ADDENDUM 1: REVIEW OF COASTAL HAZARD MAPPING - WHAANGA COAST, RAGLAN SOUTH

BACKGROUND

This addendum describes additional coastal hazard mapping undertaken to further refine the coastal hazard mapping areas described in Focus (2020).

In Focus (2020) we recommended that the Council adopt a single **coastal sensitivity area** (CSA) for undeveloped (rural zone) areas, which identifies the area that is potentially vulnerable to coastal erosion and/or flooding over the next 100 years, including the effect of future sea level rise. The 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. We defined a range of criteria that could be applied to this coastline, which reflect the different geological and geomorphic shoreline types within the District.

There are many potential complications and uncertainties associated with local factors and future sea level rise on this coastline. Detailed mapping using site-specific criteria is complex and time consuming. Our report therefore recommended application of a single, conservative sensitivity area within which more detailed site-specific investigation of coastal hazard should be required to support any future development. This sensitivity area is 200 m wide along the open rural coast of the District.

Following feedback from affected parties, Waikato District Council has commissioned a more detailed approach to coastal sensitivity mapping on the Whaanga coast south of Raglan (Figure 1). This addendum describes the methodology adopted and summarises the results.

Figure 1: "Whaanga Coast" area for revised coastal sensitivity assessment (blue indicates current 200 m sensitivity area).

COASTAL SENSITIVITY MAPPNG APPROACH

The Whaanga Coast is predominantly a rocky shoreline constructed of hard volcanic substrates (Karioi volcanic formation), which are resistant to coastal erosion. Exposed rock shore platforms and sloping boulder beaches are backed by dense established vegetation in most areas of Whale Bay (e.g. Figure 2 & Figure 3) and Manu Bay (Figure 4 & Figure 5). There is little evidence of active erosion, except in exposed areas west of Whale Bay where bare, steep rocky cliffs occur (Figure 6).

Figure 2: View of boulder beach and heavily vegetated slopes typical around Whale Bay.

Figure 3: Typical view of boulder beaches backed by steep vegetated slopes west of Whale Bay

Figure 4: Rocky shore platform at Manu Bay.

Figure 5: Mixture of sand beach and rocky shore platforms backed by steep heavily vegetated slopes at Manu Bay.

Figure 6: View of exposed coast west and south of Whale Bay showing hard, steeply cliffed shoreline

Shoreline change data has been collected by the Waikato Regional Council from historical aerial photography as part of a region-wide project. Orthorectified photography from 1944 confirms that the Whaanga coast shoreline has been largely stable since that time, with no measurable net retreat.

The coastal sensitivity area has been revised to reflect the geological and geomorphic nature of this coastline. Approaches used to identify the revised coastal sensitivity areas are outlined in the following sections and summarised in Table 1.

Cliffs

Much of the Whaanga Coast is backed by steep vegetated slopes (Figure 3 and Figure 5). Existing coastal cliff slope angles vary from near vertical exposed cliffs west of Whale Bay to the vegetated slopes (1:1 to 1:1.5) between Whale and Manu Bays. In most areas these cliffs are fronted by wide boulder beaches and/or hard volcanic rock outcrops and platforms/reefs (Figure 3 & Figure 4).

We do not expect significant erosion at the toe of these cliffs over planning timeframes due to the hard geology. While there are erosion scarps evident along the base of the slopes, the rate of retreat appears to be very slow (probably <0.01 m/yr). Where steep slopes directly intercept the coast, we have therefore defined the coastal sensitivity area using a stable land slope (Figure 7) to allow for potential but rare slope failure involving weathered surface substrates overlying the hard volcanic rock. We expect that any slope instability events will be shallow slip events rather than deep-seated slope failures. Accordingly, where necessary we have limited the landward extent of the likely coastal sensitivity to 5 m back from the top edge of slope (e.g. Figure 8), with a minimum CSA width of 20 m from the toe of cliff. This provides for these potential shallow failures while not overstating the likely vulnerability with the stable slope method.

