Appendix 2 Coastal processes advice

Science Advice

Date	27 June 2025
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Coastal information for the Washdyke stopbank consent

Key Messages

- The construction of the proposed secondary stopbank and drain further landward of the existing beach, stopbank and Seadown Drain, is unlikely to have any effect on the rates of change that are occurring along the coast from the Washdyke Lagoon to north of Aorangi Road.
- Assuming that the historic patterns of change continue into the future, the existing stopbank is likely to provide protection from coastal erosion and inundation to the surrounding area for the next approximately 10 to 15 years. However, the level of protection afforded to the surrounding area due to the presence of the existing stopbank is likely to decrease over this time as the width of the beach decreases, thereby increasing the likelihood that erosion and or overtopping of the existing stopbank occurs.
- North of Aorangi Road, the proposed secondary stopbank to be constructed in this project is generally within the 2070 band of predicted shoreline positions and therefore may potentially be interacting with and impacting on coastal processes within this timeframe. For the area south of Aorangi Road, the proposed stopbank position is currently seaward of the 2070 band of predicted shoreline positions, and is therefore likely to be restraining the beach to some degree by 2070 in this area.
- Over the longer term, it is highly likely that the existing Seadown Drain and stopbank will eventually be incorporated into the beach as it continues to roll over landward. If or, more likely, when this occurs, the amount of protection afforded to the land immediately adjacent to the beach will be reduced due to the effective removal of the Seadown Drain stopbank, with the proposed secondary stopbank then becoming the main source of protection against coastal erosion and inundation along the Washdyke/Seadown coastline.

Introduction and Purpose

The following information has been brought together to inform and assist with a consent application for the realignment of the Seadown Drain along the Washdyke and Seadown coast north of Timaru. The consent application is being applied for by Environment Canterbury, and as well as the realignment of the Seadown Drain, a series of stopbanks are also proposed to be constructed to provide protection to the repositioned drain.

The purpose of this project is to realign the position of the Seadown Drain and the accompanying coastal stopbank that provides protection to the Seadown Drain. Continued coastal erosion and rollover of the beach along the Washdyke/Seadown coast has reduced the distance from the beach to the stopbank and drain, and this reduction in distance and therefore time, has prompted local authorities to reposition the drain before natural coastal processes eventually overwhelm the existing stopbank and interrupt the current drainage patterns along the Washdyke/Seadown coast.

A further reason for repositioning the drain is that the Washdyke area has continued to become increasingly industrialized over recent times which has reduced the amount of available land on which an effective replacement drain and stopbank system could be constructed. If this demand for industrial land and growth within Washdyke continues and the repositioning of the drain and stopbank is delayed, finding an appropriate location for the drain and stopbank is likely to become increasingly difficult and more urgent. The drain is therefore becoming increasingly 'squeezed' from increased industrialisation from the landward side, and increasingly threatened by coastal processes on the seaward side.

The realignment project will be constructed landward of the existing Seadown Drain and will therefore have very few direct impacts on coastal hazards or coastal processes in the short to medium term. Over time, and assuming the current patterns of change continue into the future, the proposed drain and stopbank will begin to influence coastal processes to an increasing degree, and for this reason, the following information has been included.

Historical Background

Prior to the construction of the Timaru Harbour and breakwater in the 1870s, the coastline around Timaru was characterised by steeply shelving shingle beaches in front of small, irregular loess and basalt headlands, bays and lagoons before forming a wide, flat shingle beach north of town (Washdyke) (Todd, 1989). Gravel, predominantly derived from the Waitaki River and the Waitaki shingle fans, made its way north by prevailing southeast ocean swells around the irregular coast of Timaru to the Washdyke/Seadown coast and northwards along the Canterbury Bight.

