Raumati Adaptation Area Risk Assessment

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Kāpiti Coast District Council

Takutai Kāpiti
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Executive summary

This report presents a summary of the identified risks to the built environment, human, ecological, natural character, and cultural domains in relation to the **Raumati Adaptation Area (RAA)** from projected coastal hazards over the next 100 years (i.e. to 2130) if no future adaptation is undertaken. In the RAA, this assumes that in the future, once current protection structures fail, they are not replaced, and natural shoreline erosion will occur. This report identifies where the risk to domains within the coastal environment could change over time with increased projected relative sea level rise (RSLR); and identifies where and when high and extreme risks could occur. In combination with *Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volumes 1 and 2* (Jacobs, 2021 & 2022), this and the other three risk assessments for the Northern, Central and Paekākāriki Adaptation Areas are intended to collectively provide the substantive evidence base for a risk assessment in accordance with the direction set by the New Zealand Coastal Policy Statement 2010 (NZCPS).

The risks have been identified for individual elements to coastal erosion and coastal inundation hazards for the present day, 2050, 2070 and 2130 under the SSP2-4.5 and SSP5-8.5 sea level rise scenarios. Risks have been assessed by subject matter specialists from the Takutai Kāpiti Technical Advisory Group (TAG), which rely on a combination of spatial information of both the hazards and elements to assess the exposure of an element, and subject matter specialist opinion to determine how the element would fare when potentially exposed to the hazard now and in the future.

For this assessment, the MfE (2021) A guide to local climate change risk assessments definition of risk has been adopted, being a combination of 'exposure' and 'vulnerability'; whereby exposure is a measure of the extent to which elements intersect with the hazards layer; and vulnerability is the propensity or predisposition to be adversely affected by a coastal hazard in relation to climate change. Vulnerability encompasses a variety of concepts, including sensitivity to harm, and lack of capacity to naturally adapt (or adaptive capacity) (e.g. without intervention).

Within the RAA, the risks from coastal erosion across all domains are generally higher than the risks from coastal inundation over both SLR scenarios out to 2130 as a result in the difference in exposure across the two hazards. The RAA is potentially very exposed to coastal erosion hazards at present and through to 2130, as a result of this area having a low sediment supply as alongshore sediment transport into the district from the north is deposited updrift of Raumati around the Paraparaumu headland in the wave-shadow of Kāpiti Island. As a result of this higher exposure in the past, and lack of ability for the shoreline to recover post-storm, the shoreline throughout Raumati consists largely of seawalls to provide protection. Conversely, the land elevations in Raumati are generally above the future storm tide levels, and future coastal flooding is confined to the low-lying areas around the Wharemauku Stream.

The overall risk ratings for each element within the five domains is presented in Table 1, and can be summarised for each domain as follows:

Built Environment Domain

- The built environment domain assesses the risk to infrastructure which provides a service to the RAA communities, such as transport (roads), electricity, three waters, gas supply, and electrical supply. It also includes private properties, for which these services are built and maintained to service.

- When considering the RAA in its entirety, private properties are considered to be at moderate risk from coastal erosion through all timeframes and SLR scenarios. However, the relative number of properties impacted by erosion is generally <25% of the total number of properties within the densely populated RAA.

- Beachfront properties within the RAA (e.g. the most seaward line of properties are considered to be at extreme risk of coastal erosion under both relative sea level rise scenarios at present and through to 2130 if existing protection fails and is not replaced. By 2070, many beachfront properties could be eroded in their entirety.

- Wastewater infrastructure is currently at moderate risk to coastal erosion in an extreme storm, and would become high risk by 2050, then increasing to being at extreme risk by 2130 under both SLR scenarios due to the significant increase in exposure and cascading impacts to a larger number of properties. The areas of wastewater that are impacted by 2130 run parallel to the shoreline, and therefore could cause network-wide disruption impacting a larger number of properties than those directly impacted by erosion.

- By 2130, under both SLR scenarios most elements assessed under the built environment domain are considered to be at high or extreme risk from coastal erosion, with substantial exposure of water supply infrastructure, stormwater infrastructure, roads and bridges, and natural gas supply infrastructure.

- Risks to the built environment domain from coastal inundation are considered to be low across all timeframes and sea level rise scenarios assessed. This is due to the relatively low exposure of built assets to the flood hazard, with impacts from flooding largely being limited to the low lying areas around the Wharemauku stream mouth and catchment.

Human Domain

- The 'Human' Domain considers the risks to physical and mental health of those who live, work, or recreate in the RAA.

- Risks to the human domain are closely linked to the exposure and risk of built environment infrastructure, particularly the number of properties (or residents) that could be impacted by coastal flooding or erosion.

- Mental health and wellbeing is considered to be at low-moderate risk until 2070 under both SLR scenarios, increasing to being at extreme risk by 2130 as a result of the high number of properties within the RAA that become potentially exposed to coastal erosion over this timeframe for both SLR scenarios.

- Social infrastructure and amenity is at low risk from coastal erosion under the lower SSP2-4.5 scenario, and increases to moderate risk under the higher SSP5-8.5 scenario by 2070. This risk increases to high in 2130 under the higher SSP5-8.5 SLR scenario due to the increase in exposure of beach access points, parks and reserves, and Department of Conservation land, impacting the community's ability to enable daily patterns of life and provide for social infrastructure.

- Conflict, disruption, and loss of trust in the government is considered to become high risk in 2070 under the lower SSP2-4.5 scenario, and extreme risk under the higher SSP5-8.5 scenario by 2070 from coastal erosion, where there is increasing erosion of both private property and public spaces along the coastal strips including parks, reserves, and beach access points over time. As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to sea level rise come to the fore, and people differ in their thoughts on when different sets of adaptation should occur.

- At present, risks to the human domain from coastal inundation are considered to be low across all elements to 2050, and are generally low-moderate to 2070 across both SLR scenarios. Risks to mental health and wellbeing become high by 2130 under both SLR scenarios, due to the increased number of residents potentially impacted by coastal flooding. Risks to social infrastructure and amenity becomes high in 2070 and extreme in 2130 under the higher SSP5-8.5 scenario.

Ecological Domain

- The 'Ecological' domain considers the risks to the plants, animals and their habitats from the coast inland within the RAA.

- Risks to the ecological domain across both SLR scenarios into the future are generally low-moderate to 2130, with the exception of coastal dunes, indigenous trees, and indigenous biodiversity.

- The risks to coastal dunes within the RAA is considered to be extreme at present, and through to 2130 under both SLR scenarios in the future. With increased exposure to coastal erosion over time with sea

level rise, there is a risk that all coastal foredunes would be completely eroded and not replaced.

- Indigenous trees are at low risk to coastal erosion under both SLR scenarios, but increase to high risk by 2130 under the higher SSP5-8.5 scenario as a result of the potential increase in exposure to 12 trees being impacted by coastal erosion.

- The current risk to indigenous biodiversity is low; however increases to moderate by 2050; becoming extreme in 2070 and 2130 under both SLR scenarios. This increase in risk occurs as the estuary becomes increasingly exposed to erosion and there is a significant change to the available estuary habitat where indigenous biodiversity occurs.

- Risks to the ecological domain from coastal inundation are generally low-moderate across most elements for both sea level rise scenarios to 2130, with the exception of coastal dunes and indigenous biodiversity.

- The coastal dunelands are considered to have a low adaptive capacity to flooding, due to the cascading effects of erosion during a storm event, and the poor ability for the dunes to recover as a result of lack of sediment supply to the area. As a result of the low adaptive capacity, and increasing exposure to flooding with SLR, the risk at present is considered to be moderate, but increase to extreme by 2050 through to 2130 under both SLR scenarios.

- Risks to indigenous biodiversity from coastal inundation is considered to be moderate at present day, increasing to high by 2070 and extreme by 2130 across both SLR scenarios. This increase in risk is due to potential future changes at the Wharemauku Estuary, which provides seasonal or core habitat for seven threatened indigenous fish species and provides connectivity to upstream parts of the stream. These changes in the morphology of the estuary, due to combined effects of flooding and erosion, will change the available fish habitat and may change the connectivity to inland parts of the Wharemauku Stream, which could make it more or less suitable for certain species.

Natural Character

- The Natural Character domain considers the risks to the preservation of the natural character of the coastal environment. The Raumati area was recently assessed as part of the Kāpiti Coast Natural Character Evaluation (Boffa Miskell, 2024). Within this study, Raumati comprises part of the Coastal Terrestrial Area 2: Waikanae and Paraparaumu with an overall low-moderate natural character rating.

- The risk to the CTA2: Waikanae and Paraparaumu from coastal erosion is considered to be moderate at present through to 2070, increasing to being at high risk by 2130 under both SLR scenarios. By 2130, the exposure to the assessed areas of natural character increase from high to extreme as substantial additional erosion occurs to the extent that the defined present-day coastal environment (as per Boffa Miskell, 2024; not the Operative Kapiti Coast District Plan, 2021) would be entirely removed. As the extent of erosion extends into areas for which natural processes, influences and qualities are not currently considered to be significant, this would effectively redefine the existing coastal environment extent.

- The risk to the CTA2: Waikanae and Paraparaumu area within the RAA is considered to be at low risk to coastal inundation at present and through to 2130 under all RSLR scenarios assessed. This is a result of the relatively limited flooding that occurs within the context of the current extent of the coastal environment, which is typically elevated on historic dunes, as well as the sensitivity of natural character to coastal flooding in a extreme event being considered to be low.

Cultural Domain

- A risk assessment for the Cultural domain in relation to coastal hazard is still to be undertaken with Mana Whenua, and will be added to this document prior to being finalised.

Table 1. Summary matrices of risks to all domains from coastal erosion and coastal flood hazards.

	Coastal Erosion						Coastal Inundation					
Climate Change Scenario	**Both**		**SSP2-4.5**		**SSP5-8.5**		**Both**		**SSP2-4.5**		**SSP5-8.5**	
Element	Present	2050	2070	2130	2070	2130	Present	2050	2070	2130	2070	2130
Built Environment												
Properties - Whole Adaptation Area	M	M	M	M	M	M	L	L	L	L	L	L
Properties - Raumati Beach*	E	E	E	E	E	E	L	L	L	L	L	L
Properties – Raumati South*	E	E	E	E	E	E	L	L	L	L	L	L
Water Supply Infrastructure	L	L	L	H	L	H	L	L	L	L	L	L
Wastewater Infrastructure	M	H	H	E	H	E	L	L	L	L	L	L
Stormwater Infrastructure	L	L	L	H	L	H	L	L	L	L	L	L
Roads and Bridges	L	L	L	H	L	H	L	L	L	L	L	L
Electrical Transmission and supply infrastructure	L	L	L	M	L	M	L	L	L	L	L	L
Natural gas supply mains	L	M	M	H	M	H	L	L	L	L	L	L
Human												
Physical Health	L	L	L	L	L	M	L	L	L	L	L	L
Mental Health and Wellbeing	L	L	M	E	M	E	L	L	M	H	M	H
Social Infrastructure and Amenity	L	L	L	M	M	H	L	L	L	M	H	E
Exacerbating Inequalities	L	L	L	M	L	M	L	L	L	L	L	L
Social Cohesion and Community Wellbeing	L	L	L	M	L	M	L	L	L	L	L	M
Conflict, Disruption, and Loss of Trust in Government	M	M	H	E	E	E	L	L	M	M	M	M
Ecological												
Coastal dunes	E	E	E	E	E	E	M	E	E	E	E	E
Wetlands	L	L	L	L	L	L	L	L	L	L	L	L
Ecological sites	M	M	M	M	M	M	M	M	M	M	M	M
Indigenous Trees	L	L	L	L	L	H	L	L	L	L	L	M
Rare and threatened species	M	M	M	M	M	M	M	M	M	M	M	M
Bird habitat	M	M	M	M	M	M	M	M	M	M	M	M
Fish habitat	M	M	M	M	M	M	L	L	L	M	M	M
Indigenous biodiversity (coastal)	L	M	E	E	E	E	M	M	H	E	H	E
Natural Character												
CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	H	M	H	L	L	L	L	L	L
Cultural												
A risk assessment for the Cultural domain in relation to coastal hazard is still to be undertaken with Mana Whenua, and will be added to this document prior to being finalised.												
*For assessing the risk to coastal erosion, beachfront properties within the smaller sub-areas only have been considered; for assessing the risk to coastal flooding all properties within the sub-area are considered. See appendix A.1.2 and A.1.3 for further details.												

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to undertake a risk assessment of the Raumati Adaptation Area in accordance with the scope of services set out in the contract between Jacobs and the Kāpiti Coast District Council ('the Client'). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate, or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Kāpiti Coast District Council and/or available in the public domain at the time or times outlined in this report. Several of the domains have been developed and assessed by KCDC and external consultants. The built environment domain has been assessed by Jacobs; the ecological domain has been assessed by Dr. Astrid Dijkgraaf and the human domain has been assessed by NIWA; and the natural character domain has been assessed by Boffa Miskell. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations, and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures, and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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Contents

Appendices

Glossary

Adaptation Areas	Five defined areas within the Kāpiti District where adaptation pathways for coastal hazards will be developed by the CAP and consolidated into the Coastal Hazards Adaptation Recommendations Report. The five Adaptation Areas are: Northern Kāpiti; Central Kāpiti; Raumati; Paekākāriki; and Queen Elizabeth Park.
Adaptive Capacity	The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. It relates to how easily or efficiently an element at-risk can adapt naturally.
Beachfront Properties	The most seaward row of properties within a settlement.
Consequence	The impact or effect of an element being exposed to a hazard, based on the level of exposure.
Domain	An umbrella term to describe an overall theme of what potentially may be at risk from coastal hazards. In this assessment five domains – Built Environment, Ecological, Natural Character, Human, and Cultural – have been assessed.
Element	The term used to represent the individual aspects of the domain that has been assessed. For example, 'roads' are an element within the built environment domain.
Exposure	A measure of the extent to which elements intersect with the hazards layer.
Hazard	The interaction between a physical process (natural) or phenomenon that causes harm or damage to elements within the human, cultural, built environment, ecological or natural character domains. In this report we have assessed the coastal hazards of erosion and inundation only.
NZILA	New Zealand Institute of Landscape Architects
Raumati Adaptation Area	The Raumati Adaptation Area is located across the Raumati Beach and Raumati South settlements in the Kāpiti Coast District. Alongshore, this runs from Tahi Road at the northern boundary, south to the boundary of Queen Elizabeth Park.
Risk	A measure of combined exposure and vulnerability to determine the status of a people, place, or value when exposed to a hazard.
RSLR	Relative Sea Level Rise. This is the combination of global sea level rise due to climate change and the impacts of vertical land movement resulting in a local relative sea level rise.
Sensitivity	Subjective measure of how tolerant an element is to exposure to the hazard. Sensitivity relates to how the element will fare when exposed to a hazard, which is a function of its properties or characteristics.
SSP	Shared Socio-economic Pathway
Vulnerability	The propensity or predisposition to be adversely affected by a coastal hazard in relation to climate change. Vulnerability encompasses a variety of concepts, including sensitivity to harm, and lack of capacity to naturally adapt (or adaptive capacity) (e.g., without intervention).

1. Overview

As part of "*Takutai Kāpiti: Our community led coastal adaptation project*", the Kāpiti Coast District Council (KCDC) commissioned a *Coastal Hazard Susceptibility and Vulnerability Assessment* for the whole 38 km of the Kāpiti Coast District coastline from Ōtaki in the north to Paekākāriki in the south. The methodology employed for the underlying coastal modelling in this assessment is presented in Jacobs (2021)[1] and the results in Jacobs (2022a)[2,3]. The purpose of the assessment was to update previous coastal hazard assessments undertaken along the KCDC shoreline defining the spatial extent of areas potentially susceptible to current and future coastal erosion and inundation hazards, and undertake a high-level assessment of the exposure to built environment elements from coastal hazards. The purpose of this assessment was also to form the base hazard information and understanding for input into the development of adaptation pathways in the Takutai Kāpiti process. In combination with *Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volumes 1 and 2* (Jacobs, 2021 & 2022), this and the other three risk assessments for the Northern, Central and Paekākāriki Adaptation Areas are intended to collectively provide the substantive evidence base for a risk assessment in accordance with the direction set by the New Zealand Coastal Policy Statement 2010 (NZCPS).

A Coastal Advisory Panel (CAP) has been established and is tasked with developing and recommending coastal adaptation pathways for the district. A *Decision Making Framework* report (Jacobs 2022)[4] was prepared for the CAP to guide them in forming their recommendations to KCDC. The report outlines a three phase process for the CAP to work through to develop a set of adaptation pathways as shown in Figure 1.1.

In Phase 1 of this process, which focused on defining criteria and options to be used across the entire district, the district has been divided into five '**Adaptation Areas'** based on common morphological features, and exposure to present day and future hazards, as shown in Figure 1.2.

Phase 2 of the decision making framework is repeated separately for each Adaptation Area, and includes the presentation of a **risk assessment** for the adaptation area to the CAP:

"In Phase 2 Task 1, the CAP will be presented with a risk assessment for the Adaptation Area they are focusing on. This risk assessment will be a consolidation of all the technical assessments to date, which will provide maps of the intersection of the hazard exposure with the spatial location of elements which are at risk of damage or loss from the hazards (e.g. land parcels, land-uses, infrastructure, community services, areas of significant cultural, social and environmental uses), and commentary on the consequence of hazards to both spatial and non-spatial social, cultural, and environmental values (e.g. loss of ability to access the beach).

The presentation of this risk assessment will bring the CAP up to speed on all of the consequences of coastal erosion and inundation hazards in the Adaptation Area they are focusing on, and will provide a baseline case for the consequences of failing to address SLR in order to test the success of their potential pathways against for the MCDA assessment (e.g., the 'do-nothing' option)."[5]

The purpose of this report is to present the methodology and results of the risk assessment for the Raumati Adaptation Area (RAA), defined in Figure 1.3, and to clearly identify where the risk is greatest across multiple domains. This assessment considers the risks from coastal hazards if no future adaptation is implemented to manage the risk of coastal hazards in the future. This assessment assumes that once existing shoreline protection structures fail, they are not replaced and natural shoreline erosion will resume. The presence of current seawalls in the Raumati Adaptation Area have been accounted for within the modelling of the coastal

[1] Jacobs (2021). Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volume 1: Methodology. Report to Kāpiti Coast District Council.

[2] Jacobs (2022a). Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volume 2: Results. Report to Kāpiti Coast District Council.

[3] It is noted that in the context of the Volume 2 report, the terms 'susceptibility' and 'vulnerability' are different from those used in this report as given in the glossary.

[4] Jacobs (2022b). Decision Making Framework Report. Report to Kāpiti Coast District Council. September 2022.

[5] Jacobs (2022b). Decision Making Framework Report. Report to Kapiti Coast District Council. September 2022.

erosion hazard, with residual life of structures being based on Tonkin and Taylor (2016 & 2021) [6]. Adaptation options can be tested against this scenario through the decision-making processes to evaluate the effectiveness of an adaptation pathway in lowering the risk across multiple domains. It will be used to inform recommendations made by the CAP, and can be drawn on by Council to assist their future decisions around adaptation to have a holistic view of risk and mitigation. This assessment follows the guidance provided by Ministry for the Environment (2021) which encourages the assessment of risk to be undertaken across a range of domains.

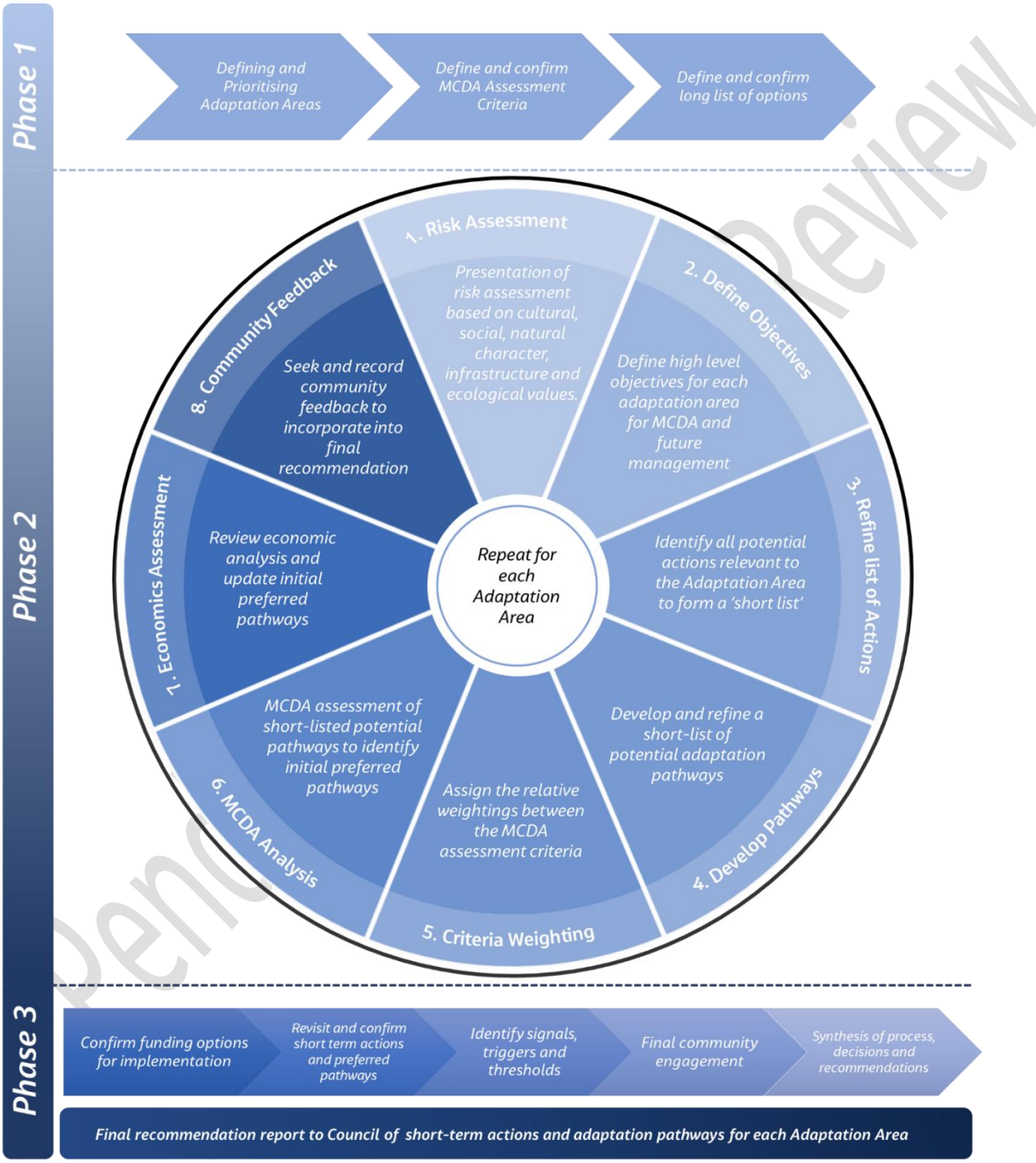


Figure 1.1: Decision Making Framework for the Community Assessment Panel (Jacobs, 2022).

[6] Tonkin and Taylor (2016 & 2021) Condition Assessment of Coastal Structures.

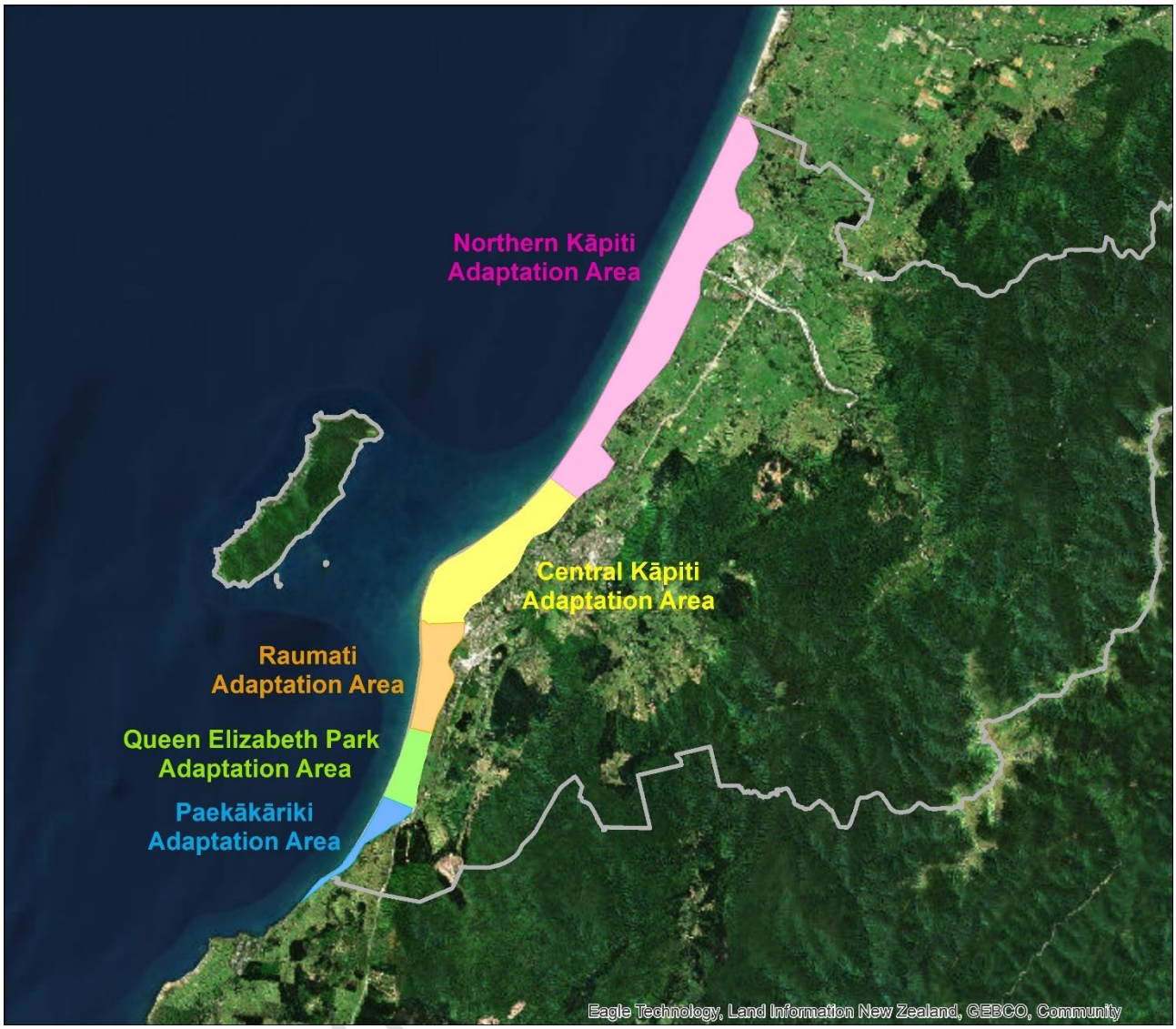


Figure 1.2: Takutai Kāpiti Adaptation Areas. The inland extent of the adaptation areas are determined by the inland extent at which either coastal inundation occurs, or where the interaction from SLR and groundwater ends. The long-shore boundaries of the adaptation areas are based on a combination of coastal processes, development, and location of communities.

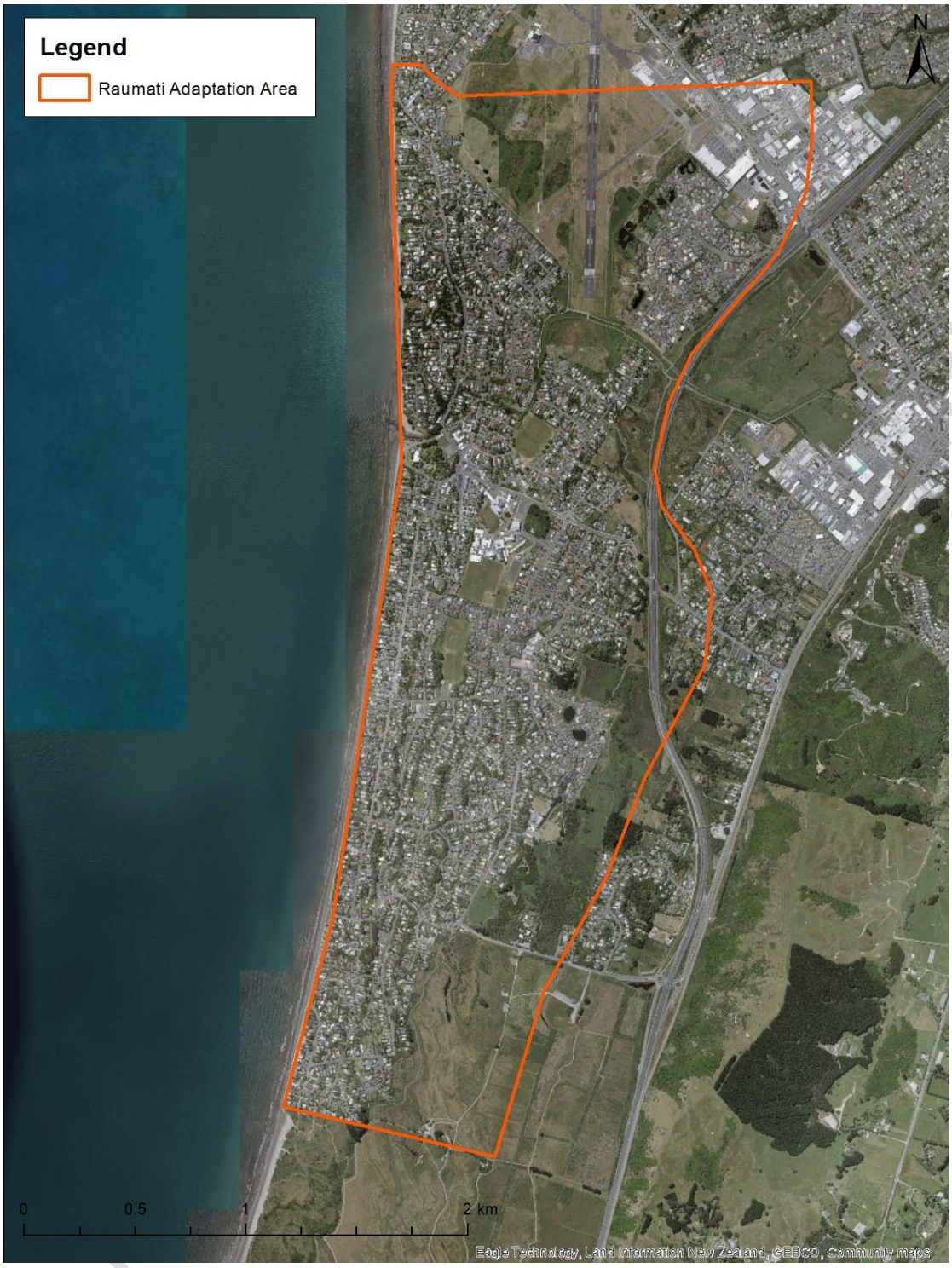


Figure 1.3: Extent and location of the Raumati Adaptation Area

This assessment looks at the risks to five 'domains':

- Built Environment
- Cultural
- Human
- Ecological
- Natural Character

The risk to individual 'elements' within each of these five domains from coastal erosion and coastal inundation hazards has been assessed by subject matter specialists for the present day, 2050, 2070 and 2130 under the SSP2-4.5 and SSP5-8.5 sea level rise scenarios[7]. The use of these scenarios is consistent with the MfE (2021), MfE (2022a)[8], and MfE (2024)[9] guidance for climate change risk assessments and adaptation planning.

This risk assessment presents a summary of the risk for each of the elements assessed within each domain and is not an exhaustive assessment of all possible elements present along the Raumati coast. Rather, elements have been selected for assessment based on the availability of data and the expert judgement of the subject matter specialists .

It should be noted that within the RAA the domains are also at risk from other sources of hazard, such as pluvial and fluvial flooding, elevated groundwater, and tsunami, which are not included in this assessment.

This report has been prepared by Jacobs in collaboration with subject matter specialists from the Technical Advisory Group (TAG). The Built Environment domain has been assessed by Jacobs. The Natural Character domain has been assessed by Boffa Miskell; the Ecological domain has been assessed by Dr. Astrid Dijkgraaf, the Human domain has been assessed by NIWA; and the Cultural domain is still to be completed with mana whenua.

1.1 Structure of this report

The structure of this risk assessment report is as follows:

- Section two provides the methodology employed to undertake the risk assessment;
- Section three provides a summary of the risk assessment results for the **Built Environment** domain;
- Section four provides a summary of the risk assessment results for the **Human** domain;
- Section five provides a summary of the risk assessment results for the **Ecological** domain;
- Section six provides a summary of the risk assessment results for the **Natural Character** domain; and
- Section seven will provide a summary of the risk assessment results for the **Cultural** domain.
- Appendix A presents the element 'templates' used to record and assess the risk to each individual element under both SLR scenarios.
- Appendix B presents the complete risk matrices for the assessments including exposure, sensitivity, adaptive capacity, and risk ratings.

[7] Data averaged across KCDC sites from NZSeaRise (https://www.searise.nz/) with 1 mm/yr land subsidence.

[8] Ministry for the Environment (2022a). Interim guidance on the use of new sea-level rise projections. Wellington: Ministry for the Environment.

[9] Ministry for the Environment (2024). Coastal hazards and climate change guidance. Wellington: Ministry for the Environment.

2. Methodology

2.1 Background

There are several central government documents produced by Ministry for the Environment since 2017 which provide guidance on the process, steps, and scenarios that should be considered when assessing risks from climate change and coastal hazards.

The MfE (2017)[10] *Coastal hazards and Climate Change: Guidance for Local Government* identifies the following three-level risk assessment approach for coastal hazard adaptation planning:

- A first-pass risk screening can be conducted as a desktop study to screen the climate change related exposure using readily available datasets.
- A second-pass risk assessment takes a standard risk-based approach using national data, regional and local information (input from hazard assessments for various SLR scenarios or increments, demographics, asset attributes) and expert knowledge. It enables identification of how climate change may compound existing risks or the emergence of new ones.
- A third-pass (detailed) risk assessment process enables further investigation of short-listed risks and enables prioritization and testing of strategies and actions in conjunction with the vulnerability assessments.

MfE (2024) *Coastal hazards and climate change guidance* released an update to this report, which provides further details on the first-pass risk screening and the detailed risk assessment stages, and highlights the importance of cascading hazards and the linkages between risks across domains. This document recommends that for detailed risk assessments, a timeframe out to 2130 should be assessed, as well as adopting both medium confidence SSP2-4.5 and SSP5-8.5 RSLR projections that include the relevant VLM rate.

A similar three-level approach was employed in the *National Climate Change Risk Assessment for New Zealand* (MfE, 2020)[11] and is recommended in the MfE (2021) *A guide to local climate change risk assessments.*

The *National Climate Change Risk Assessment for New Zealand (MfE, 2020)* applied RCP8.5 and RCP4.5 climate change scenarios to their assessment of risk for coastal and non-coastal areas. These scenarios were also those recommended by MfE (2021) guidance to be applied in local climate change risk assessments. The guidance notes (Section 2.2.1) that "t*he RCP 8.5 scenario is useful to identify the most significant risks if warming continues unabated. The RCP8.5 'high-end' scenario is a precautionary, underpinning assumption for a risk assessment (Hausfather, 2019). Predicting emissions trajectories, and their likelihood, is complex and depends on factors including climatic and atmospheric science, socio-economic and technological change over time, and international/national climate policies. Most, if not all, are extremely hard to predict with certainty. The RCP4.5 scenario is useful to identify risks under a more ambitious reduction pathway, where emissions peak around 2040 and then decline."* This is a narrower range of scenarios for sea level rise than assessed in the Jacobs (2022a) report, which included a lower RCP2.6 scenario and a higher RCP8.5H+ scenario, which was consistent with the MfE (2017) guidance for coastal hazard assessments developed for adaptation planning.

Jacobs (2022a) presented a first-pass risk screening using available information on the exposure of selected built environment assets (e.g. properties and roads) to coastal erosion and flooding hazards under relative sea level rise projections to 2120. This Raumati Adaptation Area risk assessment report is considered to be a second-pass risk assessment, which builds on the first-pass assessment by considering the hazard risks from relative sea level rise to a broader range of domains and additional elements in the built environment.

[10] Ministry for the Environment (2017). Coastal Hazards and Climate Change – Guidance for Local Government. Wellington. Ministry for the Environment.

[11] Ministry for the Environment (2020). National Climate Change Risk Assessment for Aotearoa New Zealand: Main report - Arotakenga Tūraru mō te Huringa Āhuarangi o Āotearoa: Pūrongo whakatōpū. Wellington: Ministry for the Environment.

MfE (2022b)[12] *Aotearoa New Zealand's first national adaptation plan* was published in 2022 following the release of the Jacobs (2022a) report. This document recommends that for detailed hazard and risk assessments in coastal and non-coastal areas, both the 'middle-of-the-road' scenario (**SSP2-4.5**) and the fossil fuel intensive development scenario (**SSP5-8.5**) to 2130 should be used to assess climate change risks. These two scenarios have been modelled and are used to assess risk in this assessment (see Section 2.2.3).

The most recent IPCC global climate change assessments (IPCC, 2021)[13], which post-dates the above 2017 and 2021 MfE guidance, present the scenarios as SSP (Shared Socioeconomic Pathways) rather than RCP (Representative Concentration Pathways) scenarios, with SSP5-8.5 and SSP2-4.5 scenarios being the equivalent of the former RCP 8.5 and RCP4.5 scenarios respectively. The MfE (2022a) *Interim guidance on the use of new sea level rise projections* recommends that in planning for sea level rise, the new SSP scenarios combined with local Vertical Land Movements (VLM) should be used in place of the previous RCP scenarios.

In light of the more recent information that became available since modelling for the Jacobs (2022a) was undertaken in 2021, Jacobs (2024)[14] provided an update to the SLR scenarios and VLM used to inform the coastal inundation and erosion hazard mapping. The addendum documents the new RSLR projections that were developed for the Kāpiti Coast in light of the updates, and these new RSLR scenarios were used to inform remapping of coastal hazards under the SSP2-4.5 and SSP5-8.5 scenarios to inform the risk assessments for Takutai Kāpiti (this report).

MfE (2021) *A guide to local climate change risk assessments* provides the specific steps to be carried out to assess the risks associated with climate change across multiple domains. This guidance provides a calculation for risk as being a combination of 'exposure' and 'vulnerability', as per the equation in Figure 2.1. Exposure is a measure of the extent to which elements intersect with the hazards layer; and vulnerability is the propensity or predisposition to be adversely affected by a coastal hazard in relation to climate change. Vulnerability encompasses a variety of concepts, including sensitivity to harm, and lack of capacity to naturally adapt (or adaptive capacity) (e.g. without intervention).

This definition of risk adopted by the MfE (2021) guidance is consistent with the risk definition from the IPCC, where risks are framed through the concept of hazard, exposure, and vulnerability. This differs slightly from other standard risk assessment and management processes (AS/NZS ISO 3100:2018) which uses a combination of likelihood and consequences to define risk.

The definitions and steps from the MfE (2021) guidance have been adopted in this assessment, and are discussed in detail in the following sections.

[12] Ministry for the Environment (2022b). Aotearoa New Zealand's first national adaptation plan. Wellington. Ministry for the Environment.

[13] IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group 1 to the Sixth Assessment Report.

[14] Jacobs (2024) Comparison of Relative Sea Level Rise projections presented in the Kapiti Coast Coastal Hazards and Susceptibility and Vulnerability Assessment Reports Volume 1 (2021) and Volume 2 (2022) with new information from more recent IPCC publications and MfE Guidance.

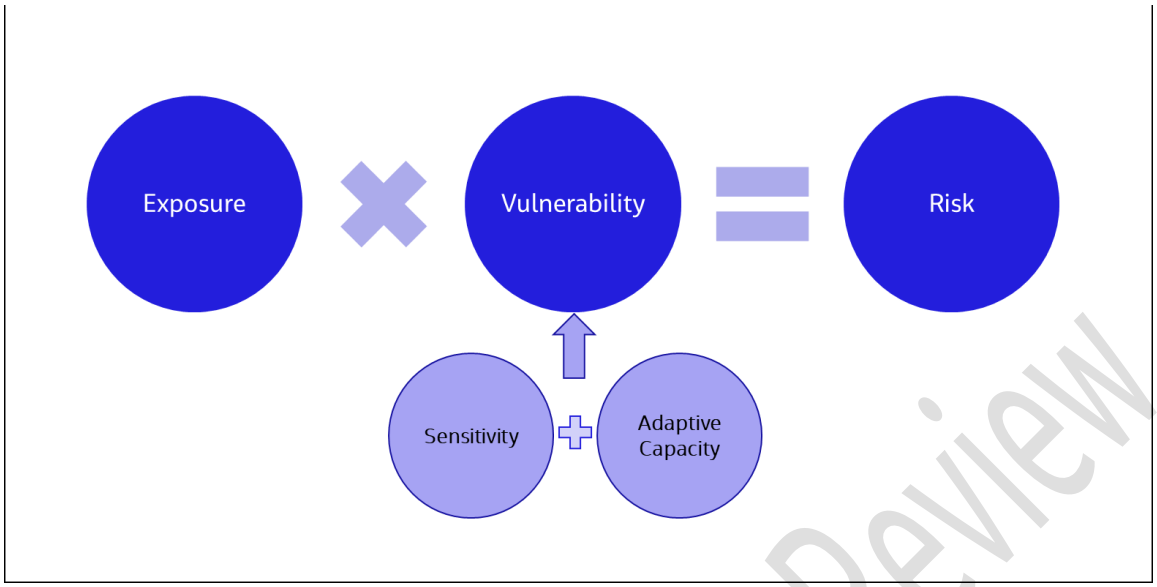


Figure 2.1: Risk equation used for this assessment from MfE (2021) Guidance for climate change risk assessments.

2.2 Methodology

2.2.1 Overview

The risk assessment methodology relies on a combination of spatial information of both the hazards and elements to assess the exposure of an element to the hazard, and subject matter specialist opinion to determine how the element would fare when exposed to the hazard. The process of calculating risk based on the equation outlined in Figure 2.1 comprises of multiple steps of information gathering to define the risk. These steps are summarised in Figure 2.2, and are outlined in detail from Sections 2.2.2-2.2.7 below.

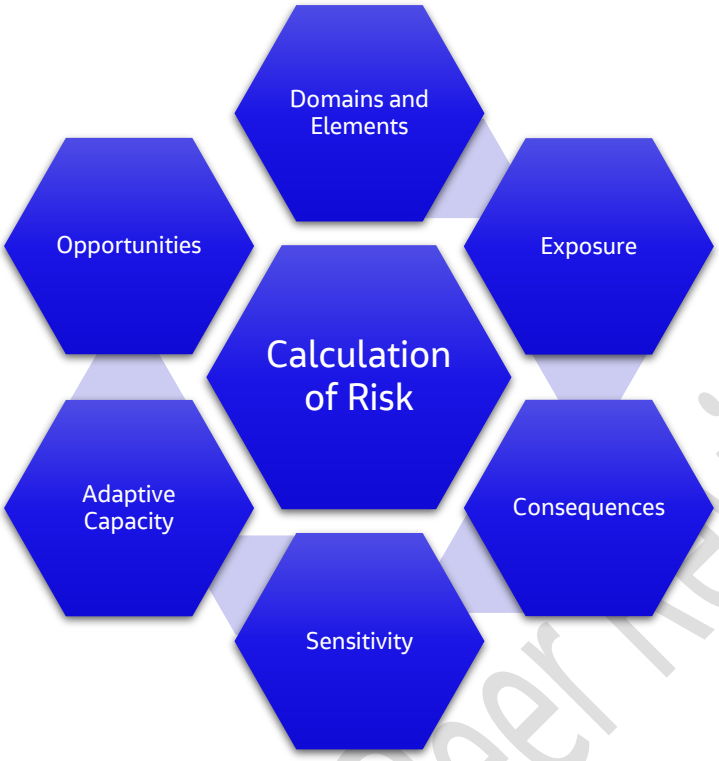


Figure 2.2: Steps for calculating risk.

2.2.2 Domains and Elements

For this risk assessment, five 'domains' have been defined based on current available information to cover the broad ranges of interests and values of the community and council, and relate to people, places and assets. These domains are similar to those outlined in the MfE (2021) guidance, and are based on information that is currently available. Each domain has been assessed by subject matter specialists, which are listed in brackets below.

These domains are:

- Built Environment (Jacobs)
- Cultural (to be completed with mana whenua)
- Human (NIWA)
- Ecological (Dr. Astrid Dijkgraaf)
- Natural character (Boffa Miskell)

For each domain, 'elements' have been selected that are representative components of the broader domain. Elements have been selected for assessment based on the availability of data and the expert judgement of the subject matter specialists in identifying the most relevant elements to inform the development of adaptation pathways. The elements assessed for each domain are presented in Table 2.1.

Some elements are broader terms which cover the risk to a range of smaller sub-elements. For example, Wastewater services has assessed the risk to wastewater pipes, pump stations and treatment plants.

Each element has been individually assessed for risks from coastal erosion and inundation under two sea level rise scenarios (see Section 2.2.3).