The coastal sensitivity area is therefore defined as the 1:1.5 slope taken landward from the toe of the cliff, limited to a maximum width of 5 m landward of the top of the seaward slope.

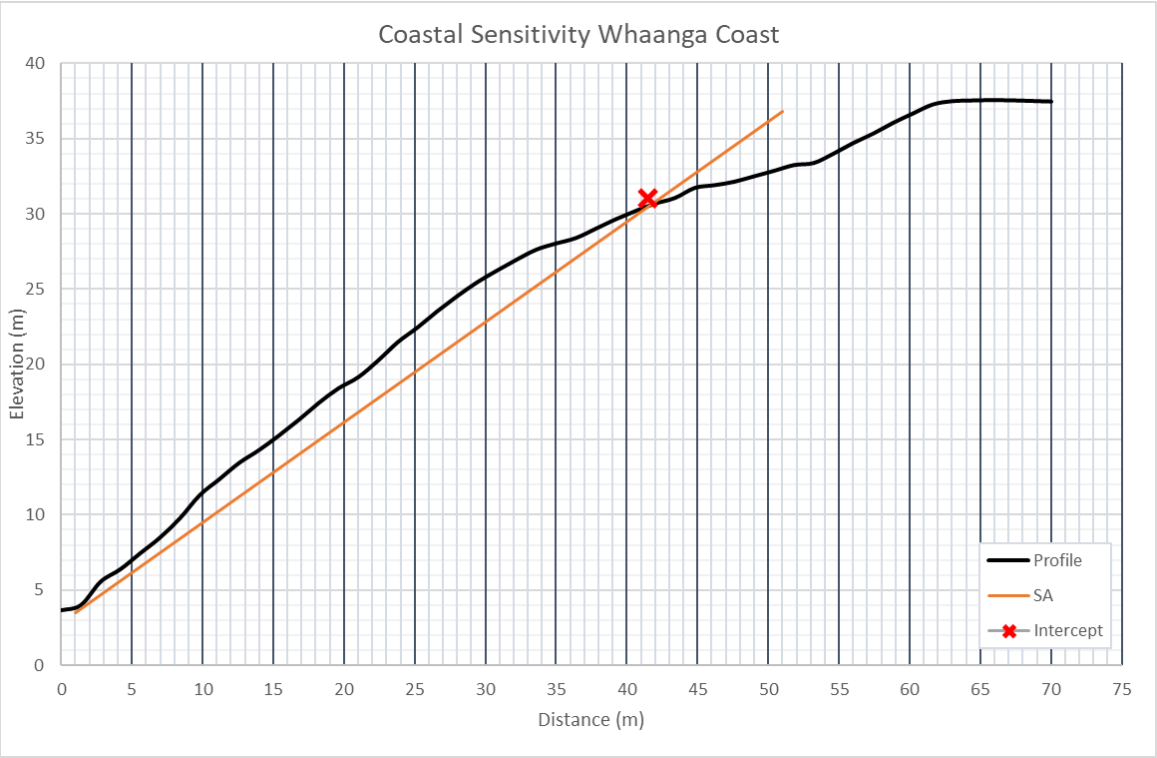

Figure 7: Example of slope based coastal sensitivity area on cliff coastline.