The development of the Timaru Harbour which began in 1878, and in particular, the construction of the harbour breakwater, has interrupted this northwards sediment transport by trapping gravels that would have naturally by-passed Timaru and nourished the beaches north of the city. As a consequence, there has been sediment starvation of gravel sized material immediately downdrift (north) of the harbour resulting in accelerated coastal erosion. A former gravel barrier beach that extended from the Benvenue Cliffs and around Dashing Rocks and enclosed a coastal lagoon (Waimataitai Lagoon) completely eroded away soon after gravel supply ceased, resulting in the complete loss of that wetland. Further north, the beach fronting Washdyke Lagoon has eroded by more than 400 metres since the 1880s which has subsequently reduced the area of Washdyke Lagoon by over 150 hectares since this time (Todd 1989, Todd 1996). This erosion and beach rollover have dramatically reduced the areas of Washdyke Lagoon and Milford Lagoon (at the Opihi River mouth), and overpowered coastal stopbanks first constructed in the 1930's to protect the low-lying farmland from sea inundation, resulting in the structures having to be relocated landward at least twice (Jacobs, 2020 p 10).

Data and analysis

Environment Canterbury and the Timaru District Council contracted Jacobs Ltd and NIWA in late 2019 to undertake coastal hazard investigations into coastal erosion and coastal inundation respectively as part of the Timaru District Council District Plan Review process. These two reports synthesized many sources of information regarding coastal erosion, inundation and coastal hazards across the Timaru District, and resulted in a series of maps showing potential future shoreline positions and areas likely to be subject to coastal inundation under a range of sea level rise (SLR) scenarios into the future. These reports and maps are considered to still be relevant and appropriate to use, and much of the following information has been taken from these two reports.

Vertical Land Movement (VLM)

Vertical land movement has a direct impact on the local sea level along coastlines. VLM data (Hamling, 2025, unpublished) indicates that the rates of vertical land movement along the coastline from Smithfield through to the Opihi River ranges from -0.4 to -2.7 mm/yr (Table 1 below). The highest rates of change occur in the central part of the Washdyke/Seadown coastline around NZ Searise sites 4563 and 4564 (see Figure 1 below), with lower rates occurring towards Smithfield and towards the Opihi River. Averaging out these rates of change along this stretch of coast results in an average vertical rate of change of -1.48 mm/yr.

NZ Searise Site ID #	Vertical Rate (mm/yr)	Error (mm/yr)
4561	-1.01	±2.50
4562	-1.30	±2.37
4563	-2.67	±2.61
4564	-2.55	±2.82
4565	-1.58	±2.79
4566	-1.36	±2.33
4567	-0.90	±2.34
4568	-0.43	±2.27

Table 1: Updated rates of VLM along the Washdyke/Seadown coast.

Figure 1: NZ Searise Site ID numbers

Relative Sea Level Rise

The information contained above shows that the Washdyke coastline is gradually sinking, and this has implications for the amount of relative sea level rise that will occur over time. The figures shown in Table 1 are recently updated values (Hamling, 2025, unpublished) that are not currently on the NZ Searise website, so in order to determine the amount of relative sea level rise between Smithfield and the Opihi River from this average rate of VLM, NZ Searise site 4489 on the eastern side of Robin Hood Bay on Banks Peninsula which has an approximately similar rate of VLM change has been used as a proxy to give some idea of the likely amounts of relative sea level rise under the various sea level rise scenarios. These amounts of SLR are shown in Table 2 below.

The resulting P50 values which represent the 50th percentile value of all simulations for each particular Shared Socioeconomic Pathway (SSP) scenario (MfE, 2024) indicate that over the next 45 years, the amount of relative SLR along the Washdyke coast is projected to be between 0.2 and 0.6 m. Over the next approximately 100 years through to 2120, the amount of relative SLR is projected to be between approximately 0.4 and 1.3 m. Values for other time periods are also available, however the 2070 and 2120 dates correspond to shoreline positions that were calculated and shown in the Jacobs 2020 report.

The Jacobs projected shoreline position with 0.4 m of SLR through to 2070 is considered to be the most appropriate value to use over this timeframe for this stretch of coast as it approximates the P50 values from many of the sea level rise scenarios in the NZ Searise website. For similar reasons, the Jacobs projected shoreline position with 1.0 m of SLR through to 2120 is also considered to be an appropriate value to use over this timeframe.

