Northern Adaptation Area Risk Assessment

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Kāpiti Coast District Council

Takutai Kāpiti
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Northern Adaptation Area Risk Assessment

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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 **Northern Adaptation Area (NAA)** from projected coastal hazards over the next 100 years (i.e. to 2130) if no future adaptation is undertaken, and natural shoreline erosion with relative sea level rise (RSLR) over the next 100 years occurs. This report identifies where the risk to domains within the coastal environment could change over time with increased projected 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 Central, Raumati, 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).

The risks within the NAA are generally greater from coastal inundation than coastal erosion across most domains. The higher risks from inundation are generally associated with the much larger exposure throughout the NAA to coastal flooding due to the relatively low land elevations, making settlements and rural land within the NAA particularly susceptible to flooding in the future with SLR. The risks are considered to be generally highest across both hazards to the ecological domain, where by 2130 there are several elements considered to be at extreme risk under both SLR scenarios. The results of the risk assessment across all domains are provided in Table 1, and can be summarised as follows:

Built Environment Domain

- The built environment domain assesses the risk to infrastructure which provides a service to the NAA communities, such as transport (roads), three waters, and electrical supply. It also includes private properties, for which these services are built, operated and maintained in order to deliver them on an ongoing basis.
- Generally, the built environment in the NAA is at low-moderate risk between now and 2070 from both coastal erosion and inundation.
- For coastal erosion, there is a high risk to beachfront property in Ōtaki Beach and Te Horo Beach, and most infrastructure elements in 2130 under the higher SSP5-8.5 scenario. This is a result of the increase in exposure over this timeframe and the extreme sensitivity of loss or damage to these elements from erosion. The loss or damage to built environment elements will have cascading impacts on all other domains.
- For coastal inundation, under the lower SSP2-4.5 scenario, there is a high risk to Ōtaki Beach properties and roads/bridges by 2130, which will have cascading impacts on the human domain – including the ability to evacuate people in significant events. Under the higher SSP5-8.5, there is extreme risk from coastal inundation for roads and bridges, Ōtaki Beach properties, and also high risk to three waters infrastructure.

Human Domain:

- The 'Human' Domain considers the risks to physical and mental health of those who live, work, or recreate in the NAA.
- The risks to the human domain within the NAA from coastal erosion are generally considered to be low to moderate across both SLR scenarios to 2130, which is generally a result of a relatively small proportion of the NAA being directly impacted by coastal erosion. The exception to this is the risk of conflict, disruption, and loss of trust in government, which under the SSP5-8.5 SLR scenario increases to high risk by 2070, and extreme risk by 2130.
- The risks to the human domain from coastal flooding are higher than the risks from coastal erosion due to the higher level of exposure to the community from the flood hazard over both SLR scenarios out to 2130. Most elements are considered to be at moderate risk from coastal flooding at present, and remain moderate risk until 2130, where risks across both SLR scenarios increases to high or extreme. Under the higher SSP5-8.5 scenario, all elements are considered to be at high or extreme risk by 2130.
- The most immediate risks from coastal flooding are to exacerbating inequities, which become high risk by 2050, and increase to extreme risk by 2130. These risks are associated with the potential purchase or renting of properties within hazardous areas by lower socio-economic groups that have less financial means to cope with or recover from flood events.

Ecological Domain

- The 'Ecological' domain considers the risks to the plants, animals and their habitats within the NAA.
- The risks to the ecological domain from coastal erosion are generally low-moderate to 2050, increasing to high risk by 2070, and extreme risk by 2130 under both SLR scenarios.
- The risk to indigenous biodiversity (coastal) becomes extreme by 2050, and remains extreme through to 2130 under both SLR scenarios. This extreme risk is due to the potential erosion impacts at the Waitohu and Mangaone Estuaries, and Ōtaki Rivermouth and nearby dune systems, which foster habitat for many indigenous species.
- The risks to ecological elements from coastal flooding similarly reaches high and extreme risks by 2130 for most elements.
- Bird habitats are currently at high risk from coastal flooding, increasing to extreme risk by 2070 under both SLR scenarios. This increase in risk occurs as low-lying areas adjacent to the bird habitat flood, beach and dune habitat becomes exposed, and the frequency and depth of flooding continues to increase. This could severely limit bird habitat availability and could affect bird populations, potentially resulting in local extinctions.
- Rare and threatened species, and ecological sites also become high risk by 2050, remain high risk through to 2070, then increase to being at extreme risk by 2130 under both SLR scenarios. Wetlands are currently at moderate risk from coastal flooding, and only increase to being at high risk by 2130 under the higher SSP5-8.5 scenario. Fish habitat is currently at moderate risk, but increases to being at high risk by 2070 under the SSP5-8.5 scenario, and by 2130 under the lower SSP2-4.5 scenario. Indigenous biodiversity is currently at moderate risk, but increases to being at extreme risk by 2130 under both SLR scenarios.

Natural Character Domain

- The Natural Character domain considers the risks to the preservation of the natural character of the coastal environment.
- Existing levels of natural character in the NAA are fairly well preserved over the 100-year timeframe with risks generally being low-moderate from both erosion and inundation under both SLR scenarios.
- Within the NAA, high risks only apply to parts of the Peka Peka dunes over a 100 year timeframe under the higher SSP5-8.5 scenario. This is a result of 'coastal squeeze' where the land area behind the dunes is not large enough to accommodate dune migration due to presence of infrastructure.

Cultural Domain

- The Cultural domain refers to the risks to Mana Whenua and their values from coastal hazards in the NAA.
- The risks to elements assessed within the cultural domain from both erosion and inundation out to 2130 are considered to be at low to moderate risk under both SLR scenarios.
- Ancestral landscape and Whānau/hapū/iwi whare and whenua become moderate risk by 2130 under the higher SSP5-8.5 scenario. For both elements, this is a result of the increase in exposure to coastal erosion over this timeframe.
- This risk to Marae from coastal inundation increases from low to moderate by 2130 under both SLR scenarios, as access to the Marae could be compromised in significant events. This would also impact the wider community as marae are often used in emergency response situations. Damage to Marae buildings from flood events could have severe consequences especially for wharenui carvings and tukutuku paneling.
- Risks to Whānau/hapū/iwi whare and whenua increase from low to moderate in 2130 under the higher SSP5-8.5 SLR scenario, where there is high exposure of Māori land assets to coastal flooding in this timeframe. However, the adaptive capacity of Whānau/hapū/iwi whare and whenua is considered to be high, as the land will remain although it will be flooded in a 1% AEP event.

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	L	L	L	L	L	L	L	L	M	M	M	E
Properties - Ōtaki Beach*	L	M	M	M	M	H	L	L	L	H	M	E
Properties - Te Horo Beach*	L	M	M	M	M	H	L	L	M	M	M	M
Properties - Peka Peka*	L	L	L	L	L	M	L	L	L	M	L	M
Water Supply Infrastructure	L	M	M	M	M	H	L	L	L	L	L	L
Wastewater Infrastructure	L	M	M	M	M	H	L	L	L	L	L	H
Stormwater Infrastructure	L	L	M	M	M	H	L	L	L	M	L	H
Roads and Bridges	L	L	L	L	L	M	L	L	L	H	L	E
Electrical Transmission and supply infrastructure	L	L	L	M	L	H	L	L	L	L	L	M
Natural gas supply mains	No Exposure						L	L	L	L	L	M
Human												
Physical Health	L	L	L	M	L	M	M	M	M	H	M	H
Mental Health and Wellbeing	L	L	L	M	M	M	M	M	M	H	M	H
Conflict, Disruption, and Loss of Trust in Government	M	M	M	M	H	E	M	M	M	H	M	E
Exacerbating Inequities	L	L	M	M	M	M	M	H	H	E	H	E
Social Cohesion and Community Wellbeing	L	L	M	M	M	M	M	M	M	M	M	H
Social Infrastructure and Amenity	L	L	L	L	L	M	L	M	M	M	M	H
Ecological												
Coastal dunes	M	M	H	H	H	E	L	L	M	M	M	M
Wetlands	L	M	M	H	M	H	M	M	M	M	M	H
Ecological sites	M	M	H	E	H	E	M	H	H	E	H	E
Indigenous trees	No Exposure						L	L	L	M	L	H
Rare and threatened species	M	M	H	E	H	E	M	H	H	E	H	E
Bird habitat	M	M	H	E	H	E	H	H	E	E	E	E
Fish habitat	L	M	M	M	M	M	M	M	M	H	H	H
Indigenous biodiversity (coastal)	M	E	E	E	E	E	M	M	M	E	M	E
Natural Character												
CTA1: Ōtaki (Coastal Terrestrial Area)	L	L	L	M	M	M	M	M	M	M	M	M
Ōtaki Dunes (High Natural Character)	M	M	M	M	M	M	M	M	M	M	M	M
Te Horo Dunes (High Natural Character)	L	L	L	L	L	M	L	L	L	L	L	L
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	M	M	H	M	M	M	H	M	H
Peka Peka Dunes (High Natural Character)	M	M	M	M	M	H	M	M	M	M	M	M
Cultural												
Ancestral landscape	L	L	L	M	L	M	L	L	L	L	L	L
Marae	L	L	L	L	L	L	L	L	L	M	L	M
Mahinga Kai	L	L	L	L	L	L	L	L	L	L	L	L
Whanau/hapu/iwi whare and whenua	L	L	L	M	L	M	L	L	L	L	L	M

*Beachfront only' properties are considered for assessment of erosion risk; for coastal flooding all properties within the defined sub-area are assessed.

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 NAA 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 KCDC 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; the human domain has been assessed by NIWA; the cultural domain has been assessed by Dr Aroha Spinks; 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.

This report should be read in full, and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

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Appendices

Glossary

In this report, the meaning of key terms used are as presented below:

Adaptation Areas	Five defined areas within the Kāpiti Coast 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 (this report); 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.
KCDC	Kāpiti Coast District Council
NZILA	New Zealand Institute of Landscape Architects
Northern Adaptation Area (NAA)	The NAA is the northern-most adaptation area in the district, and includes the settlements of Ōtaki Beach, Te Horo Beach, and Peka Peka Beach.
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 Central, Raumati, 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.

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 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)."

The purpose of this report is to present the methodology and results of the risk assessment for the **Northern Adaptation Area** (NAA), defined in Figure 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 these risks. Adaptation options can be tested against this no intervention scenario through the decision-making processes to evaluate the effectiveness of an adaptation pathway in lowering the risk across multiple domains. This assessment will be used to inform recommendations made by the CAP, and can be drawn on by Council to assist their future decisions around adaptation options and pathways to have a holistic view of risk and mitigation. This assessment follows the guidance provided by Ministry for the Environment (2021)[5] which encourages the assessment of risk to be undertaken across a range of domains.

[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] Ministry for the Environment (2021). He kupu ārahi mō te aromatawai tūraru huringa āhuarangi ā-rohe / A guide to local climate change risk assessments. Wellington: Ministry for the Environment

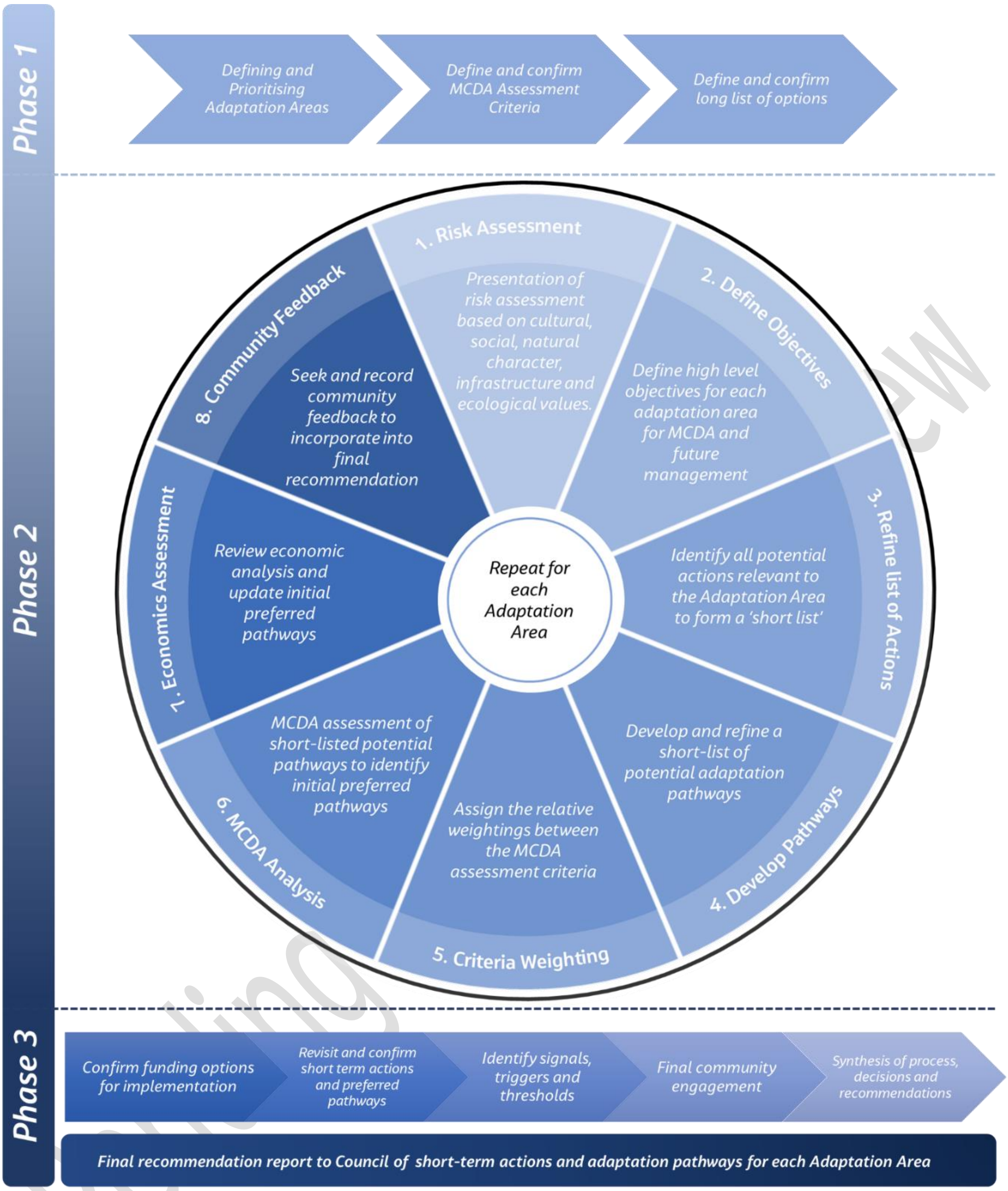

Figure 1: Decision Making Framework for the Community Assessment Panel (Jacobs, 2022).

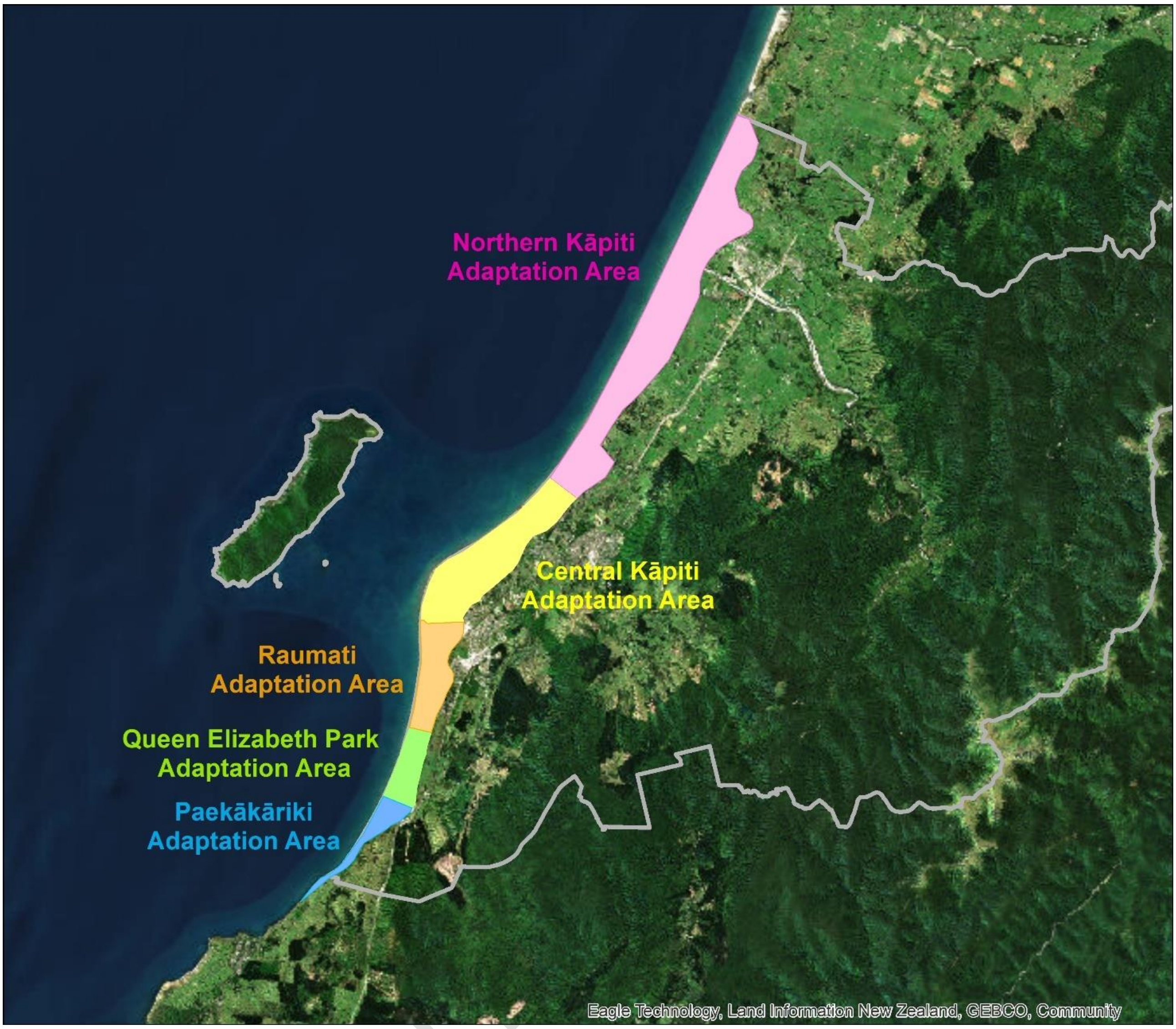

Figure 2: Takutai Kāpiti Adaptation Areas. The inland extent of the adaptation areas are determined by the inland extent at which either coastal inundation occurs, or where the interaction from SLR and groundwater ends. The long-shore boundaries of the adaptation areas are based on a combination of coastal processes, development, and location of communities.

Figure 3: Northern 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[6]. The use of these scenarios is consistent with the MfE (2021), MfE (2022a)[7], and MfE (2024)[8] guidance for climate change risk assessments and adaptation planning.

This risk assessment presents a summary of the risk for a number of elements within each domain, but it is not an exhaustive assessment of all possible elements present along the NAA 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 NAA, some elements 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 Takutai Kāpiti 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 has been assessed by Dr Aroha Spinks in collaboration 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 provides 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.

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

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

[8] 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)[9] *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 desk-top 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 the 2017 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)[10] 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 "*the 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 Northern 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.

MfE (2022b)[11] *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

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

[10] 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.

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

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)[12], 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)[13] provided an addendum to the Jacobs (2022a) report that updates 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 (i.e. this report and the risk assessments for the other adaptation areas).

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.

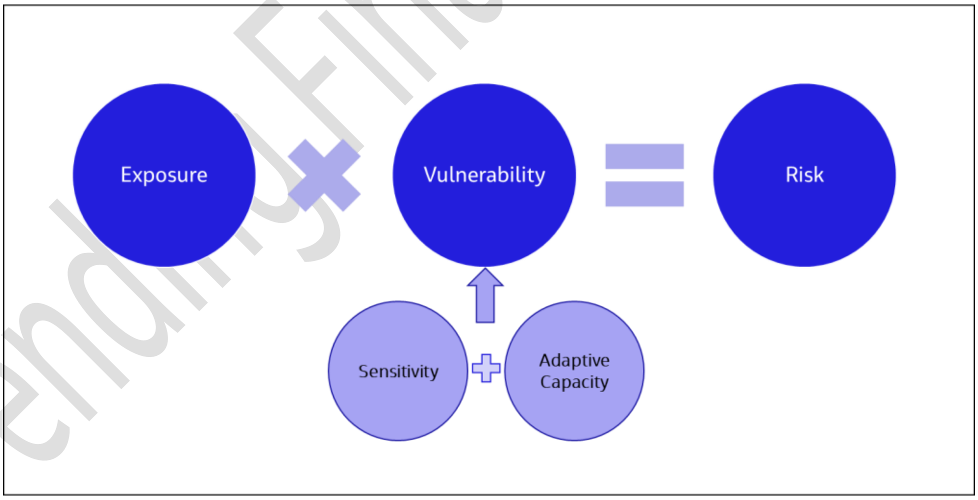

Figure 4: Risk equation used for this assessment from MfE (2021) Guidance for climate change risk assessments.

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

[13] 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.

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 4 comprises of multiple steps of information gathering to define the risk. These steps are summarised in Figure 5, and are outlined in detail from Sections 2.2.2-2.2.7 below.

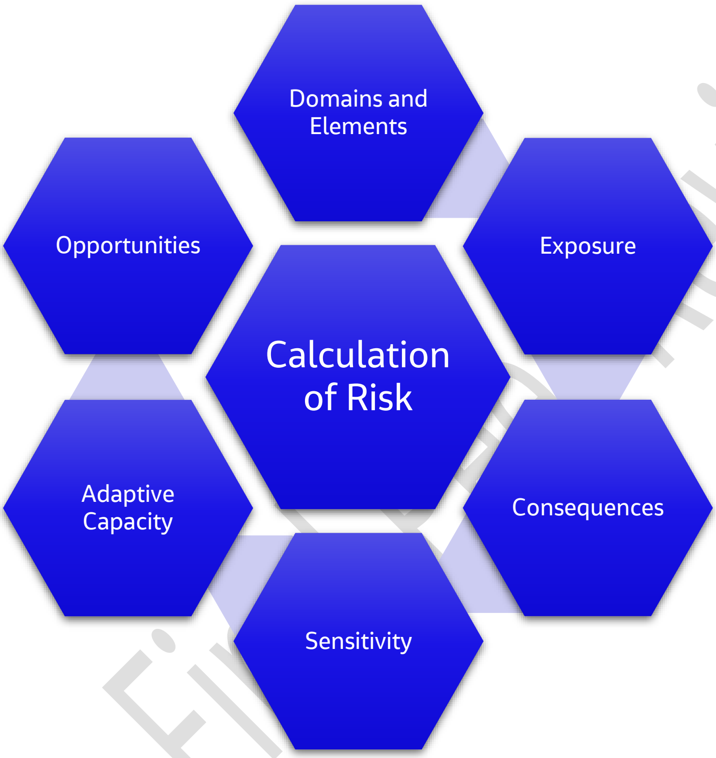

Figure 5: Steps for calculating risk.

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 (Dr. Aroha Spinks)
- 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 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 1: Domains and Elements considered in this assessment.

Domain	Elements
Built Environment	▪ Properties (total NAA) ▪ Properties by settlement ▪ Roads and bridges ▪ Wastewater services ▪ Water supply services ▪ Stormwater services ▪ Electrical supply and transmission ▪ Natural gas supply
Cultural	▪ Ancestral Landscapes ▪ Marae ▪ Mahinga Kai ▪ Whānau/hapū/iwi whare and 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	▪ CTA1: Ōtaki: Coastal Terrestrial Area ▪ Ōtaki Dunes: High Natural Character (HNC) ▪ Te Horo Dunes: High Natural Character (HNC) ▪ Part of CTA2: Waikanae and Paraparaumu: Coastal Terrestrial Area ▪ Peka Peka Dunes: High Natural Character (HNC)

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.

The RSLR projections used in this assessment uses the most recent data for the Kāpiti Coast from NZ SeaRise Programme[14], 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, 2022, and 2024) 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

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

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.

For coastal flooding, the extent of flooding has been modelled using a "bathtub 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, as this may remove the existing high dune and infrastructure along the coastline.

Table 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	SSP2-4.5 & SSP5-8.5 (0.2 m RSLR in both cases)		
2070	SSP2-4.5 (0.35 m RSLR) SSP5-8.5 (0.45 m RSLR)		
2130	SSP2-4.5 (0.85 m RSLR) SSP5-8.5 (1.25 m RSLR)		

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)[15].

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

- At Ōtaki Beach, the present-day erosion hazard is what could occur in an extremely large storm (which has a 1% chance of occurring each year in the immediate/near future). At Ōtaki Beach this erosion could be up to 19 m. In the future with RSLR, the shoreline is projected to erode (including the above mentioned 'short-term' storm erosion) an average of:
  - 23 m by 2050 (both SLR scenarios);
  - 30 m (SSP2-4.5) to 39 m (SSP5-8.5) by 2070; and
  - 57 m (SSP2-4.5) to 89 m (SSP5-8.5) by 2130.
- At Te Horo Beach, the 'short term' storm erosion could be up to be more than 13 m. The shoreline at Te Horo Beach has good sediment supply which is projected to continue. As a result, it is projected that over the next 30 years, this will continue and any erosion is likely be limited to small distances (less than the present-day hazard) if an extremely large storm occurred near the end of the timeframe. In the future with RSLR, the shoreline is projected to erode (including the above mentioned 'short-term' storm erosion) an average of:
  - -13 m by 2050 (both SLR scenarios);
  - -16 m (SSP2-4.5) to -22 m (SSP5-8.5) by 2070
  - -24 m (SSP2-4.5) to -53 m (SSP5-8.5) by 2130
- At Peka Peka Beach, the 'short term' storm erosion could result in up to 16 m of erosion. In the future with SLR, the shoreline is projected to erode (including the above mentioned 'short-term' storm erosion) by an average of:
  - 17 m by 2050;
  - 21 m to 29 m by 2070

[15] 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.

- 37 m to 70 m by 2130

For coastal inundation, the exposure increases across the NAA with sea level rise. At Ōtaki Beach, the main flooding pathways are the Rangiuru and Waitohu Streams and a low point in the dunes at the southern end of Marine Parade. While the Ōtaki River provides a path for coastal flooding, the stopbanks on both banks of the river are well above present-day storm tide levels. By 2070, the area susceptible to inundation around the Waitohu and Rangiuru Streams increases, and the largest areas of potential flooding are generally around Rangiuru Road and Moana Street. By 2130, the areas susceptible to flooding around the Waitohu and Rangiuru Streams both increase in extent, and the Moana Street area is susceptible to direct flooding from the Waitohu Stream. The Rangiuru Stream catchment is susceptible to flooding from the sea over low points in the Ōtaki River stopbank at the outfall to the stream, resulting in flooding around Kāpiti Lane, Rangiuru Road, and the back of the Ōtaki Beach settlement.

At Te Horo beach, the area most susceptible to flooding in a present day 1% AEP event is the low-lying area around the Mangaone Stream mouth. A small number of properties at the northern end of the settlement are also potentially susceptible to flooding through the road drain at the northern end of Rodney Avenue. By 2070, there is an increase in the area flooded around the mouth of Mangaone Stream, with Rodney Avenue and some properties around this road becoming potentially vulnerable from direct inundation and wave overtopping. Farmland behind the settlement between Sims Road and Harakeke Road also becomes vulnerable to flooding by this time. By 2130, the flooding that occurs along Rodney Ave is likely to be worse with additional flooding caused from waves overtopping the beach. There are extensive areas of susceptible land behind the settlement up to Pukenamu Road. Many properties around Dixie Street and Gawler Street are not mapped as become flooded, however the main evacuation route out of the settlement (Te Horo Beach Road) is vulnerable to flooding.

At Peka Peka Beach, there is currently little exposure to coastal flood hazard. The dune ridge along the Peka Peka shoreline is generally higher than the extreme storm tide water level (1% AEP) including RSLR and wave run-up), and therefore provides good protection for the settlement from coastal flood hazards. The main pathway for flooding inland is through Te Kowhai Stream. By 2070 under both SLR scenarios, the susceptibility to flooding increases in the dune swales that run parallel to the coastline either side of Paetawa Road. The area susceptible to flooding around Te Kowhai Stream increases in extent and land around the open drain south of Peka Peka Road also starts to become susceptible by this time. By 2130, under the higher RSLR scenario, the southern end of the settlement in the lower dune swale area becomes more susceptible to flooding, as well as a significantly larger area of rural land behind the settlement.

Exposure of an element was assessed through GIS mapping, where the subject matter specialist could overlay the 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 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 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 3.

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

Table 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 4) 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 4, which combines 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 5.

Vulnerability ratings for each element are recorded in Appendix A.

Table 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 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 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 rating 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 rating 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 rating. For example, when assessing the sensitivity of private properties to coastal erosion, consideration was given for where the erosion reached on the property in relation to the location of 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 properties, 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 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) can have a higher 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 may require upgrading prior to being exposed, therefore taking the opportunity to relocate this infrastructure away from the hazard as part of the upgrade 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 2.2.5), a risk rating is developed for each element against each hazard from low to extreme. This matrix is presented in Table 6. These risk ratings are compiled together in an overall matrix with the exposure, sensitivity, adaptive capacity, vulnerability and overall risk score over time in Appendix B.

Table 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 SSP5-8.5). 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 elements' sensitivity to the coastal erosion and flooding hazards
  - A description and rating of the elements' 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 a second table for coastal erosion.

3. Built Environment Domain

The 'Built Environment' domain refers to the infrastructure which provides a service to the NAA communities, such as transport, 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 NAA.

The following outlines the information used to assess the risks to the built environment in the NAA, 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 exposed an element is to coastal hazards, and also how this exposure changes over time. Table 7 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. It is recognised that many services, particularly water supply and wastewater, are managed privately in the Te Horo Beach and Peka Peka settlements. Data that was representative of private management of these services was not available at the time of this assessment, and therefore has not been included.

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

Table 7: 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 NAA.** 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.
Private properties (by settlement)	**Risks to private properties by settlements.** Smaller subsets of the NAA have been defined for each of the three main settlements (Ōtaki Beach, Te Horo Beach, Peka Peka) to assess whether the risk profile varies across the three settlements. 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.1.4.	Private property boundary outlines provided by KCDC.
Roads and Bridges	**Risk to roads and bridges in the NAA** 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) with verification using aerial imagery and Google maps street view.

Element	Description	Representative Data
Wastewater services	**Risks to public wastewater infrastructure in the NAA** which service the treatment and disposal of wastewater. This includes: ▪ Wastewater pump stations ▪ Wastewater network (pipes) There is a wastewater treatment plant located in Ōtaki, however this is outside the defined NAA. Wastewater in Te Horo and Peka Peka is managed privately (i.e., septic tank systems) and no data was available to assess these areas. It is assumed that if a property is impacted by a hazard (particularly erosion) then the wastewater treatment at that property would also be impacted.	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 NAA** which supports the supply, treatment and distribution of water to private properties. This includes: ▪ Water supply pipe network ▪ Water supply bores ▪ Water treatment plants ▪ Pump stations. Water supply is privately managed in Te Horo Beach, and no data was available to include in this assessment. It is assumed that if a property is impacted by a hazard (particularly erosion) then the water supply at that property would also be impacted.	Data for public water supply services including pipe network were supplied by KCDC. This included the location of supply bores, 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 NAA.** 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 NAA**. This included assessing the location of the gas supply mains (pipes) relative to the hazards.	Data for natural gas supply was interpreted from the FirstGas website.

3.2 Built Environment Risk Matrix

A summary of the final risk ratings for each element is presented in Table 8. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 8: Summary of risk to elements in the Built Environment Domain

	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	L	L	L	L	L	L	L	L	M	M	M	E
Properties - Ōtaki Beach	L	M	M	M	M	H	L	L	L	H	M	E
Properties - Te Horo Beach	L	M	M	M	M	H	L	L	M	M	M	M
Properties - Peka Peka	L	L	L	L	L	M	L	L	L	M	L	M
Water Supply Infrastructure	L	M	M	M	M	H	L	L	L	L	L	L
Wastewater Infrastructure	L	M	M	M	M	H	L	L	L	L	L	H
Stormwater Infrastructure	L	L	M	M	M	H	L	L	L	M	L	H
Roads and Bridges	L	L	L	L	L	M	L	L	L	H	L	E
Electrical Transmission and supply infrastructure	L	L	L	M	L	H	L	L	L	L	L	M
Natural gas supply mains	No Exposure						L	L	L	L	L	M

3.3 Built Environment Risk Summary

3.3.1 Risks from coastal erosion

The risks to the built environment domain between now and 2070 from coastal erosion are considered to be low-moderate risk under both SSP2-4.5 and SSP5-8.5 scenarios. The assessment indicates that most exposure to elements over this timeframe are generally within isolated areas, and impacts to the broader NAA from coastal erosion will be limited. The risks increase from moderate to high over a 100-year timeframe under the higher SSP5-8.5 SLR scenario for most elements, with the exception of properties (whole adaptation area), beachfront properties in Peka Peka, and roads and bridges.

Property

Risk to all properties within the total NAA is considered to be low at present and through to 2130 for both SLR scenarios, where under the highest SLR scenario 99 properties are affected in 2130 (5% of the total properties in the adaptation area).

When assessing the risk for beachfront properties within the three settlements (Ōtaki Beach, Te Horo Beach, Peka Peka) assessments, risk to beachfront property in Ōtaki Beach and Te Horo Beach increases from low at present day to moderate risk in 2050 and remains moderate risk to 2130 under the lower SSP2-4.5 scenario (10 beachfront properties exposed at Ōtaki Beach; 14 beachfront properties exposed at Te Horo). Under the higher SSP5-8.5 scenario, the risk increases high in 2130 due to moderate percentage of exposure to beachfront properties (29 beachfront properties (28%) at Ōtaki Beach, and 18 properties (31%) at Te Horo Beach) and extreme sensitivity due to erosion intersecting with dwellings on most exposed properties, as shown in Figure 6.

Beachfront property at Peka Peka Beach is only considered to be at low risk from coastal erosion to 2130 under the lower SSP2-4.5 scenario. Under the higher SSP5-8.5 scenario, the risk is low through to 2070, and increases to being at moderate risk in 2130. Although there is high exposure (32 beachfront properties (53%) exposed), the sensitivity to erosion is lower due to the majority of the houses there being setback a distance from the sea (as they are on large properties), as exhibited in Figure 6.

Figure 6: Examples of exposure to erosion under SSP5-8.5 for 2130 (dark green) at Ōtaki Beach (left) and Peka Peka (right).

Infrastructure

Risk to all infrastructure elements within the built domain is considered to be low-moderate to 2130 under the lower SSP2-4.5 scenario. However, under the higher SSP5-8.5 scenario, by 2130 all elements increase to being at high risk from coastal erosion, with the exception of roads and bridges. This increase in risk is generally due to the sensitivity of the assessed infrastructure when it becomes exposed to erosion, and which could result in significant damage or loss of the element. For example, it is considered that the wastewater network is extremely sensitive once exposed to erosion, because if it were to be damaged, it could have significant impacts causing both disruption to the broader wastewater network and also has potential cascading effects onto other domains if contaminants were discharged untreated into the environment.

The main area of infrastructure that is exposed to coastal erosion within the NAA is the approximately 500 m stretch of Marine Parade in Ōtaki Beach that separates the main settlement from the properties near the Ōtaki River mouth (e.g. near Rangiuru Road). This stretch of road connects the wastewater, water supply, and electrical transmission network back to the Ōtaki township. However, these elements are only considered 'high' risk rather than 'extreme' because although the sensitivity of these elements being exposed to coastal erosion is considered extreme (due to cascading impacts on the other domains), relative to the wider adaptation area the exposure of this infrastructure is considered to be low (e.g. 1.3 km of water supply pipes exposed in 2130 SPP5-8.5 scenario out of the total 40.3 km within the NAA). Apart from stormwater outfalls that are located perpendicular to the coastline, generally this infrastructure is not exposed to coastal erosion until 2130 under both SLR scenarios.

Water Supply Infrastructure

Water supply is considered to be at low risk from coastal erosion at present, however increases to moderate risk under both SLR scenarios in 2050, and remains moderate risk to 2070 under both SLR scenarios. Under the lower SSP2-4.5 scenario, the risk remains moderate through to 2130, however under the higher SSP5-8.5 scenario the risk increases to high. Under the lower SSP2-4.5 scenario, only 100 m of water supply pipe at Ōtaki Beach becomes exposed to erosion in 2050, and increases over time to be 150 m by 2130. However, under the higher SSP5-8.5 scenario, by 2130 1.3 km of water supply pipe along Marine Parade and at the Waitohu Stream is exposed. The potentially exposed pipes are connecting pipes within the network, and would therefore have a cascading effect on water supply to nearby houses within the settlement. However, no water supply bores, pump stations, or treatment plants are exposed to coastal erosion by 2130 under either SLR scenario.