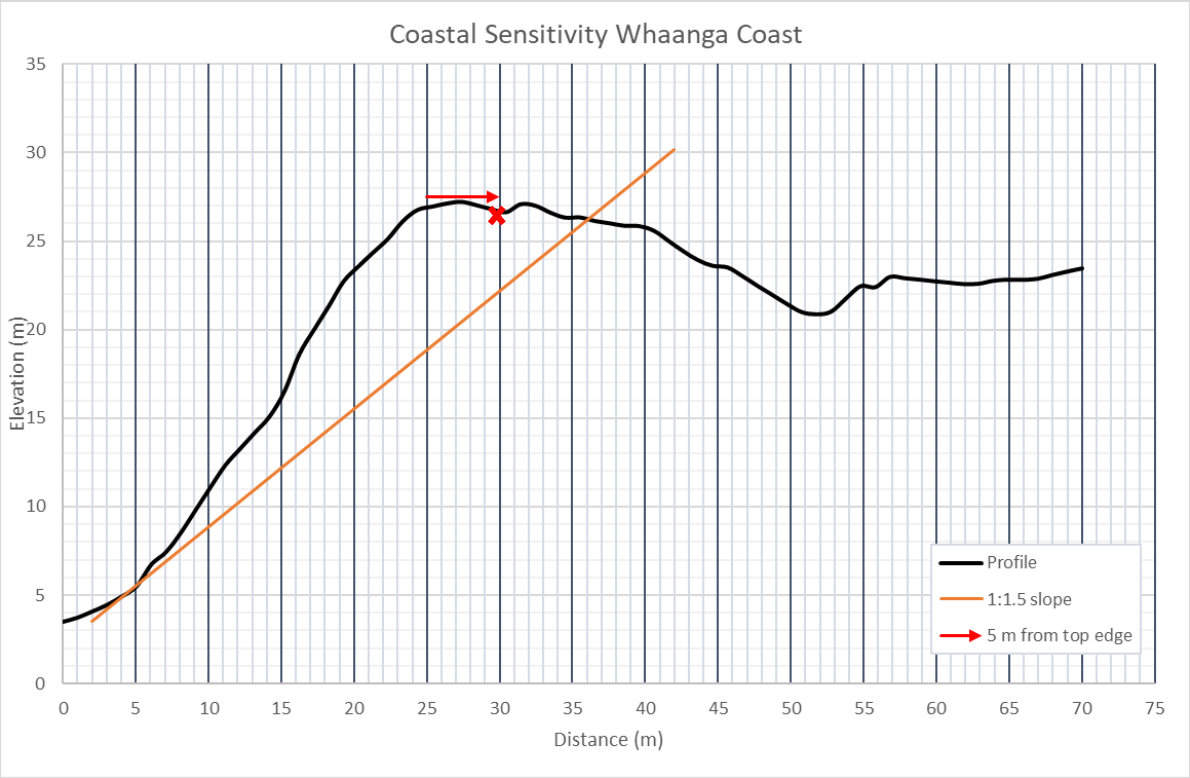

Figure 8: Identification of coastal sensitivity boundary 5 m from the top of slope.

Embayments and Beaches

Lower terraces or slopes exist near Whale Bay and Manu Bay, fronted mostly by boulder beaches and rock platforms (Figure 9). Isolated sand beaches exist at Manu Bay (Figure 5) and in the lagoon at Whale Bay. There are no active sand dune systems evident in the study area. Where sand or boulder beaches are present, we have made allowance for some landward and upward migration of the beach slope in response to sea level and a stable slope (e.g. Figure 10).

At Whale Bay we have revisited the coastal sensitivity mapping throughout the settlement and extended this approach to the adjacent areas. We have applied a minimum width of 20 m to the coastal sensitivity area. This 20 m coastal sensitivity area was also applied to the low-lying western side of the Whale Bay lagoon. This area is sheltered by the spit and is not exposed to wave action like exposed areas of shoreline nearby. This is evidenced by field and data observations, which indicate with current sea level coastal processes are limited to approximately RL 3.5 m (NZVD, 2016). We are comfortable that the 20 m sensitivity area will provide for coastal inundation hazard with 1 m of sea level rise.

Figure 9: Boulder beach at Whale Bay.