Future shoreline positions

The bands shown in Figure 2 below have been constructed from the Jacobs (2020) predicted future shoreline position shapefiles to show the possible range of shoreline positions that may occur in the future between the Opihi River and Smithfield. The 2070 shoreline band shows the P50 (50th Percentile) values for the 0.2 m SLR scenario through to the P95 (95th Percentile) value for the 0.6 m SLR scenario, while the 2120 shoreline band shows the shoreline positions from the P50 values for the 0.6 m through to the P95 values for the 1.2 m SLR scenarios. These bands incorporate a wide range of relative sea level rise values from the various SSP scenarios for this area and therefore provide the most accurate estimation of where the shoreline is likely to be in 2070 and 2120. They are therefore considered to be appropriate for use and provide confidence when comparing the range of possible shoreline positions against the proposed position of the stopbank.

		Using site 4489 as a proxy										
		Scenario	Year	p17	p50	p83		Scenario	Year	p17	p50	p83
-1.5 mm/yr	Projected amount of SLR	SSP1-1.9 (medium confidence)	2070	0.15	**0.24**	0.36	Including VLM (Relative SLR)	SSP1-1.9 + VLM (medium confidence)	2070	0.12	**0.34**	0.57
		SSP1-1.9 (medium confidence)	2120	0.29	**0.45**	0.64		SSP1-1.9 + VLM (medium confidence)	2120	0.25	**0.63**	1.02
		SSP1-2.6 (medium confidence)	2070	0.22	**0.29**	0.39		SSP1-2.6 + VLM (medium confidence)	2070	0.19	**0.39**	0.61
		SSP1-2.6 (medium confidence)	2120	0.36	**0.54**	0.76		SSP1-2.6 + VLM (medium confidence)	2120	0.31	**0.72**	1.13
		SSP2-4.5 (medium confidence)	2070	0.27	**0.35**	0.46		SSP2-4.5 + VLM (medium confidence)	2070	0.24	**0.45**	0.67
		SSP2-4.5 (medium confidence)	2120	0.53	**0.72**	0.96		SSP2-4.5 + VLM (medium confidence)	2120	0.51	**0.90**	1.32
		SSP3-7.0 (medium confidence)	2070	0.32	**0.40**	0.51		SSP3-7.0 + VLM (medium confidence)	2070	0.29	**0.50**	0.72
		SSP3-7.0 (medium confidence)	2120	0.73	**0.95**	1.24		SSP3-7.0 + VLM (medium confidence)	2120	0.71	**1.14**	1.59
		SSP5-8.5 (medium confidence)	2070	0.36	**0.44**	0.56		SSP5-8.5 + VLM (medium confidence)	2070	0.33	**0.55**	0.78
		SSP5-8.5 (medium confidence)	2120	0.83	**1.10**	1.46		SSP5-8.5 + VLM (medium confidence)	2120	0.81	**1.28**	1.81

Table 2: Projected amounts of sea level rise under a range of scenarios in 2070 and 2120. The left hand side of the table shows the projected amount of SLR in 2070 and 2120 under the various climate change scenarios without VLM, while the right hand side of the table shows the projected amount of relative SLR when -1.5 mm/yr of VLM is taken into account. Values are taken from the NZ Searise project.

Projected future shoreline positions in relation to existing and proposed structures

