34 Woolleys Bay extension

34.1 Description and geomorphology

The site is a small pocket beach around the eastern headland from the main beach at Woolleys Bay. The site is 400 m long and includes a section of headland that joins the site to the existing site at Woolleys Bay. Figure 34.1 shows the site and sits division into three coastal cells for the purpose of assessing coastal erosion hazards. Site photos of select cells are presented in Figure 34.2.

The site includes a small pocket beach located at the seaward edge of a valley, and a headland to the east. The underlying geology of the cliffs and valley at Woolleys Bay is Waipapa greywacke. At low tide the small pocket beach can be accessed on foot from Woolleys main beach on intertidal beach sediment and rock outcrops. The small pocket beach likely formed in the Holocene as coastal sediment filled in the valley and prograded. The landward edge of the beach section transitions into a gradually sloping grass reserve and valley slope where a number of dwellings are located. The valley transitions to cliff again at the east edge of the pocket beach and the site continues for another 100 m around a headland.

The beach is comprised of well sorted medium grain sand that is consistent at the foreshore, mid-beach face and backshore. A small band of pebbles is located at the cliff toe at the transition from Cell A to Cell B.

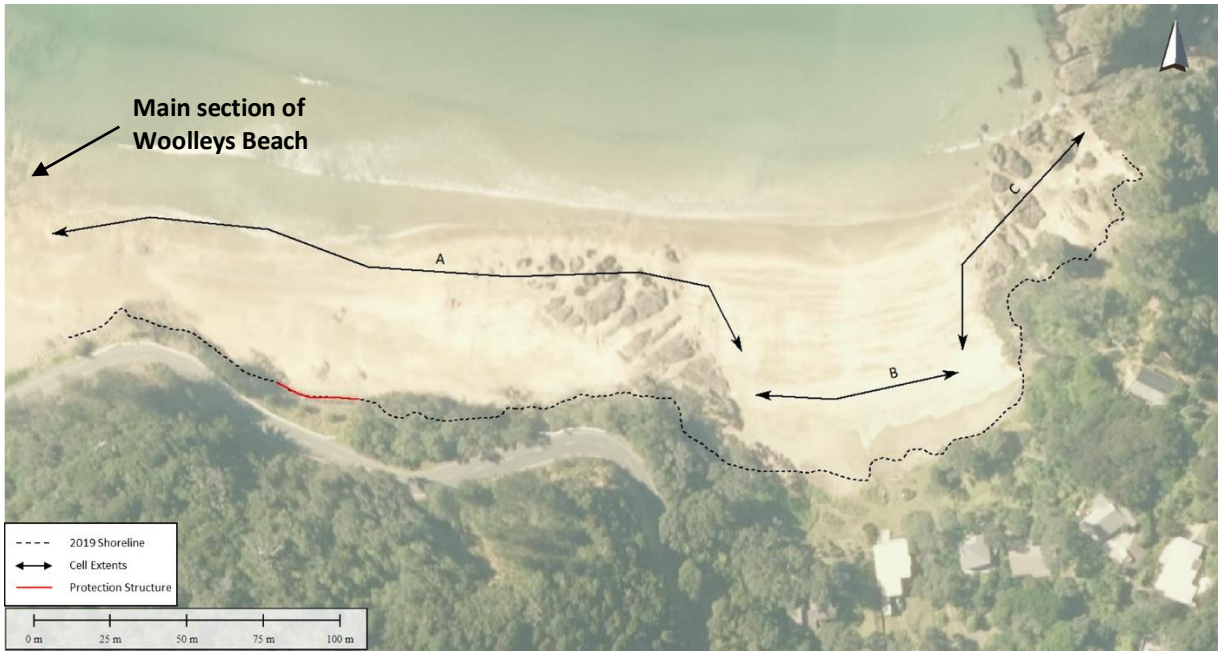


Figure 34.1: Map showing 2019 shoreline position and cell extents with background aerial imagery from 2014.