Table 2.1: Domains and Elements considered in this assessment.

Domain	Elements
Built Environment	▪ Properties ▪ Roads and Bridges ▪ Wastewater services ▪ Water supply services ▪ Stormwater services ▪ Electrical supply and transmission ▪ Natural gas supply
Cultural	▪ Still to be completed with Mana Whenua
Human	▪ Physical health ▪ Mental health and wellbeing ▪ Social infrastructure and amenity ▪ Exacerbating inequities ▪ Social cohesion and community wellbeing ▪ Conflict, disruption and loss of trust in government
Ecological	▪ Coastal dunes ▪ Wetlands ▪ Mapped ecological sites ▪ Indigenous trees ▪ Rare and threatened species ▪ Bird habitat ▪ Fish habitat ▪ Indigenous Biodiversity Coastal
Natural Character	▪ Coastal Terrestrial Area 2: Paraparaumu and Waikanae

2.2.3 Exposure

Exposure in this assessment is defined as a measure of the extent to which elements intersect with the hazards. Exposure has been assessed for two climate change scenarios across four timeframes (Present day, 2050, 2070, 2130), and for one likelihood occurrence of each hazard, as presented in Table 2.2.

The RSLR projections used in this assessment uses the most recent data for the Kāpiti Coast from NZ SeaRise Programme[15] , which incorporates the most recent IPCC (2021) SLR projections offset slightly for the New Zealand region as per MFE (2017), and a -1 mm/yr VLM, being the average for the 21 assessment sites on the Kāpiti coast presented in the NZ SeaRise data. The assessment includes the SSP2-4.5 and SSP5-8.5 RSLR scenarios as per the recommendations of the MfE (2021) and (2022) guidance documents. This approach recognises the emergence of increasing exposure and uncertainty with time, with the RSLR in the 2050 timeframe being the same amount for both SSP2-4.5 and SSP5-8.5 scenarios before becoming increasingly different over the 2070 and 2130 timeframes. All RSLR increments presented are taken from a 2020 baseline and are for the median value of the projections for that scenario over the specified timeframe.

For coastal erosion, the hazard is defined by the projected future shoreline position for which there is a 10% probability of the shoreline being further inland at the timeframe considered. For coastal inundation, the hazard is defined by the area of land potentially exposed to inundation under a storm tide event for which there is a 1% annual exceedance probability (AEP) – equivalent to a 10% chance of occurrence over a 10-year period, or a 50% chance of occurring over a 50-year period.

[15] https://www.searise.nz/

Table 2.2: Scenarios and likelihoods considered in this risk assessment.

Timeframe	Climate change scenario and Relative Sea level Rise (RSLR)	Coastal Erosion Hazard Likelihood	Coastal Inundation Hazard Likelihood
Present Day	0m RSLR	10% probability of shoreline exceeding landward limit of mapped extent (i.e., P10)	1% Annual Exceedance Probability storm tide event
2050 (30 years)	SSP2-4.5 & SSP5-8.5 (0.2 m RSLR from 2020 in both cases)		
2070 (50 years)	SSP2-4.5 (0.35 m RSLR from 2020) SSP5-8.5 (0.45 m RSLR from 2020		
2130 (110 years)	SSP2-4.5 (0.85 m RSLR from 2020) SSP5-8.5 (1.25 m RSLR from 2020)		

Updated mapping of both the erosion and inundation hazard from the Jacobs (2022a) report has been undertaken for the new SSP2-4.5 and SSP5-8.5 RSLR projections for the Kāpiti Coast from NZ SeaRise data (Jacobs, 2024)[16].

A summary of the coastal erosion distances (up to a 10% exceedance probability) calculated from the updated mapping is as follows:

- The present-day erosion hazard (i.e. what could occur in an extremely large storm (which has a 1% chance of occurring each year in the immediate/near future) if the existing protection structures failed) would result in an average of 16 to 24 m of erosion.
- By 2050, it is projected on average there could be in the order of up to 34 m erosion at Raumati Beach; and 44 m erosion at Raumati South.
- By 2070, at Raumati Beach there could be on average up to 45 m of erosion under the lower SSP2-4.5 scenario; and 56 m under the higher SSP5-8.5 scenario. At Raumati South, the distances could be in the order of up to 65 m under the lower SSP2-4.5 scenario, and in the order of 79 m under the higher SSP5-8.5 scenario.
- By 2130, at Raumati Beach, coastal erosion could be in the order of 86 m under the lower SSP2-4.5 scenario; and 132 m under the higher SSP5-8.5 scenario. At Raumati South, erosion distances could be in the order of 137 m under the lower SSP2-4.5 scenario; and 191 m under the higher SSP5-8.5 scenario.

For coastal flooding, by 2070 under a 1% AEP coastal event with sea level rise, the area around the mouth of the Wharemauku Stream becomes susceptible to inundation. The remainder of the Raumati shoreline remains generally unaffected except for smaller stormwater catchments which drain directly to the sea or to the Wharemauku Stream. By 2130 under both SLR scenarios, the mapping shows an increased area susceptible to both direct inundation from the stream and through the stormwater network (e.g. Matatua Road for example) and as far upstream as the stormwater ponds on either side of the Kāpiti Expressway. Elsewhere along the coastline, the area susceptible to flooding through stormwater outfalls to the sea increases.

This assessment of risk from coastal erosion relies upon the assumptions used in the Jacobs (2022a) hazard assessment, being:

[16] Jacobs (2024) Comparison of Relative Sea Level Rise projections presented in the Kapiti Coast Coastal Hazards and Susceptibility and Vulnerability Assessment Reports Volume 1 (2021) and Volume 2 (2022) with new information from more recent IPCC publications and MfE Guidance.

- For longer term projections of future shoreline position, the extent of the coastal erosion hazard is based on the assumption that when an existing wall is at the end of its current residual life, it fails and is not replaced.

- The present day exposure to erosion is based on the assumption that existing protection would fail in the design extreme storm event (1% AEP (annual exceedance probability) event), resulting in erosion behind the wall position. This erosion estimate is based on the 15 m erosion that was experienced along the Raumati coastline following the failure of protection structures in the 1976 extreme storm event (0.5 to 1% AEP joint storm tide and wave event).

- The risk to coastal erosion assumes no adaptation or mitigation is undertaken to prevent seawall failure, and therefore risks could be different if measures were put in place to change these underlying assumptions.

For coastal flooding, the extent of flooding has been modelled using a "bath tub mapping approach" with the assumption that the current level of natural protection (i.e. current coastal dune morphology preventing direct inundation from the sea) continues into the future. It is recognised that this may not be the case if the projected erosion is allowed to occur in the absence of further adaptation and structures failing, as this will remove the existing high dune and infrastructure along the coastline.

Exposure of an element was assessed through GIS mapping, where the subject matter specialist could overlay their spatial element data with the spatial hazard data. Exposures were then assigned one of four ratings from low to extreme, using the Exposure rating scale in Table 2.3 as a guide. Where the extent of elements was readily quantifiable (e.g., number of properties), then a spatial analysis was undertaken to determine the numerical exposure rating based on the quantitative definitions in Table 2.3. Where exposure was not quantifiable (e.g. inequities), or the element covered multiple spatial datasets (e.g. waste supply infrastructure – pipes, pump stations, treatment plants), then a more qualitative assessment was made by the subject matter specialist based on the qualitative definitions in Table 2.3.

Exposure ratings together with any limitations or assumptions made in determining an exposure rating are recorded in Appendix A.

Table 2.3: Exposure rating scale from MfE (2021).

Exposure rating	Qualitative definition	Quantitative definition
Extreme	Significant and widespread exposure of elements to the hazard	>75% of element is exposed to the hazard
High	High exposure of the elements to the hazard.	50-75% of element is exposed to the hazard
Moderate	Moderate exposure of the elements to the hazard.	25-50% of element is exposed to the hazard
Low	Isolated elements exposed to the hazard.	5-25% of element is exposed to the hazard

2.2.4 Vulnerability

The vulnerability component in this assessment forms half of the risk equation (Figure 2.1) and is determined through the combination of Sensitivity and Adaptive Capacity. Vulnerability represents how sensitive an element is to the hazard and recognises its ability to naturally adapt, or be adapted with only small amounts of intervention.

A four level vulnerability rating is produced using the matrices in Table 2.4, which combines similar rating categories for Sensitivity and Adaptive Capacity, outlined in detail below. Vulnerability rating can rank from low to extreme, with the definitions being as per Table 2.5.

Vulnerability ratings for each element are recorded in Appendix A.

Table 2.4: Vulnerability matrix (combining sensitivity and adaptive capacity). From MfE (2021).

		Sensitivity			
		Low (L)	**Moderate (M)**	**High (H)**	**Extreme (E)**
Adaptive Capacity	**Very low (VL)**	Moderate	High	Extreme	Extreme
	Low (L)	Low	Moderate	High	Extreme
	Moderate (M)	Low	Moderate	Moderate	High
	High (H)	Low	Low	Low	Moderate

Table 2.5: Vulnerability rating and definitions. From MfE (2021).

Vulnerability rating	Definition
Extreme	Extremely likely to be adversely affected, because the element is highly sensitive to a given hazard and has a low capacity to adapt.
High	Highly likely to be adversely affected, because the element is highly sensitive to a given hazard and has a low capacity to adapt.
Moderate	Moderately likely to be adversely affected, because the element is moderately sensitive to a given hazard and has a low or moderate capacity to adapt.
Low	Low likelihood of being adversely affected, because the element has low sensitivity to a given hazard and a high capacity to adapt.

2.2.4.1 Sensitivity

Sensitivity is a subjective measure of how sensitive (or tolerant) an element is to exposure to the hazard, which is a function of its properties or characteristics. Each element is assigned a sensitivity ranking (low to extreme) for input into the vulnerability matrix (Table 2.4). Sensitivity was assigned qualitatively based on subject matter specialists' opinions, as well as further analysis of the spatial data. Sensitivity is different for each hazard.

A low sensitivity ranking was assigned when, despite being potentially exposed, the element would be unlikely to be adversely impacted. For example, stormwater infrastructure is unlikely to be sensitive to flooding at the present day, as its primary purpose is to mitigate the effects of flooding. A high-extreme sensitivity ranking was assigned when the impacts or consequences of the hazard were severe due to the element being exposed. For example, sensitivity of wastewater infrastructure being exposed to erosion was considered to be extreme as the consequences of damage to the infrastructure would be critical to the settlement.

For some elements, further assessment of the intensity of the exposure was included in the sensitivity ranking. For example, when assessing the sensitivity to private properties, consideration was given for where

the erosion reached on the property in relation to the primary dwelling using a visual inspection of aerial imagery of the properties. If the erosion hazard intersected with most dwellings along the coast, it was considered to be an extreme hazard as a result of the consequences this would lead to. For properties where the erosion hazard only intersected with the edges or undeveloped parts of the property, and dwellings were setback from the hazard, these were considered to be less sensitive (e.g. low-moderate rating). In a similar sense, the sensitivity of private property to inundation hazards generally increases over time due to the increase in water depth during a flood event, causing greater potential impacts on dwellings and other buildings.

For the human domain, where some intangible elements occur, sensitivity was attributed to the ability for humans to respond and deal with the hazard. Sensitivity to exposure to the hazard would become inherently worse over time as the hazard frequency and extent increases or causes periods of prolonged disruption.

A sensitivity rating for each element is provided in Appendix A.

2.2.4.2 Adaptive capacity

Adaptive capacity refers to the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. It relates to how easily/efficiently an element at-risk can adapt naturally. An adaptive capacity rating was assigned to each element, irrespective of timeframe, from very low to high for input into the vulnerability matrix (Table 2.4).

Generally, infrastructure based elements (e.g. roads, electrical transmission infrastructure) have a lower adaptive capacity, as they would not be able to naturally adapt. In some instances, adaptive capacity of built environment elements can be moderate as small easy interventions can be undertaken to adapt (e.g. installing temporary flood protection controls to protect pump station power controls). However, infrastructure such as roads would require a significant amount of intervention and therefore would be considered to have a low adaptive capacity. Natural systems (ecological and natural character) tend to have a moderate-high adaptive capacity, which is generally based on the available space where species or natural forms can migrate to away from the hazard. However, natural systems may have a lower adaptive capacity or need human intervention to aid adaption if the ecological values are already compromised or impacted (e.g. a species that has been impacted by predation).

An Adaptive Capacity rating for each element as well as commentary is provided in Appendix A.

2.2.5 Consequences

Commentaries based on subject matter specialists' experience, local knowledge and broader literature research on the elements' response to the hazards were prepared for each element. This provides a general overview on what the potential consequences of exposure of the element could be, irrespective of the timeframe. This commentary also included, where appropriate, a description of the cascading impacts which could occur.

Consequences of coastal erosion were generally related to partial or total loss of the element (e.g., loss of property area) and what the consequences of this loss could be. Consequences of coastal inundation were more complex due to variations in effects with depth of flooding. For example, the consequence of flooding of a road could vary from nuisance surface flooding which could be controlled through vehicle speeds, to blocking off access to settlements if significant water depths occurred across key access roads.

These consequences are recorded as commentary in Appendix A for each element.

2.2.6 Opportunities

Climate change could present opportunities that lead to positive or beneficial outcomes. There will be direct and indirect opportunities from mitigation and adaptation. Direct opportunities relate to the changes that occur as a result of the hazard – for example, erosion of a road could re-establish a hydrological connection to a wetland; or can be indirect opportunities as a result of adaptation or planning/management. Opportunities, where applicable, have been recorded for each element to highlight the potential positive outcomes of allowing the hazard to occur; as well as potential opportunities where interventions may occur

outside of the adaptive planning process which would change the outcome of the identified risk. For example, the wastewater supply network that could be eroded in the 2070-2130 period consists of old infrastructure that requires upgrading prior to being exposed, therefore taking the opportunity to relocate as part of the upgrade, which would reduce the future risk.

Commentary on the potential opportunities are recorded for each element in Appendix A.

2.2.7 Overall Risk Rating

Based on the ratings developed for exposure (Section 2.2.3) and vulnerability (Section 2.2.4), a risk rating is developed for each element against each hazard from low to extreme. This matrix is presented in Table 2.6.

These risk ratings are compiled together in an overall matrix with the exposure, sensitivity, adaptive capacity, vulnerability and overall risk score over time is provided in Appendix B.

Table 2.6: Risk Matrix (combining vulnerability and exposure).

		Exposure			
		Low (L)	**Moderate (M)**	**High (H)**	**Extreme (E)**
Vulnerability	**Extreme (E)**	Moderate	High	Extreme	Extreme
	High (H)	Low	Moderate	High	Extreme
	Moderate (M)	Low	Moderate	Moderate	High
	Low (L)	Low	Low	Moderate	High

2.3 Risk Assessment Outputs

The following outputs have been developed as part of the risk assessment:

- A summary of the risk assessment methodology, results, and conclusions (this report).
- Risk assessment templates were produced for each element under each climate change scenario (SSP2-4.5 and SSP5-5). These are appended to this report in Appendix A, and provide the following information:
  - A descriptive overview of the element
  - A description of the consequence of exposure to the element to coastal erosion or flooding
  - A description of the potential opportunities
  - A description and rating of the exposure of the element to the coastal erosion and flood hazards
  - A description and rating of the element's sensitivity to the coastal erosion and flooding hazards
  - A description and rating of the element's adaptive capacity to the coastal erosion and flooding hazards
  - A calculated vulnerability rating for the element based on sensitivity and adaptive capacity ratings
  - A calculated overall risk rating for the element based on combined exposure and vulnerability ratings
- Complete risk assessment matrices are appended to this report in Appendix B. This provides the ratings for the individual components (e.g. exposure, sensitivity etc) for each element and summarises it into one table for coastal flooding, and one table for coastal erosion.

3. Built Environment Domain

The 'Built Environment' domain refers to the infrastructure which provides a service to the RAA communities, such as transport (roads), electricity, three waters, gas supply, and electrical supply. It also includes private properties, for which these services are built and maintained to service. The risk to the elements assessed under the built environment domain will likely result in cascading impacts on the human, cultural and ecological domains in the RAA.

The following outlines the information used to assess the risks to the built environment in the RAA, and a summary of the findings related to the risks to the built environment. Details for each element, including assumptions and limitations used to identify the risks, are provided in Appendix A.

3.1 Built Environment Elements

The risk assessment primarily relies on spatial information to establish how potentially exposed an element is to coastal hazards, and also how this exposure changes over time. Table 3.1 provides a summary of the elements assessed within the built environment domain, and what spatial information was used to inform the assessment of risk.

Elements were assessed using publicly available data from online sources such as LINZ Data service, private infrastructure providers (e.g. electricity, gas supply), or supplied by KCDC using their asset management database. This assessment looks at the risk to public infrastructure, therefore properties that privately manage their wastewater or water supply have not been included in the assessment.

More detailed information about the method employed to establish exposure, sensitivity, and adaptive capacity ratings for each element is included in Appendix A.

Table 3.1: Summary of elements assessed in the built environment domain and representative data used to inform the assessment.

Element	Description	Representative Data
Private properties	**Risks to private properties in the total RAA**. Property boundaries are used as a proxy for the number of homes which may be exposed to the hazards. Property boundaries have been used to quantify the exposure, with a visual assessment of where dwellings were situated on exposed properties to indicate sensitivity.	Private property boundary outlines provided by KCDC. This data is from December 2022.
Private properties (by settlement)	**Risks to private properties by settlements.** The RAA has been split into two subsets of the RAA, primarily based on key settlements (Raumati Beach and Raumati South) to assess whether the risk profile varies across the RAA and between the two areas. For coastal erosion, exposure is evaluated relative to the number of beachfront properties in the settlement (i.e., the most seaward line of properties). For coastal inundation exposure is assessed for the number of properties in the broader settlement footprint. Maps over where these areas cover are provided in Appendix A.1.2-A.1.3.	Private property boundary outlines provided by KCDC. Subset areas here defined based on the Statistical Area 2 (2022) boundaries between Raumati Beach and Raumati South.
Roads and Bridges	**Risk to roads and bridges in the RAA** that could disrupt access to individual properties, settlements and services.	Road centrelines were taken from LINZ Dataservice. Bridges have been identified manually using the intersection of the road centreline layer and stream centreline layer (accessed via LINZ dataservice)

Element	Description	Representative Data
		with verification using aerial imagery and Google maps street view.
Wastewater services	**Risks to public wastewater infrastructure in the RAA** which service the treatment and disposal of wastewater. This includes: ▪ Wastewater pump stations ▪ Wastewater network (pipes).	Data for public wastewater infrastructure was supplied by KCDC. This included wastewater pump stations and network pipes.
Water supply services	**Risk to public water supply infrastructure in the RAA** which supports the supply, treatment and distribution of water to private properties. This includes: ▪ Water supply pipe network ▪ Water supply bores.	Data for public water supply services including pipe network were supplied by KCDC. This included the location of supply bores (filtered for public water supply), the water supply network pipes, water treatment plants and pump stations.
Stormwater services	**Risk to public stormwater infrastructure** that manages stormwater in significant pluvial, fluvial and coastal driven events to support drainage of the land. This includes: ▪ Stormwater network pipes ▪ Stormwater outfalls ▪ Pump stations.	Data for public stormwater services was supplied by KCDC. This included stormwater network pipes, stormwater outfalls, and pump stations.
Electrical supply and transmission	**Risk to electricity supply and distribution to and within the RAA.** This includes: ▪ Distribution transformers (converts from 11kV to 230v for households) ▪ Underground transmission lines (11kV) ▪ Overhead transmission lines (11kV).	Data for electricity supply and transmission was supplied by Electra (supplier for Kāpiti Coast).
Natural gas supply	**Risk to supply and distribution of natural gas to private properties in the RAA**. This included assessing the location of the gas supply mains (pipes) relative to the hazards.	Data for natural gas supply was supplied by FirstGas (supplier for Kāpiti Coast).

3.2 Built Environment Risk Matrix

A summary of the final risk ratings for each element is presented in Table 3.2. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 3.2: Built Environment domain risk matrix.

	Coastal Erosion						Coastal Inundation					
Climate Change Scenario	**Both**		**SSP2-4.5**		**SSP5-8.5**		**Both**		**SSP2-4.5**		**SSP5-8.5**	
Element	Present	2050	2070	2130	2070	2130	Present	2050	2070	2130	2070	2130
Built Environment												
Properties - Whole Adaptation Area	M	M	M	M	M	M	L	L	L	L	L	L
Properties - Raumati Beach	E	E	E	E	E	E	L	L	L	L	L	L
Properties – Raumati South	E	E	E	E	E	E	L	L	L	L	L	L
Water Supply Infrastructure	L	L	L	H	L	H	L	L	L	L	L	L
Wastewater Infrastructure	M	H	H	E	H	E	L	L	L	L	L	L
Stormwater Infrastructure	L	L	L	H	L	H	L	L	L	L	L	L
Roads and Bridges	L	L	L	H	L	H	L	L	L	L	L	L
Electrical Transmission and supply infrastructure	L	L	L	M	L	M	L	L	L	L	L	L
Natural gas supply mains	L	M	M	H	M	H	L	L	L	L	L	L

3.3 Built Environment Risk Summary

3.3.1 Risks from coastal erosion

This assessment of risk relies upon the assumptions used in the Jacobs (2022a) hazard assessment, where for longer term projections of future shoreline position, the extent of the coastal erosion hazard is assessed based on the assumption that when an existing seawall is at the end of its current residual life[17], it fails and is not replaced. For present day exposure to erosion, this is based on the assumption that existing protection would fail in a design extreme storm event (i.e. 1% AEP event). This erosion estimate is based on the 15 m erosion that was experienced along the Raumati coastline following the failure of protection structures in the September 1976 extreme storm event (0.5 - 1% AEP joint storm tide and wave event). The risk to coastal erosion also assumes no adaptation or mitigation is undertaken. Risks could be different if measures were put in place to change these underlying assumptions.

Generally within the RAA, beachfront private property is the first element to become impacted by coastal erosion, with roading network and other services generally being located on the landward side of beachfront houses. This indicates that individual property owners would be impacted by the hazard prior to disruptions to the wider network. The exception is along The Esplanade, where the road and services underground the roading network are located seaward of properties.

Along most of the shoreline south of the Wharemauku Stream there is a primary KCDC seawall along Old Coach Road, with a piecemeal collection of secondary walls at the seaward boundary of the individual private properties. The presence of these primary structures has been included in the original coastal hazard assessment (Jacobs, 2022a), which assumes failure of the primary structure at the end of its residual life, and minimal protection from the secondary structure due to it being designed primarily for dune retention not coastal erosion protection.

Private property

Under present day sea levels, the risk to private properties across the wider RAA from erosion in an extreme storm event resulting in protection structure failure is considered to be moderate, due to the combination of low exposure (249 properties (7%) of the total 3605 properties) and extreme vulnerability (extreme sensitivity and low adaptive capacity).

Within the whole adaptation area, properties continue to be at moderate risk out to 2130 under both SLR scenarios, with exposure remaining as low and vulnerability remaining extreme. By 2050, 280 private properties (8% of whole RAA) could be potentially exposed to coastal erosion if current shoreline protection structures fail. This increases to 320 (9%) to 345 (10%) properties across both scenarios by 2070, and 590 (16%) to 822 (23%) properties across both scenarios by 2130.

However, when beachfront properties only are considered, the present day risk under a design extreme storm in both Raumati Beach and Raumati South areas (Figure 3.1) is rated as being extreme. In Raumati Beach 95 beachfront properties (89% of 107) are potentially exposed to this risk, and 116 beachfront properties (99% of 117) are potentially exposed in Raumati South. In line with the approach adopted in other adaptation areas, the sensitivity ranking for these assessments is also extreme, as this storm erosion extent intersects with dwellings within most of the properties that are impacted. This is considered extreme because once the land is eroded it is permanently lost, with loss of a dwelling being considered to be more sensitive than just the loss of land along the front edge of the property.

By 2050, 100% of beachfront properties in Raumati Beach and Raumati South (e.g 107 and 117 respectively) are considered to be at extreme risk of coastal erosion under both relative sea level rise scenarios if existing protection fails. This extreme risk continues for the beachfront properties across all RSLR scenarios and timeframes, with additional properties landward of those along the beachfront also projected to be

[17] Based on Tonkin and Taylor (2016 & 2021) condition assessments of coastal protection structures.

potentially exposed to coastal erosion if existing seawalls fail (i.e possibly an additional 56 non beach front properties by 2050).

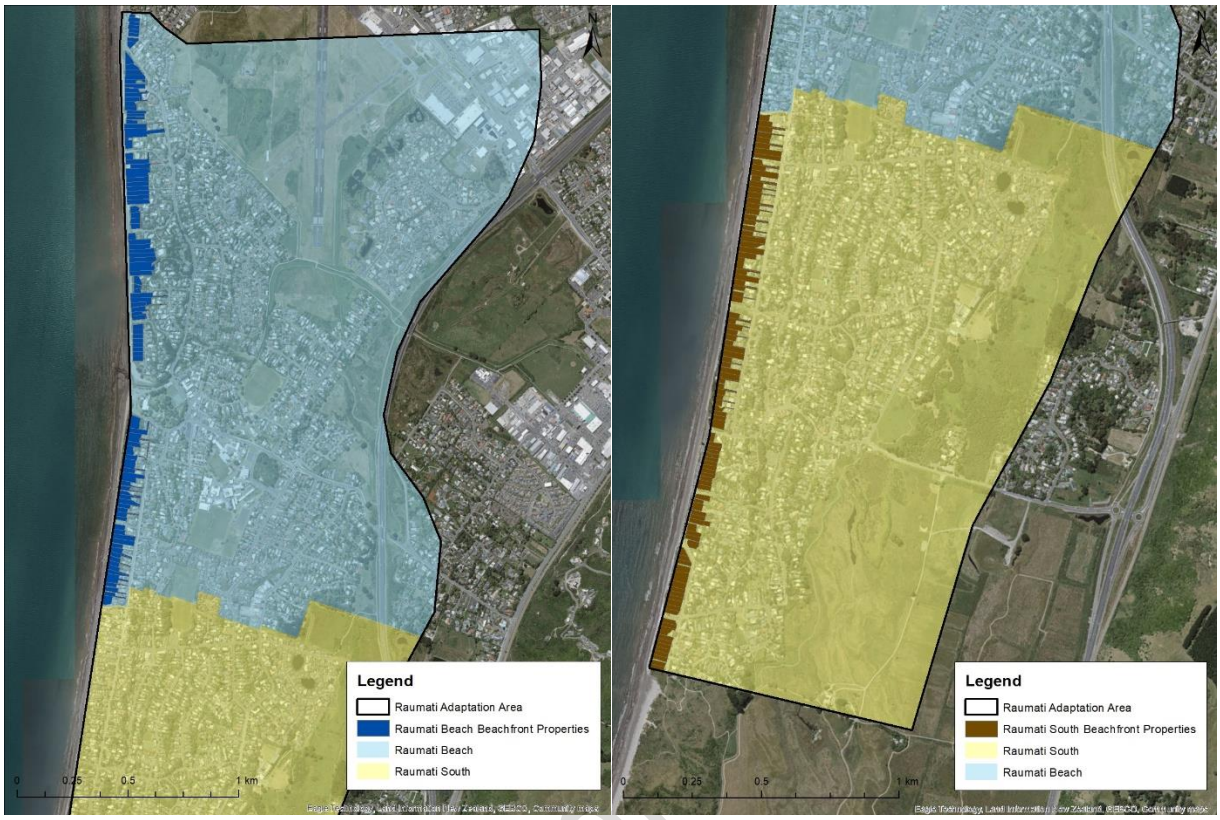


Figure 3.1: Map of the location of beach front properties in Raumati Beach (left) and Raumati South (right) included in assessment.

Wastewater Infrastructure

Wastewater infrastructure is currently at moderate risk from coastal erosion and becomes high risk by 2050. This is generally because wastewater infrastructure is considered to be extremely sensitive to coastal erosion, given that the consequences of failure could have significant health and environmental implications if untreated waste is discharged into the environment following failure.

Currently, three out of 22 pumpstations could be impacted by erosion in an extreme storm, as well as 1.7 km (3%) of wastewater pipe. Over the next 50 years with SLR, this increases to 5 pumpstations, and 2.7 km (5%) of wastewater network pipes. The increase in exposure of critical wastewater pipes which would impact a large number of properties, paired with an extreme sensitivity to erosion, means that by 2050 the wastewater network becomes high risk for properties near the shoreline.

The wastewater network is considered to remain at high risk by 2070, and increases to extreme risk by 2130 under both SLR scenarios due to the significant increase in exposure and cascading impacts to a larger number of properties. By 2130 there are 12 pump stations potentially exposed to coastal erosion, as well as 9.5 km (16%) to 10.1 km (17%) of wastewater network pipe potentially exposed to coastal erosion. The areas of wastewater that are impacted in this timeframe run parallel to the shoreline, and therefore could cause network-wide disruption.

Water supply infrastructure

Under both SLR scenario, water supply infrastructure is considered to be at low risk to 2070, and becomes high risk by 2130, where 10-11 km of water supply network pipes are potentially exposed to coastal erosion in 2130. Up until 2130, water supply pipes that are projected to be potentially exposed to coastal erosion generally only service the properties which would also be impacted by erosion themselves (e.g. high sensitivity); however by 2130 there is potential disruption to the water supply pipe network, as pipes which

run parallel to the shoreline become impacted – and therefore erosion could impact a larger number of properties within the RAA (e.g. extreme sensitivity). Consequences of loss of water supply to properties are considered to be high-extreme, depending on the number of properties impacted, and ability for water supply to be sourced externally from the network (e.g. on-site rainwater tanks).

Stormwater Infrastructure

In both SLR scenarios, stormwater infrastructure is at low risk up to 2070, and increases to high risk in 2130 as a result of the increase in exposure to stormwater pipes and stormwater outfalls. In 2130, 3.3 km (SSP2-4.5) to 3.5 km (SSP5-8.5) of stormwater pipe is potentially exposed to coastal erosion, as well as all stormwater outfalls. Stormwater network pipes up to 2070 generally run perpendicular to the coastline and therefore could be easier to adapt (e.g. shortening the ends of pipes), hence have a moderate-high sensitivity resulting in the low overall risk rating. However, the sensitivity becomes extreme by 2130 as a result of potential exposure of stormwater pipes that run parallel to the shoreline, resulting in a wider impact on the stormwater system in the RAA, and therefore an increase to high overall risk.

Roads and bridges

Under both SLR scenarios, roads and bridges are considered to be low risk up to 2070, and increase to high risk in 2130 due to the increase in key roads which could be potentially exposed to erosion. By 2130, 4.6 km (SSP2-4.5) to 5.5 km (SSP5-8.5) of road could be potentially exposed to coastal erosion. Sensitivity in timeframes from present day through to 2070 are considered high, as the impacted roads provide access to properties which would be directly impacted by erosion in a similar timeframe. This sensitivity increases to extreme when Rosetta Road is potentially impacted by 2130 which would have a network-wide impact on transport throughout the RAA, pushing the over-all risk rating to high. While the erosion of The Esplanade will cause extreme disruption to residents that live along this road, it only services the houses that will also be directly impacted by erosion over similar timeframes, and therefore is considered to be highly sensitive, rather than extremely sensitive, as it will not cause widespread disruption to the wider network.

Natural gas supply mains

Risk to natural gas supply mains is moderate from present day through to 2070, and increases to high in 2130 across both SLR scenarios. When exposed to coastal erosion, gas supply pipes are considered to have extreme sensitivity, as consequences of failure could include igniting and serious harm to life and property. The increase to high risk is driven by the increase from low to moderate exposure between 2070 and 2130, where in 2130 4.2 km (SSP2-4.5) to 4.4 km (SSP5-8.5) of gas supply mains pipe network is considered to be of moderate exposure due to the consideration of how many properties would be directly impacted, as well as disruption to the wider gas network.

Electrical Transmission and supply infrastructure

Electrical transmission and supply infrastructure is considered to be at low risk from coastal erosion up to 2070, and increases to moderate risk by 2130 under both SLR scenarios. Identified infrastructure sensitive to coastal erosion is not exposed over the next 30 years. By 2070, no underground transmission lines are exposed to erosion, however one distribution transformer becomes potentially exposed under the higher SSP5-8.5 scenario. By 2130, the risk to coastal erosion becomes moderate, where six distribution transformers are potentially exposed to erosion, as well as up to 1.6 km (9%) of underground transmission lines becoming potentially exposed. Although the exposure in 2130 is still considered to be low in the context of the wider RAA, sensitivity becomes extreme as exposure and damage potentially results in larger sections of the community being cut off from power, and there being disruptions to the wider power network, as well as health and safety risks from lines being potentially exposed to coastal processes.

3.3.2 Risks from coastal inundation

Risks from coastal inundation assume that the current shoreline and river morphology remains in its current position into the future. It is recognised that this may not be the case if the projected erosion (with no adaptation implemented) is allowed to occur, as this will remove the existing high dune and infrastructure along the coastline.

All elements have been assessed as being low risk to coastal inundation over the next 100 years within the RAA. Projected inundation by the bathtub modelling is generally localised to the areas around the Wharemauku Stream and the adjacent relic dune swales where low lying areas could be flooded through backflows in the existing stormwater network.

Private Property

At present, there are 54 private properties (1%) within the RAA that are potentially exposed to coastal inundation in a 1% AEP coastal storm event. Most of these properties are located to the north of Wharemauku stream, where private property is either low lying near the coast, or the property boundary extends onto the beach where sea water would be expected to be during large coastal events. The sensitivity to flooding is considered to be low, due to the shallow flood depths on properties, and the limited numbers of dwellings that would be impacted within exposed properties.

The number of properties potentially exposed to flooding increased to 75 (2%) by 2050, and to 96 properties (SSP2-4.5) to 114 properties (3%) (SSP5-8.5) by 2070. The risk is still considered to be low due to overall flood depths on effected properties being shallow and not intersecting with dwellings. By 2130, 223 properties (6%) (SSP2-4.5) to 458 properties (13%) (SSP5-8.5) are modelled as being potentially exposed to coastal inundation, and sensitivity increases to being moderate to high as a result of the increased depth of flooding at effected properties. However, the overall risk remains low due to the relative number of properties impacted within the RAA still being considered as low exposure (i.e < 25%). Due to the flooding largely being confined to the area around the Wharemauku Stream, most properties impacted by coastal flooding across all timeframes are located in the Raumati Beach area. Under the higher SLR scenario (SSP5-8.5) in 2130, 85% of potentially exposed properties in the RAA are located in Raumati Beach, compared to 15% located in Raumati South.

Roads and Bridges

Flooding of coastal roads and bridges can prevent them from being used to safely access properties in the community and can result in people becoming temporarily isolated during a flood event. Flooding of main roads which provide inland routes from the communities can prevent evacuation of people and property during a flood.

Roads and bridges are considered to be low risk across all timeframes and SLR scenarios. Under the highest SLR scenario assessed (1.25 m RSLR by 2130 (SSP5-8.5)), up to 0.7 km of road is projected to be impacted by flooding in a 1% AEP storm event, with general water depths being between 0.3 – 0.5 m. At this time there would be some disruption to the road network with flooding concentrated around Matatua Road, and restricting access to properties along Grove Road.

Stormwater Infrastructure

Stormwater outfalls and pipe mains are generally resilient to flooding although they do provide pathways for coastal flooding to inland areas. The electrical power supply and control systems for stormwater pumpstations can be damaged by surface flooding if this is sufficiently deep, causing the pump station to fail to operate during a storm event and so increasing flood hazard and requiring repair or replacement. No stormwater pumpstations are projected to be flooded in any SLR scenario across all timeframes, and therefore the risk to stormwater infrastructure is considered to be low out to 2130.

Wastewater Infrastructure

Wastewater pipes and mains are generally resilient to flooding, although they are susceptible to ingress of floodwater and consequent polluted flood water. The electrical power supply and control systems for stormwater pump stations can be damaged by surface flooding if this is sufficiently deep, causing the pump station to fail to operate during a storm event increasing foul flood hazard and requiring repair or replacement.

There are 22 waste water pump stations located within the RAA, and only one of these pump stations (located on Rosetta Road) becomes potentially exposed to shallow coastal flooding in a 1% AEP event by 2130 under both SLR scenarios. Due to the low number of pump stations impacted by flooding, the risk to wastewater infrastructure across all SLR scenarios and timeframes is considered to be low.

Water Supply Infrastructure

Water supply pipes are generally resilient to flooding, provided pressure is maintained in the network. Bore supplies may be contaminated by flood water. Flooding of pumpstations can result in network wide disruption, however there are no pumpstations for water supply located in the RAA.

There is low exposure to water supply infrastructure in the RAA as only a small relative number of water supply bores are potentially exposed to coastal flooding – none at present, up to two by 2070, and five to 13 bores by 2130 under the range of SLR scenarios assessed. Overall, due to the high number of water supply bores in the RAA, and the relative low number of potential properties impacted, the risk across all timeframes and both SLR scenarios is considered to be low.

Natural gas supply mains

Buried gas pipelines are relatively resilient to flooding. Under the higher SLR scenario in 2130, less than 1% (590 m) of gas supply mains network is potentially exposed to coastal flooding in a 1% AEP event. The risk to this type of infrastructure in the future is considered to be low due to its high resilience and low exposure across all SLR scenarios and timeframes.

Electrical transmission and supply infrastructure

Ground mounted distribution transformers are vulnerable to flooding which can cause short circuits, loss of supply to properties and damage to the transformer if depth exceeds the height of critical equipment. There are 81 distribution transformers in the RAA, with approximately 30% of these being ground mounted. No ground mounted distribution transformers are exposed to coastal flooding up to 2070, and only one distribution transformer becomes potentially exposed by 2130 under the higher SSP5-8.5 scenario. Overall, the risk to electrical transmission and supply infrastructure remains low risk to coastal flooding across all SLR scenarios and timeframes assessed.

4. Human Domain

The 'Human' Domain refers to physical and mental health of those who live, work, or recreate in the RAA. It is closely related to the Built Environment discussed in Section 3 above.

The following outlines the information used to assess the risks to the Human Domain in the RAA, and a summary of the findings related to the risks to the Human Domain. Details for each element, including assumptions and limitations used to identify the risks, are provided in Appendix A.

4.1 Human Elements

The risk assessment primarily relies on spatial information to establish how exposed an element is to coastal hazards, and how this exposure changes over time.

Table 4.1 provides a summary of the elements assessed within the Human Domain, and what spatial information was used to inform the assessment of risk. Elements were assessed using publicly available data from Statistics New Zealand (i.e. Stats NZ Infoshare), as well as spatial information from KCDC and GWRC including three waters infrastructure and social infrastructure online sources.

More detailed information about the method employed to establish exposure, sensitivity, and adaptive capacity ratings for each element is included in Appendix A.

Table 4.1: Summary of elements assessed in the human domain and representative data used to inform the assessment.

Element	Description	Representative Data
Physical Health	Risks to physical health from exposure to coastal flooding/inundation and the potential for water-borne disease, and issues with water quality, availability, and accessibility due to changes or disruption to essential services.	Private property boundary outlines provided by KCDC. This data is from December 2022. Data for public wastewater infrastructure was supplied by KCDC. This included wastewater pump stations and network pipes. Data for public water supply services including pipe network were supplied by KCDC. This included the location of supply bores (which has been filtered for public water supply), the water supply network pipes, water treatment plants and pump stations. Data for public stormwater services was supplied by KCDC. This included stormwater network pipes, stormwater outfalls, and pump stations. Stats NZ Infoshare 2018 data was used to determine percentage of population over the age of 65 and below the age of 5.
Mental Health and Wellbeing	Risks to mental health, identity, autonomy and sense of belonging, connections to place and nature, and personal wellbeing from loss and trauma due to ongoing coastal erosion and periodic flooding. This risk relates to the mental health and wellbeing of individuals who may experience ongoing stress, anxiety,	Private property boundary outlines provided by KCDC. This data is from December 2022. 'Beachfront' properties were extracted from the property data supplied by KCDC, and

Element	Description	Representative Data
	depression, grief, feelings of powerlessness, and an altered sense of belonging to a place as coastal erosion and inundation becomes progressively worse. These feelings and experiences may emerge as people navigate loss of, or damage to property, irreversible changes or loss of valued natural places, feeling alone or powerless to affect change, on-going stress of managing damage to property or living in damaged building, and worry about the future. It includes the stress associated with disruption to everyday routines and activities, which can impact the ability to function, undertake actions that are enjoyed, and plan for the future.	only includes the most landward line of properties. Cycle and shared walkways, and location of parks and reserves supplied by KCDC. Raumati Adaptation Area Values Summary (Kāpiti Coast District Council, 2024) Qualitative literature on wellbeing and connection to the environment is referenced within the Mental Health and Wellbeing risk assessment template – Appendix A.2.2.
Social Infrastructure and Amenity	**Risk to social infrastructure and amenity**. This element includes the objects that keep society functioning and enable daily patterns of life (e.g. shopping or travelling to work, education, engaging in community or cultural activities), and the facilities that act as social support structures (e.g. churches, supermarkets, meeting places, community facilities or halls, health care services, care homes, early childhood centres). Additionally, it includes the locations and facilitates that afford visitors and local residents the opportunity to enjoy and participate in organised sport, exercise, and spend time outdoors (e.g. parks, swimming pools, boat clubs, walkways, reserves, and natural areas). It also includes the aesthetics and amenity of places where people live, the spaces they utilise, and whether changes can be tolerated by those who live there	GIS Spatial layers provided by KCDC: ▪ Beach access Points ▪ Parks and reserves ▪ Department of Conservation properties/land ▪ Medical centres ▪ Education providers ▪ Public transport routes. Other social infrastructure facilities (e.g. Roads, Restaurants, Community Halls) were identified manually using Google maps and locations were assessed against the mapped coastal hazard projections.
Exacerbating Inequalities	**Risks of exacerbating existing inequities and creating new and additional inequities due to differential distribution of coastal erosion and coastal flooding impacts.** This element focusses on the existing inequities in society that mean some people, groups, and households are less able to access to services and resources (e.g. clean water, work, finance, insurance, safe and dry homes) that maintain and support wellbeing. It also includes the creation of new inequities though the actions taken to respond (or not) to the impacts and implications of a changing climate.	Private property boundary outlines provided by KCDC. This data is from December 2022. Stats NZ Infoshare 2018 data was used to determine median income. Spatial locations of public transport routes provided by KCDC. Roads and businesses were identified manually using Google maps and locations were assessed against the mapped coastal hazard projections.
Social Cohesion and Community Wellbeing	**Risks to social cohesion and community wellbeing from displacement of individuals, families, and communities due to climate change impacts.** This element is focused on the community level and includes aspects of community cohesion and wellbeing associated with living in a particular place. Cohesion is described as the bonds that link communities and people together, and these may be physical place based, cultural, or social connections. Wellbeing is considered a measure of happiness or satisfaction and the ability to	Private property boundary outlines provided by KCDC. This data is from December 2022. Stats NZ Infoshare 2018 data was used to determine time of residence in area.

Element	Description	Representative Data
	achieve personal and collective aspirations and enjoy a "good life" as defined by an individual, family, or group. The National Climate Change Risk Assessment describes two aspects to the risk to social cohesion. First, the risk associated with displacement and second, the risk to those left behind (NCCRA 2020). Displacement can cause trauma linked to disruption and dislocation from familiar surroundings and breaking of social and cultural bonds, and the challenges of resettlement. Movement between communities within the Kāpiti and Wellington Region may change the composition of communities, affect housing availability and affordability, change demand for social services, recreational facilities and schools, alter commuting patterns and introduce competition for other resources. Conflict may arise between existing residents and relocated households as disagreements about social norms and practices emerge. With less ties to support networks and opportunities, poorer health and wellbeing outcomes are likely. Affected communities will see a decrease in the local population as the residents relocate or are relocated. Properties may be increasingly occupied by those (from outside and within the community) who can't afford to live anywhere else. Newcomers may not have the same sense of attachment to the community. As households leave, the community will reduce in size and essential services may be slowly withdrawn, for example, education facilities, job opportunities, or community services. Investment in the affected communities will probably be reduced. Similar to displaced households, those who remain may experience trauma due to the breaking of family, social, and cultural bonds, and poorer health and wellbeing outcomes are likely. The breakdown of communities and the social bonds and connections to special places is important because fractured, less cohesive communities can result in conflict and feelings of isolation and loss.	
Conflict, Disruption, and Loss of Trust in Government	**Risks of conflict, disruption, and loss of trust in government from changing patterns in the value of assets and competition for access to scarce resources, primarily due to periodic inundation events and ongoing erosion.**	Private property boundary outlines provided by KCDC. This data is from December 2022. GIS Spatial layers provided by KCDC: ▪ Beach access points ▪ Parks and reserves ▪ Medical centres and pharmacies ▪ Education providers ▪ Department of Conservation (DOC) properties. Raumati Adaptation Area Values Summary (Kāpiti Coast District Council, 2024). Qualitative literature on conflict related to differing opinions on adaptation strategies and options is referenced

Element	Description	Representative Data
		within the Conflict, Disruption, and Loss of Trust in Government risk assessment template in Appendix A.2.6.