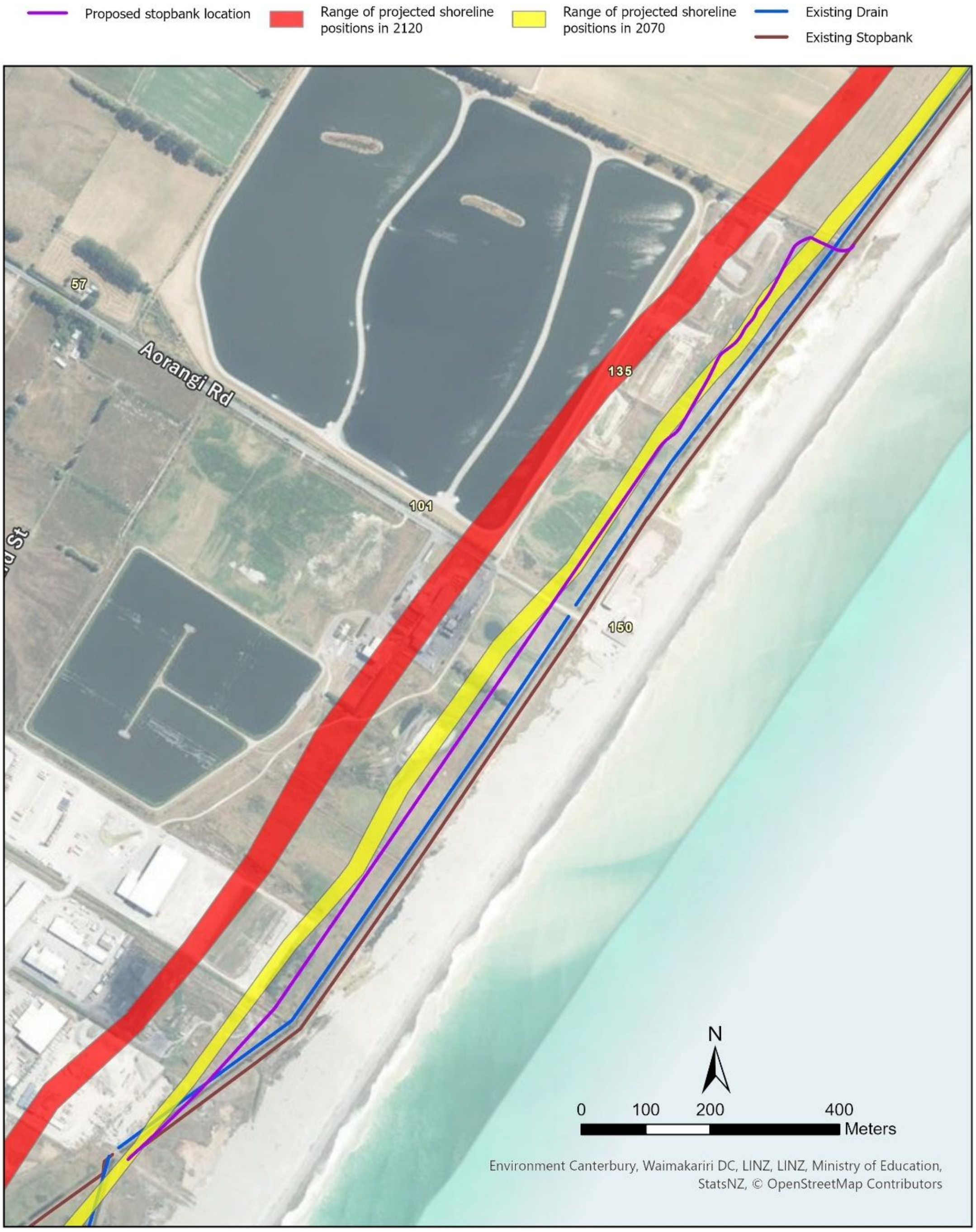

Figure 2: Bands of projected future shoreline positions in 2070 and 2120 from Jacobs (2020), compared to the existing infrastructure and proposed stopbank position north of Washdyke Lagoon.

Comparing the proposed stopbank alignment against the future shoreline position

Using the Jacobs (2020) information, the shoreline position along much of the Washdyke coast is predicted to be landward of the existing stopbanks in 2070 under a range of sea level rise scenarios. Even the most optimistic SLR scenario used in the Jacobs analysis of - 0.2 m SLR through to 2070 results in a predicted future shoreline position that is landward of the existing stopbanks from the end of Sheffield St through to north of Phar Lap Rd, and from Beach Rd through to the Opihi River. The existing stopbanks are therefore predicted to be incorporated into the beach within the next 50 years.

In several locations between Smithfield and the Opihi River, the landward edge of the beach is presently (May 2025) at the seaward edge of the existing stopbank between Waitarakao/Washdyke Lagoon and south of Aorangi Road, and from Beach Road through to the Opihi River including the break in the stopbanking at Horseshoe Lagoon. Given the lack of available space between the beach and the stopbank in these locations and the current rates of change at these same locations shown in Table 3 below, it is highly likely that the existing stopbanks will in places be incorporated into the beach and potentially rendered ineffective within the next 15 to 20 years.