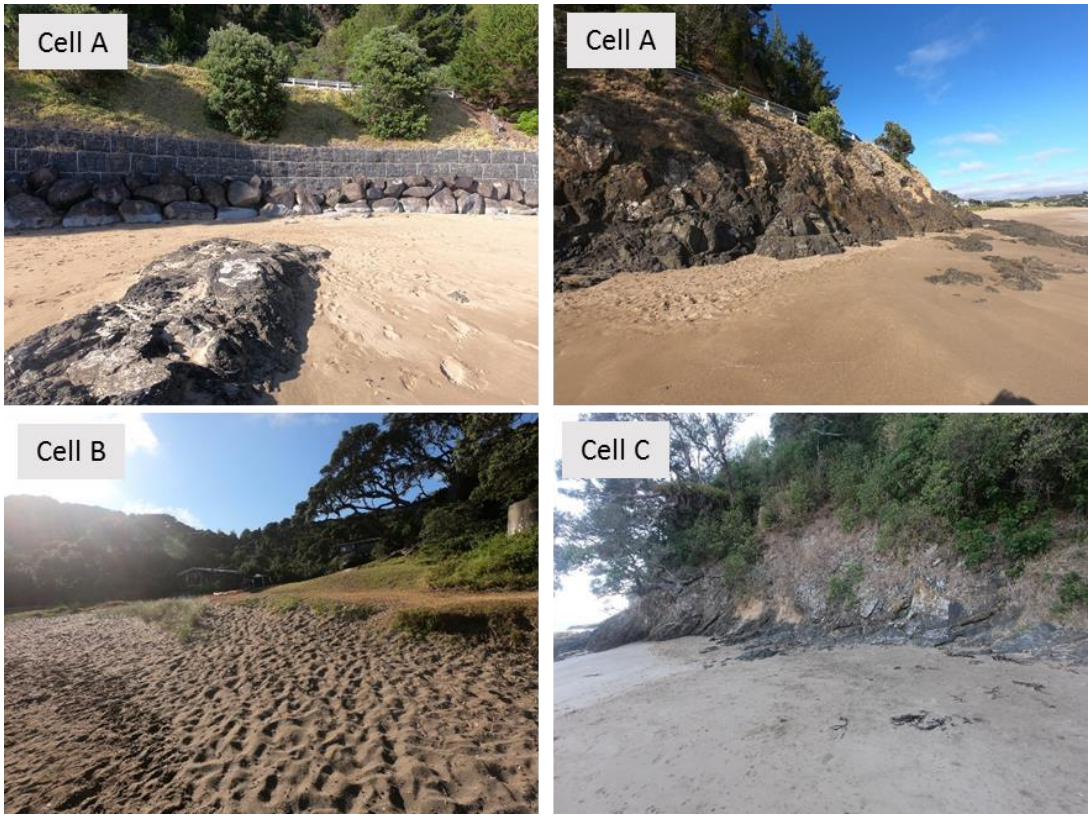


Figure 34.2: Photos from Woolleys Bay extension site visit on 21/01/2020.

34.2 Local considerations

The pocket beach can be accessed at lower tidal stages by walking from the main section of Woolleys Beach and via properties located in the valley. A road runs along the cliff section that transitions between the pocket beach and main beach and some sections of the cliff face and cliff toe have been armoured to protect the coastal highway (Figure 34.2 Cell A).

34.3 Component values

The site is split into three cells, including the pocket beach and cliff headlands to the east and west. The cliff cell separating the main beach from the pocket beach has an average height of 11 m (range 6-16 m) compared to an average height of 5 m at the eastern headland (range 3-7 m). Both cliff cells have the same underlying geology and therefore the same stable angle and sea level rise response factor was adopted based on the method outlined in the main report (T+T, 2020). Both cliff cells also had a similar long-term rate of historic shoreline change with a mean of -0.04 m/yr and maximum of -0.08 m/yr. Note that positive long-term rates were omitted because erosion on cliff coasts is not balanced by accretion. Positive long-term change on cliff sections seen in Figure 34.3 probably reflects seaward advancement of landslide material.

The pocket beach has a sloping back beach terrace with a height of approximately 1 m. This terrace is grassed but considered to be unconsolidated sediment and a short-term erosion component was adopted based on moderately exposed east coast beaches (Table 4.6 of the main report). Long-term historic shoreline rate at Cell B is dynamic and a rate of 0 ± 0.05 m/yr was adopted based on analysis of historic long-term rates (see Figure 34.3). Geometric response to sea level rise for the unconsolidated pocket beach was assessed using the method described in T+T (2020) using the same closure slopes as the main beach site at Woolleys Bay (Site number 11).

Figure 34.3: Rate of long-term shoreline change along the site showing each cell.

Table 34.1: Component values for Erosion Hazard Assessment

Site		**34. Woolleys Bay Extension**		
Cell		**34A**	**34B**	**34C**
Cell centre (NZTM)	E	1735348	1735500	1735542
	N	6063638	6063598	6063651
Chainage, m (from W)		0-240	240-310	310-420
Morphology		Waipapa greywacke cliff	Coastal terrace	Waipapa greywacke cliff
Short-term (m)	Min	-	5	-
	Mode	-	8	-
	Max	-	10	-
Dune/Cliff elevation (m above toe or scarp)	Min	6	0.8	3
	Mode	11	1.1	5
	Max	16	1.2	7
Stable angle (deg)	Min	26.6	30	26.6
	Mode	30.15	32	30.15
	Max	33.7	34	33.7
Long-term (m) -ve erosion +ve accretion	Min	-0.08	-0.05	-0.1
	Mode	-0.04	0.00	-0.07
	Max	0.00	0.05	-0.04
Closure slope (beaches) / Cliff response factor	Min	0.2	0.073	0.2
	Mode	0.3	0.067	0.3
	Max	0.4	0.03	0.4

Table 34.2: Adopted sea level rise values (m) based on four scenarios included in MfE (2017) adjusted to 2019 baseline

Coastal type	Year	RCP2.6M	RCP4.5M	RCP8.5M	RCP8.5+
Consolidated cliff	2080	0.29	0.34	0.46	0.64
	2130	0.52	0.66	1.09	1.41
Unconsolidated beach[1]	2080	0.16	0.21	0.33	0.51
	2130	0.28	0.42	0.85	1.17

[1]Adjusted to remove the influence of historic SLR (2.2 mm/year) on long-term rates of shoreline change