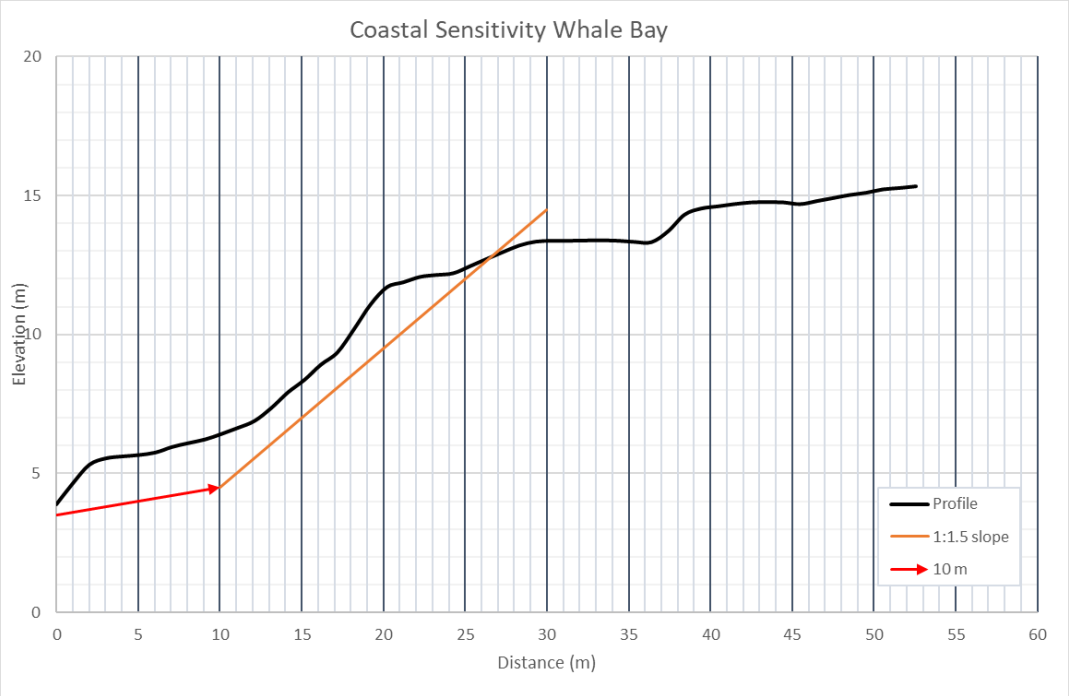

Figure 10: Coastal sensitivity example profile, Whale Bay.

Coastal Inundation

The current (200 m) rural coastal sensitivity zone covers the area of coastal margin likely to be impacted by coastal inundation as well as erosion. There is no separate coastal inundation sensitivity zone applied on this open coast. We have therefore included likely coastal inundation within this revised sensitivity zone. Coastal inundation hazard is not widespread on this mostly cliff shoreline.

Aerial photography, field observations and DEM data indicates that in the most exposed open coast areas, wave effects are currently limited to elevations below RL 5 m elevation (NZVD, 2016). We have therefore included land with elevations below RL 6 m within coastal sensitivity areas in exposed areas to accommodate 1 m sea level rise. There may be occasional wave run-up effects to higher level, but we believe this will be adequately provided for by the minimum 20 m width of the CSA. The most affected area is the Manu Bay boat ramp and car park where parts of the reserve and car park are identified within the CSA, well landward of the area likely to be impacted by erosion. Elsewhere on this coast, most areas potentially susceptible to inundation following 1 m of sea level rise are captured within the zones also potentially vulnerable to erosion.

DATA

This analysis has utilised the Waikato - West Coast and Hauraki Plains LiDAR 1 m DEM (2015) for land elevation information. Elevations referred to here are NZVD 2016. Transects were collected across this DEM (10-20 m spacing) to evaluate land slope and elevation. From these transects, points were collected to represent the appropriate width for the sensitivity area. Additional transects or analysis techniques were used where necessary to further refine the mapping. In some areas, elevation contours or set distances were used to supplement the profile-based approach.