When comparing the position of the proposed stopbank alignment with the bands of future shoreline positions, Aorangi Road acts as a divider for this area. North of Aorangi Road, the proposed stopbank is generally within the 2070 band of predicted shoreline positions which indicates that the proposed stopbank may potentially be interacting with and impacting on coastal processes within this timeframe, while for the area south of Aorangi Road, the proposed stopbank position is currently seaward of the 2070 band of predicted shoreline positions, and is therefore likely to be restraining the beach to some degree by 2070 in this area.

It is worth noting that the height of the Seadown Drain stopbank from north of Sheffield St (WCS1035) through to Beach Rd (WCS0226) is approximately 5 m LVD-1937. This is around 1 m higher than the height of the previous stopbank which has subsequently been encompassed into the current beach and also around 1 m higher than the current beach crest height. Therefore, even though the beach may reach the stopbank in the very near future in places, given the higher height of the stopbank that will need to be overcome, it is possible that the Seadown Drain stopbank will constrain the landward movement of the beach for longer than what the previous one has. This however assumes that the stopbank is not eroded or lowered by erosion and continues to function and restrain the beach until it is overwhelmed.

Profile Site Code	First survey date	Most recent survey date	Survey Period (years)	Historic annual rate of 1m amsl beach change (m/yr)	Historic annual rate of Beach Toe change (m/yr)	Distance from landward edge of beach to seaward edge of Seadown Drain stopbank (May 2025)	Approx # Years until beach reaches Seadown Drain stopbank	Seadown Drain stopbank height (m LVD1937)	Date Beach toe reached seaward edge of previous stopbank	Date stopbank overwhelmed	Stopbank life	Stopbank height (m LVD1937)
WCS0000	6/02/1977	20/03/2025	48.1	-1.5	-1.5	0	0	3.8				
WCS0081	6/02/1977	20/03/2025	48.1	-1.4	-2	0	0	6.5				
WCS0226	8/10/1984	20/03/2025	40.5	-1.5		0	0	5.1				
WCS0329	6/02/1977	20/03/2025	48.1	-1.6		0	0	5.3				
WCS0439	28/07/1977	20/03/2025	47.7	-1.9	-1	40	20	4.8	Sept-20	not yet overwhelmed		3.9
WCS0626	6/02/1977	20/03/2025	48.1	-1.9	-2.1	20	10	5.2				
WCS0693	28/07/1977	20/03/2025	47.7	-1.5	-1.2	55	37	5.0	Mar-06	not yet overwhelmed		4.0
WCS0794	28/07/1977	20/03/2025	47.7	-1.7	-1.6	35	20	4.9	Mar-97	Sept-20	23 years	4.1
WCS0891	28/07/1977	20/03/2025	47.7	-2	-1.9	35	18	5.5	Jan-86	Aug-22	36 years	3.1
WCS0966	21/12/1966	20/03/2025	58.3	-2.1		na	10*	5.0				
WCS0985	5/04/1977	20/03/2025	48.0	-2.2	-2.4	0	0	4.9	Feb-85	Jun-12	27 years	3.4
WCS1005	4/04/1977	19/03/2025	48.0	-2.2	-0.9	10	5	5.2	Mar-95	Sept-17	22 years	3.0
WCS1015	4/04/1977	19/03/2025	48.0	-2.2	-0.6	15	7	5.0	Mar-02	Mar-21	19 years	3.0
WCS1035	5/04/1977	19/03/2025	48.0	-2.1	-1.8	30	15	4.0				
WCS1055	6/04/1977	19/03/2025	48.0	-2.2	-2.4	75						
WCS1065	15/02/1961	19/03/2025	64.1	-2.3	-1.1	115						
WCS1075	6/04/1977	19/03/2025	48.0	-2.3	-3.1	140						
WCS1105	13/04/1977	19/03/2025	48.0	-1.8	-2	290						
WCS1115	13/04/1977	19/03/2025	48.0	-1.7	-1.9	310						
WCS1135	13/04/1977	19/03/2025	48.0	-1.5	-1.4	425						
WCS1155	14/04/1977	19/03/2025	48.0	-1.4	-1	545						
WCS1175	14/04/1977	19/03/2025	48.0	-1.3	-0.6	585						
WCS1195	4/04/1977	19/03/2025	48.0	-1.4	-0.3	430						
WCS1205	6/02/1977	19/03/2025	48.1	-1.3	-0.1	85		2.2				
WCS1225	20/10/1982	19/03/2025	42.4	-1.1	-2.1	150		2.7				

Table 3: Summary of beach profile information at Environment Canterbury's coastal monitoring network sites between Smithfield and the Opihi River.