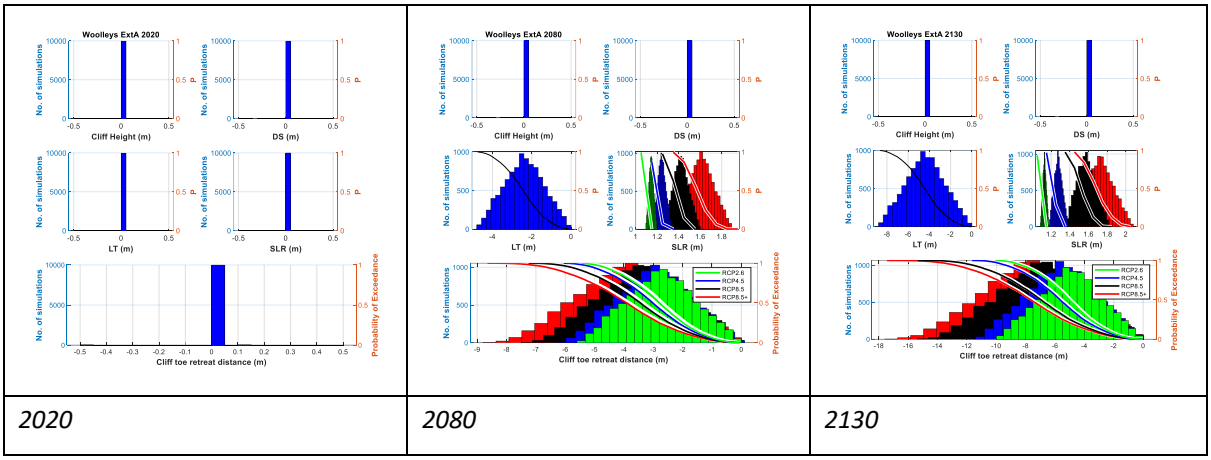
34.4 Coastal erosion hazard assessment

Histograms of individual components and resultant CEHZ distances computed using a Monte Carlo technique are shown in Figure 34.4 to Figure 34.6. Coastal Erosion Hazard Zone widths and future shoreline distances are presented within Table 34.3 to Table 34.5 and mapped in Figure 34.7.

For Cell B, CEHZ values are 14 m for CEHZ1, 31 m for CEHZ2 and 39 m for CEHZ3. For Cells A and C, the cliff projection method was adopted with future shoreline distances shown instead of CEHZ distances. Future cliff toe distances range from 3 to 6 m to 2080 for RCP 8.5, from 12 to 16 m to 2130 for RCP 8.5 and 13 to 18 to 2130 for RCP 8.5+.

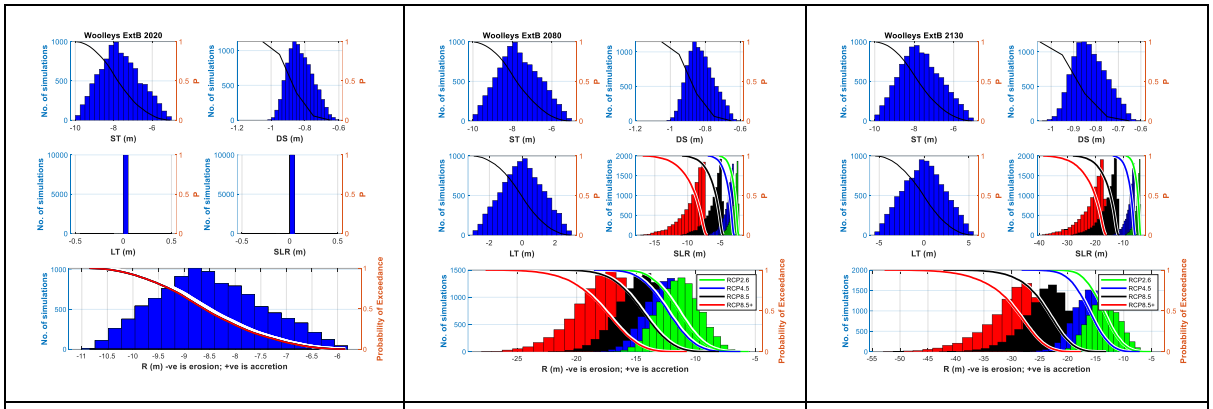
Coastal erosion hazards at cliff cells (A and C) were assessed using the projection method. Outputs from the probabilistic assessment are for the future toe position, which was used in combination with the stable angle to project the total hazard zone using LiDAR extracted profiles spaced in 10 m intervals for the length of each cliff cell. A summary of the resulting hazard distances for cliff cells are presented in Table 34.6.

Figure 34.8 shows the available historic shorelines for Woolleys Bay Extension.



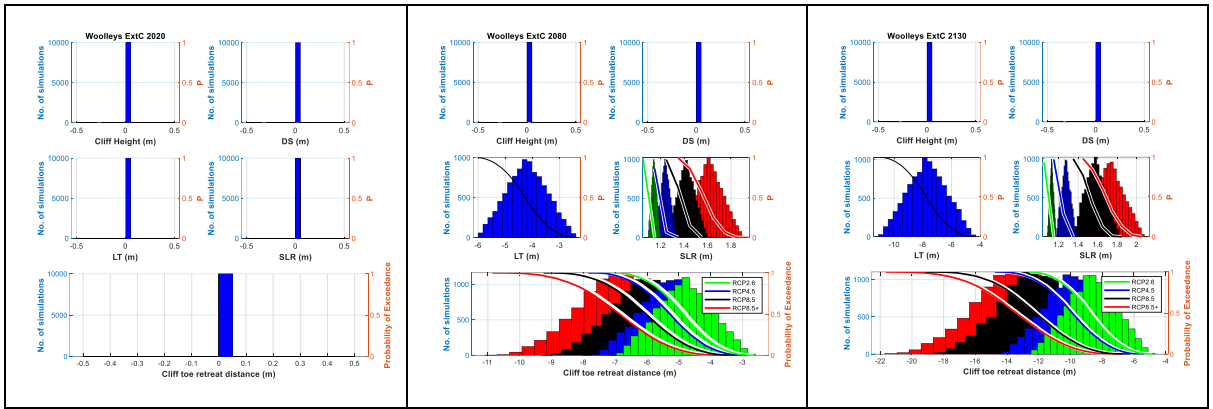
2020 | *2080* | *2130*

Figure 34.4: Histograms of parameter samples and the resultant shoreline distances for 2020, 2080 and 2130 timeframes for cell 34A



2020	2080	2130

Figure 34.5: Histograms of parameter samples and the resultant shoreline distances for 2020, 2080 and 2130 timeframes for cell 34B



2020	2080	2130

Figure 34.6: Histograms of parameter samples and the resultant shoreline distances for 2020, 2080 and 2130 timeframes for cell 34C

Table 34.3: Coastal Erosion Hazard Zone Widths (m) Projected for 2020

Site		34. Woolleys Extesion		
	Cell	34A*	34B	34C*
Probability of CEHZ (m) Exceedance	Min	0	-6	0
	99%	0	-6	0
	95%	0	-7	0
	90%	0	-7	0
	80%	0	-8	0
	70%	0	-8	0
	66%	0	-8	0
	60%	0	-8	0
	50%	0	-9	0
	40%	0	-9	0
	33%	0	-9	0
	30%	0	-9	0
	20%	0	-9	0
	10%	0	-10	0
	5%	0	-10	0
	1%	0	-11	0
	Max	0	-11	0

*Cliff projection method has been used, so cliff toe position has been tabulated, which has been assumed to be unchanged from the adopted 2019 baseline. Actual CEHZ width will be greater depending on cliff height and stable slope angle.

Table 34.4: Coastal Erosion Hazard Zone Widths (m) Projected for 2080

Site		34. Woolleys Extension											
Cell		34A				34B				34C			
RCP scenario		2.6	4.6	8.5	8.5+	2.6	4.6	8.5	8.5+	2.6	4.6	8.5	8.5+
Probability of CEHZ (m) Exceedance	Min	0	0	0	0	-6	-6	-8	-11	-3	-3	-3	-3
	99%	0	0	0	-1	-8	-8	-10	-13	-3	-3	-4	-4
	95%	-1	-1	-1	-1	-9	-9	-11	-14	-3	-4	-4	-5
	90%	-1	-1	-2	-2	-9	-10	-12	-15	-4	-4	-5	-5
	80%	-2	-2	-2	-2	-10	-11	-13	-16	-4	-4	-5	-6
	70%	-2	-2	-3	-3	-11	-11	-13	-16	-4	-5	-5	-6
	66%	-2	-2	-3	-3	-11	-12	-14	-17	-4	-5	-6	-6
	60%	-2	-3	-3	-3	-11	-12	-14	-17	-5	-5	-6	-6
	50%	-3	-3	-3	-4	-11	-12	-14	-18	-5	-5	-6	-7
	40%	-3	-3	-4	-4	-12	-13	-15	-18	-5	-5	-6	-7
	33%	-3	-4	-4	-5	-12	-13	-15	-19	-5	-6	-6	-7
	30%	-3	-4	-4	-5	-12	-13	-15	-19	-5	-6	-7	-8
	20%	-4	-4	-5	-5	-13	-14	-16	-20	-6	-6	-7	-8
	10%	-4	-5	-5	-6	-14	-15	-17	-21	-6	-6	-7	-9
	5%	-5	-5	-6	-7	-14	-15	-18	-22	-6	-7	-8	-9
	1%	-5	-6	-6	-7	-15	-16	-19	-24	-7	-7	-8	-10
	Max	-6	-6	-7	-9	-17	-19	-22	-28	-7	-8	-9	-11
	CEHZ1	-3*				-14				-6*			

*Cliff projection methodology used, so distance to future cliff toe position has been tabulated. Actual CEHZ width will be greater depending on cliff height and stable slope angle.