Wastewater Infrastructure

The risk to wastewater infrastructure is the same as the risk to water supply infrastructure, with the risk being low-moderate over the next 100 years under the lower SSP2-4.5 scenario, but increasing to high risk in 2130 under the higher SSP5-8.5 scenario, as 960 m of wastewater pipe along Marine Parade becomes potentially exposed to coastal erosion. Exposure to erosion could result in undermining and damage to the structures, and could result in a break in the network, with flow on effects to the human domain for health and hygiene. However there are no pump stations or wastewater treatment plants exposed to coastal erosion by 2130 under either SLR scenario.

Stormwater Infrastructure

The risk to stormwater infrastructure is considered to be low at present and to 2050 under both SLR scenarios. In 2070, the risk increases to moderate under both SLR scenarios (0.25 km to 0.4 km of pipe exposed). By 2130, under the lower SSP2-4.5 scenario, the risk remains moderate (0.5 km of stormwater pipe exposed). However, under the higher SSP5-8.5 scenario, the risk increases to high (0.8 km of stormwater pipe exposed). The 10 stormwater outfalls are particularly exposed to short-term erosion at present and in the future due to their locality on the beach. The exposure of outfalls in 2070 and 2130 increases as the majority of the length of outfall pipes become completely exposed, which could lead to undermining and failure. There are two stormwater pump stations in the NAA, however they are not exposed to the projected erosion under either SLR scenario to 2130.

Roads and Bridges

Roads and bridges are considered to be at low risk through to 2130 under the lower SSP2-4.5 scenario. Under the higher SSP5-8.5 scenario, the risk is low to 2070, then increases to moderate risk by 2130 under as a result of the high sensitivity in 2130 where sections of road along Marine Parade are impacted by erosion and would result in loss of access to a number of properties within the Ōtaki Beach settlement. By 2130, 2.1 km of road (3% of road within the NAA) could be impacted by erosion under the SSP-5-8.5 scenario, having cascading impacts onto the loss of access to private property.

Electrical transmission and supply infrastructure

Electrical transmission lines and supply infrastructure is considered to be low risk at present to coastal erosion, and remain low risk under both SLR scenarios through to 2070, as up to this time there is no exposure of this infrastructure to projected coastal erosion. Under the lower SSP2-4.5 scenario, exposure remains low by 2130 (22 m of underground transmission lines exposed), however overall the risk increases to moderate as a result of the extreme sensitivity of this infrastructure to coastal erosion (i.e. 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). Under the higher SSP5-8.5 scenario, 825 m of underground transmission lines along Marine Parade become exposed to coastal erosion in 2130, increasing the risk to high.

Natural gas supply mains

No natural gas supply mains are exposed to coastal erosion in either SLR scenario over the 2130 timeframe.

3.3.2 Risks from coastal inundation

This risks to the built environment domain from coastal inundation between present and 2070 are considered to be low-moderate risk under both SSP2-4.5 and SSP5-8.5 scenarios. By 2130, under the lower SSP2-4.5 scenario, roads and bridges and Ōtaki Beach properties become high risk. Under the higher SSP5-8.5 scenario, there is considered to be extreme risk to private property in relation to the whole NAA, and also within the Ōtaki Beach area. There is also considered to be extreme risk to roads and bridges. Risks to wastewater infrastructure and stormwater infrastructure also increases to high risk in 2130 under the higher SLR scenario.

Property

Across the whole NAA, 361 properties (18%) of private property are projected to be currently exposed to coastal inundation in a 1% AEP event. Under the lower SSP2-4.5 scenario, this increases to 465 properties (23%) in 2050, 598 properties by 2070, and 982 properties by 2130. Overall, the risk under SSP2-4.5 by 2130 is considered to be moderate under this RSLR scenario.

Under the higher SSP5-8.5 scenario, by 2070 704 properties could be exposed to varying degrees of flooding, increasing to 1187 properties by 2130. Under this scenario, by 2130 the risk to properties in the NAA increases from low to extreme, which is largely driven by the increase in exposure and sensitivity at the Ōtaki Beach settlement.1187 private properties in the total NAA are mapped as being exposed to coastal flooding (58%) under this SLR scenario; with 653 of these being in the Ōtaki Beach settlement.

When looking at the Ōtaki Beach settlement in isolation, under the SSP2-4.5 scenario, properties in the settlement are high risk from coastal flooding by 2130, increasing to extreme risk under the SSP5-8.5 scenario across the same timeframe.

The risk of coastal flooding at the two other settlements (Te Horo Beach and Peka Peka) is considered to be low at present and through to 2050. At Te Horo Beach, 45 properties (14%) are mapped as being currently exposed to coastal inundation during a 1% AEP event. By 2130, this increases to 130 properties (42%) under the lower SSP2-4.5 scenario, and up to 152 properties (49%) under the higher SSP5-8.5 scenario. Across both SLR scenarios, the risk increases in 2070 to be moderate, and remains moderate through to 2130.

At Peka Peka, 66 private properties are mapped as being currently exposed to coastal flooding (22%), which by 2130 increases to 171 properties (57%) under the lower SSP2-4.5 scenario, and up to 206 properties (68%) under the higher SSP5-8.5 scenario. The exposure to private properties in Peka Peka over these timeframes is considered to be high, however the sensitivity to flooding (i.e. on average how deep water is across properties) is considered to be moderate (0.15-0.65 m of flooding), and hence despite there being a high proportion of properties exposed, the risk is considered to be low to 2070, then increase to moderate in 2130 under both SLR scenarios.

Roads and Bridges

Roads and bridges are considered to be at low risk from coastal flooding under both SLR scenarios to 2070. Under the lower SSP2-4.5 scenario, the risk increases to high in 2130, and under the higher SSP5-8.5 scenario the risk increases to extreme. In 2130, under the lower SSP2-4.5 scenario, a 1% AEP could result in flooding to 8.3 km of road (13%) in Ōtaki Beach, Te Horo Beach and Peka Peka Beach settlements; at the Rangiuru Road bridge; and all inland access routes to and from Ōtaki Beach and Te Horo Beach (access to and from Peka Peka Beach would still be available). This high risk ranking is due to the roads and bridges being highly exposed and highly sensitive to coastal flooding over this timeframe, as flooding could prevent safe access to properties or services in the community, resulting in people becoming temporarily isolated during a flood event, with flooding of the four main access roads from the two settlements preventing evacuation of communities during the event.

Under the higher SSP5-8.5 scenario, by 2130 13.8 km (22%) of roads could be flooded across the NAA in a 1% AEP event, which increases the risk ranking to extreme, where during such an event it will be difficult to evacuate people from the settlement, and works will be required following such events to repair the roads and bridges. This will have cascading impacts on the human domain across all elements. 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.

Three Waters Infrastructure

There is low risk to three waters infrastructure under both SLR scenarios through to 2070. Water Supply infrastructure remains at low risk through to 2130 under both SLR scenarios. The risk to wastewater infrastructure remains low through to 2130 under the lower SSP2-4.5 scenario, however increases to high risk by 2130 under the SSP5-8.5 scenario, as a result of potentially two wastewater pumpstations being exposed to shallow flooding.

Risks to stormwater infrastructure from coastal flooding are considered to be low to 2070 under both SLR scenarios, then increase to moderate in 2130 under the SSP2-4.5 scenario, and high risk under the SSP5-8.5 scenario. This increase in risk is due to both stormwater pumpstations being potentially exposed to flooding during this event, with increased flood depth (and therefore higher sensitivity) under the higher SSP5-8.5 scenario, Stormwater outfalls and pipe mains are generally resilient to flooding, however they do provide pathways for coastal flooding to inland areas where water can flow to, which can exacerbate the flood hazard in some areas.

Electrical Transmission and Supply Infrastructure

The risk to electrical transmission and supply infrastructure is considered to be low at present and through to 2070 under both SLR scenarios, due to the low exposure of distribution transformers to coastal flooding (two exposed). The risk remains low to 2130 under the SSP2-4.5 scenario, despite 6 distribution transformers potentially being exposed. Under the higher SSP5-8.5 scenario, 9 distribution transformers are potentially exposed to flooding, with the risk increasing to moderate as depth of flooding increases on average to be greater than 0.3 m (which is the assumed level of protection on ground mounted distribution transformers).

Natural gas supply mains

The risk to gas supply mains is based on the potential exposure of gas valves. Under both SLR scenarios, the risk is considered to be low at present and remain low to 2130 under the SSP2-4.5 scenario. Under the higher SSP5-8.5 scenario, the risk remains low through to 2070, then increases to moderate by 2130, where mapping indicates gas valves on Te Horo Beach Road are susceptible to deeper flooding.

4. Human Domain

The 'Human' Domain refers to physical and mental health of those who live, work, or recreate in the NAA. 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 NAA, 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 9 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 9: 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 only includes the most landward line of properties.

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.	Cycle and shared walkways, and location of parks and reserves supplied by KCDC. Northern 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 achieve personal and collective aspirations and enjoy a "good life" as defined by an individual, family, or group.	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
	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 Northern Adaptation Area Values Summary (Kāpiti Coast District Council, 2024) Qualitative literature on conflict related to differing opinions on adaptation strategies and options is referenced within the Conflict, Disruption, and Loss

Element	Description	Representative Data
		of Trust in Government risk assessment template – Appendix A.2.3.

4.2 Human Risk Matrix

A summary of the final risk ratings for each element is presented in Table 10. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 10: Human domain risk matrix.

Climate Change Scenario	Coastal Erosion						Coastal Inundation					
	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	L	M	M	M	H	M	H
Mental health and wellbeing	L	L	L	M	M	M	M	M	M	H	M	H
Social infrastructure and amenity	L	L	L	L	L	M	L	M	M	M	M	H
Exacerbating inequities	L	L	M	M	M	M	M	H	H	E	H	E
Social cohesion and community wellbeing	L	L	M	M	M	M	M	M	M	M	M	H
Conflict, disruption and loss of trust in government	M	M	M	M	H	E	M	M	M	H	M	E

4.3 Human Risk Summary

4.3.1 Risks from coastal erosion

Risks to the human domain from coastal erosion are generally considered to be low to moderate over the next 100 years with SLR, except for risk to conflict, disruption, and loss of trust in government – which under the higher SSP5-8.5 SLR scenario becomes high risk in 2070, and extreme risk by 2130.

Physical Health

The risk to human health from coastal erosion is considered to be low at present, and remain low through to 2130 under both SLR scenarios into the future. As noted in Section 3.2, the percentage of the overall number of properties exposed to coastal erosion is small compared to the total number of properties in the NAA. However, the percentage of homes exposed to erosion in certain areas (such as Te Horo Beach settlement) is much higher, especially by 2130, and hence, whilst human health within the whole NAA may be at low risk from coastal erosion, there will be isolated areas that are directly impacted.

Although erosion will impact on a relatively small portion of the stormwater, wastewater, and water supply in the NAA, impacts are generally concentrated in one particular area (Ōtaki Beach) and could have serious implications for those in the immediate vicinity and further afield. For example, Ōtaki Beach settlement contains a residential care facility which could be indirectly impacted by loss of water/electricity as climate change becomes more severe.

Mental health and wellbeing

Risks to mental health and wellbeing within the NAA is considered to be low at present and to 2050 under both SLR scenarios. Under the lower SSP2-4.5 scenario, the risk remains low to 2070, and by 2130 the risk has increased to moderate. Under the higher SSP5-8.5 scenario, the risk increases to moderate by 2070, and remains at moderate risk to 2130.

This increase in risk is largely due to the increase in the number of properties potentially exposed to coastal erosion in these areas, as well as the potential areas that the community associate with their identity. This may generate further financial loss (e.g. insurance withdrawal or repair costs) and/or stress and uncertainty regarding the future. As the beach within the adaptation area is progressively eroded, there may be a reduction in beach access, impacting those who derive identity and wellbeing from the beach and foreshore. Other areas that may provide for residents' mental wellbeing (e.g. Ōtaki Beach Recreation Reserve) and a sense of identity (e.g. the heritage site on Marine Parade) are also at risk from erosion (i.e. by 2130 the heritage site is projected to be eroded).

The KCDC (2024) Northern Adaptation Area Values Summary demonstrated that people within the NAA associate wellbeing with recreating on the beach and being surrounded by a distinctive coastal landscape, with some individuals and households referring to important identity markers along the coast (such as wāhi tapu and kai-gathering locations). Loss of/damage to property and loss of access to the beach and recreation sites will have a potentially significant effect on residents' mental health and connections to natural spaces for recreation and enjoyment.

Social infrastructure and amenity

The risk to social infrastructure and amenity from coastal erosion is considered to be low at present, and under the SSP2-4.5 scenario remain low to 2130. Under the higher SSP5-8.5 scenario, the risk is considered to be low through to 2070, but increase to moderate by 2130.

Schools, medical practises, and places of worship are not projected to be impacted by coastal erosion within the NAA by 2130 under either SLR scenario. However, beach access points, parks and reserves, DoC land, 1 heritage site and the Ōtaki Beach surf life saving club could be impacted by coastal erosion by 2130.

While these features impacted are considered to be highly sensitive to coastal erosion, as they will no longer be able to fulfill their intended purpose, the exposure of these sites is considered to be low in relation to the social infrastructure presence within the total NAA area.

The increase in risk to moderate under SSP5-8.5 scenario by 2130 is largely due to the impact on the public transportation route along Marine Parade in Ōtaki Beach as it becomes impacted by coastal erosion.

Exacerbating inequities

As erosion becomes more severe over time, the competition for “safe” alternative land and homes within the NAA (away from erosion areas) will increase. Those with the financial resources to do so will be able to secure properties in lower-risk areas, while others will need to live with coastal erosion hazards. However, some residents may have no option but to remain in highly impacted locations as safe alternative locations become increasingly unattainable. These residents may experience difficulties with securing home insurance and could increasingly encounter situations that further deepen inequalities they face.

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 to home ownership 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 areas, thereby potentially increasing the population of lower-income and more sensitive households in the NAA over time.

Due to the relatively low exposure of private property, the risk of exacerbating inequities from coastal erosion is considered to be low at present and through to 2050. Under both SLR scenarios, the risk increases to moderate by 2070 and remains moderate through to 2130, as the number of properties potentially exposed to coastal erosion increased.

Social cohesion and community wellbeing

An exposure of coastal erosion over time may affect homes, property, businesses, and facilities, and over time may 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.

The risk to Social cohesion and community wellbeing from coastal erosion is considered to be low at present and through to 2050 due to the low exposure of properties to coastal erosion. Under both SLR scenarios, as the exposure increases (from low to moderate), the risk increases to moderate by 2070 and remains moderate through to 2130.

Conflict, disruption and loss of trust in government

Coastal erosion may cause disruption and conflict as residents and businesses compete for potential government assistance and available alternative land. There could be conflict over who pays for adaptation actions, which may 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 can lead to loss of trust in government institutions, cynicism within the community, and community opposition. As time passes, there is a risk that conflict between community members will escalate as differing opinions on how to respond to erosion 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.

Risks of conflict, disruption, and loss of trust in the government due to coastal erosion are considered to be moderate at present, and remain moderate to 2130 under the SSP2-4.5 SLR scenario. Under the higher SSP5-8.5 scenario, as the exposure to erosion increases, the risk remains moderate to 2050, however by 2070 the risk has increased to high, and by 2130 the risk has increased to extreme.

4.3.2 Risks from coastal inundation

Physical Health

Risks associated with physical health in relation to coastal flooding can 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 (pipes, bores, pumping stations, etc) are overwhelmed or damaged by floodwaters, 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.

The risks to human health from coastal inundation in a 1% AEP event is considered to be moderate at present. Under both SLR scenarios, the risk remains moderate through to 2070, then increases to high by 2130. The increase in risk is driven by the increase in exposure to not only properties (being extreme by 2130), but also critical infrastructure such as stormwater and wastewater pump stations that could be exposed to flooding during events. Exposure to coastal inundation is more severe and widespread than exposure to erosion for the NAA, and becomes progressively more severe over time, especially for some communities such as Ōtaki Beach.

Mental health and wellbeing

There is likely to be stress, anxiety and trauma associated with the loss of property or on-going damage to property due to flooding. Stress could be associated with the temporary effects of the event (i.e. being trapped at home or within a small geographic area), or due to further financial loss (e.g. insurance withdrawal or repair costs, loss of stock or business revenue) and/or stress and uncertainty regarding the future.

The risks to mental health and wellbeing from coastal inundation in a 1% AEP event is considered to be moderate at present. Under both SLR scenarios, the risk remains moderate through to 2070, then increases to high by 2130. By 2130, under both SLR scenarios, coastal inundation reaches further inland during a significant event, periodically flooding low-lying areas around the beach, waterways, and further inland. Other areas that may provide for residents' mental wellbeing (e.g. walking tracks around Ōtaki River) are at risk of inundation, as are heritage areas (such as the millstones in Ōtaki, at risk by 2130) that may be associated with identity. These places may be unable to be used temporarily (i.e. during the event), or could be damaged as a result of the event.

Social infrastructure and amenity

The temporary inundation during a 1% AEP event of social infrastructure in coastal areas 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). The risks to coastal infrastructure and amenity from coastal inundation are considered to be low at present. Under both SLR scenarios, the risk increases to moderate by 2050, and remains moderate through to 2070. Under the lower SSP2-4.5 scenario, the risk remains moderate through to 2130. However, under the higher SSP5-8.5 scenario, the risk becomes high by 2130.

Exacerbating inequities

As coastal flooding becomes more pronounced over time, the value of affected properties could decrease. This could result in these properties being sold by those who can afford to move away, and purchased or rented by people with less financial means to cope with and recover from hazard events or insure against loss. This could 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.

Under both SLR scenarios, the risk of exacerbating inequities is considered to be moderate at present due to the low exposure, but high sensitivity within the NAA. The risk increases to high by 2050 and remains high through to 2070. In both SLR scenarios, by 2130 the risk is considered to be extreme.

Social cohesion and community wellbeing

Certain areas of the community could progressively become unlivable due to the increased exposure to inundation. This could affect social cohesion at a slow pace as the sea slowly rises, affecting coastal homes, assets, and key infrastructure and access routes. Households may relocate after an event or due to the on-going stress of living with coastal inundation, or 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 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 social wellbeing.

The risk to social cohesion and community wellbeing is considered to be moderate at present, and remain moderate through to 2070 under both SLR scenarios. Under the lower SSP2-4.5 scenario, the risk remains moderate through to 2130. However, under the higher SSP5-8.5 scenario, the risk becomes high by 2130.

Conflict, disruption and loss of trust in government

Coastal flooding may cause disruption and conflict as residents and businesses compete for potential government assistance and available alternative land. There could be conflict over who pays for adaptation actions, leading to community fragmentation and disagreement, with flow on impacts to social cohesion and potential to exacerbate existing inequalities in the community.

Given that flooding is a more widespread issue than erosion, and will affect more properties and areas of the NAA, conflict may be less because a greater proportion of residents may feel they directly benefit from adaptation actions. However, there will still be the potential for conflict and resentment arising from the funding of adaptation, with households that do not directly benefit from adaptation actions potentially being placed in a position where they need to fund adaptation (via rates) that benefits others more significantly. Additionally, the increasingly widespread nature of coastal inundation could drive significant demand for properties and land outside of inundation hazard areas that are not at risk of being cut off by flooding. Competition amongst residents for these properties could drive tension and disruption to community relationships, especially given the somewhat rural nature of the NAA with limited housing stock.

The risks of conflict, disruption and loss of trust in government from coastal inundation in a 1% AEP event is considered to be moderate at present, and under both SLR scenarios, the risk remains moderate through to 2070. Under the lower SSP2-4.5 scenario, by 2130 the risk has become high; and under the higher SSP5-8.5 scenario, the risk is considered to be extreme.

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 NAA.

The coastal area along the Kāpiti Coast District is part of the Foxton Ecological District. This Ecological District contains the most extensive sand-dune system in the country and 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. Before human settlement, the habitats consisted of dune forest on the ridges and various types of wetlands between the dunes. The dune landscape is easily visible on aerial imagery, where shadows cast by the dunes can be seen across the area. This Ecological District still includes several estuaries, wetlands and lagoons, although the vegetation on this dune system is severely modified. Soils in the area are sandy soils of various ages depending on the age of the sand dunes and the height of the water table (McEwen 1987[16]).

The open coast at Ōtaki Beach is mostly sandy beach backed by sand dunes and includes small amounts of gravel from the Ōtaki River. The 30-80 m wide dunes provide protection to the Ōtaki Beach settlement and the almost continuous dunes and the Ōtaki River stopbanks provide good protection from coastal flooding.

The open coast at Te Horo Beach is a composite (sand and gravel) beach with a low gravel ridge behind the beach. Sand is supplied to this area by the persistent southward longshore transport of sediments from the north, and the gravel is supplied by the Ōtaki River.

The open coast at Peka Peka is a sandy beach backed by vegetated sand dunes which provide good natural protection of the hinterland from the effects of coastal erosion and flooding. Sand is supplied to this area by the persistent southward longshore transport. Approximately 28 hectares of the Peka Peka Coastal Dune system is located within the NAA, and the remaining 21 hectares are in the Central Adaptation Area to the south.

The following outlines the information used to assess the risks to the Ecological domain in the NAA, 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 11 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 NAA 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.

[16] McEwen W.M., (Ed.) 1987. Booklet to accompany SHEET 2: descriptions of Districts in the central North Island, from Meremere to Eastern Hawkes Bay. Ecological Regions and Districts of New Zealand. Wellington, Department of Conservation. 92 pp.

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 and modelling, and meet at least one of the criteria set down in Policy 23 of the Greater Wellington Regional Policy Statement (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.

The GWRC spatial layer for Regional Parks, Community Environmental Restoration sites and Managed Open Space 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 11: 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 NAA**. 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. The NAA includes a nearly continuous band of coastal dunes.	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 fifteen known wetlands within the NAA. 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 NAA** 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	KCDC District Plan Schedule 1- Ecological Sites Queen Elizabeth II covenants map (29/09/2023)

Element	Description	Representative Data
	Community Environmental Projects. There are 39 mapped ecological sites in the NAA.	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 NAA.** 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 22 Key Indigenous Trees and 1 Notable Tree in the NAA.	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 NAA.** 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[17] 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 populations and/or are more used to human activities and perturbations.	KCDC Rare and Threatened Vegetation Species (Schedule 3) Other data referred to include: ▪ DOC herpetofauna database and bioweb ▪ 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) This data from GWRC was a combination of site visits and desktop assessment. Other data referred to include: ▪ iNaturalist ▪ eBird
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)

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

5.2 Ecological Risk Matrix

A summary of the final risk ratings for each element is presented in Table 12. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 12: Ecological domain risk 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
Coastal dunes	M	M	H	H	H	E	L	L	M	M	M	M
Wetlands	L	M	M	H	M	H	M	M	M	M	M	H
Ecological sites	M	M	H	E	H	E	M	H	H	E	H	E
Indigenous trees	No Exposure						L	L	L	M	L	H
Rare and threatened species	M	M	H	E	H	E	M	H	H	E	H	E
Bird habitat	M	M	H	E	H	E	H	H	E	E	E	E
Fish habitat	L	M	M	M	M	M	M	M	M	H	H	H
Indigenous biodiversity (coastal)	M	E	E	E	E	E	M	M	M	E	M	E

5.3 Ecological Risk Summary

5.3.1 Risks from coastal erosion

Risks to the ecological domain from coastal erosion are generally moderate at present and through to 2050, then increase to high by 2070 and extreme by 2130. These risks are generally driven by the increasing exposure of dune and estuary habitat to coastal erosion in the future with SLR. The exception to this is indigenous biodiversity, which becomes extreme risk by 2050 and remains at extreme risk through to 2130 under both SLR scenarios.

Coastal dunes

There are three distinctive dune systems in the NAA; the Ōtaki dunes, the Te Horo beach gravel dune system, and Peka Peka dunes. The southern boundaries of these dune systems are the following waterways; Ōtaki River, Te Kowhai/Ngawhakangutu Stream at the end of Paetawa Road, and Waimeha Stream (in CAA). Dunes provide habitat for a range of dune species, plants, and animals as well as providing protection to human infrastructure. Therefore, the loss of dunes will have consequences for both ecology, through the loss of habitat for dune dwelling flora and fauna, and for human infrastructure. Where there is space available, dune species and the sand dunes themselves could migrate further inland, but this will not be possible where human infrastructure needs to be protected.

Under present day sea levels, the risk to coastal dunes from erosion in the NAA is considered to be moderate, as the toes of the dunes are already subject to erosion during storm events but can generally recover between storm events. In an unmodified duneland, the function of eroded foredunes would be taken over by more inland dunes (i.e. more inland dunes would become the foredunes). However, human infrastructure on landward side of the existing dune system precludes this in places, so areas with more human infrastructure could be less resilient (for instance Ōtaki Beach, Te Horo and Peka Peka settlements and rural areas where there is housing on the rear dunes).

Under the lower SSP2-4.5 scenario, present day risk is considered to be moderate due to potential loss of dune habitat, some room for the dune re-establish inland, and good coastal sand input. This risk remains moderate to 2050, and increases to high by 2070 due to the potential for significant loss of foredunes, and in places where rear dunes could be affected too.

Under the higher SSP5-8.5 scenario, coastal dunes are moderate risk through to 2050, but become high risk by 2070 due to the width to which the coastal dunes are projected to be eroded. This risk increases to extreme in 2130 because erosion is predicted to penetrate much further inland along the entire coast. By 2130 at Ōtaki Beach under the higher SLR scenario, erosion could extend into the settlement past the current extent of dunes and a result in complete loss of dunes. At Te Horo Beach, 90-100% of the dune system could be lost, and at Peka Peka Beach, approximately 50% of the dunes could be exposed to coastal erosion.

Wetlands

There are 15 mapped wetlands in the NAA. Two of these are considered to be outstanding wetlands (Te Harakeke Wetland and Te Hapua Road, Swamp A), eight are identified natural wetlands, and three are known to be wetlands but not yet included in GWRC Natural Resource Plan Schedules. One wetland, Pharazyn Reserve, is currently not recognized or mapped as a natural wetland as it is a constructed wetland (i.e. old sewage pond), but it is in the process of being naturalized. Eleven of the identified wetlands are also named Ecological Sites in the KCDC District Plan. There may be other wetlands that have not yet been identified or mapped that would qualify as natural wetlands under the National Policy Statement for Freshwater Management (NPS-FM) and/or the National Environmental Standard-Freshwater (NES-F)[18].

Erosion could result in seawater penetrating further inland in groundwater systems as well as potential greater volumes of wave overtopping, which may change the salinity of nearby coastal wetlands, resulting in the loss of wetland vegetation and fauna and altering the hydrology and wetland soil composition.

[18] The NPS-FM excludes wetlands in the coastal zone, but the NES-F includes all wetlands.

Present day risk from coastal erosion is considered to be low. Under both SLR scenarios, this risk increases to moderate in 2050, remains moderate through to 2070, and becomes high risk by due to the amount of erosion predicted in the estuarine systems. Of the 15 mapped wetlands present in the NAA, three could be exposed to coastal erosion under both the SSP2-4.5 and SSP5-8.5 scenarios by 2130 (Waitohu Stream mouth, Ōtaki River mouth, Kowhai Stream mouth).

Mapped ecological sites

There are 39 mapped ecological sites in the NAA, however only 16 are considered to be unique sites[19]:

- 13 KCDC Ecological Sites (Schedule 1 of the Operative Kāpiti Coast District Plan 2021)
- 8 QEII Trust sites (Queen Elizabeth the Second National Trust Act 1977)
- 1 DOC owned/managed sites including Waikanae Estuary Scientific Reserve
- 1 Conservation Area (Reserves Act 1977)
- 7 Areas identified by GWRC as being managed to protect environmental values
- 7 GWRC Key Native Ecosystems (KNE)
- 2 Sites that are being looked after by community groups.

Ecological Sites are located throughout the NAA and includes estuaries, dune systems, wetlands, and rare tree species. Two areas are identified by GWRC as Outstanding Wetlands - Te Hapua Road (Swamp A) and Te Harakeke Swamp. Most sites are located either on the coast or are associated with waterways, and 3 of the 16 unique sites are only partially within the NAA.

Erosion could result in the loss of dune and wetland vegetation and fauna, which may alter the hydrology and soil composition at these sites. It could also result in modifications of the waterway beds, leading to more or increased rates of erosion and loss of fish passage connectivity.

Coastal erosion will primarily impact ecological sites close to the coastline and river and stream outlets. This includes Lake Waiorongomai (estuary only), Waitohu Stream Mouth, Ōtaki River Mouth, Te Horo Gravel Beach, Peka Peka Coast KNE, and Ōtaki Beach Reserve. Risk under both SLR scenarios to ecological sites is considered to be moderate in the present day and remain moderate to 2050, then increase to high by 2070, and then extreme by 2130 due to the increasing number of wetlands and the proportion of wetlands affected. By 2130, six mapped ecological sites could be exposed to coastal erosion under both the SSP2 4.5 and SSP5 8.5 scenarios.

Indigenous trees

The survey for Key Indigenous Trees (Operative Kāpiti Coast District Plan 2021: Schedule 2) was restricted to urban allotments. Neither Te Horo nor Peka Peka were considered urban areas at the time due to lack of connectivity to a serviced sewerage system. The areas in between these villages are rural and thus also excluded. Hence, the only area of Key Indigenous Trees identified within the NAA is in the Ōtaki Beach Settlement. There are 17 Key Indigenous Trees and one Notable Tree identified within the Operative Kāpiti Coast District Plan within this settlement, however none of these trees are exposed to coastal erosion under both SLR scenarios to 2130.

Rare and threatened species

Within the NAA, 78 nationally or regionally Threatened or At Risk species have been reported. Most of these species are associated with coastal areas such as the beach and dunes, waterways, estuaries, or wetland areas. This includes 52 bird species, 13 freshwater fish species, 1 invertebrate species, 2 lizard species, 10 plant species including one liverwort and fungus species (See Appendix A.3.5 for full list of species).

Most of the fauna and some of the flora occurs mostly within the Waitohu Stream and Ōtaki River Estuary, wetlands and along the Paraparaumu Beach. For instance, the greatest number of species and number of birds observed are within the Waitohu Stream mouth and Ōtaki River estuary, with smaller numbers for Te Horo Beach, Peka Peka Beach, and Ōtaki Beach. Erosion could result in the loss of habitat for rare and threatened species, including alterations to the Ōtaki River and Waitohu Stream mouths, and coastal dune habitat. This will have a more significant adverse effect for species with less mobility such as lizards and

[19] Some sites are identified by multiple agencies

plants. Due to the urban nature of much of the inland landscape, if rare and threatened species do occur then they are probably in relatively low numbers, except for in reserve areas and areas where predator control is being undertaken. 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 NAA, alternative coastal habitat may be significantly reduced even for mobile species.

Risk to rare and threatened species within the NAA is currently moderate from coastal erosion, as coastal fauna and flora habitats are already affected by erosion in storms. Under both SLR scenarios, risk is considered to remain moderate to 2050, and increases to high by 2070, then extreme by 2130. By 2130, under both SLR scenarios more than 50% of the habitats could be affected by coastal erosion.

Bird habitat

Significant bird habitats were classified in the 2019 report Preparing Coastal Communities for Climate Change by GWRC as one of three ecological criteria which were identified to be representative of components that would be affected by increases in sea level rise and coastal erosion. Three classes of significant bird habitats were identified in the Wellington Region: lakes, rivers and coastal marine areas. In the NAA, GWRC identified two coastal significant bird habitats and one river habitat; Waitohu Stream Estuary, the Ōtaki River Estuary and the inland part of the Ōtaki River (from the downstream end of Ōtaki River gorge to the coastal marine area boundary). These three areas combined are approximately 91 hectares. Additionally, ebird data illustrates that the Ōtaki Beach, Te Horo Beach and Peka Peka Beach areas are also very important bird habitats.

Under both SLR scenarios, the current risk to bird habitat from coastal erosion is considered to be moderate, due to the current moderate exposure for coastal beaches, dunes and estuaries during storms, however the coastal systems and the species living in them are somewhat adapted to existing erosion processes. Under both SLR scenarios, the risk remains moderate to 2050, then increases to high by 2070 as all coastal bird habitat will be affected to some extent, and then to extreme in 2130. Extreme risk in 2130 under both SLR scenarios is due to the potential for significant loss of estuarine and beach and dune habitat in all six areas.

Fish habitat

The main-stem stream and all tributaries of the Waitohu Stream, Ōtaki River, Mangaone Stream, and some reaches of the Waimeha Stream within the NAA are listed in GWRC Natural Resources Plan Schedule F1: Rivers and lakes with significant indigenous ecosystems. Waitohu Stream, Ōtaki River, Mangaone Stream are also included in Schedule F1b Īnanga spawning habitat and Schedule F4: Sites with significant indigenous biodiversity values in the coastal marine area. Upstream portions of the Waitohu Stream and Ōtaki River are included in Schedule I: Important trout fishery rivers and spawning waters. All the aforementioned waterways are subject to GWRC NRP Rule R214: River, stream and lake mouth cutting (permitted activity).

These waterways provide habitat for 18 indigenous species[20] including 13 Threatened/At Risk fish species, as well as and habitat for 16 migratory indigenous fish species. Fish species known from the NAA include: Threatened-Nationally Vulnerable - shortjaw kōkopu and lamprey; At Risk-Naturally Uncommon – giant bully; At Risk-Declining - New Zealand longfin Eel, torrentfish, giant kōkopu, koaro, dwarf galaxias, īnanga and brown mudfish; Regionally Declining - common smelt and black flounder; and Not Threatened - shortfin eel, Banded kōkopu, upland bully, common bully and redfin bully.

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 (i.e. fish need connected wet surfaces; a sudden drop or waterfall is an obstacle for many species).

For both scenarios, the present-day coastal erosion risk to fish habitat is considered to be low, as there are small overall areas of erosion at two of the three affected waterways and none at Waitohu Stream. Under both SLR scenarios, the risk increases to moderate in 2050 as erosion increases around waterway mouths/estuaries. This risk remains moderate through to 2130 under both SLR scenarios.

Coastal indigenous biodiversity

[20] Trout is not an indigenous species.

Coastal indigenous biodiversity areas have been identified in GWRC Natural Resources Plan Schedule F4: Sites with significant indigenous biodiversity values in the coastal marine area include the following in the NAA;

- Waitohu Estuary provides seasonal or core habitat for eight threatened indigenous migratory fish species: longfin eel, giant kōkopu, shortjaw kōkopu, Īnanga, kōaro, redfin bully, torrentfish and lamprey. The Estuary is one of only a few providing estuarine wetland habitats in the district.
- Ōtaki River Estuary provides seasonal or core habitat for seven threatened indigenous fish species: longfin eel, giant kōkopu, shortjaw kōkopu, kōaro, Īnanga , redfin bully and torrentfish.
- Mangaone Estuary provides seasonal or core habitat for five threatened indigenous fish species: longfin eel, shortjaw kōkopu, kōaro, Īnanga and redfin bully.

All three estuaries are known to be Īnanga spawning sites, and Ōtaki estuary is especially important. Additionally, these areas are important for a range of birds and other species.

Erosion can cause narrowing of the foreshore, providing less foraging and roosting space at high tide for shore birds. This could alter the habitat, including any saline wetlands, within the waterway mouths and make it less appropriate habitat for indigenous fish, bird, and plant species and too deep to be suitable for shorebirds and wading birds.

Erosion could widen the mouth of the waterways and increase exposure to waves and tides and currents. This could make it less suitable for fish, shorebirds, and wading birds. Erosion will likely impact some of the dune systems, which could affect bird roosting or nesting habitat. Coastal erosion is likely to cause increased coastal squeeze for these coastal habitats as erosion inland reduces the amount of space available for habitats to 'migrate' due to human infrastructure and residential areas on the landward sides.

For both the SSP2 4.5 and SSP5 8.5 scenarios, the present-day risk is considered to be moderate. However, by 2050 this risk increases to be extreme under both SLR scenarios, as erosion could impact the estuaries for both Waitohu and Mangaone estuaries from 2050. The risk remains extreme under both SLR scenarios through to 2130, as the lagoons on the northern side of Ōtaki Estuary and the dunes on the southern side of Ōtaki are projected to be eroded under both scenarios.

5.3.2 Risks from coastal inundation

The risks across the ecological domain from coastal inundation are variable over time with SLR across all elements. At present, the risks are generally moderate, increasing to moderate to high by 2050. By 2070 under both SLR scenarios, risks range from low to extreme, and by 2130 generally risks increase to being high-extreme. The risks to the various elements are similar across both SLR scenarios.