Coastal inundation

The second coastal hazard faced by this project is inundation of the surrounding land from seawater during storm events, and this inundation is likely to arise from either erosion of the existing stopbank leading directly to inundation, or from overtopping of the beach resulting in water backing up through the drainage channels and eventually out onto the surrounding land.

Seawater inundation was assessed in the NIWA (2020) Timaru District Coastal hazard assessment report by using lidar information across the Timaru District to create an accurate ground level surface, and then modelling a 3 hr long, 1-in-100 year ARI (Annual Recurrence Interval) storm event on top of various amounts of sea level rise. Of most relevance for this project are the resulting inundation maps from the 0.4 m SLR scenario through to 2070, and the 1.2 m SLR scenario through to 2130, and the extents of inundation around Washdyke under these two scenarios are shown in Figure 3 below. Unfortunately, a 1 m SLR scenario through to 2120 was not modelled in the NIWA inundation assessment, and a more conservative value for the amount of SLR over a slightly longer period has therefore been used.

It is worth noting that the inundation investigation carried out by NIWA included the assumption that the existing stopbanks along the Washdyke/Seadown coast would be maintained at their current position and height into the future. This assumption, and therefore the modelling that has been undertaken, doesn’t take into account the rates of change that are occurring along the coast, and also doesn’t include the potential scenario of erosion of the stopbank occurring during the modelling period. The NIWA modelling therefore represents a ‘best-case’ future inundation situation which is unlikely to occur given the changes that are occurring along the coast. It does however, accurately represent the low-lying areas around Washdyke and Seadown and as these areas are unlikely to change, the modelling provides a broad scale overview of areas susceptible to inundation into the future along the coast.

The results of the inundation modelling found that although the existing stopbanks do get overtopped during the modelled 1-in-100 year ARI storm event, they are effective at limiting the extent of inundation during such an event. In both the 2070 scenario with 0.4 m of SLR and the 2130 scenario with 1.2 m SLR, the inundation extents during such a storm are hundreds of meters landward of the current stopbank and cover large areas of the Washdyke Lagoon and adjacent industrial area. The inundation depths within the extents shown below have not been included for simplicity, however these were also calculated during the NIWA inundation assessment and are available if required.

The proposed stopbank and drain to be constructed under this project will be landward of the existing Seadown Drain and its accompanying stopbank, and this secondary stopbank is likely to reduce the extents of inundation that are shown in Figure 3. At the time of writing, the height of the secondary stopbank shown in Figure 3 is still to be confirmed, and the extents of inundation in both 2070 and 2130 are also likely to be reduced further by carrying out modifications to some of the existing infrastructure and by constructing several additional features landward of the secondary stopbank.