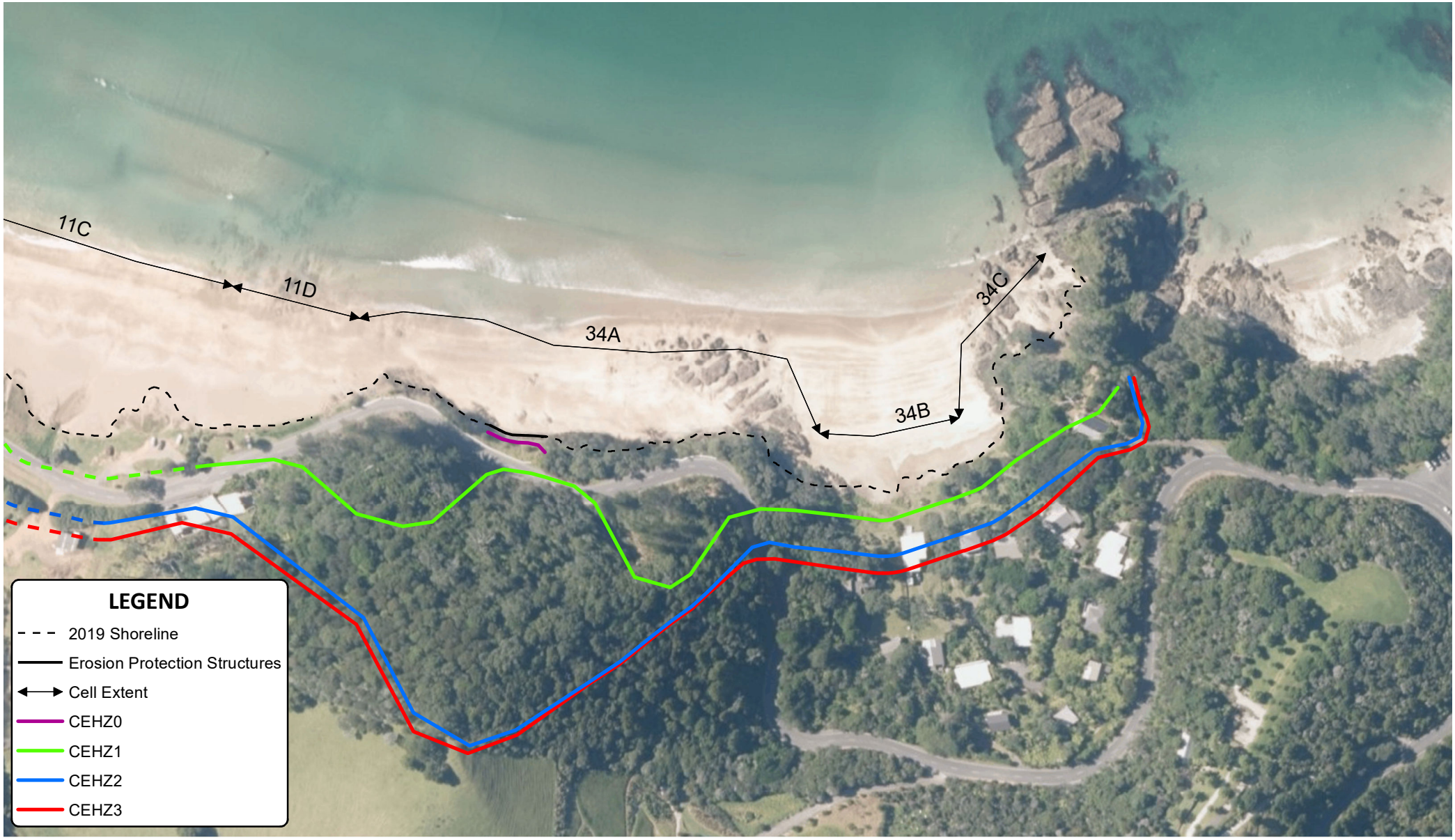
Table 34.5: Coastal Erosion Hazard Zone Widths (m) Projected for 2130