All slope analysis used the toe of slope as the baseline for the analysis. On this open coast this is approximated by the 3.5 m contour (NZVD, 2016), but adjustments were made at each site to ensure the analysis utilised the toe of cliff. The geomorphic feature is considered more important here than the absolute elevation.

REVISED COASTAL SENSITIVITY AREAS

The revised coastal sensitivity areas are available through the Waikato District Council's online maps. The figures below provide an overview of key areas.

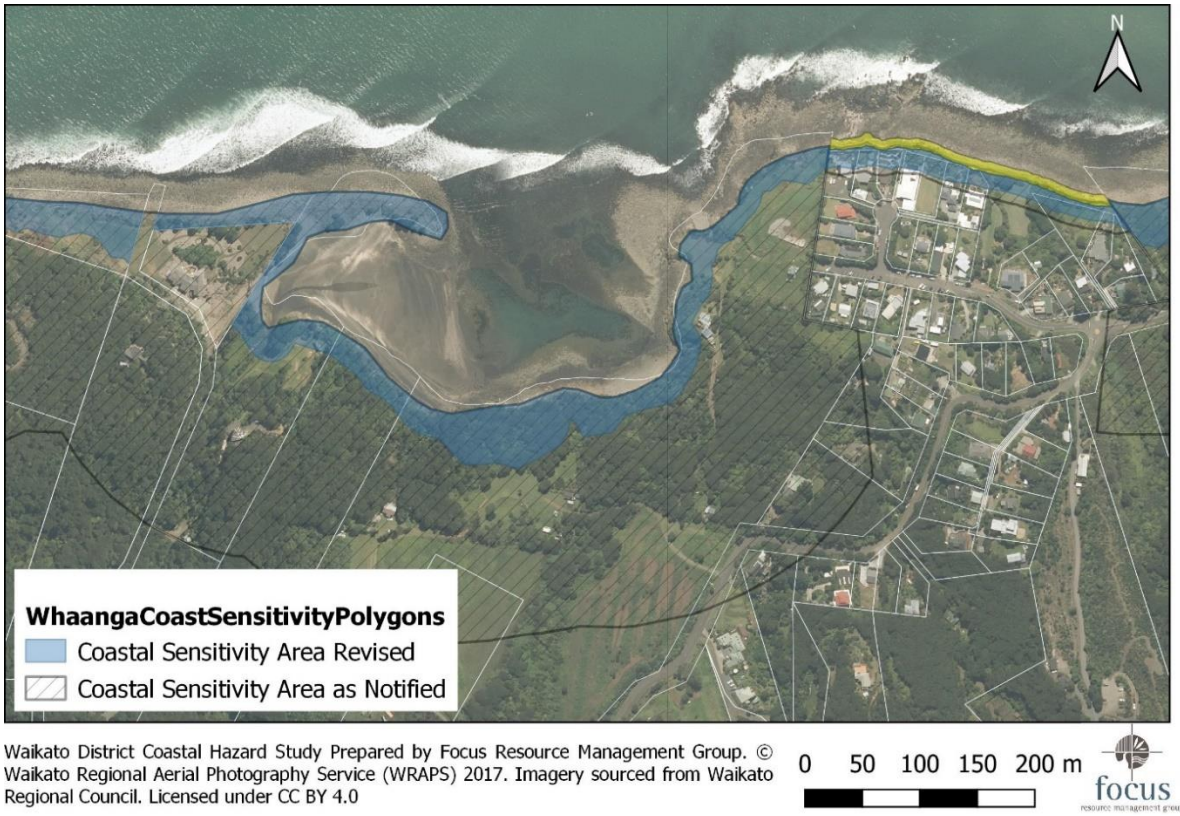

Figure 11: Revised coastal sensitivity area at Whale Bay. The previous 200 m sensitivity area from the draft District Plan is also shown.

Figure 12: Revised coastal sensitivity area at Manu Bay. The previous 200 m sensitivity area from the draft District Plan is also shown.

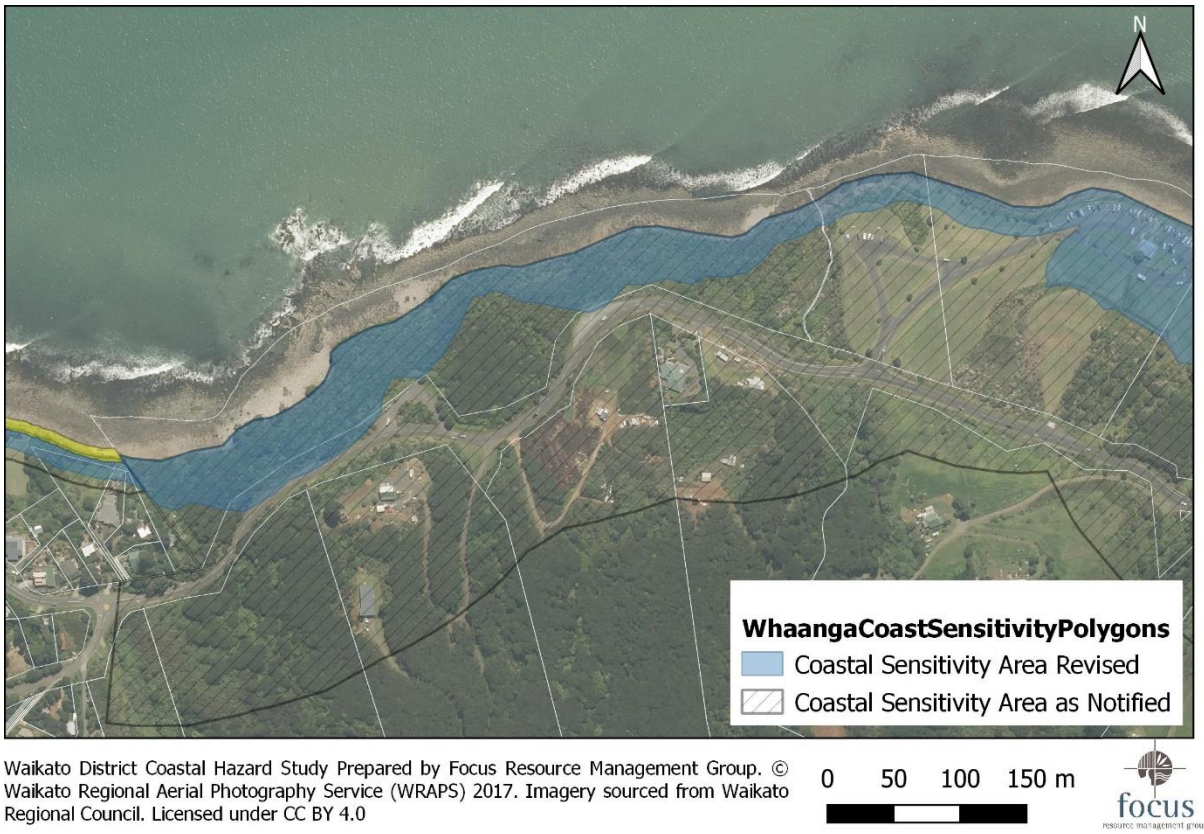

Figure 13: Revised coastal sensitivity area between Whale Bay and Manu Bay. The previous 200 m sensitivity area from the draft District Plan is also shown.

SUMMARY OF METHODOLOGY AND OUTCOMES

Table 1: Coastal sensitivity mapping approaches for Whaanga Coast.

Sensitivity Area	Shoreline	Criteria for Mapping	Notes
Open West Coast (Rural) **Erosion and Inundation**	All rural open coast outside current study area.	200 m	Provides for diverse range of coastal hazards on the open west coast, which could be otherwise estimated by: 10 m toe erosion + 1:2 slope for tertiary sedimentary rocks 75 m of erosion (per 1.0 m of SLR) + 1:2 slope for Pleistocene sands 200 m at stream mouths on the open coast Also provides for long term potential sensitivity to coastal flooding, including the effects of wave run-up. Measured from 2012 shoreline baseline.
Raglan South	Whaanga Coast West (West of Lagoon)	1:1.5 m slope 5 m landward from top edge of slope 20 m minimum 6 m RL minimum	Provides for potential land instability, further investigation warranted for development on steep seaward slopes. Top of slope applied on high steep cliffs where 1:1.5 slope cuts very deeply. Hard volcanic geology. Only expect occasional and relatively shallow slips, setback from top of slope to provide for this. In some areas that are lower, minimum setback width is set at 20 m, measured from edge of vegetation (top of rock shore platform). 6 m contour allows for coastal inundation with 1 m of sea level rise. Sensitivity measured from toe of cliff or bank (approximately 3.5 m NZVD 2016).

Whale Bay	Whale Bay Lagoon	1:1.5 slope 20 m minimum	Provides for potential land instability, further investigation warranted for development on steep seaward slopes. Some areas low lying and 1:1.5 slope provides insufficient certainty given lack of knowledge about exact nature of substrate. 20 m minimum SA provides for potential landward and upward migration of shore. Much more sheltered here so 6 m minimum not required. Sensitivity measured from toe of cliff or bank (approximately 3.5 m NZVD 2016).
Whale Bay (settlement)	Boulder beach and bank.	15 m + 1:1.5 slope 10 m + 1:2 slope 20 m minimum 6 m RL	Allowance for 2 m toe erosion and stable slope for high risk. 10 m + 1:2 slope - allowance for inland migration of beach in response to sea level rise of 1.0 m and stable slope. 20 m minimum SA provides for potential future effects and uncertainty. Small areas where land below 6 m RL have been included. Sensitivity measured from 4.5 m contour (NZVD, 2016). Allows for landward and upward migration with 1 m SLR.
Whale Bay to Manu Bay	Cliff	1:1.5 m slope 20 m minimum	Greater of these criteria. In some areas that are lower, minimum setback width is set at 20 m, measured from edge of vegetation (top of rock shore platform). Sensitivity measured from toe of cliff or bank (approximately 3.5 m NZVD 2016).

Manu Bay Car Park and Boat Ramp	Rocky boulder beach and shore platform.	15 m landward migration of beach + 1:1.5 slope 20 m minimum 6 m RL	Coast very exposed and hard here. Possible landward and upward migration of shore in response to sea level rise. In some areas that are lower, minimum setback width is set at 20 m, measured from 3.5 m contour (edge of vegetation). 6 m contour allows for coastal inundation. Shore profiles indicate wave effects to approximately 5 m. 6 m contour allows for 1 m sea level rise in sensitivity area. May be very occasional wave run-up effects to higher level but this should be covered by minimum 20 m width of SA. This applies to eastern portion of car park, which is more low lying. <u>Sensitivity measured from toe of bank/edge of vegetation.</u>
Manu Bay East to Ngarunui	High steep cliffs.	1:1.5 m slope 5 m landward from top edge of slope 20 m minimum 1:15 beach	Lesser of slope-based criteria. In this area dominantly defined by 5 m landward of break in slope at top of cliff. Where not clearly defined, change in slope chosen where slope becomes consistently flatter than 1:2. Where sandy beach present (Manu Bay), 15 m to allow for inland migration of beach where coastal plain wide enough + 1:1.5 slope. In some areas that are lower, minimum setback width is set at 20 m, measured from edge of vegetation (top of rock shore platform). <u>Sensitivity measured from toe of bank/edge of vegetation (typically 3.5 m RL but adjusted as necessary to pick up toe of cliff).</u>