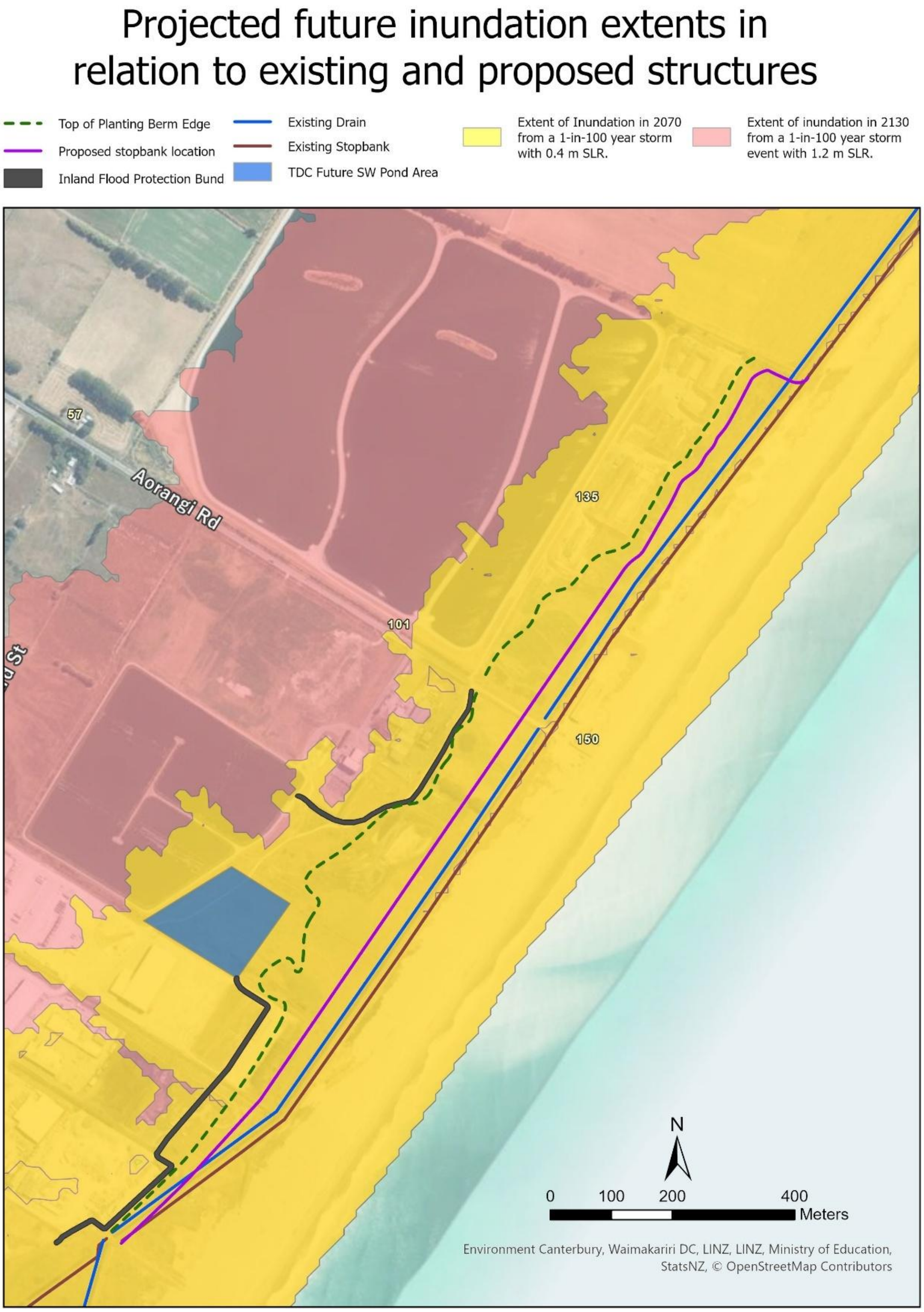

Figure 3: Extents of modelled inundation around Washdyke under a 1-in-100 year (ARI) storm event in 2070 with 0.4 m of SLR (yellow) and in 2130 with 1.2 m of SLR (red). From NIWA (2020).

Two Inland Flood Protection bunds are proposed to be constructed south of Aorangi Road, and these bunds are intended to tie into the existing TDC wastewater treatment pond bunding and into a proposed future ponding area before continuing south towards Washdyke Lagoon. The crest heights of the new and existing coastal stopbanks are to be kept lower than the crest height of existing bunding at the wastewater treatment plant south of Aorangi Road and the existing banking associated with the wastewater treatment plant and rifle range north of Aorangi Road, and any gaps between banks will be filled to create a consistent level of inundation protection. This height differential is to ensure that in the case of an extreme freshwater flooding event from an Opihi River breakout, the coastal stopbanks and the natural beach crest will be overtopped in a seaward direction before the floodwater causes flooding of the adjacent infrastructure and industrial areas. If these protective structures are built, inundation in a 1-in-100 year ARI coastal storm event in 2070 and 2130 is anticipated to be contained between industry and the coastal margin without significant flooding of the existing built development.