4.2 Human Risk Matrix

A summary of the final risk ratings for each element is presented in Table 4.2. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 4.2: Human domain risk matrix.

	Coastal Erosion						Coastal Inundation					
Climate Change Scenario	**Both**		**SSP2-4.5**		**SSP5-8.5**		**Both**		**SSP2-4.5**		**SSP5-8.5**	
Element	Present	2050	2070	2130	2070	2130	Present	2050	2070	2130	2070	2130
Human												
Physical Health	L	L	L	L	L	M	L	L	L	L	L	L
Mental Health and Wellbeing	L	L	M	E	M	E	L	L	M	H	M	H
Social Infrastructure and Amenity	L	L	L	M	M	H	L	L	L	M	H	E
Exacerbating Inequalities	L	L	L	M	L	M	L	L	L	L	L	L
Social Cohesion and Community Wellbeing	L	L	L	M	L	M	L	L	L	L	L	M
Conflict, Disruption, and Loss of Trust in Government	M	M	H	E	E	E	L	L	M	M	M	M

4.3 Human Risk Summary

4.3.1 Risks from coastal erosion

Physical Health

The physical risk to life and health from an erosion event, for example, sudden collapse of infrastructure, community assets, and homes leading to dangerous physical environments, and/or damage to stormwater and wastewater services and subsequent exposure to pathogens and contaminants, is considered to be low risk to 2130 under the lower SSP2-4.5 scenario. However, under the SSP5-8.5 scenario, the risk increases from low to moderate risk by 2130. This increase to moderate risk is due to the high exposure of properties and three waters infrastructure by 2130 under this SLR scenario.

By 2130 under the higher SLR scenario, 23% of properties within the RAA could be impacted by erosion. Older and younger residents are likely to be more sensitive to harm because of their physiology (i.e. immunity and health, ability to mobilise out of the way of danger). In the RAA, 19% of residents are aged over 65, which is 4% higher than the national average (EHINZ 2018), and 5% are below the age of 5, which is 2.5% below the national average (Stats NZ infoshare 2018 data).

Physical health is considered to have a high adaptive capacity, as generally humans will have warning of incidents of erosion and are able to avoid being in the area during times when hazards and damage may be more likely. Once removed from the area of hazard they are no longer exposed or at risk.

Mental Health and Well Being

The risk to mental health, identity, autonomy and sense of belonging, connections to place and nature, and personal wellbeing from loss and trauma due to ongoing coastal erosion is considered to be low at present to 2050, increasing to moderate risk by 2070, and extreme by 2130 under both SLR scenarios. This increase of risk is driven by the increase in the number of properties (and therefore residents) within the RAA that could be impacted by erosion in the future, as well as impacts on the wider community as a result of lost access to the beach, impacting those who derive identity and wellbeing from the beach.

Stress, anxiety, and trauma associated with the permanent loss of property or ongoing damage to property will directly impact effected property owners, which may generate further financial loss (e.g. insurance withdrawal or repair costs) and/or stress and uncertainty regarding the future. Further impacts may be experienced on an individual's autonomy as constraints on individuals' options and choices arise, for example, the ability to live certain places (e.g. erosion areas) or undertake particular activities (e.g. needing to stay away from erosion-prone areas of the coast).

From a community-wide perspective, loss of or damage to key places and natural systems that provide a sense of identity or belonging, for example, the loss of a favorite beach or landscape, can generate a sense of distress because a place that is loved by the community changes and there is relative powerlessness to do anything about it. Research demonstrates that many people derive a sense of wellbeing and mental health from recreating on and near the beach, and many feel their identity and sense of belonging is strongly connected to their community, especially in coastal locations. The situation is likely to be similar for residents of Raumati given that the Raumati Adaptation Area community values summary (Kāpiti Coast District Council, 2023) demonstrates that people within the community have a strong emotional affiliation to the area, particularly the beach and coastline.

Mental health and wellbeing is considered to have a low adaptive capacity to coastal erosion. Due to the high exposure to erosion, it is difficult for individuals to adapt in the long term. When identity and wellbeing is tied up with place, and these places are lost or damaged, coping and adapting is not a straightforward or linear task, and can take a long time and require considerable cognitive and social change to achieve. Special places are not easily replaced, as the connections are highly personal, and have been built up over time. Their loss may cause grief and anxiety. As well as this, financial barriers to adaptation or relocation may cause significant stress or place an individual in the position of needing to remain in a continually affected location.

Social Infrastructure and Amenity

The risk to social infrastructure and amenity considers both the infrastructure that keeps society functioning and enables daily patterns of life (e.g. shopping or travelling to work, education, engaging in community or cultural activities), and the facilities that act as social support structures (e.g. churches, supermarkets, meeting places, community facilities or halls, health care services, care homes, early childhood centres). The risk to social infrastructure and amenity is considered to be low until 2070. By 2130, the risk increases to moderate under the SSP2-4.5 SLR scenario, and high under the SSP5-8.5 SLR scenario.

The increase to moderate and high risk by 2130 under the two SLR scenarios is driven by the increase in exposure of beach access points, parks and reserves, and Department of Conservation land, where by 2130 the beach is exposed to coastal erosion, as are 13 parks and reserves, 10 beach access points, and 6 Department of Conservation properties. However, it is noted that no other social infrastructure (e.g. churches, supermarkets, community halls, health care services, care homes, early childhood centres) are exposed.

The ability for social infrastructure and amenity to adapt is considered to be low, as there are limited options to adapt when impacts on beaches and parks are constrained by adjoining private properties.

Exacerbating Inequalities

The risk to exacerbating inequalities from coastal erosion considers the consequences of exacerbating existing inequities and creating new and additional inequities due to differential distribution of coastal erosion impacts. This element focusses on the existing inequities in society that mean some people, groups, and households are less able to access services and resources (e.g. clean water, work, finance, insurance, safe and dry homes) that maintain and support wellbeing. It also considers the creation of new inequities through the actions taken to respond (or not) to the impacts and implications of a changing climate.

The risk to exacerbating inequalities is considered to be low to 2070, and increases to moderate by 2130 under both SLR scenarios.

The increase to moderate risk by 2130 is due to the increase in number of properties (and therefore residents) potentially impacted by erosion, as well as an increase in sensitivity to 'high' as the hazard exposure increases over time. As properties are impacted, people are likely to lose their ability to insure against loss. They may either sell their property or remain in place as long as possible (and experience a slow worsening of living conditions).

Based on 2018 census data (StatsNZ), the median income in the RAA is $34,237, which is slightly higher than the national median personal income ($31,800) for 2018. However, of the total population in the adaptation area, 26% earn under $20,000 per annum. These people may face financial inequities that increase their sensitivity to coastal erosion.

Additionally, the population of the adaptation area is somewhat diverse, containing groups (such as Māori, Pacific peoples, disabled, and older peoples) that have traditionally been shown to face barriers when applying for rental properties and often occupy the lower end of the rental and property market (due to higher propensity for being rejected as tenants, and the intersection of multiple forms of inequity that increase the likelihood that these groups are also low-income). These groups may end up occupying properties that have devalued in erosion and inundation areas.

Social Cohesion and Community Wellbeing

Risks to social cohesion and community wellbeing from displacement of individuals, families, and communities due to climate change impacts, is considered to be low to 2070, increasing to moderate risk by 2130 under both SLR scenarios.

The increase to moderate risk by 2130 is largely driven by the increase in exposure of private property to coastal erosion (16-23% of all properties in the RAA). As these properties are impacted, people are likely to move either within the same community or further afield, whereby an impact on social cohesion is possible if the composition of the community changes.

An increased incidence of coastal erosion will affect homes, property, businesses, and facilities over time, and decrease the desire and ability of people to remain in affected areas. As residents reach the limits of their tolerance, or properties become unlivable, they may relocate to other safe areas within the same community

or elsewhere. Those leaving may experience loss of social and cultural bonds they held within their previous community, and an associated sense of 'dislocation.' They may also face challenges with integrating into new communities where there are different socio-cultural norms, precedents, and social networks.

Those who stay because they are unable to leave may experience grief, sadness, anxiety and other emotional impacts from loss of social networks, which may be intensified if conflicts arise with newcomers (who may have different values or priorities in terms of how they live and how they wish to respond to hazards). Those who move to the community (to occupy lower value homes) may experience a sense of social isolation as the community 'hollows out' and there are limited opportunities for social connection, and access to normal services and opportunities.

Conflict, Disruption, and Loss of Trust in Government

Risks of conflict, disruption, and loss of trust in government from changing patterns in the value of assets and competition for access to scarce resources, primarily due to ongoing erosion is considered to be moderate at present to 2050, increasing to high by 2070 and extreme by 2130 under SSP2-4.5 SLR scenario; and becoming extreme risk by 2070 under SSP5-8.5 scenario.

Coastal erosion can cause disruption and conflict as residents and businesses compete for government assistance and safe land. Conflict can arise over who pays for adaptation actions, which can lead to community fragmentation and disagreement, with flow on impacts to social cohesion and potential to exacerbate existing inequalities in the community. Inaction (or action) by the government can lead to loss of trust in government institutions, cynicism within the community, and community opposition.

The high-extreme risk by 2070 is largely driven by the extreme exposure over this timeframe, where there is increasing erosion of both private property and public spaces along the coastal strips including parks, reserves, and beach access points over time (see risk to social infrastructure and amenity). As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to sea level rise come to the fore, and people differ in their thoughts on when different sets of adaptation should occur. It is highly likely that residents of beachfront properties will favour hard protection structures that protect their properties, yet this action may not be universally accepted by others in the community, leading to intra-community conflict.

The Raumati Adaptation Area Values Engagement Summary Report (Kāpiti Coast District Council, 2023) demonstrates evidence that some segments of the community already have doubts about planned adaptation actions (or lack thereof), which could lead to future conflicts between residents themselves, and conflict and lack of trust between the community and local government. The report also demonstrates that residents of Raumati have strong feelings of attachment to their community, and particularly the beach. There is likely to be a heightened risk of conflict about structures that change the appearance and access to the beach and other places of importance, particularly between property owners who directly benefit from these actions, and those who feel they "lose out" due to reduced amenity value and connection to important places and spaces.

4.3.2 Risks from coastal inundation

Risks to the human domain from coastal flooding are generally lower than those assessed for coastal erosion due to the relative lower exposure of flooding throughout the RAA area. High and Extreme risks from coastal flooding are only observed for Mental Health and Wellbeing, and Social Infrastructure and Amenity elements over the 2070-2130 period. Other elements assessed are only considered to be at low-moderate risk to 2130 under both SLR scenarios.

Physical Health

Risks to physical health from exposure to coastal flooding and the potential for water-borne disease, and issues with water quality, availability, and accessibility due to changes or disruption to essential services, is considered to be low risk to 2130 under both SLR scenarios.

The exposure of three waters infrastructure and private properties to coastal flooding increases over time to 6-13% of properties within the RAA being potentially exposed. The sensitivity to physical health is considered to be moderate, as the impact of exposure to pathogens and contaminants in water or dangerous buildings

which may result in sickness, injury or death. As for coastal erosion, older and younger residents are likely to be more sensitive to harm, where the impact of exposure to pathogens and contaminants in water or danergous buildings may result in sickness, injury or death.

Overall, it is considered that physical health has a high adaptive capacity, as people have warning of incidents of inundation and are able to avoid being in the area during times when hazards and risks to health may be more likely. Once removed from the area of hazard they are no longer exposed or at risk. Residents may be exposed to hazards on return to their homes or other places (for example, Wharemauku Stream walkway), however through careful actions (e.g. checking weather forecast, listening to local emergency/civil defense warnings) the hazard could be avoided.

Mental Health and Well Being

Risks to mental health, identity, autonomy and sense of belonging, connections to place and nature, and personal wellbeing from loss and trauma due to periodic flooding is considered to be low at present and through to 2050, increasing to moderate in 2070, and high in 2130 under both SLR scenarios.

The increase to high risk by 2130 in a 1% AEP event occurs as flooding begins to encroach on the first row of beach-front properties, but remains largely confined to the gardens of private properties adjacent to the beach. Public access to the beach front areas is likley to be lost during events. The Wharemauku Stream provides a conduit inland, temporarily inundating surrounding properties and the creek walkway, as well as Matauta, Garden and Groves Road and the edge of Weka Park.

There may be stress, anxiety, and trauma associated with the loss of property (homes and businesses) due to coastal flooding, which may generate financial loss (e.g. insurance withdrawal or repair costs, loss of stock or business revenue) and/or stress and uncertainty regarding the future. Further impacts may be experienced on an individual's autonomy as constraints on individuals' options and choices arise, for example ability to live certain places (high hazard areas), or undertake particular activities (e.g. walking along flood-prone areas).

There may be temporary stress for the community associated with being trapped at home or within a small geographic area while coastal flooding recedes, potentially unable to get to work, school, or access other services.

Social Infrastructure and Amenity

Risks to social infrastructure and amenity, being the infrastructure that keeps society functioning and enables daily patterns of life (i.e. beach access, parks, medical centres, education providers, public transport routes) and the facilities that act as social support structures, are considered to be low risk at present and to 2050 for both scenarios. Under the lower SSP2-4.5 scenario the risk remains low in 2070 and increases to moderate by 2130; under the higher SSP5-8.5 scenario the risk increases to high by 2070, and extreme by 2130.

The permanent or semi-permanent inundation of social infrastructure along the beach means that people are not able to access services that they need to go about their daily lives, do the things that they enjoy, or engage in social activities with others. The loss of amenity and recreational space reduces the ability to enjoy outdoor activities and connect with nature (with flow on impacts to wellbeing).

The increase to high then extreme risk by 2130, under the SSP5-8.5 scenario, is largely driven by the increase to extreme exposure by 2130, where 4 beach access points, 8 parks and reserves, 2 pieces of land owned and managed by the Department of Conservation, two shared paths (along the Wharemauku Stream, close to Alexander St and Matatua Rd), one playground, approximately nine businesses around Raumati Beach (including the Four Square supermarket, bars, cafes, restaurants, and a bakery) and two carparks servicing businesses and the beach are potentially exposed during a flood event.

Exacerbating Inequalities

The risks of exacerbating existing inequities and creating new and additional inequities due to differential distribution of coastal flooding impacts is considered to be low at present, and remains low through to 2130 under both SLR scenarios. This low risk is largely driven by the relatively low exposure of private properties to coastal flooding by 2130 (6-13%) within the RAA, however it is noted that isolated areas (e.g. around

Wharemauku Stream) will have higher numbers of homes inundated, with pockets of adverse effects for residents, which could in turn result in exacerbation of inequalities in these areas.

Social Cohesion and Community Wellbeing

Risks to social cohesion and community wellbeing from displacement of individuals, families, and communities due to climate change impacts is considered to be low risk to 2130 under the lower SSP2-4.5 scenario; and low risk until 2070 under the higher SSP5-8.5 scenario, increasing to moderate risk in 2130.

Community cohesion could be suddenly affected after an event as the desirability of the community is reduced by both the hazard and the diminishing provision of or access to support, education, job and education opportunities and social services. Based on the 2018 census, 48% of residents had lived in the RAA for less than 5 years, which means that there is a reasonable population turnover, and hence sensitivity is considered to be low-moderate from coastal flooding. It is, however, also worth noting that 16% of the population in the adaptation area have resided there for over 15 years and are likely to be embedded in the local community. The latter group are likely to be more sensitive to long term changes associated and challenges associated with social cohesion.

However, in relation to the flood hazard, only 6-13% of properties within the RAA could be impacted by coastal flooding by 2130, and therefore the exposure to coastal flooding within the RAA is considered to be low, and hence with also low-moderate sensitivity, the risk is low.

Conflict, Disruption, and Loss of Trust in Government

Risks of conflict, disruption, and loss of trust in government from changing patterns in the value of assets and competition for access to scarce resources, primarily due to coastal inundation is considered low at present and to 2050, increasing to moderate risk in 2070 to 2130 under both sea level rise scenarios.

As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to increases to inundation come to the fore, and people differ in their thoughts on when different sets of adaptation should occur. Depending on how the impacts of the hazards unfold and the decision made regarding what actions (if any) are taken, a large number of residents within the adaptation area may be at risk of conflict, and in particular the conflict arising from the perceived "winners" and "losers" of various courses of action. Certain portions of the community (primarily low income households) may not be able to compete for safe land and will face little choice but to live in hazardous locations, or leave the area.

5. Ecological Domain

The 'Ecological' domain refers to the plants, animals and their habitats from the coast inland. This assessment looks at the risks of losing plant or animal species, or areas considered to be of ecological importance. It does not include the marine environment. The risk to the elements assessed under the Ecological domain will likely result in cascading impacts on the other domains in the RAA.

The following outlines the information used to assess the risks to the Ecological domain in the RAA, and a summary of the findings related to the risks to the Ecological domain. Details for each element, including assumptions and limitations used to identify the risks, are provided in Appendix A.

5.1 Ecological Elements

The risk assessment relies on spatial information and expert knowledge to establish how exposed an element is to coastal hazards and how this exposure changes over time. Table 5.1 provides a summary of the elements assessed within the ecological domain, and what spatial information was used to inform the assessment of risk.

Elements were assessed using publicly available data from online sources such as the Department of Conservation (DOC), Queen Elizabeth II National Trust (QEII), iNaturalist or supplied by KCDC or Greater Wellington Regional Council (GWRC) through the various schedules included in the District Plan or Natural Resources Plan respectively.

Information available relevant to assessing the risks within the ecological domain varies between elements. Most ecologically significant sites in the Raumati Adaptation Area are fully or partially on private land. Location data for small species is often sparse as they tend to be overlooked. This includes small plant species, lizards, and invertebrates. Information is also lacking for some large species such as the New Zealand fur seal. The location of Threatened and At Risk species are obscured in databases to stop people collecting rare species from the wild.

The Operative Kāpiti Coast District Plan 2021 includes maps of Ecological sites, and Key Indigenous Trees across the district (Figure 7) and four schedules identifying important ecological values:

- Schedule 1 – Ecological Sites - areas of significant indigenous vegetation, and significant habitats of indigenous fauna
- Schedule 2 - Key Indigenous Trees
- Schedule 3 – Rare and Threatened Vegetation Species
- Schedule 8 – Notable Trees

The GWRC Natural Resources Plan maps and describes ecosystems and habitats with significant indigenous biodiversity values, including in the coastal area. These areas and waterways were identified through surveys, but also modelling and meet at least one of the criteria set down in Policy 23 of the Regional Policy Statement for the Wellington Region 2013 for representativeness, rarity, diversity and ecological context. Within the Kāpiti Coast coastal area there are Outstanding Wetlands, Significant Wetlands, Waterways with significant indigenous biodiversity values, Inanga Spawning Habitat, Significant Indigenous Bird Habitat, and Indigenous Biodiversity Coastal.

Also included are the GWRC spatial layer for Regional Parks (Queen Elizabeth Park is within the coastal hazard area), Community Environmental Restoration sites and Managed Open Space which compiles areas where management is being undertaken by various agencies including GWRC, QEII National Trust, district councils, and some iwi and other organisations. Management may be undertaken for purposes other than ecological values (e.g. river management) but generally this map layer highlights areas with ecological importance.

There are QEII National Trust covenants within the Kāpiti coastal area. These areas of private land are legally protected in perpetuity to safeguard ecological, geological or cultural values. Additionally, there are areas of DOC managed land and Reserves Act 1977 Conservation Covenants.

More detailed information about the method employed to establish exposure, sensitivity, and adaptive capacity ratings for each element is included in Appendix A.

Table 5.1: Summary of elements assessed in the ecological domain and representative data used to inform the assessment.

Element	Description	Representative Data
Coastal dunelands	**Risks to any coastal dunelands in the total RAA**. This is a layer provided by GWRC, and the premise for selection is not known by this author. Presumably, these are areas where coastal dunes still retain some of their natural topography plant species. There is a small area of natural duneland at Raumati Beach by Matatua Road, and the Paraparaumu Beach Duneland is within the northern most part of this adaptation area.	Natural Duneland map layer provided by GWRC.
Wetlands	**Risks to known or potential wetlands as defined by the National Policy Statement for Freshwater management (NPS-FM).** There are three areas of mapped wetland within the RAA. For coastal erosion and inundation, exposure is based on the number of wetlands exposed to the hazard relative to the total number of wetlands in the Adaptation Area. Maps for these areas are provided in Appendix A.3.2	GWRC NRP includes schedules for Outstanding Wetlands, and Significant Wetlands. These wetlands correspond with wetland areas within the KCDC Ecological Sites schedule. Additional mapping information referred to includes the Landcare Research current wetland extent (2013) which also includes deeper water, and GWRC scientific wetland extent (NPS-FM) (2016)
Mapped ecological sites	**Risk to ecological sites within the RAA** that could result in the complete or partial loss, or changes (adverse or positive) to the ecological and biodiversity values of these sites. The sites include KCDC Ecological Sites, QEII covenants, DOC managed reserves, Conservation covenants, Regional Parks, Managed Open Space, and Community Environmental Projects. There are three mapped ecological sites in the RAA.	KCDC District Plan Schedule 1- Ecological Sites Queen Elizabeth II covenants map (29/09/2023) DOC managed reserves and Conservation covenants GWRC Regional Parks, Managed Open Space, and Community Environmental Projects
Indigenous trees	**Risks to indigenous trees identified as being significant within the RAA.** This information is obtained from the Operative Kāpiti Coast District Plan and assesses whether these trees would be lost or adversely affected by proposed management activities. There are 32 Key Indigenous Trees and 24 Notable Trees in the RAA.	Operative Kāpiti Coast District Plan Schedules - Key Indigenous Trees (Schedule 2), and Notable Trees (Schedule 8)
Rare and threatened species	**Risk to indigenous species including the loss of their habitat within the RAA.** Some species may be able to move to other areas, but other species could be restricted because there are no other areas available, or potential habitat is too far away. The focus is on Threatened and At Risk[18] species as defined by the New Zealand Threat Classification System. The effects on more common (Not Threatened) species will be similar, but less impactful because these species have larger	KCDC Rare and Threatened Vegetation Species (Schedule 3) Other data referred to include: • DOC herpetofauna database and bioweb

[18] Capitalised as these are the threat classification terms used in the database.

Element	Description	Representative Data
	populations and/or are more used to human activities and perturbations.	• iNaturalist • New Zealand Plant Conservation Network plant lists
Bird habitat	**Risk to significant bird habitat.** This includes habitat that provides feeding habitat or nesting or resting areas for Threatened or At Risk bird species, and also areas that provide important habitat for a range of species, or a significant proportion of a population of common species. The data from GWRC was a combination of site visits and desktop assessment.	GWRC NRP - Bird habitat (Schedule F2)
Fish habitat	**Risks to freshwater fish spawning and feeding habitat and loss of upstream and downstream connectivity.** Many indigenous freshwater fish species are diadromous meaning that they migrate between freshwater and saltwater. This includes species such as long-fin eel where the adults travel to Tonga to breed at the end of their lives. Short-fin eels are thought to breed in the Coral Sea between Fiji and Samoa. Many of the kōkopu species have larval stages that wash down to the ocean and then migrate back up to their preferred habitat once large enough – also known as whitebait.	GWRC NRP includes schedules for Migratory fish habitat (GWRC NRP Schedule F1), Threatened or At Risk fish habitat (GWRC NRP Schedule F1), High macroinvertebrate community health (GWRC NRP Schedule F1), and Inanga spawning habitat (GWRC NRP Schedule F1b) Other data referred to includes: • iNaturalist
Indigenous Biodiversity Coastal	**Risk to coastal indigenous biodiversity as mapped by GWRC.** Sites with significant indigenous biodiversity values in the Coastal Marine Areas (CMA) were identified with existing information and expert opinion and using the criteria in Policy 23 of the Regional Policy Statement for the Wellington Region.	GWRC NRP - Indigenous Biodiversity Coastal (Schedule F4)

5.2 Ecological Risk Matrix

A summary of the final risk ratings for each element is presented in Table 5.2. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 5.2: Ecological domain risk matrix

	Coastal Erosion						Coastal Inundation					
Climate Change Scenario	**Both**		**SSP2-4.5**		**SSP5-8.5**		**Both**		**SSP2-4.5**		**SSP5-8.5**	
Element	Present	2050	2070	2130	2070	2130	Present	2050	2070	2130	2070	2130
Ecological												
Coastal dunes	E	E	E	E	E	E	M	E	E	E	E	E
Wetlands	L	L	L	L	L	L	L	L	L	L	L	L
Ecological sites	M	M	M	M	M	M	M	M	M	M	M	M
Indigenous trees	L	L	L	L	L	H	L	L	L	L	L	M
Rare and threatened species	M	M	M	M	M	M	M	M	M	M	M	M
Bird habitat	M	M	M	M	M	M	M	M	M	M	M	M
Fish habitat	M	M	M	M	M	M	L	L	L	M	M	M
Indigenous biodiversity (coastal)	L	M	E	E	E	E	M	M	H	E	H	E

5.3 Ecological Risk Summary

5.3.1 Risks from coastal erosion

The RAA falls within the Foxton Ecological District which is the most extensive sand-dune system in the country. This is a long belt of Holocene sand-dune country extending from Paekākāriki to Patea. In the Kāpiti Coast District dunelands extend as far inland as the old SH1 route. Within the RAA there is a reduced sediment supply to the Raumati foreshore due to the shape of the coast, which means that the beach and dune systems are not naturally replenished regularly and has resulted in near continuous ad-hoc seawalls being built along to RAA coastline to protect property and assets from coastal erosion. As a result, there is little opportunity for coastal indigenous species habitat, other than at the northern end of the RAA (Paraparaumu Beach bird habitat), Raumati Beach dunes north of Matatua Road at the mouth of the Wharemauku Stream, the Wharemauku Stream, people's gardens, and the beach during lower tides.

Generally, within the RAA, coastal dunes and coastal habitat including the Wharemauku Stream are the first ecological element to be affected by coastal erosion. Most of the mapped ecological sites, mapped wetlands, and Key Indigenous Trees are located further inland and would therefore be not as significantly affected.

Coastal dunes

Within the RAA there are two areas of defined coastal dunelands as mapped by GWRC within the RAA:

- Raumati Beach dunes north of Matatua Road at the mouth of the Wharemauku Stream (*c*. 4,280 m^2) and
- The southern part of the Paraparaumu dunelands is located at the northern end of the RAA at Marine Parade (*c*. 2,970 m^2).

There also are two areas of DOC managed public land within the RAA. These are Conservation Act S25 Stewardship Areas:

- Raumati No2 is 0.0397 hectares of beach with some dunes behind the seawall.
- Raumati No3 is 0.0329 hectares of beach[19].

As a result of the low volumes of natural sand supply to the area, and the 'coastal squeeze' due to development of the land immediately behind the dunes, the adaptive capacity of the dunes to respond to SLR is considered to be very low.

Under present day sea levels in a rare storm event, the risk to these coastal dune areas is considered to be extreme, with the majority of the areas potentially being fully eroded in a significant storm event. With increased exposure to coastal erosion over time with sea level rise, there is a risk that all coastal foredunes would be completely eroded and not replaced. The Raumati Beach dunes are also part of the Wharemauku Stream estuary, and therefore increased stream flooding could speed up this process. Hence, the risk remains extreme through to 2130 under both SLR scenarios.

Wetlands

There are three areas of mapped wetlands within the RAA, however none of the defined wetlands are exposed to coastal erosion under any future SLR scenario or timeframe assessed, and therefore overall, the risk to wetlands from coastal erosion is considered low.

The National Policy Statement for Freshwater Management has broadened the definition of natural wetlands, and therefore there may be additional areas of unmapped wetland within the RAA, as historically the area comprised of alternating dunes with wetlands in the hollows. However, additional surveying to identify any new wetlands has not been undertaken for assessment.

Mapped Ecological Sites

[19] Raumati No1 is on the south bank of the Wharemaukū Stream near the airport and appears to have been largely built over.

There are three areas of mapped KCDC Ecological Sites and two areas of DOC managed public land[20] located within the RAA. None of the mapped KCDC Ecological Sites are exposed to coastal erosion over the future SLR scenarios and timeframes in this assessment.

The two areas of DOC managed land are affected by present day erosion, and this will increase significantly over time, potentially resulting in the complete loss of these areas. However, the ecological values within these areas are likely to be low.

Overall, the risk to mapped ecological sites is considered to be moderate from present day through to 2130 under both SLR scenarios. The exposure is considered to be moderate, with two of the five assessed sites being potentially exposed to coastal erosion at present and in the future; the sensitivity of the two impacted sites is low as a result of the likely low ecological values associated with the specific sites; however the adaptive capacity of the two sites is considered to be very low, as a result of sites not being able to change location.

Indigenous Trees

There are 32 key indigenous trees and about 24 notable trees within the RAA. Most of the notable trees are exotic trees, or indigenous trees such as pohutukawa, mountain celery pine, or kauri that are not native to the coastal areas of the Kāpiti Coast. There is one key indigenous tree, a Podocarpus totara at 241 Rosetta Road, that could be affected by erosion in all future SLR scenarios considered in this assessment. The number of trees potentially exposed increases to two trees 2070, and four trees by 2130 under both future SLR scenarios. Under the higher SSP5-8.5 scenarios, an additional eight trees could be due to changes in hydrology and soil stability.

Overall, the risk to Key Indigenous Trees in the RAA is considered to be low at present day and through to 2130 under the lower SSP2-4.5 scenario. Under the higher SSP5-8.5 scenario, the risk is considered to be low to 2070, and increase to high in 2130 as a result of the potential increase in exposure to 12 trees being impacted by coastal erosion.

Rare and threatened species

In terms of fauna species, at lower tides the beach provides space for feeding and resting habitat for a range of seabirds and shore birds including At Risk-Declining species. The Wharemauku Stream mouth provides core or seasonal habitat for such species. Some At Risk-Declining lizard species[21] have been reported from the RAA. Not threatened common skinks are known from foreshore habitat including dune habitat.

There are no Nationally and Regionally Rare and Threatened Species populations listed for RAA in Schedule 3 of the KCDC Operative District Plan. There are no records for Threatened or At Risk plant species, but it is possible that Sand Dune Kanuka (*Kunzea amathicola*; Threatened – Nationally Vulnerable) could still occur.

Erosion could result in the loss of habitat for rare and threatened species, including alterations to the Wharemauku Stream mouth, and dune habitat. This will have a more significant adverse effect for species with less mobility such as lizards and plants, rather than seabirds or other birds. Due to the highly modified nature of the landscape, if rare and threatened species do occur then they are probably in relatively low numbers and mostly on private property in people's gardens. Given that coastal erosion will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species.

To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would disappear at the same rate as has been used for loss of private property. Exposure of this habitat therefore increases over time to high by 2130 across both SLR scenarios due to a significant increase in the percentage of property eroded and the loss of dunes and the significant alterations of the Wharemauku Stream mouth. However, the adaptive capacity is considered to be moderate, as mobile species could relocate to inland habitat. As a result, overall the risk to rare and threatened species is considered to be moderate at present, and through to 2130 under both SLR scenarios.

[20] These are Conservation Act S25 Stewardship Areas. Raumati No2 is 0.0397 hectares of beach with some dunes behind the seawall. Raumati No3 is 0.0329 hectares of beach.

[21] Lizards and the habitats of lizards are protected under the Wildlife Act 1977

Bird habitat

At lower tides, the foreshore provides feeding and resting habitat for a range of seabirds including At Risk-Declining species and the Wharemauku Stream mouth provides core or seasonal habitat for such species. Erosion could result in the loss of habitat for bird species, including alterations to the Wharemauku Stream mouth, and dune habitat. Due to much of the southern coastline will be similarly affected, this also will reduce the potential habitat for birds to move too. Erosion could alter the foreshore habitat and potentially bury in-shore benthic food sources, resulting in reduction of bird food supplies. Loss of coastal bird habitat may also result in greater human vs bird conflict/interaction if birds seek out alternative locations to rest, nest and feed.

Bird habitat is considered to have a moderate adaptive capacity, as there is other habitat where the birds can forage for food, and not be disturbed by humans. However, most of the coastal habitat in the Kāpiti District is subject to erosion, and the adaptive capacity will be Low, as there will be very limited places for birds to move to.

The overall risk to bird habitat is considered to be moderate at present and through to 2130 under both SLR scenarios assessed. Over time, the exposure of bird habitats to coastal erosion increases to high, however mobile species have a better capacity to adapt to these changes if there is available alternative habitat for them to inhabit.

Fish habitat

The Wharemauku Stream (and all its tributaries) is a river with significant indigenous ecosystems because it provides habitat for indigenous Threatened and/or At Risk fish species and habitat for six or more migratory indigenous fish species. The Wharemauku Estuary provides seasonal or core habitat for seven threatened indigenous fish species but is not known to provide īnanga spawning habitat due to human modifications.

Coastal erosion would alter how the mouth of the Wharemauku Stream connects to more upstream portions. The exposure of the Wharemauku Stream mouth could be high by 2070-2130, where the mouth could be totally eroded to where the Wharemauku Stream runs beneath Matatua Road. This could widen the mouth of the estuary, which may provide more fish habitat for some species, or make it less suitable for others.

Increased sediment in the stream (from coastal erosion or upstream erosion) reduces the quality of fish habitat through reduced oxygen levels, reduced visibility (some fish hunt by sight), reduced prey items (poorer quality water supports a smaller array of invertebrate species), and sediment deposition on spawning areas (vegetation and gravels) and resting areas (gravel substrates and side eddies). It is assumed that erosion could potentially undermine up and downstream connectivity for fish and cause deterioration of in-stream habitat and stream bank habitat. Especially if any culverts are left perched above the in- or outflow (fish need connected wet surfaces - a sudden drop or waterfall is an obstacle for many species).

The Wharemauku Stream mouth can be reshaped as a permitted activity under GWRC NRP Rule R214, therefore, fish habitat within the stream mouth already experiences occasional perturbations. The adaptive capacity of fish habitat is considered to be moderate, as fish are mobile and can move to new habitat upstream if it is suitable and not already occupied by other species.

Exposure of fish habitats to future erosion was estimated by measuring inland from the seaward edge of the beach to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) at Matatua Road-Wharemauku Stream. The risk to fish habitat at present is moderate, as erosion already extends inland from the beach indicating that fish habitat may already be deteriorating. The risk to fish habitat, as a result of their moderate adaptive capacity, also remains moderate through to 2130, as it is likely that fish habitat may be able to migrate upstream if the mouth modifies with erosion in the future.

Indigenous biodiversity coastal

Wharemauku Estuary provides seasonal or core habitat for seven threatened indigenous fish species and provides connectivity to upstream parts of the stream.

The Wharemauku Stream mouth in its current form could be totally eroded to where the Wharemauku Stream is piped beneath Matatua Road by 2130 under future SLR scenarios. This widens the mouth of the estuary which may provide more fish habitat for certain species or make it less suitable for others as well as potentially reducing connectivity to inland parts of the Wharemauku Stream. Future erosion may force the

estuary to migrate upstream into more urban areas where it will be constrained for space – i.e. reduced in size to a smaller estuary. These changes to the estuary and coastal currents may result in fewer fish species using this habitat or reduced food availability.

Indigenous biodiversity is anticipated to have a very low adaptive capacity to coastal erosion, as once the estuary has been eroded it will be very difficult to re-establish due to low coastal sand availability. Species will stop using an area if it has frequent perturbations or becomes unsuitable habitat. Over the future scenarios for SLR, the exposure and sensitivity of the estuary habitat becomes increasingly higher, from low at present through to extreme by 2130.

Overall, the current risk to indigenous biodiversity is low; however increases to moderate by 2050; then extreme in 2070 and 2130 under both SLR scenarios, as the estuary becomes increasingly exposed to erosion and there is a significant change to the available estuary habitat.

5.3.2 Risks from coastal inundation

The inundation risk within the RAA is generally localised to the areas around the Wharemauku Stream, and the adjacent low-lying dune swales where areas could be flooded through backflows in the existing stormwater network. Risks to coastal inundation assume that the current level of natural protection continues into the future. However, it is noted that this may not be the case if erosion of the foredunes and existing flood protection infrastructure is allowed to occur.

Coastal dunes

Of the two areas of defined coastal dunelands mapped by GWRC within the RAA (Raumati Beach dunes; and southern end of Paraparaumu dunelands), and the two areas of DOC managed public land within the RAA (Raumati No2 and Raumati No3), all areas are projected to be inundated in a coastal storm event with present day sea levels. With increased flood depth with SLR in the modelled storm event, there is a risk that coastal foredunes would be completely eroded and not replaced. The Raumati Beach dunes are also part of the Wharemauku Estuary, increased stream flooding could speed up this process.

The coastal dunelands are considered to have a low adaptive capacity to flooding, due to the cascading effects of erosion during a storm event, and the poor ability for the dunes to recover as a result of lack of sediment supply to the area. As a result of the low adaptive capacity, and increasing exposure to flooding with SLR, the risk at present is considered to be moderate, but increase to extreme by 2050 through to 2130 under both SLR scenarios.

Wetlands

There are three areas of mapped wetlands within the RAA, however none of the defined wetlands are exposed to coastal flooding in a large storm event under either future SLR scenario or timeframe assessed, and therefore overall the risk to wetlands from coastal erosion is considered to be low.

The National Policy Statement for Freshwater Management has broadened the definition of natural wetlands, and therefore there may be additional areas of unmapped wetland within the RAA, as historically the area comprised alternating dunes with wetlands in the hollows. However, additional surveying to identify any new wetlands has not been undertaken for this assessment.

Mapped Ecological Sites

There are three areas of mapped KCDC Ecological Sites within the RAA and two areas of DOC managed public land. None of these mapped KCDC Ecological Sites are exposed to coastal flooding in either future SLR scenario out to 2130.

The two areas of DOC managed land are affected by present day flooding in a 1% AEP, and over time the depth of flooding at these sites during a storm event will increase with SLR. However, it is considered that the ecological values within these areas are likely to be low, and hence the sensitivity of sites impacted by flooding is also considered to be low. The adaptive capacities of these sites are considered to be very low, as they cannot move to another location. Therefore, the overall risk to mapped ecological sites is considered to be moderate at present and remains moderate to 2130 across both SLR scenarios.

There are some areas mapped by GWRC as Managed Open Space, namely the Marine Gardens at the mouth of the Wharemauku Stream and the Tennis Road area. The Marine Gardens at the mouth of the Wharemauku Stream would be affected by flooding in coastal storms in the future. However, the values of these areas relate to organized sport and activities rather than ecological values.

Key Indigenous Trees

Most of the notable trees are exotic trees, or indigenous trees such as pohutukawa, mountain celery pine, or kauri that are not native to the coastal areas of the Kāpiti Coast. Of the 32 Key Indigenous Trees and about 24 Notable Trees within the RAA, there is one Key Indigenous Tree, a *Podocarpus totara* at 241 Rosetta Road, that could be affected by flooding in all future scenarios. Two trees could be affected by flooding by 2070 for both SLR scenarios, which could increase to 4 trees by 2130 under the lower SSP2-4.5 scenario, and 6 under the higher SSP5-8.5 scenario.

Overall, the risk to Key Indigenous Trees in the RAA is considered to be low across all timeframes up to 2130 under the lower SSP2-4.5 SLR scenario; and under the higher SSP5-8.5 scenario, the risk is anticipated to be low up to 2070 and increase to moderate in 2130.

Rare and threatened species

As noted in Section 5.3.1, there are no Nationally and Regionally Rare and Threatened Species populations listed for RAA in Schedule 3 of the Operative Kāpiti Coast District Plan. There are no records for Threatened or At Risk plant species, but it is possible that Sand Dune Kanuka (*Kunzea amathicola*; Threatened – Nationally Vulnerable) could still occur.

Flooding could result in the temporary loss of habitat for rare and threatened species, including alterations to the Wharemauku Stream mouth, and dune habitat. This will be a more significant adverse effect for species with less mobility such as lizards and plants rather than seabirds or other birds. Due to the highly modified nature of the landscape, if rare and threatened species do occur then they are probably in relatively low numbers and mostly on private property in people's gardens. Given that coastal flooding will likely affect more of the coastline and inland areas than just within the RAA, temporary alternative habitat may be significantly reduced even for mobile species.

To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would be temporarily lost at the same rate as has been used for flooding of private property. Risk increases to high in 2130 due to an increase in the percentage of property flooded, as well as the loss of dune habitat and the significant alterations of the Wharemauku Stream mouth. Overall, the risk to rare and threatened species is considered to be moderate at present and through to 2130 across both SLR scenarios, due to their moderate adaptive capacity, and the likely reduced effects from flooding (relative to erosion) due to habitat likely only being changed temporarily.

Bird habitat

The beach foreshore provides feeding and resting habitat for a range of seabirds including At Risk-Declining species and the Wharemauku Stream mouth provides core or seasonal habitat for such species. Flooding could result in the temporary loss of habitat for bird species, including alterations to the Wharemauku Stream mouth, and dune habitat. Increased flood levels with SLR could result in greater sediment input into waterways, smothering in-shore benthic food sources (buried invertebrates in the sand) reducing food supplies which could adversely affect bird populations.

Overall, the risk to bird habitat from coastal flooding is considered to be moderate at present and remains moderate through to 2130 under both SLR scenarios.

Fish habitat

The Wharemauku Stream (and all its tributaries) is a river with significant indigenous ecosystems because it is habitat for indigenous Threatened and/or At Risk fish species and habitat for six or more migratory indigenous fish species. The Wharemauku Estuary provides seasonal or core habitat for seven threatened indigenous fish species but is not known to provide īnanga spawning habitat due to human modifications.

The depth of the water in the estuary and stream both permanently and temporarily during flood events, will get progressively deeper from present day to 2130 with SLR. Coastal flooding could result in saltwater penetrating further upstream and could potentially kill freshwater species (especially plants). The current

during flood events could be so strong that species are unable to swim upstream or are swept out to sea. Flooding could result in additional pollutants including plastics being washed into the stream from bank-side locations. During such events however, there are potential opportunities where areas beside the stream that could be flooded create additional temporary habitat for freshwater fish which are known to 'graze' flooded paddocks and sometimes also spawn.

Fish habitat is considered to have a moderate adaptive capacity to coastal flooding, as many fish species can move to new habitat upstream if it is not occupied by other individuals or not suitable. Many fish species rely on relatively stable banks and stream beds for habitat; however these can become unstable during flood events; and hence across all timeframes fish habitat is considered to be moderately sensitive to flooding, and increasing to high in 2130 due to the flooding penetrating considerably further upstream. For flooding the effects are often offset by temporary additional habitat in flooded parts of the floodplain.

The present-day risk to fish habitat is considered to be low through 2070 and increase to moderate in 2130 under the SSP2-4.5 scenario; however, under the SSP5-8.5 scenario the risk becomes moderate in 2070 as a result of the increased exposure in the earlier period. The risk from coastal flooding considers both the negative and potentially positive effects on fish habitat.

Indigenous biodiversity coastal

The Wharemauku Estuary provides seasonal or core habitat for seven threatened indigenous fish species and provides connectivity to upstream parts of the stream. However as discussed in the previous sections, changes in the morphology of the estuary due to the combined effects of flooding and erosion will change the available fish habitat and may change the connectivity to inland parts of the Wharemauku Stream, which could make it more or less suitable for certain species.

Flooding could also be detrimental to indigenous fish species due to rapid changes in salinity, increased turbidity, reduced in-stream prey, preventing fish from swimming upstream or downstream, (temporary) loss of connectivity, washing fish out to sea, and salinity killing vegetation. Changes to the estuary and coastal currents may result in fewer fish species using this habitat or reduced food availability. Indigenous biodiversity is considered to have a low adaptive capacity to coastal flooding, as the Wharemauku Stream mouth provides relatively shallow habitat, and flooding would result in increased water depths which (temporarily) change the estuary environment. Once this happens, it will be less suitable for fauna habitat.

For coastal flooding the availability of the habitat for fauna has been estimated due to lack of available data, and lack of habitat availability would depend on the frequency, duration and height of flooding. Overall, the risk to indigenous biodiversity is moderate at present day, increasing to high by 2070 and extreme by 2130 across both SLR scenarios.

6. Natural Character Domain

Natural Character has specific application under the RMA s.6(a) for:

The preservation of the natural character of the coastal environment (including the coastal marine area) wetlands, and lakes and rivers and their margins and the protection of them from inappropriate subdivision, use and development.

The New Zealand Coastal Policy Statement 2010 (NZCPS) sets out relevant policies for the identification of the coastal environment (Policy 1), preservation (Policy 13) and restoration (Policy 14) of coastal natural character.

In accordance with current NZILA (New Zealand Institute of Landscape Architects) best practice an understanding of natural character can be interpreted as:

- *The naturalness or degree of modification of an area*
- *An area's distinct combination of natural characteristics and qualities.*

Note: For the purpose of this Raumati Adaptation Risk Assessment Report and the RAA natural character domain risk assessments, the natural character rating and description of coastal environment are from the Kāpiti Coast Natural Character Evaluation (Boffa Miskell, Final Draft 2024) report and not the Operative Kāpiti Coast District Plan 2021.

The Raumati area was recently assessed as part of the Kāpiti Coast Natural Character Evaluation (Boffa Miskell, Final Draft 2024). Within this study, Raumati comprises part of the **Coastal Terrestrial Area 2: Waikanae and Paraparaumu** with an overall **low-moderate** natural character rating. The adjoining coastal marine area below Mean High Water Springs (MHWS), **Coastal Marine Area A: Innershelf and nearshore**, extends out to a depth of 35 meters and has an overall **moderate** natural character rating.