Site		34. Woolleys Extension											
Cell		34A				34B				34C			
RCP scenario		2.6	4.6	8.5	8.5+	2.6	4.6	8.5	8.5+	2.6	4.6	8.5	8.5+
Probability of CEHZ (m) Exceedance	Min	0	0	0	0	-5	-7	-13	-18	-5	-5	-6	-7
	99%	-1	-1	-1	-1	-8	-10	-16	-21	-5	-6	-8	-8
	95%	-2	-2	-2	-2	-9	-12	-18	-23	-6	-7	-8	-9
	90%	-2	-3	-3	-3	-10	-12	-19	-24	-7	-7	-9	-10
	80%	-3	-4	-4	-5	-11	-14	-21	-26	-7	-8	-10	-11
	70%	-4	-4	-5	-6	-12	-15	-22	-27	-8	-9	-11	-12
	66%	-4	-5	-6	-6	-12	-15	-22	-27	-8	-9	-11	-12
	60%	-4	-5	-6	-7	-13	-15	-23	-28	-8	-9	-11	-13
	50%	-5	-6	-7	-8	-14	-16	-24	-29	-9	-10	-12	-13
	40%	-5	-6	-8	-8	-14	-17	-25	-30	-9	-10	-13	-14
	33%	-6	-7	-8	-9	-15	-17	-25	-31	-9	-11	-13	-14
	30%	-6	-7	-8	-9	-15	-18	-26	-32	-10	-11	-13	-15
	20%	-7	-8	-9	-10	-16	-19	-27	-34	-10	-11	-14	-16
	10%	-8	-9	-11	-12	-17	-20	-29	-37	-11	-12	-15	-17
	5%	-8	-9	-12	-13	-18	-21	-31	-39	-11	-13	-16	-18
	1%	-9	-10	-13	-15	-20	-23	-35	-44	-12	-14	-17	-19
	Max	-10	-12	-15	-17	-24	-28	-42	-53	-13	-15	-19	-22
	CEHZ2	-12*				-31				-16*			
	CEHZ3	-13*				-39				-18*			

*Cliff projection methodology used, so distance to future cliff toe position has been tabulated. Actual CEHZ width will be greater depending on cliff height and stable slope angle.

Table 34.6: Summary of CEHZ distances for cliff cells mapped using cliff projection method

	CEHZ1			CEHZ2			CEHZ3		
Cell	**Min (m)**	**Average (m)**	**Max (m)**	**Min (m)**	**Average (m)**	**Max (m)**	**Min (m)**	**Average (m)**	**Max (m)**
34A	-7	-39	-92	-40	-108	-158	-41	-109	-160
34C	-27	-38	-49	-31	-49	-77	-31	-50	-83



Notes: Dashed CEHZ indicates greater uncertainty around stream mouths and backshore topography.
Northland 0.4m Rural Aerial Photos (2014-2016).

A4 SCALE 1:2,500

0 0.1 (km)

N

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Coastal Erosion Hazard Assessment
Wooleys Bay Ext
Site: 34

FIGURE No. Figure 34-7

Rev. 1

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Notes: Dashed CEHZ indicates greater uncertainty around stream mouths and backshore topography.
Northland 0.4m Rural Aerial Photos (2014-2016).

A4 SCALE 1:2,500

0 0.1 (km)

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Historic Shorelines
Wooleys Bay Ext
Site: 34

FIGURE No. Figure 34-8

Rev. 1

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