Coastal dunes

The highest exposure to coastal flooding within the NAA is generally along the estuaries including the Mangaone Stream, but in particular the Waitohu Stream and Ōtaki River and lower lying surrounding areas. Under both SSP2-4.5 and SSP5-8.5 scenarios, the risk at present day to coastal dunes from coastal inundation is considered to be low, remaining low to 2050. Under both SLR scenarios, the risk increases to moderate by 2070, and remains moderate through to 2130, as it is more likely that significant and/or more frequent flood events would undermine dune toes and increase erosion and susceptibility to flooding, and could also break through parts of the dune resulting in effects on the hind dunes.

Wetlands

Of the 15 wetlands present in the NAA, ten will experience coastal flooding under both SLR scenarios by 2130. These are:

- Outstanding wetlands: Te Hapua Road, Swamp A and Te Harakeke Swamp;
- Identified wetlands: Waitohu Stream Mouth, Ōtaki River Mouth, Ōtaki Stewardship, South Waikawa Beach Dune Lake, Sims wetland, Kowhai Stream Mouth (Hadfields); and
- Other wetlands: Puruaha Road, Ōtaki and Pharazyn Reserve.

Coastal flooding could alter the vegetation composition within a wetland depending on the length of floodwater retention, the depth of the flooding and whether the flooding changes the salinity of the wetlands for more than a few hours. Additional potential effects include changes in channels and water flow, sediment deposition killing plants and animals, decrease light penetration, increase turbidity, reduce primary productivity, and/or changes in salinity. All of these potentially effects could change ecosystems, habitats and the flora and fauna that use these areas. Flooding may potentially also create additional wetland areas, but these need to be retained and protected if they are to replace lost habitats.

Under both SLR scenarios, the risk to wetlands from coastal flooding is considered to be moderate, as flooding of the brackish wetlands occurs already. Under the low SSP2-4.5 scenario, the risk remains moderate through to 2130. Under the higher SSP5-8.5 scenario, the risk remains moderate through to 2070, however by 2130 the risk is considered to increase to high, as flood exposure increases as low-lying areas adjacent to the wetlands also flood. This flooding tends to be more temporary and may also result in additional areas of wet land enabling potential expansion of wetlands (through planting or natural processes).

Mapped ecological sites

Loss or permanent changes of the identified ecological sites due to inundation will mostly affect coastal and waterway-based sites and existing wetland sites. Flood control measures already in place (such as stopbanks and floodgates present in Ōtaki catchment) have already modified the system, and further flooding may exacerbate an already altered ecological system. Increased incidences of flooding in low lying areas due to sea level rise will be magnified during storm events, and may cause floodwaters to back upstream and in the long term may lead to permanent inundation in some areas.

Under both SLR scenarios, the current risk to these sites from coastal flooding is considered to be moderate (as it already occurs) and the habitats have already been modified with little opportunity to 'migrate' within the landscape. Under both SLR scenarios, this risk increases to high in 2050, remains high through to 2070, and increases to extreme in 2130 due to the increasing areas flooded, and the increased depth and duration of flooding. By 2130 under both SLR scenarios, coastal flooding could affect 13 of the 16 (unique) mapped ecological sites in the NAA.

Indigenous trees

The NAA has 22 Key Indigenous Trees and one Notable Tree identified within the Ōtaki Beach settlement in the Operative Kāpiti Coast District Plan 2021: Schedule 2 and Schedule 8. The risks to Key Indigenous Trees include increased flooding and ponding around indigenous trees which can cause waterlogging and poor health or even kill trees. There may be loss of amenity value for individuals upon whose properties the tree occurs if the trees decline in health or die.

Five Key Indigenous Trees out of 22 could be exposed to inundation under scenario SSP2-4.5 by 2130, and 15 trees under SSP5-8.5 by 2130. No indigenous Notable Trees are projected to be exposed. The risk from coastal flooding is considered to be low at present and through to 2070, as only a select few trees could be exposed. The risk increases to moderate in 2130 under the lower SSP2-4.5 scenario when more than 25% of Indigenous Trees could be affected by flooding, and high for the SSP5-8.5 scenario when more than 50% of Key Indigenous Trees could be affected by flooding.

Rare and threatened species

Risk to rare and threatened species was assessed based on the approximate area of ecological habitats potentially affected by coastal flooding. Currently, coastal habitats and wetlands are already exposed to flooding; hence the current risk is considered to be moderate. For both the SSP2-4.5 and SSP5-8.5, this risk increases to high in 2050 as greater portions of the habitat are affected. The risk remains high through to 2070, then increases to extreme in 2130 under both SLR scenarios, as nearly all habitats could be affected by flooding, with some areas being 100% flooded.

Bird habitat

The risk to bird habitat was estimated as the proportion of the bird habitats affected by flooding with sea levels rise, and considered the flooding of adjacent areas which may increase the area of wetland bird habitat over time.

For both the SSP2-4.5 and SSP5-8.5 the current flooding risk is high, and remains high to 2050, as flooding of the coastal and saline bird habitats occurs already (and is expected), but it is likely that the entire Kāpiti coastline will be experiencing similar effects, reducing the availability of possible alternative habitat.

Flood risk increases to extreme from 2070 through to 2130 for both SLR scenarios, as low-lying areas adjacent to the bird habitat also flood, beach and dune habitat is exposed, and the frequency and depth of flooding continues to increase. This could severely limit bird habitat availability and could affect bird populations, potentially resulting in local extinctions. Flooding may result in additional areas of wetland which could provide alternative bird habitat, but this would need to be secured through planting, (legal) protection, and predator control.

Fish habitat

Coastal flooding could 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. However, flooding could also be beneficial to indigenous fish species, as it could provide additional areas of flooded habitat for feeding and spawning. For coastal flooding, the effects of the flood are potentially offset by the temporary additional habitat created in flooded areas of the floodplain.

For both SSP2-4.5 and SSP5-8.5 scenarios, the risk from to these habitats from coastal flooding is considered to be moderate at present and through to 2050, as flooding already penetrates a good distance inland and floods surrounding areas during large events. Under the lower SSP2-4.5 scenario, the risk remains moderate to 2070, then increases to high by 2130. Under the higher SSP5-8.5 scenario, the risk increases to high by 2070, and remains high by 2130, as much of the low-lying area between the Waitohu Stream and Ōtaki River is projected to flooded in a 1%AEP coastal event.

Coastal indigenous biodiversity

More frequent and extensive flooding of indigenous bird and fish habitats may cause changes in the food availability due to increased diving depth, die-off of plants and habitats due to flooding, changes in waterflow patterns, and increased water velocity and sedimentation smothering benthic food sources (buried invertebrates in the sand). These changes will likely affect the prey species available in rivers, lagoons and coastal marine areas, which could reduce food availability for birds and fish. Saltwater may penetrate further upstream and could potentially kill freshwater species (especially plants), which could be in areas where īnanga spawn.

For both the SSP2-4.5 and SSP5-8.5 scenarios, the present-day risk is considered to be moderate as flooding is already occurring. Under both SLR scenarios, the risk remains moderate through to 2070, then increases to extreme by 2130 due to the greater depth of flooding and the additional areas flooded. However, these additional flooded areas may also convey some benefits in providing additional (temporary) habitat for fauna.

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 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 Northern Adaptation Area Risk Assessment Report and the NAA natural character domain risk assessments, the natural character rating and description of coastal environment are from the Kāpiti Coast Natural Character Evaluation (Boffa Miskell, 2024[21]) report and not the Operative Kāpiti Coast District Plan 2021.

The areas which are included within the NAA were assessed as part of the Kāpiti Coast Natural Character Evaluation (Boffa Miskell, 2024). Within that evaluation, these areas comprise part of the **Coastal Terrestrial Area 1: Ōtaki**, with an overall **moderate** natural character rating, and the northern part of **Coastal Terrestrial Area 2: Waikanae and Paraparaumu** encompassing Peka Peka Beach, 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 m and has an overall **moderate** natural character rating.

At a finer assessment scale, the NAA contains three components identified with high natural character, all of which encompass dynamic areas of relatively intact dune systems and the mouths of Te Waitohu and Kowhai Streams which all support existing native dune vegetation. Specifically, these form parts of the Ōtaki Beach, Te Horo Beach and Peka Peka Beach Natural Dunelands[22]. Figure 7 illustrates the natural forms and patterns which typically occur in such coastal terrestrial areas, within which components of high natural character are predominantly identified along parts of the beach berm and foredune.

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 as outlined in the Kāpiti Coast Natural Character Evaluation (Boffa Miskell, Final Draft 2024) when considering the effects of coastal erosion and inundation on coastal natural character. Where projected inundation increasingly extends beyond the coastal environment and into the coastal context further inland, potential natural character implications are also considered, acknowledging this may include potential future delineation of this inherently dynamic environment.

[21] Boffa Miskell (2024) Kāpiti Coast Natural Character Evaluation.

[22] Greater Wellington Regional Council (2022), Ecological Data, Natural Dunelands.

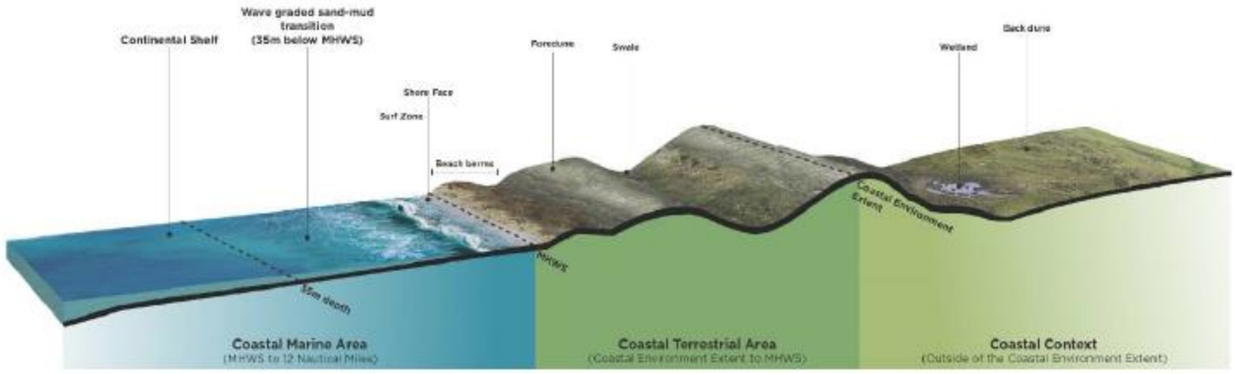

Figure 7: Typical transect through Kāpiti Coast duneland (from Boffa Miskell, 2024)

The following outlines the information used to assess the risks to the Natural Character domain in the NAA, 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 13 provides a summary of the elements assessed within the natural character domain, and what spatial information was used to inform the assessment of risk. Details for each element, including assumptions and limitations used to identify the risks, are provided in Appendix A.

The coastal terrestrial area (CTA) is representative of the broader coastal environment, and within the adaptation area there are two CTA – "Ōtaki", which includes the Ōtaki and Te Horo dunes, and "Waikanae and Paraparaumu" – the northern end of which covers Peka Peka. Within these two CTA's are areas of high natural characters, being parts of the existing dune environments.

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

Element	Description	Representative Data
CTA1: Ōtaki (Coastal Terrestrial Area)	**Risks to the natural character of the Ōtaki Coastal Terrestrial Area, which has a 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.	Spatial overlays of the identified coastal terrestrial area completed by Boffa Miskell for GWRC and KCDC.
Ōtaki Dunes (High Natural Character)	**Risks to the area of High Natural Character at the Ōtaki Dunes.** These areas encompass dynamic areas of relatively intact dune systems, and includes part of the northern Ōtaki Beach Natural Dunelands and mouth of Waitohu Stream [23] which support existing levels of native dune vegetation.	Spatial overlays of the identified areas of high natural character completed by Boffa Miskell for GWRC and KCDC.

[23] Greater Wellington Regional Council (2022), Ecological Data, Natural Dunelands.

Element	Description	Representative Data
Te Horo Dunes (High Natural Character)	**Risks to the area of High Natural Character at the Te Horo Dunes.** These areas encompass dynamic areas of relatively intact dune systems, including part of the southern Te Horo Beach Natural Dunelands.	Spatial overlays of the identified areas of high natural character completed by Boffa Miskell for GWRC and KCDC
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	**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 Waikanae and Paraparaumu CTA incorporates the southern end of the NAA.	Spatial overlays of the identified coastal terrestrial area completed by Boffa Miskell for GWRC and KCDC.
Peka Peka Dunes (High Natural Character)	**Risks to the area of High Natural Character at the Peka Peka Dunes.** These areas encompass dynamic areas of relatively intact dune systems, including part of the northern Peka Peka Beach Natural Dunelands and mouth of Te Kowhai Stream	Spatial overlays of the identified areas of high natural character 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 14 (page 51). A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 14: Natural Character Domain Risk 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
CTA1: Ōtaki (Coastal Terrestrial Area)	L	L	L	M	M	M	M	M	M	M	M	M
Ōtaki Dunes (High Natural Character)	M	M	M	M	M	M	M	M	M	M	M	M
Te Horo Dunes (High Natural Character)	L	L	L	L	L	M	L	L	L	L	L	L
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	M	M	H	M	M	M	M	M	H
Peka Peka Dunes (High Natural Character)	M	M	M	M	M	H	M	M	M	M	M	M

6.3 Natural Character Risk Summary

6.3.1 Risks from coastal erosion

All elements assessed are considered to be at a low to moderate risk to coastal erosion to 2070. Under the lower SSP2-4.5 scenario, these elements continue to be at low to moderate risk up to 2130.

By 2130 under SSP5-8.5 scenario, the Peka Peka dunes and the Waikanae and Paraparaumu Coastal Terrestrial Area (CTA) become high risk. This increase to high risk in the Waikanae and Paraparaumu CTA is closely linked to the impacts on the high natural character of the Peka Peka Dunes. The Peka Peka dunes are largely intact coastal dunes containing Taupo Pumice lapilli. They have native vegetation cover that has reduced over time, but is still present. The area provides opportunities for swimming, walking, blow-carting, boating, and surfing in a relatively open and undeveloped context, and gives expansive views of Kāpiti Island and the Rauoterangi Channel. Over this timeframe, erosion impacts on areas of duneland (up to 74 m) will modify most of the extent of dunes identified with high natural character.

Erosion extends further inland at the mouth of Kowhai Stream and in close proximity to the adjoining coastal settlement. Coastal erosion will primarily impact areas of beach berm and foredunes and the margins adjoining the mouth of Te Kowhai Stream, formed by a mixture of Waitarere-Motuiti dunes. These contain a large amount of Taupo Pumice lapilli and support remaining populations of native duneland vegetation including spinifex and pingao amongst broader colonizing exotic grasses and scrub. Broader areas of natural duneland and gentle sandy beaches form existing natural buffers between coastal hazards and settlement. Erosion of these dunes would result in loss of these environments if they are not able to migrate landward in response to SLR (e.g. coastal squeeze). Built coastal protection and associated human induced changes in response to coastal erosion has the potential to adversely impact natural elements, patterns and processes and therefore reduce natural character.

6.3.2 Risks from coastal inundation

All elements assessed are considered to be at low to moderate at risk of coastal inundation up to 2070. Under the lower SSP2-4.5 scenario, these elements continue to be at low to moderate risk up to 2130.

By 2130 under the SSP5-8.5 scenario, the risk to the Waikanae and Paraparaumu CTA near Peka Peka becomes high. Substantial flooding occurs within low lying dune swales and extends inland of the coastal environment into back dunes and field drains formed along Te Kowhai Stream, and encompassing the former oxidation ponds at Pharazyn Reserve. The coastal terrestrial area supports a range of natural elements including uncommon ecosystem types (e.g. coastal turfs, shingle beaches), native coastal plants (e.g. knobby clubrush, sand sedge, patches of pingao, remuremu, bachelor's button) and native avifauna and fish species, and flooding of these area has the potential to cause damage and reduce natural character. The responses to flood hazard and potential construction of flood defences with increased presence of built form also has potential to reduce natural character.

Most of NAA is considered to have a moderate or high adaptive capacity as within the coastal environment, most coastal flooding occurs in the context of mouths of streams, foredunes characteristic of these more dynamic areas of the coastal environment. Within the northern part of CTA2: Waikanae and Paraparaumu: Coastal Terrestrial Area, coastal flooding extends into dune swales and back dunes and beyond the existing coastal environment. Such areas retain some capacity to absorb areas of flooding through ponding in the context of existing coastal development. Where this extends in the immediate context of coastal development, there is more limited capacity to adapt.

7. Cultural Domain

The Cultural domain refers to the risks to Mana Whenua and their values from coastal hazards in the NAA. The following outlines the information used to assess the risks to the cultural domain in the NAA, and a summary of the findings related to the risks to the cultural domain. Details for each element, including assumptions and limitations used to identify the risks, are provided in Appendix A.

7.1 Cultural Elements

The risk assessment primarily relies on spatial information of the hazards and physical values of mana whenua, as well as experience and knowledge of local mana whenua.
Table 15 provides a summary of the elements assessed within the cultural domain, and what information was used to inform the assessment of risk.

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

Table 15: Summary of elements assessed in the cultural domain and representative data or information used to inform the assessment.

Element	Description	Representative Data
Ancestral Landscapes	**Risk to Ancestral Landscapes from coastal hazards.** This includes culturally significant sites to mana whenua ancestors, including: ▪ Historic pā, ▪ Papakāinga, ▪ Historic battle grounds ▪ Urupā ▪ Wāhi tapu	GIS Spatial layers provided by KCDC as per the KCDC district plan: ▪ Marae ▪ Wāhi tapu (Sites and areas of significant to Māori) Local knowledge obtained from a series of wānanga with Mana Whenua on the location of sites of cultural significance which are not public.
Marae	**Risk to marae within the NAA.** There are two marae within the NAA: ▪ Katihiku Marae; and ▪ Te Pou o Tainui marae Te Marae o Hine is located just outside of the NAA.	Location of the Marae were provided as GIS layers by KCDC.
Mahinga Kai	**Risk to Mahinga Kai, and culturally significant sites for mana whenua to gather food.** These are in the ocean, waterways and forests.	Location of Wetlands with significant indigenous biodiversity (Schedule F3 of GWRC NRP 2023) and Other outstanding wetland water bodies were provided by GWRC. Local knowledge obtained from a series of wānanga with Mana Whenua on the location of important Mahinga Kai sites which are not public.
Whānau/hapū/iwi whare and whenua	**Risk to Whānau/hapū/iwi whenua such lands in trust and personally owned homes along within the NAA.** Ture whenua lands are only a small percentage of adaptation areas; thus they have become more valuable in time and a	Location of Māori owned land using the Māori Land Spatial Dataset (Data.govt.nz). Local knowledge obtained from a series of wānanga with Mana Whenua on the location of important Whānau/hapū/iwi whenua.

Element	Description	Representative Data
	number of Māori land trusts are within the Northern Adaptation Area.	

7.2 Cultural Risk Matrix

A summary of the final risk ratings for each element is presented in Table 12. A more extensive matrix which details the exposure, sensitivity, adaptive capacity, vulnerability, and final risk ratings is provided in Appendix B.

Table 16: Cultural domain risk 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
Ancestral Landscape	L	L	L	M	L	M	L	L	L	L	L	L
Marae	L	L	L	L	L	L	L	L	L	M	L	M
Mahinga Kai	L	L	L	L	L	L	L	L	L	L	L	L
Whānau/hapū/iwi whare and whenua	L	L	L	M	L	M	L	L	L	L	L	M

7.3 Cultural Risk Summary

7.3.1 Risks to coastal erosion

Risks to elements assessed within the cultural domain are considered to be low risk to 2130 under both SLR scenarios, with risks to ancestral landscape and risk to whānau/hapū/iwi whare and whenua elements increasing to moderate risk under the higher SSP5-8.5 scenario by 2130. The low-moderate risk to the assessed elements is generally as a result of the low-moderate exposure to coastal erosion over the assessment timeframes.

Risk to ancestral landscapes from coastal erosion could lead to partial and/or permanent loss of culturally significant historic sites along the NAA coastline, and around river and stream outlets. Accumulated gradual loss of associated knowledge and cultural practices with sites, resulting in loss of connection by mana whenua and deterioration of wellbeing of mana whenua. The exposure of these sites to coastal erosion will increase over time, and will be compounded by inequalities from other domains. Exposure of these sites is considered to be low to 2070, but increases to moderate in 2130 under both SLR scenarios. These sites have low adaptive capacity, as the historic sites can not be physically relocated.

The two Marae located within the NAA (Katihiku Marae and Te Pou o Tainui Marae) are not currently exposed to coastal erosion hazards, and are not anticipated to be impacted by coastal erosion in the assessed timeframes, as they are setback at least 1 km from the coastline, hence these two marae are considered to be at low risk from coastal erosion.

The risk to mahinga kai from coastal erosion is considered to be low over both SLR scenarios to 2130. Traditional mahinga kai sites in the coastal area will remain exposed to the elements of weather and sea level rise, and beach narrowing due to coastal erosion may impact on shellfish populations. However, these sites are considered to have high adaptive capacity. As natural areas it is assumed that te taiao and climate impacts, if left unmodified by human intervention (mana whenua preference), these areas will remain although the locations, habitats and species might differ over time.

Whānau/hapū/iwi whenua lands in trust and personally owned homes along the NAA coastline will be exposed to coastal erosion over time. Ture whenua lands are only a small percentage of adaptation areas; thus they have become more valuable in time and a number of Māori land trusts are within the NAA. The potential consequences of losing further Māori owned lands will be devastating to mana whenua. Many whānau and hapū/iwi members still feel the impacts of colonisation that drastically reduced mana whenua lands and are still being addressed in Te Tiriti o Waitangi Settlement claims in the district. Losing land to coastal erosion from Ōtaki to Peka Peka due to the forces of Tangaroa and the ocean is likely to be permanent. The exposure is considered to be low to 2070, and increase to moderate in 2130 under both SLR scenarios. Sensitivity is also considered to be low until 2070, and increase to high in 2130 as impacts due to an increase in exposure to erosion. Adaptive capacity is considered to be moderate, as mana whenua indicated in wānanga the desire to work with taiao and Ātua. Mana whenua and community groups are engaged in dune planting and re-introducing native species into coastal ecosystems, and have a desire to help build resilience. Overall, risk is considered to be low to 2070, increasing to moderate in 2130 under both SLR scenarios due to the increased exposure of Whānau/hapū/iwi whare and whenua to coastal erosion.

7.3.2 Risks to coastal inundation

Risks to the cultural domain elements in this assessment are considered to be at low-moderate risk from coastal flooding to 2130 under both SLR scenarios. Marae are considered to be at low risk to 2070, and increase to being at moderate risk by 2130 under both SLR scenarios. Risk to whānau/hapū/iwi whare and whenua is considered to increase to moderate risk in 2130 under the higher SLR scenario.

Ancestral landscapes are considered to be at low risk from coastal flooding into the future under both SLR scenarios however, access to cultural heritage sites may be impacted. Coastal flooding is considered to have low sensitivity over the 100 year period under both scenarios because although wetlands and swamps might increase in the low lying areas, the sites would still exist. Ancestral landscapes are considered to have a low adaptive capacity, as historic sites cannot be physically moved, however the kaupapa (purpose) could reluctantly be shifted. In doing so, following traditional practices would be important, and mana whenua must lead any decision making in regards to ancestral landscapes.

Marae are considered to be at low risk to coastal flooding to 2070, and increase to moderate risk by 2130 under both SLR scenarios. Access to marae within the adaptation area are already at risk presently during 1% AEP events, which has impacts on the wider community as Marae are often used in emergency response situations. Projections of increased coastal flooding with RSLR could have moderate impacts on the physical location of Katihiku marae in the long term. Damage to buildings from flood events could have severe consequences especially for wharenui carvings and tukutuku paneling. Te Pou o Tainui surrounding lands and car park could be at risk of flooding from the Mangapouri Stream in the future (however this is outside of the timeframes used in this assessment). The exposure to marae is considered to be low to 2070 under both SLR scenarios, and increase to moderate under both scenarios in 2130. The sensitivity to flooding is considered to increase from low to extreme in 2130 under both scenarios due to the significance of flooding on the marae.

Risks to mahinga kai sites from coastal flooding hazards are considered to be low at present and to 2130 under both SLR scenarios. Severe flooding and long periods of inundation could damage taonga species populations and ephemeral wetland areas, and a reduction of access to food gathering areas and opportunities in the future could decrease the wellbeing of mana whenua. There is potential for cascading impacts on the manaaki of visitors and hospitality. The loss of taonga species (e.g. inanga population and habitat, eels) leads to the loss of associated knowledge and cultural practices such as local techniques for gathering. However, these sites are considered to have a high adaptive capacity. As natural areas it is assumed that te taiao and climate impacts, if left unmodified by human intervention or low levels of modification (mana whenua preference), that these areas will remain although locations, habitats and species might differ over time. Potentially, ephemeral wetlands could change to permanent lagoons or dune lakes, and could increase mahinga kai habitat and associated species.

Whānau/hapū/iwi whenua such lands in trust and personally owned homes along the coastline will be exposed to coastal flooding in the future with RSLR. A large area of the NAA is low lying and vulnerable, with trust lands such as Porirua Trust Board and Katihiku X at higher risk. Retaining Māori land assets in the future will remain important to mana whenua. The exposure to coastal flooding is considered to be low at present and increase to moderate in 2070 to 2130 under the lower SSP2-4.5 scenario, and to high by 2130 under the higher SSP5-8.5 scenario. Adaptive capacity of whānau/hapū/iwi whare and whenua is considered to be high, as the land will remain although it is projected to be temporarily submerged by water during flood events. Overall, risk to whānau/hapū/iwi whare and whenua is considered to be low to 2070, and increase to high under the higher SSP5-8.5 SLR scenario as exposure of flooding on Māori land assets increases with higher sea levels.

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 NAA, of which there is 2062 private properties. Individual settlements (Ōtaki Beach, Te Horo Beach, and Peka Peka Beach) are assessed separately.

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.1.1.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 3 private properties (<1%) currently exposed to short term storm erosion. These are rural land parcels.	Future exposure: - 2050: 37 private properties (2%) - 2070: 36 private properties (2%)[24] - 2130: 44 private properties (2%)
Currently exposed to coastal flooding - 361 private properties are exposed (18%)	Future exposure: - 2050: 465 private properties are exposed (23%) - 2070: 598 private properties are exposed (29%) - 2130: 982 private properties are exposed (48%)

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

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 NAA (2062).

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	L	M	M	M
Coastal Flooding	M	M	H	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 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. Majority of the properties that were signficantly effected by erosion under this scenario were in hydrosystem cells where there is uncertainty abround hydrosystem responses. Over 100 years, up to 25% of the effected properties were significantly effected, while the remaining 75% were only effected by a small amount of erosion, hence over later timeframes the sensitivity increases to moderate.
- 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[25]):
    - 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)

[24] There is one less property exposed in 2070 relative to 2050 due to the long term accretion rate at one property north of Otaki Beach being greater than the effect of SLR, so the property is slightly exposed in 2050, but not in 2070 due to the extrapolation of the high accretion rate.

[25] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

- 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	L	M	M	M	L	L	M	M	M
Flooding	M	M	H	H	L	M	M	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	L	L	M	M	M	L	L	L	L
Risk from Flooding	L	L	M	M	M	M	H	H	L	L	M	M

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 - 3 private properties (<1%) currently exposed to short term storm erosion. These are rural land parcels.	Future exposure: - 2050: 37 Private properties (2%) - 2070: 37 Private properties (2%) - 2130: 99 Private properties (5%)
Currently exposed to coastal flooding - 361 private properties are exposed (18%)	Future exposure: - 2050: 465 private properties are exposed (23%) - 2070: 704 private properties are exposed (34%) - 2130: 1187 private properties are exposed (58%)

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

Note: For both coastal erosion and coastal flooding, exposure is calculated based on the percentage of private land parcels effected relative to the total private land parcels in the NAA (2062).

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 considered to be high-extreme sensitivity; 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 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[26]):
  - 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

[26] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

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	L	M	M	H	L	L	M	M	H
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	L	L	L	L	M	M	H	L	L	L	L
Risk from Flooding	L	L	M	H	M	M	H	E	L	L	M	E

A.1.2 Private Property (Ōtaki Beach)

Domain	Element at Risk	Overview
Built Environment	Private Properties (Ōtaki)	Private properties in the Ōtaki Beach settlement. - For coastal erosion, only beachfront properties (i.e. most seaward row of houses) have been assessed. In the defined Ōtaki Beach erosion hazard area, there are 105 beach front 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 Ōtaki Beach settlement have been considered since properties inland of the shoreline are also susceptible to flooding. In the defined Ōtaki Beach coastal flood hazard area, there are 1151 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.

Figure A.1.1: This map outlines the boundary used for the Ōtaki Beach settlement to assess coastal inundation risks, and the location of the beach front properties used to assess erosion risk.

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 - No private properties (0%) in the defined area are currently exposed	Future exposure: - 2050: 10 private properties are exposed (10%) - 2070: 10 private properties are exposed (10%) - 2130: 10 private properties are exposed (10%)
Currently exposed to coastal flooding - 179 private properties are exposed (16%)	Future exposure: - 2050: 220 private properties are exposed (19%) - 2070: 281 private properties are exposed (24%) - 2130: 546 private properties are exposed (47%)

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

Note: For coastal erosion, exposure is is calculated based on the percentage of private land parcels affected relative to the total number of beach front properties in a defined Ōtaki Beach Settlement footprint. For coastal flooding, exposure is based on the percentage of private land parcels susceptible to flooding within the entire defined Ōtaki Beach Settlement footprint.

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 area of the property and dwellings on the property become exposed, and therefore results in loss of land that is not reestablished. The properties impacted by erosion in Ōtaki sit within the hydrosystem cell, and are generally completed eroded – hence an extreme sensitivity over longer timeframes.
- 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[27]):
    - 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)

[27] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

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	L	E	E	E	L	L	E	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	L	L	L	L	E	E	E	L	M	M	M
Risk from Flooding	L	L	L	M	M	M	H	E	L	L	L	H

A.1.2.2 **SSP5-8.5**

Exposure

Details of exposure	
Currently exposed to coastal erosion - No private properties (0%) in the defined area are currently exposed	Future exposure: - 2050: 10 private properties are exposed (10%) - 2070: 10 private properties are exposed (10%) - 2130: 29 private properties are exposed (28%)
Currently exposed to coastal flooding - 179 private properties are exposed (16%)	Future exposure: - 2050: 220 private properties are exposed (19%) - 2070: 355 private properties are exposed (31%) - 2130: 653 private properties are exposed (57%)

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

Note: For coastal erosion, exposure is is calculated based on the percentage of private land parcels effected relative to the total number of beach front properties in a defined Ōtaki Beach Settlement footprint. For coastal flooding, exposure is based on the percentage of private land parcels susceptible to flooding within the entire defined Ōtaki Beach Settlement footprint.

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 sensitivity; 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 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. The properties impacted by erosion in Ōtaki sit within the hydrosystem cell, and are generally completed eroded – hence an extreme sensitivity over longer timeframes.
- 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[28]):
  - 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.

[28] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

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	L	E	E	E	L	L	E	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	L	L	M	L	E	E	E	L	M	M	H
Risk from Flooding	L	L	M	H	M	M	H	E	L	L	M	E

A.1.3 Private Property (Te Horo)

Domain	Element at Risk	Overview
Built Environment	Private Properties (Te Horo Beach)	Private properties in the Te Horo Beach settlement. - For coastal erosion only beachfront properties (i.e. most seaward row of houses) has been assessed. In the defined Te Horo Beach area, there are 59 beach front 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 Te Horo Beach settlement have been considered since properties inland of the shoreline are also susceptible to flooding. In the defined Te Horo Beach coastal flood hazard area, there are 313 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. Erosion into the property boundary will also result in removal of any defense mechanisms (e.g. dune system, structures) and will increase 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.

Figure A.1.2: This map outlines the boundary used for the Te Horo Beach settlement to assess coastal inundation risks, and the location of the beach front properties used to assess erosion risk.

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 - No private properties (0%) in the defined area are currently exposed	Future exposure: - 2050: 14 private properties are exposed (24%) - 2070: 14 private properties are exposed (24%) - 2130: 14 private properties are exposed (24%)
Currently exposed to coastal flooding - 45 private properties are exposed (14%)	Future exposure: - 2050: 63 private properties are exposed (20%) - 2070: 87 private properties are exposed (28%) - 2130: 130 private properties are exposed (42%)

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

Note: For coastal erosion exposure is calculated based on the percentage of private land parcels effected relative to the total number of beach front properties in a defined Te Horo Beach Settlement footprint. For coastal flooding, exposure is based on the percentage of private land parcels susceptible to flooding within the entire defined Te Horo Beach Settlement footprint.

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 sensitivy; 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 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. The properties impacted by erosion in Te Horo Beach sit within the hydrosystem cell, and are generally completed eroded – hence an extreme sensitivity over longer timeframes.
- 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[29]):
  - 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 sensitvity (up to a depth of 0.5 m above typical floor level in which a signficant proportion of contents are damaged)

[29] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

- 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 sensitivty 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	L	E	E	E	L	L	E	E	E
Flooding	L	M	M	H	L	L	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	L	L	E	E	E	L	M	M	M
Risk from Flooding	L	L	M	M	L	M	M	H	L	L	M	M

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 - No private properties (0%) in the defined area are currently exposed	Future exposure: - 2050: 14 private properties are exposed (24%) - 2070: 14 private properties are exposed (24%) - 2130: 18 private properties are exposed (31%)
Currently exposed to coastal flooding - 45 private properties are exposed (14%)	Future exposure: - 2050: 63 private properties are exposed (20%) - 2070: 98 private properties are exposed (31%) - 2130: 152 private properties are exposed (49%)

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

Note: For coastal erosion exposure is calculated based on the percentage of private land parcels effected relative to the total number of beach front properties in a defined Te Horo Beach Settlement footprint. For coastal flooding, exposure is based on the percentage of private land parcels susceptible to flooding within the entire defined Te Horo Beach Settlement footprint.

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 sensitivity; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to me 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. The properties impacted by erosion in Te Horo Beach sit within the hydrosystem cell, and are generally completed eroded – hence an extreme sensitivity over longer timeframes.
- 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[30]):
  - 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 sensitivty (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)

[30] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

- 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	L	E	E	E	L	L	E	E	E
Flooding	L	M	M	H	L	L	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	L	E	E	E	L	M	M	H
Risk from Flooding	L	L	M	M	L	M	M	H	L	L	M	M

A.1.4 Private Property (Peka Peka)

Domain	Element at Risk	Overview
Built Environment	Private Properties (Peka Peka)	Private properties in the Peka Peka settlement. - For coastal erosion only beachfront properties (i.e. most seaward row of houses) has been assessed. In the defined Peka Peka area, there are 60 beach front 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 Peka Peka settlement have been considered since properties inland of the shoreline are also susceptible to flooding. In the defined Peka Peka coastal flood hazard area, there are 302 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.

Figure A.1.3: This map outlines the boundary used for the Peka Peka settlement to assess coastal inundation risks, and the location of the beach front properties used to assess erosion risk.

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 - No private properties (0%) in the defined area are currently exposed	Future exposure: - 2050: No private properties are exposed (0%) - 2070: No private properties are exposed (0%) - 2130: 9 private properties are exposed (15%)
Currently exposed to coastal flooding - 66 private properties are exposed (22%)	Future exposure: - 2050: 96 private properties are exposed (32%) - 2070: 131 private properties are exposed (43%) - 2130: 171 private properties are exposed (57%)

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

Note: For coastal erosion exposure is calculated based on the percentage of private land parcels effected relative to the total number of beach front properties in a defined Peka Peka Settlement footprint. For coastal flooding, exposure is based on the percentage of private land parcels susceptible to flooding within the entire defined Peka Peka Settlement footprint.

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 sensitivity; 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 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. In Peka Peka, properties that are effected in 2130 are generally only eroded at the seaward edge of larger properties, hence these are considered to be low sensitivity.
- 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[31]):
    - 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)

[31] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

- 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	L	L	L	M	L	L	L	L	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	L	L	L	L	M	L	L	L	L
Risk from Flooding	L	M	M	H	L	L	L	M	L	L	L	M

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 - No private properties (0%) in the defined area are currently exposed	Future exposure: - 2050: No private properties are exposed (0%) - 2070: No private properties are exposed (0%) - 2130: 32 private properties are exposed (53%)
Currently exposed to coastal flooding - 66 private properties are exposed (22%)	Future exposure: - 2050: 96 private properties are exposed (32%) - 2070: 145 private properties are exposed (48%) - 2130: 206 private properties are exposed (68%)

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

Note: For coastal erosion exposure is calculated based on the percentage of private land parcels effected relative to the total number of beach front properties in a defined Peka Peka Settlement footprint. For coastal flooding, exposure is based on the percentage of private land parcels susceptible to flooding within the entire defined Peka Peka Settlement footprint.

Sensitivity

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

Notes:

- Coastal erosion sensitivity 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 sensitivity; whereas if only the front edges of most of the properties effected is exposed and no dwellings are effected, the sensitivity is considered to me 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. In Peka Peka, generally the properties that are effected in 2130 are only eroded at the seaward edge of larger properties and therefore overall it is considered to be moderate. However, there are 5 properties that the erosion line would be up to or intersecting with their dwelling, which for these properties could be considered extremely sensitive.
- 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[32]):
  - 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)

[32] Reese & Ramsay (2010). RiskScape: Flood fragility methodology, NIWA Technical Report: WLG2010-45

- 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 sensitivty 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	L	L	L	M	L	L	L	L	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	H	L	L	L	M	L	L	L	M
Risk from Flooding	L	M	M	H	L	L	L	M	L	L	L	M

A.1.5 Roads and Bridges

Domain	Element at Risk	Overview
Built Environment	Roads and Bridges	All roads and bridges in the NAA. Roads include unsealed and sealed roads as per the LINZ Roads Centreline dataset from LINZ Data service. In the NAA there is 61.6 km of roads (3 km 'metaled'; 41.5 km 'sealed'; and 17.1 km 'unmetalled'). Bridges (including culverts) 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 NAA there are 16 bridges/culverts identified.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	There are three main roads which provide access to the three settlements within the NAA, which are used by the whole district to access the beach in these settlements. Closure/loss of the access roads 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. Marine Parade, Ōtaki Beach). 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.1.5.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 10 m of road length (beach accessway Ōtaki Beach) - 0 Bridges	Future exposure: - 2050: 0.5 km of road (1%) – around inlet areas, no disruption to key access routes; 0 Bridges. - 2070: 0.5 km of road (1%) – around inlet areas, no disruption to key access routes; 0 Bridges. - 2130: 0.7 km of road (1%) – some access to properties on Marine Parade (Ōtaki Beach) effected; 0 Bridges.
Currently exposed to coastal flooding - 2.1 km of road (3%) – 34 m beach access in Te Horo Beach, the remainder are minor roads in Ōtaki Beach and part of Rangiuru Road (inland access available via Tasman Road) - No bridges	Future exposure: - 2050: 3.0 km of road (5%) in Ōtaki Beach and Te Horo Beach and Rangiuru Road bridge; (inland access routes available). - 2070: 3.7 km of road (6%) in Ōtaki Beach and Te Horo Beach and Rangiuru Road bridge; (inland access routes available). - 2130: 8.3 km of road (13%) in Ōtaki Beach, Te Horo Beach and Peka Peka Beach; Rangiuru Road bridge; all inland access routes from Ōtaki Beach and Te Horo Beach (access to Peka Peka available).

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

Note: Exposure rankings for Coastal Erosion is calculated as a percentage of the effected road length of the total road length (61.6 km) in the NAA. Exposure ranking for Coastal Flooding additionally considers loss of access inland.

Sensitivity

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

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.
- 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[33]):

- 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	L	M	M	H	L	L	M	M	H
Flooding	L	M	M	H	L	L	M	M	H

Overall Risk Score

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

Additional Commentary:

Coastal Erosion – No Bridges within the NAA are projected to be exposed to coastal erosion. Te Horo Beach and Peka Peka Beach settlements did not have any projected erosion which would prevent access to the settlement or to individual properties. However, in 2130 under the SSP2-4.5 scenario access to properties along Marine Parade at the northern end (corner of Marine Parade and Konini Street) as well as between Karaka Street and Scotts Avenue are projected to have their access effected. While over the total adaptation

[33] Ball J. et al (2019), Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia).

area the risk to roads is considered ‘low’, erosion over the 2130 timeframe will impact the access to the above mentioned properties.

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 - 10 m of road length (beach accessway Ōtaki Beach) - 0 Bridges	Future exposure: - 2050: 0.5 km of road (1%) – around inlet areas, no disruption to key access routes; 0 Bridges. - 2070: 0.5 km of road (1%) – around inlet areas, no disruption to key access routes; 0 Bridges. - 2130: 2.1 km of road (3%) – Access to properties on Marine Parade (Ōtaki Beach) effected; 0 Bridges.
Currently exposed to coastal flooding - 2.1 km of road (3%) – 34 m beach access in Te Horo Beach, the remainder are minor roads in Ōtaki Beach and part of Rangiuru Road (inland access available via Tasman Road) - No bridges	Future exposure: - 2050: 3.0 km of road (5%) in Ōtaki Beach and Te Horo Beach and Rangiuru Road bridge; (inland access routes available). - 2070: 4.3 km of road (7%) in Ōtaki Beach, Te Horo Beach and Peka Peka; Rangiuru Road bridge; (inland access routes available). - 2130: 13.8 km of road (22%) in Ōtaki Beach, Te Horo Beach and Peka Peka; Rangiuru Road bridge; all inland access routes from Ōtaki Beach and Te Horo Beach (access to Peka Peka available).

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

Note: Exposure rankings for Coastal Erosion is calculated as a percentage of the effected road length of the total road length (61.6 km) in the NAA, with further consideration of whether exposed roads were critical access routes or would impact a significant number of properties. Exposure ranking for Coastal Flooding additionally considers loss of access inland.

Sensitivity

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

Notes:

- Sensitivity to coastal erosion is based where the effected area of road is, and if it would impact accessability to properties and key access routes to the settlement.
- 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[34]):

- 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	L	M	M	H	L	L	M	M	H
Flooding	L	M	M	E	L	L	M	M	E

Overall Risk Score

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

Additional Commentary:

Coastal Erosion **–** No Bridges within the NAA are projected to be exposed to coastal erosion. Te Horo Beach and Peka Peka Beach settlements did not have any projected erosion which would prevent access to the settlement or to individual properties. However, in 2130 under the SSP2-4.5 scenario access to properties 1.5 km of Marine Parade (Ōtaki Beach) are projected to have access effected. While over the total adaptation area the risk to roads is considered low increasing to moderate by 2130, erosion over the 2130 timeframe will significantly effect access to properties along Marine Parade in Ōtaki Beach. Many of these properties will also

[34] Ball J. et al (2019), Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia).

be impacted by erosion over the same timeframe, but as they are located on the landward side of the road, access to these properties will be impacted first.

A.1.6 Stormwater Infrastructure

Domain	Element at Risk	Overview
Built Environment	Storm water 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. In the NAA, stormwater infrastructure is generally concentrated around the Ōtaki Beach settlement. Within the NAA there are two pump stations (located in Ōtaki Beach); 10.8 km length of stormwater network pipe (91% in Ōtaki Beach; 6% in Peka Peka; and 3% in Te Horo), and 10 stormwater outfalls (9 Ōtaki Beach, 1 Te Horo Beach) located along the open coast. 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 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 efficient discharge the stormwater to the sea. Erosion at the pump station could result in undermining of the structure and eventual loss of the structure. If this occurred during a significant event, it could mean the infrastructure was not able to be used and water would not be able to be drained via pump station.
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.1.6.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0.1 km of stormwater pipes (1% of total network, mostly outfall pipes to sea at Ōtaki Beach) - No pump stations exposed. - 7 Stormwater outfalls exposed.	Future exposure: - 2050: o 0.2 km of stormwater pipe (2% of total network, mostly outfall pipes to sea at Ōtaki Beach) o No pump stations exposed. o 7 stormwater outfalls exposed - 2070: o 0.25 km of stormwater pipe (2% of total network, mostly outfall pipes to sea at Ōtaki Beach) o No pump stations exposed o 8 stormwater outfalls exposed - 2130: o 0.5 km of stormwater pipe (5% of total network, mostly outfall pipes to sea at Ōtaki Beach) o No pump stations exposed o 8 stormwater outfalls exposed
Currently exposed to coastal flooding - None	Future exposure: - 2050: None - 2070: None - 2130: Both pump stations

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

Notes:

- Exposure ranking for coastal erosion is based on total pipe length within the Northen Adaptation Area. 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 2070 and 2130 to account for the continued exposure of these key pieces of infrastructure in which the erosion to these structures by that time could lead to some failure due to increased exposure.
- Exposure ranking for coastal flooding only considers stormwater pumpstations (pipes and outfalls are considered resilient).

Sensitivity

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

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

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Stormwater pipes and pump stations 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	L	M	H	H	L	L	M	H	H
Flooding	L	L	L	M	M	L	L	L	M

Overall Risk Score

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

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 - 0.1 km of stormwater pipes (1% of total network, mostly outfall pipes to sea at Ōtaki Beach) - No pump stations exposed. - 7 stormwater outfalls exposed.	Future exposure: - 2050: o 0.2 km of stormwater pipe (2% of total network, mostly outfall pipes to sea at Ōtaki Beach) o No pump stations exposed. o 7 stormwater outfalls exposed - 2070: o 0.4 km of stormwater pipe (4% of total network, mostly outfall pipes to sea at Ōtaki Beach) o No pump stations exposed o 8 stormwater outfalls exposed - 2130: o 0.8 km of stormwater pipe (7% of total network, mostly outfall pipes to sea at Ōtaki Beach) o No pump stations exposed o 8 stormwater outfalls exposed
Currently exposed to coastal flooding - None	Future exposure: - 2050: None - 2070: None - 2130: Both pump stations

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

Notes:

- Exposure ranking for coastal erosion is based on total pipe length within the NAA. 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 2070 and 2130 to account for the continued exposure of these key pieces of infrastructure in which the erosion to these structures by the time could lead to some failure due to increased exposure, especially in 2130 where majority of the length of outfall pipes are completely exposed and are likely to have failed.
- Exposure ranking for coastal flooding only considers stormwater pump stations (pipes and outfalls are considered resilient).

Sensitivity

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

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

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Stormwater pipes and pump stations 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	L	M	H	H	L	L	M	H	H
Flooding	L	L	L	E	M	L	L	L	H

Overall Risk Score

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

A.1.7 Wastewater Infrastructure

Domain	Element at Risk	Overview
Built Environment	Wastewater Infrastructure	Public wastewater infrastructure in the NAA is only in the Ōtaki Beach settlement. Wastewater in Te Horo and Peka Peka is managed privately (i.e. septic tank systems). Public wastewater infrastructure includes wastewater pump stations (two) and the wastewater pipe network (20.1 km). There is a wastewater treatment plant located in Ōtaki, however this is outside the defined NAA. Due to data availability, the risk to privately managed wastewater has not been assessed for the NAA.

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. 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. In Ōtaki settlement, wastewater from the main Ōtaki Beach settlement is carried through the smaller section of development to the south then back up to the wastewater treatment plant. Disruption to the wastewater pipes along Marine Parade would affect the whole of Ōtaki Beach settlement. 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. Pipes affected by erosion in the 100-year timeframe are asbestos cement pipes installed in 1980's, so will be likely to need renewing prior to the 100-year timeframe when they would be affected. 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.1.7.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	

Currently exposed to coastal erosion
- No pumping stations are currently exposed.
- No wastewater pipes are currently exposed.
	Future exposure:
	- 2050:
	  o No pumping stations are currently exposed
	  o 80 m of wastewater pipe could be exposed (corner of Marine Parade and Konini Street)
	- 2070:
	  o No pumping stations are exposed.
	  o 80 m of wastewater pipe could be exposed (corner of Marine Parade and Konini Street).
	- 2130:
	  o No pumping stations are exposed
	  o 90 m of wastewater pipe could be exposed (corner of Marine Parade and Konini Street, and surf club connection).

Currently exposed to coastal flooding - 1 pump station (of 2)	Future exposure: - 2050: 1 pump station (of 2) - 2070: 1 pump station (of 2) - 2130: 1 pump station (of 2)

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

Note: This is based on percentange of network effected for erosion and proportion of pump stations for flooding.

Sensitivity

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

Note: Erosion would result in undermining and damage to the structure, and would result in a break in the network, with flow on effects to the human domain. Therefore, damage/breakage in the network would be considered extreme. 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	L	E	E	E	L	L	E	E	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

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

Note: There is no wastewater network in Peka Peka or Te Horo Beach, and therefore the risk ranking is based on the network that exists in Ōtaki Beach within the adaptation area.
Although the physical infrastructure is relatively resilient to coastal flooding, ingress of flood water to the network either from coastal flooding or through elevated groundwater levels can reduce the capacity of the system to carry wastewater and increases the risk of foul flooding and exceeding the capacity of the wastewater treatment works in Ōtaki.

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 - No pumping stations are currently exposed. - No wastewater pipes are currently exposed.	Future exposure: - 2050: o No pumping stations are currently exposed o 80 m of wastewater pipe could be exposed (corner of Marine Parade and Konini Street) - 2070: o No pumping stations are exposed. o 85 m of wastewater pipe could be exposed (corner of Marine Parade and Konini Street). - 2130: o No pumping stations are exposed o 960 m of wastewater pipe could be exposed along Marine Parade, Ōtaki Beach.
Currently exposed to coastal flooding - 1 pump station (of 2)	Future exposure: - 2050: 1 pump station (of 2) - 2070: 1 pump station (of 2) - 2130: 2 pump stations (of 2)

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

Note: This is based on exposure percentage, and proportion of pump stations for flooding. For coastal erosion, by 2130 only 5% of the total network is exposed, however it would have a signficant impact on the Ōtaki Beach settlement due to the area being exposed impacting the total network.

Sensitivity

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

Notes:

- Erosion would result in undermining and damage to the structure, and would result in a break in the network, with flow on effects to the human domain for health and hygiene. Therefore, damage/breakage in the network would be considerd extreme. 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.

Domain	Adaptive Capacity	Key Assumptions
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	L	E	E	E	L	L	E	E	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	L	E	E	E	L	M	M	H
Risk from Flooding	M	M	M	E	L	L	L	L	L	L	L	H

Note: There is no wastewater network in Peka Peka or Te Horo, and therefore the risk ranking is based on the network that exists in Ōtaki Beach within the adaptation area.
Although the physical infrastructure is relatively resilient to coastal flooding, ingress of flood water to the network either from coastal flooding or through elevated groundwater levels can reduce the capacity of the system to carry wastewater and increases the risk of foul flooding and exceeding the capacity of the wastewater treatment works in Ōtaki.

A.1.8 Water Supply Infrastructure

Domain	Element at Risk	Overview
Built Environment	Water Supply Infrastructure	Water supply infrastructure in the NAA is the infrastructure used to service the treatment and supply of water to properties. For this assessment, this includes water supply service pipes; water supply bores; pump stations; and water treatment plants. In the NAA there is: - 40.3 km of water supply pipes (Ōtaki Beach and Peka Peka only) - Three water supply bores (two in Ōtaki Beach; one in Peka Peka) - One water treatment plant (Ōtaki Beach) - Two pump stations (Ōtaki Beach) The public water supply is only connected to Peka Peka and Ōtaki Beach settlements within the NAA. Te Horo Beach settlement is privately supplied (i.e. private tank supply; private bores), however this information was not available for this assessment.

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 the Ōtaki Beach or Peka Peka Beach settlements. There is potential that the water supply could be cut off to larger sections of the Ōtaki Beach Settlement if pipes are damaged along Marine Parade where water is transported between the two separated areas of development. 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. In Ōtaki Beach, as a result of the water supply pipes being along Marine Parade, the water supply will be impacted before the properties themselves; however in Peka Peka Beach the water supply pipes reach properties from Paetawa Road, and therefore coastal properties would be impacted before the water supply mains are.
Coastal Flooding	Water supply pipes are generally resilient to flooding provided pressure is maintained in the network. Power supply and controls at pump stations can be damaged by flooding resulting in interruption of supply and repair or replacement. Consequent loss of network pressure can result in contamination of supply from flood water. Bore supplies may be contaminated by flood water.

Opportunities

Hazard	Opportunities
Coastal Erosion	Many of the coastal water supply pipes were installed in 1980 (cement asbestos or PVC) and therefore are likely to need upgrading prior to erosion becoming an issue. 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.1.8.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - 0 m water supply pipes - 0 pump stations - 0 water supply bores - 0 water treatment plants	Future exposure: - 2050: o 0.1 km water supply pipes (Waitohu Stream & Marine Parade, Ōtaki Beach) o 0 pump stations o 0 water supply bores o 0 water treatment plants - 2070: o 0.1 km water supply pipes (Waitohu Stream & Marine Parade, Ōtaki Beach) o 0 pump stations o 0 water supply bores o 0 water treatment plants - 2130: o 0.15 km water supply pipes (Waitohu Stream & Marine Parade, Ōtaki Beach) o 0 pump stations o 0 water supply bores o 0 water treatment plants
Currently exposed to coastal flooding - No pump stations	Future exposure: - 2050: No pump stations - 2070: No pump stations - 2130: No pump stations

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

Note: For flooding only pump stations have been considered.

Sensitivity

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

Notes: For coastal erosion, supply pipes that are exposed are connecting pipes within the network, and would therefore have a cascading effect on water supply to nearby houses within the settlement. Therefore, sensitivty of a break in the network would be considered extreme.

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	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	L	E	E	E	L	L	E	E	E
Flooding	L	L	L	L	M	L	L	L	L

Overall Risk Score

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

Note: Groundwater sources and private bores are susceptible to increasing salinity in the future as a result of sea level rise which could affect the quality or sustainability of current sources of water supply.

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
- 0 m Water supply pipes
- 0 pump stations
- 0 water supply bores
- 0 water treatment plants
	Future exposure:
	- 2050:
	  o 0.1 km Water supply pipes (Waitohu Stream)
	  o 0 pump stations
	  o 0 water supply bores
	  o 0 water treatment plants
	- 2070:
	  o 0.1 km Water supply pipes (Waitohu Stream & Marine Parade, Ōtaki Beach)
	  o 0 pump stations
	  o 0 water supply bores
	  o 0 water treatment plants
	- 2130:
	  o 1.3 km Water supply pipes (Waitohu Stream & Marine Parade, Ōtaki Beach)
	  o 0 pump stations
	  o 0 water supply bores
	  o 0 water treatment plants

Currently exposed to coastal flooding - No pump stations	Future exposure: - 2050: No pump stations - 2070: No pump stations - 2130: No pump stations

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

Note: For flooding ony pump stations have been considered. Exposure to water supply pipes falls into the 'low' exposure category, however for erosion has been assessed as 'moderate' by 2130 due to the number of properties the pipes service that would be impacted due to the area being exposed causing disruption to the total network.

Sensitivity

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

Notes:

- For coastal erosion, supply pipes that are exposed are connecting pipes within the network, and would therefore have a cascading effect on water supply to nearby houses within the settlement. Therefore, sensitivty of a break in the network would be considered extreme.

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	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	L	E	E	E	L	L	E	E	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	L	E	E	E	L	M	M	H
Risk from Flooding	L	L	L	L	L	L	L	L	L	L	L	L

Note: Groundwater sources and private bores are susceptible to increasing salinity in the future as a result of sea level rise which could affect the quality or sustainability of current sources of water supply.

A.1.9 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.

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. Above ground valve stations susceptible to damage.

Opportunities

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

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 natural gas supply mains shown in the available dataset are exposed to the erosion hazard.	Future exposure: - 2050: None - 2070: None - 2130: None
Currently exposed to coastal flooding - No natural gas supply mains shown in the available dataset are exposed to the flooding hazard.	Future exposure: - 2050: None - 2070: None - 2130: Small sections of Tasman Road and Te Horo Beach Road are susceptible to flooding and available data indicates gas main these roads. Mapping indicates gas valve on Te Horo Beach road susceptible to flooding.

Hazard	Present	2050	2070	2130
Coastal Erosion	None	None	None	None
Coastal Flooding	L	L	L	L

Note: Due to the assessed infrastructure not being exposed to coastal erosion, assessment of risk is not taken any further than this step.

Sensitivity

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

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	-	-
Coastal Flooding	L	No opportunity identified

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	-	-	-	-	-	-	-	-	-
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	None	None	None	None	-	-	-	-	-	-	-	-
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 natural gas supply mains shown in the available dataset are exposed to the erosion hazard.	Future exposure: - 2050: None - 2070: None - 2130: None
Currently exposed to coastal flooding - No natural gas supply mains shown in the available dataset are exposed to the flooding hazard.	Future exposure: - 2050: None - 2070: None - 2130: Sections of Tasman Road and Te Horo Beach road susceptible to flooding and available data indicates gas main these roads. Mapping indicates gas valve on Te Horo Beach Road are susceptible to deeper flooding.

Hazard	Present	2050	2070	2130
Coastal Erosion	None	None	None	None
Coastal Flooding	L	L	L	M

Note: Due to the assessed infrrastructure not being exposed to coastal erosion, assessment of risk to erosion is not taken any further than this step.

Sensitivity

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

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	-	-
Coastal Flooding	L	No opportunity identified

Vulnerability Score

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

Overall Risk Score

Domain	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	None	None	None	None	-	-	-	-	-	-	-	-
Risk from Flooding	L	L	L	M	L	L	L	M	L	L	L	M

A.1.10 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. The main high voltage transmission line runs along the eastern edge of the NAA, supplying electricity to all properties in the District. Electrical transmission infrastructure assessed includes distribution transformers; overhead and underground transmission lines; and substation zones. In the NAA there is: - 89 distribution transformers (which convert electricity from 11kV to 230 V for distribution to all households) – approximately 30% of these are ground mounted and the remainder are pole mounted. - 11.8 km of underground lines (11kV) - 23.4 km of overhead lines (11kV) Data was also obtained for the location of substations, however no substations are located within the NAA and therefore have not been assessed.

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. Erosion or subsidence of the foundations of electricity transmission towers and poles could cause collapse, breakage of power lines and loss of supply.

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. Cables exposed over 100 years in Ōtaki Beach settlement (see below) were installed in 1977, so may require upgrading prior to being exposed to coastal erosion.

Hazard	Opportunities
Coastal Flooding	Routine upgrade of equipment can include floodproofing measures

A.1.10.1 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 - No overhead tranmission lines are exposed.	Future exposure: - 2050: o No distribution transformers are exposed; o No underground transmission lines are exposed; and o No overhead tranmission lines are exposed. - 2070: o No distribution transformers are exposed; o No underground transmission lines are exposed; and o No overhead tranmission lines are exposed. - 2130: o No distribution transformers are exposed; o 22 m of underground transmission line at Ōtaki Beach settlement (corner of Marine Parade and Karaka Street) is exposed to erosion; o No overhead tranmission lines are exposed.
Currently exposed to coastal flooding - ~1 ground mounted distribution transformer	Future exposure: - 2050: ~2 ground mounted distribution transformers - 2070: ~2 ground mounted distribution transformers - 2130: ~6 ground mounted distribution transformers

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

Note:

For flooding, only ground mounted distribution transformers have been considered.

Sensitivity

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

Notes:

- Sensisitivity 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	M	H	M	L	L	M	M

Overall Risk Score

Domain	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	M	M	L	L	L	L

A.1.10.2 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
- No overhead tranmission lines are exposed.
	Future exposure:
	- 2050:
	  o No distribution transformers are exposed;
	  o No underground transmission lines are exposed; and
	  o No overhead tranmission lines are exposed.
	- 2070:
	  o No distribution transformers are exposed;
	  o No underground transmission lines are exposed; and
	  o No overhead tranmission lines are exposed.
	- 2130:
	  o No distribution transformers are exposed;
	  o 825 m of underground transmission lines are exposed (Marine Parade, Ōtaki Beach); and
	  o No overhead tranmission lines are exposed.

Currently exposed to coastal flooding - ~1 ground mounted distribution transformer	Future exposure: - 2050: ~2 ground mounted distribution transformers - 2070: ~2 ground mounted distribution transformers - 2130: ~9 ground mounted distribution transformers

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

Note: High ranking for exposure to erosion in 2130 based of the fact the exposed area between two developed area of Ōtaki Beach, in which the transmission line supplies a signficant number of houses in the area. For flooding, only ground mounted distribution transformers have been considered.

Sensitivity

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

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	H	H	M	L	L	M	M

Overall Risk Score

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

A.2 Human Risk Assessment Templates

A.2.1 Physical health

Domain	Element at Risk	Overview
Human	Risks to physical health	Risks to physical health from collapse of/damage to infrastructure and homes, exposure to coastal flooding/inundation and the potential for water-borne disease, 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 (like stormwater outfalls, wastewater pipes and pumps) 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 (pipes, bores, pumping stations, etc) are overwhelmed or damaged by floodwaters, 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 - 1% of properties (n= 3) in the adaptation area are exposed to coastal erosion, and potentially at risk of undermining and collapse, and loss of water services, with associated risks for occupants and those recreating in the area - At present, 1% of stormwater pipes, 7 stormwater outfalls, and no wastewater, or water supply infrastructure in the NAA is exposed to coastal erosion	Future exposure • By 2050 2% of properties (n= 37) 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 number of properties at risk (n=36) marginally decreases (2% of all properties in the adaptation area) • By 2130 number of private properties in the NAA at risk of coastal erosion increases (n=44 or 2% of all properties). In certain areas of the NAA (for example Te Horo) coastal erosion is more pronounded (affecting 24% or n=14 properties at all timestamps) Increasing amounts of water service pipes and points, stormwater pipes and points, and wastewater pipes and points in the NAA are exposed to coastal erosion as time progresses. By 2050, 2% of the stormwater network in the NAA is exposed to coastal erosion.This remains unchanged in 2070, but in 2130 increases to, 5% of the total stormwater network (primarily around Ōtaki Beach). In 2050 80m of wastewater pipe could be exposed (on the corner of Marine Parade/Konini Street), by 2130 this could increase to 90m of wastewater pipe (on the corner of Marine Parade/Konini Street), and include the surf club connection.
Currently exposed to coastal inundation/flooding - 18% of properties (n= 361) 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 no risk to stormwater or water supply infrastructure in the NAA, but 1 of 2 wastewater pumping stations are exposed.	Future exposure By 2050 23% of properties (n=465) in the adaptation areas are exposed to periodic flooding, which could present risks for residents of being isolated in their homes and experiencing wastewater service and drinking supply loss. By 2070 the % of properties at risk (n=598) increases to 29% By 2130 48% of private properties in the NAA are at risk of coastal flooding (n=982). 56% of these properties (n=546) are located in the Ōtaki Beach settlement (where 47% of properties in the settlement will be affected by flooding by 2130). The stormwater network is not exposed until 2130 when both stormwater pump stations in the NAA are at risk of coastal flooding. The risk to wastewater pumping stations remains consistent (1 of 2 exposed) over all timestamps, and no damage to water supply network is anticipated.

Details of exposure

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

Notes:

- The percentage of the overall number of properties exposed to erosion is small compared to the total number of properties in the NAA. However, the percentage of homes exposed to erosion in certain areas (such as Te Horo beach) is much higher, especially at 2130. In particular, the exposure covers beachfront properties.
- Although erosion will impact on a relatively small portion of the storm-, waste-, water, supply in the NAA, impacts are generally concentrated in one particular area (Ōtaki Beach) and could have serious implications for those in the immediate vicinity and further afield.
- Exposure to coastal inundation is more severe and widespread than exposure to erosion for the NAA, and becomes progressively more severe over time, especially for some communities such as Ōtaki Beach.

Sensitivity

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

Notes:

- Sensitivity is related to the impact of exposure to pathogens and contaminants in water (which may result in sickness, injury or death), the ability to move out of harms way quickly (e.g. in the events of a collapse or flood), and the implications of loss of water services and supply on residents.
- Because of their physiology, older and younger residents are likely to be more sensitive to harm from water contamination, have lowered capacity to move away from collapse events and floodwaters, and could be more acutely affected In the NAA 23% of residents were aged over 65 in 2018 (which is higher than the national average of 15.2% (EHINZ 2018)) and 5% are below the age of 5 (which is 2.5% below the national average) (Stats NZ infoshare 2018 data). Ōtaki Beach settlement contains a residential care facility which could be indirectly impacted by loss of water/electricity as climate change becomes more severe.
- Many people in the area use the beach for swimming, fishing, surfing, and walking (Takutai Kāpiti 2023), which increases potential for people to come into contact with contaminated waters and unstable areas. Scoring of sensitivity assumes that beach use stays consistent into the future.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	▪ 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. ▪ Diverting water, electricity and gas supply infrastructure away from erosion-prone areas is possible but could be costly.

Domain	Adaptive Capacity	Key Assumptions
Coastal Flooding	M	▪ 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, when recreating in the Ōtaki River area) 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	M	M	M	M	M
Flooding	H	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	L	L	L	M	M	M	M	M	L	L	L	M
Risk from Flooding	M	H	H	E	M	M	M	M	M	M	M	H

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 • 1% of properties (n=3) 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, 1% of the total stormwater network in the NAA and 7 stormwater outfalls are exposed to coastal erosion, and no wastewater, or water supply infrastructure is exposed.	Future exposure • By 2050 2% of properties (n=37) 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 at risk (n=37) remains at 2% • By 2130 5% of properties in the NAA are at risk of coastal erosion (n=99), however in certain areas, the impacts are significantly larger. For example, in Ōtaki Beach settlement, 28% (n=29) of properties are affected by erosion by 2130, in Te Horo, 31% of properties (n=18) are affected by erosion, and in Peka Peka, 53% of properties (n=32) are affected. • Small but increasing amounts of the stormwater network are affected by erosion in the NAA over time. In 2050 2% of the network is affected, this increases to 4% in 2070 and by 2130, 7% of the stormwater infrastructure is affected The impact on wastewater systems is greater after 2130. Between 2050 and 2070 short sections of wastewater pipes are exposed however (80m), primarily on the corner of Marine Parade and Konini Street however by 2130 960m is exposed along Marine Parade at Ōtaki Beach. Only small sections of water supply pipes are affected until 2130 when 1.3km of water supply pipes are at risk of erosion (around Waitohu Stream and Marine Parade areas in Ōtaki Beach)
Currently exposed to coastal inundation/flooding • 18% of properties (n=361) 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 does not present a risk to stormwater or water supply infrastructure in the NAA, but 1 of 2 wastewater pumping stations is exposed	Future exposure By 2050 23% of properties (n=465) 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 at risk (n=704) increases to 34% By 2130 58% of private properties are at risk of coastal flooding in the NAA (n=1187). 653 (55%) of these properties are located in Ōtaki Beach, where over half (57%) of properties will be impacted by flooding by 2130. Risks to stormwater and wastewater infrastructure do not arise until 2130 when both (2) stormwater pump

Details of exposure	
	stations and both (2) wastewater pumping stations are impacted by coastal flooding.

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

Note:

- The percentage of the overall number of properties exposed to erosion is small compared to the total number of properties in the adaptation area. However, certain settlements such as Peka Peka and Te Horo Beach will experience very high rates of erosion risk to properties. In particular, the exposure covers beachfront property.
- Coastal inundation exposure is much more widespread and significant for the NAA as a whole, affected over half of all properties by 2130, and having a potential impact on infrastructure and the roading network.

Sensitivity

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

Notes:

- Sensitivity is related to the impact of exposure to pathogens and contaminants in water (which may result in sickness, injury or death), the ability to move out of harms way quickly (e.g. in the events of a collapse or flood).
- Because of their physiology, older and younger residents are likely to be more sensitive to harm from water contamination, have lowered capacity to move away from collapse events and floodwatersIn the northern adaptation area 23% of residents are aged over 65 (which is higher than the national average of 15.2% (EHINZ 2018)) and 5% are below the age of 5 (which is 2.5% below the national average) (Stats NZ infoshare 2018 data).
- Many people in the area use the beach for swimming, fishing, surfing, and walking (KCDC 2023), which increases potential for people to come into contact with contaminated waters and unstable areas. Scoring of sensitivity assumes that beach use stays consistent into the future.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	▪ 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	M	▪ 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

Domain	Adaptive Capacity	Key Assumptions
		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, when recreating around Ōtaki River) 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	M	M	M	M	M
Flooding	H	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	L	L	L	M	M	M	M	M	L	L	L	M
Risk from Flooding	M	H	H	E	M	M	M	M	M	M	M	H

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EHINZ. (2024). Age Profile. Population Vulnerability. Environmental Health Intelligence New Zealand. https://www.ehinz.ac.nz/indicators/population-vulnerability/age-profile/

Stats NZ. (2024). Stats NZ Geographic Data Service. https://datafinder.stats.govt.nz/

A.2.2 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 buildings, 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 activities 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, and/or support mental health and wellbeing. 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 undertake particular activities (e.g. needing to stay away from erosion-prone areas of the coast that are significant to the individual).
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 may be 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, and/or support mental health and wellbeing. 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 areas), or undertake particular activities (e.g. walking in 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 • 1% of properties (n=3) in the adapation area are currently exposed to coastal erosion and could be lost or damaged. • Beach and periphery of Ōtaki Beach Recreation Reserve is currently experiencing erosion	Future exposure • By 2050 2% of properties (n=37) in the adaptation area are at risk of erosion and could be lost or damaged. • By 2070 2% of properties (n=36) in the adaptation area are at risk. • By 2130 2% of properties (n=44) in the adaptation area are exposed. In certain areas of the NAA (for example Te Horo) coastal erosion is more pronounded (affecting 24% or n=14 properties at all timestamps). • The beach within the adaptation area will be progessively eroded, reducing beach access and impacting those who derive identity and wellbeing from the beach and foreshore. • Other areas that may provide for residents' mental wellbeing (e.g. Ōtaki Beach Recreation Reserve) and a sense of identity (e.g. the heritage site on Marine Parade) are also at risk from erosion (by 2130 the heritage site is eroded).
Currently exposed to coastal flooding • 18% of properties (n=361) in the adaptation area are at risk of coastal inundation and could be lost or damaged • The beach, areas around waterways, reserves in Te Horo and Ōtaki and some inland areas of Te Horo currently experience coastal flooding	Future exposure • By 2050, 23% of properties (n=465) within the adaptation area will experience coastal inundation and could be lost or damaged. • By 2070 the % increases to 29% (n=598) • By 2130 the % increases to 48% (n=982). 56% of these properties (n=546) are located in the Ōtaki Beach settlement (where 47% of properties in the settlement will be affected by flooding by 2130). • By 2130 coastal inundation reaches further inland, periodically flooding low-lying areas around the beach, waterways, and residential areas of the NAA. • Other areas that may provide for residents' mental wellbeing and/or sense of identity (e.g. walking tracks around Ōtaki River, as well as the mill stones in Ōtaki) are at risk of inundation

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

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 and flood-prone areas) is likely due to their connection with the coast and other features of the NAA.

Sensitivity

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

Notes:

- Loss of/damage to property and loss of access to the beach and recreation sites 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 the NAA as evidenced in the Northern Adaptation Area Summary (KCDC, 2023). This document demonstrates that people within the NAA associate wellbeing with recreating on the beach and being surrounded by a distinctive coastal landscape, with some individuals and households referring to important identity markers along the coast (such as wāhi tapu and kai-gathering locations).

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 ▪ 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 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	H	L	H	H	H	H
Flooding	H	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	L	L	L	M	H	H	H	H	L	L	L	M
Risk from Flooding	M	H	H	E	M	M	M	M	M	M	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 • 1% of properties (n=3) in the adapation area are currently exposed to coastal erosion and could be lost or damaged. • Beach and periphery of Ōtaki Beach Recreation Reserve is currently experiencing erosion	Future exposure • By 2050 2% of properties (n=37) in the adaptation area are at risk of erosion and could be lost or damaged. • By 2070 2% of the total properties (n=37) in the adaptation area are affected • By 2130 the % increases to 5% of the total properties (n=99) in the adaptation area, however in certain areas, the impacts are significantly larger. For example, in Ōtaki Beach settlement, 28% (n=29) of properties are affected by erosion by 2130, in Te Horo, 31% of properties (n=18) are affected by erosion, and in Peka Peka, 53% of properties (n=32) are affected • The beach within the adaptation area will be progessively eroded, reducing beach access and impacting those who derive identity and wellbeing from the beach. • Other areas that may provide for residents' mental wellbeing (e.g.the reserves in Te Horo and Ōtaki Beach) and a sense of identity (e.g. the monument on Marine Parade) are also at risk from erosion (e.g. the monument is at risk of erosion by 2070)
Currently exposed to coastal flooding • 18% of properties (n=361) in the adaptation area are at risk of coastal inundation and could be lost or damaged • The beach, areas around waterways, reserves in Te Horo and Ōtaki and some inland areas of Te Horo currently experience coastal flooding	Future exposure • By 2050, 23% of properties (n=465) within the adaptation area will experience coastal inundation and could be lost or damaged. • By 2070 the % increases to 34% (n=704) • By 2130 the % increases to 58% (n=1187). 653 (55%) of these properties are located in Ōtaki Beach, where over half (57%) of properties will be impacted by flooding by 2130. • By 2130 coastal inundation reaches further inland, periodically flooding low-lying areas around the beach, waterways, and further inland. • Other areas that may provide for residents' mental wellbeing (e.g. walking tracks around Ōtaki River) are at risk of inundation, as are heritage areas (such as the millstones in Ōtaki, at risk by 2130) that may be associated with identity

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	M	M

Hazard	Present	2050	2070	2130
Coastal Flooding	M	H	H	E

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 and flood-prone areas) is likely due to their connection with the coast and other features of the NAA.

Sensitivity

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

Notes:

- Loss of/damage to property and loss of access to the beach and recreation sites 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 the NAA as evidenced in the Northern Adaptation Area Summary KCDC, 2023). This document demonstrates that people within the NAA associate wellbeing with recreating on the beach and being surrounded by a distinctive coastal landscape, with some individuals and households referring to important identity markers along the coast (such as wāhi tapu and kai-gathering locations).

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	▪ There are no co-ordinated adaptation actions, the shoreline is allowed to erode. ▪ Few actions that can be taken be autonomously are applied on affected properies ▪ 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.

Domain	Adaptive Capacity	Key Assumptions
		▪ 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	H	L	H	H	H	H
Flooding	H	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	L	L	M	M	H	H	H	H	L	L	M	M
Risk from Flooding	M	M	H	E	M	M	M	M	M	M	M	H

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A.2.3 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 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.
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.2.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion • 1% of properties (n=3) in the adaptation area are currently exposed to coastal erosion and could be lost or damaged. • 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.	Future exposure • By 2050 2% of properties (n=37) in the adaptation area are at risk of erosion and could be lost or damaged. • By 2070 2% (n=36) of the total properties in the adaptation area are exposed • By 2130 2% (n=44) of the total properties in the adaptation area are exposed. In certain areas of the NAA (for example Te Horo) coastal erosion is more pronounced (affecting 24% or n=14 properties at all timestamps) • Increasing erosion of public spaces along the coastal strip including parks, reserves, and beach access points, businesses, and transportation networks over time (see risk to social infrastructure and amenity) • Erosion of land/sea interface 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 erosioncome 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 • 18 % of properties (n=361) in the adaptation area are at risk of coastal inundation and could be lost or damaged • Periodic flooding is mostly confined to the beach and residential area around the Ōtaki River.	Future exposure • By 2050, 23% of properties (n=465) within the adaptation area will experience coastal inundation and could be lost or damaged • By 2070 29% (n=598) of properties are at risk • By 2130 48% (n=982) of properties are at risk. 56% of these properties (n=546) are located in the Ōtaki Beach settlement (where 47% of properties in the settlement will be affected by flooding by 2130). • Increase to flooding of public spaces along the coastal strip and further inland 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 NAA for safe land. As time passes, there is a risk that conflict between community members will escalate as differing opinions

Details of exposure	
	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	M	H	H	H
Coastal Flooding	M	M	H	E

Notes:

- Depending on how the impacts of the hazards unfold and the decisions made regarding what action (if any) are taken, a large number of residents within the adaptation area may be at risk of conflict and loss of trust in government. In particular, the conflict and tension arising from the percieved "winners" and "losers" of various courses of action. Erosion affects a limited number of properties in the NAA overall, which could drive resentment and conflict within the community and/or directed at council, especially if the majority of residents feel that adaptation actions do not directly benefit them. For example, seawalls and other hard protection structures offer significant benefits to the small number of beach-front properties affected by erosion, yet potentially cost all residents of the NAA if adaptation actions are funded through rates increases. Hard protection could also change the appearance and accessibility of the beach, compounding residents' frustrations and sense of loss as they witness the change in a place they cherish, because of adaptation actions they do not necessarily support. The clustering of erosion risk in certain communities (such as Te Horo) could drive further conflict and loss of trust in government if adaptation actions are focussed on these communities, and limited investment is made in assisting other communities not at risk of erosion in the NAA to adapt to climate change.
- Given that flooding is a more widespread issue than erosion, and will affect more properties and areas of the NAA, conflict may be less because a greater proportion of residents may feel they directly benefit from adaptation actions. However, there will still be the potential for conflict and resentment arising from the funding of adaptation, with households that do not directly benefit from adatpation actions potentially being placed in a position where they need to fund adaptation (via rates) that benefits others more significantly. Additionally, the increasingly widespread nature of coastal inundation could drive significant demand for properties and land outside of inundation hazard areas, and/or that are not at risk of being cut off by flooding. Competition amongst residents for these properties could drive tension and disruption to community relationships, especially given the somewhat rural nature of the NAA with limited housing stock.

Sensitivity

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

Notes:

- Research has shown that intra-community conflict around the choice of coastal erosion control, hazard mitigation and climate change adaptation action is common in settlements around New Zealand. This includes conflict related to building seawalls or pursuing approaches such as dune reconstruction (Gesing, 2017, 2019, 2021; Hayward, 2008; Rouse et al., 2016; Scouller, 2011). Such conflicts could also arise in the NAA, especially since there is evidence that residents have strong feelings of attachment to their community, and particularly the beach (KCDC, 2023).
- 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. The Northern Adaptation Area Summary (KCDC, 2023) demonstrates that community members place great importance on accessing the beach for recreational purposes, and also to maintain and enhance the wellbeing of themselves and their families. Additionally, the document

shows that community members hold a range of different adaptation preferences which may serve as the basis for potential disagreement.

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 at the household level ▪ 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 at the household level ▪ 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	H	M	M	M	M	M
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	M	H	H	H	M	M	M	M	M	M	M	M
Risk from Flooding	M	M	H	E	M	M	M	M	M	M	M	H

A.2.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion • 1% of properties (n=3) in the adaptation area are currently exposed to coastal erosion and could be lost or damaged. • 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	Future exposure • By 2050 2% of properties (n=37) in the adaptation area are at risk of erosion and could be lost or damaged. • By 2070 the % remains at 2% (n=37) of the total properties in the adaptation area • By 2130 the % increases to 5% (n=99) of the total properties in the adaptation area. In certain areas the impacts are significantly larger. For example, in Ōtaki Beach settlement, 28% (n=29) of properties are affected by erosion by 2130, in Te Horo, 31% of properties (n=18) are affected by erosion, and in Peka Peka, 53% of properties (n=32) are affected • Increasing erosion of public spaces along the coastal strips including parks, reserves, and beach access points, etc 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 erosion 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 • 18 % of properties (n=361) in the adaptation area are at risk of coastal inundation and could be lost or damaged • Periodic inundation is mostly confined to the beach and residential areas around the Ōtaki River	Future exposure • By 2050, 23% of properties (n=465) within the adaptation area will experience coastal inundation and could be lost or damaged • By 2070 the % increases to 34% (n=704) • By 2130 the % increases to 58% (n=1187). 653 (55%) of these properties are located in Ōtaki Beach, where over half (57%) of properties will be impacted by flooding by 2130. • Increased incidence of flooding of public spaces along the coastal strip and further inland including parks, reserves, and beach access points over time (see risk to social infrastructure and amenity)

Details of exposure	
	• Increasing periodic inundation over time increases the competition within the communtity 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	M	H	H	E
Coastal Flooding	M	H	H	E

Notes:

- Depending on how the impacts of the hazards unfold and the decision made regarding what action (if any) are taken, a large number of residents within the adaptation area may be at risk of conflict and loss of trust in government. In particular, the conflict and tension arising from the percieved "winners" and "losers" of various courses of action.
- Erosion affects a limited number of properties in the NAA overall, which could drive resentment and conflict within the community and/or directed at council, especially if the majority of residents feel that adaptation actions do not directly benefit them. For example, seawalls and other hard protection structures offer significant benefits to the small number of beach-front properties affected by erosion, yet potentially cost all residents of the NAA if adaptation actions are funded through rates increases. Hard protection could also change the appearance and accessibility of the beach, compounding residents' frustrations and sense of loss as they witness the change in a place they cherish, because of adaptation actions they do not necessarily support. The clustering of erosion risk in certain communities (such as Te Horo) could drive further conflict and loss of trust in government if adaptation actions are focussed on these communities, and limited investment is made in assisting other communities not at risk of erosion in the NAA to adapt to climate change.
- Given that flooding is a more widespread issue than erosion, and will affect significant amounts of properties and large areas of the NAA, conflict may be less because a greater proportion of residents may feel they directly benefit from adaptation actions. However, there will still be the potential for conflict and resentment arising from the funding of adaptation, with households that do not directly benefit from adatpation actions potentially being placed in a position where they need to fund adaptation (via rates) that benefits others more significantly. Additionally, the increasingly widespread nature of coastal inundation could drive significant demand for properties and land outside of inundation hazard areas, and/or that are not at risk of being cut off by flooding. Competition amongst residents for these properties could drive tension and disruption to community relationships, especially given the somewhat rural nature of the NAA with limited housing stock.

Sensitivity

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

Notes:

- Research has shown that intra-community conflict around the choice of coastal erosion control, hazard mitigation and climate change adaptation action is common in settlements around New Zealand. This includes conflict related to building seawalls or pursuing approaches such as dune reconstruction (Gesing, 2017, 2019, 2021; Hayward, 2008; Rouse et al., 2016; Scouller, 2011). Such conflicts could also arise in the NAA, especially since there is evidence that residents have strong feelings of attachment to their community, and particularly the beach KCDC, 2024).

- 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.The Northern Adaptation Area Summary (KCDC, 2024) demonstrates that community members place great importance on accessing the beach for recreational purposes, and also to maintain and enhance the wellbeing of themselves and their families. Additionally, the document shows that community members hold a range of different adaptation preferences which may serve as the basis for potential disagreement.

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, competing for safe land, or protecting their property against erosion. These households may also experience extra financial burden from contributing to coordinated adaptation actions through rates ▪ 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 competing for safe land, resulting in limited capacity to adapt to flooding at the household level, and extra financial burden from contributing to co-ordinated adaptation (through rates increases). ▪ 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	M	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	M	H	H	E	M	M	H	H	M	M	H	E
Risk from Flooding	M	H	H	E	M	M	M	H	M	M	M	E

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A.2.4 Exacerbating 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 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.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	As erosion becomes more severe over time, the competition for "safe" land and homes within the NAA (away from erosion areas) will increase. Those with the financial resources to do so will be able to secure properties in lower-risk areas of the area 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. These residents may experience difficulties with securing home insurance and could increasingly encounter situations that further deepen inequalities they face. With increased erosion, the value of affected properties will decrease. Decreasing values mean it is likely these properties will be sold by those who can afford to move, and 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. 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.
Coastal Flooding	As flooding becomes more severe over time, the competition for "safe" land and homes within the NAA will increase. Those with the financial resources to do so will be able to secure properties in lower-risk areas while others with lower financial capacity 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. These residents may experience difficulties with securing home insurance and could increasingly encounter situations that further deepen inequalities they face (e.g. inability to access work or school due to flooding, living in a damp or damaged building). 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 sold by those who can afford to move away, and 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

Hazard	Description of Consequence (note any cascading impacts)
	exacerbate existing health inequities that are associated with low-income and other marginalised groups. 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.

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 • 1% of private properties (n=3) 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 2% of properties (n=37) in the adaptation area are at risk of erosion and could be lost or damaged. • By 2070 the % remain at 2% of the total properties (n=36) in the adaptation area • By 2130 the % remains at 2% of the total properties (n=44) in the adaptation area. In certain areas of the NAA (for example Te Horo) coastal erosion is more pronounded (affecting 24% or n=14 properties at all timestamps)
Currently exposed to coastal inundation • 18% of properties in the adaptation area (n=361) are at risk of coastal inundation.	Future exposure • By 2050, 23% of properties within the adaptation area (n=465) will experience coastal inundation and could be lost or damaged. • By 2070 29% of properties (n=598) are at risk of inundation • By 2130 the % increases to 48% (n=982). 56% of these properties (n=546) are located in the Ōtaki Beach settlement (where 47% of properties in the settlement will be affected by flooding by 2130).

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

Notes:

- The total number of properties within the adaptation area has been assessed rather than just the beach front properties. As properties are impacted by erosion and flooding, homes are likely to devalue and people are likely to lose their ability to insure against loss. A recent paper by Storey et al. (2024) demonstrates that insurance withdrawal could become commonplace in coastal settlements around Aotearoa by 2020-2025 due to sea-level rise. Given these challenges, occupants may either sell their property (moving within the same community or further afield) or remain in place as long as possible (and experience a slow worsening of living conditions). Competition for “safe” properties within the area is likely to increase, and those with the financial resources to occupy these properties will likely do so, which could lead to hazard-affected areas largely becoming home to households of lesser economic means. New socio-economic and health inequities may be created and experienced by property owners and/or renters living in or moving into lower value homes.

- Reduction of services may occur as the community reduces in size, changes in socio-economic composision, and there is less investment in the area because of the known hazards. This can lead to “hollowing out” (Smith et al. 2011) of communities – people with fewer means are effectively trapped in a place with few opportunities to access services, resources, employment, and social connections. An impact on social cohesion is also possible if the composition of the community changes.

Sensitivity

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

Notes:

- Based on 2018 census data (StatsNZ), the median personal income in the NAA was approximately $34,000 which is slightly higher than the national median personal income ($31,800) for 2018. While approximately 18% of residents in the NAA earned over $70,000 per annum in 2018, 32% earned under $20,000 per annum in 2018, and particular regions of the NAA (such as Ōtaki Beach, where flooding risk is also very significant) were amongst the most deprived in the nation at the time (Atkinson et al. 2019). People within low-income households may face financial inequities that increase their sensitivity to coastal erosion and inundation (for instance, being unable to strengthen their home so it withstands hazards more effectively or being unable move to non-hazardous locations) (Cutter et al. 2003, Chakraborty et al. 2019).
- 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 to home ownership 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 (Houkamau et al. 2015, Murray and Loveless 2021)). These groups may end up occupying properties that have devalued in erosion and inundation areas, thereby potentially increasing the population of lower-income and more sensitive households in the NAA over time. Furthermore, 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). With approximately 24% of NAA residents identifying as Māori in 2018, and 23% aged over 65 years old, there is significant sensitivity amongst the population of the NAA.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	There are no coordinated adaptation actions, coastal erosion continues. 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 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 coastal flooding.

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	M	H	H	H	H	L	L	M	M
Risk from Flooding	M	H	H	E	H	H	H	H	M	H	H	E

A.2.4.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion • 1% of private properties (n=3) 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 2% of properties in the adaptation area (n=37) are at risk of erosion and could be lost or damaged. • By 2070 the % remains at 2% of the total properties (n=37) in the adaptation area • By 2130 the % increases to 5% of the total properties (n=99) in the adaptation area, however in certain areas, the impacts are significantly larger. For example, in Ōtaki Beach settlement, 28% (n=29) of properties are affected by erosion by 2130, in Te Horo, 31% of properties (n=18) are affected by erosion, and in Peka Peka, 53% of properties (n=32) are affected.
Currently exposed to coastal inundation • 18% of properties (n=361) in the adaptation area are at risk of coastal inundation.	Future exposure • By 2050, 23% of properties (n=465) within the adaptation area will experience coastal inundation and could be lost or damaged. • By 2070 the % increases to 34% (n=704) • By 2130 the % increases to 58% (n=1187). 653 (55%) of these properties are located in Ōtaki Beach, where over half (57%) of properties will be impacted by flooding by 2130.

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

Notes:

- The total number of properties within the adaptation area has been assessed rather than just the beach front properties. As properties are impacted by erosion and flooding, homes are likely to devalue and people are likely to lose their ability to insure against loss. A recent paper by Storey et al. (2024) demonstrates that insurance withdrawal could become commonplace in coastal settlements around Aotearoa by 2020-2025 due to sea-level rise. Given these challenges, occupants may either sell their property (moving within the same community or further afield) or remain in place as long as possible (and experience a slow worsening of living conditions). Competition for "safe" properties within the area is likely to increase, and those with the financial resources to occupy these properties will likely do so, which could lead to hazard-affected areas largely becoming home to households of lesser economic means. New socio-economic and health inequities may be created and experienced by property owners and/or renters living in or moving into lower value homes.
- Reduction of services may occur as the community reduces in size, changes in socio-economic composision, and there is less investment in the area because of the known hazards. This can lead to

"hollowing out" (Smith et al. 2011) of communities – people with fewer means are effectively trapped in a place with few opportunities to access services, resources, employment, and social connections. An impact on social cohesion is also possible if the composition of the community changes.

Sensitivity

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

Notes:

- Based on 2018 census data (Stats NZ 2018), the median personal income in the northern adaptation area was approximately $34,000 which is slightly higher than the national median personal income ($31,800) for 2018. While approximately 18% of residents in the NAA earned over $70,000 per annum in 2018, 32% earned under $20,000 per annum in 2018, and particular regions of the NAA (such as Ōtaki Beach, where flooding risk is also very significant) were amongst the most deprived in the nation at the time (Atkinson et al. 2019). People within low-income households may face financial inequities that increase their sensitivity to coastal erosion and inundation (for instance, being unable to strengthen their home so it withstands hazards more effectively or being unable move to non-hazardous locations) (Cutter et al. 2003, Chakraborty et al. 2019).
- 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 to home ownership 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 (Houkamau et al. 2015, Murray and Loveless 2021)). These groups may end up occupying properties that have devalued in erosion and inundation areas, thereby potentially increasing the population of lower-income and more sensitive households in the NAA over time Furthermore, 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). With approximately 24% of NAA residents identifying as Māori in 2018, and 23% aged over 65 years old (Stats NZ 2018) there is significant sensitivity amongst the population of the NAA.

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 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 inundation.

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	M	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	M	H	H	H	H	L	L	M	M
Risk from Flooding	M	H	H	E	M	H	H	H	M	H	H	E

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A.2.5 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

Hazard	Description of Consequence (note any cascading impacts)
	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' (Smith et al. 2011) 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. Households may relocate after an event or due to the on-going stress of living with coastal inundation, or 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 (Campbell, 2019; Boege, 2018).

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 (1%) and other community services. • However, there is no data to indicate people may be moving due to the percieved risks	Future exposure • By 2050 2% of properties (n=37) in the adaptation area are at risk of erosion and could be lost or damaged. • By 2070 the % remain at 2% of the total properties (n=36) in the adaptation area • By 2130 the % remains at 2% of the total properties (n=44) in the adaptation area. In certain areas of the NAA (for example Te Horo) coastal erosion is more pronounded (affecting 24% or n=14 properties at all timestamps)
Current exposue to coastal inundation • Moderate impacts to social cohesion due to exposure of 361 properties (18%) and other community services However, there is no data to indicate people may be moving due to the percieved risks	Future exposure • By 2050, 23% of properties within the adaptation area (n=465) will experience coastal inundation and could be lost or damaged. • By 2070 29% of properties (n=598) are at risk of inundation • By 2130 the % increases to 48% (n=982). 56% of these properties (n=546) are located in the Ōtaki Beach settlement (where 47% of properties in the settlement will be affected by flooding by 2130).

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

Notes:

- Exposure for the total properties in the adaptation area is considered, rather than just a focus on the beach front properties. As these properties are impacted by erosion and periodic inundation they will likely devalue and become harder to insure (Storey ey al. 2024). People with the financial means to do so 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. Conversly, some residents may not be able to leave because of financial constraints. Hazard affected areas are likely to become home to households with lesser economic means.
- Hollowing out of services may occur as the community reduces in size, potentially becomes less affluent 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.

Sensitivity

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

Note:

- Based on the 2018 census approximately 43% of residents had lived at their usual residence in the NAA for less than 5 years, which means that there is a reasonable population turnover. It is, however, also worth noting that approximately 17% of the population in the adaptation area had resided there (in 2018) 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 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	M	M	M	M	L	M	M	M	M
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	M	M	M	M	M	M	L	L	M	M
Risk from Flooding	M	M	H	H	M	M	M	M	M	M	M	M

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 imapcts 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 percieved risks	Future exposure • By 2050 2% of properties in the adaptation area (n=37) are at risk of erosion and could be lost or damaged. • By 2070 the % remains at 2% of the total properties (n=37) in the adaptation area • By 2130 the % increases to 5% of the total properties (n=99) in the adaptation area, however in certain areas, the impacts are significantly larger. For example, in Ōtaki Beach settlement, 28% (n=29) of properties are affected by erosion by 2130, in Te Horo, 31% of properties (n=18) are affected by erosion, and in Peka Peka, 53% of properties (n=32) are affected.
Current exposue to coastal inundation • Moderate impacts to social cohesion due to limited exposure of 361 properties (18%) and other community services • However, there is no data to indicate people may be moving due to the percieved risks	Future exposure • By 2050, 23% of properties (n=465) within the adaptation area will experience coastal inundation and could be lost or damaged. • By 2070 the % increases to 34% (n=704) • By 2130 the % increases to 58% (n=1187). 653 (55%) of these properties are located in Ōtaki Beach, where over half (57%) of properties will be impacted by flooding by 2130.

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

Notes:

- Exposure for the total properties in the adaptation area is considered, rather than just a focus on the beach front properties. As these properties are impactedby erosion and periodic inundation they will likely devalue and become harder to insure (Storey ey al. 2024). People with the financial means to do so 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. Conversly, some residents may not be able to leave because of financial consrtaints. Hazard affected areas are likely to become home to households with lesser economic means.

- Hollowing out of services may occur as the community reduces in size, potentially becomes less affluent 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.

Sensitivity

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

Note:

- Based on the 2018 census approximately 43% of residents had lived at their usual residence in the NAA for less than 5 years, which means that there is a reasonable population turnover. It is, however, also worth noting that approximately 17% of the population in the adaptation area had resided there (in 2018) 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 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	M	M	M	M	L	M	M	M	M
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	M	M	M	M	M	M	L	L	M	M

	Exposure				Vulnerability				Risk			
Risk from Flooding	M	M	H	E	M	M	M	M	M	M	M	H

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A.2.6 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 utilise, 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 seafront 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 semi-permanent inundation of social infrastructure in coastal areas 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.2.6.1 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 1 beach access point within the current day hazard line.
- A total of 5 parks and reserves are exposed, and no DOC land.
- No other social infrastructure is exposed

Future exposure

- The exposure of beach access points increases from 3 (in 2050 and 2070) to 6 in 2130
- 5 parks and reserves are exposed in 2050 and 2070, and by 2130 6 are exposed
- One parcel of DOC land is affected by 2130 (0 in 2050 and 2070)
- 1 heritage site is impacted by 2130 (0 in 2050 and 2070)
- By 2130 the surf life saving building is at risk of erosion in Ōtaki Beach
- From 2050 onwards the corner of the property housing Tamarillo Active Travel (a tour operator) in Te Horo Beach is at risk of erosion

Present exposure – coastal inundation

- At present, 6 parks and reserves, and 3 parcels of DOC landare exposed to coastal flooding
- The walking areas near to Waitohu Stream and Ōtaki River are currently exposed
- Health Camp Road in Ōtaki Beach is currently inundated periodically which may prevent access for those working at Kiwi Can Do (a recruitment agency)
- No other social infrastructure is affected

Future exposure

- Coastal inundation affects 2 beach access points by 2130 (0 in 2050 and 2070)
- Affected DOC land increases from 3 parcels (2050 and 2070) to 4 (2130)
- Parks and reserves are significantly impacted, with 9 affected in 2050, 11 in 2070, and 15 by 2130, and increasing impact will be observed to walking tracks in inundation areas such as around Ōtaki River
- 2 heritage sites are impacted by 2130 (0 in 2050 or 2070)
- From 2050 onwards 4 businesses are potentially at risk (Grace Massage and Jewellery for You in Ōtaki Beach, and Tamarillo Active Travel and Black Pine Construction in Te Horo). The disused Children's Village in Ōtaki Beach is also affected by periodic inundation from 2050. From 2070, About Beauty in Peka Peka is affected, and by 2130 Kakihiku Trust Museum and Beauty and the Beach beauty salon is affected (making a total of 7 businesses affected by 2130).
- From 2050 onwards the public toilets south of Atkinson Rd in Ōtaki Beach are affected
- No other social infrastructure is exposed

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

Notes:

- Aside from features mentioned above, no other social infrastructure is exposed: the schools, 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	M	▪ Limited options to adapt because parks are constrained by adjoining private properties ▪ Beach access points and community facilities in erosion zones could possibly be preserved in the short term through hard protection structures
Coastal Flooding	M	▪ Limited options to adapt because parks are constrained by adjoining private properties, but walking tracks could be re-routed out of inundation areas.

Vulnerability Score

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

A.2.6.2 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 1 beach access point within the current day hazard line. • A total of 5 parks and reserves are exposed, and no DOC land. • No other social infrastructure is exposed	Future exposure • Increasing amounts of beach access points are exposed to erosion over time: 3 in 2050, 4 in 2070, and 9 in 2130 • 5 parks and reserves are exposed in 2050, 6 in 2070 and 8 by 2130 • By 2070, 1 parcel of DOC land is exposed (0 in 2050), and by 2130 this rises to 2 • By 2070 1 heritage site is exposed (0 in 2050), and by 2130 this becomes 2 • By 2130 a public transportation route along Marine Parade in Ōtaki Beach is affected by erosion. • From 2050 onwards the corner of a property housing Tamarillo Active Travel (a tour operator) in Te Horo Beach is at risk • By 2130 the surf life saving club and public toilets on Marine Parade, Ōtaki Beach, are at risk of erosion
Present exposure – coastal inundation • At present, 6 parks and reserves, and 3 parcels of DOC landare exposed to coastal flooding • The walking areas near to Waitohu Stream and Ōtaki River are currently exposed • Health Camp Road in Ōtaki Beach is currently inundated periodically which may prevent access for those working at Kiwi Can Do (a recruitment agency) • No other social infrastructure is affected	Future exposure • Coastal inundation impacts 2 beach access points in 2070 and 5 in 2130 (0 in 2050) • 3 DOC land parcels are affected in 2050 and 2070, and 5 in 2130 • There is a significant impact to parks and reserves with 9 impacted in 2050, 13 in 2070 and 17 by 2130 • 2 heritage sites are impacted by 2130 • From 2050 onwards 4 businesses are potentially at risk (Grace Massage and Jewellery for You in Ōtaki Beach, and Tamarillo travel and Black Pine Construction in Te Horo). The disused Children's Village in Ōtaki Beach is also affected by periodic inundation from 2050. From 2070, the Ōtaki Boating Club and About Beauty in Peka Peka is affected, and by 2130 Kakihiku Trust Museum, Beauty and the Beach beauty salon, Anam Cara Gardens, the Hall of Fame framing shop, Kiwi Can Do recruiters, and the Residential care facility (Ōtaki Beach) will experience inundation (a total of 12) • From 2050 onwards the public toilets south of Atkinson Rd in Ōtaki Beach are affected • No other social infrastructure is exposed

Hazard	Present	2050	2070	2130
Coastal Erosion	L	L	L	M

Hazard	Present	2050	2070	2130
Coastal Flooding	L	L	L	M

Note:

- No other social infrastructure is exposed than that mentioned above.

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	M	▪ Limited options to adapt because parks are constrained by adjoining private properties ▪ Beach access points and community facilities in erosion zones could possibly be preserved in the short term through hard protection structures ▪ Walking tracks and bus routes could be re-routed away from erosion hazard (e.g. buses take alternative roads) ▪ Alternative methods of providing community facilities/assets with wastewater, water supply and electricity services are possible (e.g. solar, wetland wastewater treatment systems) but largely impractical (due to cost and other socio-cultural/ecological constraints) ▪ It could be costly to build new roads away from erosion areas and present ecological, social and cultural challenges
Coastal Flooding	M	▪ Limited options to adapt because parks are constrained by adjoining private properties, but walking tracks and public transportation routes could be re-routed out of inundation areas. ▪ Alternative methods of providing community facilities/assets with wastewater, water supply and electricity services are possible (e.g. solar, wetland wastewater treatment systems) but largely impractical (due to cost and other socio-cultural/ecological constraints) ▪ Roads can be elevated to avoid flooding and culverts could be created, however this is likely to be costly and/or ecologically/culturally inappropriate

Vulnerability Score

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

A.3 Ecological Risk Assessment Templates

A.3.1 Coastal dunes

Domain	Element at Risk	Overview
Natural	Dunes	There are three distinctive dune systems in the NAA; the Ōtaki dunes, the Te Horo Beach gravel dune system, and Peka Peka dunes. The boundaries between these dune systems are the following waterways; Ōtaki River, Te Kowhai/Ngawhakangutu Stream at the end of Paetawa Road, and Waimeha Stream). Dunes in the Kāpiti Coast district are fed by a typically westerly swell and locally generated waves which transport large quantities of sand-sized sediment along the coast down to the south. Dune formation by aeolian processes in a coastal environment is controlled by wind velocity, the supply and size of sediment, and available accumulation sites. Dunes in the NAA are typically stable or in a state of accretion. Dunes provide a natural dynamic environment acting as a host for indigenous flora and fauna as key habitat for breeding with species including a mix of regionally threatened species, other key indigenous dune land species, species highlighted in the regional pest management plan and emerging pest plants. As well as existing as a natural protection for human settlements and infrastructure from actions of the sea. Ōtaki dunes are mapped as being about 48 hectares in size and are a series of low dunes, except at Waitohu Stream mouth where they have been able to grow to significant heights due to high sediment supply. The dunes south of Waitohu Stream can stretch up to 300 m inland, making it one of the deepest dune systems on the Kāpiti Coast. It is also one of the few remaining dune systems in the wider Wellington Region which have naturally occurring populations of sand daphne, speckled sedge and sand coprosma. The dune system encompasses the entire distance from the northern most part of the Kāpiti Coast District to the Ōtaki River. The *c.* 115 hectares Te Horo dune complex is morphologically different as the beach in front is largely a sand and gravel composite beach fed from coarse cobble and gravel-sized materials from the Ōtaki River and rivers from the Horowhenua District from North of Ōtaki. The Te Horo dunes are covered with several dense ground hugging native climbers, as well as other special assemblages of native plant species which provide important refugia for native invertebrates and lizards. The dune system extends from the southern shore of the Ōtaki River to the meander of Te Kowhai/Ngawhakangutu Stream near Peka Peka. About 27 hectares of the Peka Peka dunes are within the NAA, the remaining 21 are in the Central Adaptation Area. These dunes are characterised by active coastal sand foredunes with native vegetation present. The dunes are relatively unmodified, with native species planted in the foredunes to support indigenous biodiversity. The northern limit is the meander of Te Kowhai/Ngawhakangutu Stream and the southern (for the purposes of this report) the boundary with the Central Adaptation Area.

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. Removal of the toe of the dunes and potentially erosion of much or even all of the fore- and mid-dunes if wave action or storm surge is severe enough. Mobilising sand enabling it to blow inland. 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, there are houses and roads and other human infrastructure inland of the dunes that would be affected by mobilised sand and dune movement. Thus, there is a risk that coastal foredunes would be eroded and not replaced and this would limit inland dune migration.

Hazard	Description of Consequence (note any cascading impacts)
	- These dunes and the sandy beaches are known to provide habitat for a range of dune species. There would be a consequent loss of dune and beach dwelling species (indigenous animals and plants) due to loss of habitat but also due to lack of alternative habitat to move to. - Native dune species such as pīngao and spinifex are deep rooting plants, a loss of such species would create dune instability, and create a higher susceptibility to aeolian erosion. - Ecological weeds are widespread through the dune systems and are considered one of the greatest threats to the ecological value of the dunes. A species of concern is marram grass, which can alter sand dune structure and function, creating higher, steeper dune systems which are less stable, resulting in increased erosion and steeper erodible dune faces. Marram grass dominated dunes do not have the same ability to recover after storm events as pīngao or spinifex dunes. - Natural coastal dunes are important elements of natural character, protection and enhancement of coastal biodiversity and habitat, and the protection of landscape and other costal amenity values (Coastline Consultants, 2009). - Increased stream flooding could result in accelerated erosion of dunes around stream and river mouths (Waitohu Stream, Rangiuru Stream, Ōtaki River, Mangaone Stream, Te Kowhai/Ngawhakangutu Stream). - A cascading effect of a loss of dunes includes increased susceptibility to future erosion for coastal properties and assets, as well as a loss of natural character of the coastline and reduced biodiversity value along the coastline.
Coastal Flooding	- Storm surges can result in increased storm damage and/or complete inundation of sea water into dune systems dramatically affecting the condition of the vegetation communities and or breeding succession of fauna within the dunes. - Flooding could increase the rate of sand removal through scour and subsequent dune collapse accelerating coastal erosion. - Flooding would flood any low-lying penguin burrows possibly killing chicks and make access more difficult for the adults potentially resulting in nest abandonment. It would also reduce the area of beach available to shoreline feeding and nesting bird species. - Increased sedimentation from coastal flooding can reduce habitat suitability and smother existing indigenous species and increase the risk of invasion by more saline-tolerant, exotic species. - Bacteria contamination from ponding water in and around dune systems can pose a threat to human health and the social value people place on dunes for amenity values. - Earthworks part of flood protection development can cause habitat loss, affect dune stability, disturb fauna and affect natural stream patterns and hydrological patterns such as drainage.

Opportunities

Hazard	Opportunities
Coastal Erosion	- Remove pest plant species, especially marram grass and plant the foredunes 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. - Remove pest plant species from mid and more rearward dunes and replace these with appropriate indigenous species; keeping in mind that the natural habitat is alternating dry sandy ridges and wetter swamp forest hollows. - Undertaking further ecological weed control, working with Greater Wellington Regional Council to work on their Key Native Ecosystem program and align KCDC environmental management schemes. - Undertake pest animal control to enable greater breeding success of birds and other species and partially offset loss of habitat. - A key threat to dunes is through human off-road recreational driving causing dune erosion, and disturbing native species. While driving and recreation is banned within dunes, there is the opportunity for further education on why it is banned, and the importance of the dunes. Further signage and human deterrents (i.e.) more and better sectioning off the dunes could be placed.

Hazard	Opportunities
	- 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	- Opportunity to plant more saline resistant plants surrounding waterways to anticipate future saltwater intrusion events and ensure better drainage and less sedimentation and nutrient leeching. - Remove pest plant species, especially marram grass and plant the foredunes with pīngao and spinifex to make the dunes more resilient and less prone to erosion and reduce potential for future flooding. - Remove pest plant species from mid and more rearward dunes and replace these with appropriate indigenous species; keeping in mind that the natural habitat is alternating dry sandy ridges and wetter swamp forest hollows. The wetter swamp hollows could serve as temporary flood holding areas and reduce more inland flooding. - Increased ecological weed control in alignment with the GWRC Key Native Ecosystem plans. - Undertake pest animal control to enable greater breeding success of birds and other species and partially offset loss of habitat.

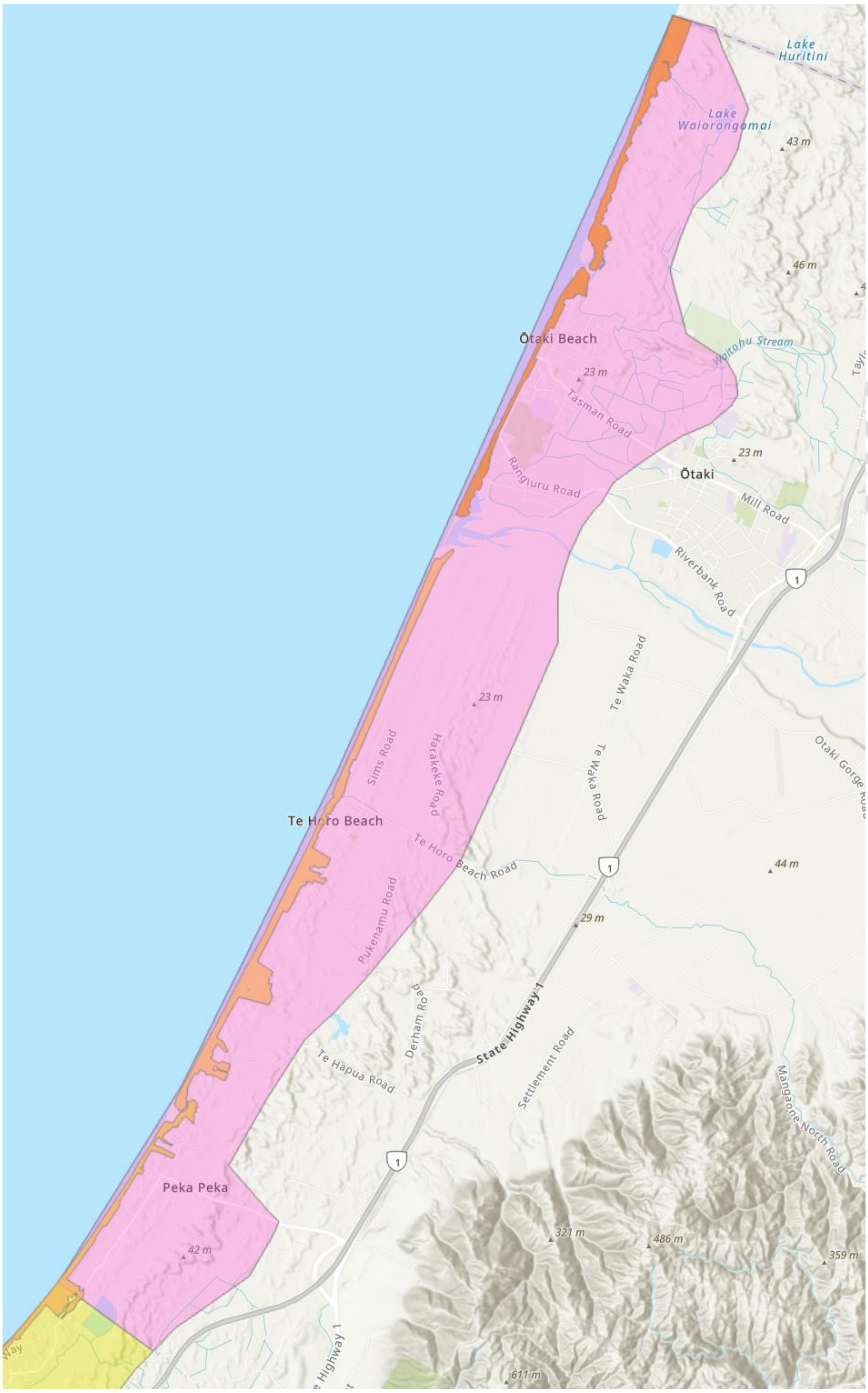

Figure A.3.1. Coastal dunes as mapped by GWRC, shown in light brown areas.

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 - Ōtaki: At least 20 m erosion inland across the Ōtaki shoreline and more in places. The entire length affected. Moderate exposure (about 50%) of dunes at risk of erosion. - Te Horo: At least 15 m of erosion into dunes across shoreline. The entire length affected. Moderate exposure (25-50%) of dunes at risk of erosion. - Peka Peka: Approximately 15 m of erosion into dunes across shoreline. The entire length affected. Moderate exposure (approximately 50%) of dunes in Peka Peka at risk of erosion.	Future exposure: 2050: - Ōtaki: Moderate exposure (approximately 50%) of dunes at risk of erosion. Loss of landward side of dunes surrounding waterways. - Te Horo: Moderate exposure (25-50%) of dunes at risk of erosion. - Peka Peka: Approximately 15 m of erosion into dunes across shoreline. Moderate exposure (approximately 50%) of dunes in Peka Peka at risk of erosion. 2070: - Ōtaki: Moderate exposure (approximately 50%) of dunes at risk of erosion. Loss of landward side of dunes surrounding waterways. - Te Horo: Moderate exposure (25-50%) of dunes at risk of erosion. - Peka Peka: High exposure (more than 50%) of dunes at risk of erosion. 2130: - Ōtaki: High exposure (more than 50%) of dunes at risk of erosion, erosion breaking through dunes away from waterways, and erosion of river mouth habitat. - Te Horo: Moderate exposure (could be up to 50%) of dunes at risk of erosion. - Peka Peka: High exposure (more than 50%) of dunes in Peka peka at risk of erosion.
Currently exposed to coastal flooding - Dunes adjacent to waterway mouths are experiencing coastal flooding, but much of the coastline has low (>15m) flood risk due to dune elevation - Ōtaki: Low risk of flooding (<25%) of dunes. - Te Horo: Low flooding risk (<10%) of dunes - Peka Peka: Moderate flooding risk (25-50%) for dunes	Future exposure: 2050: - Ōtaki: Low risk to flooding (< 25%) of dunes - Te Horo: Low flooding risk <10% for dunes - Peka Peka: Moderate flooding risk (25-50%) for dunes 2070: - Ōtaki: Low risk to flooding (< 25%) of dunes - Te Horo: Low flooding risk (<10%) for dunes - Peka Peka: Moderate flooding risk (25-50%) for dunes and potential for low-lying areas in back dunes also flooding/retaining water 2130: - Ōtaki: Moderate risk to flooding (25- 50%) of dunes due to low lying areas in the backdunes also flooding/retaining water. - Te Horo: Moderate (25-50%) flooding risk for dunes due to low-lying areas in back dunes also flooding/retaining water.

Details of exposure	
	- Peka Peka: High flooding risk (more than 50%) for dunes due to low-lying areas in back dunes also flooding/retaining water.

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

Notes:

- This part of the shoreline has a good supply of sand.
- Based on exposure percentage of the existing dune and associated beach systems to the hazards and is a combined hazard rating for the three dune areas

Erosion:

- Estimated from the toe of the dunes mapped by GWRC to the highest modelled erosion line.
- Erosion is more significant adjacent to stream and river mouths.
- Present day sensitivity has been ranked as moderate due to present day erosion risk, potential loss of dune habitat, some room for the dune re-establish inland, and good coastal sand input.
- Erosion risk increases to high in 2070 due to the significant erosion potential of the foredunes and in places rear dunes could be affected also.

Flooding:

- Estimated as the approximate area of dune affected by the modelled flooding.
- Present-day risk of flood events is ranked as low as dunes are elevated and therefore somewhat resilient to flooding, however waterway mouths associated with the dunes will be flooded and this increases the risk to the dunes.
- This increases to moderate in 2130 because flooding is predicted to occur inland of the dunes and could affect rear-dunes and as it is more likely that significant and/or more frequent flood events would undermine dune toes and increase erosion and susceptibility to flooding.

Sensitivity

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

Notes:

- Due to good sand supply it is likely damaged dunes will re-establish after storm events, up to a point. Once the erosion exceeds the sand supply then dunes would progressively 'move' inwards with the more inland dunes taking up the role of the foredunes. This is still possible to some extent for all dune areas but the human built environment would limit this movement eventually.
- 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 susceptible to being underminded, causing dune collapse and further erosion.
- We currently do not have a great ability to understand, predict and respond to climate change driven impacts on biodiversity, due to an under-investment in biodiversity science (Ministry for the Environment, 2020).

Erosion:

- Present day sensitivity has been ranked as moderate due to present day erosion risk, some room for the dune re-establish inland, and good coastal sand input.
- From 2070 on the sensitivity has been increased to high because in certain locations the mapped dunes could be completely eroded and/or rear dunes affected.

Flooding:

- Present-day sensitivity to flood events is ranked as low as dunes are elevated and therefore somewhat resilient to flooding.
- This increases to moderate from 2070 because flooding is predicted to occur inland of the dunes and could affect rear-dunes and as it is more likely that significant and/or more frequent flood events would undermine dune toes and increase erosion.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	- The dunes in Ōtaki, Te Horo and north Peka Peka are restricted in their ability to naturally migrate back from rising seas due to human development already creating coastal squeeze. - Storm surge and more frequent flood events lowering beach profile, and tectonic subsidence, allowing storm surge to move further inland and causing greater erosion. - Areas of pest plants resulting in less stable dunes. - Little opportunity to create new dunes inland from the existing areas as most of this land is privately owned.
Coastal Flooding	M	- The area is generally more elevated and therefore flooding may not be as frequent or severe as in other parts of the Kāpiti Coast. - Ecosystems and species that are more tolerant of periodic exposure to saline waters are likely to have a greater adaptive capacity (Ministry for the Environment, 2020).

Notes:

- Dunes in the Kāpiti Coast district are fed by a typically westerly swell and locally generated waves which transport large quantities of sand-sized sediment along the coast down to the south. Due to this, dunelands in the NAA are more stable than in other parts of the Kāpiti Coast district as the sediment supplies are greater than the transport losses to the south.
- Dunes provide a natural dynamic environment acting as a host for indigenous flora and fauna as key habitat for breeding with species including a mix of regionally threatened species, other key indigenous dune land species, species highlighted in the regional pest management plan and emerging pest plants. As well as providing a natural protection for human settlements and infrastructure from actions of the sea.
- For adaptive capacity of coastal ecosystems to occur, it will rely on effective human management rather than on their own characteristics.
- Natural adaptation will take sufficient time and space but is limited along the Waikanae and Paraparaumu coastlines due to a lack of sufficient space available behind dune systems due to the presence of settlements.

Vulnerability Score

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

Overall Risk Score

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

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 - Ōtaki: At least 20 m erosion inland across the Ōtaki shoreline and more in places. The entire length affected. Moderate exposure (about 50%) of dunes at risk of erosion. - Te Horo: At least 15 m of erosion into dunes across shoreline. The entire length affected. Moderate exposure (25-50%) of dunes at risk of erosion. - Peka Peka: Approximately 15 m of erosion into dunes across shoreline. The entire length affected. Moderate exposure (approximately 50%) of dunes in Peka Peka at risk of erosion.	Future exposure: 2050: - Ōtaki: Moderate exposure (approximately 50%) of dunes at risk of erosion. Loss of landward side of dunes surrounding waterways. - Te Horo: Moderate exposure (25-50%) of dunes at risk of erosion. - Peka Peka: Approximately 15 m of erosion into dunes across shoreline. Moderate exposure (approximately 50%) of dunes in Peka Peka at risk of erosion 2070: - Ōtaki: Moderate exposure (approximately 50%) of dunes at risk of erosion. Loss of landward side of dunes surrounding waterways. - Te Horo: Moderate exposure (25-50%) of dunes at risk of erosion. - Peka Peka: High exposure (more than 50%) of dunes at risk of erosion. 2130: - Ōtaki: High exposure (more than 50%) of dunes at risk of erosion, erosion breaking through dunes away from waterways, and erosion of river mouth habitat. - Te Horo: Moderate exposure (could be up to 50%) of dunes at risk of erosion. - Peka Peka: High exposure (more than 50%) of dunes in Peka peka at risk of erosion.
Currently exposed to coastal flooding - Dunes adjacent to waterway mouths are experiencing coastal flooding, but much of the coastline has low (>15m) flood risk due to dune elevation - Ōtaki: Low risk of flooding (<25%) of dunes. - Te Horo: Low flooding risk (<10%) for dunes - Peka Peka: Moderate flooding risk (25-50%) for dunes	Future exposure: 2050: - Ōtaki: Low risk to flooding (< 25%) of dunes - Te Horo: Low flooding risk (<10%) for dunes - Peka Peka: Moderate flooding risk (25-50%) for dunes 2070: - Ōtaki: Low risk to flooding (< 25%) of dunes - Te Horo: Low flooding risk (<10%) for dunes - Peka Peka: Moderate flooding risk (25-50%) for dunes and potential for low-lying areas in back dunes also flooding/retaining water 2130: - Ōtaki: Moderate risk to flooding (25- 50%) of dunes due to low lying areas in the backdunes also flooding/retaining water. - Te Horo: High (>50%) flooding risk for dunes as well as due to low-lying areas in back dunes also flooding/retaining water.

Details of exposure

	- Peka Peka: High flooding risk (more than 50%) for dunes due to low-lying areas in back dunes also flooding/retaining water.

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

Notes:

- This part of the shoreline has a good supply of sand.
- Based on exposure percentage of the existing dune and associated beach systems to the hazards and is a combined hazard rating for the three dune areas

Erosion:

- Estimated from the toe of the dunes mapped by GWRC to the highest modelled erosion line.
- Erosion is more significant adjacent to stream and river mouths.
- Present day sensitivity has been ranked as moderate due to present day erosion risk, potential loss of dune habitat, some room for the dune re-establish inland, and good coastal sand input.
- Erosion risk increases to high in 2070 due to the significant erosion potential of the foredunes and in places rear dunes could be affected also.
- Erosion is predicted to penetrate much further inland along the entire coast hence the risk is increased to extreme, as this will have consequences for both ecology and human infrastructure.

Flooding:

- Estimated as the approximate area of dune affected by the modelled flooding.
- Present-day risk of flood events is ranked as low as dunes are elevated and therefore somewhat resilient to flooding, however waterway mouths associated with the dunes will be flooded and this increases the risk to the dunes.
- This increases to moderate in 2070 because flooding is predicted to occur inland of the dunes and could affect rear-dunes and as it is more likely that significant and/or more frequent flood events would undermine dune toes and increase erosion and susceptibilty to flooding.
- The increase to high in 2130 is due to the possibility of much of the Te Horo dunes being affected by flooding.

Sensitivity

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

Notes:

- Due to good sand supply it is likely damaged dunes will re-establish after storm events, up to a point. Once the erosion exceeds the sand supply then dunes would progressively 'move' inwards with the more inland dunes taking up the role of the foredunes. This is still possible to some extent for all dune areas but the human built environment would limit this movement eventually.
- 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 susceptible to being underminded, causing dune collapse and further erosion.
- We currently do not have a great ability to understand, predict and respond to climate change driven impacts on biodiversity, due to an under-investment in biodiversity science (Ministry for the Environment, 2020).

Erosion:

- Present day sensitivity has been ranked as moderate due to present day erosion risk, some room for the dune re-establish inland, and good coastal sand input.
- From 2070 on the sensitivity has been increased to high because in certain locations the mapped dunes could be completely eroded and/or rear dunes affected.

Flooding:

- Present-day sensitivity to flood events is ranked as low as dunes are elevated and therefore somewhat resilient to flooding.
- This increases to moderate from 2070 because flooding is predicted to occur inland of the dunes and could affect rear-dunes and as it is more likely that significant and/or more frequent flood events would undermine dune toes and increase erosion.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	Low	- The dunes in Ōtaki, Te Horo and northern Peka Peka are restricted in their ability to naturally migrate back from rising seas due to human development already creating coastal squeeze. - Storm surge and more frequent flood events lowering beach profile, and tectonic subsidence, allowing storm surge to move further inland and causing greater erosion. - Areas of pest plants resulting in less stable dunes. - Little opportunity to create new dunes inland from the existing areas as most of this land is privately owned.
Coastal Flooding	Moderate	- The area is generally more elevated and therefore flooding may not be as frequent or severe as in other parts of the Kāpiti Coast. - Ecosystems and species that are more tolerant of periodic exposure to saline waters are likely to have a greater adaptive capacity (Ministry for the Environment, 2020).

Notes:

Dunes in the Kāpiti Coast district are fed by a typically westerly swell and locally generated waves which transport large quantities of sand-sized sediment along the coast down to the south. Due to this, dunelands in the NAA are more stable than in other parts of the Kāpiti Coast district as the sediment supplies are greater than the transport losses to the south.

Dunes provide a natural dynamic environment acting as a host for indigenous flora and fauna as key habitat for breeding with species including a mix of regionally threatened species, other key indigenous dune land species, species highlighted in the regional pest management plan and emerging pest plants. As well as providing a natural protection for human settlements and infrastructure from actions of the sea.

For adaptive capacity of coastal ecosystems to occur, it will rely on effective human management rather than on their own characteristics.

Natural adaptation will take sufficient time and space but is limited along the Waikanae and Paraparaumu coastlines due to a lack of sufficient space available behind dune systems due to the presence of settlements.

Vulnerability Score

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

Overall Risk Score

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

A.3.2 Wetlands

Domain	Element at Risk	Overview
Natural	Wetlands	There are 15 mapped wetlands in the NAA, of which two are outstanding wetlands, eight are identified natural wetlands (GWRC NRP Schedule F3) and another three that are known to be wetlands but not yet included in GWRC Natural Resource Plan Schedules. Another area is currently not recognized as a natural wetland as it was constructed but is an important habitat for birds and fish. And there is one area described as wetland in KCDC Schedule 1 that is not included in the GWRC data. GWRC Schedule A3: Wetlands with outstanding indigenous biodiversity values: - Te Harakeke Wetland - Te Hapua Road, Swamp AGWRC Schedule F3: Identified natural wetlands: - Lake Waiorongomai - Waitohu Stream Mouth - Ōtaki River Mouth - Pekapeka Road Swamp - Ōtaki Stewardship - South Waikawa Beach Dune Lake - Tasman Road/Te Rauparaha Street, Ōtaki - Sims wetland GWRC other scientific wetlands: - Te Hapua Wetland Complex B - Kowhai Stream Mouth (Hadfields) - Charlton Wetland Other wetlands: - Puruaha Road, Ōtaki - Pharazyn Reserve Most of the wetlands, except those as GWRC other scientific wetlands, are also KCDC Ecological Sites. Note that there may be other wetlands, that have not yet been identified or mapped, that would qualify as natural wetlands under the National Policy Statement for Freshwater Management (NPS-FM) and/or the National Environmental Standard-Freshwater (NES-F). The NPS-FM excludes wetlands in the coastal zone, but the NES-F includes all wetlands.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	– Of the 15 wetlands present in the NAA, three will experience coastal erosion under SSP2-4.5 scenario. These are the Waitohu Stream Mouth saltmarsh, the Ōtaki River Mouth Lagoon and Rangiuru Wetland and Kowhai Stream Mouth (Hadfields). – Erosion could remove part or all of these wetland areas resulting in the loss of wetland vegetation and fauna and altering the hydrology and wetland soil composition. – For the Ōtaki River Mouth Lagoon, existing flood barriers already restrict the extent of the salt marsh vegetation in the estuary, further potential erosion of estuary edges would place further pressure on existing vegetation. – The river mouth for all of these waterways can be subject to being modified to ensure water doesn't back up (GWRC NRP Rule R214: River, stream and lake mouth cutting) and this has the potential to increase erosion and affect the wetlands. – Wetlands are effective sinks for carbon dioxide and encouraged as carbon sequestration tools. Wetlands that experience erosion and as a result habitat loss can have cascading

Hazard	Description of Consequence (note any cascading impacts)
	impacts on the amount of carbon the ecosystem is able to take in in the future (Were, et al, 2019). – Ongoing erosion is likely to result in the displacement of coastal ecosystems for breeding and migratory species and has the potential to block or alter upstream pathways for migratory breeding fish. – Erosion could result in seawater penetrating further inland in groundwater systems changing salinity of nearby coastal wetlands and affecting vegetation and habitat types. – Loss of wetland vegetation can also result in further destabilization of dunes and loss of storm surge protection for inland portions and could also result in modifications of the waterway riverbeds leading to more or increased rates of erosion. – High-intensity human use, and development in the coastal area could also exacerbate erosion or sediment deposition in these wetlands. Preventing or limiting future development surrounding wetlands will allow the ecosystems a greater chance at natural adaptation.
Coastal Flooding	– Of the 15 wetlands present in the NAA, ten will experience flooding under SSP2-4.5 scenario. These are: o Outstanding wetlands: Te Hapua Road, Swamp A and Te Harakeke Swamp; o Identified wetlands: Waitohu Stream Mouth, Ōtaki River Mouth, Ōtaki Stewardship, South Waikawa Beach Dune Lake, Sims wetland, Kowhai Stream Mouth (Hadfields); and o Other wetlands: Puruaha Road, Ōtaki and Pharazyn Reserve. – Flooding could alter the vegetation composition within a wetland depending on the length of floodwater retention, the depth of the flooding and whether the flooding changes the salinity of the wetlands for more than a few hours. – Flooding can adversely affect fauna populations especially if these are sedentary (don't or can't move very far), during nesting or breeding, and/or if connections to other habitat are cut off so individuals are unable to retreat from flooding (this includes increased flows preventing fish movements). – Saltmarshes, such as found in the various estuaries, have the potential to have reduced species richness and experience species shifts in response to increased periods of salinity and flooding following disturbance events (Baldwin & Mendelssohn, 1998). – Increased sediment deposition through increased storm and flood frequencies are likely to decrease light penetration, increase turbidity and reduce primary productivity. Silt deposition can smother plants and animals. Changes in sediment size can reduce habitat suitability for aquatic species causing species mortality, through for example fine silts deposited over coarser sandy sediments (Ministry for the Environment, 2020a). – Coastal wetlands in areas of low relief are susceptible to saline intrusion, which can then impact the community structure of wetland plants and animals (Finlayson., et al, 2017). – Flood waters could move plant seeds or parts around the landscape, expanding and/or introducing new pest species that are likely to impact the integrity and functioning of indigenous ecosystems. This includes species such as willows (*Salix* spp), blackberry (*Rubus fruticosus* agg) and gorse (*Ulex europaeus*) (Robertson et al, 2016) *from* (Ministry for the Environment, 2020a). – Increased flooding may result in additional areas of natural inland wetland establishing or being recognized. Many of the low-lying areas within the sand dune belt of Kāpiti were historically wetlands. These have been drained or are continually suppressed through mowing, grazing, plowing and weed spraying. Flood events may result in 'boggy' areas expressing their previous wetland characteristics including a change to more wetland plant species dominance. – Wetlands surviving in drier environments (such as dune systems) have high relative conservation significance because they are irreplaceable in those environments and have a proportionally high number of plant species which are confined to these environments. Changes to these wetlands are likely to reduce the viability of populations of at-risk species (Ministry for the Environment, 2020). Increased flooding from sea level rise may result in the ongoing decline in these environments and more indigenous species will likely be lost, and invasion by introduced species could increase. – The disruption of wetland ecosystems and loss of species is likely to impact on the agricultural sector, which relies on freshwater systems for water. The agricultural sector could also further impact wetland ecosystems (Ministry for the Environment, 2020a). – This risk to wetlands can pose a threat to Māori social, economic, cultural capital and cultural heritage values and spiritual wellbeing (Ministry for the Environment, 2020a).

Opportunities

Hazard	Opportunities
Coastal Erosion	Plant up adjacent low-lying areas with estuarine and inland wetland species to help retain wetland habitat. Remove pest plants from dunes and existing wetlands. Where possible, create additional estuarine wetland habitat upstream of waterways to retain wetland habitat and enable plant and animal species to migrate. Include habitat suitable as whitebait spawning sites. Undertake pest animal control to enable terrestrial species to have higher survival and breeding success rates. Integrate governance, legislative and regulatory frameworks across sectors and scales to ensure effective wetland management (Finlayson., et al, 2017). Erosion and disturbance of wetland areas can create gaps in the vegetation that stimulate recruitment and colonization by indigenous plant species (Baldwin & Mendelssohn, 1998). However, this would need to be monitored to ensure that pest plant species do not establish. Prevent or limit future development surrounding wetlands to provide the ecosystems with a greater chance at natural adaptation and reduce high-intensity human use.
Coastal Flooding	Plant up adjacent low-lying areas with estuarine and inland wetland species to help retain wetland habitat. Remove pest plants from dunes and existing wetlands. Where possible, create additional estuarine wetland habitat upstream of waterways to retain wetland habitat and enable plant and animal species to migrate. Include habitat suitable as whitebait spawning sites. Undertake pest animal control to enable terrestrial species to have higher survival and breeding success rates. Consider adaptation actions such as land acquisition in areas adjacent to wetlands. The extent of flooding may result in areas of wetland expanding from the current situation. This could include saline, semi-saline, riparian and other fresh-water wetlands. Create buffers of suitable indigenous plant species around wetlands so that the wetland edge protected/maintained when flooded. Introduce new suitable indigenous species so that local seed sources are available to colonise deeper (higher water table) wetland types.

There are 15 known wetlands in the NAA. Two are outstanding wetlands (Te Harakeke Wetland and Te Hapua Road, Swamp A), eight are identified natural wetlands (refer to table below) and another three are known to be wetlands but not yet included in GWRC Natural Resource Plan Schedules. One wetland (Pharazyn Reserve) is currently not recognized or mapped as a natural wetland. Pharazyn is constructed (old sewage pond) but it is in the process of being naturalized. Eleven of the identified wetlands are also within KCDC Ecological Sites. And there is one area described as wetland in the Operative Kāpiti Coast District Plan 2021: Schedule 1 that is not included in the GWRC data. Tasman Road/Te Rauparaha Street, Ōtaki, Te Hapua Road, Swamp A, and Pharazyn Reserve are only partially within the NAA. A full list of these wetlands are as follows.

Table A.3.1: Table of Mapped Wetlands.

# wetlands	Name	Area in Hectares	% in NAA	KCDC Wetland	KCDC Site number	GWRC Identified wetland	GWRC scientific wetland
1	Lake Waiorongomai	15.123	100	Yes	K001	Yes F3: 10 ha- Not including deep water	Yes
2	Waitohu Stream Mouth	33.048	100	Yes	K014	Yes F3: 7 ha saltmarsh	Yes
3	Ōtaki River Mouth	69.029	100	Yes	K027	Yes F3: Ōtaki River Mouth Lagoon & Rangiruru Wetland 5.21 ha and Ōtaki River Mouth South10.441ha	Yes
4	Te Hapua Road, Swamp A	47.927	100	Yes	K055	Yes Outstanding Wetland: plus additional fingers	Yes
5	Pekapeka Road Swamp	4.399	100	Yes	K060	Yes F3:	Yes
6	Te Harakeke Swamp	65.264	85	Yes	K066	Yes Outstanding Wetland:	Yes
7	Ōtaki Stewardship	25.388	100	Yes	K176	Yes F3: wetland parts 6.718ha Ōtaki Stewardship area wetland and Ōtaki Porirua Trust Board Wetland	Yes
8	South Waikawa Beach Dune Lake	0.809	100	Yes	K185	Yes F3:	Yes
9	Puruaha Road, Ōtaki	0.222	100	Yes	K193	No	No

10	Tasman Road,/Te Rauparaha Street, Ōtaki	2.088	90	Yes	K210	Yes F3: plus additional 0.387 ha	Yes
11	Pharazyn Reserve	41.622	25%	Yes	K236	No - artificially created	No
12	Sims wetland	0.726	100			Yes F3:	Yes
13	Te Hapua Wetland Complex B	4.337	69				Yes
14	Kowhai Stream Mouth (Hadfields)	2.198	100				Yes
15	Charlton Wetland	0.633	100				Yes

Figure A.3.2: Location of Identified Natural Wetlands, Scientific Wetlands, and KCDC Ecological Sites.

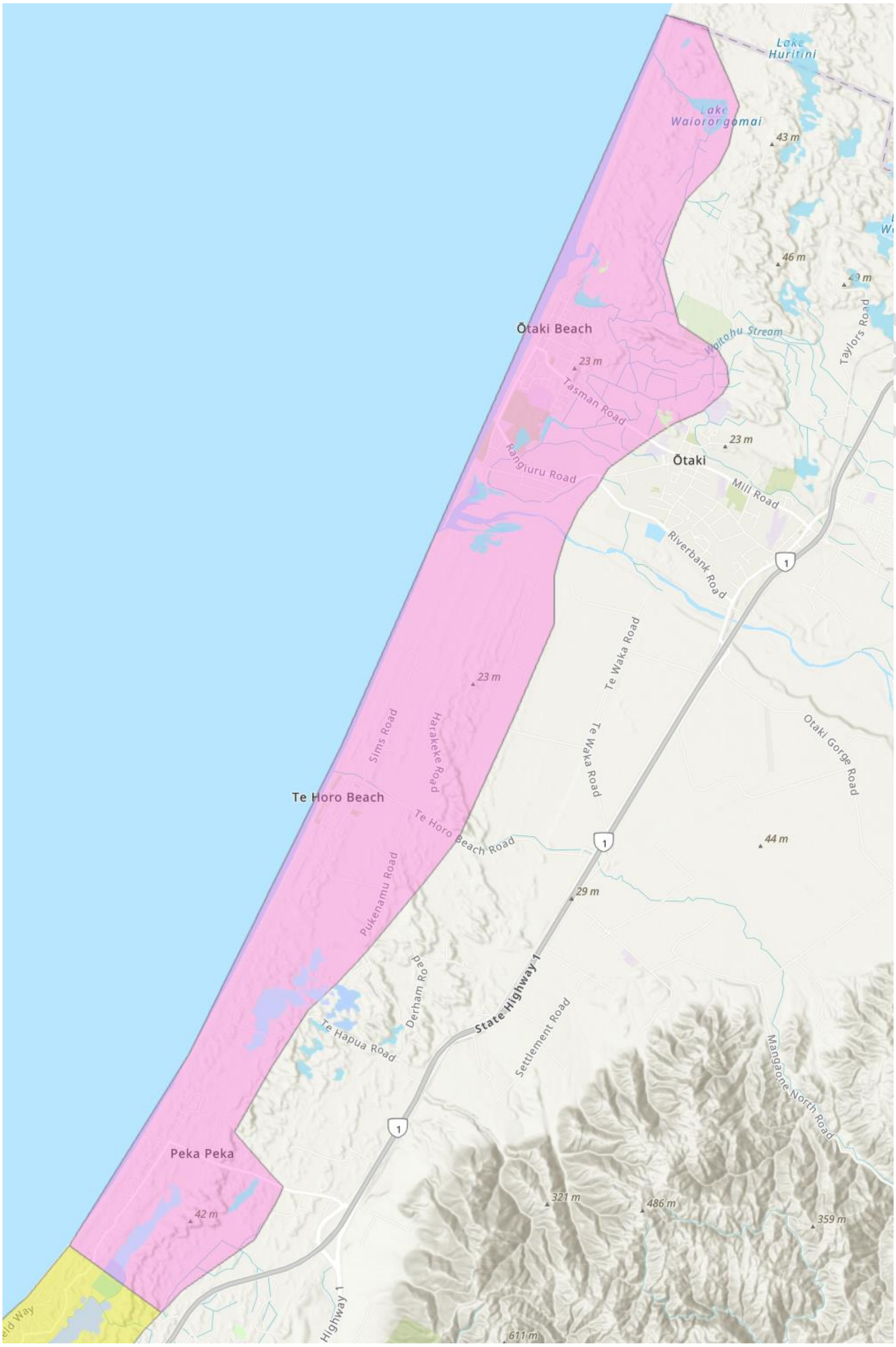

Figure A.3.3: Location of Wetlands (blue) as identified in GWRC Natural Resources Plan within the Northern Adaptation Area (pink).

A.3.2.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	

Currently exposed to coastal erosion:
All estuaries will experience some level of erosion and rebuilding. This is a natural part of estuary functioning. The current erosion levels are thought to be within 'normal' levels.
- Outstanding wetlands: 0
- Significant, natural wetlands: 2
- Significant, likely to be a natural wetlands: 1
- Other wetlands: 0
	Future exposure:
	2050:
	- Outstanding wetland: 0
	- Significant, natural wetland: 2
	  o Waitohu Stream Mouth - moderate to severe erosion
	  o Ōtaki River Mouth - some erosion
	- Significant, likely to be a natural wetland: 1
	  o Kowhai Stream Mouth (Hadfields) – moderate to severe erosion
	- Other wetlands: 0
	2070:
	- Outstanding wetland: 0
	- Significant, natural wetland: 2
	  o Waitohu Stream Mouth - moderate to severe erosion
	  o Ōtaki River Mouth - some erosion;
	- Significant, likely to be a natural wetland: 1
	  o Kowhai Stream Mouth – moderate to severe erosion
	- Other wetlands: 0
	2130:
	- Outstanding wetland: 0
	- Significant, natural wetland: 2
	  o Waitohu Stream Mouth – moderate to severe erosion
	  o Ōtaki River Mouth – moderate to severe erosion
	- Significant, likely to be a natural wetland: 1
	  o Kowhai Stream Mouth – moderate to severe erosion
	- Other wetlands: 0

Currently exposed to coastal flooding: All estuaries will experience some level of erosion and rebuilding currently. This is a natural part of estuary functioning. The current erosion levels are thought to be within 'normal' levels. - Outstanding wetlands: 0 - Significant, natural wetlands: 2 completely flooded and 2 partially flooded (all estuarine) - Significant, likely to be a natural wetlands: 1 completely flooded (estuarine) - Other wetlands: 0	Future exposure: 2050: - Outstanding wetland: 0 - Significant, natural wetland: 4 completely flooded – all estuarine - Significant, likely to be a natural wetland: 1 completely flooded (estuarine) - Other wetlands: 1 partially 2070: - Outstanding wetland: 0 - Significant, natural wetland: 4 completely flooded – all estuarine

Details of exposure	
	- Significant, likely to be a natural wetland: 1 completely flooded (estuarine) - Other wetlands: 1 partially 2130: - Outstanding wetland: 0; - Significant, natural wetland: 4 completely flooded – all estuarine - Significant, likely to be a natural wetland: 1 completely flooded (estuarine) - Other wetlands: 1 completely

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

Note:

- There may be inland areas where wetlands could be planted or established after flooding. This would moderate some of the effects.
- Changes to salinity and duration and depth of flooding will change plant species composition. This will have knock-on effects on fauna and habitat types.

Erosion

- Estimated as the number and severity of the wetland affected by erosion.
- Current threat is low.
- This increases to moderate in 2050 and then high in 2130 due to the amount of erosion predicted in the estuarine systems.
- Due to the dunes along the coast, inland wetlands will be protected from erosion for a considerable period of time. However, erosion could result in seawater penetrating further inland in groundwater systems and changing salinity of near coastal wetlands.

Flooding

- Estimated as the number and severity of wetlands affected by flooding. Includes flooding of adjacent areas as this may increase the area of wetland over time.
- Current flooding risk is moderate, as flooding of the saline wetlands occurs already (and is expected).
- Flood risk increases to high from 2070 as low-lying areas adjacent to the wetlands also flood. This could potentially be set as extreme risk, but moderate is seen as more appropriate because flooding tends to be more temporary and may also result in additional areas of wet land enabling potential expansion of wetlands (through planting or natural processes).

Sensitivity

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

Notes:

Erosion:

- Present-day sensitivity has been set as low as erosion is thought to be within 'normal' parameters and likely to have few adverse effects on wetlands.
- From 2050 on risk is considered to be medium. Erosion of dunes along and buffering estuary could affect saltmarshes by seawater infiltration or increased salinity both of which would change plant species

composition. Depending on the rate of erosion and the presence of saline tolerant plant species this could result in areas of this wetland dying back and slow recolonisation by other plant species.

- Risk increases to high in 2130 as it is likely that greater areas will have been opened up to the effects of the sea increasing the risk of further erosion and increased salinity in other parts of this wetland.

Flooding:

- Present-day sensitivity has been set as moderate as flooding could adversely affect plants within the wetland. On the other hand, flooding also contributes to keeping a wetland wet.
- The risk for future flooding scenarios has been maintained as moderate because it is uncertain if flooding would maintain or adversely affect wetlands. Effects would depend, in part, on the duration of flooding. There is potential for aditional areas of wetland to establish which moderates potential effects.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	Low	- Erosion of estuarine wetlands is predicted to be moderate to severe. There is limited opportunity to establish additional areas of saline wetland upstream to replace areas that are lost as most of the surrounding land is privatly owned or iwi land. - Ōtaki River also has significant flood protection infrastructure that would limit relocation of a saline wetland. - Saline intrusion into the wetland can occur earlier as sand is a permeable medium. Increases salinity will affect the plant species composition with consequent effects on fauna. .
Coastal Flooding	Moderate	- The effects of flooding will depend on the duration and height of flooding. Prolonged flooding and sustained emersion will kill plants (even tough species such as flax). - Some terrestrial fauna species (e.g. lizards and small invertebrates) may not be able to escape floods quickly enough with effects on the local population. More mobile species may be able to find alternative habitat, but wetlands are rare in the landscape. - Flooding could result in changes to the habitats within the wetland (e.g. more open water, greater area of deeper water reeds, less rushland), and could result in loss of species diversity. - Areas adjacent to the wetlands will flood and could become permanent boggy over time. This has the potential to increase the area of wetlands through planting or natural processes. Hence adaptive capacity is moderate rather than low.

Notes:

- The adaptive capacity of coastal ecosystems will rely somewhat on effective management, as well as intrinsic wetland characteristics. Wetland management plans should include provisions to adapt to and/or take advantage of climatic changes capacity and will need to be implemented by the relevant authorities or entities.

Vulnerability Score

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

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

A.3.2.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	

Currently exposed to coastal erosion:
All estuaries will experience some level of erosion and rebuilding. This is a natural part of estuary functioning. The current erosion levels are thought to be within 'normal' levels.
- Outstanding wetlands: 0
- Significant, natural wetlands: 2
- Significant, likely to be a natural wetlands: 1
- Other wetlands: 0
	Future exposure:
	2050:
	- Outstanding wetland: 0
	- Significant, natural wetland: 2
	  o Waitohu Stream Mouth – moderate to severe erosion
	  o Ōtaki River Mouth some erosion
	- Significant, likely to be a natural wetland: 1
	  o Kowhai Stream Mouth - moderate to severe erosion
	- Other wetlands: 0
	2070:
	- Outstanding wetland: 0
	- Significant, natural wetland: 2
	  o Waitohu Stream Mouth – moderate to severe erosion
	  o Ōtaki River Mouth - some erosion
	- Significant, likely to be a natural wetland: 1
	  o Kowhai Stream Mouth – moderate to severe erosion
	- Other wetlands: 0
	2130:
	- Outstanding wetland: 0
	- Significant, natural wetland: 2
	  o Waitohu Stream Mouth - moderate to severe erosion
	  o Ōtaki River Mouth - moderate-severe erosion
	- Significant, likely to be a natural wetland:
	  o 1 Kowhai Stream Mouth – moderate to severe erosion
	- Other wetlands: 0

Currently exposed to coastal flooding: All estuaries will experience some level of erosion and rebuilding currently. This is a natural part of estuary functioning. The current erosion levels are thought to be within 'normal' levels. - Outstanding wetlands: 0 - Significant, natural wetlands: 2 completely flooded and 2 partially flooded (all estuarine) - Significant, likely to be a natural wetlands: 1 completely flooded (estuarine) - Other wetlands: 0	Future exposure: - 2050: Outstanding wetland: 0; Significant, natural wetland: 4 completely flooded – all estuarine; Significant, likely to be a natural wetland: 1 completely flooded (estuarine). Other wetlands: 1 partially - 2070: Outstanding wetland: 0; Significant, natural wetland: 4 completely flooded – all estuarine; Significant, likely to be a natural wetland: 1 completely flooded (estuarine). Other wetlands: 1 partially - 2130: Outstanding wetland: 2 completely flooded; Significant, natural wetland: 5 completely flooded – 4

Details of exposure	
	estuarine and one dune wetland; Significant, likely to be a natural wetland: 1 completely flooded (estuarine). Other wetlands: 1 completely

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

Note:

- There are 15 mapped wetlands in the Northern Adaptation Area (NAA), of which two are outstanding wetlands, 8 are identified natural wetlands and another 3 that are known to be wetlands, and 2 other KCDC wetlands.
- There may be inland areas where wetlands could be planted or established after flooding. This would moderate some of the effects.
- Changes to salinity and duration and depth of flooding will change plant species composition. This will have knock-on effects on fauna and habitat types.