No high natural character has been identified within the RAA. Notwithstanding this, Policy 14 of the NZCPS promotes the restoration or rehabilitation of the natural character of the coastal environment. To achieve this outcome, Policy 14 directs the identification of areas and opportunities for restoration and the inclusion of provisions in statutory plans and the use of restoration conditions when granting resource consents and designations.

This assessment has been undertaken in the context of the inland extent of the coastal environment and associated evaluation of natural character[22] when considering the effects of coastal erosion and inundation on coastal natural character, as shown in Figure 6.1. Where projected inundation increasingly extends beyond the coastal environment and into the coastal context further inland, potential cascading impacts on natural character are considered, acknowledging this may include potential future delineation of this inherently dynamic environment.

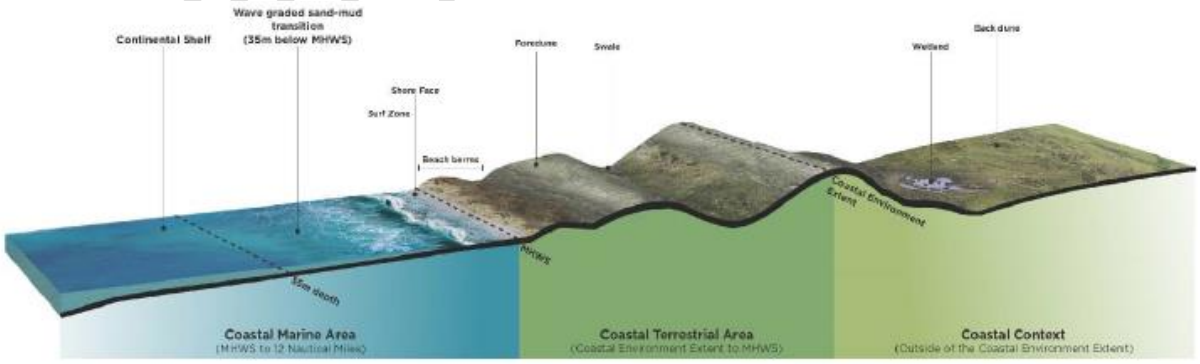


Figure 6.1: Typical transect through Kāpiti Coast duneland (from Boffa Miskell, 2024)

[22] Boffa Miskell (2021) Kapiti Coast Natural Character Evaluation: Natural Character of the Kapiti Coast Coastal Environment

The following outlines the information used to assess the risks to the Natural Character domain in the RAA, and a summary of the findings. Details for each element, including assumptions and limitations used to identify the risks, are provided in Appendix A.

6.1 Natural Character Elements

The risk assessment primarily relies on spatial information to establish how exposed an element is to coastal hazards, and how this exposure changes over time. Table 6.1 provides a summary of the elements assessed within the natural character domain, and what spatial information was used to inform the assessment of risk.

Only one element in the natural character domain has been assessed. The coastal terrestrial area (CTA) is representative of the broader coastal environment. Within the RAA, there is part of one CTA – "Waikanae and Paraparaumu: Coastal Terrestrial Area." There are no areas of high natural character located within the RAA.

This assessment used spatial layers generated from the Boffa Miskell assessment of natural character for district and regional planning purposes, commissioned by GWRC and KCDC. More detailed information about the method employed to establish exposure, sensitivity, and adaptive capacity ratings for each element is included in Appendix A.

Table 6.1: Summary of elements assessed in the natural character domain and representative data used to inform the assessment

Element	Description	Representative Data
CTA2: Waikanae and Paraparaumu	**Risks to the natural character of the Waikanae and Paraparaumu Coastal Terrestrial Area, which has a low-moderate level of natural character.** This is representative of the naturalness of the area, or degree of modification to the area, as well as an area's distinct combination of natural characteristics and qualities. The broader terrestrial coastal environment encompasses the most populated area in Kāpiti Coast's Coastal Environment and adjoining coastal context and is assessed as having **low-moderate** level of natural character overall.	Spatial overlays of the identified coastal terrestrial area completed by Boffa Miskell for GWRC and KCDC.

6.2 Natural Character Risk Matrix

A summary of the final risk ratings for each element is presented in Table 6.2. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 6.2: Natural Character Domain Matrix.

	Coastal Erosion						Coastal Inundation					
SLR Scenario	**Both**		**SSP2-4.5**		**SSP5-8.5**		**Both**		**SSP2-4.5**		**SSP5-8.5**	
Element	Present	2050	2070	2130	2070	2130	Present	2050	2070	2130	2070	2130
CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	H	H	H	L	L	L	L	L	L

6.3 Natural Character Risk Summary

6.3.1 Risks from coastal erosion

The risk to the CTA2: Waikanae and Paraparaumu within the RAA is considered to be at moderate risk to erosion at present through to 2070, increasing to being at high risk by 2130 under both RSLR scenarios.

The dune systems within the RAA have been almost completely modified to accommodate housing and urban development. Coastal erosion occurs in the context of this more modified coastal environment (seawalls, rock revetment and flood defences) and extends into adjoining established settlement. Hence, the level of natural character within this broader coastal environment for which RAA forms a part is considered to be low-moderate on account of the remnant, albeit modified dunes and primarily planted exotic and native coastal vegetation which remains. As a result of the higher level of existing modification and corresponding lower levels of natural character where impacts occur, the sensitivity of natural character to erosion in this location is considered to be low.

Whilst in the present day through to 2070 exposure is ranked as being 'high' as a result of increasing areas of erosion in this modified coastal environment and including the mouth of the Wharemauku Stream, by 2130 this exposure ranking increases from high to extreme as substantial additional erosion occurs inland from present day, to the extent that the present-day coastal environment as defined would be entirely removed. As the extent of erosion extends into areas for which natural processes, influences and qualities are not currently considered to be significant, this would effectively redefine the landward edge of the existing coastal environment extent.

6.3.2 Risks from coastal inundation

The risk to the CTA2: Waikanae and Paraparaumu area within the RAA is considered to be at low risk to coastal inundation at present and through to 2130 under all RSLR scenarios assessed.

The low-risk ranking is a result of the relatively limited flooding that occurs within the context of the current extent of the coastal environment, which is typically elevated on historic dunes. There are some areas of coastal flooding that occur within lower lying areas adjoining the margins of Wharemauku Stream as well as some lower lying pockets of some more modified interdunal hollows. Under longer term scenarios out to 2130, some limited flooding also extends inland of the identified coastal environment, including more modified areas containing coastal settlement and consequently more limited levels of natural character. This typically extends along lower lying areas inland of Wharemauku Stream. As a result of the increase in flood

extent by 2130 due to sea level rise, the exposure to coastal flooding increases from 'low' in 2070 to 'moderate'. However, the sensitivity of natural character within the CTA2 is considered to be low, and therefore across all timeframes the risk from coastal inundation is considered to remain low.

7. Cultural Domain

A risk assessment for the Cultural domain in relation to coastal hazard is still to be undertaken with Mana Whenua, and will be added to this document prior to being finalised.

Appendix A Risk Assessment Templates

The following templates were used to calculate the risk scores for each element within the domains by the subject matter specialists. Subject matter specialists were provided these templates to fill out for each of their defined elements under each domain. Each template contains the following information:

- Relative sea level rise scenario assessed (SSP2-4.5/SSP5-8.5)
- A descriptive overview of the element
- A description of the consequence of exposure to the element to flooding or erosion
- A description of the potential opportunities
- A description of the exposure of the element to the erosion and flood hazards
- An exposure 'ranking' (low/moderate/high/extreme)
- A sensitivity 'ranking' (low/moderate/high/extreme)
- A description of the elements' adaptive capacity and its 'ranking' (very low/low/moderate/high)
- A calculated vulnerability score based on sensitivity and adaptive capacity rankings (low/moderate/high/extreme)
- A calculated overall risk score based on combined exposure and vulnerability rankings (low/moderate/high/extreme)

One template has been prepared for each SLR scenario for each element in each domain. It is recognised that some generalized information about the element description and the consequences is duplicated, however these templates have been prepared to be read in isolation from each other to understand to full risk to an element under one sea level rise scenario.

A.1 Built Environment Risk Assessment Templates

A.1.1 Private Property (Whole Adaptation Area)

Domain	Element at Risk	Overview
Built Environment	Private property (whole adaptation area)	Private land parcels within the whole RAA, of which there is 3605 private properties. Properties are assessed as the property boundaries of private parcels, supplied by KCDC.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Potential erosion would lead to loss of an individual's property parcel (partially or whole). If erosion interacted with any buildings on the properties, they would likely become undermined and damaged, and result in loss or relocation of the dwelling. Erosion into the property boundary will also result in removal of any defence mechanisms (e.g. dune system, structures) and will have a cascading impact by increasing the coastal inundation hazard at the property.
Coastal Flooding	Flooding has the potential to cause damage to buildings and their contents through waterlogging, sediment deposition, contamination from pollutants, debris impacts and erosion. Flood affected buildings need to be repaired or rebuilt, depending on the severity of the damage, and contents replaced. The severity of the damage (and cost of repair or replacement) depends on the method of construction of the building and the materials used, its age and its contents and the depth and speed of the floodwater.

Opportunities

Hazard	Opportunities
Coastal Erosion	Replacement of the older building stock at risk to erosion with relocatable design, sustainable, low carbon buildings which abide to potential planning provisions – such as setback distances outside of the hazard zone.
Coastal Flooding	Replacement of the older building stock at risk of flooding with new, more sustainable, healthier, lower carbon buildings outside of hazard area.

A.1.1.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 249 (7%) properties exposed to short term storm erosion	Future exposure: 2050: 280 private properties (8%) 2070: 320 private properties (9%) 2130: 590 private properties (16%)
Currently exposed to coastal flooding - Currently there are 54 (1%) private properties exposed to coastal inundation - generally at properties north of Wharemauku Stream.	Future exposure: 2050: 75 private properties are exposed (2%) 2070: 96 private properties are exposed (3%) 2130: 223 private properties are exposed (6%) – mostly around low lying properties in historic dune swales inland from the coast.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Note:

- For both coastal erosion and coastal flooding, exposure is calculated based on the percentage of private land parcels affected relative to the total private land parcels in the RAA (3605).
- It is noted that exposure to erosion is based on the estimated erosion that could occur when there is failure of an existing structure during a significant storm event. This erosion estimate is based on the 15 m erosion that was experienced along the coastline in 1976 in a significant storm event (close to a 1% annual exceedance probability event) which occurred following structure failure. This assessment assumes that all walls would fail in a significant storm event, and this level of erosion would occur. The risk to coastal erosion would be low-moderate if walls were designed to withstand this significant storm event, and were maintained to this level of protection over the 100 year period.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	M

Notes:

- Coastal erosion sensitivity is based on a subjective measure of the total area of property that has been lost to erosion, and whether the loss of the property has resulted in loss of a dwelling on the property. Generally, if erosion has resulted in the total loss of the property and dwelling, it is extremely sensitive; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to be low-moderate. Sensitivity therefore can increase over time as more of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished.

- Coastal flooding sensitivity is based on sample inspections of the potential depths of flooding above ground level at buildings in the affected properties and typical fragility characteristics for residential buildings (Reese & Ramsay, 2010):

- Depth less than 0.15 m = Low sensitivity (below typical floor level as per Building Code)
- Depth 0.15 m to 0.65 m = Medium sensitivity (up to a depth of 0.5 m above typical floor level in which a significant proportion of contents are damaged)
- Depth 0.65 m to 1.65 m = High sensitivity (Reparable structural damage)
- Depth greater than 1.65 m = Extreme sensitivity (Irreparable structural damage)

The extent of features which may prevent or reduce flooding at properties – such as a dune, stopbank or non-return valves on stormwater outfalls has then been used to moderate the sensitivity rating if appropriate. The extents of the classes of water depth and mitigating measures have been evaluated in a qualitative manner

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Properties have no natural adaptive capacity as they have set boundaries. See note on potential adaption with relocation of buildings to enhance protection from flood and erosion hazards.
Coastal Flooding	L	Sensitivity of existing properties to damage by flooding can be reduced through use of more resilient materials and raising services and contents. Property-level protection (e.g. flood walls and stoplogs) or raising buildings can reduce exposure to flooding.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	E	E	E	E	M	M	M	M
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.1.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 249 (7%) properties exposed to short term storm erosion.	Future exposure: - 2050: 280 private properties (8%) - 2070: 345 private properties (10%) - 2130: 822 private properties (23%)
Currently exposed to coastal flooding - Currently there are 54 (1%) private properties exposed to coastal inundation.	Future exposure: - 2050: 75 private properties are exposed (2%) - 2070: 114 private properties are exposed (3%) - 2130: 458 private properties are exposed (13%) – generally inland properties in historic dune swales around the Wharemauku Stream.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Note:

- For both coastal erosion and coastal flooding, exposure is calculated based on the percentage of private land parcels affected relative to the total private land parcels in the RAA (3605).
- It is noted that exposure to erosion is based on the estimated erosion that could occur when there is failure of an existing structure during a significant storm event. This erosion estimate is based on the 15 m erosion that was experienced along the coastline in 1976 in a significant storm event (close to a 1% annual exceedance probability event) which occurred following structure failure. This assessment assumes that all walls would fail in a significant storm event, and this level of erosion would occur. The risk to coastal erosion would be low-moderate if walls were designed to withstand this significant storm event, and were maintained to this level of protection over the 100 year period.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	M	H

Notes:

- Coastal erosion sensitivity is based on a subjective measure of the total area of property that has been lost to erosion, and whether the loss of the property has resulted in loss of a dwelling on the property. Generally, if erosion has resulted in the total loss of the property and dwelling, it is extremely sensitive; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to be low-moderate. SensitiviMty therefore can increase over time as more of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished.

- Coastal flooding sensitivity is based on sample inspections of the potential depths of flooding above ground level at buildings in the affected properties and typical fragility characteristics for residential buildings (Reese & Ramsay, 2010):
    - Depth less than 0.15 m = Low sensitivity (below typical floor level as per Building Code)

- Depth 0.15 m to 0.65 m = Medium sensitivity (up to a depth of 0.5 m above typical floor level in which a significant proportion of contents are damaged)
- Depth 0.65 m to 1.65 m = High sensitivity (Reparable structural damage)
- Depth greater than 1.65 m = Extreme sensitivity (Irreparable structural damage)

The extent of features which may prevent or reduce flooding at properties – such as a dune, stopbank or non-return valves on stormwater outfalls has then been used to moderate the sensitivity rating if appropriate. The extents of the classes of water depth and mitigating measures have been evaluated in a qualitative manner

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Properties have no natural adaptive capacity as they have set boundaries. See note on potential adaption with relocation of buildings to enhance protection from flood and erosion hazards.
Coastal Flooding	L	Sensitivity of existing properties to damage by flooding can be reduced through use of more resilient materials and raising services and contents. Property-level protection (e.g. flood walls and stoplogs) or raising buildings can reduce exposure to flooding.

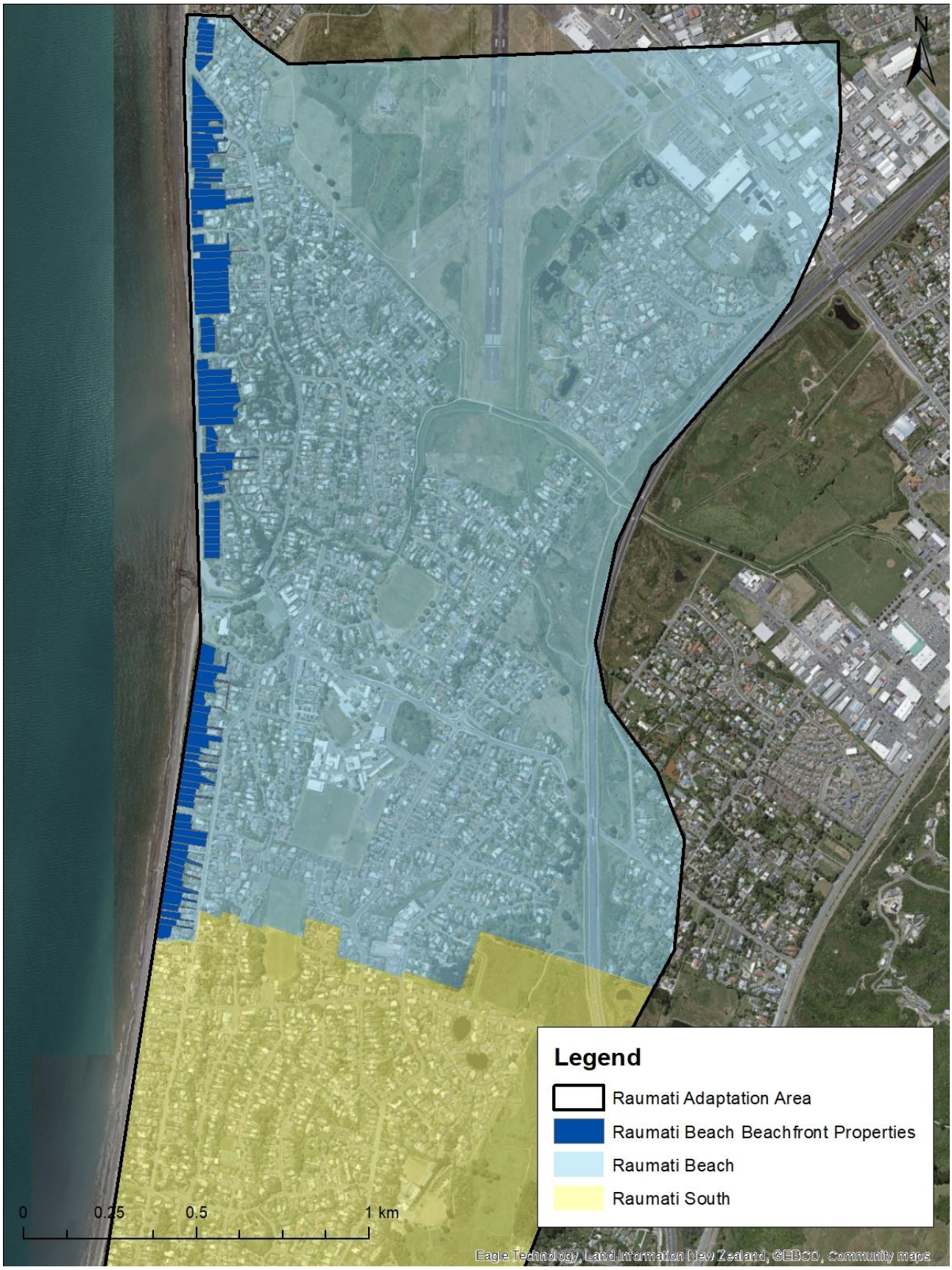
Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	M	H	L	L	L	M	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	E	E	E	E	M	M	M	M
Risk from Flooding	L	L	L	L	L	L	M	H	L	L	L	L

A.1.2 Private Property (Raumati Beach)



Domain	Element at Risk	Overview
Built Environment	Private property (Raumati Beach)	Private properties in Raumati Beach - For coastal erosion, only beachfront properties (i.e. most seaward row of houses) have been assessed. In the defined Raumati Beach area, there are 107 beachfront private properties. Only beachfront properties have been assessed to ensure the risks are assessed relative to the hazard throughout the entire district, in relation to the housing density in the area. - For coastal flooding, all properties in the broader Raumati Beach area up to the landward extent of the RAA have been considered since properties inland of the shoreline are also susceptible to flooding. In the defined Raumati coastal flood hazard area, there are 2171 private properties.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Potential erosion would lead to loss of an individual's property parcel (partially or whole). If erosion interacted with any buildings on the properties, they would likely become undermined and damaged, and result in loss or relocation of the dwelling. Erosion into the property boundary will also result in removal of any defence mechanisms (e.g. dune system, structures) and will have a cascading impact by increasing the coastal inundation hazard at the property.
Coastal Flooding	Flooding has the potential to cause damage to buildings and their contents through waterlogging, sediment deposition, contamination from pollutants, debris impacts and erosion. Flood affected buildings need to be repaired or rebuilt, depending on the severity of the damage, and contents replaced. The severity of the damage (and cost of repair or replacement) depends on the method of construction of the building and the materials used, its age and its contents and the depth and speed of the floodwater.

Opportunities

Hazard	Opportunities
Coastal Erosion	Replacement of the older building stock at risk to erosion with relocatable design, sustainable, low carbon buildings which abide to potential planning provisions – such as setback distances outside of the hazard zone.
Coastal Flooding	Replacement of the older building stock at risk of flooding with new, more sustainable, healthier, lower carbon buildings outside of hazard area.

A.1.2.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 95 (89%) beach front properties exposed to short term storm erosion.	Future exposure: 2050: 107 private beachfront properties (100%). 2070: 107 private beachfront properties (100%) 2130: 107 private beachfront properties (100%) *Additional properties behind the beachfront properties also become impacted.*
Currently exposed to coastal flooding - Currently there are 54 (2%) private properties exposed to coastal inundation.	Future exposure: 2050: 72 private properties are exposed (3%) 2070: 91 private properties are exposed (4%) 2130: 190 private properties are exposed (9%)

Hazard	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	L

Notes:

- It is noted that exposure to erosion is based on the estimated erosion that could occur when there is failure of an existing structure during a significant storm event. This erosion estimate is based on the 15 m erosion that was experienced along the coastline in 1976 in a significant storm event (close to a 1% annual exceedance probability event) which occurred following structure failure. This assessment assumes that all walls would fail in a significant storm event, and this level of erosion would occur. The risk to coastal erosion would be low-moderate if walls were designed to withstand this significant storm event, and were maintained to this level of protection over the 100 year period.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	M

Notes:

- Coastal erosion sensitivity is based on a subjective measure of the total area of property that has been lost to erosion, and whether the loss of the property has resulted in loss of a dwelling on the property. Generally, if erosion has resulted in the total loss of the property and dwelling, it is extremely sensitive; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to be low-moderate. Sensitivity therefore can increase over time as more of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished.

- Coastal flooding sensitivity is based on sample inspections of the potential depths of flooding above ground level at buildings in the affected properties and typical fragility characteristics for residential buildings (Reese & Ramsay, 2010):
  - Depth less than 0.15 m = Low sensitivity (below typical floor level as per Building Code)
  - Depth 0.15 m to 0.65 m = Medium sensitivity (up to a depth of 0.5 m above typical floor level in which a signficant proportion of contents are damaged)

- Depth 0.65 m to 1.65 m = High sensitivity (Reparable structural damage)
- Depth greater than 1.65 m = Extreme sensitivity (Irreparable structural damage)

The extent of features which may prevent or reduce flooding at properties – such as a dune, stopbank or non-return valves on stormwater outfalls has then been used to moderate the sensitivity rating if appropriate. The extents of the classes of water depth and mitigating measures have been evaluated in a qualitative manner

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Properties have no natural adaptive capacity as they have set boundaries. See note on potential adaption with relocation of buildings to enhance protection from flood and erosion hazards.
Coastal Flooding	L	Sensitivity of existing properties to damage by flooding can be reduced through use of more resilient materials and raising services and contents. Property-level protection (e.g. flood walls and stoplogs) or raising buildings can reduce exposure to flooding.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	E	E	E	E	E	E	E	E	E	E	E	E
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.2.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 95 (89%) beach front properties exposed to short term storm erosion.	Future exposure: - 2050: 107 private beachfront properties (100%) - 2070: 107 private beachfront properties (100%) *Additional properties behind the beachfront properties also become impacted.* - 2130: 107 private beachfront properties (100%) *Additional properties behind the beachfront properties also become impacted.*
Currently exposed to coastal flooding - Currently there are 54 (2%) private properties exposed to coastal inundation.	Future exposure: - 2050: 72 private properties are exposed (3%) - 2070: 101 private properties are exposed (5%) - 2130: 392 private properties are exposed (18%)

Hazard	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	L

Notes:

- It is noted that exposure to erosion is based on the estimated erosion that could occur when there is failure of an existing structure during a significant storm event. This erosion estimate is based on the 15 m erosion that was experienced along the coastline in 1976 in a significant storm event (close to a 1% annual exceedance probability event) which occurred following structure failure. This assessment assumes that all walls would fail in a significant storm event, and this level of erosion would occur. The risk to coastal erosion would be low-moderate if walls were designed to withstand this significant storm event, and were maintained to this level of protection over the 100 year period.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	M	H

Notes:

- Coastal erosion sensitivity is based on a subjective measure of the total area of property that has been lost to erosion, and whether the loss of the property has resulted in loss of a dwelling on the property. Generally, if erosion has resulted in the total loss of the property and dwelling, it is extremely sensitive; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to be low-moderate. Sensitivity therefore can increase over time as more of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished.

- Coastal flooding sensitivity is based on sample inspections of the potential depths of flooding above ground level at buildings in the affected properties and typical fragility characteristics for residential buildings (Reese & Ramsay, 2010):
    - Depth less than 0.15 m = Low sensitivity (below typical floor level as per Building Code)

- Depth 0.15 m to 0.65 m = Medium sensitivity (up to a depth of 0.5 m above typical floor level in which a signficant proportion of contents are damaged)
- Depth 0.65 m to 1.65 m = High sensitivity (Reparable structural damage)
- Depth greater than 1.65 m = Extreme sensitivity (Irreparable structural damage)

The extent of features which may prevent or reduce flooding at properties – such as a dune, stopbank or non-return valves on stormwater outfalls has then been used to moderate the sensitivity rating if appropriate. The extents of the classes of water depth and mitigating measures have been evaluated in a qualitative manner

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Properties have no natural adaptive capacity as they have set boundaries. See note on potential adaption with relocation of buildings to enhance protection from flood and erosion hazards.
Coastal Flooding	L	Sensitivity of existing properties to damage by flooding can be reduced through use of more resilient materials and raising services and contents. Property-level protection (e.g. flood walls and stoplogs) or raising buildings can reduce exposure to flooding.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	M	H	L	L	L	M	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	E	E	E	E	E	E	E	E	E	E	E	E
Risk from Flooding	L	L	L	L	L	L	M	H	L	L	L	L

A.1.3 Private Property (Raumati South)

Domain	Element at Risk	Overview
Built Environment	Private property (Raumati South)	Private properties in Raumati South - For coastal erosion, only beachfront properties (i.e. most seaward row of houses) have been assessed. In the defined Raumati South area, there are 117 beachfront private properties. Only beachfront properties have been assessed to ensure the risks are assessed relative to the hazard throughout the entire district, in relation to the housing density in the area. - For coastal flooding, all properties in the broader Raumati South area up to the landward extent of the RAA have been considered since properties inland of the shoreline are also susceptible to flooding. In the defined Raumati South area, there are 1434 private properties.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Potential erosion would lead to loss of an individual's property parcel (partially or whole). If erosion interacted with any buildings on the properties, they would likely become undermined and damaged, and result in loss or relocation of the dwelling. Erosion into the property boundary will also result in removal of any defence mechanisms (e.g. dune system, structures) and will have a cascading impact by increasing the coastal inundation hazard at the site.
Coastal Flooding	Flooding has the potential to cause damage to buildings and their contents through waterlogging, sediment deposition, contamination from pollutants, debris impacts and erosion. Flood affected buildings need to be repaired or rebuilt, depending on the severity of the damage, and contents replaced. The severity of the damage (and cost of repair or replacement) depends on the method of construction of the building and the materials used, its age and its contents and the depth and speed of the floodwater.

Opportunities

Hazard	Opportunities
Coastal Erosion	Replacement of the older building stock at risk to erosion with relocatable design, sustainable, low carbon buildings which abide to potential planning provisions – such as setback distances outside of the hazard zone.
Coastal Flooding	Replacement of the older building stock at risk of flooding with new, more sustainable, healthier, lower carbon buildings outside of hazard area.

A.1.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 116 (99%) properties exposed to short term storm erosion.	Future exposure: - 2050: 117 private beachfront properties (100%) - 2070: 117 private beachfront properties (100%) *Additional properties behind the beachfront properties also become impacted.* - 2130: 117 private beachfront properties (100%) *Additional properties behind the beachfront properties also become impacted.*
Currently exposed to coastal flooding - Currently there are 0 (0%) private properties exposed to coastal inundation.	Future exposure: - 2050: 3 private properties are exposed (<1%) - 2070: 5 private properties are exposed (<1%) - 2130: 33 private properties are exposed (7%)

Hazard	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	L

Notes:

- It is noted that exposure to erosion is based on the estimated erosion that could occur when there is failure of an existing structure during a significant storm event. This erosion estimate is based on the 15 m erosion that was experienced along the coastline in 1976 in a significant storm event (close to a 1% annual exceedance probability event) which occurred following structure failure. This assessment assumes that all walls would fail in a significant storm event, and this level of erosion would occur. The risk to coastal erosion would be low-moderate if walls were designed to withstand this significant storm event, and were maintained to this level of protection over the 100 year period.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	M

Notes:

- Coastal erosion sensitivity is based on a subjective measure of the total area of property that has been lost to erosion, and whether the loss of the property has resulted in loss of a dwelling on the property. Generally, if erosion has resulted in the total loss of the property and dwelling, it is extremely sensitive; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to be low-moderate. Sensitivity therefore can increase over time as more of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished.

- Coastal flooding sensitivity is based on sample inspections of the potential depths of flooding above ground level at buildings in the affected properties and typical fragility characteristics for residential buildings (Reese & Ramsay, 2010):
    - Depth less than 0.15 m = Low sensitivity (below typical floor level as per Building Code)

- Depth 0.15 m to 0.65 m = Medium sensitivity (up to a depth of 0.5 m above typical floor level in which a signficant proportion of contents are damaged)
- Depth 0.65 m to 1.65 m = High sensitivity (Reparable structural damage)
- Depth greater than 1.65 m = Extreme sensitivity (Irreparable structural damage)

The extent of features which may prevent or reduce flooding at properties – such as a dune, stopbank or non-return valves on stormwater outfalls has then been used to moderate the sensitivity rating if appropriate. The extents of the classes of water depth and mitigating measures have been evaluated in a qualitative manner

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Properties have no natural adaptive capacity as they have set boundaries. See note on potential adaption with relocation of buildings to enhance protection from flood and erosion hazards.
Coastal Flooding	L	Sensitivity of existing properties to damage by flooding can be reduced through use of more resilient materials and raising services and contents. Property-level protection (e.g. flood walls and stoplogs) or raising buildings can reduce exposure to flooding.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	E	E	E	E	E	E	E	E	E	E	E	E
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 116 (99%) properties exposed to short term storm erosion.	Future exposure: - 2050: 117 private beachfront properties exposed (100%) - 2070: 117 private beachfront properties exposed (100%) *Additional properties behind the beachfront properties also become impacted.* - 2130: 117 private beachfront properties exposed (100%) *Additional properties behind the beachfront properties also become impacted.*
Currently exposed to coastal flooding - Currently there are 0 (<1%) private properties exposed to coastal inundation.	Future exposure: - 2050: 3 private properties are exposed (<1%) - 2070: 11 private properties are exposed (1%) - 2130: 52 private properties are exposed (5%)

Hazard	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	L

Notes:

- It is noted that exposure to erosion is based on the estimated erosion that could occur when there is failure of an existing structure during a significant storm event. This erosion estimate is based on the 15 m erosion that was experienced along the coastline in 1976 in a significant storm event (close to a 1% annual exceedance probability event) which occurred following structure failure. This assessment assumes that all walls would fail in a significant storm event, and this level of erosion would occur. The risk to coastal erosion would be low-moderate if walls were designed to withstand this significant storm event, and were maintained to this level of protection over the 100 year period.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	H

Notes:

- Coastal erosion sensitivity is based on a subjective measure of the total area of property that has been lost to erosion, and whether the loss of the property has resulted in loss of a dwelling on the property. Generally, if erosion has resulted in the total loss of the property and dwelling, it is extremely sensitive; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to be low-moderate. Sensitivity therefore can increase over time as more of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished.

- Coastal flooding sensitivity is based on sample inspections of the potential depths of flooding above ground level at buildings in the affected properties and typical fragility characteristics for residential buildings (Reese & Ramsay, 2010):

- Depth less than 0.15 m = Low sensitivity (below typical floor level as per Building Code)
- Depth 0.15 m to 0.65 m = Medium sensitivity (up to a depth of 0.5 m above typical floor level in which a signficant proportion of contents are damaged)
- Depth 0.65 m to 1.65 m = High sensitivity (Reparable structural damage)
- Depth greater than 1.65 m = Extreme sensitivity (Irreparable structural damage)

The extent of features which may prevent or reduce flooding at properties – such as a dune, stopbank or non-return valves on stormwater outfalls has then been used to moderate the sensitivity rating if appropriate. The extents of the classes of water depth and mitigating measures have been evaluated in a qualitative manner

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Properties have no natural adaptive capacity as they have set boundaries. See note on potential adaption with relocation of buildings to enhance protection from flood and erosion hazards.
Coastal Flooding	L	Sensitivity of existing properties to damage by flooding can be reduced through use of more resilient materials and raising services and contents. Property-level protection (e.g. flood walls and stoplogs) or raising buildings can reduce exposure to flooding.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	L	H	L	L	L	L	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	E	E	E	E	E	E	E	E	E	E	E	E
Risk from Flooding	L	L	L	L	L	L	L	H	L	L	L	L

A.1.4 Roads and Bridges

Domain	Element at Risk	Overview
Built Environment	Roads and Bridges	All roads and bridges in the RAA. Roads include unsealed and sealed roads as per the LINZ Roads Centreline dataset from LINZ Data service. In the RAA there is 44.6 km of roads. Bridges were determined by the intersect of the Road centreline layer with the river centreline layer (also obtained from LINZ Data service) and confirmed with inspection of aerial imagery. In the RAA there are 2 bridges, which are situated on the Wharemauku Stream.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Roads in the RAA that are key to transport throughout the area to private property and to the broader district generally run parallel to the coast. These include The Esplanade, Rosetta Road, Matatua Road, and Wharemauku Road. Raumati Road and Poplar Ave provide access from Raumati Beach and Raumati South to SH1. Closure/loss of the access roads (Raumati Road and Poplar Ave) would lead to significant disruption to the local communities with limited alternative routes. Access to the beach would not be possible with loss of key access roads. Cascading impacts of loss of key access routes would include increased travel time through longer journeys and increased traffic, impact to tourism, impact to education, and reduced access for emergency services. Consequences of roads parallel to the coast being lost includes loss for individuals to their properties, with limited opportunity for relocation of the road further landward due to the development behind. This is particularly the case with roads which run parallel to the shoreline (e.g. The Esplanade, Rosetta Road, Matatua Road, and Wharemauku Road) The consequence of erosion reaching a bridge/culvert structure would likely result in undermining of the structure and cause failure. In some instances this would have a cascading impact on access to an area, and an alternative transport route would need to be used.
Coastal Flooding	Flooding of coastal roads and bridges can prevent them from being used to safely access properties in the community and can result in people becoming temporarily isolated during a flood event. Flooding of the four main roads which provide inland routes from the communities can prevent evacuation of people and property during a flood. Flooding can also damage the road surface or structural integrity of bridges, resulting in the need for repairs and potentially affecting or preventing access to the communities over a longer period. The severity of the damage depends on factors such as depth, speed and duration of flooding and the construction method and materials of the road or bridge.

Opportunities

Hazard	Opportunities
Coastal Erosion	No opportunities identified.
Coastal Flooding	No opportunities identified.

A.1.4.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.6 km (1%) of road exposed (The Esplanade, Marine Parade, several road ends perpendicular to the shoreline) - 0 Bridges	Future exposure: - 2050: 1 km of road (2%) - The Esplanade, Garden Road, Marine Parade, several road ends perpendicular to the shoreline. - 2070: 1.3km of road (3%) – The Esplanade, Garden Road, Marine Parade, several road ends perpendicular to the shoreline. - 2130: 4.6 km of road (10%) – All previous grow in exposed length. Rosseta Road exposed to erosion, and all roads seaward of this road.
Currently exposed to coastal flooding - 0 km of road (0%) - 0 bridges	Future exposure: - 2050: 0 km of road (0%), 0 bridges - 2070: 0.05 km of road (<1%), 0 bridges - 2130: 0.2 km of road (<1%), 1 bridge (Alexander Road)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Notes:

- Exposure rankings for Coastal Erosion is calculated as a percentage of the effected road length of the total road length (44.6 km) in the RAA, with consideration of erosion of key access roads providing connection within the wider RAA (e.g. Rosetta Road in 2130).
- Exposure ranking for Coastal Flooding additionally considers loss of access inland or isolation of sections of the community.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	L	L	L	M

Notes:

- Sensitivity to coastal erosion is based where the effected area of road is, and if it would impact accessability to properties and key routes. In the RAA, key access roads are those that run parallel to the shoreline (The Esplanade, Rosetta Road, Matatua Road, and Wharemauku Road) and the ones which provide access to SH1 (Raumati Road and Poplar Ave). High sensitivity is representative of loss of access to individual homes generaly through the loss of roads that run perpenidcular to the coast, and extreme sensitivity is widespread loss of roading network – generally through loss of roads that run parallel with the coastline.
- While the erosion of The Esplande will cause extreme disruption to residents that live along this road, it only services the houses that will also be directly impacted by erosion, and therefore is considered

to be highly sensitive, but not extremely sensitive, as it will not cause widespread disruption to the wider network.

- Sensitivity to coastal flooding is based on potential depth of flooding which affects accessibility and the amount of damage to roads and bridges and the importance of the road for access to the community from outside the hazard area.

  Sample inspections of the potential depths of flooding have been used to guide the hazard classe through reference to the combined flood hazard curves of the Australian Rainfall and Runoff Guide (Ball J. et al, 2019):

  - Depth less than 0.3 m = Low hazard (generally safe for people and vehicles)
  - Depth 0.3 m to 0.5 m = Medium hazard (unsafe for small vehicles)
  - Depth greater than 0.5 m = High hazard (unsafe for large vehicles)

  The importance of the road has been used with hazard class to assign the sensitivity to flooding – if a road is of low importance (not essential for access or evacuation) the hazard class (low/medium/high) is adopted for the sensitivity rating. If the road is of high importance (essential for access or evacuation) a sensitivity rating of one level higher than the hazard class is assigned. E.G. A road of high importance exposed to 'medium' hazard is assigned a 'high' sensitivity rating. The presence of features which may prevent or reduce flooding of roads such as a stopbank, dune or stormwater management structures has then be used to moderate the rating if appropriate. These factors are considered through visual inspection and judgement of the hazard data.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Roads and bridges do not have any natural adaptive capacity.
Coastal Flooding	L	Roads and bridges do not have any natural adaptive capacity. Although they can be raised to adapt to increasing flood levels this can conflict with other infrastructure.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	L	H	H	H	E
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	H	H	H	E	L	L	L	H
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.4.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.6 km (1%) of road exposed (The Esplanade, Marine Parade, several road ends perpendicular to the shoreline) - 0 Bridges	Future exposure: - 2050: 1 km of road (2%) - The Esplanade, Garden Road, Marine Parade, several road ends perpendicular to the shoreline. - 2070: 1.8km of road (4%) – The Esplanade, Garden Road, Marine Parade, several road ends perpendicular to the shoreline. - 2130: 5.5 km of road (12%) – All previous roads grow in exposed length. Rosseta Road exposed to erosion, and all roads seaward of this road.
Currently exposed to coastal flooding - 0 km of road (0%) - 0 bridges	Future exposure: - 2050: 0 km of road (0%), 0 bridges - 2070: 0.05 km of road (<1%), 0 bridges - 2130: 0.7 km of road (2%), 1 bridge (Alexander Road)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- Exposure rankings for Coastal Erosion is calculated as a percentage of the effected road length of the total road length (44.6 km) in the RAA, with consideration of erosion of key access roads providing connection within the RAA.
- Exposure ranking for Coastal Flooding additionally considers loss of access inland or isolation of sections of the community.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	L	L	L	M

Notes:

- Sensitivity to coastal erosion is based where the effected area of road is, and if it would impact accessability to properties and key routes. In the RAA, key access roads are those that run parallel to the shoreline (The Esplanade, Rosetta Road, Matatua Road, and Wharemauku Road) and the ones which provide access to SH1 (Raumati Road and Poplar Ave). High sensitivity is representative of loss of access to individual homes generaly through the loss of roads that run perpenidcular to the coast, and extreme sensitivity is widespread loss of roading network – generally through loss of roads that run parallel with the coastline.
- While the erosion of The Esplande will cause extreme disruption to residents that live along this road, it only services the houses that will also be directly impacted by erosion, and therefore is considered to be highly sensitive, but not extremely sensitive, as it will not cause widespread disruption to the wider network.

- Sensitivity to coastal flooding is based on potential depth of flooding which affects accessibility and the amount of damage to roads and bridges and the importance of the road for access to the community from outside the hazard area.

  Sample inspections of the potential depths of flooding have been used to guide the hazard class through reference to the combined flood hazard curves of the Australian Rainfall and Runoff Guide (Ball J. et al, 2019):

  - Depth less than 0.3 m = Low hazard (generally safe for people and vehicles)
  - Depth 0.3 m to 0.5 m = Medium hazard (unsafe for small vehicles)
  - Depth greater than 0.5 m = High hazard (unsafe for large vehicles)

  The importance of the road has been used with hazard class to assign the sensitivity to flooding – if a road is of low importance (not essential for access or evacuation) the hazard class (low/medium/high) is adopted for the sensitivity rating. If the road is of high importance (essential for access or evacuation) a sensitivity rating of one level higher than the hazrd class is assigned. E.G. A road of high importance exposed to 'medium' hazard is assigned a 'high' sensitivity rating. The presence of features which may prevent or reduce flooding of roads such as a stopbank, dune or stormwater management structures has then be used to moderate the rating if appropriate. These factors are considered through visual inspection and judgement of the hazard data.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Roads and bridges do not have any natural adaptive capacity.
Coastal Flooding	L	Roads and bridges do not have any natural adaptive capacity. Although they can be raised to adapt to increasing flood levels this can conflict with other infrastructure.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	L	H	H	H	E
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	H	H	H	E	L	L	L	H
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.5 Stormwater Infrastructure

Domain	Element at Risk	Overview
Built Environment	Stormwater Infrastructure	Stormwater infrastructure is council infrastructure used to control and discharge stormwater throughout the district. Infrastructure assessed in this category includes: Pump stations, Stormwater pipes, and Stormwater outfalls. Within the RAA there is 41.9 km of stormwater network pipes, 27 stormwater outfalls (direct to the coast), and six pump stations (Rainbow Court, Southleigh, Tennis Court Rd, Clunie Ave, Tiromoana Rd, Matatua Road). Data used to assess stormwater infrastructure was supplied by KCDC.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Erosion of stormwater infrastructure would result in exposure, undermining, and damage to the infrastructure. Erosion around stormwater outfalls on the open coast or in dynamic fluvial environments will result in undermining of the outfall, which can result in damage to the end of the outfall (i.e. breaking if not supported). If severely damaged in a large event, if could have a cascading impact on the flood hazard if the outfall is unable to efficiently discharge the stormwater to the sea. Stormwater network pipes which are undermined by erosion will require cutback of the pipes, and additional protection around the outfall to protect from further scour at the coast. Consequences are greater to stormwater pipes that are eroded which run parallel to the shoreline, as erosion would cause the pipes to be undermined and fail, and due to being within the network and not at the ends of the network (i.e. discharging at an outfall) there is wider-spread impacts to the network.
Coastal Flooding	Stormwater outfalls and pipe mains are generally resilient to flooding although they do provide pathways for coastal flooding to inland areas. The electrical power supply and control systems for stormwater pumpstations can be damaged by surface flooding if this is sufficiently deep, causing the pump station to fail to operate during a storm event and so increasing flood hazard and requiring repair or replacement.

Opportunities

Hazard	Opportunities
Coastal Erosion	Upgrades to stormwater infrastructure as part of the LTP could incorporate designs which are more resilient to coastal erosion in the future to avoid exposure and failure.
Coastal Flooding	Stormwater upgrades can include measures to prevent inland flooding from coastal storms (e.g., non-return valves) and increased resilience of pump stations to surface flooding.

A.1.5.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.5 km (1%) of stormwater pipe currently exposed to storm erosion. - 24 (89%) stormwater outfalls exposed. - No pump stations exposed.	Future exposure: 2050: - 0.8 km (2%) of stormwater pipe - - 26 (96%) stormwater outfalls exposed - No pump stations 2070: - 1.1 km (3%) of stormwater pipe - 27 (100%) stormwater outfalls exposed - No pump stations 2130: - 3.3 km (8%) of stormwater pipe - 27 (100%) stormwater outfalls exposed - No pump stations
Currently exposed to coastal flooding - No pump stations exposed to flooding.	Future exposure: - 2050: None - 2070: None - 2130: None

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- Exposure ranking for coastal erosion is based on total pipe length within the RAA. However, it is noted that stormwater outfall pipes are particularly exposed now due to their locality on the coast, and in the future. The exposure ranking increases in 2130 as stormwater network running parallel to the shoreline becomes exposed, which would have a wider impact on the greater stormwater network in the RAA.
- Exposure ranking for coastal flooding only considers stormwater pumpstations (pipes and outfalls are considered resilient).