Interpretation

<u>Combining the potential future shoreline position information with the inundation information</u>

This project is not attempting to address the causes of change along the Washdyke coast, but is an attempt to lessen the impacts of natural coastal processes on the Washdyke and Seadown areas over the short to medium term.

The following predictions and estimations of stopbank lifespan assume that the historical rates of change along the coast continue into the future. One unknown likely to have a large bearing on the timeframes mentioned is how the beach will react as it increasingly interacts with the comparatively higher Seadown Drain stopbank. This stopbank is generally higher than the crest height of the beach immediately adjacent, and there is therefore potential for a greater volume of beach material to be accumulated against the stopbank before it is overtopped, thereby effectively lengthening the lifespan of the stopbank. However, erosion of the stopbank may occur before overtopping occurs and thereby lead to a landward translation of the beach as the stopbank breach location grows in width. Due to this uncertainty in the future potential interactions between the stopbank and the beach and the potential mechanisms of stopbank failure and the resulting implications for the stopbank lifespan, it has been assumed that a linear rate of change will continue into the future.

<u>Short term implications</u>

The construction of the proposed secondary stopbank and drain further landward of the existing beach, stopbank and Seadown Drain, is unlikely to have any effect on the rates of change that are occurring along the coast from the Washdyke Lagoon to north of Aorangi Road. The econdary stopbank is therefore unlikely to provide any additional protection against coastal erosion in this area until the existing Seadown Drain stopbank is compromised. Assuming that the historic patterns of change continue into the future and as the current position of the landward edge of the beach is at or very close to the seaward edge of the stopbank within this area, the existing stopbank is likely to provide protection from coastal erosion and inundation to the surrounding area for the next approximately 10 to 15 years. However, the level of protection afforded to the surrounding area due to the presence of the existing stopbank is likely to decrease over this time as the width of the beach decreases, thereby increasing the likelihood that erosion and or overtopping of the existing stopbank occurs.

The secondary stopbank proposed under this project is however, likely to reduce the area of surrounding land that is potentially inundated with seawater during storm events for at least the next 10 to 15 years, thereby increasing the level of protection to the surrounding area against this hazard. This likelihood assumes that no changes are made to the existing Seadown Drain stopbank and that the historical rates of change along this coastline continue into the future.

Medium term implications

Beyond the 10 to 15 year timeframe through to around 2050, the existing Seadown Drain stopbank is likely to become increasingly threatened by either overtopping and or erosion during storms, particularly for the area between the top of Washdyke Lagoon and Aorangi Road. If or when failure or breaching of this stopbank happens, a rapid repositioning of the beach landward of the Seadown Drain stopbank may potentially occur as the breach location rapidly expands in width. At this point in time, the Seadown Drain stopbank will be reduced in its ability to provide both erosion and inundation protection to the surrounding land, and this protective function will therefore primarily fall on the secondary stopbank constructed under this project.

The distance from the landward edge of the beach to the seaward edge of the stopbank for the area north of Aorangi Road is in the order of 20 to 55 m at the present time. Assuming the historic rates of change continue into the future at similar rates within this area, the stopbank in this area is likely to continue to provide protection against coastal erosion and inundation for the next approximately 20-25 years. The secondary stopbank in this area is therefore unlikely to increase the amount of protection against erosion over this time but is likely to provide a small increase in protection to the surrounding land against inundation over this timeframe.

Longer term implications

Over the longer term, it is highly likely that the existing Seadown Drain and stopbank will eventually be incorporated into the beach as it continues to roll over landward. If or, more likely, when this occurs, the amount of protection afforded to the land immediately adjacent to the beach will be reduced due to the effective removal of the Seadown Drain stopbank, with the secondary stopbank then becoming the main source of protection against coastal erosion and inundation along the Washdyke/Seadown coastline. Given the proposed alignment of the stopbank to be built under this project and the rates of change involved and possible increases in sea level rise and the implication from those, the secondary stopbank is likely to become increasingly impacted into the future. The height at which the secondary stopbank is built to is also likely to be a key determinant in the lifespan of the stopbank, but based on the projections shown above, it is likely that the secondary stopbank will be interacting with and influencing coastal processes within the next 50 years, particularly for the area south of Aorangi Road.

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Attachments:

File reference: