast

Submission: #2070 Whaanga Road

Submission: that the Coastal Sensitivity Area (Erosion) be amended using the same approach applied to the coast immediately east, including Whale Bay and Manu Bay. The geology is hard resistant volcanic rock. The sudden change in sensitivity area could undermine the Plan's credibility.

Discussion: The submitter's property on Whaanga Road is located west of Whale Bay on the exposed open coast. The proposed 200 m wide Coastal Sensitivity Area (Open Coast) overlay in this area is applied along the length of the rural open coast, and is intended to identify the area that is potentially vulnerable to coastal hazards over the next 100 years, including the effects of sea level rise. As discussed in Section 3, these identified sensitivity areas are designed to be conservative and serve simply as a trigger or "flag" to indicate areas where further site-specific investigation is required prior to further development.

Following feedback from affected parties, Waikato District Council commissioned a more detailed approach to coastal sensitivity mapping on the Whaanga coast south of Raglan prior to notification of the proposed District Plan Stage 2. The review applied a slope based Coastal Sensitivity Area (Open Coast) approach along the adjacent Whaanga Coast and Whale Bay and Manu Bay that reflects the hard underlying volcanic geology (boulder beaches, basaltic rock platforms and steep rocky slopes), and therefore limited potential for significant shoreline retreat or deep slope failure (Focus, 2020b).

The underlying volcanic geology extends southwards beyond the area covered by the Whaanga coast mapping and as noted by the submitter, a similar detailed study to that undertaken for the adjacent coast may reduce the width of the sensitivity zone. However, such work is complex and has not yet been undertaken.

Recommendation:
The Coastal Sensitivity Area (Open Coast) cannot be revised without a detailed and time-consuming mapping exercise. The Coastal Sensitivity overlay does not define an identified hazard zone, and simply requires that future development consider coastal erosion processes.

We therefore recommend that the Coastal Sensitivity Area (Open Coast) be retained as notified.

References

Blair, S. 1998: Coastal Stability and Failure Mechanisms in the Vicinity of Raglan Township. Master of Science Thesis, University of Waikato. 217 p.

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Environment Waikato, 2008: West Coast Hazard Study. Prepared by Tonkin & Taylor Ltd for Environment Waikato. Environment Waikato Technical Report 2008/14. 59p.

Focus, 2020: Waikato District Council Coastal Hazard Assessment. Prepared for the Waikato District Council by Focus Resource Management Group. February 2020. 120p.

Focus, 2020b: Waikato District Council Coastal Hazard Assessment – Addendum 1: Review of Coastal Hazard Mapping - Whaanga Coast, Raglan South. Prepared for the Waikato District Council by Focus Resource Management Group. February 2020. 120p.

Waterhouse, B.C. & White, P.J. 1994: Geology of the Raglan-Kawhia Area. Geological Map. Geological & Nuclear Sciences Limited. 48p.

Appendix 1: Summary Table

The following table summarises the mapping approaches and highlights (blue rows) where amendments are recommended based on submissions received.

	Shoreline Type	High Risk Hazard Area	Coastal Sensitivity Area	Recommended Changes
PORT WAIKATO				
Port Waikato Northern Coast	Major River Entrance	n/a	1,500 m	No change
Port Waikato - Sunset Beach	Beach	60 m		No change
Port Waikato Spit	Wider spit	n/a	Entire spit.	No change
Port Waikato Upstream - Putataka Headland	Estuarine bank - specific	2 m + 1:1.5 slope	5 m + 1:2 slope	No change
Open Coast Port Waikato to Raglan	All	n/a	200 m	
Maunsell Road	Open coast cliff/beach	n/a	Landward limit of coastal ridge.	Amend Maunsell Road to reflect residential zoning.
Port Waikato Upstream	Rural Estuary	n/a	100 m	Waikato River shoreline
Tuakau Bridge Road	Rural Estuary	n/a	Landward limit of road reserve.	Reflects major access road to seaward.
RAGLAN HARBOUR				
Raglan Harbour Entrance Northern coast	Major Estuary Entrance	n/a	400 m	No change

Raglan Harbour Shoreline	Rural Estuary	n/a	100 m	
Te Akau South	Estuarine cliff developed	1V:1.5H slope	Toe erosion (varied) + 1V:2H slope.	Reflects village zoning and residential character development. Site specific investigation.
Estuarine Cliffs Developed	Banks/Cliffs	1:2 slope	5 m toe erosion + 1:2 slope	
Cox Bay, Greenslade Road, Wainui Road, Rangitahi Peninsula.	Banks/Cliffs	1:1.5 slope	5 m toe erosion + 1:2 slope	Amend High Risk Coastal Hazard Area (Erosion) to 1V:1.5H stable slope Coastal Sensitivity Area (Erosion) no change (back fills amended high risk area).
Norrie Avenue	Banks/Cliffs	1V:1.5H slope	Landward limit of road reserve.	Reflects major access road to seaward.
Lorenzen Bay	Estuary Shorelines (Developed)	10 m	25 m	No change.
Whale Bay	Bank/cliff	2 m + 1V:1.5H slope	10 m + 1V:2H slope	No change
Raglan Entrance Area (south)	Beach	16-24 m	All areas on sand	24 m on open coast, reducing to 16 m at toilet block continuing at 16 m around to Te Kopua. No change
Te Kopua	Estuarine beach/entrance	Northern shore: 12 m. Southern shore: 7 m.	All areas on sand	No change
Cliff Street	Low Estuary Bank	5.5-8.0 m	14.5 m	No change

Wallis Street	Low Estuary Bank	7.0 m	11.5 m	No change
AOTEA HARBOUR				
Aotea Harbour Northern Coast	Major Estuary Entrance	n/a	400 m	No change
Aotea Harbour Estuary Shoreline	Rural Estuary	n/a	100 m	No change
COASTAL INUNDATION				
Raglan Harbour Residential	Estuary developed	3.1 m (MVD-53) (mapped as 3.0 m)	4.1 m (MVD-53) (mapped as 4.0 m)	No change in Raglan or Aotea.
Port Waikato Township		3.1 m (MVD-53) (mapped as 3.0 m)	4.1 m (MVD-53) (mapped as 4.0 m)	Amendment to High Risk Coastal Hazard Area (Inundation) and Coastal Sensitivity Area (Inundation) where sections in Port Waikato Township are elevated.
Coastal Sensitivity Area (Inundation)	Rural Estuary	n/a	<5.0 m elevation	No change

Appendix 2: Review of Coastal Hazards and Coastal Sensitivity Area at Te Akau South

Cover: Shoreline of Horongarara Point and Ryan Road subdivision (looking west).

Prepared by: **Bronwen Gibberd**[3]
4D Environmental Ltd
Jim Dahm[3]
Eco Nomos Ltd

For: **Waikato District Council**

[3] **Member of Focus Resource Management Group**

Background

This report describes additional site-specific coastal hazard mapping undertaken to further refine the coastal hazard mapping areas described in Focus (2020) and notified as part of the review of the Waikato District Plan (Stage 2 – Natural Hazards).

Detailed mapping using site-specific criteria is complex and time consuming. Accordingly, we recommended that the Council adopt a single coastal sensitivity area (CSA) for undeveloped (rural zone) areas, within which more detailed site-specific investigation of coastal hazard should be required to support any future development. This sensitivity area is 100 m wide along the rural estuarine coast of the District.

The rural Coastal Sensitivity Area (Erosion) overlays the "village" zone area at Te Akau South, on the northern shore of the Raglan Harbour. The Ryan Road subdivision consists of 37 cliff top residential sections located on Horongarara Point, approximately 14 with coastal frontage (cover photo & Figure 41). The area is elevated (10-40 m above sea level) and fronted by near vertical cliffs of varied height and geology.

During notification of the proposed Plan, submissions were received from property owners in this area highlighting the need for a site-specific investigation to define coastal erosion hazard. Given the higher intensity of development and Village zoning, it is appropriate to consider likely coastal erosion hazard in more detail. As part of the response to submissions, Council therefore commissioned a more detailed assessment of coastal erosion hazard in this area.

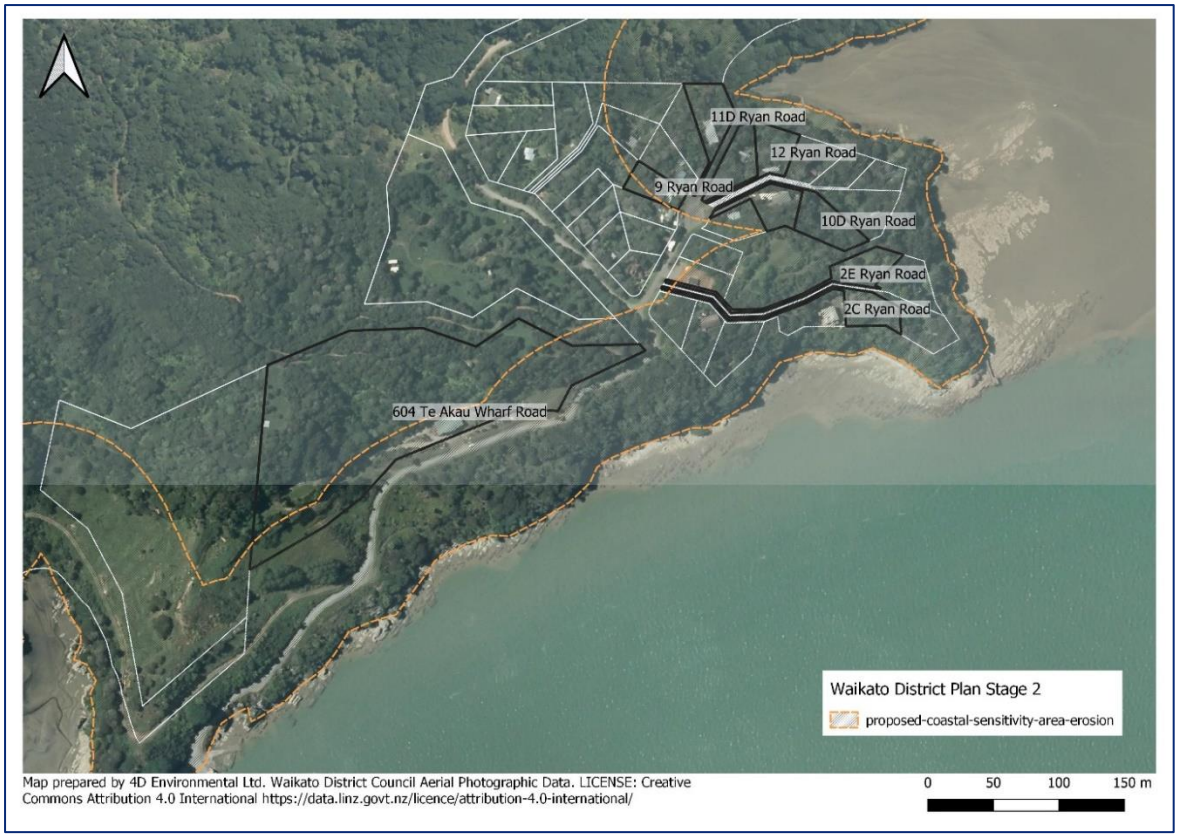

Figure 41: Horongarara Point (Te Akau south) area for revised coastal sensitivity assessment). Properties edged with black indicate submissions received.

Coastal Erosion Hazard Assessment

Approach

We considered a range of information in assessing the potential coastal erosion hazard, including (though not limited to):

- meeting on site with affected residents – gathering local knowledge about coastal erosion, land stability issues etc.
- vertical aerial photography dating from the 1940s to the present and historic shoreline data mapped from ortho-rectified aerial photography (Waikato Regional Council dataset).
- available topographic (LiDAR) data and bathymetric information
- geological maps and reports
- existing reports on coastal erosion and other relevant published resources (e.g. local history books and a range of technical reports and studies)
- physical and geomorphic characteristics of the coast
- field observations around the coast of Te Akau south

The Te Akau South coastline is backed by steep cliffs of varying geology. For the purposes of this report and for establishing an approach to mapping coastal erosion hazard, this shoreline has divided into four broad sections as described below (Figure 42):

1. South facing limestone shoreline, near vertical cliffs fronted by narrow shore platform and channel. Covers rural area west of Ryan Road subdivision and 604 Te Akau Wharf Road.
2. South facing siltstone cliffs, frontage of 2a-2c Ryan Road.
3. Eastern shoreline, mixed geology, evidence of active failures and some shoreline erosion. Wide shore platform, frontage of 2d, 10d Ryan Road.
4. Low lying coastal reserve (backed by 11d, 12 and 13 Ryan Road).

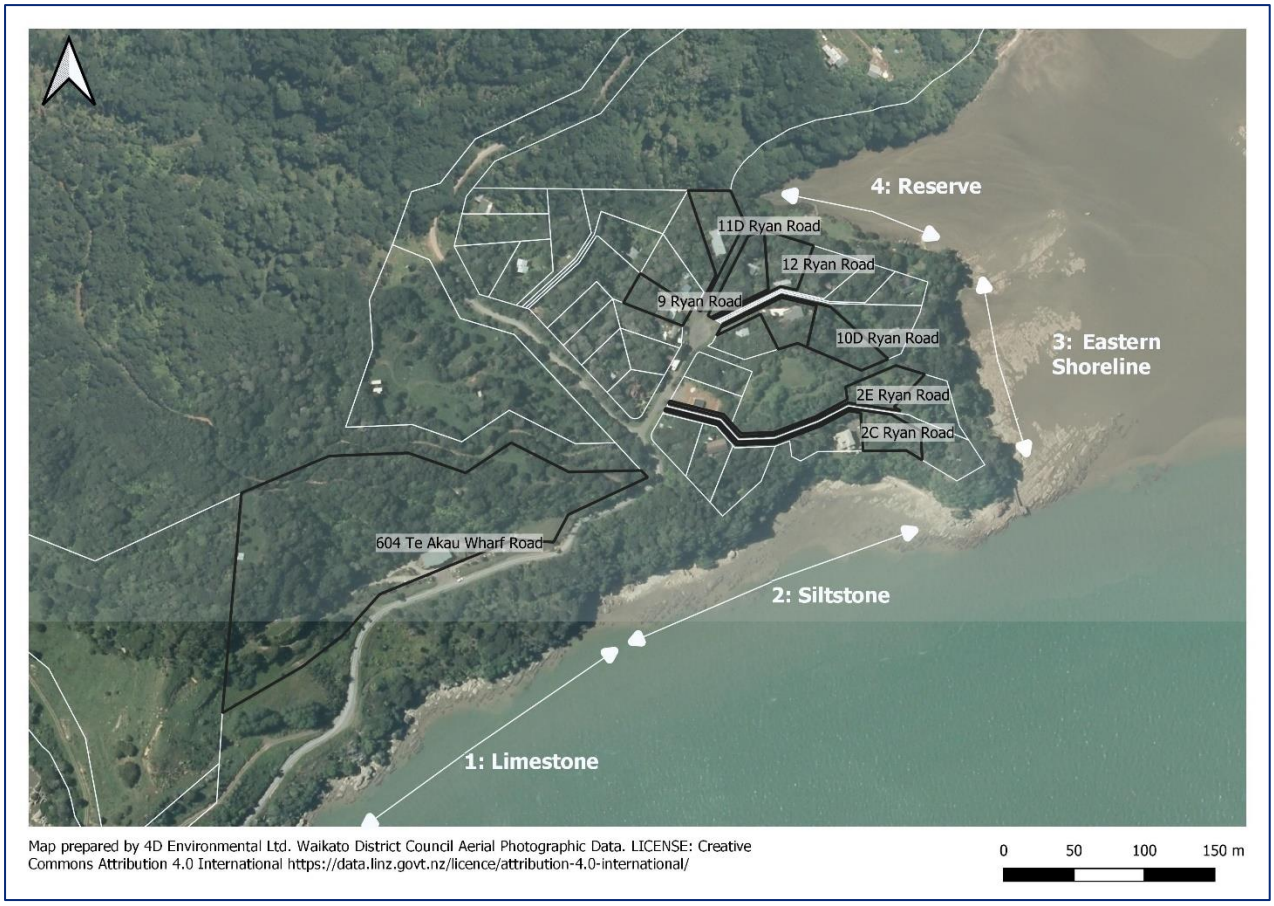

Figure 42: Te Akau south shoreline, showing sections defined based on cliff geology and topography.

Mapping of shoreline change by the Waikato Regional Council from orthorectified historical aerial photography (part of a region-wide project) indicates that shoreline change since 1944 is within the error of measurement. Accordingly, erosion in each area was assessed using field investigations, advice from local property owners and shoreline platform widths.

Section 1: Limestone Cliffs

This section of the shoreline faces south and is backed by steep limestone cliffs (Te Akatea Formation – Raglan Limestone). The hard flaggy limestone weathers gradually, which together with very slow shoreline retreat has created "pillars" of rock on the upper shore platform (Figure 43). The steeply sloping coastal cliff is up to 8 m high (near vertical in places), backed by more gentle vegetated slopes (Figure 44 & Figure 45).

The road is approximately 70 m landward of the coast and 15 m above sea level. The nearest private property at 604 Te Akau Wharf Road is landward of the road (Figure 41).

Figure 43: Limestone shoreline – fronting 604 Te Akau Wharf Road.

Figure 44: Limestone shoreline (taken looking east from Te Akau Wharf). Section 2 can be seen in the background.

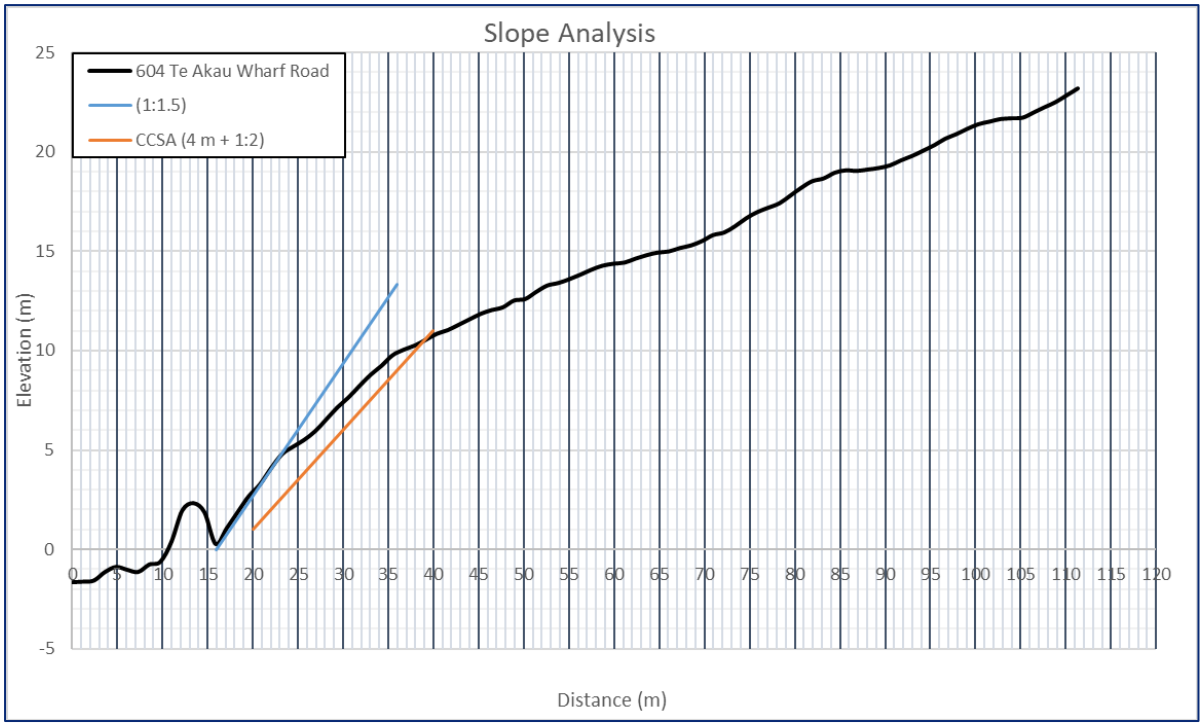

Figure 45: Cross section typical of Section 1 (Limestone Cliffs). Cross section location directly in front of dwelling on 604 Te Akau Wharf Road. Note limestone pillar at shoreline and toe of slope at ~0-1 m. The blue and orange lines indicate the method used o define High Risk Coastal Hazard Area (Erosion) (blue) and Coastal Sensitivity Area (Erosion) (orange).

The primary cause of erosion appears to be slow weathering processes (e.g. salt weathering, wetting and drying) acting on the rock surface with wave removal of the weathered debris. Accordingly, we would expect limited erosion of this hard material over planning timeframes, shoreline retreat likely averaging in the order of 1.0 m per century or less. This assessment is also supported by the narrow shore platform. Sea level rise may accentuate the erosion processes but is not likely to lead to excessive rates given the nature of the geology and the erosion processes operating at this site. We believe a doubling of toe erosion rates to 2.0 m per century will provide adequate allowance for any change.

In terms of potential slope instability associated with the toe erosion, the limestone exposed at sea level holds very steep gradients (near vertical), while the slopes to landward are typically in the order of 1V:1.5H. While the limestone appears to provide an effective buttress to slope failure and will likely remain so with expected sea level rise, we have nonetheless assumed potential for isolated slope instability by way of precaution.

Recommendations

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended here to produce a slope-based High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on observations of local geology, and topographical data. The land adjacent to this section of land is the subject of a submission, and while zoned “rural”, the available usable land area is relatively small. The shoreline in this area is particularly hard and it is relatively simple to identify that the coastal erosion hazard is limited to the coastal reserve landward of the road.

Given the limited potential for significant toe erosion in the short term, we recommend the High Risk Coastal Hazard Area (Erosion) be identified based on a stable slope of 1V:1.5H, measured from the toe of the cliff. This area is entirely within the coastal reserve and simply identifies the margin that may be subject to slope instability in the short term.

We also recommend a Coastal Sensitivity Area (Erosion)[4] that incorporates 2 m of toe erosion and a conservative 1V:2H stable slope. This conservative slope has been applied throughout the study area and reflects the lack of detailed information about the nature and structure of the sub-surface materials. The area overlain by the revised Coastal Sensitivity Area (Erosion) is predominantly coastal reserve (Figure 46). However, the high steep slopes at the eastern end of the 604 Te Akau Wharf Road property result in a wider Coastal Sensitivity Area (Erosion) at this location, which extends across the road and into the property.

Figure 46: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) in Section 1 (Limestone Cliffs). The 100 m wide proposed Coastal Sensitivity Area (Erosion) is shown as notified for comparison.

[4] The Coastal Sensitivity Area (Erosion) is not a defined "hazard area", but simply acts to trigger further site-specific consideration of coastal processes and associated land stability when significant development is proposed.

Section 2: Siltstone Cliffs

This section of the shoreline is separated from Section 1 (Limestone) at the location of a known fault, where the geology at the shoreline changes. Materials exposed at the shoreline are varied but the area is broadly characterised by high siltstone cliffs (Figure 47) and a shore platform 30-60 m wide. The grey-white calcareous siltstone cliffs show evidence of recent slope failure in places. Where exposed, the siltstone is weathering and fracturing to pebble sized material through to small and large boulders. Typical cliff slopes in this area are 1V:1H and in some places are near vertical (Figure 48).

Relatively recent shallow land slips exist along this section of the coast, indicating that this shoreline is actively eroding (albeit slowly) and potentially vulnerable to slope failure. The top of a recent land slip (2015) fronting 2c Ryan Road is close to the property boundary (Figure 49). It is difficult to accurately map the slope of these failures as they post-date the elevation data available. However, based on field observations and aerial photography, the recent land slips are still generally within a 1V:1H slope.

While the exposed cliff faces suggest the slope is largely composed of in situ rock, the depth of weathered materials and regolith further landward is uncertain and accordingly we have taken a precautionary approach with regard to slope instability.

Figure 47: Shoreline near the Western end of Section 2 (west of Ryan Road).

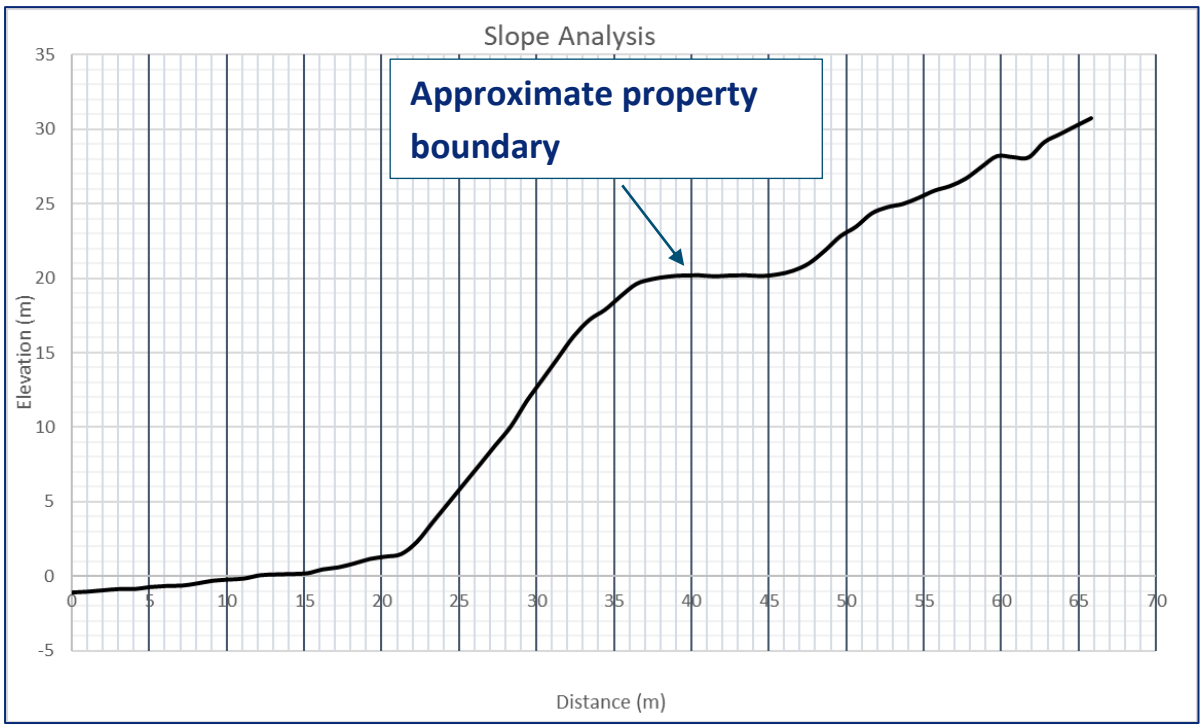

Figure 48: Typical cross section in Section 2.

Figure 49: Shoreline in Section 2 (fronting 2c Ryan Road). Note evidence of recent slope failure (slip occurred in 2020).

Recommendations

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended here to produce a slope-based High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on observations of local geology, and topographical data. This approach is consistent with that taken along other developed estuarine coasts in the District.

We recommend the identification of a High Risk Coastal Hazard Area (Erosion) based on a stable slope of 1V:1.5H, measured from the toe of the cliff. Where the topography slopes steeply to landward, strict application of the slope-based approach can generate an unrealistically wide coastal management area. We therefore recommend that the width of the High Risk Coastal Hazard Area (Erosion) is limited to twice the height of the seaward cliff face.

This area identifies a margin that may be subject to slope instability in the short term. While site specific geotechnical investigations may demonstrate that the underlying materials can support a steeper slope closer to the 1V:1H observed, we do not have sufficient data to be confident about this, particularly in the higher areas.

We estimate that current rates of cliff toe erosion are likely to be no more than 2.0 m per century. Based on an increase in this rate with future sea level rise, we have revised the Coastal Sensitivity Area (Erosion)[5] to incorporate 4.0 m of toe erosion and a conservative 1V:2H stable slope. This conservative stable slope has been applied throughout the study area and reflects the lack of data on underlying materials. More detailed investigation may reveal that the slope is largely composed of in situ rock with a limited depth of overlying regolith but we are uncertain of this. Similarly, more detailed investigation would be required to assess the potential for slope instability of the in situ rock materials (e.g. due to fractures and jointing).

In defining the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) we have also applied a minimum width of 20 m and 30 m respectively, measured from the toe of the cliff. This minimum distance provides for isolated lower lying areas with lower gradient slopes.

The revised coastal hazard and sensitivity areas vary in width from 20-60 m width (High Risk Coastal Hazard) and 30-80 m (Coastal Sensitivity) depending on the elevation and slope of the coastal margin (Figure 12). The area is widest where the coast is backed by high steep slopes at 2a and 2c Ryan Road and 585 Te Akau Wharf Road.

The identified High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) extend landward over several residential properties. We suspect (based on existing cliff slopes and the nature of materials exposed on the shoreline) that steeper stable slopes may be appropriate to

[5] **The Coastal Sensitivity Area (Erosion) is not a defined "hazard area", but simply acts to trigger further site-specific consideration of coastal processes and associated land stability when significant development is proposed.**

define coastal erosion hazard. However, this would need to be determined by a site-specific study by a suitably qualified engineering geologist or geotechnical engineer, in the context of any proposed activity.

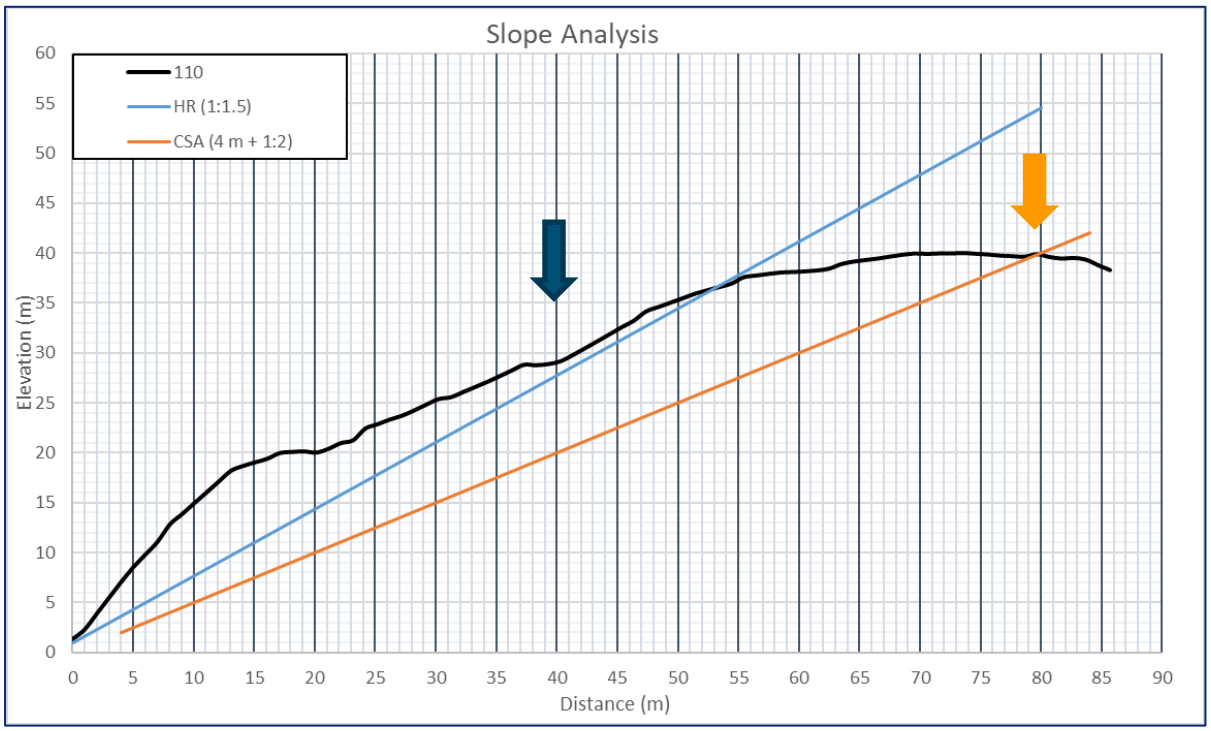

Figure 50: Cross section at Transect 110 (2a Ryan Road). In this location, the High Risk Coastal Hazard Area (Erosion) was limited to a distance of 40 m (blue arrow), based on a frontal cliff height of 20 m, and the closeness of the gradient to the land surface at that distance. The landward limit of the Coastal Sensitivity Area (Erosion) is shown by the orange arrow.

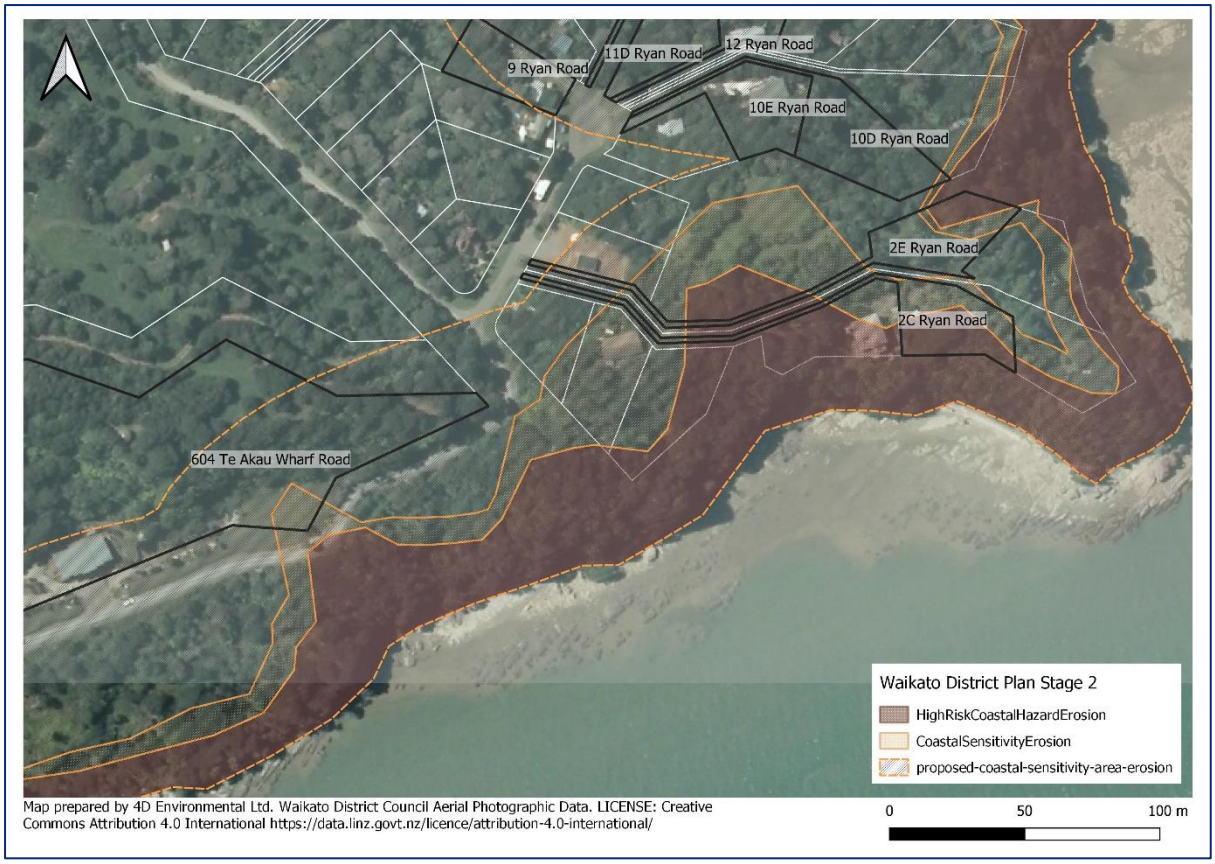

Figure 51: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) in Section 2 (Siltstone Cliffs).

Section 3: Mixed Geology Eastern Shoreline

This section includes the eastern facing cliff shoreline north of Horongarara Point. This shoreline is fronted by a shore platform up to 100 m wide and has a varied backshore, including steep siltstone bluffs in some areas (Figure 52), and vegetated slopes in others (Figure 53). While some areas are relatively low lying (7-12 m), slopes near the centre of this shoreline rise to 25-30 m above sea level.

Field observations and information provided by local residents indicate that the shoreline is eroding more actively than Section 1 and Section 2. The wider shore platform in this area (up to 100 m) further supports this. Cliff erosion rates are estimated to average 2-3 m per century, though may exceed this in isolated areas during some periods. This shoreline appears to be slightly more vulnerable to toe erosion due to the nature of the geology and the greater high tide wave fetch.

Cliff slopes in the headland areas at either end vary from 1V:1H to 1V:1.5H but more gentle slopes (typically 1V:1.5H to 1V:2H) are noted in some central areas. A deep-seated landslide was observed on this shoreline fronting 2e Ryan Road (Figure 53). This failure is only 2-3 years old, so occurred since the land elevation data used for his study was collected (2015). Slopes may therefore vary slightly from those measured and reported in this area. Cracks developing on the upper slopes above steep areas near the north end of the Bay indicate further slope failures are likely to occur.

Figure 52: Shoreline at Transect 142 (10d Ryan Road).

Figure 53: Eastern Shoreline. Approximate location of recent land slip indicated by white arrow.

Recommendations

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended to produce a slope-based High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on observations of local geology, and topographical data. This approach is consistent with that taken along other developed estuarine coasts in the District.

Given the complex shoreline and evidence of ongoing active slope failures, we recommend that the High Risk Coastal Hazard Area (Erosion) be defined by a 1V:2H stable slope in the more gently sloping areas (e.g. Figure 54). At locations fronted by steep siltstone cliffs, a slope of 1V:1.5H is appropriate, as applied in Section 2 (Figure 55). The highly varied nature of the shoreline makes slope-based mapping complex, and we have also applied minimum width of 20 m and 30 m to the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion)respectively, measured from the toe of the cliff.

We estimate that current rates of cliff toe erosion are likely to be 2-3 m per century. Based on an increase in this rate with future sea level rise, we have revised the Coastal Sensitivity Area (Erosion)[6]

[6] **The Coastal Sensitivity Area (Erosion) is not a defined "hazard area", but simply acts to trigger further site-specific consideration of coastal processes and associated land stability when significant development is proposed.**

to incorporate 5 m of toe erosion and a conservative 1V:2H stable slope. This conservative slope has been applied throughout the study area and reflects the lack of data on underlying materials.
In defining the Coastal Sensitivity Area (Erosion) we have also applied a minimum width of 30 m, measured from the toe of the cliff. This minimum distance provides for isolated lower lying areas with lower gradient slopes.

The revised coastal hazard and sensitivity areas vary in width depending on the elevation and slope of the coastal margin from 20-60 m (High Risk Coastal Hazard) and 30-80 m (Coastal Sensitivity) (Figure 56). The area is widest fronting 2e Ryan Road, due to the steep slopes and high elevation. This is the location of the recent significant land instability. Detailed site-specific investigations may indicate that the 1V:2H stable slope is overly conservative, but we have taken a precautionary approach due to lack of knowledge about subsurface geology and characteristics.

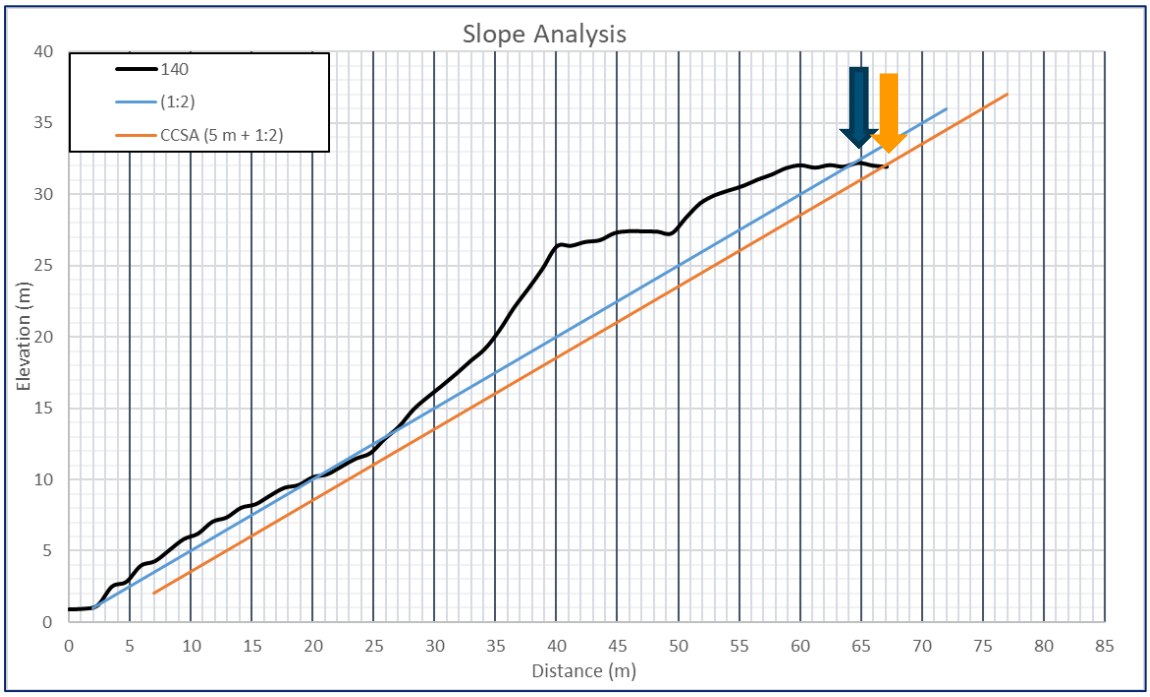

Figure 54: Cross shore profile in the vicinity of the recent land slip (elevation data pre-dates the landslip). Blue and orange arrows indicate the landward boundary of the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) respectively.