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	H	E
Coastal Flooding	L	L	L	L

Notes:

- For coastal erosion, sensitivity considers the increasing exposure of the infrastructure over the 100 year timeframe, where more exposure indicates the pipes will be more susceptible to damage and failure, and therefore effect their ablity to discharge water effectively in storms. When stormwater

pipes run perpendicular to the shoreline, it is assumed that these pipes could be cut back to still discharge to the sea and function. However, when stormwater pipes running parallel to the shoreline become impacted there will be wide-scale implications on the RAA stormwater network, with cascading impacts on the flood hazard.

- For coastal flooding, sensitivity considers the potential depth of flooding at pump stations if flooded and effects on above ground equipment.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Stormwater pipes have no natural adaptive capacity. However, exposed ends of the pipes could be cut back to allow for continued support along the shoreline.
Coastal Flooding	M	Flood protection to power supply and controls can be implemented relatively readily

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	H	E	L	M	M	H	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	M	M	H	E	L	L	L	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.5.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.5 km (1%) of stormwater pipe currently exposed to storm erosion. - 24 (89%) stormwater outfalls exposed. - No pump stations exposed.	Future exposure: 2050: - 0.8 km (2%) of stormwater pipe - - 26 (96%) stormwater outfalls exposed - No pump stations 2070: - 1.5 km (4%) of stormwater pipe - 27 (100%) stormwater outfalls exposed - No pump stations 2130: - 4.1 km (10%) of stormwater pipe - 27 (100%) stormwater outfalls exposed - No pump stations
Currently exposed to coastal flooding - No pump stations exposed to flooding.	Future exposure: - 2050: None - 2070: None - 2130: None

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- Exposure ranking for coastal erosion is based on total pipe length within the RAA. However, it is noted that stormwater outfall pipes are particularly exposed now due to their locality on the coast, and in the future. The exposure ranking increases in 2130 as stormwater network running parallel to the shoreline becomes exposed, which would have a wider impact on the greater stormwater network in the RAA.
- Exposure ranking for coastal flooding only considers stormwater pumpstations (pipes and outfalls are considered resilient).

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	H	E
Coastal Flooding	L	L	L	L

Notes:

- For coastal erosion, sensitivity considers the increasing exposure of the infrastructure over the 100 year timeframe, where more exposure indicates the pipes will be more susceptible to damage and failure, and therefore effect their ablity to discharge water effectively in storms. When stormwater pipes run perpendicular to the shoreline, it is assumed that these pipes could be cut back to still

discharge to the sea and function. However, when stormwater pipes running parallel to the shoreline become impacted there will be wide-scale implications on the RAA stormwater network, with cascading impacts on the flood hazard.

- For coastal flooding, sensitivity considers the potential depth of flooding at pump stations if flooded and effects on above ground equipment.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Stormwater pipes have no natural adaptive capacity. However, exposed ends of the pipes could be cut back to allow for continued support along the shoreline.
Coastal Flooding	M	Flood protection to power supply and controls can be implemented relatively readily

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	H	E	L	M	M	H	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	M	M	H	E	L	L	L	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.6 Wastewater Infrastructure

Domain	Element at Risk	Overview
Built Environment	Wastewater Infrastructure	Public wastewater infrastructure in the RAA includes wastewater pump stations (22) that are generally located south of the Wharemauku Stream in the RAA; and the wastewater pipe network (60.2 km). Throughout the RAA, most properties are reliant on the public wastewater network. There are no wastewater treatment plants identified in the RAA.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Erosion of wastewater pipes could lead to exposure and damage to the pipes. Erosion of the land surrounding the pipe would leave the pipe unsupported. Continued exposure could lead to failure of the pipe and cause contaminants enter the coastal environment. Generally, the wastewater network runs under the roads, and therefore when properties are directly on the coast, properties would be eroded before the wastewater system would be impacted. Where there is a road in front of houses (e.g. The Esplanade) then the system would be impacted prior to the properties themselves would be impacted. Generally the network pipes running in this area are asbestos cement and were installed in the 1970-1980's. If a wastewater pump station was exposed to erosion, the structure would likely be undermined and fail, which could have cascading impacts into the broader waste collection network if it cannot be naturally carried to the treatment plant. Consequences of damage to these networks can be very high and result in spread of human disease and infection. Breakdown of the network will result in some properties no longer being able to be serviced.
Coastal Flooding	Wastewater pipe mains are generally resilient to flooding although they are susceptible to ingress of floodwater and consequent polluted flood water. The electrical power supply and control systems for stormwater pump stations can be damaged by surface flooding if this is sufficiently deep, causing the pump station to fail to operate during a storm event increasing foul flood hazard and requiring repair or replacement.

Opportunities

Hazard	Opportunities
Coastal Erosion	There is likely to be upgrades to some of the wastewater network as part of the LTP and asset management plan. There are potentially opportunities for realignment of this infrastructure to avoid the hazard in areas as upgrades are undertaken. New designs can better account for the interaction of the infrastructure with sea level rise and coastal hazards in the future.
Coastal Flooding	Wastewater upgrades can include measures to increase the resilience of pump stations to surface flooding.

A.1.6.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 3 pump stations (14%) are currently exposed. - 1.7 km (3%) of wastewater pipes are currently could be exposed during storms	Future exposure: 2050: - 5 pump stations are exposed (23%) - 2.7 km (5%) of wastewater pipe could be exposed 2070: - 8 pump stations are exposed (36%) - 3.7 km (6%) of wastewater pipe could be exposed 2130: - 12 pump stations are exposed (55%) - 9.5 km (16%) of wastewater pipe could be exposed – (The Esplanade, Rosetta Road, Groves Road)
Currently exposed to coastal flooding - No pump stations exposed	Future exposure: - 2050: No pump stations exposed - 2070: No pump stations exposed - 2130: 1 pump station exposed (Rosetta Road)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	M	M	H
Coastal Flooding	L	L	L	L

Note:

- Exposure to wastewater infrastructure from erosion is a combined consideration for number of pump stations and wastewater pipes impacted, and the number of properties that would be affected by the impact.
- It is considered that wastewater networks pipes will be resilient to flooding, and therefore exposure ranking is largely weighted by exposure of pump stations.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	M

Notes:

- Erosion would result in undermining and damage to the infrastructure, and would result in a break in the network, with flow on impacts to the human domain and directly impact individuals health. Therefore, damage/breakage in the network would be considered extreme, and would impact a larger number of properties than those directly impacted by erosion themselves.
- For flooding, sensitivity takes account of relative proportion of properties dependent on pump stations.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	No natural capacity for the wastewater network pipes to adapt. See note about opportunities to upgrade.
Coastal Flooding	M	Flood protection to power supply and controls for pump stations can be implemented relatively readily and remainder of infrastructure relatively resilient to flooding

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	M	M	H	E	E	E	E	M	H	H	E
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.6.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - 3 pump stations (14%) are currently exposed. - 1.7 km (3%) of wastewater pipes are currently could be exposed during storms	Future exposure: 2050: - 5 pump stations are exposed (23%) - 2.7 km (5%) of wastewater pipe could be exposed 2070: - 9 pump stations are exposed (41%) - 5 km (8%) of wastewater pipe could be exposed 2130: - 12 pump stations are exposed (55%) - 10.9 km (18%) of wastewater pipe could be exposed
Currently exposed to coastal flooding - No pump stations expoxed	Future exposure: - 2050: No pump stations exposed - 2070: No pump stations exposed - 2130: 1 pump station exposed

Hazard	Present	2050	2070	2130
Coastal Erosion	L	M	M	H
Coastal Flooding	L	L	L	L

Notes:

- Exposure to wastewater infrastructure from erosion is a combined consideration for number of pump stations and wastewater pipes impacted, and the number of properties that would be affected by the impact.
- It is considered that wastewater networks pipes will be resilient to flooding, and therefore exposure ranking is largely weighted by exposure of pump stations.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	E	E	E	E
Coastal Flooding	L	L	L	M

Notes:

- Erosion would result in undermining and damage to the infrastructure, and would result in a break in the network, with flow on impacts to the human domain and directly impact individuals health. Therefore, damage/breakage in the network would be considered extreme, and would impact a larger number of properties than those directly impacted by erosion themselves.
- For flooding, sensitivity takes account of relative proportion of properties dependent on pump stations.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	No natural capacity for the wastewater network pipes to adapt. See note about opportunities to upgrade.
Coastal Flooding	M	Flood protection to power supply and controls for pump stations can be implemented relatively readily and remainder of infrastructure relatively resilient to flooding

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	E	E	E	E	L	E	E	E	E
Flooding	L	L	L	M	M	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	M	M	H	E	E	E	E	M	H	H	E
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.1.7 Water Supply Infrastructure

Domain	Element at Risk	Overview
Built Environment	Water Supply Infrastructure	Water supply infrastructure in the RAA is the infrastructure used to service the treatment and supply of water to properties. For this assessment, this includes water supply service pipes and water supply bores; there was no identified pump stations or water treatment plants within the RAA area. In the RAA there is: - 78.8 km of water supply pipes - 6 water supply bores Water Supply bores were filtered from the wells and bores KCDC dataset for Public, Domestic, and Community supply. Nearby reservoirs and pump stations are generally located landward of SH1 outside of the RAA.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Exposure of water supply infrastructure to coastal erosion would generally result in damage to the infrastructure as a result of undermining and eventual failure of the structure. Damage to water supply pipes would result in loss in water supply to some properties within RAA, and could cause disruption to the wider network if pipes were damaged at critical points (i.e. along sections which connected the total network). The water supply network in the RAA is very extensive, and it is likely that small disruptions would not break the total network. Loss of water supply will affect individual properties and would likely lead to affects on people health as a result of loss of water for drinking and cleaning, and could have severe consequences to one's wellbeing. Generally, the water supply network pipes are located landward of private properties, and therefore erosion would result in damage to properties before the network itself.
Coastal Flooding	Water supply pipes are generally resilient to flooding provided pressure is maintained in the network. Bore supplies may be contaminated by flood water. Power supply and controls at pump stations can be damaged by flooding resulting in interruption of supply and repair or replacement, and consequent loss of network pressure can result in contamination of supply from flood water. However, there are no pump stations located in the RAA, and this is therefore not applicable here.

Opportunities

Hazard	Opportunities
Coastal Erosion	Many of the coastal water supply pipes were installed in 1980's (cement asbestos or PVC) and therefore are likely to need upgrading at some time in the future. There is an opportunity for the network to be realigned and incorporate design to accommodate/avoid coastal erosion in the future.
Coastal Flooding	Future upgrades to network and infrastructure could include further protection from flooding if required.

A.1.7.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.7 km water supply pipes (1%) – Marine Parade, The Esplanade. - 0 water supply bores (0%)	Future exposure: 2050: - 1.2 km water supply pipes (2%) – Marine Parade, The Esplanade. - 1 water supply bores (17%) 2070: - 1.6 km water supply pipes (2%) – Marine Parade, The Esplanade. - 1 water supply bores (17%) 2130: - 10 km water supply pipes (13%) – The Esplanade, Rosetta Road, Marine Parade. - 1 water supply bores (17%)
Currently exposed to coastal flooding - 0 water supply bores (0%)	Future exposure: - 2050: 0 water supply bore (0%) - 2070: 0 water supply bore (0%) - 2130: 0 water supply bores (0%)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- For exposure to coastal erosion is the combined exposure on water supply bores and water supply pipes, and consideration of damage to the wider water supply network (i.e. number of properties impacted by damage).
- For exposure to flooding, only water supply bores have been considered and it is assumed the water supply pipe network is resilient to flooding. Reservoirs and pump stations do not appear in the RAA and therefore are not assessed.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	L	L	L	L

Notes:

- For coastal erosion, supply pipes that are exposed are connecting pipes within the network could be damaged and break, and would therefore have a cascading effect on water supply to nearby houses within the area. Due to the extensive nature of the network, disruption is likely to directly impact a smaller number of houses up to 2070 relative to the total RAA; and therefore is considered high and not extreme. In comparrison to the wastewater network, it is not considered extreme in the earlier timeframes for water supply as it will generally only impact the properties which are also being impacted by erosion directly. Wastewater has an extreme ranking as damage to the pipes could lead to wider-spread health impacts if there are leakages into the environment of waste material.

- Sensitivitiy of water supply bores is weighted by how many properties could be impacted by contamination of the water supply bore.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Water supply infrastructure does not have any natural adaptive capacity. See note in opportunities about potential for realignment to avoid hazards in future.
Coastal Flooding	M	Bores could be easily floodproofed if required.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	L	H	H	H	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	H	H	H	E	L	L	L	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.7.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.7 km water supply pipes (1%) - 0 water supply bores (0%) -	Future exposure: 2050: - 1.2 km water supply pipes (2%) - 1 water supply bores (17%) 2070: - 2.8 km water supply pipes (4%) - 1 water supply bores (17%) 2130: - 12.8 km water supply pipes (16%) - 1 water supply bores (17%)
Currently exposed to coastal flooding - 0 water supply bores (0%)	Future exposure: - 2050: 0 water supply bore (0%) - 2070: 0 water supply bore (0%) - 2130: 0 water supply bores (0%)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- For exposure to coastal erosion is the combined exposure on water supply bores and water supply pipes, and consideration of damage to the wider water supply network (i.e. number of properties impacted by damage).
- For exposure to flooding, only water supply bores have been considered and it is assumed the water supply pipe network is resilient to flooding. Reservoirs and pump stations do not appear in the RAA and therefore are not assessed.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	L	L	L	L

Notes:

- For coastal erosion, supply pipes that are exposed are connecting pipes within the network could be damaged and break, and would therefore have a cascading effect on water supply to nearby houses within the area. Due to the extensive nature of the network, disruption is likely to directly impact a smaller number of houses up to 2070 relative to the total RAA; and therefore is considered high and not extreme. In comparrison to the wastewater network, it is not considered extreme in the earlier timeframes for water supply as it will generally only impact the properties which are also being impacted by erosion directly. Wastewater has an extreme ranking as damage to the pipes could lead to wider-spread health impacts if there are leakages into the environment of waste material.
- Sensitivity of water supply bores is weighted by how many properties could be impacted by contamination of the water supply bore..

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Water supply infrastructure does not have any natural adaptive capacity. See note in opportunities about potential for realignment to avoid hazards in future.
Coastal Flooding	M	Bores could be easily floodproofed if required.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	L	H	H	H	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	H	H	H	E	L	L	L	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.8 Natural Gas Supply Mains

Domain	Element at Risk	Overview
Built Environment	Natural Gas Supply Mains	Natural gas that is piped directly to homes/business, supplied by 'First Gas' on the Kāpiti Coast. Information about the location of existing gas supply mains was obtained from the First Gas website (https://firstgas.co.nz/connecting-natural-gas/connection-process/check-availability/). These supply mains are generally robust concealed underground pipes which would require high disturbance to cause damage. This assessment uses the gas supply mains network to indicate potential exposure to the hazard. In the RAA there is 33.7 km of gas supply mains throughout the area.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Erosion of natural gas supply mains would result in exposing, undermining, and potential damage to the pipe. Damage to a gas pipeline could result in escaping gas, which can ignite and cause serious harm to life and property.
Coastal Flooding	Buried gas pipelines are relatively resilient to flooding.

Opportunities

Hazard	Opportunities
Coastal Erosion	Future upgrades to the network and infrastructure could inclue re-routing to avoid future erosion risks.
Coastal Flooding	Future upgrades to the network and infrastructure could inclue further protection from flooding if required to reduce risk.

A.1.8.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - No natural gas supply mains effected at present.	Future exposure: - 2050: 200 m (1%) Marine Parade - 2070: 390 m (1%) Marine Parade - 2130: 4.2 km (13%) Marine Parade, Rosetta Road
Currently exposed to coastal flooding - At present, 10 m of supply mains could be inundated.	Future exposure: - 2050: 10 m (<1%) - 2070: 20 m (<1%) - 2130: 140 m (<1%)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- Exposure of gas supply mains to flooding is based on the percentage of pipe exposed in relation to the RAA, noting that the buried mains are likely to be resilient to the hazard.
- Exposure to erosion considers the length of pipe, the number of homes it services, and the disruption to the wider network.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	E	E	E
Coastal Flooding	L	L	L	L

Notes:

- Gas mains will be generally resilient to flooding, and therefore the sensitivity is considered to be low.
- Given the extreme consequences of broekn gas supply mains on human health and safety, once exposed they are considered to be extreme sensitive if damaged.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Natural gas supply mains do not have any natural adaptive capacity. See note in opportunities about potential for realignment to avoid hazards in future.
Coastal Flooding	L	No natural adaptive capacity of gas supply mains.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	E	E	E	L	L	E	E	E

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Flooding	L	L	L	L	L	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	L	E	E	E	L	M	M	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.8.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - No natural gas supply mains effected at present.	Future exposure: - 2050: 200 m (1%) Marine Parade - 2070: 850 m (3%) Marine Parade - 2130: 5.2 km (15%) Marine Parade, Rosetta Road
Currently exposed to coastal flooding - At present, 10 m of supply mains could be inundated.	Future exposure: - 2050: 10 m (<1%) - 2070: 40 m (<1%) - 2130: 590 m (<1%)

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

- Exposure of gas supply mains to flooding is based on the percentage of pipe exposed in relation to the RAA, noting that the buried mains are likely to be resilient to the hazard.
- Exposure to erosion considers the length of pipe, the number of homes it services, and the disruption to the wider network.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	E	E	E
Coastal Flooding	L	L	L	L

Notes:

- Gas mains will be generally resilient to flooding, and therefore the sensitivity is considered to be low.
- Given the extreme consequences of broekn gas supply mains on human health and safety, once exposed they are considered to be extreme sensitive if damaged.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Natural gas supply mains do not have any natural adaptive capacity. See note in opportunities about potential for realignment to avoid hazards in future.
Coastal Flooding	L	No natural adaptive capacity of gas supply mains.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	E	E	E	L	L	E	E	E

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Flooding	L	L	L	L	L	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	L	E	E	E	L	M	M	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.9 Electrical transmission and supply infrastructure

Domain	Element at Risk	Overview
Built Environment	Electrical transmission and supply infrastructure	Electrical transmission through the Kāpiti Coast is supplied by Electra Energy. Electrical transmission infrastructure assessed includes distribution transformers; overhead and underground transmission lines; and substation zones. In the RAA there is: - 81 distribution transformers (which convert electricity from 11kV to 230 V for distribution to all households) – generally, approximately 30% of these are ground mounted and the remainder are pole mounted. - 17 km of underground lines (11kV) - 9.3 km of overhead lines (11kV) Data was also obtained for the location of substations, of which there is one substation in the RAA – located on Matai Road.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	The consequence of erosion to electricity transmission infrastructure could result in damage and eventual failure of the infrastructure. This would typically occur when the infrastructure is undermined due to the loss of support around the structure, and result in failure. For distribution transformers, loss of these structures due to erosion would result in electricity loss to households that the transformer was supplying. The number on households effected will vary depending how many households the transformer was servicing. The exposure of underground transmission lines would result in exposure and damage, and could potentially cut off transmission to larger groups of houses than the transformers are supplying. Exposure of the cables is also likely to result in significant health and safety issues in the surrounding area. The exposure of overhead transmission lines to erosion has little consequence due to being elevated far above ground level, and therefore would not interact, however the adjoining power poles exposure to erosion could result in structural failure and damage to the overhead lines. It is assumed that erosion of a property would result in the loss of electricity supply to that individual property.
Coastal Flooding	Overhead and underground transmission lines and pole mounted distribution transformers are relatively resilient to flooding. Ground mounted distribution transformers are vulnerable to flooding which can cause short circuits, loss of supply to properties and damage to the transformer if depth exceeds the height of critical equipment.

Opportunities

Hazard	Opportunities
Coastal Erosion	Potential for cables to need to be upgraded in the future, which could provide opportunity for realignment of infrastructure away from the erosion hazard or more resilience built into design.
Coastal Flooding	Routine upgrade of equipment can include floodproofing measures.

A.1.9.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: - No distribution transformers are exposed; - No underground transmission lines are exposed; and - 30 m of overhead tranmission lines are exposed (<1%)	Future exposure: 2050: - No distribution transformers are exposed; - No underground transmission lines are exposed; and - 170 m (2%) overhead tranmission lines are exposed. 2070: - No distribution transformers are exposed; - No underground transmission lines are exposed; and - 200 m (2%) overhead tranmission lines are exposed. 2130: - 6 distribution transformers are exposed (7%); - 1.5 km (9%) underground transmission lines are exposed; and - 300 m (3%) overhead tranmission lines are exposed.
Currently exposed to coastal flooding - 0 ground mounted distribution transformer	Future exposure: - 2050: 0 ground mounted distribution transformers - 2070: 0 ground mounted distribution transformers - 2130: 0 ground mounted distribution transformers

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Note:

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	E
Coastal Flooding	L	L	L	L

Notes:

- Sensitivity is based the consequence of the loss/damage to transmission infrastructure as it becomes exposed to the hazard. Exposure and damage would cause disruption to the network and could result in larger sections of the community being cut off from the transmission line, as well as healthy and safety risks from the line being exposed. Hence, if the infrastructure is not exposed to erosion then the sensitivity is considered to be low; however when it becomes exposed it is considered to be extremely sensitive.
- For flooding, sensitivity considers depth of flood water at transformers and a typical protection level of 0.3 m for surface water flooding.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Electrical transmision lines and infrastructure has no natural adaptive capacity. See note on opportunities for potential realignment.
Coastal Flooding	M	Resilience of ground mounted transformers can be increased through flood proofing or raising pad level.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	E	L	L	L	L	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	L	L	L	E	L	L	L	M
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.1.9.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: - No distribution transformers are exposed; - No underground transmission lines are exposed; and - 30 m of overhead tranmission lines are exposed (<1%)	Future exposure: 2050: - No distribution transformers are exposed; - No underground transmission lines are exposed; and - 170 m (2%) overhead tranmission lines are exposed. 2070: - 1 distribution transformers is exposed (1%); - No underground transmission lines are exposed; and - 230 m (2%) overhead tranmission lines are exposed. 2130: - 8 distribution transformers are exposed (7%); - 1.9 km (11%) underground transmission lines are exposed; and - 500 m (5%) overhead tranmission lines are exposed.
Currently exposed to coastal flooding - 0 ground mounted distribution transformer	Future exposure: - 2050: 0 ground mounted distribution transformers - 2070: 0 ground mounted distribution transformers - 2130: 1 ground mounted distribution transformer is exposed

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	E
Coastal Flooding	L	L	L	L

Notes:

- Sensitivity is based the consequence of the loss/damage to transmission infrastructure as it becomes exposed to the hazard. Exposure and damage would cause disruption to the network and could result in larger sections of the community being cut off from the transmission line, as well as healthy and safety risks from the line being exposed. Hence, if the infrastructure is not exposed to erosion then the sensitivity is considered to be low; however when it becomes exposed it is considered to be extremely sensitive.
- For flooding, sensitivity considers depth of flood water at transformers and a typical protection level of 0.3 m for surface water flooding.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Electrical transmision lines and infrastructure has no natural adaptive capcity. See note on opportunities for potential realignment.
Coastal Flooding	M	Resilience of ground mounted transformers can be increased through flood proofing or raising pad level.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	E	L	L	L	L	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	L	L	L	E	L	L	L	M
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.2 Human Risk Assessment Templates

A.2.1 Risk to physical human health

Domain	Element at Risk	Overview
Human	Risks to physical health	Risks to physical health from exposure to coastal flooding/inundation and the potential for water-borne disease, and issues with water quality, availability, and accessibility due to changes or disruption to essential services.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Physical risk to life and health from erosion event. For example, sudden collapse of infrastructure, community assets, and homes leading to dangerous physical environments, and/or damage to stormwater and wastewater services and subsequent exposure to pathogens and contaminants (for example, for beach users/swimmers).
Coastal Flooding	Risk to life and health resulting from periodic inundation of properties and coastal areas with sea water. This may include risk of being washed away or isolated in homes and unable to escape (which could lead to drowning/injury). Additionally, if waste-, storm-, or drinking water supply systems are overwhelmed or damaged, people may be exposed to pathogens and contaminants in flood waters or drinking water, with subsequent risk of illness. Risk of water contamination to those recreating in the area may extend beyond the initial event, for example, lingering contamination for swimmers.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reconfigure aging assets and infrastructure away from areas at risk, creating new fit-for-purpose services.
Coastal Flooding	Reconfigure aging assets and infrastructure away from areas at risk and/or remediate/update/enhance robustness of assets, creating new fit-for-purpose services.

A.2.1.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7% of properties (n=249) in the adaptation area are exposed to coastal erosion, and potentially at risk of collapse and loss of water and wastewater services, with associated risks for occupants and those recreating in the area ▪ At present, there are a number of wells and bores, water service pipes and points, stormwater pipes and points, and wastewater pipes and points exposed to coastal erosion	Future exposure: ▪ By 2050 8% of properties (n=280) in the adaptation area will be exposed to erosion and potentially at risk of collapse and loss of water and wastewater services, with associated risks for occupants and those recreating in the area ▪ By 2070 the % of properties (n=320) at risk increases to 9% ▪ By 2130 the % of properties (n=590) at risk increases to 16% Increasing amounts of wells and bores, water service pipes and points, stormwater pipes and points, and wastewater pipes and points are exposed to coastal erosion as time progresses. By 2130, there is significant impact to the network, and especially water service pipes and points and wastewater pipes and points around people's homes.
Currently exposed to coastal inundation/flooding ▪ 1% of properties (n=54) in the adaptation area are currently exposed to flooding with subsequent risks for residents of being isolated in their homes and experiencing water and waste water service loss. ▪ Current flooding extent presents risks to a small number of stormwater points in the coastal area, plus a significant length of stormwater pipe along the Wharemauku Stream, with potential risks for recreational users of these areas (e.g swimmers and those walking on the track beside the stream).	Future exposure: ▪ By 2050 2% of properties (n=75) in the adaptation areas are exposed to periodic flooding, which could present risks for residents of being isolated in their homes and experiencing water and wastewater service loss. ▪ By 2070 the % of properties (n=96) at risk increases to 3% ▪ By 2130 the % of properties (n=223) at risk increases to 6% Risks to stormwater points in the coastal area persist and areas around Raeburn Rd, Matatua Rd, and Wharemauku Stream see increasing levels of inundation of water service pipes and points, stormwater pipes and points, and wastewater pipes and points

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

The percentage of the overall number of properties is small compared to the total number of properties in the adaptaion area and Raumati area more generally. In particular, the erosion area is confined to the first few rows of homes, even in 2130.

Coastal inundation is more widespread in 2130, however it still affects only a small percentage of the overall community. Risks from inundation/flooding events are particularly evident around Raumati Beach and the Wharemauku Stream – users of the streamside walkway and beach adjoining the stream may be at risk of injury/drowing in a sudden flood event, however there is no data to support this assumption.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	M
Coastal Flooding	M	M	M	M

Notes: Sensitivity is related to the impact of exposure to pathogens and contaminants in water or danergous buildings which may result in sickness, injury or death. Older and younger residents are likely to be more sensitive to harm because of their physiology. In this adaptation area 19% of residents are aged over 65, which is 4% higher than the national average (EHINZ 2018), and 5% are below the age of 5, which is 2.5% below the national average (Stats NZ infoshare 2018 data).

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	▪ There are no co-ordinated adaptation actions, the shore line is allowed to erode ▪ People have warning of incidents of erosion and are able to avoid being in the area during times when hazards and damage may be more likely. Once removed from the area of hazard they are no longer exposed or at risk. ▪ Residents may be exposed to hazards on return to their homes or at other places (such as the beach), however through careful actions (e.g. listening to local emergency/civil defense/council warnings) the hazard could be avoided
Coastal Flooding	H	▪ There are no co-ordinated adaptation actions, indundation occurs frequently but intermittently. ▪ People have warning of incidents of inundation and are able to avoid being in the area during times when hazards and risks to health may be more likely. Once removed from the area of hazard they are no longer exposed or at risk. ▪ Residents may be exposed to hazards on return to their homes or at other places (for example, Wharemauku Stream walkway), however through careful actions (e.g. checking weather forecast, listening to local emergency/civil defense warnings) the hazard could be avoided.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	M	H	L	L	L	L
Flooding	M	M	M	M	H	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	L	L	L	L	L	L	L	L
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.2.1.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7% of properties (n=249) in the adaptation area are exposed to coastal erosion, and potentially at risk of collapse and loss of water and wastewater services, with associated risks for occupants and those recreating in the area ▪ At present, there are a number of wells and bores, water service pipes and points, stormwater pipes and points, and wastewater pipes and points exposed to coastal erosion	Future exposure: ▪ By 2050 8% of properties (n=280) in the adaptation area will be exposed to erosion and potentially at risk of collapse and loss of water and wastewater services, with associated risks for occupants and those recreating in the area ▪ By 2070 the % of properties (n=345) at risk increases to 10% ▪ By 2130 the % of properties at risk increases to 23% (822 properties of 3605 total properties) Increasing amounts of wells and bores, water service pipes and points, stormwater pipes and points, and wastewater pipes and points are exposed to coastal erosion as time progresses. By 2130, there is significant impact to the network, and especially water service pipes and points and wastewater pipes and points around people's homes. For example, 54.5% (12 of 22) of wastewater pump stations in Raumati adaptation area will be impacted by erosion in 2130, and approximately 18% (10,903 of 60,246) of the wastewater network in the Raumati adaptation area will be impacted by this time. All 27 stormwater outfalls in the Raumati adaptation area will be impacted by erosion in 2130, and approximately 16% (12,822 of 78,802) of water supply networks will be affected by erosion then.
Currently exposed to coastal inundation/flooding: ▪ 1% of properties (n=54) in the adaptation area are currently exposed to flooding with subsequent risks for residents of being isolated in their homes and experiencing water and waste water service loss. ▪ Current flooding extent presents risks to a small number of stormwater points in the coastal area, plus a significant length of stormwater pipe along the Wharemauku stream, with potential risks for recreational users of these areas (e.g swimmers and those walking on the track beside the stream).	Future exposure: ▪ By 2050 2% of properties (n=75) in the adaptation areas are exposed to periodic flooding, which could present risks for residents of being isolated in their homes and experiencing water and wastewater service loss. ▪ By 2070 the % of properties (n=114) at risk increases to 3% ▪ By 2130 the % of properties (n=458) at risk increases to 13% Risks to stormwater points in the coastal areapersist and areas around Raeburn Rd, Matatua Rd, and Wharemauku Stream see increasing levels of inundation of water service pipes and points, stormwater pipes and points, and wastewater pipes and points

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	H
Coastal Flooding	L	L	L	L

Note:

The percentage of the overall number of properties is relatively small compared to the total number of properties in the adaptation area and Raumati area more generally. In particular, the erosion area is confined

to the first few rows of homes, even in 2130. Coastal inundation is more widespread in 2130, however it still affects only a small percentage of the overall community.

Risks from inundation/flooding events are particularly evident around Raumati beach and the Wharemauku Stream – users of the streamside walkway and beach adjoining the stream may be at risk of injury/drowing in a sudden flood event, however there is no data to support this assumption. The significant impact of erosion to water infrastructure by 2130 poses a substantial risk to human health (particularly of beach/stream area users).

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	M
Coastal Flooding	M	M	M	M

Notes:

Sensitivity is related to the impact of exposure to pathogens and contaminants in water or danergous buildings which may result in sickness, injury or death. Older and younger residents are likely to be more sensitive to harm because of their physiology. In this adaptation area 19% of residents are aged over 65, which is 4% higher than the national average (EHINZ 2018), and 5% are below the age of 5, which is 2.5% below the national average (Stats NZ infoshare 2018 data).

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	There are no co-ordinated adaptation actions, the shore line is allowed to retreat People have warning of incidents of erosion and are able to avoid being in the area during times when hazards and damage may be more likely. Once removed from the area of hazard they are no longer exposed or at risk. Residents may be exposed to hazards on return to their homes or at other places (such as the beach), however through careful actions (e.g. listening to local emergency/civil defense/council warnings) the hazard could be avoided
Coastal Flooding	H	There are no co-ordinated adaptation actions, indundation occurs frequently but intermittently. People have warning of incidents of inundation and are able to avoid being in the area during times when hazards and risks to health may be more likely. Once removed from the area of hazard they are no longer exposed or at risk. Residents may be exposed to hazards on return to their homes or at other places (for example, Wharemauku Stream walkway), however through careful actions (e.g. checking weather forecast, listening to local emergency/civil defense warnings) the hazard could be avoided.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	M	H	L	L	L	L

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Flooding	M	M	M	M	H	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	H	L	L	L	L	L	L	L	M
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.2.2 Risks to mental health and wellbeing

Domain	Element at Risk	Overview
Human	Risks to mental health and wellbeing	Risks to mental health, identity, autonomy and sense of belonging, connections to place and nature, and personal wellbeing from loss and trauma due to ongoing coastal erosion and periodic flooding. This risk relates to the mental health and wellbeing of individuals who may experience ongoing stress, anxiety, depression, grief, feelings of powerlessness, and an altered sense of belonging to a place as coastal erosion and inundation becomes progressively worse. These feelings and experiences may emerge as people navigate loss of, or damage to property, irreversible changes or loss of valued natural places, feeling alone or powerless to affect change, on-going stress of managing damage to property or living in damaged building, and worry about the future. It includes the stress associated with disruption to everyday routines and activities, which can impact the ability to function, undertake actions that are enjoyed, and plan for the future.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Stress, anxiety, and trauma associated with the permanent loss of property or ongoing damage to property. This may generate further financial loss (e.g. insurance withdrawal or repair costs) and/or stress and uncertainty regarding the future. Loss of or damage to key places and natural systems that provide a sense of identity or belonging. For example, the loss of a favorite beach or landscape that generates a sense of distress because a place that you know and love changes and there is relative powerlessness to do anything about it. Further impacts may be experienced on an individual's autonomy as constraints on individuals' options and choices arise, for example, ability to live certain places (e.g. erosion areas), or under take particular activities (e.g. needing to stay away from erosion-prone areas of the coast).
Coastal Flooding	Stress, anxiety, and trauma associated with the loss of property (homes and businesses) or on-going damage to property due to periodic potentially frequent coastal flooding. This may generate further financial loss (e.g. insurance withdrawal or repair costs, loss of stock or business revenue) and/or stress and uncertainty regarding the future. Stress associated with being trapped at home or within a small geographic area while coastal flooding recedes, potentially unable to get to work, school, or access other services. Loss of or damage to key places and natural systems that provide a sense of identity or belonging. For example, the loss of a favorite beach or landscape that generates a sense of distress because a place that you know and love changes and there is relative powerlessness to do anything about it. Further impacts may be experienced on an individual's autonomy as constraints on individuals' options and choices arise, for example ability to live certain places (flood zones), or undertake particular activities (e.g. walking along flood-prone areas).

Opportunities

Hazard	Opportunities
Coastal Erosion	Create new recreational options and areas away from erosion areas
Coastal Flooding	Create or explore new recreational options and areas away from inundation prone areas

A.2.2.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7 % of properties (n=249) in the adaptation area are currently exposed to coastal erosion and could be lost or damaged. However, 95/104 (89%) beach front properties are exposed. ▪ Beach is currently experiencing erosion	Future exposure • By 2050 8% of properties (n=280) in the adaptation area are at risk of erosion and could be lost or damaged. 100% of beach front properties are affected. • By 2070 the % increases to 9% of the total properties (n=320) in the adaptation area • By 2130 the % increases to 16% of the total properties (n=590) in the adaptation area The beach within the adaptation area will be progessively eroded, reducing beach access and impacting those who derive identity and wellbeing from the beach.
Currently exposed to coastal flooding: ▪ 1 % of properties (n=54) in the adaptation area are at risk of coastal inundation and could be lost or damaged ▪ Few areas are inudated during events at present, mostly just the beach area.	Future exposure • By 2050, 2% of properties (n=75) within the adaptation area will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream • By 2070 the % increases to 3% of the total properties (n=96) in the adaptation area • By 2130 the % increases to 6% of the total properties (n=223) in the adaptation area By 2130 coastal inundation reaches further inland, periodically flooding low-lying areas mainly around the beach. Inundation begins to encroach on the first row of beach-front properties, but remains largely confined to the gardens of private properties adjacent to the beach. The Wharemauku Stream provides a conduit inland, temporarily inundating surrounding properties and the creek walkway, as well as Matauta, Garden and Groves Road and the edge of Weka Park.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	M	H
Coastal Flooding	L	L	M	H

Notes:

In the above, we are focussing on all the properties within the adaptation area, not just the beach front properties. A focus on just the beach front properties would yield a different result. Exposure of other residents (living away from the beach front) is likely due to their connection with the coast.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	H	H	H	E

Notes:

Loss of property and loss of access to the beach and recreation sites around the Wharemauku Stream will have a potentially significant effect on residents' mental health and connections to natural spaces for recreation and enjoyment.

Research demonstrates that many people globally (Bell et al., 2015; Bryce et al., 2016) and across Aotearoa New Zealand (Cosgriff, 2023; Foley et al., 2019; Foley & Kistemann, 2015; Panelli & Tipa, 2007; Wheaton et al., 2020) derive a sense of wellbeing and mental health from recreating on and near the beach, and many feel their identity and sense of belonging is strongly connected to their community, especially in coastal locations (Chen et al., 2021; Collins & Kearns, 2010, 2013; Floyd, 2023; Murton, 2006; Panelli et al., 2008; Schneider et al., 2017; Waiti & Awatere, 2019; Widener, 2018).

The situation is likely to be similar for residents of Raumati given that the Raumati Adaptation Area community values summary (Kāpiti Coast District Council, 2023) demonstrates that people within the community have a strong emotional affiliation to the area, particularly the beach and coastline.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	There are no co-ordinated adaptation actions, the shore line is allowed to erode. Few actions that can be taken be autonomously are applied on affected properies (can easily adapt as an individual in the long term). When identity and wellbeing is tied up with place, and these places are lost or damaged, coping and adapting is not a straightforward or linear task, and can take a long time and require considerable cognitive and social change to achieve. Special places are not easily replaced since the connections are highly personal, and have been built up over time. Their loss may cause grief and anxiety. Financial barriers to adaptation or relocation may cause significant stress or place an individual in the position of needing to remain in a continually affected location.
Coastal Flooding	M	There are no coordinated adaptation actions, indundation occurs frequently but intermittently. Some actions that can be taken be autonomously are applied on affected properies (can easily adapt as an individual in the long term). When identity and wellbeing is tied up with place, and these places are lost or damaged, coping and adapting is not a straightforward or linear task, and can take a long time and require considerable cognitive and social change to achieve. Special places are not easily replaced since the connections are highly personal, and have been built up over time. Their loss may cause grief and anxiety. Financial barriers to adaptation or relocation may cause significant stress or place an individual in the postion of needing to remain in a continually affected location.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	L	H	H	H	E
Flooding	H	H	H	E	M	M	M	M	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	M	H	H	H	H	E	L	L	M	E
Risk from Flooding	L	L	M	H	M	M	M	H	L	L	M	H

A.2.2.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7 % of properties (n=249) in the adapation area are currently exposed to coastal erosion and could be lost or damaged. However, 95/104 (89%) beach front properties are exposed. ▪ Beach is currently experiencing erosion	Future exposure: ▪ By 2050 8% of properties (n=280) in the adaptation area are at risk of erosion and could be lost or damaged. ▪ 100% of beach front properties are affected. ▪ By 2070 the % increases to 10% of the total properties (n=345) in the adaptation area. ▪ By 2130 the % increases to 23% (822 properties of 3605 total properties) of the total properties in the adaptation area The beach within the adaptation area will be progessively eroded, reducing beach access and impacting those who derive identity and wellbeing from the beach.
Currently exposed to coastal flooding: ▪ 1 % of properties (n=54) in the adaptation area are at risk of coastal inundation and could be lost or damaged ▪ Few areas are inudated during events at present, mostly just the beach area.	Future exposure: • By 2050, 2% of properties (n=75) within the adaptation area will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream • By 2070 the % increases to 3% of the total properties (n=114) in the adaptation area • By 2130 the % increases to 13% of the total properties (n=458) in the adaptation area By 2130 coastal inundation reaches further inland, perodically flooding low-lying areas mainly around the beach. Inundation begins to encroach on the first row of beach-front properties, but remains largely confined to the gardens of private properties adjacent to the beach. Public access to the beach front areas is likley to be lost. The Wharemauku Stream provides a conduit inland, temporarily inundating surrounding properties and the creek walkway, as well as Matauta, Garden and Groves Road and the edge of Weka park.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	M	H
Coastal Flooding	L	L	M	H

Note:

In the above, we are focussing on all the properties within the adaptation area, not just the beach front properties. A focus on just the beach front properties would yield a different result. Exposure of other residents (living away from the beach front) is likely due to their connection with the coast.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	H	H	H	E

Notes:

Loss of property and loss of access to the beach and recreation sites around the Wharemauku Stream will have a potentially significant effect on residents' mental health and connections to natural spaces for recreation and enjoyment.

Research demonstrates that many people globally (Bell et al., 2015; Bryce et al., 2016) and across Aotearoa New Zealand (Cosgriff, 2023; Foley et al., 2019; Foley & Kistemann, 2015; Panelli & Tipa, 2007; Wheaton et al., 2020) derive a sense of wellbeing and mental health from recreating on and near the beach, and many feel their identity and sense of belonging is strongly connected to their community, especially in coastal locations (Chen et al., 2021; Collins & Kearns, 2010, 2013; Floyd, 2023; Murton, 2006; Panelli et al., 2008; Schneider et al., 2017; Waiti & Awatere, 2019; Widener, 2018).

The situation is likely to be similar for residents of Raumati given that the Raumati Adaptation Area community values summary (Kāpiti Coast District Council, 2023) demonstrates that people within the community have a strong emotional affiliation to the area, particularly the beach and coastline.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	There are no co-ordinated adaptation actions, the shore line is allowed to erode. Few actions that can be taken be autonomously are applied on affected properties (can easily adapt as an individual in the long term) When identity and wellbeing is tied up with place, and these places are lost or damaged, coping and adapting is not a straightforward or linear task, and can take a long time and require considerable cognitive and social change to achieve. Special places are not easily replaced since the connections are highly personal, and have been built up over time. Their loss may cause grief and anxiety. Financial barriers to adaptation or relocation may cause significant stress or place an individual in the postion of needing to remain in a continually affected location.
Coastal Flooding	M	There are no coordinated adaptation actions, indundation occurs frequently but intermittently. Some actions that can be taken be autonomously are applied on affected properies (can easily adapt as an individual in the long term When identity and wellbeing is tied up with place, and these places are lost or damaged, coping and adapting is not a straightforward or linear task, and can take a long time and require considerable cognitive and social change to achieve. Special places are not easily replaced since the connections are highly personal, and have been built up over time. Their loss may cause grief and anxiety. Financial barriers to adaptation or relocation may cause significant stress or place an individual in the postion of needing to remain in a continually affected location.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	L	H	H	H	E
Flooding	H	H	H	E	M	M	M	M	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	M	H	H	H	H	E	L	L	M	E
Risk from Flooding	L	L	M	H	M	M	M	H	L	L	M	H

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A.2.3 Risk to social infrastructure and amenity

Domain	Element at Risk	Overview
Human	Risk to social infrastructure and amenity	This element includes the objects that keep society functioning and enable daily patterns of life (e.g. shopping or travelling to work, education, engaging in community or cultural activities), and the facilities that act as social support structures (e.g. churches, supermarkets, meeting places, community facilities or halls, health care services, care homes, early childhood centres). Additionally, it includes the locations and facilitates that afford visitors and local residents the opportunity to enjoy and participate in organised sport, exercise, and spend time outdoors (e.g. parks, swimming pools, boat clubs, walkways, reserves, and natural areas). It also includes the aesthetics and amenity of places where people live, the spaces they utilize, and whether changes can be tolerated by those who live there

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	The loss of social infrastructure along the beach means that people are not able to access services that they need to go about their daily lives, do the things that they enjoy, or engage in social activities with others. Loss of amenity and recreational space reduces ability to enjoy outdoor activities and connect with nature (with flow on impacts to wellbeing).
Coastal Flooding	The permanent or semi-permanent inundation of social infrastructure along the beach means that people are not able to access services that they need to go about their daily lives, do the things that they enjoy, or engage in social activities with others. Loss of amenity and recreational space reduces ability to enjoy outdoor activities and connect with nature (with flow on impacts to wellbeing).

Opportunities

Hazard	Opportunities
Coastal Erosion	Creation of new outdoor recreational space
Coastal Flooding	Creation of new outdoor recreational space in areas that are intermittently inundated

A.2.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Present exposure – coastal erosion: ▪ The beach is currently exposed to erosion with 6 beach access points within the current day hazard line. ▪ A total of 5 Department of Conservation properties and 10 parks and reserves are exposed ▪ No other social infrastructure is exposed	Future exposure: ▪ By 2050 the beach is exposed, as are 11 parks and reserves, 6 beach access points, and 6 Department of Conservation properties. No other social infrastructure is exposed ▪ By 2070 all of the beach is exposed, as are 7 beach access points, 11 parks and reserves, and 6 Department of Conservation properties. No other social infrastructure is exposed ▪ By 2130 the beach is exposed as are 13 parks and reserves, 10 beach access points, and 6 Department of Conservation properties. No other social infrastructure is exposed
Present exposure – Coastal inundation: ▪ At present, 3 beach access points, 5 parks and reserves, and 4 Department of Conservation (DOC) propertiesare exposed to coastal flooding	Future exposure: ▪ By 2050, 3 beach access points, 5 parks and reserves, and 4 Department of Conservation properties are exposed to coastal flooding. ▪ By 2070, 3 beach access points, 5 parks and reserves, 4Department of Conservation properties and one shared path (along Wharemauku Stream by Alexander Rd and Tui Rd) are exposed to coastal flooding. ▪ By 2130, 3 beach access points, 8 parks and reserves, 5 Department of Conservation properties, and two shared pathways (along Wharemauku Stream and Matatua Rd) are exposed to coastal flooding. ▪ No other social infrastructure is exposed

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	M

Notes:

Exposure for erosion is limited to the beach and foreshore parks. Coastal flooding appears to impact some of the parks and reserves within the adaptation area and travels inland via the Wharemauku Stream and associated drainage network. No other social infrastructure is exposed: the schools, hertiage areas, medical practices, and places of worship are all unaffected.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	H
Coastal Flooding	H	H	H	H

Notes:

The elements that are exposed are highly sensitive to the hazard and would no longer be able to fulfil their intended purpose.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Limited options to adapt because the beach and parks are constrained by adjoining private properties
Coastal Flooding	L	Limited options to adapt because the beach and parks are constrained by adjoining private properties

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	H	L	H	H	H	H
Flooding	H	H	H	H	L	H	H	H	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	H	H	H	H	L	L	L	M
Risk from Flooding	L	L	L	M	H	H	H	H	L	L	L	M

A.2.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Present exposure – coastal erosion: ▪ The beach is currently exposed to erosion with 6 beach access points within the current day hazard line. ▪ A total of 5 parcels of land owned and managed by the Department of Conservation and 10 parks and reserves are exposed ▪ No other social infrastructure is exposed	Future exposure: ▪ By 2050 the beach is exposed, as are 11 parks and reserves, 6 beach access points, and 6 pieces of land owned and managed by the Department of Conservation. No other social infrastructure is exposed ▪ By 2070 all of the beach is exposed, as are 11 parks and reserves, 8 beach access points, and 6 pieces of land owned and managed by the Department of Conservation. No other social infrastructure is exposed ▪ By 2130 the beach is exposed as are 15 parks and reserves, 10 beach access points, and 6 pieces of land owned and managed by the Department of Conservation. No other social infrastructure is exposed.
Present exposure – Coastal inundation: ▪ At present, 3 beach access points, 5 parks and reserves, and 4 Department of Conservation (DOC) properties are exposed to coastal flooding. No other social infrastructure is impacted.	Future exposure: ▪ By 2050, 3 beach access points, 5 parks and reserves, and 4 the Department of Conservation properties are exposed to coastal flooding. ▪ By 2070, 3 beach access points, 6 parks and reserves, 5 Department of Conservation properties, one shared path (along the Wharemauku Stream, close to Alexander St, and one playground (at Marine Gardens) are exposed to coastal flooding. ▪ By 2130, 4 beach assess points, 8 parks and reserves, 2 pieces of land owned and managed by the Department of Conservation, two shared paths (along the Wharemauku Stream, close to Alexander St and Matatua Rd), and oneplayground are exposed to coastal flooding, as are approximately nine businesses around Raumati Beach (including the Four Square supermarket, bars, cafes, restaurants, and a bakery) and two carparks servicing businesses and the beach. ▪ No other social infrastructure is exposed

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	M	H
Coastal Flooding	L	L	H	E

Note:

Exposure for erosion is limited to the beach and foreshore parks. Coastal flooding appears to impact some of the parks and reserves within the adaptation area and travels inland via the Wharemauku Stream and associated drainage network. Some areas including public amenities and facilities in Raumati Beach are affected by coastal flooding.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	H
Coastal Flooding	H	H	H	H

Notes:

The elements that are exposed are highly sensitive to the hazard and would no longer be able to fulful their intended purpose.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Limited options to adapt because the beach and parks are constrained by adjoining private properties
Coastal Flooding	L	Limited options to adapt because the beach and parks are constrined by adjoining private properties. Local Business have only limited response options

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	H	L	H	H	H	H
Flooding	H	H	H	H	L	H	H	H	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	M	H	H	H	H	H	L	L	M	H
Risk from Flooding	L	L	H	E	H	H	H	H	L	L	H	E

A.2.4 Risk of exacerbating existing inequities and creating new and additional inequities

Domain	Element at Risk	Overview
Human	**Risks of exacerbating existing inequities and creating new and additional inequities**	Risks of exacerbating existing inequities and creating new and additional inequities due to differential distribution of coastal erosion and coastal flooding impacts. This element focusses on the existing inequities in society that mean some people, groups, and households are less able to access services and resources (e.g. clean water, work, finance, insurance, safe and dry homes) that maintain and support wellbeing. It also includes the creation of new inequities though the actions taken to respond (or not) to the impacts and implications of a changing climate.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	As erosion becomes more pronounced over time, the value of affected properties will decrease. Decreasing values mean it is likely these properties will be purchased or rented by people with less financial means to cope with and recover from hazard events or insure against loss. This will trigger a progressive downward spiral of worsening living conditions and less access to services for those with fewer resources, deepening existing socio-economic inequities over time. The competition for "safe" land and homes within the community (away from erosion areas) will increase, meaning that those with the financial resources will be able to secure properties in low-risk areas while others will need to live with coastal erosion hazards. Some residents may have no option but to remain in highly impacted locations as safe locations become increasingly unattainable. New inequalities may be created or existing inequalities exacerbated through the response to managing the hazard. Inaction (or maladaptation) may create a series of ongoing losses and damages which will reduce wellbeing through lowered levels of access to services, opportunities, and safety. Access to insurance for affected properties may be reduced over time leading to further inequities within the community.
Coastal Flooding	As coastal flooding becomes more pronounced over time, the value of affected properties will decrease. Decreasing values mean it is likely these properties will be purchased or rented by people with less financial means to cope with and recover from hazard events or insure against loss. This will trigger a progressive downward spiral of worsening living conditions and less access to services for those with fewer resources, deepening existing socio-economic inequities over time. Living conditions in affected properties may be damp and create impacts on health and wellbeing, or exacerbate existing health inequities that are associated with low-income and other marginalised groups. The competition for "safe" land and homes within the community will increase meaning that those with the financial resources will be able to secure properties in low-risk areas while others will need to live with increasingly regular coastal flooding. Some residents may have no option but to remain in highly impacted locations as safe locations become increasingly unattainable. New inequalities may be created or existing inequalities exacerbated through the response to managing the hazard. Inaction (or maladaptation) may create a series of ongoing losses and damages which will reduce wellbeing through restricted access to services, opportunities, and safety. Access to insurance for affected properties may be reduced over time leading to further inequities within the community.

Opportunities

Hazard	Opportunities
Coastal Erosion	Adaptation can allow for a specific focus on managing local inequalities and avoiding creating new inequities
Coastal Flooding	Adaptation can allow for a specific focus on managing local inequalities and avoiding creating new inequities

A.2.4.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7% of private properties (n=249) are currently exposed to coastal erosion. As a result, the excerbation of existing inequities or the creation of new ones are low. ▪ However, there it is not possible to access data to describe the current situation. In particular, there is no data to indicate people may be moving due to the percieved risks; the impact of erosion on property values has not been explored in this region; and ability to access insurance has not been explored as data cannot be obtainined from insurance companies.	Future exposure: ▪ By 2050 8% of properties (n=280) in the adaptation area are at risk of erosion and could be lost or damaged. 100% of beach front properties are affected. ▪ By 2070 the % increases to 9% of the total properties (n=320) in the adaptation area ▪ By 2130 the % increases to 16% of the total properties (n=590) in the adaptation area As these properties are impacted, people are likely to lose their ability to insure against loss, they may either sell their property or remain in place as long as possible (and experience a slow worsening of living conditions). New inequities may be created and experienced by property owners. Properties that are sold for progressively lower value, or become a low-value rental will exacerbate existing socio-economic and health inequities. Reduction of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. This can lead to "hollowing out" of communities – people with fewer means are effectively trapped in a place with few opportunities to access services, resources, employment, and social connections. Conflict between different elements of the community may emerge over change in social norms and disagreement over what to do about ongoing physical social and economic change.
Currently exposed to coastal inundation: ▪ 1% of properties (n=54) in the adaptation area are at risk of coastal inundation. As a result, the excerbation of existing inequities or the creation of new ones are low.	Future exposure: ▪ By 2050, 2% of properties (n=75) within the adaptation area will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream ▪ By 2070 the % increases to 3% of the total properties (n=96) in the adaptation area ▪ By 2130 the % increases to 6% of the total properties (n=223) in the adaptation area As these properties are impacted, people are likely to move, either within the same community or further afield. An impact on social cohesion is possible if the composition of the community changes. Conversely, some residents may not be able to leave because of finaical constraints. Simultaneously, properties affected by semi-permenant inundation may devalue, and the areas affected may largely become home to households of lesser economic means. Reduction of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. This can lead to "hollowing out" of communities – people with fewer means are effectively

Details of exposure	
	trapped in a place with few opportunities to access services, resources, employment, and social connections. Conflict between different elements of the community may emerge over change in social norms and disagreement over what to do about ongoing physical, social, and economic change.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Notes:

The total number of properties within the adaptation area have been assessed rather than just the beach front properties, or areas adjacent to a waterway or drain. Targeted areas (e.g. around Wharemauku Stream) will have higher numbers of homes inundated with pockets of adverse effects for residents.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	M

Notes:

Based on 2018 census data (StatsNZ), the median income in the adaptation area was $34,237, which is slightly higher than the national median personal income ($31,800) for 2018. However, of the total population in the adaptation area, 26% earn under $20,000 per annum.

These people may face financial inequities that increase their sensitivity to coastal erosion and inundation. Additionally, the population of the adaptation area is somewhat diverse, containing groups (such as Māori, Pacific peoples, disabled, and older peoples) that have traditionally been shown to face barriers when applying for rental properties and often occupy the lower end of the rental and property market (due to higher propensity for being rejected as tenants, and the intersection of multiple forms of inequity that increase the likelihood that these groups are also low-income). These groups may end up occupying properties that have devalued in erosion and inundation areas.

Additionally, older peoples' physiology and the health inequities faced by groups such as Māori, Pacific peoples, and members of the disablity community increase their sensitivity to risks from occupying damp and mouldy homes (due to inundation).

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	There are no coordinated adaptation actions, indundation occurs frequently but intermittently. People with limited financial means may find it difficult to cope with, respond to, and adapt to erosion (e.g. by moving away) and may increase their exposure to hazards by moving to inexpensive homes in hazard areas. Owners of affected properties may face difficulties attaining home insurance, reducing their ability to respond to and recover from hazards like erosion.
Coastal Flooding	L	There are no coordinated adaptation actions, indundation occurs frequently but intermittently. People with limited financial means may find it difficult to cope with, respond to, and adapt to inundation (e.g. by moving away) and may

Domain	Adaptive Capacity	Key Assumptions
		increase their exposure to hazards by moving to inexpensive homes in hazard areas. Owners of affected properties may face difficulties attaining home insurance, reducing their ability to respond to and recover from hazards like erosion.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	L	M	M	M	H
Flooding	M	M	M	M	L	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	M	M	M	H	L	L	L	M
Risk from Flooding	L	L	L	L	M	M	M	M	L	L	L	L

A.2.4.1 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7% of private properties (n=249) are currently exposed to coastal erosion. As a result, the excerbation of existing inequities or the creation of new ones are low. ▪ However, it is not possible to access data to describe the current situation. In particular, there is no data to indicate people may be moving due to the percieved risks; the impact of erosion on property values has not been explored in this region; and ability to access insurance has not been explored as data cannot be obtainined from insurance companies.	Future exposure: ▪ By 2050 8% of properties (n=280) in the adaptation area are at risk of erosion and could be lost or damaged. ▪ 100% of beach front properties are affected. ▪ By 2070 the % increases to 10% of the total properties (n= 345) in the adaptation area ▪ By 2130 the % increases to 23% (822 properties of 3605 total properties) As these properties are impacted, people are likely to lose their ability to insure against loss, they may either sell their property or remain in place as long as possible (and experience a slow worsening of living conditions). New inequities may be created and experienced by property owners. Properties that are sold for progressively lower value, or become a low-value rental will exacerbate existing socio-economic and health inequities. Reduction of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. This can lead to "hollowing out" of communities – people with fewer means are effectively trapped in a place with few opportunities to access services, resources, employment, and social connections. Conflict between different elements of the community may emerge over change in social norms and disagreement over what to do about ongoing physical social and economic change.
Currently exposed to coastal inundation ▪ 1% of properties (n=54) in the adaptation area are at risk of coastal inundation. As a result, the excerbation of existing inequities or the creation of new ones are low.	Future exposure: ▪ By 2050, 2% of properties (n=280) within the adaptation area will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream ▪ By 2070 the % increases to 3% of the total properties (n= 114) in the adaptation area ▪ By 2130 the % increases to 13% of the total properties (n= 458) in the adaptation area As these properties are impacted, people are likely to move, either within the same community or further afield. An impact on social cohesion is possible if the composition of the community changes. Conversely, some residents may not be able to leave because of financial constraints. Simultaneously, properties affected by semi-permenant inundation may devalue, and the areas affected may largely become home to households of lesser economic means. Reduction of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. This can lead to "hollowing out" of communities – people with fewer means are effectively trapped in a place with few opportunities to access services, resources, employment, and social connections. Conflict between different elements of the community may emerge over change in social norms and disagreement over

Details of exposure	
	what to do about ongoing physical, social, and economic change.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Note:

The total number of properties within the adaptation area have been assessed rather than just the beach front properties, or areas adjacent to a waterway or drain. Targetted areas (e.g. around Wharemauku Stream) will have higher numbers of homes inundated with pockets of adverse effects for residents.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Notes:

Based on 2018 census data (StatsNZ), the median income in the adaptation area was $34,237, which is slightly higher than the national median personal income ($31,800) for 2018. However, of the total population in the adaptation area, 26% earn under $20,000 per annum. These people may face financial inequities that increase their sensitivity to coastal erosion and inundation.

Additionally, the population of the adaptation area is somewhat diverse, containing groups (such as Māori, Pacific peoples, disabled, and older peoples) that have traditionally been shown to face barriers when applying for rental properties and often occupy the lower end of the rental and property market (due to higher propensity for being rejected as tenants, and the intersection of multiple forms of inequity that increase the likelihood that these groups are also low-income). These groups may end up occupying properties that have devalued in erosion and inundation areas.

Additionally, older peoples' physiology and the health inequities faced by groups such as Māori, Pacific peoples, and members of the disability community increase their sensitivity to risks from occupying damp and mouldy homes (due to inundation).

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	There are no coordinated adaptation actions, indundation occurs frequently but intermittently. People with limited financial means may find it difficult to cope with, respond to, and adapt to erosion (e.g. by moving away) and may increase their exposure to hazards by moving to inexpensive homes in hazardous areas. Owners of affected properties may face difficulties attaining home insurance, reducing their ability to respond to and recover from hazards like erosion.
Coastal Flooding	L	There are no coordinated adaptation actions, indundation occurs frequently but intermittently. People with limited financial means may find it difficult to cope with, respond to, and adapt to inundation (e.g. by moving away) and may increase their exposure to hazards by moving to inexpensive homes in hazardous areas.

Domain	Adaptive Capacity	Key Assumptions
		Owners of affected properties may face difficulties attaining home insurance, reducing their ability to respond to and recover from hazards like erosion.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	L	M	M	M	H
Flooding	M	M	M	H	L	M	M	M	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	M	M	M	H	L	L	L	M
Risk from Flooding	L	L	L	L	M	M	M	H	L	L	L	L

A.2.5 Risk to social cohesion and community wellbeing

Domain	Element at Risk	Overview
Human	Risks to social cohesion and community wellbeing	**Risks to social cohesion and community wellbeing from displacement of individuals, families, and communities due to climate change impacts.** This element is focused on the community level and includes aspects of community cohesion and wellbeing associated with living in a particular place. Cohesion is described as the bonds that link communities and people together, and these may be physical place based, cultural, or social connections. Wellbeing is considered a measure of happiness or satisfaction and the ability to achieve personal and collective aspirations and enjoy a "good life" as defined by an individual, family, or group. The National Climate Change Risk Assessment describes two aspects to the risk to social cohesion. First, the risk associated with displacement and second, the risk to those left behind **(Ministry for the Environment, 2020)**. Displacement can cause trauma linked to disruption and dislocation from familiar surroundings and breaking of social and cultural bonds, and the challenges of resettlement. Movement between communities within the Kāpiti and Wellington Region may change the composition of communities, affect housing availability and affordability, change demand for social services, recreational facilities and schools, alter commuting patterns and introduce competition for other resources. Conflict may arise between existing residents and relocated households as disagreements about social norms and practices emerge. With less ties to support networks and opportunities, poorer health and wellbeing outcomes are likely. Affected communities will see a decrease in the local population as the residents relocate or are relocated. Properties may be increasingly occupied by those (from outside and within the community) who can't afford to live anywhere else. Newcomers may not have the same sense of attachment to the community. As households leave, the community will reduce in size and essential services may be slowly withdrawn, for example, education facilities, job opportunities, or community services. Investment in the affected communities will probably be reduced. Similar to displaced households, those who remain may experience trauma due to the breaking of family, social, and cultural bonds, and poorer health and wellbeing outcomes are likely. The breakdown of communities and the social bonds and connections to special places is important because fractured, less cohesive communities can result in conflict and feelings of isolation and loss.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	An increased incidence of coastal erosion will affect homes, property, businesses, and facilities and over time, decrease the desire and ability of people to remain in affected areas. As residents reach the limits of their tolerance, or properties become unlivable, they may relocate to other safe areas within the same community or elsewhere. Those leaving may experience loss of social and cultural bonds they held within their previous community, and an associated sense of 'dislocation.' They may also face challenges with integrating into new communities where there are different socio-cultural norms, precedents, and social networks. Those who stay because they are unable to leave may experience grief, sadness, anxiety and other emotional impacts from loss of social networks, which may be intensified if conflicts arise with newcomers (who may have different values or priorities in terms of how they live and how they wish to respond to hazards). Those who move to the community (to occupy lower value homes) may experience a sense of social isolation as the community 'hollows out' and there are limited opportunities for social connection, and access to normal services and opportunities.
Coastal Flooding	Certain areas of the community will progressively become unlivable due to the risk of periodic inundation. This will affect social cohesion at a slow pace as the sea slowly rises, affecting coastal homes, assets, and key infrastructure and access routes. A few households at a time may relocate after an event or due to the on-going stress of living with coastal inundation, or

Hazard	Description of Consequence (note any cascading impacts)
	isolation. The result will be a slowly reducing population size and the loss of essential services and opportunities, with consequent impacts for those who leave and those who stay. Community cohesion could be suddenly affected probably after an event as the desirability of the community is reduced by both the hazard and the diminishing provision of or access to support, education, job and education opportunities and social services. Social relationships, support networks and connections may be diminished, affecting wellbeing **(Boege, 2018; Campbell, 2019)**.

Opportunities

Hazard	Opportunities
Coastal Erosion	Create new opportunities to grow social cohesion, perhaps other opportunities to connect with others nearby or new ways to connect.
Coastal Flooding	Create new opportunities to grow social cohesion, perhaps other opportunities to connect with others nearby or new ways to connect.

A.2.5.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Current exposure to coastal erosion: ▪ Minimal impacts to social cohesion due to limited exposure of properties (7%) and other community services. ▪ However, there is no data to indicate people may be moving due to the percieved risks	Future exposure ▪ By 2050, 8% of properties (n=280) in the adaptation area are in erosion areas that could be lost or damaged. ▪ 100% of beach front properties are affected. ▪ By 2070 the % increases to 9% of the total properties (n=320) in the adaptation area ▪ By 2130 the % increases to 16% of the total properties (n=590) in the adaptation area As these properties are impacted, people are likely to move either within the same community or further afield. An impact on social cohesion is possible as if the compostion of the community changes. Hollowing out of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. Conflict between different elments of the community may emerge over change in social norms and disagreement over what to do about ongoing physical, social, and economic change.
Current exposure to coastal inundation: ▪ Minimal impacts to social cohesion due to limited exposure of properties (1%) and other community services. ▪ However, there is no data to indicate people may be moving due to the perceived risks	Future exposure: ▪ By 2050, 2% of properties (n=75) will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream ▪ By 2070, the % increases to 3% of the total properties (n=96) in the adaptation area ▪ By 2130 the % increases to 6% of the total properties (n=223) in the adaptation area As these properties are impacted, people are likely to move either within the same community or further afield. An impact on social cohesion is possible if the composition of the community changes. Conversely, some residents may not be able to leave because of financial constraints. Simultaneously, properties affected by periodic inundation may devalue and the areas affected become home to households with lesser economic means. Hollowing out of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. Conflict between different elements of the community may emerge over change in social norms and disagreement over what to do about ongoing physical, social, and economic change.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	L

Notes:

Exposure for the total properties in the adaptation area is considered, rather than just a focus on the beach front properties.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	M	M
Coastal Flooding	L	L	L	M

Notes:

Based on the 2018 census 48% of residents had lived at the location for less than 5 years, which means that there is a reasonable population turnover. It is, however, also worth noting that 16% of the population in the adaptation area have resided there for over 15 years and are likely to be embedded in the local community. The latter group are likely to be more sentivie to long term changes associated and challenges associated with social cohesion.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	People generally struggle to adjust to change within their communities, particularly where loss of properties and change in community composition occur. If people move, it is hard to maintain and re-establish social networks and connections that underpin social cohesion.
Coastal Flooding	L	People generally struggle to adjust to change within their communities, particularly where loss of properties and change in community composition occur. If people move, it is hard to maintain and re-establish social networks and connections that underpin social cohesion.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	M	M	L	L	L	M	M
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	L	L	M	M	L	L	L	M
Risk from Flooding	L	L	L	L	L	L	L	M	L	L	L	L

A.2.5.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Current exposure to coastal erosion: ▪ Minimal impacts to social cohesion due to limited exposure of properties (7%) and other community services. ▪ However, there is no data to indicate people may be moving due to the percieved risks	Future exposure: ▪ By 2050, 8% of properties (n=280) in the adaptation area are in erosion areas that could be lost or damaged. ▪ 100% of beach front properties are affected. ▪ By 2070 the % increases to 10% of the total properties (n= 345) in the adaptation area ▪ By 2130 the % increases to 23% (822 properties of 3605 total properties) As these properties are impacted, people are likely to move either within the same community or further afield. An impact on social cohesion is possible as if the composition of the community changes. Hollowing out of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. Conflict between different elements of the community may emerge over change in social norms and disagreement over what to do about ongoing physical, social, and economic change.
Current exposue to coastal inundation ▪ Minimal impacts to social cohesion due to limited exposre of properties (1%) and other community services. ▪ However, there is no data to indicate people may be moving due to the perceived risks	Future exposure: ▪ By 2050, 2% of properties will expereince periodic coastal indundation and could be lost or damaged, principally around Wharemauku Stream ▪ By 2070, the % increases to 3% of the total properties (n= 114) in the adaptation area ▪ By 2130 the % increases to 13% of the total properties (n= 458) in the adaptation area As these properties are impacted people are likely to move either within the same community or further afield. An impact on social cohesion is possible if the composition of the community changes. Conversely, some residents may not be able to leave because of financial constraints. Simultaneously, properties affected by periodic inundation may devalue and the areas affected become home to households with lesser economic means. Hollowing out of services may occur as the community reduces in size and there is less investment in the area because of the known hazards. Conflict between different elements of the community may emerge over change in social norms and disagreement over what to do about ongoing physical, social, and economic change.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M
Coastal Flooding	L	L	L	M

Note:

Exposure for the total properties in the adaptation area is considered, rather than just a focus on the beach front properties.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	M	H
Coastal Flooding	L	L	M	H

Notes:

Based on the 2018 census 48% of residents had lived at the location for less than 5 years, which means that there is a reasonable population turnover. It is, however, also worth noting that 16% of the population in the adaptation area have resided there for over 15 years and are likely to be embedded in the local community. The latter group are likely to be more sentivie to long term changes associated and challenges associated with social cohesion.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	People generally struggle to adjust to change within their communities, particularly where loss of properties and change in community composition occur. If people move, it is hard to maintain and re-establish social networks and connections that underpin social cohesion.
Coastal Flooding	L	People generally struggle to adjust to change within their communities, particularly where loss of properties and change in community composition occur. If people move, it is hard to maintain and re-establish social networks and connections that underpin social cohesion.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	M	H	L	L	L	M	H
Flooding	L	L	M	H	L	L	L	M	H

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	M	L	L	M	H	L	L	L	M
Risk from Flooding	L	L	L	M	L	L	M	H	L	L	L	M

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A.2.6 Risk of conflict, disruption, and loss of trust in government

Domain	Element at Risk	Overview
Human	Risks of conflict, disruption, and loss of trust in government	Risks of conflict, disruption, and loss of trust in government from changing patterns in the value of assets and competition for access to scarce resources, primarily due to periodic inundation events and ongoing erosion.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion causes disruption and conflict as residents and businesses compete for government assistance and safe land. Conflict over who pays for adaptation actions leads to community fragmentation and disagreement, with flow on impacts to social cohesion and potential to exacerbate existing inequalities in the community. Inaction/action by the government leads to loss of trust in government institutions, cynicism within the community, and community opposition.
Coastal Flooding	Coastal flooding causes disruption and conflict as residents and businesses compete for government assistance and safe land. Conflict over who pays for adaptation actions lead to community fragmentation and disagreement, with flow on impacts to social cohesion and potential to exacerbate existing inequalities in the community. Inaction/action by the government leads to loss of trust in government institutions, cynicism within the community, and community opposition.

Opportunities

Hazard	Opportunities
Coastal Erosion	Build strong transparent relationships with the local community
Coastal Flooding	Build strong transparent relationships with the local community

A.2.6.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7% of properties (n=249) in the adapation area are currently exposed to coastal erosion and could be lost or damaged. However, 95/104 (89%) beach front properties are exposed. It is highly likely that residents of beachfront properties will favour hard protection structures that protect their properties (Rouse et al., 2016), yet this action may not be universally accepted by others in the community, leading to intra-community conflict. CAP Engagement: Raumati Adaptation Area Summary (Kāpiti Coast District Council, 2023) shows residents of Raumati hold diverse views on their preferred adaptation options: many support seawalls, but others have a preference for beach re-nourishment, dune planting, or stricter regulatory conrols on building in coastal areas.	Future exposure ▪ By 2050 8% of properties (n=280) in the adaptation area are at risk of erosion and could be lost or damaged. 100% of beach front properties are affected. ▪ By 2070 the % increases to 9% of the total properties (n=320) in the adaptation area ▪ By 2130 the % increases to 16% of the total properties (n=590) in the adaptation area Increasing erosion of public spaces along the coastal strips including parks, reserves, and beach access points over time (see risk to social infrastructure and amenity). Increasing erosion increases competition for safe land over time. As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to increases to inundation come to the fore, and people differ in their thoughts on when different sets of adaptation should occur. It is highly likely that residents of beachfront properties will favour hard protection structures that protect their properties, yet this action may not be universally accepted by others in the community, leading to intra-community conflict.
Currently exposed to coastal flooding: ▪ 1% of properties (n=54) in the adaptation area are at risk of coastal inundation and could be lost or damaged ▪ Beach access points, parks and reserves and a walkway are exposed to periodic flooding (see risk to social infrastructure and amenity)	Future exposure: ▪ By 2050, 2% of properties (n=75) within the adaptation area will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream ▪ By 2070 the % increases to 3% of the total properties (n=96) in the adaptation area ▪ By 2130 the % increases to 6% of the total properties (n=223) in the adaptation area Increased incidence of flooding of public spaces along the coastal strips including parks, reserves, and beach access points over time (see risk to social infrastructure and amenity) Increasing periodic inundation over time increases the competition within the community for safe land. As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to increases to inundation come to the fore, and people differ in their thoughts on when different sets of adaptation should occur.

Hazard	Present	2050	2070	2130
Coastal Erosion	H	H	E	E
Coastal Flooding	L	L	M	M

Notes:

Depending on how the impacts of the hazards unfold and the decision made regarding what actions (if any) are taken, a large number of residents within the adaptation area may be at risk of conflict. In particular, the conflict arising from the percieved "winners" and "losers" of various courses of action. Percentages of beach front properties at risk of inundation are unavailable, therefore we have used only percentages of total

properties at risk of inundation in the adaptation area. If the values for beach front properties were available for inundation this may have yielded a higher exposure to this risk. Certain portions of the community (primarily low income households) will not be able to compete for safe land and will face little choice but to live in hazardous locations, or leave the area.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	M	M	H	H

Notes:

Raumati Adaptation Area Values Engagement Summary Report (Kāpiti Coast District Council, 2023) demonstrates evidence that some segments of the community already have doubts about planned adaptation actions (or lack thereof), which could lead to future conflicts between residents themselves, and conflict and lack of trust between the community and local government.

The report also demonstrates that residents of Raumati have strong feelings of attachment to their community, and particularly the beach. There is likely to be a heightened risk of conflict about structures that change the appearance and access to the beach and other places of importance, particularly between property owners who directly benefit from these actions, and those who feel they "lose out" due to reduced amenity value and connection to important places and spaces.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Adaptation actions are consistent with existing pathways Some portions of the community will face financial barriers to relocation and competition for safe land, resulting in limited capacity to adapt to erosion It is possible to build trust and overcome intra-community and community/government conflicts through robust and transparent engagement
Coastal Flooding	M	Adaptation actions are consistent with existing pathways Some portions of the community will face financial barriers to relocation and competition for safe land, resulting in limited capacity to adapt to flooding It is possible to build trust and overcome intra-community and community/government conflicts through robust and transparent engagement

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	H	E	M	M	M	M	H
Flooding	M	M	H	H	M	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	H	H	E	E	M	M	M	H	M	M	H	E
Risk from Flooding	L	L	M	M	M	M	M	M	L	L	M	M

A.2.6.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ 7% of properties (n=249) in the adaptation area are currently exposed to coastal erosion and could be lost or damaged. However, 95/104 (89%) beach front properties are exposed. It is highly likely that residents of beachfront properties will favour hard protection structures that protect their properties (Rouse et al., 2016), yet this action may not be universally accepted by others in the community, leading to intra-community conflict. CAP Engagement: Raumati Adaptation Area Summary (Kāpiti Coast District Council, 2023) shows residents of Raumati hold diverse views on their preferred adaptation options: many support seawalls, but others have a preference for beach re-nourishment, dune planting, or stricter regulatory conrols on building in coastal areas.	Future exposure: ▪ By 2050 8% of properties (n=280) in the adaptation area are at risk of erosion and could be lost or damaged. 100% of beach front properties are affected. ▪ By 2070 the % increases to 10% of the total properties (n= 345) in the adaptation area ▪ By 2130 the % increases to 23% (822 properties of 3605 total properties) Increasing erosion of public spaces along the coastal strips including parks, reserves, and beach access points over time (see risk to social infrastructure and amenity) Increasing erosion increases competition for safe land over time As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to increases to inundation come to the fore, and people differ in their thoughts on when different sets of adaptation should occur. It is highly likely that residents of beachfront properties will favour hard protection structures that protect their properties, yet this action may not be universally accepted by others in the community, leading to intra-community conflict.
Currently exposed to coastal flooding: ▪ 1% of properties (n=54) in the adaptation area are at risk of coastal inundation and could be lost or damaged ▪ Beach access points, parks and reserves and a walkway are exposed to periodic flooding (see risk to social infrastructure and amenity)	Future exposure: ▪ By 2050, 2% of properties (n=280) within the adaptation area will experience coastal inundation and could be lost or damaged, principally around Wharemauku Stream ▪ By 2070 the % increases to 3% of the total properties (n= 114) in the adaptation area ▪ By 2130 the % increases to 13% of the total properties (n= 458) in the adaptation area Increased incidence of flooding of public spaces along the coastal strips including parks, reserves, and beach access points over time (see risk to social infrastructure and amenity) Increasing periodic inundation over time increases the competition within the community for safe land. This may also include competition between the 8 businesses affect by periodic inundation by 2130. As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to increases to inundation come to the fore, and people differ in their thoughts on when different sets of adaptation should occur.

Hazard	Present	2050	2070	2130
Coastal Erosion	H	H	E	E

Hazard	Present	2050	2070	2130
Coastal Flooding	L	L	M	M

Note:

Depending on how the impacts of the hazards unfold and the decision made regarding what actions (if any) are taken, a large number of residents within the adaptation area may be at risk of conflict. In particular, the conflict arising from the percieved "winners" and "losers" of various courses of action. Percentages of beach front properties at risk of inundation are unavailable, therefore we have used only percentages of total properties at risk of inundation in the adaptation area. If the values for beach front properties were available for inundation this may have yielded a higher exposure to this risk. Certain portions of the community (primarily low income households) will not be able to compete for safe land and will face little choice but to live in hazardous locations, or leave the area.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	H	E	E
Coastal Flooding	M	H	H	H

Notes:

Raumati Adaptation Area Values Engagment Summary Report (Kāpiti Coast District Council, 2023) demonstrates evidence that some segments of the community already have doubts about planned adaptation actions (or lack thereof), which could lead to future conflicts between residents themselves, and conflict and lack of trust between the community and local government.

The report also demonstrates that residents of Raumati have strong feelings of attachment to their community, and particularly the beach. There is likely to be a heightened risk of conflict about structures that change the appearance and access to the beach and other places of importance, particularly between property owners who directly benefit from these actions, and those who feel they "lose out" due to reduced amenity value and connection to important places and spaces.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Adaptation actions are consistent with existing pathways Some portions of the community will face financial barriers to relocation and competition for safe land, resulting in limited capacity to adapt to erosion It is possible to build trust and overcome intra-community and community/government conflicts through robust and transparent engagement
Coastal Flooding	M	Adaptation actions are consistent with existing pathways Some portions of the community will face financial barriers to relocation and competition for safe land, resulting in limited capacity to adapt to flooding It is possible to build trust and overcome intra-community and community/government conflicts through robust and transparent engagement

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	H	E	E	M	M	M	H	H
Flooding	M	H	H	H	M	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	H	H	E	E	M	M	H	H	M	M	E	E
Risk from Flooding	L	L	M	M	M	M	M	M	L	L	M	M

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A.3 Ecological Risk Assessment Templates

A.3.1 Coastal dunelands

Domain	Element at Risk	Overview
Ecological	Coastal dunelands	Areas of duneland as mapped by GWRC. There are two areas of defined coastal dunelands within the RAA (Figure A.3.1): (1) Raumati Beach dunes north of Matatua Road at the mouth of the Wharemaukū Stream (*c.* 4,280 m^2) and (2) the southern part of the Paraparaumu dunelands located at the northern end of the RAA at Marine Parade (*c.* 2,970 m^2). There are two areas of DOC managed public land shown on the lower map in the Mapped Ecological Sites section; Raumati No 2 and No 3 Conservation Areas. These are Conservation Act S25 Stewardship Areas. Raumati No2 is 0.0397 hectares of beach with some dunes behind the seawall. Raumati No3 is 0.0329 hectares of beach[23]. Potential effects on the beach within the RAA are also considered.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Removal of sand from the beach, lowering the beach profile, and allowing waves to travel further inland. Depending on the storm's size, the area affected may be the toe of the dunes, but larger storms could wash away all of them if wave action or surge is severe enough. In an unmodified duneland, the function of eroded foredunes would be taken over by more inland dunes. That is the more inland dunes would become the foredunes. However, the amount of human infrastructure on more inland dunes precludes this. Thus, there is a risk that coastal foredunes would be completely eroded and not replaced. The Raumati Beach dunes are also part of the Wharemauku Estuary, increased stream flooding could speed up this process. Dunes help protect human infrastructure as well as providing habitat for plants and animals.
Coastal Flooding	The bathtub model illustrates the potential effect of rare events such as the 1976 flood. In combination with coastal erosion, land subsidence and increased flooding from the Wharemauku Stream the Raumati Beach dunes could be affected earlier than the southern Paraparaumu dune section. Flooding would increase the rate of sand removal accelerating coastal erosion.

Opportunities

Hazard	Opportunities
Coastal Erosion	Remove pest plant species, especially marram grass and plant the dunes with pīngao and spinifex to make the dunes more resilient and less prone to erosion. These indigenous species typically result in a more stable but lower elevation dunes and can assist with retaining sand and growing the beach seawards. Where other required coastal works enable this (e.g. sewerage line or road upgrades), include dune reconstruction and restoration to create additional/greater areas of natural duneland.
Coastal Flooding	Remove pest plant species, especially marram grass and plant the dunes with pīngao and spinifex to make the dunes more resilient and less prone to erosion, and reduce potential for future flooding

[23] Raumati No1 is on the south bank of the Wharemaukū Stream near the airport and appears to have been largely built over.

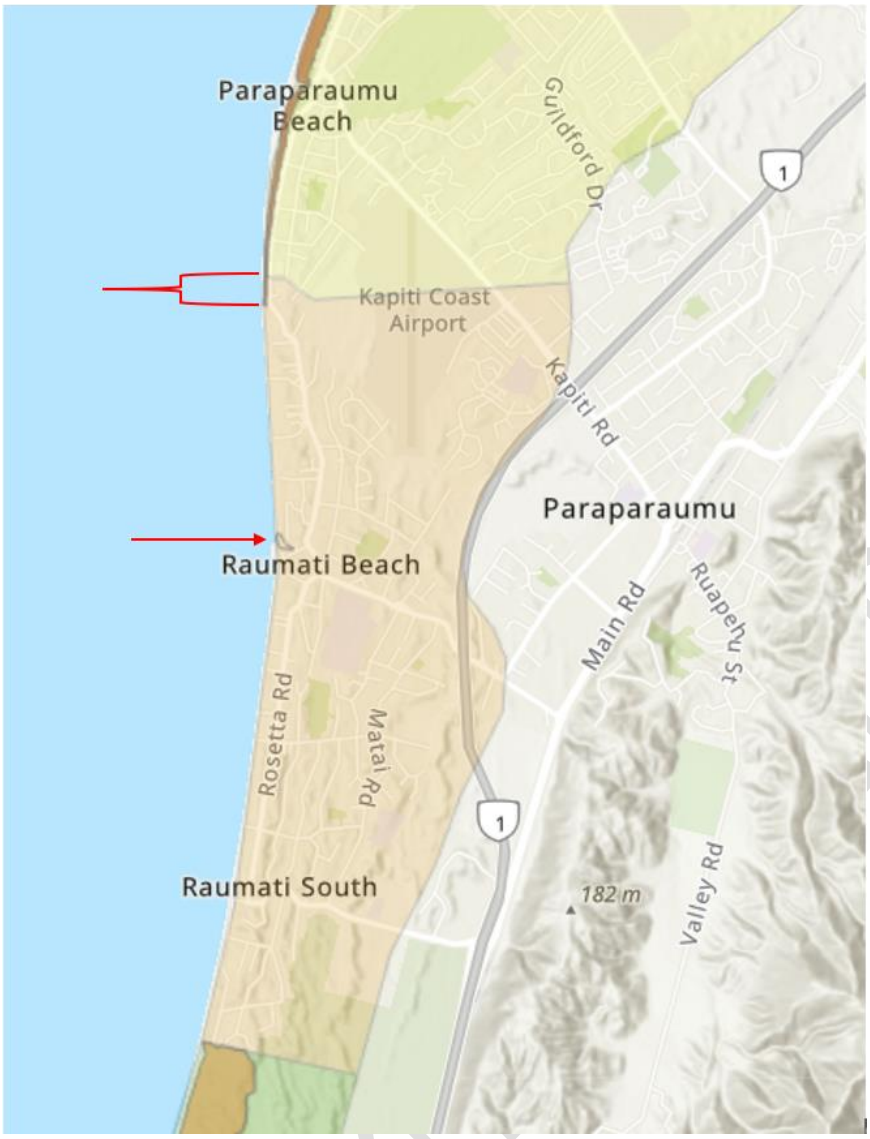

Figure A.3.1: Location of Coastal Dunelands in the Raumati Adaptation Area

A.3.1.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	

Currently exposed to coastal erosion
- Currently there are two areas of dune exposed to short term storm erosion:
  o Raumati Beach dunes
  o The southern part of the Paraparaumu dunelands
- And two small Conservation areas.
	Future exposure:
	- 2050: 100% of both areas of dunes could be affected
	- 2070: 100% of both areas of dunes could be affected
	- 2130: 100% of both areas of dunes could be affected
	- The conservation areas will be affected under all scenarios.

Currently exposed to coastal flooding
- Currently there are two areas of dune exposed to potential flooding:
  o The Raumiti Beach dunes could be affected by both sea and Wharemaukū Stream flooding
  o The southern part of the Paraparaumu dunelands could be affected by sea flooding.
- And two small conservation areas.
	Future exposure:
	- 2050: Approximately 91% of Raumati Beach dunes and 28% of southern Paraparaumu dunes likely to be affected
	- 2070: Approximately 94% of Raumati Beach dunes and 33% of southern Paraparaumu dunes likely to be affected
	- 2130: Approximately 100% of Raumati Beach dunes and 45% of southern Paraparaumu dunes likely to be affected
	- The Conservation Aresa will be affected under all the scenarios.

Hazard	Present	2050	2070	2130
Coastal Erosion	H	E	E	E
Coastal Flooding	M	H	H	E

Notes:

- Due to the shape of the coast, there is a reduced sediment supply to the Raumati foreshore.
- This means that the beach and dune systems are not replenished and move inland with erosion.
- Ad hoc public and private coastal protection structures (seawalls) have been constructed since at least 1955.
- Hard structures can cause waves to deflect, so erosion can occur in two directions, one from the sea and the other from deflected waves.
- Hence there is little duneland remaining, other than the Raumati Beach dunes north of Matatua Road at the mouth of the Wharemauku Stream, and the southern part of the Paraparaumu dunelands along Marine Parade. Fauna also use the beach during lower tides.
- The Kāpiti Coast is subsiding due to tectonic movement and this in incorporated into the future projections of erosion hazard, and therefore is considered for effects on the dunes.

Erosion:

- Measured from the toe of the dunes to the highest modelled erosion line.
- The data indicates that the coastal 30 m of Raumati dunes are currently at risk of erosion but the inland half could be retained. The Paraparaumu dunes have a higher possibility of erosion with the present day erosion line some 30 m behind the toe of the dune.
- From 2050 on the erosion zone includes 100% of both areas of dune.

Flooding:

- Measured as the area of dune affected by the modelled flooding.
- The bathtub model illustrates the potential effect of rare events such as the 1976 flood. If such an event would occur today, then the Raumati dunes would be 78% inundated by floods. For the Paraparaumu dunes the model indicates that the most seaward 21% of the dune toe could be affected. Hence a combined risk assessment of medium.
- This increases to high from 2050 as more than 90% of the Raumati dunes could be affected as well as nearly a third of the Paraparaumu dunes.
- The increase to extreme in 2130 is because 100% of the Raumati dunes and nearly half of the Paraparaumu dunes could be affected by flooding.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	E	E	E
Coastal Flooding	H	E	E	E

Notes:

- Due to reduced sand supply to the Raumati foreshore, and the human-built environment inland of the dunes, the dunes are not able to progressively move inland.
- Storm surge lowering the beach profile, ongoing tectonic subsidence, and increased flood or high flow events coming from waterways increase the level of sensitivity.
- Pest plant species such as marram increasing the height of dunes and providing a less robust sand retention environment than indigenous dune species. This makes the toes of the foredunes more succeptible to being underminded, causing dune collapse and further erosion.

Erosion:

- Present day sensitivity has been ranked as high due to present day erosion risk, no room for the dune re-establish inland, and lack of coastal sand input.
- From 2050 on the erosion zone includes 100% of both areas of dune and they are unlikely to be able to recover hence sensitivity increases to extreme.

Flooding:

- Present-day sensitivity to flood events is ranked as high due to the Raumati dunes being exposed to both coastal and stream flood events.
- This increases to extreme from 2050 as more than 90% of the Raumati dunes could be affected as well as nearly a third of the Paraparaumu dunes.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	Low volume of sand supply. Dunes are unable to progressively move inland. Storm surge and more frequent flood events lowering beach profile, and tectonic subsidence, allowing storm surge to move further inland. Pest plants resulting in less stable dunes.
Coastal Flooding	L	The Raumati dunes could be eroded from 1) storm surge, 2) Wharemaukū Stream flood events, 3) deflected waves from hard structures. If this happens then the dunes will disapear and make the area more sensitive to flooding. Due to low sand input and inability of dunes to move progressively inland there is very low adaptive capacity. The southern part of the Paraparaumu dunes are modelled to be more resilient; hence low adaptive capacity overall.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	E	E	E	VL	E	E	E	E
Flooding	H	E	E	E	L	H	E	E	E

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	H	E	E	E	E	E	E	E	E	E	E	E
Risk from Flooding	M	H	H	E	H	E	E	E	M	E	E	E

A.3.1.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	

Currently exposed to coastal erosion
- Currently there are two areas of dune exposed to short term storm erosion:
  - Raumati Beach dunes; and
  - The southern part of the Paraparaumu dunelands.
- And two small Conservation areas.
	Future exposure:
	- 2050: 100% of both areas of dunes could be affected
	- 2070: 100% of both areas of dunes could be affected
	- 2130: 100% of both areas of dunes could be affected
	- The conservation areas will be affected under all scenarios.

Currently exposed to coastal flooding
- Currently there are two areas of dune exposed to potential flooding:
  - The Raumiti Beach dunes could be affected by both sea and Wharemaukū Stream flooding
  - The southern part of the Paraparaumu dunelands could be affected by sea flooding
- And two small Conservation areas.
	Future exposure:
	- 2050: Approximately 91% of Raumati Beach dunes and 28% of southern Paraparaumu dunes likely to be affected
	- 2070: Approximately 94% of Raumati Beach dunes and 38% of southern Paraparaumu dunes likely to be affected
	- 2130: Approximately 100% of Raumati Beach dunes and 49% of southern Paraparaumu dunes likely to be affected
	- The conservation areas will be affected under all scenarios.

Hazard	Present	2050	2070	2130
Coastal Erosion	H	E	E	E
Coastal Flooding	M	H	H	E

- Due to the shape of the coast, there is a reduced sediment supply to the Raumati foreshore.
- This means that the beach and dune systems are not replenished and move inland with erosion.
- Ad hoc public and private coastal protection structures (seawalls) have been constructed since at least 1955.
- Hard structures can cause waves to deflect, so erosion can occur in two directions, one from the sea and the other from deflected waves.
- Hence there is little duneland remaining, other than the Raumati Beach dunes north of Matatua Road at the mouth of the Wharemauku Stream, and the southern part of the Paraparaumu dunelands along Marine Parade. Fauna also use the beach during lower tides.
- The Kāpiti Coast is subsiding due to tectonic movement and this in incorporated into the future projections of erosion hazard, and therefore is considered for effects on dunes.

Erosion:

- Measured from the toe of the dunes to the highest modelled erosion line.
- The data indicates that the coastal 30 m of Raumati dunes are currently at risk of erosion but the inland half could be retained. The Paraparaumu dunes have a higher possibility of erosion with the present day erosion line some 30 m behind the toe of the dune.
- From 2050 on the erosion zone includes 100% of both areas of dune.

Flooding:

- Measured as the area of dune affected by the modelled flooding.
- The bathtub model illustrates the potential effect of rare events such as the 1976 flood. If such an event would occur today, then the Raumati dunes would be 78% inundated by floods. For the Paraparaumu

Dunes the model indicates that the most seaward 21% of the dune toe could be affected. Hence a combined risk assessment of moderate.

- This increases to high from 2050 as more than 90% of the Raumati dunes could be affected as well as nearly a third of the Paraparaumu dunes.
- The increase to extreme in 2130 is because 100% of the Raumati dunes and nearly half of the Paraparaumu dunes could be affected by flooding.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	H	E	E	E
Coastal Flooding	H	E	E	E

Notes:

- Due to reduced sand supply to the Raumati foreshore, and the human-built environment inland of the dunes, the dunes are not able to progressively move inland.
- Storm surge lowering the beach profile, ongoing tectonic subsidence, and increased flood or high flow events coming from waterways increase the level of sensitivity.
- Pest plant species such as marram increasing the height of dunes and providing a less robust sand retention environment than indigenous dune species. This makes the toes of the foredunes more succeptible to being underminded, causing dune collapse and further erosion.

Erosion:

- Present day sensitivity has been ranked as high due to present day erosion risk, no room for the dune re-establish inland, and lack of coastal sand input.
- From 2050 on the erosion zone includes 100% of both areas of dune hence sensitivity increases to extreme.

Flooding:

- Present-day sensitivity to flood events is ranked as high due to the Raumati dunes being exposed to both coastal and stream flood events.
- This increases to extreme from 2050 as more than 90% of the Raumati dunes could be affected as well as nearly a third of the Paraparaumu dunes.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	Low volume of sand supply. Dunes are unable to progressively move inland. Storm surge and more frequent flood events lowering beach profile, and tectonic subsidence, allowing storm surge to move further inland. Pest plants resulting in less stable dunes.
Coastal Flooding	L	The Raumati dunes could be eroded from 1) storm surge, 2) Wharemauku Stream flood events, 3) deflected waves from hard structures. If this happens then the dunes will disapear and make the area more sensitive to flooding. The toe of the southern Paraparaumu dunes would be undermined weaking the dunes and potentially allowing the dunes to be breached to flood more inland areas. Due to low sand input and the inability of dunes to move progressively inland there is low adaptive capacity.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	H	E	E	E	VL	E	E	E	E

Hazard	Sensitivity			Adaptive Capacity		Vulnerability		
Flooding	H	E	E	E	L	H	E	E	E

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	H	E	E	E	E	E	E	E	E	E	E	E
Risk from Flooding	M	H	H	E	H	E	E	E	M	E	E	E

A.3.2 Wetlands

Domain	Element at Risk	Overview
Ecological	Wetlands	There are three areas of mapped wetlands indicated in Figure A.3.2. From north to south these are K093-Andrew's Pond, K131 Raumati South Peatlands, and K184 Poplar Ave Wetland. None of these mapped wetlands intersect with modelled erosion or coastal flooding risks of any modelled timespan. These three areas are also identified as GWRC Significant Wetlands, but they are not Outstanding Wetlands.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Not within the erosion zone of any of the modelled time periods. However, these are the mapped wetlands; the National Policy Statement for Freshwater Management has broadened the definition of natural wetlands so there may be additional areas of unmapped wetland.
Coastal Flooding	Not within the coastal flooding zone of any of the modelled time periods. However, these are the mapped wetlands; the National Policy Statement for Freshwater Management has broadened the definition of natural wetlands so there may be additional areas of unmapped wetland.

Opportunities

Hazard	Opportunities
Coastal Erosion	Probably very low to nil.
Coastal Flooding	Probably very low to nil.

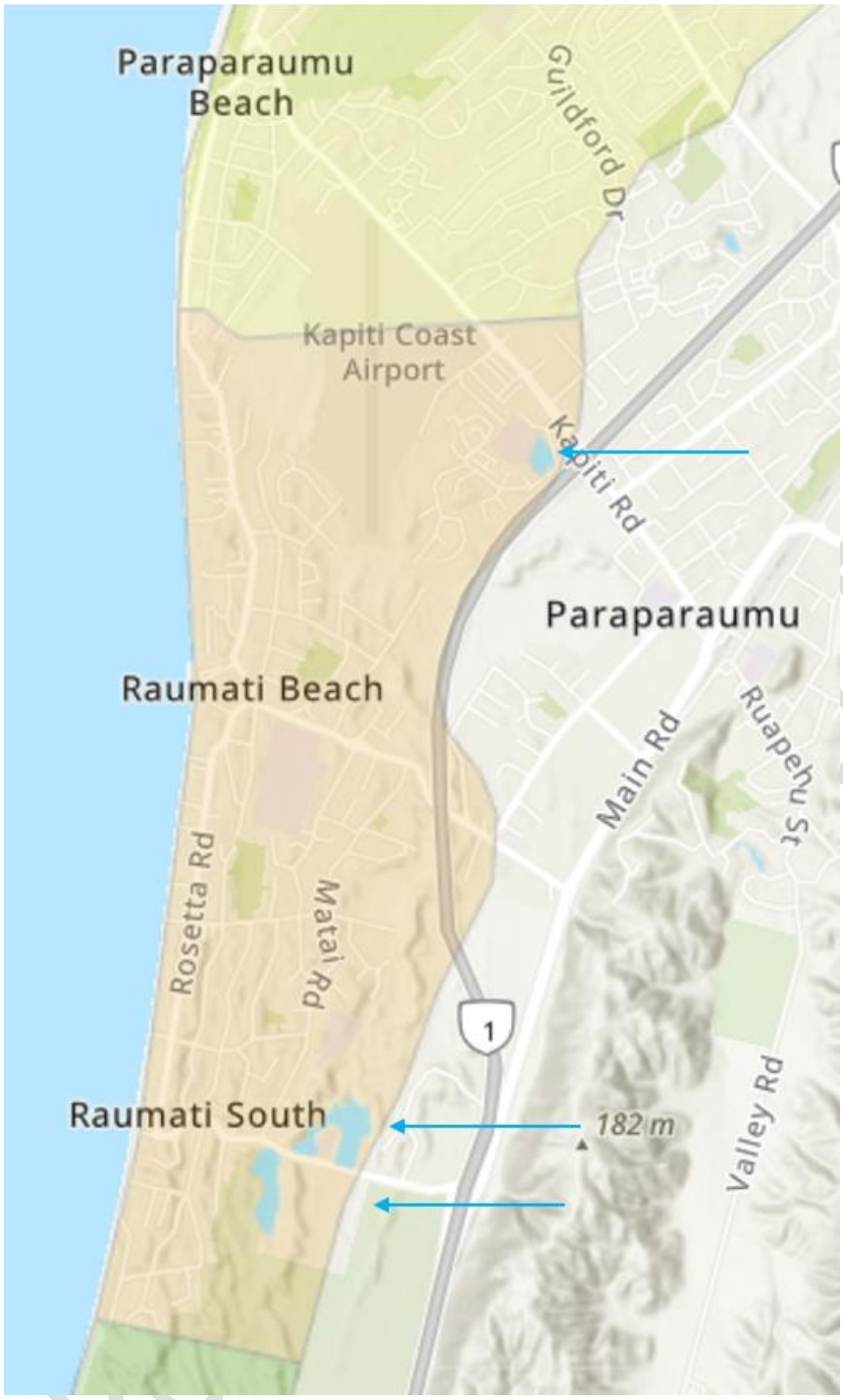

Figure A.3.2: Location of mapped wetlands in the Raumati Adaptation Area.

A.3.2.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
▪ Coastal erosion; three mapped inland wetlands - K093-Andrew's Pond, - K131 Raumati South Peatlands, and - K184 Poplar Ave Wetland. ▪ All three wetlands are not exposed to coastal erosion over any timeframe.	▪ The mapped wetlands are not at risk of coastal erosion over any timeframe assessed with SLR.
▪ Coastal flooding; three mapped inland wetlands - K093-Andrew's Pond, - K131 Raumati South Peatlands, and - K184 Poplar Ave Wetland. ▪ All three wetlands are not exposed to coastal inundation over timeframe.	▪ The mapped wetlands are not at risk of coastal flooding over any timeframe assessed with SLR.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Note:

- Mapped wetlands are not exposed to coastal erosion or flooding for any of the modelled time periods.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

- Sensitivity is only ranked for the mapped wetlands. None of the mapped wetlands are within the coastal erosion or flooding areas of any of the modelled time periods.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	The modelled erosion zones currently do not affect these mapped wetlands. However, should wetlands be affected then they will have a low adaptive capacity. Wetlands require hollows, impervious or semi-impervious base substrate, a source of water (ground, inflow, or rain) and it can take many years to develop wetland soils. Wetlands cannot easily move across the landscape.
Coastal Flooding	VL	The modelled erosion zones currently do not affect these mapped wetlands. However, should wetlands be affected then they will have a low adaptive capacity. Wetlands require elevational hollows, impervious or semi-impervious base substrate, a source of water

Domain	Adaptive Capacity	Key Assumptions
		(ground, inflow, or rain) and it can take many years to develop wetland soils. Wetlands cannot easily move across the landscape.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	VL	M	M	M	M
Flooding	L	L	L	L	VL	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	M	M	M	M	L	L	L	L
Risk from Flooding	L	L	L	L	M	M	M	M	L	L	L	L

A.3.2.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
▪ Coastal erosion; three mapped inland wetlands - K093-Andrew's Pond, - K131 Raumati South Peatlands, and - K184 Poplar Ave Wetland. ▪ All three wetlands are not exposed to coastal erosion over any timeframe.	▪ The mapped wetlands are not at risk of coastal erosion across any of the three future timeframes assessed.
▪ Coastal flooding; three mapped inland wetlands - K093-Andrew's Pond, - K131 Raumati South Peatlands, and - K184 Poplar Ave Wetland. ▪ All three wetlands are not exposed to coastal flooding over any timeframe.	▪ The mapped wetlands are not at risk of coastal flooding across any of the three future timeframes assessed.

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Note:

None of the mapped wetlands are within the coastal erosion or flooding areas for any of the modelled time periods.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

Sensitivity is only ranked for the mapped wetlands. None of the mapped wetlands are within the coastal erosion or flooding areas of any of the modelled time periods.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	The modelled erosion zones currently do not affect these mapped wetlands. However, should wetlands be affected then they will have a low adaptive capacity. Wetlands require hollows, impervious or semi-impervious base substrate, a source of water (ground, inflow, or rain) and it can take many years to develop wetland soils. Wetlands cannot easily move across the landscape.
Coastal Flooding	VL	The modelled erosion zones currently do not affect these mapped wetlands. However, should wetlands be affected then they will have a low adaptive capacity. Wetlands require elevational hollows,

Domain	Adaptive Capacity	Key Assumptions
		impervious or semi-impervious base substrate, a source of water (ground, inflow, or rain) and it can take many years to develop wetland soils. Wetlands cannot easily move across the landscape.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	VL	M	M	M	M
Flooding	L	L	L	L	VL	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	M	M	M	M	L	L	L	L
Risk from Flooding	L	L	L	L	M	M	M	M	L	L	L	L

A.3.3 Mapped ecological sites

Domain	Element at Risk	Overview
Ecological	Mapped ecological sites	There are three areas of mapped ecological site within the RAA – shown in Figure A.3.3 with green diagonal hexing. From north to south these are K093-Andrew's Pond (which is also DOC managed land), K131 Raumati South Peatlands, and K184 Poplar Ave Wetland within Queen Elizabeth Park managed by GWRC. None of these mapped ecological sites intersect with modelled erosion or coastal flooding risks of any modelled timespan. There are two areas of DOC managed public land indicated by the blue arrows in the map on the right of Figure A.3.3; Raumati No 2 (upper most) and No 3 (lower most) Conservation Areas. These are Conservation Act S25 Stewardship Areas. Raumati No2 is 0.0397 hectares of beach with some dunes behind the seawall. Raumati No3 is 0.0329 hectares of beach. There are some areas mapped by GWRC as Managed Open Space, namely the Marine Gardens at the mouth of the Wharemauku Stream and the Tennis Road area. However, the values of these areas relate to organised sport and activities rather than ecological values and will not be discussed further.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	KCDC Ecological Sites are not within the erosion zone of any of the modelled time periods. DOC managed public land, Conservation Act S25 Stewardship Areas, Raumati No2 and Raumati No3 are affected by present day erosion. Erosion of the dunes behind the seawall is visible on aerials of Raumati No2, and progressive erosion of the beach is affecting both areas. There is a high risk that both areas will be completely eroded and lost under all future scenarios. But the ecological values within these areas are probably low.
Coastal Flooding	KCDC Ecological Sites are not within the coastal flooding zone of any of the modelled time periods. DOC managed public land, Conservation Act S25 Stewardship Areas, Raumati No2 and Raumati No3 are affected by present day flooding. Flooding can cause erosion of sand dunes and beach systems. Erosion of the dunes behind the seawall is visible on aerials of Raumati No2, and progressive erosion of the beach is affecting both areas. There is a high risk that both areas will be completely underwater and lost under all future scenarios. But the ecological values within these areas are probably low.

Opportunities

Hazard	Opportunities
Coastal Erosion	Probably very low to nil.
Coastal Flooding	Creation of additional wetland areas.

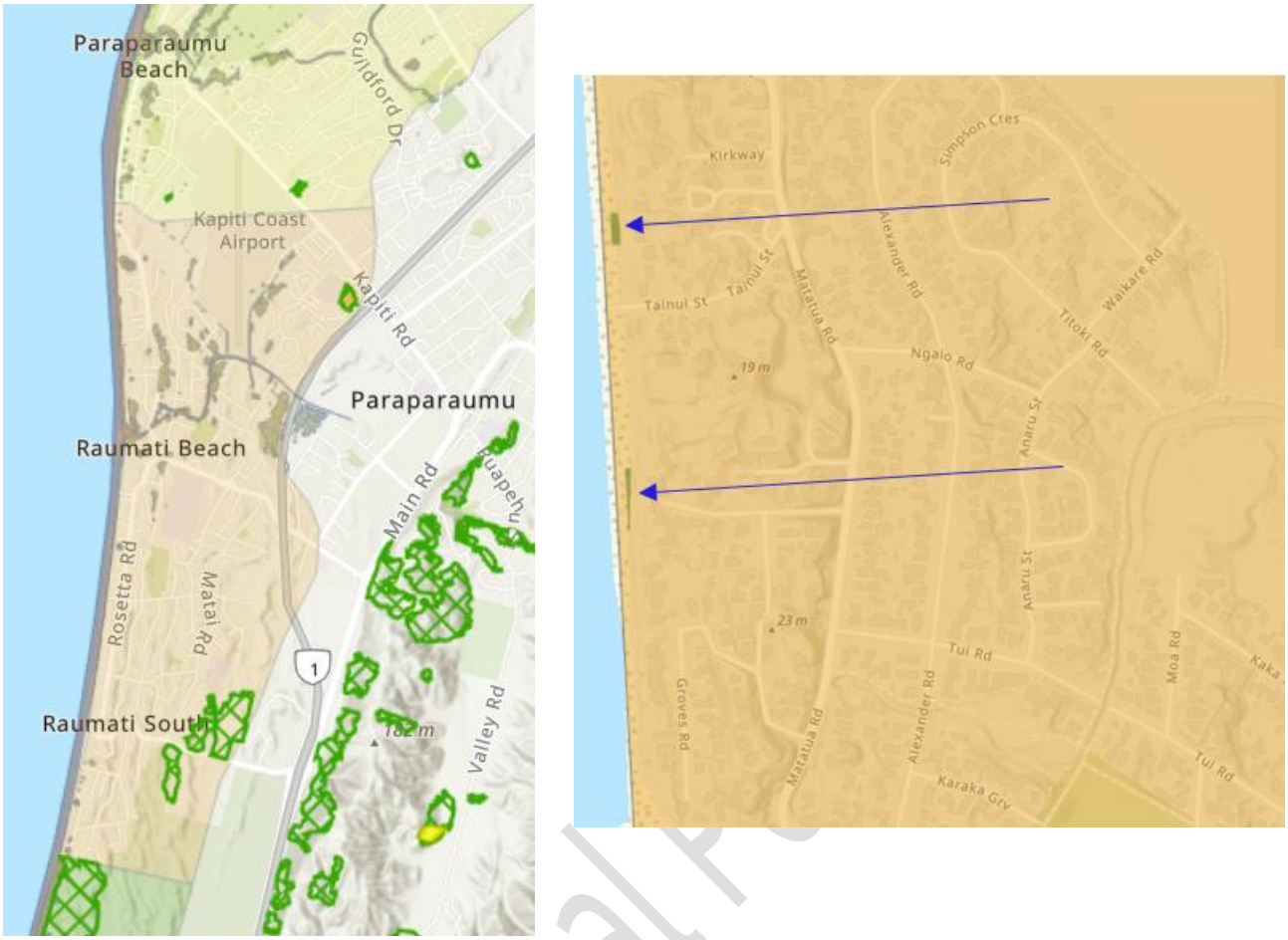

Figure A.3.3: Location of Mapped Ecological Sites (left) and two areas of DOC managed public land (right).

A.3.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	

- Coastal erosion; three mapped KCDC Ecological Sites and two areas of DOC managed land
  o K093-Andrew's Pond,
  o K131 Raumati South Peatlands, and
  o K184 Poplar Ave Wetland.
- None of the above sites are currently exposed to coastal erosion.
  o Raumati No2 (DOC)
  o Raumati No3 (DOC)
	- KCDC Ecological Sites are not at risk of coastal erosion.
	- Raumati No2 and Raumati No3 are affected by present day erosion. Erosion of the dunes behind the seawall is visible on aerials of Raumati No2, and progressive erosion of the beach is affecting both areas. But the ecological values within these areas are probably low.
	- Hence the risk has been set as moderate as 2 of 5 sites are already and will be increasingly affected.

- Coastal flooding; three mapped KCDC Ecological Sites and two areas of DOC managed land
  o K093-Andrew's Pond,
  o K131 Raumati South Peatlands, and
  o K184 Poplar Ave Wetland.
- None of the above sites are currently exposed to coastal erosion.
  o Raumati No2 (DOC)
  o Raumati No3 (DOC)
	- KCDC Ecological Sites are not at risk of coastal flooding.
	- Raumati No2 and Raumati No3 are affected by present day flooding which will exacerbate erosion of dunes and the beach. But the ecological values within these areas are probably low.
	- Hence the risk has been set as moderate as 2 of 5 sites are already and will be increasingly affected.

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	M
Coastal Flooding	M	M	M	M

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

- Sensitivity is ranked for the mapped KCDC Ecological Sites. None of the KCDC Ecological Sites are within the coastal erosion or flooding zones of any of the modelled time periods.
- The ecological values of the two area of DOC managed public land are likely to be low, and the sensitivity of these dune and beach areas has already been assessed under Coastal dunelands.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	Ecological sites have a very low adaptive capacity, as they cannot move to another location.
Coastal Flooding	VL	Ecological sites have a very low adaptive capacity, as they cannot move to another location.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	VL	M	M	M	M
Flooding	L	L	L	L	VL	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	M	M	M	M	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	M	M	M	M	M	M	M	M	M

A.3.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Coastal erosion: - The three mapped KCDC Ecological Sites are not affected by erosion. - the two areas of DOC managed land are affected by erosion: o Raumati No2 (DOC) o Raumati No3 (DOC)	- KCDC Ecological Sites are not at risk of coastal erosion. - Raumati No2 and Raumati No3 are affected by present day erosion. Erosion of the dunes behind the seawall is visible on aerials of Raumati No2, and progressive erosion of the beach is affecting both areas. But the ecological values within these areas are probably low. - Hence the risk has been set as moderate as 2 of 5 sites are already and will be increasingly affected.
- Coastal flooding; three mapped KCDC Ecological Sites and two areas of DOC managed land o K093-Andrew's Pond, o K131 Raumati South Peatlands, and o K184 Poplar Ave Wetland. - None of the above sites are currently exposed to coastal erosion. o Raumati No2 (DOC) o Raumati No3 (DOC)	- KCDC Ecological Sites are not at risk of coastal flooding. - Raumati No2 and Raumati No3 are affected by present day flooding which will exacerbate erosion of dunes and the beach. But the ecological values within these areas are probably low. - Hence the risk has been set as moderate as 2 of 5 sites are already and will be increasingly affected.

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	M
Coastal Flooding	M	M	M	M

Notes:

In 2130 flooding will penetrating much further inland, especially up the Wharemauku Stream past the Expressway near Ihakara Street, with the potential to increase erosion of the inland dune areas as well as changes to hydrology from flooding causing changes in vegetation and habitat types. However, the three KCDC Ecological Sites are not modelled to be flooded.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

Sensitivity is only ranked for the mapped wetlands. None of the mapped wetlands are within the coastal erosion or flooding zones of any of the modelled time periods.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	Ecological sites have a very low adaptive capacity, as they cannot move to another location.

Domain	Adaptive Capacity	Key Assumptions
Coastal Flooding	VL	Ecological sites have a very low adaptive capacity, as they cannot move to another location.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	VL	M	M	M	M
Flooding	L	L	L	L	VL	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	M	M	M	M	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	M	M	M	M	M	M	M	M	M

A.3.4 Indigenous trees

Domain	Element at Risk	Overview
Ecological	Indigenous tree species	There are 32 Key Indigenous Trees (KCDC Schedule 2) as shown in Figre A.3.4, and about 24 Notable Trees (KCDC Schedule 8) within the RAA. Most of the notable trees are exotic trees, or indigenous trees such as pohutukawa, mountain celery pine, or kauri that are not native to the Kāpiti Coast. There are five Key Indigenous Trees that could be affected by erosion (4) or flooding (2), including one totara at 241 Rosetta Road that will be affected by most future erosion and flooding scenarios. Most of the notable trees are exotic trees, or indigenous trees such as pohutukawa, mountain celery pine, or kauri that are not native to the Kāpiti Coast.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Four Key Indigenous Trees (all totara) within the erosion zone of any of the modelled time periods. These trees would be lost to erosion.
Coastal Flooding	Only one of the Key Indigenous Trees (a 17 m tall totara) occurs within a small outlier of the coastal flooding zone of all of the modelled time periods. Another rimu will be affected the most extreme modelled flooding. These trees could be lost due to root rotting if flooding is frequent or persistent.

Opportunities

Hazard	Opportunities
Coastal Erosion	Planting coastal shrubs and trees may help consolidate the dunes behind the seawall. However, this would reduce people's sea views from the houses, and if the trees got tall and fell over it may increase the rate of erosion.
Coastal Flooding	Collect seeds from the trees that are at risk and propagate these to grow in areas that are less susceptible to flooding to preserve the genes of these trees.

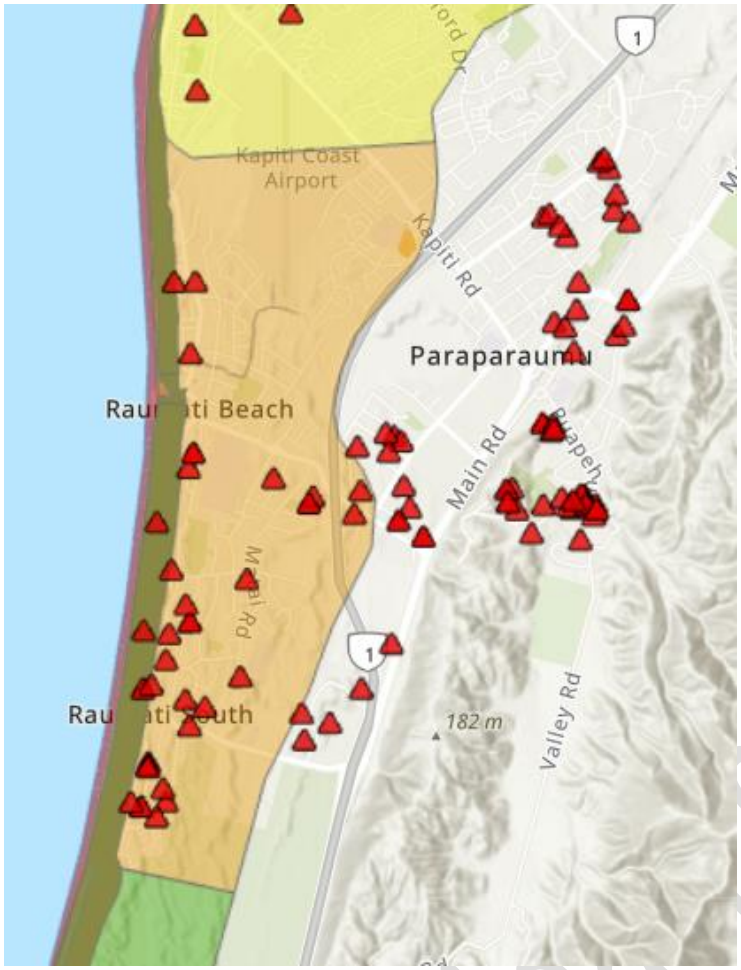

Figure A.3.4: Location of key indigenous trees within the Raumati Adaptation Area.

A.3.4.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Erosion: - No Key Indigenous Trees will be affected by coastal erosion - No indigenous Notable Trees are exposed to coastal erosion	Future exposure: - 2050: No trees affected - 2070: 2 of 32 Key Indigenous Trees will be affected - 2130: 4 of 32 Key Indigenous Trees will be affected
- Flooding - No Key Indigenous Trees will be affected by coastal flooding - No indigenous Notable Trees are exposed to coastal flooding	Future exposure: - 2050: 1 of 32 Key Indigenous Trees will be affected - 2070: 1 of 32 Key Indigenous Trees will be affected - 2130: 2 of 32 Key Indigenous Trees will be affected

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Note:
The effects of coastal erosion and flooding would affect up to four Key Indigenous Tree out of 32 (KCDC Schedule 2) and all the Notable Trees (KCDC Schedule 8) that might be affected are not indigenous species. Hence the exposure is considered to be low.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:
The effects of coastal erosion and flooding would only affect one Key Indigenous Tree out of about 50 trees listed in KCDC Operative District Plan Schedules (Key Indigenous Trees in Schedule 2, and Notable Trees in Schedule 8). Hence the sensitivity is considered to be low.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	It would be very difficult and costly to relocate any of these large Key Indigenous Trees or Notable Trees.
Coastal Flooding	L	It would be very difficult and costly to relocate any of these large Key Indigenous Trees or Notable Trees.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Erosion	L	L	L	L	L	L	L	L	L
Flooding	L	L	L	L	L	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	L	L	L	L	L	L	L	L	L	L	L
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

A.3.4.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Domain	Element at Risk	Overview
Ecological	Key indigenous tree species	There are 32 Key Indigenous Trees (KCDC Schedule 2, red triangles), and about 24 Notable Trees (KCDC Schedule 8, not shown) within the RAA. Most of the notable trees are exotic trees, or indigenous trees such as pohutukawa, mountain celery pine, or kauri that are not native to the Kāpiti Coast. There are 16 Key Indigenous trees that could be affected by erosion (12) or flooding (6), including one totara at 241 Rosetta Road that will be affected by most future erosion and flooding scenarios.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Four Key Indigenous Trees (all totara) within the erosion zone of any of the modelled time periods. These trees would be lost to erosion. Another eight trees (one northern rata, one rewarewa, two rimu and four totara) might be affected by erosion changing hydrology or soil stability.
Coastal Flooding	Only one of the Key Indigenous Trees (a 17 m tall totara) occurs within a small outlier of the coastal flooding zone of all of the modelled time periods. Another four trees (one rimu, and three totara) will be affected by the most extreme modelled flooding, and a northern rata may also be affected. These trees could be lost due to root rotting if flooding is frequent or persistent.

Opportunities

Hazard	Opportunities
Coastal Erosion	Planting coastal shrubs and trees may help consolidate the dunes behind the seawall. However, this would reduce people's sea views from the houses, and if the trees got tall and fell over it may increase the rate of erosion.
Coastal Flooding	Collect seeds from the trees that are at risk and propagate these to grow in areas that are less susceptible to flooding to preserve the genes of these trees.

Exposure

Details of exposure	
Erosion: - No Key Indigenous Trees will be affected by coastal erosionNo indigenous Notable Trees are exposed to coastal erosion	Future exposure: - 2050: No trees affected - 2070: 2 of 32 Key Indgenous Trees will be affected - 2130: 4 of 32 Key Indgenous Trees will be affected, and 8 could be
Flooding: - No Key Indigenous Trees will be affected by coastal floodingNo indigenous Notable Trees are exposed to coastal flooding	Future exposure: - 2050: 1 of 32 Key Indgenous Trees will be affected - 2070: 1 of 32 Key Indgenous Trees will be affected

Details of exposure	
	- 2130: 5 of 32 Key Indgenous Trees will be affected, and one could be

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	H
Coastal Flooding	L	L	L	M

Note:

For most of the erosion modelling scenarios only a small number of Key Indigenous Trees of 32 in the RAA (KCDC Schedule 2) would or could be affected by coastal erosion. However this increased to 12 for the 2130 SSP5-8.5 scenario. Thus the exposure changes from low to high.

Flooding would only affect one Key Indigenous Tree, but another five would or could be affected for the 2130 SSP5-8.5 scenario. Thus, the exposure changes from low to moderate.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	H
Coastal Flooding	L	L	L	M

Notes:

For most of the erosion modelling scenarios only a small number of Key Indigenous Trees of 32 in the RAA (KCDC Schedule 2) would or could be affected by coastal erosion. However, this increased to 12 for the 2130 SSP5-8.5 scenario. Thus the sensitivity changes from low to high.

Flooding would only affect one Key Indigenous Tree, but another five would or could be affected for the 2130 SSP5-8.5 scenario. Thus, the sensitivity changes from how to moderate.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	It would be very difficult and costly to relocate any of these large Key Indigenous Trees or Notable Trees.
Coastal Flooding	L	It would be very difficult and costly to relocate any of these large Key Indigenous Trees or Notable Trees.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	H	L	L	L	L	H
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130

	Exposure				Vulnerability				Risk			
Risk from Erosion	L	L	L	H	L	L	L	H	L	L	L	H
Risk from Flooding	L	L	L	M	L	L	L	M	L	L	L	M

A.3.5 Rare and threatened species

Domain	Element at Risk	Overview
Ecological	Rare and threatened species	In terms of fauna species, at lower tides the beach would provide feedings and resting habitat for a range of seabirds including At Risk-Declining species such as red-billed Gull (Tarāpunga), black-billed gull (Tarāpuka), At Risk-Recovering pied shag (Kāruhiruhi). At Risk-Relict fluttering shearwater (Pakahā) might occasionally rest on the beach but are more often sea floating in large groups just off the coast. The Wharemauku Stream mouth provides core or seasonal habitat for red-billed gulls[24]. This stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios. At Risk-Declining copper skink has been reported from Raumati South and At Risk-Declining Goldstripe Gecko may occur in areas of flax. Lizards and the habitats of lizards are protected under the Wildlife Act 1977. Not threatened common skinks are known from foreshore habitat including dune habitat. There are no Nationally and Regionally Rare and Threatened Species populations listed for RAA in Schedule 3 of the Operative Kāpiti Coast District Plan. There are no records for Threatened or At Risk plant species, but it is possible that Sand Dune Kanuka (Kunzea amathicola; Threatened – Nationally Vulnerable) could still occur. The exposure to rare and threatened species is based on the proxy of loss of properties, as there still may be areas of habitat in people's gardens where these species persist.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Erosion could result in the loss of habitat for rare and threatened species, including alterations to the Wharemauku Stream mouth, and dune habitat. This will have a more significant adverse effect for species with less mobility such as lizards and plants. Due to the highly modified nature of the landscape, if rare and threatened species do occur then they are probably in relatively low numbers. More mobile species, such as birds, could use other areas, including more inland areas. However, given that erosion will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species. The Wharemauku Stream mouth would be totally eroded to where the Wharemauku Stream is piped beneath Matatua Road under the 2130 modelled scenario.
Coastal Flooding	Coastal flooding could result in the loss of habitat (possibly temporary) for rare and threatened species, especially alterations to the Wharemauku Stream mouth and remnant dune habitat. This will have a more significant adverse effect for species with less mobility such as lizards and plants. Due to the highly modified nature of the landscape, if rare and threatened species do occur then they are probably in relatively low numbers. More mobile species, such as birds, could use other areas, including more inland areas. However, given that coastal flooding will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species. The Wharemauku Stream mouth would be totally flooded to where the Wharemauku Stream is piped beneath Matatua Road under the 2130 modelled scenario.

[24] McArthur N., Lawson J. 2014. Coastal and freshwater sites of significance for indigenous birds in the Wellington region, September 2013. Environmental Science Department , Greater Wellington Regional Council, Wellington, No. Publication No. GW/ESCI-T-14/67.

Opportunities

Hazard	Opportunities
Coastal Erosion	Planting more indigenous dune species to strengthen the dunes would also provide more habitat for rare or threatened fauna. This could include planting dune plant species that are Threatened or At Risk. Undertake pest animal and/or pest plant control to help retain rare and threatened species. Collect seed or plants of rare or threatened species and establish secure populations inland. Create inland habitat for fauna (e.g. lizards, invertebrates) with excellent predator control and establish secure inland populations (note for some species such as lizards a Wildlife Permit would be required from DOC). Fauna individuals could be relocated to these secure sites from other salvage operations in the district (with appropriate management plan and/or Wildlife Permit).
Coastal Flooding	Planting more indigenous dune species to strengthen the dunes would also provide more habitat for rare or threatened fauna. This could include planting dune plant species that are Threatened or At Risk. Undertake pest animal and/or pest plant control to help retain rare and threatened species. Collect seed or plants of rare or threatened species and establish secure populations inland. Create inland habitat for fauna (e.g. lizards, invertebrates) with excellent predator control and establish secure inland populations (note for some species such as lizards a Wildlife Permit would be required from DOC). Fauna individuals could be relocated to these secure sites from other salvage operations in the district (with appropriate management plan and/or Wildlife Permit).

A.3.5.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 249 (7%) properties exposed to short term storm erosion	Future exposure: 2050: 280 private properties (8%) 2070: 320 private properties (9%) 2130: 590 private properties (16%)
Currently exposed to coastal flooding - Currently there are 54 (1%) private properties exposed to coastal inundation - generally at properties north of Wharemauku Stream.	Future exposure: 2050: 75 private properties are exposed (2%) 2070: 96 private properties are exposed (3%) 2130: 223 private properties are exposed (6%) – mostly around low lying properties in historic dune swales inland from the coast.

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Note:

- There is little information about rare and threatened species to help quantify effects. The lack of information may be due to there being few rare or threatened species but can also be due to lack of observations and recording of such species, rather than their absence. Many of the smaller species can still occur in people's backgardens without being observed, or observed but not reported to a national peer-reviewed database. Hence there is no or little information for most of these species. To assess the loss of potential habitat of Threatened or At Risk species a proxy was used of the number of properties that could be affected.
- Given the high level of human modification in the RAA it is probably more likely that few rare or threatened species remain.
- Adverse will be greater for species with less mobility such as lizards and plants, rather than seabirds or other birds.
- However, given that coastal flooding will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species.
- Effects on the Wharemauku Stream mouth and small areas of dune elevate the risk of loss of rare or threatened species, but this is moderated by the probably low abundance of species.
- The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.

Erosion:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would disapear at the same rate as has been used for loss of private property.
- The increase to high in 2130 is due to the percentage increase of property eroded and the loss of dunes and the Wharemauku Stream mouth.

Flooding:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would disapear at the same rate as has been used for loss of private property. Flooding may only be temporary, which would reduce the effects.
- The increase to high in 2130 is due to the percentage increase of property flooded and the loss of dunes and the Wharemauku Stream mouth.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Notes:

- Assigned a moderate sensitivity as more mobile species such as birds can relocate to new habitat, but less mobile rare and threatened species such as lizards and plants will be at risk.
- The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.
- However, given that coastal flooding will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species.
- There may also be some political/legislation sensitivity around loss of species and their habitat protected under the Wildlife Act 1977.

Erosion:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would disapear at the same rate as has been used for loss of private property.
- The increase to high in 2130 is due to the percentage increase of property eroded and the loss of dunes and the Wharemauku Stream mouth.

Flooding:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would disapear at the same rate as has been used for loss of private property. Flooding may only be temporary, which would reduce the effects.
- The increase to high in 2130 is due to the percentage increase of property flooded and the loss of dunes and the Wharemauku Stream mouth.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	That less mobile rare or threatened species will not be able to move to alternative habitat and will be lost. That mobile species such as birds move to other locations, or inland.
Coastal Flooding	M	That less mobile rare or threatened species will not be able to move to alternative habitat and will be lost. That mobile species such as birds move to other locations, or inland.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130

	Exposure				Vulnerability				Risk			
Risk from Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.3.5.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - Currently there are 249 (7%) properties exposed to short term storm erosion.	Future exposure: - 2050: 280 private properties (8%) - 2070: 345 private properties (10%) - 2130: 822 private properties (23%)
Currently exposed to coastal flooding - Currently there are 54 (1%) private properties exposed to coastal inundation.	Future exposure: - 2050: 75 private properties are exposed (2%) - 2070: 114 private properties are exposed (3%) - 2130: 458 private properties are exposed (13%) – generally inland properties in historic dune swales around the Wharemauku Stream.

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Note:

- There is little information about rare and threatened species to help quantify effects. The lack of information may be due to there being few rare or threatened species but can also be due to lack of observations and recording of such species, rather than their absence. Many of the smaller species can still occur in people's backgardens without being observed, or observed but not reported to a national peer-reviewed database. Hence there is no or little information for most of these species. To assess the loss of potential habitat of Threatened or At Risk species a proxy was used of the number of properties that could be affected.
- Given the high level of human modification in the RAA it is probably more likely that few rare or threatened species remain.
- Adverse will be greater for species with less mobility such as lizards and plants, rather than seabirds or other birds.
- However, given that coastal flooding will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species.
- Effects on the Wharemauku Stream mouth and small areas of dune elevate the risk of loss of rare or threatened species, but this is moderated by the probably low abundance of species. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.

Erosion:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would dissapear at the same rate as has been used for loss of private property.
- The increase to high in 2130 is due to the percentage increase of property eroded and the loss of dunes and the Wharemauku Stream mouth.

Flooding:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would dissapear at the same rate as has been used for loss of private property. Flooding may only be temporary, which would reduce the effects.
- The increase to high in 2130 is due to the percentage increase of property flooded and the loss of dunes and the Wharemauku Stream mouth.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Notes:

- Assigned a moderate sensitivity as more mobile species such as birds can relocate to new habitat, but less mobile rare and threatened species such as lizards and plants will be at risk.
- However, given that coastal flooding will likely affect more of the coastline than just within the RAA, alternative coastal habitat may be significantly reduced even for mobile species.
- The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.
- There may also be some political/legislation sensitivity around loss of species and their habitat protected under the Wildlife Act 1977.

Erosion:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would dissapear at the same rate as has been used for loss of private property.
- The increase to high in 2130 is due to the percentage increase of property eroded and the loss of dunes and the Wharemauku Stream mouth.

Flooding:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat (people's gardens) would dissapear at the same rate as has been used for loss of private property. Flooding may only be temporary, which would reduce the effects.
- The increase to high in 2130 is due to the percentage increase of property flooded and the loss of dunes and the Wharemauku Stream mouth.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	That less mobile rare or threatened species will not be able to move to alternative habitat and will be lost. That mobile species such as birds move to other locations, or inland.
Coastal Flooding	M	That less mobile rare or threatened species will not be able to move to alternative habitat and will be lost. That mobile species such as birds move to other locations, or inland.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130

	Exposure				Vulnerability				Risk			
Risk from Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.3.6 Bird habitat

The RAA was surveyed for birds as part of the southern Paraparaumu bird survey (pink bracket). Paraparaumu Beach (blue area north of the RAA) is identified in the GWRC NRP as important bird habitat because the area provides seasonal or core habitat for variable oystercatcher, red-billed gull, Caspian tern and white-fronted tern. Although this area does not extend into the RAA the habitat is similar and likely to provide seasonal habitat for these same species, as borne out by the eBird species list for Wharemauku Stream (see below). It also seems unlikely that these species would not use adjacent areas of beach at lower tides for feeding and resting.

According to the GWRC NRP Wharemauku Stream mouth provides seasonal or core habitat for red-billed gulls. However, the eBird species list for this area also includes white-fronted tern (At Risk-Declining), Caspian tern (Threatened-Nationally Vulnerable), black-billed gull (At Risk-Declining), fluttering shearwater (At Risk-Relict), black-fronted dotterel (At Risk- Naturally Uncommon), and smaller numbers of little pied shag (Non-Resident Vagrant), and At Risk-Recovering variable oystercatcher and pied shag[25].

Domain	Element at Risk	Overview
Ecological	Bird habitat	The RAA was surveyed for birds as part of the southern Paraparaumu bird survey. The Paraparaumu Beach area identified as important for birds by GWRC does not extend into the RAA, but the habitat does as evidenced by eBird data for parts of the Raumati Beach. At lower tides the beach would provide feeding and resting habitat for a range of seabirds including At Risk-Declining species such as red-billed Gull (Tarāpunga), black-billed gull (Tarāpuka), At Risk-Recovering pied shag (Kāruhiruhi). At Risk-Relict fluttering shearwater (Pakahā) might occasionally rest on the beach but are more often sea floating in large groups just off the coast. The Wharemauku Stream mouth provides core or seasonal habitat for red-billed gulls and the eBird species list also includes white-fronted tern (At Risk-Declining), Caspian tern (Threatened-Nationally Vulnerable), black-billed gull (At Risk-Declining), fluttering shearwater (At Risk-Relict), black-fronted dotterel (At Risk- Naturally Uncommon), and smaller numbers of little pied shag (Non-Resident Vagrant), and At Risk-Recovering variable oystercatcher and pied shag. Inland erosion and flooding distances were used as a proxy to measure the potential loss of shoreline bird habitat.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Erosion could result in the loss of habitat for bird species, including alterations to the Wharemauku Stream mouth, and dune habitat. The issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the RAA but also reducing habitat for birds to move too. The Wharemauku Stream mouth would be totally eroded to where the Wharemauku Stream is piped beneath Matatua Road under the 2130 modelled scenario. Erosion could alter the nearshore morphology in relation to the coastline, and could potentially result in a change in food supplies which could adversely affect bird populations, putting them at greater risk of (local or more wide-spread) extinction. Erosion could also bury in-shore benthic food sources (buried invertebrates in the sand), reducing food for the birds.

[25] https://ebird.org/hotspot/L7706184/bird-list?rank=lrec

Hazard	Description of Consequence (note any cascading impacts)
	Loss of coastal bird habitat might result in greater human vs bird conflict/interaction if birds seek out alternative locations to rest, nest and feed. Locations such as sports fields, roof tops, trees in gardens and parks, local ponds and amenity features.
Coastal Flooding	Flooding could result in the (temporary) loss of habitat for bird species, including alterations to the Wharemauku Stream mouth, and dune habitat. The issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the RAA but also reducing habitat for birds to move too. The Wharemauku Stream mouth would be totally flooded to where the Wharemauku Stream is piped beneath Matatua Road under the 2130 modelled scenario. Increased flooding is likely to result in greater sediment input into waterways, smothering in-shore benthic food sources (buried invertebrates in the sand) reducing of food supplies which could adversely affect bird populations, putting them at greater risk of (local or more wide-spread) extinction.

Opportunities

Hazard	Opportunities
Coastal Erosion	Predator control program to keep birds safe. Education to ensure that humans keep their dogs under control and allow birds to rest and recuperate. Creating and/or maintaining safe bird habitat somewhere away from coastal erosion (e.g. predator control around the old Otaki sewage treatment site, assisting private landowners with predator control around lakes and ponds with high bird values, creating an inland dune lake with beach as bird habitat).
Coastal Flooding	Predator control program to keep birds safe. Education to ensure that humans keep their dogs under control and allow birds to rest and recuperate. Creating and/or maintaining safe bird habitat somewhere away from coastal flooding (e.g. predator control around the old Otaki sewage treatment site, assisting private landowners with predator control around lakes and ponds with high bird values, creating an inland dune lake with beach as bird habitat).

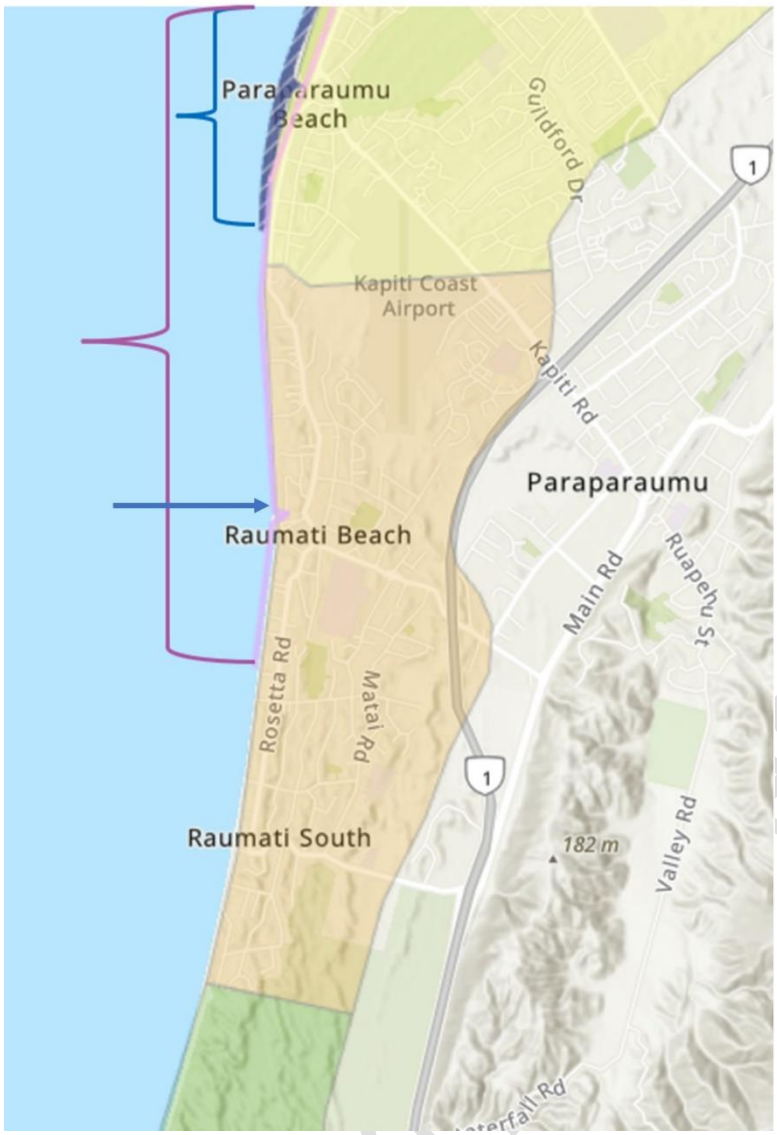

Figure A.3.4: Location of the Southern Paraparaumu bird survey (pink bracket) and the Paraparaumu Beach important bird habitat

A.3.6.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Erosion: Present-day average coastal erosion 49 m from current seaward beach edge	- 2050 average coastal erosion 66 m from current seaward beach edge - 2070 average coastal erosion 91 m from current seaward beach edge - 2130 average coastal erosion 154 m from current seaward beach edge
Flooding: Present-day average coastal erosion 31 m from current seaward beach edge to inland edge of coastal inundation or first coastal most 'ponding area' if there was one.	- 2050 average coastal erosion 40 m from current seaward beach edge - 2070 average coastal erosion 48 m from current seaward beach edge - 2130 average coastal erosion 56 m from current seaward beach edge

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Notes:

- Bird habitat is a function of:
  - roosting space above high tide, so that birds can rest.
  - tidal feeding areas.
  - lack of disturbance by humans and their pets, and predators (wider beaches are better). Eroded beaches are likely to provide narrower habitat.
  - availability of food - river and stream mouths, and onshore coastal currents can deliver more food items. Erosion could change coastal currents and alter the location of river and stream mouths.
  - Availability of food – sediment deposition from erosion and/or flooding could also bury in-shore benthic food sources (buried invertebrates in the sand), reducing food for the birds.
- This part of the coast is already experiencing erosion. The issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the RAA but also reducing habitat for birds to move too. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.
- Loss of bird habitat might result in greater human vs bird conflict/interaction if birds seek out alternative locations to rest, nest and feed. Locations such as sports fields, roof tops, trees in gardens and parks, local ponds and amenity features.
- An assumption has been made that the eroded beach and foreshore provides poorer quality habitat for birds and put birds in greater conflict with human interaction.

Erosion:

- The present-day hazard has been set at moderate as it already extends inland from the beach indicating that bird habitat may already be deteriorating.
- Erosion was estimated by measuring inland from the seaward edge of the beach (as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050,

2070, and 2130) at the following locations Wharemauku Road, Tainui Street, Matatura Road-Wharemauku Stream, Menin Road, Tiromoana Road, Kainui Road, and southern point of The Esplanade. These estimates were then averaged for the RAA.

- The increase to high in 2130 is due to the more rapid loss of coastal habitats than previous periods.

Coastal flooding:

- The present-day hazard has been set at moderate as it already extends inland from the beach indicating that bird habitat may already be deteriorating.
- Coastal flooding was estimated by measuring inland from the seaward edge of the beach (as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) at the following locations Wharemauku Road, Tainui Street, Garden Road[26], Menin Road, Tiromoana road, Kainui Road, and southern point of The Esplanade. These estimates were then averaged for the RAA.
- The increase to high in 2130 is due to the more rapid loss of coastal habitats than previous periods.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Notes:

- Although the birds could potentially move to other locations when their habitat is eroded or flooded (thus a low sensitivity) the issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the RAA but also reducing habitat for birds to move too. Hence Sensitivity for the present and earlier models is set to Medium.
- The increase to high in 2130 is to the substantially greater area of bird habitat modelled to be affected. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemaukū Stream is piped beneath Matatua Road under both 2130 modelled scenarios.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	That there is other habitat where the birds can forage for food, and not be disturbed by humans. If most of the coastal habitat in the Kāpiti Coast District is subject to erosion then the adaptive capacity will be low, as there will be very limited places for birds to move to.
Coastal Flooding	M	That there is other habitat where the birds can forage for food, and not be disturbed by humans. If most of the coastal habitat in the Kāpiti Coast District is subject to flooding then the adaptive capacity will be low, as there will be very limited places for birds to move to.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M

[26] Coastal flooding at Matatura Road-Wharemauku Stream extended all the way up the stream and would have overly skewed the results.

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Flooding	M	M	M	H	M	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.3.6.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
- Erosion – present-day average coastal erosion 49 m from current seaward beach edge	- 2050 average coastal erosion 66 m from current seaward beach edge - 2070 average coastal erosion 110 m from current seaward beach edge - 2130 average coastal erosion 199 m from current seaward beach edge
- Flooding – present-day average coastal erosion 31 m from current seaward beach edge to inland edge of coastal inundation or first coastal most 'ponding area' if there was one.	- 2050 average coastal erosion 40 m from current seaward beach edge - 2070 average coastal erosion 50 m from current seaward beach edge - 2130 average coastal erosion 76 m from current seaward beach edge

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Note:

- Bird habitat is a function of:
  - roosting space above high tide, so that birds can rest.
  - lack of disturbance by humans and their pets, and predators (wider beaches are better). Eroded beaches are likely to provide narrower habitat.
  - availability of food - river and stream mouths, and onshore coastal currents can deliver more food items. Erosion could change coastal currents and alter the location of river and stream mouths.
  - Availability of food – sediment deposition from erosion and/or flooding could also bury in-shore benthic food sources (buried invertebrates in the sand), reducing food for the birds
- The issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the RAA but also reducing habitat for birds to move too. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.
- Loss of bird habitat might result in greater human vs bird conflict/interaction if birds seek out alternative locations to rest, nest and feed. Locations such as sports fields, roof tops, trees in gardens and parks, local ponds and amenity features.
- An assumption has been made that the eroded beach and foreshore provides poorer quality habitat for birds and put birds in greater conflict with human interaction.

Erosion:

- The present-day hazard has been set at moderate as it already extends inland from the beach indicating that bird habitat may already be deteriorating.
- Erosion was estimated by measuring inland from the seaward edge of the beach (as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) at the following locations Wharemaukū Road, Tainui Street, Matatura Road-Wharemaukū Stream, Menin Road, Tiromoana road, Kainui Road, and southern point of The Esplanade. These estimates were then averaged for the RAA.

- The increase to high in 2130 is due to the more rapid loss of coastal habitats than previous periods.

Coastal flooding:

- The present-day hazard has been set at moderate as it already extends inland from the beach indicating that bird habitat may already be deteriorating.
- Coastal flooding was estimated by measuring inland from the seaward edge of the beach (as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) at the following locations Wharemauku Road, Tainui Street, Garden Road[27], Menin Road, Tiromoana road, Kainui Road, and southern point of The Esplanade. These estimates were then averaged for the RAA.
- The increase to high in 2130 is due to the more rapid loss of coastal habitats than previous periods.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	H

Notes:

- Although the birds could potentially move to other locations when their habitat is eroded or flooded (thus a low sensitivity) the issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the RAA but also reducing habitat for birds to move too. Hence Sensitivity for the present and earlier models is set to moderate. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.
- The increase to high in 2130 is to the substantially greater area of bird habitat modelled to be affected.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	That there is other habitat where the birds can forage for food, and not be disturbed by humans. If most of the coastal habitat in the Kāpiti Coast District is subject to erosion then the adaptive capacity will be low, as there will be very limited places for birds to move to.
Coastal Flooding	M	That there is other habitat where the birds can forage for food, and not be disturbed by humans. If most of the coastal habitat in the Kāpiti Coast District is subject to flooding then the adaptive capacity will be low, as there will be very limited places for birds to move to.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M

[27] Coastal flooding at Matatura Road-Wharemaukū Stream extended all the way up the stream and would have overly skewed the results.

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.3.7 Fish habitat

Wharemauku Stream is a river with significant indigenous ecosystems because the stream and all tributaries provides habitat for indigenous Threatened and/or At Risk fish species and habitat for six or more migratory indigenous fish species (GWRC NRP Schedule F1: Rivers and lakes with significant indigenous ecosystems).

Domain	Element at Risk	Overview
Ecological	Fish habitat (freshwater)	Wharemauku Stream is a river with significant indigenous ecosystems because the stream and all tributaries provides habitat for indigenous Threatened and/or At Risk fish species and habitat for six or more migratory indigenous fish species. Species include Not Threatened banded kokopu, redfin bully, shortfin eel, and At Risk-Declining kōaro, longfin eel, and Threatened-Nationally Vulnerable shortjaw kokopu. All these species have migratory stages. (GWRC NRP Schedule F1: Rivers and lakes with significant indigenous ecosystems). Additionally, Wharemauku Estuary provides seasonal or core habitat for seven threatened indigenous fish species (GWRC NRP Schedule F4 - Indigenous Biodiversity Coastal) further discussed under Coastal indigenous biodiversity. The mouth of the Wharemauku Stream is not known to provide īnanga (At Risk-Declining) spawning habitat due to human modifications. The proxies to estimate effects on the stream mouths were distance of inland erosion and area of additional flooding or pooling.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion would alter how the mouth of the Wharemauku Stream connects to more upstream portions. Rapid erosion could at times temporarily block the stream with sediment. The Wharemauku Stream mouth would be totally eroded to where the Wharemauku Stream is piped beneath Matatua Road under the 2130 modelled scenario. This widens the mouth of the estuary and may provide more fish habitat or make it less suitable. Increased sediment in the stream (from coastal erosion or upstream erosion) reduces the quality of fish habitat through reduced oxygen levels, reduced visibility (some fish hunt by sight), reduced prey items (poorer quality water supports a smaller array of invertebrate species), and sediment deposition on spawning areas (vegetation and gravels) and resting areas (gravel substrates and side eddies).
Coastal Flooding	Salt water would penetrate further upstream and could potentially kill freshwater species (especially plants). There could be additional areas for īnanga to spawn. The depth of the water in the Wharemauku Estuary and stream would be progressively deeper from present day to the 2130 modelling. The current could be so strong that species are unable to swim upstream or are swept out to sea (depending on which flood-flow was strongest). Areas beside the stream would be flooded creating additional temporary habitat for freshwater fish which are known to 'graze' flooded paddocks and sometimes also spawn. The Wharemauku Stream mouth would be totally flooded to where the Wharemauku Stream is piped beneath Matatua Road under the 2130 modelled scenario. Flooding could result in additional pollutants including plastics from being washed into the stream from bank-side locations.

Opportunities

Hazard	Opportunities
Coastal Erosion	Where possible, plant the banks of the Wharemauku Stream with suitable indigenous plant species, including the floodplain. This will strengthen the stream banks and reduce erosion of the banks. It would also create habitat for indigenous species.
Coastal Flooding	Where possible, plant the banks of the Wharemauku Stream with suitable indigenous plant species, including the floodplain. Planting the floodplain will assist with retaining/slowing water from upstream reaches which could reduce the extent of coastal flooding. Planting will strengthen the stream banks and create habitat for indigenous species. The Kāpiti Expressway project has already created some good habitat between Kiwi Road and Rata Road. This could be recreated on the northern side of the Wharemauku Stream between the Expressway and Rimu Road. Small areas of that floodplain have already been planted up with indigenous species, including by Friends of the Wharemauku Stream near Ihakara Street, and an area near Iver Trask Place by KCDC. Creating more meandering stream paths within the floodplain would also be beneficial to retaining water – rather than flowing rapidly to the lower-lying areas and the sea. The salt wedge (the location where sea water flowing upstream meets freshwater coming down stream at highest tides) is likely to move upstream as sea-levels increase and flooding progressively moves upstream. Īnanga (At Risk-Declining) lay eggs (spawn) on vegetation draping into the stream or just above flood height on the banks of waterways within the salt wedge. There is an opportunity to revegetate the banks of the Wharemauku Stream with suitable indigenous species to create additional spawning habitat for īnanga (which is the largest portion of whitebait). This could be further enhanced by creating a series of spoon-shaped 'ponds' on the banks, such that the 'handle' of the 'spoon' connects to the stream and enables the salt wedge to enter the 'bowl' during higher tides.

Figure A.3.5: Location of rivers, lakes and streams in the RAA.

A.3.7.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
- Erosion – present-day average coastal erosion 72 m from current seaward beach edge	- 2050 average coastal erosion 88 m from current seaward beach edge - 2070 average coastal erosion 164 m from current seaward beach edge - 2130 average coastal erosion 239 m from current seaward beach edge
- Present day flooding is modelled to penetrate inland up the Wharemauku Stream as far as Kiwi Road. Total area of flooding estimated at 23,700 m^2	- 2050 some of the side channels would also back up and small areas of ponding in the lowest-lying areas. Total area of flooding estimated at 25,300 m^2 - 2070 some of the side channels would also back up and large areas of ponding in the lowest-lying areas. Total area of flooding estimated at 29,600 m^2 - 2130 all of the side channels would also back up, including near Kiwi Road and ponding in the lowest-lying areas would be extensive and nearly continuous. Total area of flooding estimated at 67,700 m^2

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	L	L	L	M

Note:

- The Wharemauku Stream mouth can be cut (reshaped) as a permitted activity under GWRC NRP Rule R214 when the channel outlet within the coastal marine area migrates either 20m south or 70m north from the corner of the southern bank protection wall. And/or when the stream mouth closes or the distance from the soffit to the water level at the downstream end of the single span bridge across Matatua Road is less than 2.3m in normal flow at low tide.
- Therefore, fish habitat within the stream mouth already experiences occasional perturbations.
- The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.

Erosion:

- It is assumed that erosion could undermine up and downstream connectivity for fish and cause deterioration of in-stream habitat and stream bank habitat. Especially if any culverts are left perched above the in or outflow (fish need connected wet surfaces, a sudden drop or waterfall is an obstacle for many species).
- The present-day hazard has been set at moderate as erosion already extents inland from the beach indicating that fish habitat may already be deteriorating.
- Erosion was estimated by measuring inland from the seaward edge of the beach (as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) at Matatura Road-Wharemauku Stream.
- The increase to high in 2130 is due to the more rapid erosion than previous periods.

Flooding:

- Flooding was estimated by measuring the area of the stream mouth, total stream length and width, and areas of pooling associated with or close to any part of the stream.
- Flooding could be benefical to indigenous fish species as it could provide additional areas of flooded habitat for feeding and spawning.
- Flooding could also be detrimental to indigenous fish species due to rapid changes in salinity, increased turbidity, reduced in-stream prey, preventing fish from swimming upstream or downstream ((temporary) loss of connectivity), washing fish out to sea, and salinity killing vegetation.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	M	M	M	M

Notes:

- Many fish species rely on relatively stable banks and stream beds for habitat. They can move, but upstream habitat may already be occupied by other individuals or not suitable. Hence, moderate sensitivity. For coastal erosion, sensitivity increased in 2130 due the erosion penetrating considerable further upstream. For flooding the effects are offset by temporary additional habitat in flooded parts of the floodplain.
- The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Fish can move, but upstream habitat may already be occupied by other individuals or not suitable.
Coastal Flooding	M	Flooding the effects are offset by temporary additional habitat in flooded parts of the floodplain.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M
Flooding	M	M	M	M	M	M	M	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	M	M	M	H	M	M	M	M	M	M	M	M

	Exposure					Vulnerability				Risk		
Risk from Flooding	L	L	L	M	M	M	M	M	L	L	L	M

A.3.7.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
- Erosion – present-day average coastal erosion 72 m from current seaward beach edge	- 2050 average coastal erosion 88 m from current seaward beach edge - 2070 average coastal erosion 228 m from current seaward beach edge - 2130 average coastal erosion 239 m from current seaward beach edge
- Present day flooding is modelled to penetrate inland up the Wharemauku Stream as far as Kiwi Road. Total area of flooding estimated at 23,700 m^2	- 2050 some of the side channels would also back up and small areas of ponding in the lowest-lying areas. Total area of flooding estimated at 25,300 m^2 - 2070 some of the side channels would also back up and large areas of ponding in the lowest-lying areas. Total area of flooding estimated at 38,700 m^2 - 2130 all of the side channels would also back up, including near Kiwi Road and ponding in the lowest-lying areas would be extensive and nearly continous. Total area of flooding estimated at 239,300 m^2

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	H	H
Coastal Flooding	M	M	M	H

Note:

- The Wharemauku Stream mouth can be cut (reshaped) as a permitted activity under GWRC NRP Rule R214 when the channel outlet within the coastal marine area migrates either 20m south or 70m north from the corner of the southern bank protection wall. And/or when the stream mouth closes or the distance from the soffit to the water level at the downstream end of the single span bridge across Matatua Road is less than 2.3m in normal flow at low tide.
- Therefore, fish habitat within the stream mouth already experiences occasional perturbations.

Erosion:

- It is assumed that erosion could undermine up and downstream connectivity for fish and cause deterioration of in-stream habitat and stream bank habitat. Especially if any culverts are left perched above the in or outflow (fish need connected wet surfaces, a sudden drop or waterfall is an obstacle for many species).
- The present-day hazard has been set at moderate as erosion already extends inland from the beach indicating that fish habitat may already be deteriorating.
- Erosion was estimated by measuring inland from the seaward edge of the beach (as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) at Matatura Road-Wharemauku Stream.
- The increase to high in 2130 is due to the more rapid erosion than previous periods.

Flooding:

- Flooding was estimated by measuring the area of the stream mouth, total stream length and width, and areas of pooling associated with or close to any part of the stream.
- Flooding could be beneficial to indigenous fish species as it could provide additional areas of flooded habitat for feeding and spawning.
- Flooding could also be detrimental to indigenous fish species due to rapid changes in salinity, increased turbidity, reduced in-stream prey, preventing fish from swimming upstream or downstream ((temporary) loss of connectivity), washing fish out to sea, and salinity killing vegetation.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	M	M	M	H
Coastal Flooding	L	L	M	M

Notes:

- Many fish species rely on relatively stable banks and stream beds for habitat. They can move, but upstream habitat may already be occupied by other individuals or not suitable. Hence, moderate sensitivity. For coastal erosion, sensitivity increased in 2130 due the erosion penetrating considerable further upstream. For flooding the effects are offset by temporary additional habitat in flooded parts of the floodplain.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Fish can move, but upstream habitat may already be occupied by other individuals or not suitable.
Coastal Flooding	M	Flooding the effects are offset by temporary additional habitat in flooded parts of the floodplain.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M
Flooding	L	L	M	M	M	L	L	M	M

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	M	M	H	H	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	M	H	L	L	M	M	L	L	M	M

A.3.8 Coastal indigenous biodiversity

Domain	Element at Risk	Overview
Ecological	Coastal indigenous biodiversity	Coastal indigenous biodiversity as mapped by GWRC in the NRP Schedule F4: Sites with significant indigenous biodiversity values in the coastal marine area. The Wharemauku Estuary provides seasonal or core habitat for seven threatened indigenous fish species: longfin eel, giant kōkopu, shortjaw kōkopu, inanga, kōaro, redfin bully and torrentfish. For Coastal erosion a proxy was used of the area of additional erosion to estimate effects on the habitat. For coastal flooding the availability of the habitat for fauna was estimated,

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Erosion would widen the mouth of the stream which may provide more fish habitat or make it less suitable, and also may reduce connectivity to inland parts of the Wharemauku Stream. Or it may require that the estuary to move upstream into more urban areas where it will be constrained for space – i.e. a smaller estuary. Changes to the estuary may result in fewer fish species using this habitat or reduced food availability. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios. This widens the mouth of the estuary and may provide more fish habitat or make it less suitable, and also may reduce connectivity to inland parts of the Wharemauku Stream. Changes to coastal currents resulting in alter food supplies.
Coastal Flooding	Fish species being washed inland, and potentially left to dry on temporary flooded areas. The Wharemauku Stream mouth would be totally eroded and/or flooded to where the Wharemauku Stream is piped beneath Matatua Road under both 2130 modelled scenarios. The size of the hazard would depend on the frequency, duration and height of flooding as to how much of the habitat was no longer available for fauna

Opportunities

Hazard	Opportunities
Coastal Erosion	Some of the species also occur in freshwater and creating additional upstream habitat may support/enhance the population.
Coastal Flooding	Some of the species also occur in freshwater and creating additional upstream habitat may support/enhance the population.

Figure A.3.6: Location of potential coastal indigenous biodiversity within the RAA.

A.3.8.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
- Coastal erosion – present day does not indicate significant erosion of Wharemauku Stream mouth	- 2050 – an estimated 9% of the estuary would be affected by erosion - 2070 – an estimated 13% of the estuary would be affected by erosion - 2130 – an estimated 35% of the estuary would be affected by erosion
- Coastal flooding – present day the whole Wharemauku Estuary would be flooded. - Effects for future scenarios are estimates – more information is required on flood frequency and depth to enable more robust estimates to be made.	- 2050 – the frequency, duration and height of flooding would increase and reduce habitat availability by 10% compared to present day - 2070 – the frequency, duration and height of flooding would increase and reduce habitat availability by 25% compared to present day - 2130 – the frequency, duration and height of flooding would increase and reduce habitat availability by 50% compared to present day

Hazard	Present	2050	2070	2130
Coastal Erosion	L	M	H	E
Coastal Flooding	M	M	H	E

Note:

- For coastal erosion the area of additional erosion was estimated for each of the scenarios.
- For coastal flooding the availability of the habitat for fauna was estimated. Lack of habitat availability would depend on the frequency, duration and height of flooding.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	M	H	E
Coastal Flooding	M	M	H	E

Notes:

Species become used to where they can go to obtain food or hang out. The frequent the pertubations are, the more likely species will avoid an area. Hence sensitivity has been assessed to follow the same rank as the hazard assessment.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	Once the estuary has been eroded it will be very difficult to re-establish due to low coastal sand availability. Species will stop using an area if it has frequent pertubations or becomes unsuitable habitat.
Coastal Flooding	L	Flooding can be a more temporary pertubation, however, an estuary provides relatively shallow habitat and flooding would increase the

Domain	Adaptive Capacity	Key Assumptions
		depth of the water. Once that happens it will be less suitable fauna habitat.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	M	H	E	VL	M	H	E	E
Flooding	M	M	H	E	L	M	M	H	E

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	M	H	E	M	H	E	E	L	M	E	E
Risk from Flooding	M	M	H	E	M	M	H	E	M	M	H	E

A.3.8.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
- Coastal erosion – present day does not indicate significant erosion of Wharemauku Stream mouth	- 2050 – an estimated 9% of the estuary would be affected by erosion - 2070 – an estimated 18% of the estuary would be affected by erosion - 2130 – an estimated 48% of the estuary would be affected by erosion
- Coastal flooding – present day the whole Wharemauku Estuary would be flooded. - Effects for future scenarios are guestimates – more information is required on flood frequency and depth to enable more robust estimates to be made.	- 2050 – the frequency, duration and height of flooding would increase and reduce habitat availability by 10% compared to present day - 2070 – the frequency, duration and height of flooding would increase and reduce habitat availability by 30% compared to present day - 2130 – the frequency, duration and height of flooding would increase and reduce habitat availability by 70% compared to present day

Hazard	Present	2050	2070	2130
Coastal Erosion	L	M	H	E
Coastal Flooding	M	M	H	E

Note:

- For coastal erosion the area of additional erosion was estimated for each of the scenarios.
- For coastal flooding the availability of the habitat for fauna was estimated. Lack of habitat availability would depend on the frequency, duration and height of flooding.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	M	H	E
Coastal Flooding	M	M	H	E

Notes:

Species become used to where they can go to obtain food or hang out. The frequent the pertubations are, the more likely species will avoid an area. Hence sensitivity has been assessed to follow the same rank as the hazard assessment.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	VL	Once the estuary has been eroded it will be very difficult to re-establish due to low coastal sand availability. Species will stop using an area if it has frequent pertubations or becomes unsuitable habitat.
Coastal Flooding	L	Flooding can be a more temporary pertubation, however, an estuary provides relatively shallow habitat and flooding would increase the

Domain	Adaptive Capacity	Key Assumptions
		depth of the water. Once that happens it will be less suitable fauna habitat.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	M	H	E	VL	M	H	E	E
Flooding	M	M	H	E	L	M	M	H	E

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	L	M	H	E	M	H	E	E	L	M	E	E
Risk from Flooding	M	M	H	E	M	M	H	E	M	M	H	E

A.4 Natural Character Risk Assessment Templates

A.4.1 CMA A. Innershelf and nearshore marine (Coastal Marine Area)

Note: This is included for Information only as this area falls outside the RAA. Direct or indirect effects within the CMA on the natural character have not been identified or assessed.

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☒

Domain	Element at Risk	Overview
Natural Character	CMA A. Innershelf and nearshore marine: Coastal Marine Area	For the most part, the CMA adjoining Kāpiti is exposed to oceanic conditions. Nearshore inter-tidal and shallow sub-tidal rocky reefs are virtually absent, as are visible structures. The seafloor is predominantly sand which gradually slopes down and transitions to mud at a depth of approximately 35 meters, between approximately 3 and 5.5 km offshore. The regional tidal range is up to approximately 2.0 m. Bedforms (e.g. sand ripples) are likely in the nearshore and innershelf from the prevailing ocean swells and currents. Ocean currents transport coastal waters southward around the South Taranaki Bight through to Cook Strait. Transport of oceanic and river-modified coastal water is routinely evident on the innershelf, inshore of Kāpiti Island. The broader inner shelf has received relatively limited commercial bottom-trawling effort, however parts of the shoreline are subjected to frequent shore-based recreational harvesting of shellfish, paddle crabs and shallow water fishes, particularly in summer months. Demersal fish species diversity is predicted to be average at a national scale. Through the RAA, the wave shadow of Kāpiti Island is clearly apparent alongside the sweeping form south of the Cuspate Foreland. MHWS springs coincides or comes close to seawalls and rock revetment along the length of this coastline. This area of coastal environment reflects a moderate level of natural character overall.

A.4.2 CTA2: Paraparaumu and Waikanae

Domain	Element at Risk	Overview
Natural Character	**Part of CTA2: Waikanae and Paraparaumu: Coastal Terrestrial Area** (NB: assessment of effects occurs within RAA)	Coastal Terrestrial Area 2: Waikanae and Paraparaumu encompasses the larger section of coastal environment which extends between Ngawhakangutu Reserve in the north and Queen Elizabeth Park in the south. This encompasses the cuspate (tapering) foreland which extends outwards at Paraparaumu Beach and creates the sweeping form of Waikanae and Raumati Beaches. Due to adjoining residential settlements, the dune systems which comprise this section of coastal environment have been almost completely modified to accommodate housing and urban development. Nevertheless, the cuspate foreland remains apparent, along an established residential edge which typically reflects seawalls and rock revetment along MHWS which reduces the significance of coastal processes, influences or qualities inland. A small area of dunes remains at the mouth of Wharemauku Stream. Historically, the broader Waikanae and Paraparaumu coastal terrestrial area would have been vegetated in native duneland and wetland species with lowland podocarp/broadleaf forest in dune slacks. Today extremely little native vegetation remains and is often planted because of extensive land use changes now comprising residential development. The broader terrestrial coastal environment encompasses the most populated area in Kāpiti Coast's Coastal Environment and adjoining Coastal Context and is assessed as having low-moderate level of natural character overall within which no components of high natural character have been identified.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Throughout this adaptation area, coastal erosion occurs in the context of existing modified areas accommodating existing seawalls and adjoining coastal settlement. Such modification has previously impacted natural elements and patterns, including the previous underlying dune process. Affected areas typically represent rock revetment and other hard built elements which foreshortens adjoining beach areas and reduces natural character. Public access has been extended between Raumati Marine Gardens and The Esplanade in association with built modification.
Coastal Flooding	Relatively limited flooding occurs within the context of the current extent of the coastal environment, which is typically elevated on historic dunes. Notwithstanding this, some coastal flooding occurs within lower lying areas adjoining the margins of Wharemauku Stream as well as some lower lying pockets of some more modified interdunal hollows. Some limited flooding also extends inland of the identified coastal environment, including more modified areas containing coastal settlement and consequently more limited levels of natural character. This typically extends along lower lying areas inland of Wharemauku Stream.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reinforce and restore native vegetation along riparian margins. Ensure built development and modification is sympathetic to and supports underlying natural characteristics and qualities including utilizing nature-based solutions where possible.
Coastal Flooding	Reinforce indigenous margins and associated habitat opportunities at the mouths of streams, including developing nature-based solutions which restore natural character where possible.

Hazard	Opportunities
	Identify opportunities to enhance and restore ecological connectivity between the coastal environment and its context / catchment.

A.4.2.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ Areas of seawall which extends along the length of Raumati Beach ▪ The mouth of the Wharemauku Stream.	Future exposure: 2050: ▪ Erosion is expected to impact existing modified seawalls and beach front properties and beach access along The Esplanade. These areas express higher levels of human modification and corresponding lower levels of natural character. ▪ Some more limited erosion occurs at the mouth of Wharemauku Stream. 2070: ▪ There is continuation of erosion along a more modified coastal edge. ▪ Additional erosion occurs in the context of existing modification at Wharemauku Stream. 2130: ▪ Substantial additional erosion occurs in the context of existing modified areas of coastline supporting established settlement. The extent of erosion extends into areas for which coastal processes, influences or qualities are not currently significant, effectively redefining the existing coastal edge.
Currently exposed to coastal flooding: ▪ Parts of the coastal environment adjoining Wharemauku Stream, presently managed with a hard edge.	2050: ▪ Within the coastal environment, very limited coastal flooding occurs in association with Wharemauku Stream ▪ Some very small pockets of flooding occurs in the context of existing coastal settlement 2070: ▪ Some small increase in flooding occurs within the context of established coastal settlement. 2130: ▪ Some small increase in flooding occurs within the context of established coastal settlement. ▪ Some small notable increase in flooding occurs within the context of established coastal settlement beyond the identified coastal environment and typically beyond the margins of Wharemauku Stream

Hazard	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	L	L	L	M

Note:

Whilst the exposure of the coastal environment to erosion increases in this area, this impacts more highly modified areas of the coastal environment and increasingly extends inland of the current delineation of the coastal environment.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

Through the RAA, the hazards created by coastal erosion almost entirely impact highly modified areas of coastal environment including existing seawalls, rock revetment and flood defences which border established areas of existing settlement. This uniformly has resulted in lower levels of natural character and corresponding low levels of sensitivity. Conversely, ongoing change to modified elements, patterns and processes may also provide opportunities to restore natural character and the trajectory of such change.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	▪ Coastal erosion almost entirely impacts more modified areas which contribute to lower existing levels of natural character and therefore very limited adaptive capacity. ▪ To restore natural character where possible, responses should seek to ensure that natural elements, patterns and processes can continue to operate through appropriate human intervention and management.
Coastal Flooding	L	▪ Limited coastal flooding occurs in the context of an elevated coastal settlement. ▪ Where flooding occurs beyond the mouth of Wharemauku Stream this extends beyond established flood defenses with very limited natural adaptive capacity. ▪ Some coastal flooding inland of coastal environment beyond associated with Wharemauku Stream. Such areas reflect limited existing levels of natural character resulting from increasing modification associated with coastal settlement.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	L	L	L	L	L
Flooding	L	L	L	L	L	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	H	H	H	E	L	L	L	L	M	M	M	H
Risk from Flooding	L	L	L	M	L	L	L	L	L	L	L	L

A.4.2.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: ▪ Areas of seawall which extends along the length of Raumati Beach ▪ The mouth of the Wharemauku Stream.	Future exposure: 2050: ▪ Erosion is expected to impact existing modified seawalls and beach front properties and beach access along The Esplanade. These areas express higher levels of human modification and corresponding lower levels of natural character. ▪ Some more limited erosion occurs at the mouth of Wharemauku Stream. 2070: ▪ There is continuation of erosion along a more modified coastal edge. ▪ Additional erosion occurs in the context of existing modification at Wharemauku Stream. 2130: ▪ Substantial additional erosion occurs in the context of existing modified areas of coastline supporting established settlement. The extent of erosion extends into areas for which natural elements, patterns and processes do not currently occur and inland of the current day coastal environment, effectively redefining the existing coastal edge.
Currently exposed to coastal flooding: ▪ Parts of the coastal environment adjoining Wharemauku Stream, presently managed with a hard edge.	2050: ▪ Within the coastal environment, very limited coastal flooding occurs in association with Wharemauku Stream ▪ Some very small pockets of flooding occurs in the context of existing coastal settlement 2070: ▪ Some small increase in flooding occurs within the context of established coastal settlement. 2130: ▪ Some small increase in flooding occurs within the context of established coastal settlement. ▪ Some additional flooding occurs within the context of established coastal settlement beyond the identified coastal environment and typically beyond the margins of Wharemauku Stream

Hazard	Present	2050	2070	2130
Coastal Erosion	H	H	H	E
Coastal Flooding	L	L	L	M

Note:

Whilst the exposure of the coastal environment to erosion increases in this area, this continues to impact more highly modified areas of the coastal environment and increasingly extends inland of the current delineation of the coastal environment.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	L	L	L
Coastal Flooding	L	L	L	L

Notes:

Through the RAA, the hazards created by coastal erosion almost entirely impact highly modified areas of coastal environment including existing seawalls, rock revetment and food defences which border established areas of existing settlement. This uniformly has resulted in lower levels of natural character and corresponding low levels of sensitivity. Conversely, ongoing change to modified elements, patterns and processes may also provide opportunities to restore natural character and the trajectory of such change.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	▪ Coastal erosion almost entirely impacts more modified areas which contribute to lower existing levels of natural character and therefore very limited adaptive capacity. ▪ To restore natural character where possible, responses should seek to ensure that natural elements, patterns and processes can continue to operate through appropriate human intervention and management.
Coastal Flooding	L	▪ Limited coastal flooding occurs in the context of an elevated coastal settlement. ▪ Where flooding occurs beyond the mouth of Wharemauku Stream this extends beyond established flood defenses with very limited natural adaptive capacity. ▪ Some coastal flooding inland of coastal environment beyond associated with Wharemauku Stream. Such areas reflect limited existing levels of natural character resulting from increasing modification associated with coastal settlement.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	L	L	L	L	L
Flooding	L	L	L	L	L	L	L	L	L

Overall Risk Score

	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	H	H	H	E	L	L	L	L	M	M	M	H
Risk from Flooding	L	L	L	M	L	L	L	L	L	L	L	L

A.5 Cultural Risk Assessment Templates

A risk assessment for the Cultural domain in relation to coastal hazard is still to be undertaken with Mana Whenua, and will be added to this document prior to being finalised.

Appendix B Complete Risk Matrices

	Coastal Erosion Hazard																											
	SSP2-4.5																SSP5-8.5											
	Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk				Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk			
Element	Present	2050	2070	2130	Present	2050	2070	2130		Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130		Present	2050	2070	2130	Present	2050	2070	2130
Built Environment																																	
Properties - Whole Adaptation Area	L	L	L	L	E	E	E	E	L	E	E	E	E	M	M	M	M	L	L	L	L	E	E	E	E	L	E	E	E	E	M	M	M	M
Properties - Raumati Beach	E	E	E	E	E	E	E	E	L	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	L	E	E	E	E	E	E	E	E
Properties – Raumati South	E	E	E	E	E	E	E	E	L	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	L	E	E	E	E	E	E	E	E
Water Supply Infrastructure	L	L	L	M	H	H	H	E	L	H	H	H	E	L	L	L	H	L	L	L	M	H	H	H	E	L	H	H	H	E	L	L	L	H
Wastewater Infrastructure	L	M	M	H	E	E	E	E	L	E	E	E	E	M	H	H	E	L	M	M	H	E	E	E	E	L	E	E	E	E	M	H	H	E
Stormwater Infrastructure	L	L	L	M	M	M	H	E	L	M	M	H	E	L	L	L	H	L	L	L	M	M	M	H	E	L	M	M	H	E	L	L	L	H
Roads and Bridges	L	L	L	M	H	H	H	E	L	H	H	H	E	L	L	L	H	L	L	L	M	H	H	H	E	L	H	H	H	E	L	L	L	H
Electrical Transmission and supply infrastructure	L	L	L	L	L	L	L	E	L	L	L	L	E	L	L	L	M	L	L	L	L	L	L	L	E	L	L	L	L	E	L	L	L	M
Natural gas supply mains	L	L	L	M	L	E	E	E	L	L	E	E	E	L	M	M	H	L	L	L	M	L	E	E	E	L	L	E	E	E	L	M	M	H
Ecological																																	
Coastal dunes	H	E	E	E	H	E	E	E	VL	E	E	E	E	E	E	E	E	H	E	E	E	H	E	E	E	VL	E	E	E	E	E	E	E	E
Wetlands	L	L	L	L	L	L	L	L	VL	M	M	M	M	L	L	L	L	L	L	L	L	L	L	L	L	VL	M	M	M	M	L	L	L	L
Mapped ecological sites	M	M	M	M	L	L	L	L	VL	M	M	M	M	M	M	M	M	M	M	M	M	L	L	L	L	VL	M	M	M	M	M	M	M	M
Indigenous trees	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	L	L	L	L	H	L	L	L	H
Rare and threatened species	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Bird habitat	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Fish habitat	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M	M	M	H	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Indigenous Biodiversity Coastal	L	M	H	E	L	M	H	E	VL	M	H	E	E	L	M	E	E	L	M	H	E	L	M	H	E	VL	M	H	E	E	L	M	E	E
Human																																	
Physical Health	L	L	L	L	M	M	M	M	H	L	L	L	L	L	L	L	L	L	L	L	H	M	M	M	M	H	L	L	L	L	L	L	L	M
Mental Health and Wellbeing	L	L	M	H	H	H	H	E	L	H	H	H	E	L	L	M	E	L	L	M	H	H	H	H	E	L	H	H	H	E	L	L	M	E
Social Infrastructure and Amenity	L	L	L	M	H	H	H	H	L	H	H	H	H	L	L	L	M	L	L	M	H	H	H	H	H	L	H	H	H	H	L	L	M	H
Exacerbating Inequalities	L	L	L	M	M	M	M	H	L	M	M	M	H	L	L	L	M	L	L	L	M	M	M	M	H	L	M	M	M	H	L	L	L	M
Social Cohesion and Community Wellbeing	L	L	L	M	L	L	M	M	L	L	L	M	M	L	L	L	M	L	L	L	M	L	L	M	H	L	L	L	M	H	L	L	L	M
Conflict, Disruption, and Loss of Trust in Government	H	H	E	E	H	H	H	E	M	M	M	M	H	M	M	H	E	H	H	E	E	H	H	E	E	M	M	M	H	H	M	M	E	E
Natural Character																																	
CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	H	H	H	E	L	L	L	L	L	L	L	L	L	M	M	M	H	H	H	H	E	L	L	L	L	L	L	L	L	L	M	M	M	H

	Coastal Flood Hazard																													
	SSP2-4.5																SSP5-8.5													
	Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk				Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk			
Element	Present	2050	2070	2130	Present	2050	2070	2130		Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130		Present	2050	2070	2130	Present	2050	2070	2130
Built Environment																																	
Properties - Whole Adaptation Area	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	M	H	L	L	L	M	H	L	L	L	L
Properties - Raumati Beach	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	M	H	L	L	L	M	H	L	L	L	L
Properties – Raumati South	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	H	L	L	L	L
Water Supply Infrastructure	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Wastewater Infrastructure	L	L	L	L	L	L	L	M	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	L	M	L	L	L	L
Stormwater Infrastructure	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Roads and Bridges	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L
Electrical Transmission and supply infrastructure	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Natural gas supply mains	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Ecological																																	
Coastal dunes	M	H	H	E	H	E	E	E	L	H	E	E	E	M	E	E	E	M	H	H	E	H	E	E	E	L	H	E	E	E	M	E	E	E
Wetlands	L	L	L	L	L	L	L	L	VL	M	M	M	M	L	L	L	L	L	L	L	L	L	L	L	L	VL	M	M	M	M	L	L	L	L
Mapped ecological sites	M	M	M	M	L	L	L	L	VL	M	M	M	M	M	M	M	M	M	M	M	M	L	L	L	L	VL	M	M	M	M	M	M	M	M
Indigenous trees	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	M	L	L	L	L	M	L	L	L	M
Rare and threatened species	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Bird habitat	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Fish habitat	L	L	L	M	M	M	M	M	M	M	M	M	M	L	L	L	M	M	M	M	H	L	L	M	M	M	L	L	M	M	L	L	M	M
Indigenous Biodiversity Coastal	M	M	H	E	M	M	H	E	L	M	M	H	E	M	M	H	E	M	M	H	E	M	M	H	E	L	M	M	H	E	M	M	H	E
Human																																	
Physical Health	L	L	L	L	M	M	M	M	H	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	M	H	L	L	L	L	L	L	L	L
Mental Health and Wellbeing	L	L	M	H	H	H	H	E	M	M	M	M	H	L	L	M	H	L	L	M	H	H	H	H	E	M	M	M	M	H	L	L	M	H
Social Infrastructure and Amenity	L	L	L	M	H	H	H	H	L	H	H	H	H	L	L	L	M	L	L	H	E	H	H	H	H	L	H	H	H	H	L	L	H	E
Exacerbating Inequalities	L	L	L	L	M	M	M	M	L	M	M	M	M	L	L	L	L	L	L	L	L	M	M	M	H	L	M	M	M	H	L	L	L	L
Social Cohesion and Community Wellbeing	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	M	L	L	M	H	L	L	L	M	H	L	L	L	M
Conflict, Disruption, and Loss of Trust in Government	L	L	M	M	M	M	H	H	M	M	M	M	M	L	L	M	M	L	L	M	M	M	H	H	H	M	M	M	M	M	L	L	M	M
Natural Character																																	
CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L