Erosion

- Estimated as the number and severity of the wetland affected by erosion.
- Current threat is Low.
- This increases to Moderate in 2050 and then High in 2130 due to the amount of erosion predicted in the estuarine systems.
- Due to the dunes along the coast inland wetlands will be protected from erosion for a considerable period of time. However, erosion could result in seawater penetrating further inland in groundwater systems and changing salinity of near coastal wetlands.

Flooding

- Estimated as the number and severity of wetlands affected by flooding. Includes flooding of adjacent areas as this may increase the area of wetland over time.
- Current flooding risk is Moderate, as flooding of the saline wetlands occurs already (and is expected).
- Flood risk increases to High from 2070 as low-lying areas adjacent to the wetlands also flood. This could potentially be set as Extreme risk, but Moderate is seen as more appropriate because flooding tends to be more temporary and may also result in additional areas of wet land enabling potential expansion of wetlands (through planting or natural processes).
- Flooding risk increases to Extreme in 2130 as 66% of all known/mapped wetlands would be subject to complete flooding.

Sensitivity

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

Notes:

Erosion:

- Present-day sensitivity has been set as Low as erosion is thought to be within 'normal' parameters and likely to have few adverse effects on wetlands.
- From 2050 on risk is considered to be Medium. Erosion of dunes along and buffering estuary could affect saltmarshes by seawater infiltration or increased salinity both of which would change plant species composition. Depending on the rate of erosion and the presence of saline tolerant plant species this could result in areas of this wetland dying back and slow recolonisation by other plant species.

- Risk increases to High in 2130 as it is likely that greater areas will have been opened up to the effects of the sea increasing the risk of further erosion and increased salinity in other parts of this wetland.
- Flooding:
- Present-day sensitivity has been set as Moderate as flooding could adversely affect plants within the wetland. On the other hand, flooding also contributes to keeping a wetland wet.
- The risk for future flooding scenarios has been maintained as Moderate because it is uncertain if flooding would maintain or adversely affect wetlands. Effects would depend, in part, on the duration of flooding. There is potential for aditional areas of wetland to establish which moderates potential effects.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	- Erosion of estuarine wetlands is predicted to be moderate to severe. There is limited opportunity to establish additional areas of saline wetland upstream to replace areas that are lost as most of the surrounding land is privatly owned or iwi land. - Ōtaki River also has significant flood protection infrastructure that would limit relocation of a saline wetland. - Saline intrusion into the wetland can occur earlier as sand is a permeable medium. Increases salinity will affect the plant species composition with consequent effects on fauna. .
Coastal Flooding	M	- The effects of flooding will depend on the duration and height of flooding. Prolonged flooding and sustained emersion will kill plants (even tough species such as flax). - Some terrestrial fauna species (e.g. lizards and small invertebrates) may not be able to escape floods quickly enough with effects on the local population. More mobile species may be able to find alternative habitat, but wetlands are rare in the landscape. - Flooding could result in changes to the habitats within the wetland (e.g. more open water, greater area of deeper water reeds, less rushland), and could result in loss of species diversity. - Areas adjacent to the wetlands will flood and could become permanent boggy over time. This has the potential to increase the area of wetlands through planting or natural processes. Hence adaptive capacity is Moderate rather than Low.

Notes:

- The adaptive capacity of coastal ecosystems will rely somewhat on effective management, as well as intrinsic wetland characteristics. Wetland management plans should include provisions to adapt to and/or take advantage of climatic changes capacity and will need to be implemented by the relevant authorities or entities.

Vulnerability Score

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

A.3.3 Mapped Ecological Sites

Domain	Element at Risk	Overview
Natural	Ecological Sites	There are 39 mapped ecological sites across the different management agencies (aerial map shown above and associated table) that relate to 16 unique sites (several sites are mapped by more than one agency). Two of the areas are also being restored by community groups. Most of the sites are associated with waterways. Three of the 16 sites are only partially within the NAA, these are: K210-Tasman Road/Te Rauparaha Street, Ōtaki, K055-Te Hapua Road, Swamp A, and K236-Pharazyn Reserve. In summary there are: - 13 KCDC Ecological Sites, - 8 QEII covenant, - 7 GWRC areas of Managed Open Space (only includes those where ecology/conservation is a key driver), - 7 GWRC Key Native Ecosystems (KNE), - 2 areas with community project, - 1 area of Department of Conservation (DOC) Public Conservation land, and - 1 DOC Conservation covenant. Ecological Sites are located throughout the NAA including estuaries, dune systems, wetlands, and rare tree species. Two areas are identified by GWRC as Outstanding Wetlands Te Hapua Road, Swamp A and Te Harakeke Swamp. Te Hapua Road, Swamp A is a network of wetlands that extend over a substantive area and provide stepping stone habitat for native fauna in the coastal environment. Foreshore dunes around the mouth of Kowhai Stream support an indigenous matrix including relicts of coastal shrubland with estuarine vegetation at the mouth. Fresh water values and vegetation patterns have been enhanced by fencing under QEII covenants[35]. Te Harakeke (Kawakahia) Wetland complex is identified by numerous reports and inventories as containing some of the most ecologically significant indigenous vegetation and habitats and the highest concentration of species of conservation concern[36]. Waitohu Stream mouth is a significant habitat for intertidal sandflats, marram-spinifex grassland, restiad rushland, sea rush-saltmarsh ribbonwood (regionally sparse) rush-shrubland, three square sedgeland, bachelors' button herbfield, sand flats, fish spawning ground and beach. The loss of this habitat would remove a valued piece of biodiversity on the Ōtaki coastline. The Ōtaki Coast KNE site is considered to be of regional importance because it contains highly representative ecosystems that were once typical or commonplace in the region, ecological features that are rare or distinctive in the region, has a high level of ecosystem diversity, with several ecosystem types, including several naturally uncommon ecosystems, and contains a variety of inter-connected habitats and, provides core/seasonal habitat for threatened indigenous plant and animal species[37]. Te Horo Beach dune complex is defined as a gravel beach and dune ridges with turf and matting plants, wind shorn shrubs and trees and exotic species. Gravel beaches with indigenous vegetation are nationally regarded as endangered rare ecosystem types. The dune system is host to both at risk-declining flora such as *pingao* and *coprosma acerosa*, and home to fauna such as the Threatened-

[35] KCDC Operative Plan Schedule 5 — Special Amenity Landscapes

[36] Park M. 2012. MacKays to Peka Peka Expressway. Technical Report 26 Ecological Impact Assessment. P:\332\3320901\Technical Investigations (Planning)\LODGED DOCUMENTS\Final for Printer\Volume 3 Technical Reports\Technical Report 26\Technical Report 26 - Ecological Impact Assessment.doc. 198 pp.

[37] GWRC 2020. Key Native Ecosystem Operational Plan for Ōtaki Coast 2019-2024. GW/BD-G-19/116. 48 pp.

Domain	Element at Risk	Overview
		Nationally-Vulnerable-red-billed gull (Kāpiti Coast District Council, Greater Wellington Regional Council, n.d.) The Peka Peka Coast KNE site (39 ha) is located on the Kāpiti Coast between Peka Peka Beach and Waikanae Beach townships. It comprises three areas: the Te Kōwhai Stream estuary; the coastal dunes and wetlands of Pharazyn Reserve; and the three-kilometre strip of coastline between the two. The KNE site includes various coastal ecosystems including sand dunes, wetlands, and a relatively unmodified estuary. These ecosystems provide habitat for various threatened coastal flora and fauna. The vegetated sand dunes behind the beach provide natural protection to inland areas from coastal erosion and seaborn flooding[38]. K197-Paetawa Road, Peka Peka protects a stand of rawiritoa (sand kanuka; *Kunzea amathicola*) and this the dune kanuka is a Threatened–Nationally Vulnerable species.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	– Six areas would be affected by erosion under the SSP2-4.5 scenario at 2130 and seven under the SSP5-8.5 scenario. Coastal erosion will primarily impact areas of ecological significance close to the coastline and river and stream outlets. This includes the K001-Lake Waiorongomai (estuary only), K014-Waitohu Stream Mouth, K027-Ōtaki River Mouth, K231-Te Horo Gravel Beach, Peka Peka Coast KNE, and Ōtaki Beach Reserve for the SSP2-4.5, and the additional site under SSP5-8.5 is K179-Ōtaki Stewardship. – Ōtaki Estuary provides habitat for a range of indigenous vegetation and fauna. Erosion could remove part of this area resulting in the loss of wetland vegetation and fauna and altering the hydrology and wetland soil composition. It could also result in modifications of the Ōtaki Riverbed leading to more or increased rates of erosion and loss of fish passage connectivity. – Existing modified channels already, especially in the Ōtaki River but also other rivers and streams, restrict the extent of the salt marsh vegetation in the upper estuary, further potential erosion of estuary edges would place further pressure on existing vegetation (Stevens & Forrest, 2019). – Ongoing erosion is likely to result in the displacement of coastal ecosystems for breeding and migratory species and has the potential to block or alter upstream pathways for migratory breeding fish. – Erosion could result in seawater penetrating further inland in groundwater systems changing salinity of nearby coastal wetlands and affecting vegetation and habitat types. – A loss of riparian vegetation through coastal erosion at within estuaries and the stream mouth could affect the in-stream ecological quality as it slows the rate of run-off and water entering rivers and streams, contributes to the quality of water by trapping silt and other contaminants, provides a corridor of vegetation that birds and insects can use, and provides food and shelter for local animals (Greater Wellington Regional Council, 2014). – Removal of sand from the beach, lowering the beach profile, and allowing waves to travel further inland. Removal of the toe of the dunes where these are not protected, and potentially erosion of much or even all of the fore- and mid-dunes if wave action or storm surge is severe enough. – Pharazyn Reserve includes spinifex foredunes and these are at risk of erosion. This would reduce areas of relatively intact indigenous vegetation, as well as remove habitat for fauna including 26 species of indigenous bird species, and seven indigenous fish species in the streams. – Erosion could result in the destabilization of the dune systems (including loss of any indigenous fauna and flora) and loss of storm surge protection for inland portions.

[38] GWRC 2023. Key Native Ecosystem Operational Plan for Peka Peka Coast 2023-2028. GW/BD-G-23/11. 35pp.

Hazard	Description of Consequence (note any cascading impacts)
	– Erosion of habitat of native fauna including northern blue penguin nesting areas and resting and feeding areas of coastal and seabirds such as pied shag, red-billed gulls. More advanced erosion would also affect vegetation types of dry dune habitats including the flora and fauna associated with these. Dunes that have been over-steepened through erosion (or in combination with introduced marram grass) will be more prone to collapsing and this could destabilize more inland areas of the dune system. – The natural environment is interconnected with the social and economic systems. Erosion could open up areas to invasive species which could in turn affect human health, wellbeing, cultural and spiritual wellbeing. Erosion would also remove some of the human infrastructure such as beach access locations and perhaps walking/cycling tracks, and bridges. – Fisheries and aquaculture could be affected by species distribution changes due to changed habitats and increased sediment and nutrients run off (Ministry for the Environment, 2022).
Coastal Flooding	– At 2130, flooding would affect 13 mapped ecological sites under the SSP2-4.5 scenario at 2130 and 14 sites under the SSP5-8.5 scenario. A loss or permanent changes of the identified ecological sites due to inundation will mostly affect coastal and waterway-based sites and existing wetland sites. Flood control measures already in place such as stopbanks and floodgates present in Ōtaki catchment have already modified the system, further flooding will exacerbate an already altered ecological system. – Increased incidences of flooding in low lying areas due to sea level rise will be magnified during storm events causing floodwaters to back upstream and in the long term may lead to permanent inundation in some areas (Greater Wellington Regional Council, 2014). – Existing sites provide important nursery habitats for juvenile fish, which under increased flooding from inundation will reduce habitat quality, increase sedimentation and salinity, and change the nutrients present in these sites, overall reducing the quality of breeding habitats and creating shifts in species distributions. – Flooding could scour out waterways and flood associated wetlands reducing habitat (temporarily). Prolonged flooding will kill existing vegetation or cause a change to more wet-tolerant vegetation. – Flooding would affect any low-lying penguin burrows possibly killing chicks and make access more difficult for the adults potentially resulting in nest abandonment. Any birds nesting in low lying areas or flooded wetland areas would be affected, as could lizards and skinks and invertebrates. – Flooding may result in additional 'wet areas' that could start to exhibit wetland characteristics. – Impacts on Ōtaki River sites will have cascading effects to Te Horo Beach dune system and its biodiversity values, which is directly fed by gravels from the Ōtaki River. – Specific loss and increased flooding of the Te Horo dune system specifically will have negative cultural impacts on Ngā Hapū ō Ōtaki as it is valued for its ecological richness (Kāpiti Coast District Council, Greater Wellington Regional Council, n.d.)

Notes:

- Overall, the current expansion of pest species along with the additions of new ones (due to expanding species tolerances), is likely to significantly compromise the ability to maintain integrity and function of indigenous ecosystems and will make protecting at-risk and threatened species more challenging (Ministry for the Environment, 2020).
- K066 Te Harakeke Swamp and K236 Pharazyn Reserve are split across the Northern Adaptation Area and the Central Adaptation Area and will be assessed for the area within each risk assessment area for these ecological sites.

Opportunities

Hazard	Opportunities
Coastal Erosion	- Adding and implementing periodic monitoring of indigenous fauna into the Operative Kāpiti Coast District Plan 2021. - Continued funding and encouragement for community environmental restoration projects to have partnership with Local, Regional and National government. - Remove pest plant species, especially marram grass and plant the foredunes 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. Remove pest plant species from mid and more rearward dunes and replace these with appropriate indigenous species; keeping in mind that the natural habitat is alternating dry sandy ridges and wetter swamp forest hollows. - Undertake predator control to protect fauna, create dog-exclusion areas to allow undisturbed nesting of birds; including more inland areas to replace coastal habitat. - 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	- Develop management plans for at risk sites, including identifying areas that will be prone to future flooding. Plant up potentially wet areas with a range of appropriate dry and wet-tolerant species (to cover the range of possibilities) to pre-empt a change to wetter conditions and enable the ecosystems and habitats to self-adjust to changes. This will also strengthen the protection for human infrastructure (vegetation reduces erosion). - Remove willows and other exotic tree species (where not needed to provide front-line riverbank defenses) where there is a mix of indigenous and exotic species to encourage a greater abundance of indigenous vegetation (better habitat for other indigenous plant species and animals). - Water quality monitoring in wetlands and estuaries where sedimentation is occurring to track the health of waterways and subsequent health of riparian vegetation and potential impacts on river dwellers including fish species. - Remove existing waterway fish passage barriers to enable fish to more easily move up-/downstream so that they can escape more easily during a flood. Maintain/enhance connections with waterway floodplains. Some native fish species will 'graze' in flooded pastures and other habitat during flood events as the water velocity is slower there. - In dune areas, remove pest plant species, especially marram grass, and plant the foredunes with pīngao and spinifex (and other appropriate species) to make the dunes more resilient and less prone to erosion, and reduce potential for future flooding. Remove pest plant species from mid and more rearward dunes and replace these with appropriate indigenous species; keeping in mind that the natural habitat is alternating dry sandy ridges and wetter swamp forest hollows. - Anticipate future flooding and create vegetation types in those areas that are adaptable and also found in wetlands.

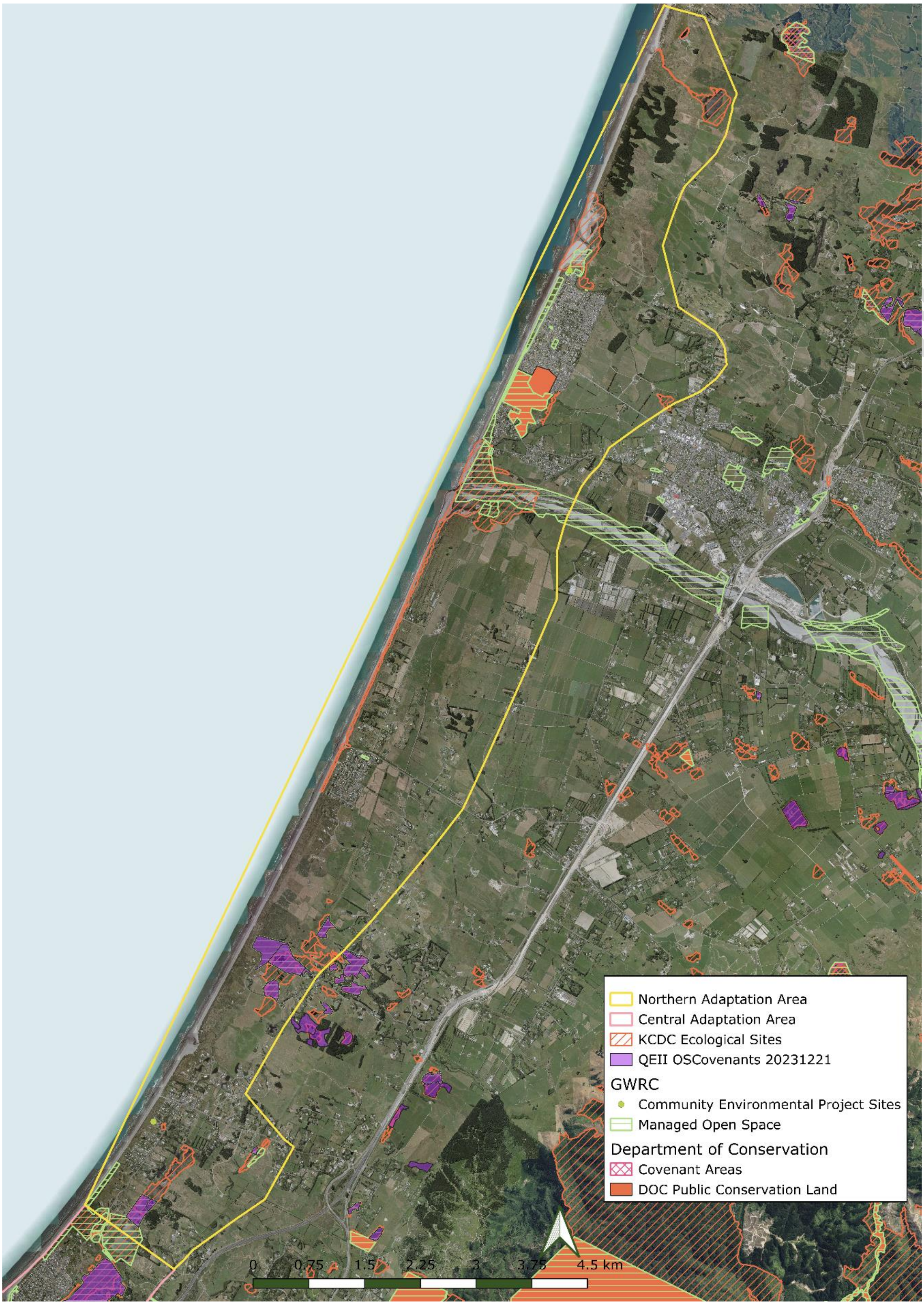

Figure A.3.4: Location of Mapped Ecological Sites within the NAA.

There are 39 mapped ecological sites but only 16 unique sites (as some sites are identified by multiple agencies). The 39 mapped sites include 13 KCDC Ecological Sites, 8 QEII covenant, 7 GWRC areas of Managed Open Space (MOS [only includes those where ecology/conservation is a key driver]), 7 GWRC Key Native Ecosystems (KNE), 2 areas with community project, 1 area of Department of Conservation (DOC) Public Conservation land, and 1 DOC Conservation covenant. The names and sizes of the areas are provided in the table below, with indications as to overlap with other jurisdictions. No up-to-date GIS layer was available for KNE sites – so this information has come from the GWRC website and is shown below.

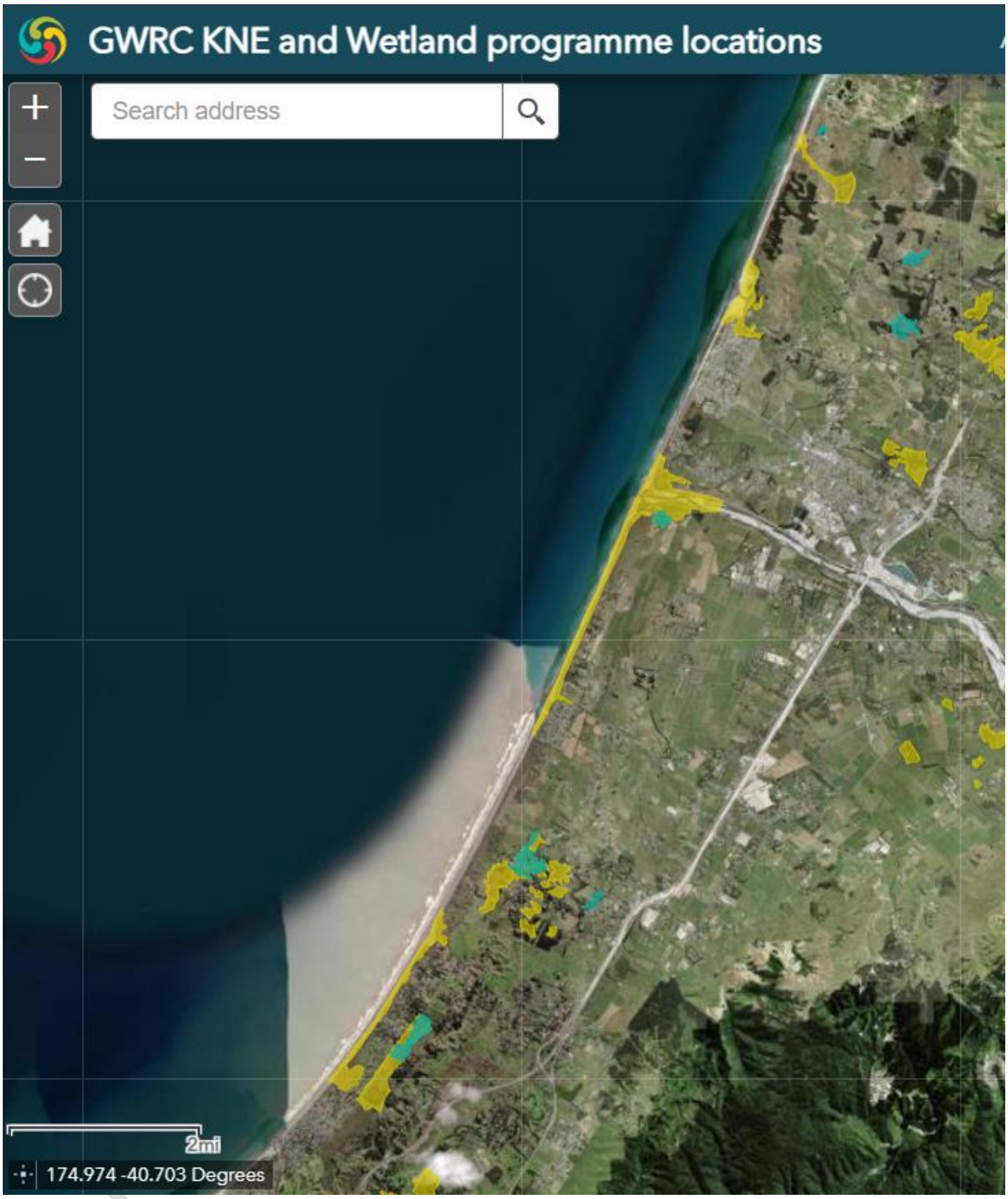

Figure A.3.5: Location of Key Ecosystem locations (yellow) from GWRC[39]. Note that the blue polygons are GWRC identified wetlands, not all wetlands are visible as some seem to be below the Key Native Ecosystem layer.

[39] https://www.arcgis.com/apps/webappviewer/index.html?id=2844233a5d9745bab939df9355f541a9

Table A.3.2: Table of Mapped Ecological Sites

Organization	Name	Area (ha)	Area within NAA	Max[40] coastal erosion	Max potential flood	Overlaps with	Unique
KCDC Ecological Site	K001-Lake Waiorongomai	15.1	100%	7%	12%	KNE	1
KCDC Ecological Site	K014-Waitohu Stream Mouth	33.0	100%	100%	Nil95%	MOS, KNE	1
KCDC Ecological Site	K027-Ōtaki River Mouth	69.0	100%	30%	100%	MOS, KNE	1
KCDC Ecological Site	K055-Te Hapua Road, Swamp A	47.9	100%	Nil	100%	QEII, KNE	1
KCDC Ecological Site	K060-Pekapeka Road Swamp	4.4	100%	Nil	Nil	QEII partial, MOS partial, DOC cov partial	1
KCDC Ecological Site	K066-Te Harakeke Swamp	65.3	85%	Nil	90%	QEII, KNE, MOS partial	1
KCDC Ecological Site	K176-Ōtaki Stewardship	25.4	100%	5%	60%	MOS, KNE	1
KCDC Ecological Site	K185-South Waikawa Beach Dune Lake	0.8	100%	Nil	100%	-	1
KCDC Ecological Site	K193-Puruaha Road, Ōtaki	0.2	100%	Nil	100%	-	1
KCDC Ecological Site	K210-Tasman Road,/Te Rauparaha Street, Ōtaki	2.1	90%	Nil	Nil	-	1
KCDC Ecological Site	K236-Pharazyn Reserve	41.6	25%	Nil	60%	MOS, KNE partial	1
KCDC Ecological Site	K197-Paetawa Road, Peka Peka	0.3	100%	Nil	40%	-	1
KCDC Ecological Site	K231-Te Horo Gravel Beach	13.3	100%	100%	80%	KNE	1
DOC Conservation covenant	Pekapeka Covenant	1.4	100%			KCDC, MOS	
DOC Public Cons land	Ōtaki Beach Conservation Area	26.4	100%			KCDC,MOS	
QEII covenant	5-07-320	10.9	100%			KCDC, KNE	
QEII covenant	5-07-351	9	100%	Nil	15%	-	1
QEII covenant	5-07-356	2.7	100%			KCDC, KNE	
QEII covenant	5-07-443	4.1	100%			KCDC, KNE	
QEII covenant	5-07-544	0.5	100%			MOS, KCDC partial	
QEII covenant	5-07-323	6.9	100%			KCDC, MOS, KNE	
QEII covenant	5-07-571	0.6	100%			KCDC, KNE	
QEII covenant	5-07-321	1.2	100%			KCDC, MOS, KNE	
GWRC KNE	Lake Wairongomai & Stream KNE	15	100%			KCDC	
GWRC KNE	Waitohu Coast and Wetlands KNE	31	100%			KCDC,MOS	
GWRC KNE	Ōtaki Coast KNE	119	100%			KCDC	
GWRC KNE	Ōtaki River Mouth	118	100%			KCDC,MOS	
GWRC KNE	Te Hapua Wetland Complex KNE	61	100%			KCDC, QEII partial, MOS partial	
GWRC KNE	Peka Peka Coast KNE	39	100%	104%	25%	partial MOS	1
GWRC KNE	Te Harakeke Wetland Complex KNE	28	100%			KCDC, QEII partial, MOS partial	
Managed open space[41]	Moana Street Reserve, Ōtaki	5.8	100%			KCDC,MOS	

[40] Maximum, as per SSP5-8.5 scenario at 2130

[41] GWRC Managed Open Space only includes those sites that are managed for environmental reasons as one of the primary reasons.

Organization	Name	Area (ha)	Area within NAA	Max[40] coastal erosion	Max potential flood	Overlaps with	Unique
Managed open space	Ōtaki Beach Reserve	10.3	100%	90	60%	-	1
Managed open space	Ōtaki Beach Conservation Area (DOC)	26.4	100%			KCDC,MOS	
Managed open space	Ōtaki River Lower Reach	136.3	100%			KCDC,MOS	
Managed open space	Pekapeka Covenant (DOC)	1.4	100%			MOS, KCDC	
Managed open space	Pharazyn Reserve, Waikanae Beach	17.5	25%			KCDC, KNE	
Managed open space	Rutherford Drive Reserve, Waikanae Beach	29.5	100%			KCDC	
Community project	Peka Peka Beach Dune Restoration Group						
Community project	Waitohu Streamcare Inc						
Community project	Friends of the Ōtaki River						
Total							16

A.3.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion Four sites are are risk to coastal erosion: - K027-Ōtaki River Mouth – 5% - K231-Te Horo Gravel Beach - 80% - Peka Peka Coast KNE - 25% - Ōtaki Beach Reserve – 25% The Ōtaki River, Waitohu Stream mouths and Te Horo dune system are nationally rare ecosystem and dune types. Te Horo dune system likely to experience an average of 10.8 m of erosion across the dune face.	Future exposure: 2050: Six sites exposed: - K001-Lake Waiorongomai (estuary) – 5% - K014-Waitohu Stream Mouth – 100% - K027-Ōtaki River Mouth – 7% - K231-Te Horo Gravel Beach – 90% - Peka Peka Coast KNE – 28% - Ōtaki Beach Reserve – 50% 2070: Six sites exposed: - K001-Lake Waiorongomai (estuary) – 5% - K014-Waitohu Stream Mouth – 100% - K027-Ōtaki River Mouth – 10% - K231-Te Horo Gravel Beach – 90% - Peka Peka Coast KNE – 32% - Ōtaki Beach Reserve – 60% 2130: Six sites exposed: - K001-Lake Waiorongomai (estuary) – 6% - K014-Waitohu Stream Mouth – 100% - K027-Ōtaki River Mouth – 30% - K231-Te Horo Gravel Beach – 100% - Peka Peka Coast KNE – 58% - Ōtaki Beach Reserve – 70% Ōtaki River mouth will experience a large amount of erosion on the north side of the river with approximately 30% of the area affected by erosion.
Currently exposed to coastal flooding Eight ecological sites are currently exposed to coastal flooding: - K001-Lake Waiorongomai – 5% - K014-Waitohu Stream Mouth -60% - K027-Ōtaki River Mouth – 70% - K179-Ōtaki Stewardship 30% - K231-Te Horo Gravel Beach – 5% - QEII covenant 5-07-351 – 1% - Peka Peka Coast KNE – 10% - Ōtaki Beach Reserve – 50% Most of the flooding occurring in Ōtaki River and Waitohu Stream mouths. Ōtaki Conservation area will also experience flooding. Occasional flooding of coastal areas is expected and a natural occurance. QEII covenant 5-07-351 is associated with waterways/drains.	Future exposure: 2050: Ten Ecological sites will experience inundation in some form: - K001-Lake Waiorongomai - 6% - K014-Waitohu Stream Mouth - 65% - K027-Ōtaki River Mouth - 75% - K179-Ōtaki Stewardship - 32% - K193-Puruaha Road, Ōtaki - 5% - K236-Pharazyn Reserve - 2% - K231-Te Horo Gravel Beach - 7% - QEII Covenant 5-07-351 - 2% - Peka Peka Coast KNE - 12% - Ōtaki Beach Reserve - 55% 2070: Eleven ecological sites will experience inundation in some form. - K001-Lake Waiorongomai - 7% - K014-Waitohu Stream Mouth - 70% - K027-Ōtaki River Mouth - 80% - K179-Ōtaki Stewardship - 35%

Details of exposure	
	- K193-Puruaha Road, Ōtaki - 10% - K236-Pharazyn Reserve - 8% - K197-Paetawa Road, Peka Peka - 5% - K231-Te Horo Gravel Beach - 8% - QEII Covenant 5-07-351 - 4% - Peka Peka Coast KNE - 15% - Ōtaki Beach Reserve - 57% 2130: Thirteen ecological sites will experience inundation in some form. - K001-Lake Waiorongomai - 8% - K014-Waitohu Stream Mouth - 83% - K027-Ōtaki River Mouth - 95% - K055-Te Hapua Road, Swamp A - 40% - K179-Ōtaki Stewardship - 45% - K185-South Waikawa Beach Dune Lake - 100% - K193-Puruaha Road, Ōtaki - 90% - K236-Pharazyn Reserve - 20% - K197-Paetawa Road, Peka Peka - 30% - K231-Te Horo Gravel Beach - 25% - QEII Covenant 5-07-351 - 10% - Peka Peka Coast KNE - 20% - Ōtaki Beach Reserve - 65%

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

Note:

- Exposure is based on the number of sites and the approximate percentage of the elements within the NAA which are exposed to the hazard.

Erosion:

- Risk was assessed as the approximate area affected for all sites (only including those that will be affected by erosion), and reflects both the highest percentage of effect for any one site and the proportion of sites (out of 16) affected.
- The increase to high in 2070 is because three of the six sites are more than 50% affected.
- The increase to extreme in 2130 is because two of the six sites will be 100% affected and another two sites will be more than 50% affected.

Flooding:

- Risk was assessed as the approximate area affected for all sites (only including those that will be affected by erosion), and reflects both the highest percentage of effect for any one site and the proportion of sites (out of 16) affected.
- The increase to high in 2050 is because ten of the 16 mapped ecological sites will be affected by flooding to some extent, including three that will be flooded by more than 50%.
- The increase to extreme in 2130 is because 13 of the 16 mapped ecological sites will be affected by flooding to some extent, including five that will be flooded by more than 50%.

Sensitivity

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

Notes:

- Many of New Zealand's ecosystems and species are very vulnerable to the projected changes in climate, due to the remaining areas being very fragmented, reduced in size, or highly modified, as well as the anticipated rapid changes. This limits their ability to adapt by moving through the landscape to adjust to changing environmental conditions. Ecosystems and habitats and plants can also move up and down gradients provide areas are connected or in close proximity and appropriate species and conditions are present.
- Ecological sites cannot move to another location, but it may be possible to relocate specific values within affected sites if there is sufficient room to do so.
- Each of the sites identified has different morphology, species distribution, density and communities. The sensitivity of these systems to climate change is an estimation, as we currently lack scientific knowledge and investigation into the adaptability and sensitivity of ecological sites.
- Sensitivity is scored on the basis of the mapped ecological sites that are most affected.
- Sensitivity is generally somewhat higher for flood risk as there are more ecosystems affected because they are associated with waterways of some sort.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	- There are populated and urban areas inland of the coastal environment which reduces the amount of space for ecological sites to naturally adapt and migrate away from hazards. - Erosion will affect a relatively narrow coastal zone, and once the dune system is breached the potential effects on more inland systems could occur quickly. - Ecological sites that are at risk that occur within dynamic river systems and dune systems and may have some ability to adapt due to continually adapting to tidal cycles and high flow scenarios. - Substantial modifications of waterways (e.g. stopbanks, and rivermouth opening) have have reduced the ability of ecosystems to adapt to changes.
Coastal Flooding	L	- Increased flooding may result in the loss of some vegetation and habitat types, but may also result in additional areas becoming 'wet' enabling expansion of some ecosystem and habitat types. - To ensure good adaptive capacity for ecological sites, management plans will need to be developed and implemented to take advantage of these potential changes. - Ecological sites will experience coastal squeeze in a similar way that dune systems will due to increasing human densities along the coast limited adequate space for adaptation (Holle., et al., 2019).