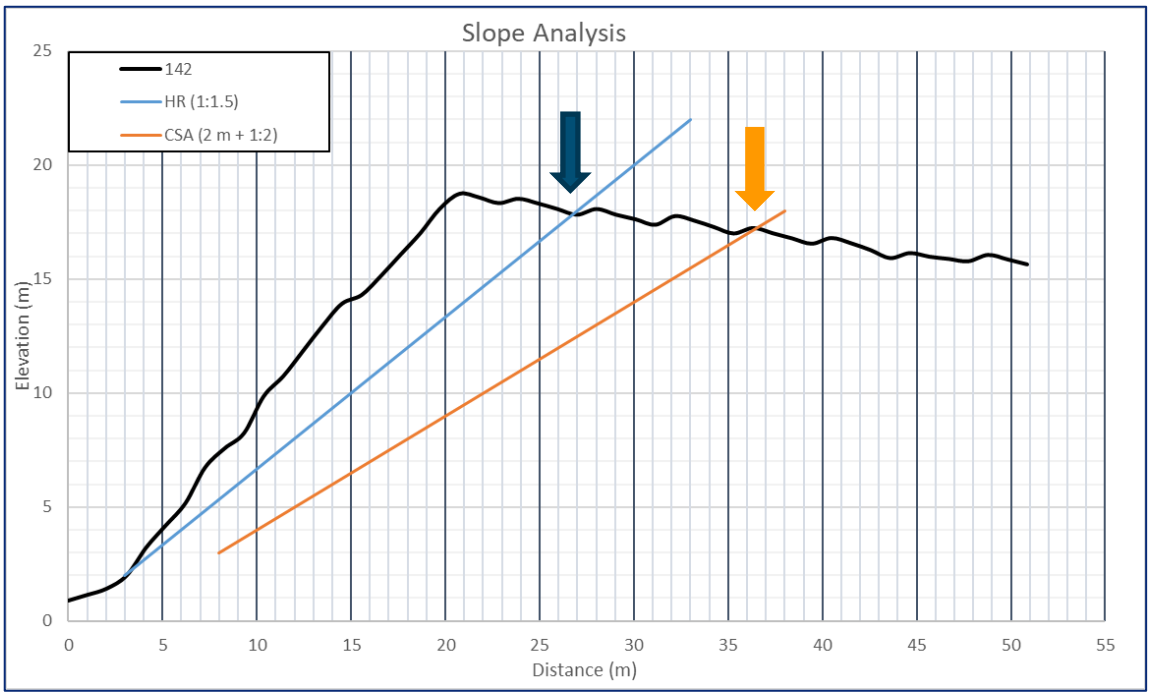

Figure 55: Cross shore profile near the northern end of the eastern shoreline at Transect 142 (Figure 52). Blue and orange arrows indicate the landward boundary of the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) respectively.

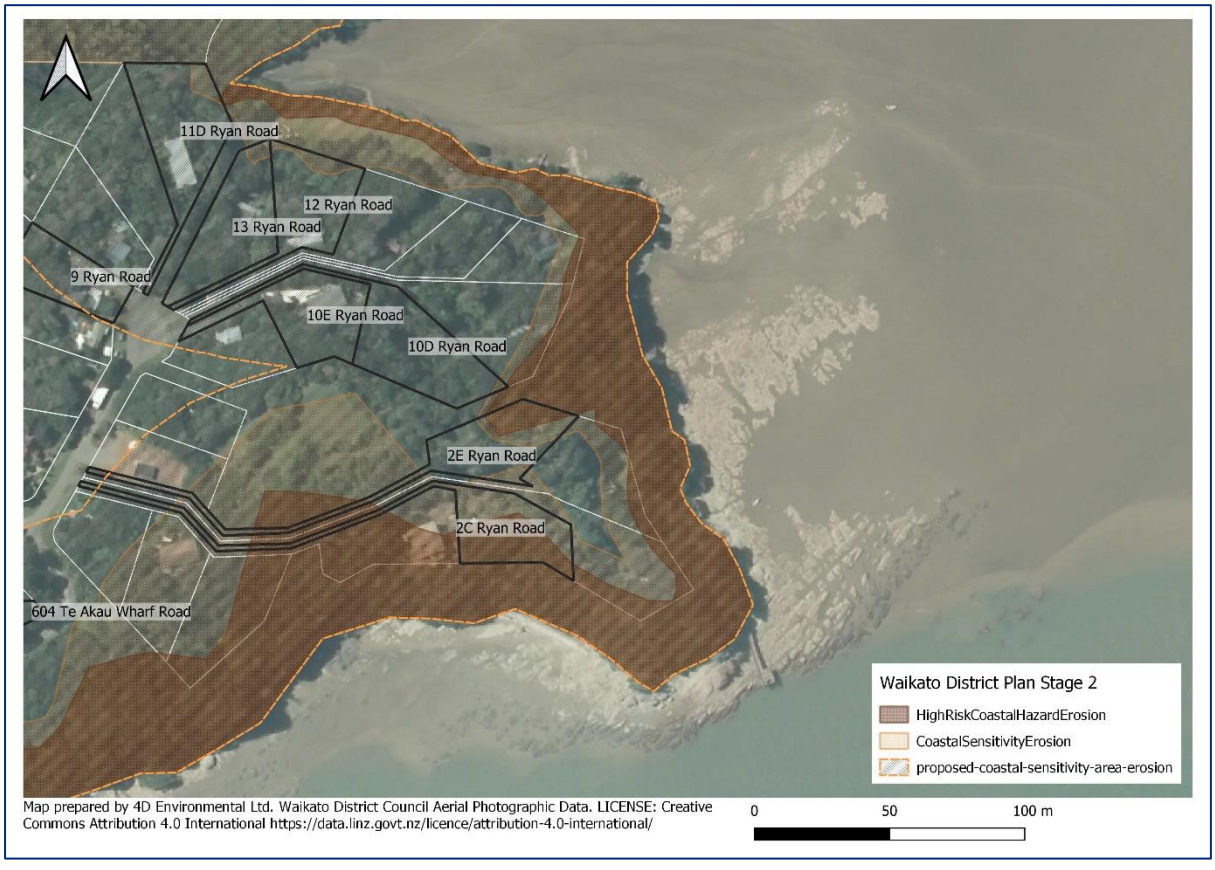

Figure 56: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) at Te Akau South.

Section 4: Reserve and Embayment

Section 4 is backed mostly by a low-lying grassed reserve up to 20 m wide (Figure 57). Residential sections are located on the elevated slopes to landward. During the site visit, it was noted by residents that there has been some minor erosion of the frontage over time. Works have been undertaken to stabilise and revegetate some areas. This area is relatively sheltered from wave action. The seaward edge of the reserve is relatively low lying (RL 2-3 m), so is potentially susceptible to occasional coastal inundation during extreme events.

In the short term, erosion is unlikely to be severe, but with increased sea level, the area will be frequently overtopped and exposed to wave and current action for greater periods over the tidal cycle. This could increase the hazard from coastal erosion.

Figure 57: Coastal reserve at Section 4. The reserve is potentially susceptible to coastal inundation with future sea level rise.

Recommendations:

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended here to produce a High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on a pragmatic approach that reflects the local setting (Figure 58).

In the relatively short term, significant shoreline erosion is unlikely, and will only affect reserve land. We propose a 5.0 m wide High Risk Coastal Hazard Area (Erosion) measured from the toe of the bank.

The residential properties in this area are located well landward of a very sheltered coastline and are unlikely to be impacted by coastal erosion even in the longer term with future sea level rise. However, we do not have detailed information about the materials within the low-lying reserve area, which may be fill, or other readily erodible substrate. As such we suggest that this area is flagged as a Coastal Sensitivity Area (Erosion). In defining the low-lying reserve, we have adopted the 5 m contour as the landward limit. This is equivalent to the extent of the Coastal Sensitivity Area (Inundation). These two overlays reflect the potential of the area to be influenced by coastal processes in the long term with sea level rise.

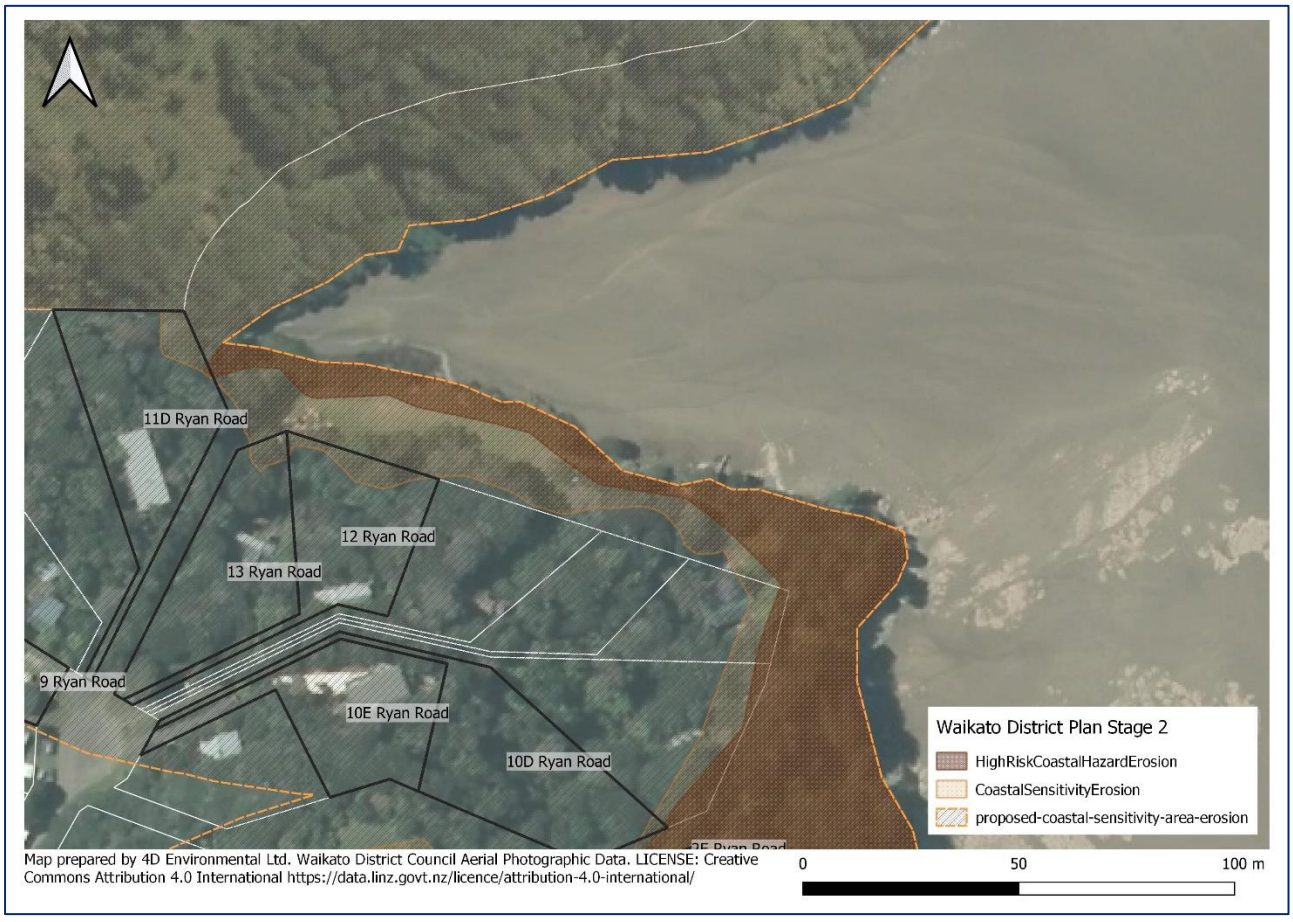

Figure 58: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) at Te Akau South (Section 4).

Summary

We have undertaken a broad assessment of coastal geomorphology and coastal hazards at the Horongarara Peninsula, Te Akau south. From the available information and site observations we have made some recommendations for amendment of the (previously 100 m wide) Coastal Sensitivity Area (Erosion) in the proposed Waikato District Plan.

The area is predominantly a cliff shoreline, with complex and variable geology and elevation. We recommend two coastal management areas at this site, in an approach that is consistent with other developed cliff shorelines in the District:

- High Risk Coastal Hazard Area (Erosion): the area potentially vulnerable to slope failure associated with coastal cliff processes in the short term (10-15 years).
- Coastal Sensitivity Area (Erosion): the additional area that MAY be impacted by coastal erosion processes in the next 100 years, including the effects of projected sea level rise of 1.0 m.

In identifying these areas, we have assumed relatively low rates of cliff toe erosion, particularly on the south facing shoreline (Section 1 and Section 2). We expect the impact of sea level rise on these sections of coast to be limited but have allowed for a small acceleration of toe erosion due to increased time of exposure to coastal processes and wave exposure. The toe erosion component is generally a small proportion of the total sensitivity area. The amount of land affected is a function of both the slope angle and the height of the cliff and adjacent land. The criteria used to define the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) are summarized in Table 1 below.

We acknowledge here that the proposed Coastal Sensitivity Area (Erosion), while considerably refined in relation to the 100 m wide generic area, still extends inland to overlay a number of existing residential properties. We emphasise that the Coastal Sensitivity Area (Erosion) is not a defined hazard area. It is an area within which we feel that coastal erosion processes should be considered (including the effects of sea level rise). We suspect (based on existing cliff slopes and the nature of materials exposed on the shoreline) that steeper stable slopes may be appropriate to define coastal erosion hazard. However, the geology at this site is complex and highly variable, and implementation of this steeper slope would need to be based on more detailed information about the underlying geology and associated failure mechanisms. Such investigations are best undertaken on a site-specific basis, by a suitably qualified engineering geologist or geotechnical engineer, in the context of the proposed activity. The provisions of the proposed District Plan provide for development within the Coastal Sensitivity Area (Erosion), provided that coastal hazards are considered.

We note that the Ryan Road subdivision is located on steeply sloping land and there may be other (land-based) hazards associated with the steep nature of these sections. We have only considered those processes that are influenced by coastal erosion.

Table 4: Coastal sensitivity mapping approaches for Te Akau Coast.

	Location	High Risk Hazard Area	Coastal Sensitivity Area
TE AKAU SOUTH			
Section 1: Limestone Cliffs (Transects 80-89)	Coastline fronting 604 Te Akau Wharf Road	1V:1.5H slope. Measured from toe of cliff. 2 m provided from profile toe to allow for limestone shoreline – pillars.	2 m of erosion + 1V:2H slope. Measured from toe of cliff (+ 1.0 m for sea level rise). 2 m provided from profile toe to allow for limestone shoreline – pillars.
Section 2: Siltstone/Sandstone Cliffs (Transects 90-129)	Coastline fronting 2a- 2c Ryan Road.	1V:1.5H slope. Minimum width 20 m. Measured from toe of cliff.	4 m of erosion + 1V:2H slope. Measured from toe of cliff (+ 1.0 m for sea level rise).
Section 3: Eastern Shoreline (Transects 130-149)	Coastline fronting 2d, 10d Ryan Road	1V:1.5H slope in rock/bluffed areas. 1V:2H in sloped areas. Minimum width 20 m. Measured from toe of cliff.	5 m of erosion + 1V:2H slope. Measured from toe of cliff (+ 1.0 m for sea level rise).
Section 4: Low Lying Reserve (Transects 150+)	Area fronting 11d, 12 and 13 Ryan Road	5.0 m Measured from toe of bank.	Width of low-lying reserve. 5.0 m contour to define landward boundary.