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	M	H	H	E	L	M	H	H	E

Overall Risk Score

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

A.3.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion Four sites are are risk to coastal erosion: - K027-Ōtaki River Mouth – 5% - K231-Te Horo Gravel Beach - 80% - Peka Peka Coast KNE - 25% - Ōtaki Beach Reserve – 25% The Ōtaki River, Waitohu Stream mouths and Te Horo dune system are nationally rare ecosystem and dune types. Te Horo dune system likely to experience an average of 10.8 m of erosion across the dune face.	Future exposure: 2050: Six sites exposed: - K001-Lake Waiorongomai (estuary) – 5% - K014-Waitohu Stream Mouth – 100% - K027-Ōtaki River Mouth – 7% - K231-Te Horo Gravel Beach – 90% - Peka Peka Coast KNE – 28% - Ōtaki Beach Reserve – 50% 2070: Six sites exposed: - K001-Lake Waiorongomai (estuary) – 6% - K014-Waitohu Stream Mouth – 100% - K027-Ōtaki River Mouth – 12% - K231-Te Horo Gravel Beach – 95% - Peka Peka Coast KNE – 49% - Ōtaki Beach Reserve – 75% 2130: Seven sites exposed: - K001-Lake Waiorongomai (estuary) – 7% - K014-Waitohu Stream Mouth – 100% - K027-Ōtaki River Mouth – 30% - K231-Te Horo Gravel Beach – 100% - Peka Peka Coast KNE – 104% - Ōtaki Beach Reserve – 90% - K179-Ōtaki Stewardship – 5% Ōtaki River mouth will experience a large amount of erosion on the north side of the river with approximately 30% of the area affected by erosion.

Currently exposed to coastal flooding
- Eight ecological sites are currently exposed to coastal flooding:
  o K001-Lake Waiorongomai – 5%
  o K014-Waitohu Stream Mouth -60%
  o K027-Ōtaki River Mouth – 70%
  o K179-Ōtaki Stewardship 30%
  o K231-Te Horo Gravel Beach – 5%
  o QEII covenant 5-07-351 – 1%
  o Peka Peka Coast KNE – 10%
  o Ōtaki Beach Reserve – 50%
 	
Most of the flooding occurring in Ōtaki River and Waitohu Stream mouths. Ōtaki Conservation area will also experience flooding.
Occasional flooding of coastal areas is expected and a natural occurance. QEII covenant 5-07-351 is associated with waterways/drains.
	Future exposure:
	2050:
	Ten Ecological sites will experience inundation in some form.
	- K001-Lake Waiorongomai - 6%
	- K014-Waitohu Stream Mouth - 65%
	- K027-Ōtaki River Mouth - 75%
	- K179-Ōtaki Stewardship - 32%
	- K193-Puruaha Road, Ōtaki - 5%
	- K236-Pharazyn Reserve - 2%
	- K231-Te Horo Gravel Beach - 7%
	- QEII Covenant 5-07-351 - 2%
	- Peka Peka Coast KNE - 12%
	- Ōtaki Beach Reserve - 55%
	
	2070:
	Eleven ecological sites will experience inundation in some form.
	- K001-Lake Waiorongomai - 9%
	- K014-Waitohu Stream Mouth - 75%

Details of exposure

- K027-Ōtaki River Mouth - 85%
- K179-Ōtaki Stewardship - 37%
- K193-Puruaha Road, Ōtaki - 15%
- K236-Pharazyn Reserve - 15%
- K197-Paetawa Road, Peka Peka - 7%
- K231-Te Horo Gravel Beach - 10%
- QEII Covenant 5-07-351 - 5%
- Peka Peka Coast KNE - 18%
- Ōtaki Beach Reserve - 57%

2130:

Fourteen ecological sites will experience inundation in some form.

- K001-Lake Waiorongomai - 12%
- K014-Waitohu Stream Mouth - 95%
- K027-Ōtaki River Mouth - 100%
- K055-Te Hapua Road, Swamp A - 100%
- K066-Te Harakeke Swamp – 90%
- K179-Ōtaki Stewardship - 60%
- K185-South Waikawa Beach Dune Lake - 100%
- K193-Puruaha Road, Ōtaki - 100%
- K236-Pharazyn Reserve - 60%
- K197-Paetawa Road, Peka Peka - 40%
- K231-Te Horo Gravel Beach - 25%
- QEII Covenant 5-07-351 - 80% (water behind dunes)
- Peka Peka Coast KNE - 25%
- Ōtaki Beach Reserve - 65%

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

Note: this

- Exposure is based on the number of sites and the approximate percentage of the elements within the NAA which are exposed to the hazard.

Erosion:

- Risk was assessed as the approximate area affected for all sites (only including those that will be affected by erosion), and reflects both the highest percentage of effect for any one site and the proportion of sites (out of 16) affected.

Flooding:

- Risk was assessed as the approximate area affected for all sites (only including those that will be affected by erosion), and reflects both the highest percentage of effect for any one site and the proportion of sites (out of 16) affected.

Sensitivity

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

Notes:

- Many of New Zealand's ecosystems and species are very vulnerable to the projected changes in climate, due to the remaining areas being very fragmented, reduced in size, or highly modified, as well as the anticipated rapid changes. This limits their ability to adapt by moving through the landscape to adjust to changing environmental conditions. Ecosystems and habitats and plants can also move up and down gradients provide areas are connected or in close proximity and appropriate species and conditions are present.
- Ecological sites cannot move to another location, but it may be possible to relocate specific values within affected sites if there is sufficient room to do so.
- Each of the sites identified has different morphology, species distribution, density and communities. The sensitivity of these systems to climate change is an estimation, as we currently lack scientific knowledge and investigation into the adaptability and sensitivity of ecological sites.
- Sensitivity is scored on the basis of the mapped ecological sites that are most affected.
- Sensitivity is generally somewhat lower for flood risk as most of the ecosystems are associated with waterways of some sort and will be used to some degree of flooding.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	- There are populated and urban areas inland of the coastal environment which reduces the amount of space for ecological sites to naturally adapt and migrate away from hazards. - Erosion will affect a relatively narrow coastal zone, and once the dune system is breached the potential effects on more inland systems could occur quickly. - Ecological sites that are at risk that occur within dynamic river systems and dune systems and may have some ability to adapt due to continually adapting to tidal cycles and high flow scenarios. - Substantial modifictions of waterways (e.g. stopbanks, and rivermouth opening) have have reduced the ability of ecosystems to adapt to changes.
Coastal Flooding	L	- Increased flooding may result in the loss of some vegetation and habitat types, but may also result in additional areas becoming 'wet' enabling expansion of some ecosystem and habitat types. - To ensure good adaptive capacity for ecological sites, management plans will need to be developed and implemented to take advantage of these potential changes. - Ecological sites will experience coastal squeeze in a similar way that dune systems will due to increasing human densities along the coast limited adequate space for adaptation (Holle., et al., 2019).

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	M	H	H	E	L	M	H	H	E

Overall Risk Score

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

A.3.4 Indigenous Trees

Domain	Element at Risk	Overview
Natural	Key Indigenous Trees	The NAA has 22 key indigenous trees identified within the Operative Kāpiti Coast District Plan 2021 (District Plan) at 11 different properties. The exact location of each tree within a property is not included in the mapping files as all trees are 'centralised' on the property. Hence, if erosion or flooding affects part (or all) of the listed property then it is assumed that the Key Indigenous tree(s) would also be affected. Some properties contain several trees. There is one Notable Tree, a cabbage tree thought to be more than 100 years old. The District Plan protects the values and characteristics of indigenous biodiversity, as well as aims to maintain and enhance the unique character and amenity values of the district's distinct communities for residents and visitors. Key Indigenous Trees are defined as significant locally indigenous vegetation. Notable trees also have a level of protection in the District Plan.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	There are no Key Indigenous Trees or Notable trees within the modelled erosion hazard area under this SLR scenario.
Coastal Flooding	- Increased flooding and ponding around indigenous trees can cause waterlogging and poor health or even kill trees. - Loss of amenity value for individuals upon whose properties the tree occurs if the trees decline in health or die. - Opening up of the canopy due to tree poor health or death resulting in pest plants to establish.

Opportunities

Hazard	Opportunities
Coastal Erosion	While no Key Indigenous or Notable trees are at risk from erosion in the next 100 years, there is continued opportunity to educate the public about the values of trees and continue the process to identify Key Indigenous Trees on private and public properties within the NAA. 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	Enhance the habitats of identified key indigenous trees so that they are part of a more resilient landscape. This can be done through pest plant and pest animal control and by planting up adjacent or additional areas. 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. Planting more flood tolerant tree species in at risk locations to potentially replace sensitive species in the future. Further control of tree browsing species such as possum, rats, and mice to reduce impacts on canopy and fruiting trees.

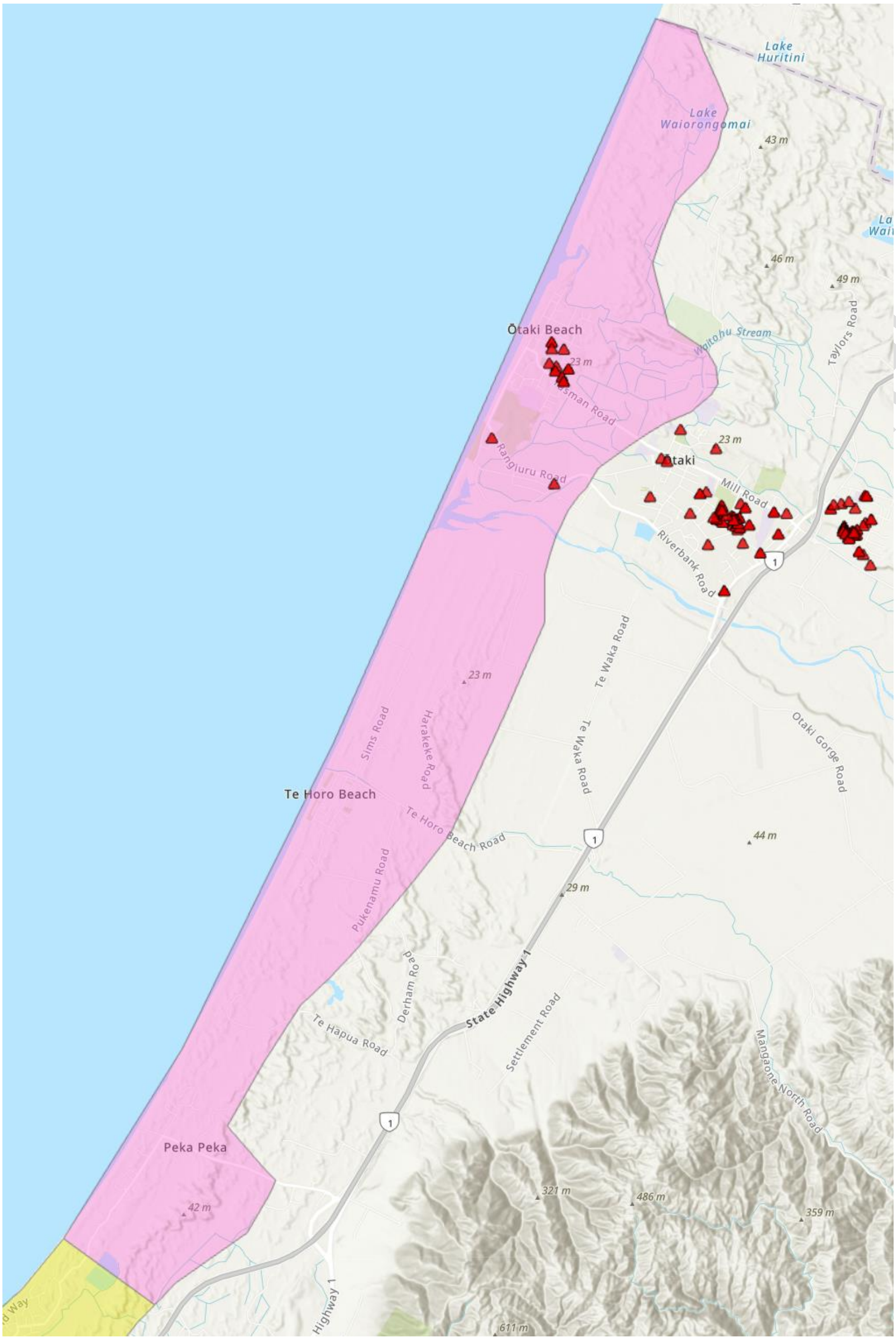

Figure A.3.6: Location of Indigenous Trees within the NAA.

The survey for Indigenous Trees (KCDC Schedule 2) within the Operative Kāpiti Coast District Plan 2021 was restricted to urban allotments. Neither Te Horo nor Peka Peka were urban areas at the time due to lack of connectivity to a serviced sewerage system. The areas in between these villages are rural and thus also excluded. Hence, there are only Key Indigenous Trees in the NAA in Ōtaki Beach. There also is one Notable Tree in Ōtaki Beach.

Table A.3.3: Table of Indigenous Trees

Type#	Scientific name	Common name	Site address	Erosion SSP2-4.5	Erosion SSP5-8.5	Flooding SSP2-4.5	Flooding SSP5-8.5
1	*Elaeocarpus dentatus*	Hinau	129b Rangiuru Road	Not	Not		
1	*Podocarpus totara*	Totara	14 Manuka Street	Not	Not	2130	2130
1	*Podocarpus totara*	Totara	14 Manuka Street	Not	Not	2130	2130
1	*Podocarpus totara*	Totara	17 Manuka Street	Not	Not	2130	2130
1	*Podocarpus totara*	Totara	3 The Avenue	Not	Not	2050	2070
1	*Dacrydium cupressinum*	Rimu	30 Manuka Street	Not	Not	2130	2130
1	*Alectryon excelsus*	Titoki	33 Ngaio Street	Not	Not		2130
1	*Alectryon excelsus*	Titoki	41 Ngaio Street	Not	Not		
1	*Alectryon excelsus*	Titoki	41 Ngaio Street	Not	Not		
1	*Alectryon excelsus*	Titoki	44c Tasman Road	Not	Not		2130
1	*Podocarpus totara*	Totara	64 Tasman Road	Not	Not		
1	*Podocarpus totara*	Totara	64 Tasman Road	Not	Not		
1	*Alectryon excelsus*	Titoki	70 Tasman Road	Not	Not		2130
1	*Alectryon excelsus*	Titoki	70 Tasman Road	Not	Not		2130
1	*Alectryon excelsus*	Titoki	70 Tasman Road	Not	Not		2130
1	*Beilschmiedia tawa*	Tawa	70 Tasman Road	Not	Not		2130
1	*Dacrydium cupressinum*	Rimu	70 Tasman Road	Not	Not		2130
1	*Podocarpus totara*	Totara	70 Tasman Road	Not	Not		2130
1	*Podocarpus totara*	Totara	70 Tasman Road	Not	Not		2130
1	*Podocarpus totara*	Totara	70 Tasman Road	Not	Not		2130
1	*Alectryon excelsus*	Titoki	9 Rata Street	Not	Not		
1	*Alectryon excelsus*	Titoki	9 Rata Street	Not	Not		
2	*Cordyline australis*	Cabbage Tree - age 100 years+	131 Rangiuru Road, Ōtaki	Not	Not		

Note: 1= Key Indigenous Tree; 2 = Notable Tree

A.3.4.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - No risk to Key Indigenous Trees - No risk to <u>indigenous</u> Notable Trees	Future exposure: - 2050: No risk to Key Indigenous Trees - 2070: No risk to Key Indigenous Trees - 2130: No risk to Key Indigenous Trees
Currently exposed to coastal flooding - No trees will be exposed to inundation	Future exposure: - 2050: One Key Indigenous Tree will be exposed to inundation - 2070: One Key Indigenous Tree will be exposed to inundation - 2130: Five Key Indigenous Trees will be exposed to increased inundation

Hazard	Present	2050	2070	2130
Coastal Erosion	None	None	None	None
Coastal Flooding	L	L	L	M

Note:

- The effects of coastal flooding would affect up to five Key Indigenous Tree out of 22 (KCDC Schedule 2) and no <u>indigenous</u> Notable Trees (KCDC Schedule 8) will be affected. Hence the exposure is considered to be low initially (only a few trees affected) but increases to moderate once more than 25% of Key Indigenous Trees could be affected .

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	None	None	None	None
Coastal Flooding	L	L	L	M

Note:

- The effects of coastal flooding would affect up to five Key Indigenous Tree out of 22 (KCDC Schedule 2) and no <u>indigenous</u> Notable Trees (KCDC Schedule 8) will be affected. However, the affected trees could decline in health or even die from flooding and/or waterlogged ground. Hence the sensitivity is considered to be low initially (only a few trees affected) but increases to moderate once more than 25% of Key Indigenous Trees could be affected .

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	Not Applicable	There is no risk to Key Indigenous Trees or Notable Trees from erosion under this scenario therefore any adaptive capacity is high.
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	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flooding	L	L	L	M	L	L	L	L	M

Overall Risk Score

Domain	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Risk from Flooding	L	L	L	M	L	L	L	M	L	L	L	M

A.3.4.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - No risk to Key Indigenous Trees - No risk to <u>indigenous</u> Notable Trees	Future exposure: - 2050: No risk to Key Indigenous Trees - 2070: No risk to Key Indigenous Trees - 2130: No risk to Key Indigenous Trees
Currently exposed to coastal flooding - No trees will be exposed to inundation	Future exposure: - 2050: One Key Indigenous Tree will be exposed to inundation - 2070: One Key Indigenous Tree will be exposed to inundation - 2130: Fifiteen Key Indigenous Trees will be exposed to increased inundation

Hazard	Present	2050	2070	2130
Coastal Erosion	None	None	None	None
Coastal Flooding	L	L	L	H

Note:

- The effects of coastal flooding would affect up to 15 Key Indigenous Tree out of 22 (KCDC Schedule 2) and no <u>indigenous</u> Notable Trees (KCDC Schedule 8) will be affected. Hence the exposure is considered to be low initially (only a few trees affected) but increases to high once more than 50% of Key Indigenous Trees could be affected.

Sensitivity

	Present	2050	2070	2130
Coastal Erosion	None	None	None	None
Coastal Flooding	L	L	L	H

Note:

- The effects of coastal flooding would affect up to 15 Key Indigenous Tree out of 22 (KCDC Schedule 2) and no <u>indigenous</u> Notable Trees (KCDC Schedule 8) will be affected. However, the affected trees could decline in health or even die from flooding and/or waterlogged ground. Hence the sensitivity is considered to be low initially (only a few trees affected) but increases to high once more than 50% of Key Indigenous Trees could be affected.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	Not Applicable	There is no risk to Key Indigenous Trees or Notable Trees from erosion under this scenario therefore any adaptive capacity is high.

Domain	Adaptive Capacity	Key Assumptions
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	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flooding	L	L	L	H	L	L	L	L	H

Overall Risk Score

Domain	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Risk from Erosion	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Risk from Flooding	L	L	L	H	L	L	L	H	L	L	L	H

A.3.5 Rare and threatened species

Domain	Element at Risk	Overview
Natural	Rare and threatened species	Within the NAA 78 nationally or regionally Threatened or At Risk species have been reported. Most of these species are associated with coastal areas such as the beach and dunes, or waterways, estuaries, and/or wetland areas. This includes 52 bird species, 13 freshwater fish species, 1 invertebrate species, 2 lizard species, 10 plant species including one liverwort and fungus species (refer to tables above). Most of the fauna and some of the flora occur mostly within the Waitohu Stream and Ōtaki River Estuary, wetlands and along the Paraparaumu Beach. For instance, the greatest number of species and number of birds observed are within the Waitohu Stream mouth and Ōtaki River estuary, with smaller numbers for Te Horo Beach, Peka Peka beach, and Ōtaki Beach. The Waitohu Stream mouth is a nationally important location for At Risk-Declining white-fronted tern and another five Threatened or At Risk species are known to be resident or regular visitors to this site: red-billed gull, variable oystercatcher, banded dotterel, pied stilt and Caspian tern. The Ōtaki River provides important nesting sites for nationally At Risk-Declining banded dotterel, and South Island pied oystercatcher, and nationally At Risk-Recovering variable oyster catchers, and red-billed gulls and another five Threatened or At Risk species are known to be resident or regular visitors to this site: royal spoonbill, black shag, pied shag, pied stilt and white-fronted tern. The Waitohu Stream provides habitat for eight Threatened or At Risk fish species and fourteen migratory native freshwater fish species. The Estuary is one of only a few providing estuarine wetland habitats in the district. Ōtaki River mouth Estuary provides seasonal or core habitat for seven Threatened or At Risk fish species. Mangaone Estuary provides seasonal or core habitat for five threatened indigenous fish species. Te Horo Beach provides seasonal or core habitat for up to 21 Threatened or At Risk bird species, 20 at Peka Peka Beach and 13 at Ōtaki Beach.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	- Northern blue penguin or kororā nest in holes dug into the dunes. Erosion and flooding could destroy their nesting holes and drown or bury eggs and chicks. It could also make access to nesting and resting areas more difficult for the adults and/or put them at greater exposure of attack by predators and domestic dogs. - Erosion could result in the loss of habitat for rare and threatened species, including alterations to the Waitohu Stream, Ōtaki River and Mangaone Stream mouths, and coastal dune habitat. This will have a more significant adverse effect for species with less mobility such as lizards and plants. Areas around stream mouths tend to be more urbanized than other parts of the NAA and thus there may be fewer rare and threatened species compared to more 'remote' areas, except for in reserve areas and areas where predator control is being undertaken. 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 NAA, alternative coastal habitat may be significantly reduced even for mobile species. - Sea level rise induced hazards will threaten the stability and productivity of important fauna breeding, feeding and resting habitats. - Increasing sea level rise, coupled with erosion is likely to cause increased coastal squeeze for these coastal habitats as erosion inland reduces the amount of space available for habitats to extend into especially in areas of human infrastructure and residential areas on the landward sides.

Hazard	Description of Consequence (note any cascading impacts)
	- Loss of indigenous species can result in an invasion of exotic species which can also bring the threat of vector-borne diseases and associated health implications (Ministry for the Environment, 2020a). - Erosion will have cascading effects for significant bird habitats as the surrounding environment including waterway estuaries and dunes are physically removed and habitat space is reduced. - The Kāpiti Coast District has frequent rare and endangered birds returning to the coast for nesting which encourages tourism from wildlife photographers. Reduced habitat affecting the numbers of birds returning for nesting will have cascading effects for tourism to the district.
Coastal Flooding	- Coastal flooding could result in the loss of habitat (possibly temporary) for rare and threatened species, especially alterations to the Waitohu Stream, Ōtaki River and Mangaone Stream mouths, dune habitat and wetlands. This will have a more significant adverse effect for species with less mobility such as lizards and plants. Areas around stream mouths tend to be more urbanized than other parts of the NAA and thus there may be fewer rare and threatened species compared to more 'remote' areas, except for in reserve areas and areas where predator control is being undertaken. 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 and wetlands than just within the NAA, alternative habitat may be significantly reduced even for mobile species. - More frequent and extensive flooding will cause increased sedimentation which is likely to affect the freshwater species present in rivers and coastal marine areas, reducing food availability for nesting birds through marine harvesting. - Altered river flows and flood frequencies are likely to impact on habitat and food availability as well as breeding success for river-nesting birds. This is likely to be most significant for species that breed and forage on the beds of river islands, such as in the Waitohu and Ōtaki Estuaries, due to losses of intertidal feeding areas for shorebirds and loss of nesting sites for other species. - Inundation due to sea level rise will reduce foraging area available to bird species in those areas where tidal zone movement (i.e. braided or meandering rivers) is limited or stopped by surrounding topography and human infrastructure (such as sea walls, stormwater infrastructure, roading and bridges). - Nests of shorebirds and seabird species are regularly washed out with storm surges (Holle, et al., 2019). Birds may not continue to return to sites due to continued flooding creating unsuitable nesting habitats. Overall reducing biodiversity and increasing opportunity for exotic fauna to settle in its place. - Increased flooding will reduce habitat for a range of species but may also result in additional areas of wetland being created.

Opportunities

Hazard	Opportunities
Coastal Erosion	Some of the areas, for instance the Ōtaki River Estuary, Peka Peka Beach and Waitohu Stream have active current management and indigenous planting to restore the ecosystems and an intensive pest program has been initiated. Continuing and enhancing these activities will enhance stability of salt marshes and the bordering plant system and dunes to prevent further erosion inland into residential dwellings. 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

Hazard	Opportunities
	other salvage operations in the district (with appropriate management plan and/or Wildlife Permit). Create areas in suitable northern blue penguin habitat where dogs are excluded and predator control is undertaken to increase where and how many penguins can nest outside of the coastal hazard areas.
Coastal Flooding	Options to manage vehicle damage in the estuary and coastal bird habitats should be explored. Current access is technically restricted, however difficult to enforce, and vehicles are often used irresponsibly in the areas. Coordinated governance may help to avoid maladaptation or inadequate adaptation actions that are aimed at protecting migratory, coastal and riverbed nesting birds and help to expand the ability of these species to adapt to climate change induced hazards. Identify coastal and riverine breeding sites that are most vulnerable to climate change impacts. The opportunity for a national coastal vulnerability index for coastal species could be adopted and manipulated to suit Aotearoa, New Zealand species as a way to monitor and rank risk for coastal ecosystems (as seen in Holle, et al., 2019). Minimise the effects of the flood gates on the Ōtaki River Estuary and artificial opening of the river mouths on the higher quality estuarine areas associated with the Ōtaki River, Waitohu Stream and Mangaone Stream. 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). Create areas in suitable northern blue penguin habitat where dogs are excluded and predator control is undertaken to increase where and how many penguins can nest outside of the coastal hazard areas.

Table A.3.4: Summary of Threatened and At Risk species known from the NAA. Data from KCDC Operative District Plan Schedules 1 and 3, iNaturalist, DOC herpetofauna and Bioweb databases.

National Threat Category	Bird	Fish	Insect	Lizard	Plant	Total
Threatened-Nationally Critical	3				1	4
Threatened-Nationally Endangered	2					2
Threatened-Nationally Vulnerable	3	2			1	6
Threatened-Nationally Increasing	4					4
At Risk-Declining	12	7	1	2	5	27
At Risk-Naturally Uncommon	5	1			2	8
At Risk-Relict	4					4
At Risk-Recovering	4					4
Data Deficient					1	1
Native--Migrant	5					5
Native-Vagrant	1					1
Vagrant	1					1
Rare vagrant	1					1

National Threat Category	Bird	Fish	Insect	Lizard	Plant	Total
Not Threatened[42]	7	3				10
Total	52	13	1	2	10	78

Table A.4.5: Summary of the number of bird species and number of birds recorded in eBird for specified localities.

Location	Number of species recorded	Total number of birds
Waitohu stream mouth	45	493
Ōtaki River estuary	33	137
Te Horo Beach	21	76
Peka peka beach	20	40
Ōtaki Beach	13	80

[42] Not classified as Threatened or At Risk at a national level, but is classified as such at a regional level.

Table A.4.6: List of Threatened and At Risk species known from the NAA. This only includes those species that are known to naturally occur on the Kāpiti Coast, and also excludes historic records for species that may no longer occur within the NAA.

Scientific Name	Common Name	National Threat Category[43]	GWRC Threat Category[44]	Species Type	Information Source
Anarhynchus frontalis	Wrybill	Threatened-Nationally Increasing	Regionally Critical	Shore bird	eBird[45], iNaturalist
Anas chlorotis	Brown Teal	Threatened-Nationally Increasing	Regionally Critical	Wetland bird	eBird
Anas gracilis	Grey Teal	Not Threatened	Regionally Recovering	Wetland bird	eBird
Anas superciliosa	Grey Duck	Not Threatened	Regionally Critical	Wetland bird	eBird
Anthus novaeseelandiae	New Zealand Pipit	At Risk-Naturally Uncommon	Regionally Vulnerable	Open spaces	eBird
Aptenodytes forsteri	Emperor penguin	Vagrant		Antartic bird	iNaturalist
Ardea ibis coromanda	Eastern Cattle Egret	Rare vagrant	Regional Vagrant	Open spaces	eBird
Ardea modesta	White Heron	Threatened-Nationally Critical	Regional Migrant	Wetland bird	eBird
Arenaria interpres	Ruddy Turnstone	Native--Migrant	Regional Vagrant	Shore bird	eBird
Aythya novaeseelandiae	New Zealand Scaup	Not Threatened	Regionally Vulnerable	Wetland bird	eBird
Botaurus poiciloptilus	Australasian Bittern	Threatened-Nationally Critical	Regionally Critical	Wetland bird	eBird
Calidris acuminata	Sharp-tailed Sandpiper	Native--Migrant	Regional Vagrant	Shore bird	eBird
Calidris canutus	Red Knot	At Risk-Declining	Regionally Critical	Shore bird	eBird
Calidris ruficollis	Red-necked Stint	Native--Migrant	Regional Vagrant	Shore bird	eBird
Charadrius bicinctus	Banded Dotterel	At Risk-Declining	Regionally Vulnerable	Shore bird/ River bird	eBird, GWRC, iNaturalist

[43] Fungi - Conservation status of selected species of non-lichenised agarics, boletes and russuloid fungi in Aotearoa New Zealand, 2021; By: Jerry A. Cooper, Peter K. Buchanan, Pat Leonard, Lois Allison-Cooper, Peter Johnston, Mahajabeen Padamsee, Eric McKenzie and Pascale Michel. New Zealand Threat Classification Series 38. Department of Conservation, Wellington. 49p.

Birds - Conservation status of birds in Aotearoa New Zealand, 2021; By: Hugh A. Robertson, Karen A. Baird, Graeme P. Elliott, Rodney A. Hitchmough, Nikki J. McArthur, Troy Makan, Colin M. Miskelly, Colin. J. O'Donnell, Paul M. Sagar, R. Paul Scofield, Graeme A. Taylor and Pascale Michel. New Zealand Threat Classification Series 36. Department of Conservation, Wellington. 43 p.

Reptiles - Conservation status of New Zealand reptiles, 2021; Rod A. Hitchmough, Ben Barr, Carey Knox, Marieke Lettink, Joanne M. Monks, Geoff B. Patterson, James T. Reardon, Dylan van Winkel, Jeremy Rolfe and Pascale Michel. New Zealand Threat Classification Series 35. Department of Conservation, Wellington. 15 p.

Hornworts and liverworts - Conservation status of New Zealand Hornworts and liverworts 2020; de Lange, P.J.; Glenny, D.; Frogley, K.; Renner, M.A.M.; von Konrat, M.; Engel, J.J.; Reeb, C.; Rolfe, J.R. 2020: Conservation status of New Zealand hornworts and liverworts, 2020. New Zealand Threat Classification Series 31. Department of Conservation, Wellington. 30 p.

Freshwater fish - Conservation status of New Zealand freshwater fishes, 2017.; Nicholas R. Dunn, Richard M. Allibone, Gerard P. Closs, Shannan K. Crow, Bruno O. David, Jane M. Goodman, Marc Griffiths, Daniel C. Jack, Nicholas Ling, Jonathan M. Waters and Jeremy R. Rolfe. New Zealand Threat Classification Series 24. 11 p.

Plants - Conservation status of New Zealand vascular plants 2017; de Lange, P.J.; Rolfe, J.R.; Barkla, J.W.; Courtney, S.P.; Champion, P.D.; Perrie, L.R.; Beadel, S.M.; Ford, K.A.; Breitwieser, I.; Schonberger, I.; Hindmarsh-Walls, R.; Heenan, P.B.; Ladley, K. 2018: Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Department of Conservation, Wellington. 82 p.

[44] Crisp P. 2020. Conservation status of native bird species in the Wellington region. Greater Wellington Regional Council Report GW/ESCI-G-20/75. 37pp.

Crisp P. 2020. Conservation status of indigenous lizard species in the Wellington region. Greater Wellington Regional Council Report WRC/ESCI-G-20/2. 10pp.

Crisp P. 2020. Conservation status of indigenous vascular plant species in the Wellington Region. Wellington Regional Council, Wellington, No. GW/ESCI-G-20/20 33 pp.

Crisp P., Perrie A., Morar S. and Royal C. 2022. Conservation status of indigenous freshwater fish in the Wellington region. Wellington Regional Council, Wellington, No. GW/ESCI-T-22/02. 8 pp

[45] eBird data from:

Peka peka https://ebird.org/hotspot/L4190183/bird-list?hs_sortBy=count
Te Horo https://ebird.org/hotspot/L22219987/bird-list
Otaki Beach https://ebird.org/hotspot/L19051786/bird-list
Otaki Estuary https://ebird.org/hotspot/L2891694/bird-list
Waitohu Stream mouth https://ebird.org/hotspot/L16887114/bird-list

Scientific Name	Common Name	National Threat Category[43]	GWRC Threat Category[44]	Species Type	Information Source
Charadrius obscurus aquilonius	northern New Zealand dotterel	Threatened-Nationally Increasing	Regionally Critical	Shore bird/ River bird	iNaturalist, eBird
Chlidonias albostriatus	Black-fronted Tern	Threatened-Nationally Endangered	Regional Migrant	Shore bird	eBird, iNaturalist
Chroicocephalus bulleri	Black-billed Gull	At Risk-Declining	Regionally Critical	Shore bird/ River bird	eBird
Egretta sacra	Reef Heron	Threatened-Nationally Endangered	Regionally Critical	Shore bird	eBird
Elseyornis melanops	Black-fronted Dotterel	At Risk-Naturally Uncommon	Regionally Vulnerable	Shore bird/ River bird	eBird
Eudyptula minor iredalei	Northern blue penguin	At Risk-Declining	Regionally Vulnerable	Shore bird	iNaturalist
Falco novaeseelandiae	New Zealand Falcon	At Risk-Recovering	Regionally Critical	Forest bird	eBird
Fulica atra	Eurasian Coot	At Risk-Naturally Uncommon	Regionally Critical	Wetland bird	eBird
Gallirallus philippensis	Banded Rail	At Risk-Declining	Regional Vagrant	Wetland bird	eBird
Haematopus finschi	South Island Pied Oystercatcher (SIPO)	At Risk-Declining	Regional Migrant	Shore bird	eBird
Haematopus unicolor	Variable Oystercatcher	At Risk-Recovering	Regionally Vulnerable	Shore bird	eBird, GWRC
Hemiphaga novaeseelandiae	New Zealand pigeon, kereru	Not threatened	Regionally Recovering	Forest bird	iNaturalist
Himantopus himantopus	Pied Stilt	Not Threatened	Regionally Vulnerable	Shore bird	eBird, GWRC
Himantopus novaezelandiae	Black stilt	Threatened-Nationally Critical	Regional Vagrant	Shore bird/ River bird	iNaturalist
Hydroprogne caspia	Caspian Tern	Threatened-Nationally Vulnerable	Regionally Critical	Shore bird	eBird, GWRC, iNaturalist
Larus novaehollandiae scopulinus	red-billed gull	At Risk-Declining	Regionally Vulnerable	Shore bird	eBird, GWRC, iNaturalist
Limosa lapponica	Bar-tailed Godwit	At Risk-Declining	Regionally Critical	Shore bird	eBird, iNaturalist
Microcarbo melanoleucos	Little Shag	At Risk-Relict	Regionally Vulnerable	Shore bird/ river/ wetland	eBird
Morus serrator	Australasian Gannet	Not Threatened	Regional Migrant	Shore bird	eBird
Nestor meridionalis septentrionalis	North Island kaka	At Risk-Recovering	Regionally Recovering	Forest bird	iNaturalist
Pachyptila turtur	Fairy Prion	At Risk-Relict	Regionally Critical	Shore bird	eBird
Phalacrocorax carbo	Black Shag	At Risk-Relict	Regionally Critical	Shore bird/ river/ wetland	eBird, GWRC
Phalacrocorax punctatus	Spotted Shag	Threatened-Nationally Vulnerable	Regionally Endangered	Shore bird	eBird
Phalacrocorax sulcirostris	Little Black Shag	At Risk-Naturally Uncommon	Regionally Vulnerable	Shore bird/ river/ wetland	eBird
Phalacrocorax varius	Pied Shag	At Risk-Recovering	Regionally Vulnerable	Shore bird/ river/ wetland	eBird, GWRC, iNaturalist
Platalea regia	Royal Spoonbill	At Risk-Naturally Uncommon	Regional Coloniser	Shore bird	eBird, GWRC
Pluvialis fulva	Pacific Golden-Plover	Native--Migrant	Regional Migrant	Shore bird	eBird
Poliocephalus rufopectus	New Zealand Dabchick	Threatened-Nationally Increasing	Regionally Vulnerable	Wetland bird	eBird, iNaturalist
Poodytes punctatus	New Zealand Fernbird	At Risk-Declining	Regionally Critical	Wetland bird	eBird
Porzana tabuensis	Spotless Crake	At Risk-Declining	Regionally Endangered	Wetland bird	eBird
Pterodroma gouldi	Grey-faced Petrel	Not Threatened	Regional Migrant	Shore bird	eBird
Puffinus gavia	Fluttering Shearwater	At Risk-Relict	Regionally Critical	Shore bird	eBird
Puffinus griseus	Sooty Shearwater	At Risk-Declining	Regionally Critical	Shore bird	eBird
Puffinus huttoni	Hutton's Shearwater	Threatened-Nationally Vulnerable	Regional Migrant	Shore bird	eBird
Stercorarius parasiticus	Arctic Skua	Native--Migrant	Regional Migrant	Shore bird	eBird

Scientific Name	Common Name	National Threat Category[43]	GWRC Threat Category[44]	Species Type	Information Source
Sterna hirundo	Common Tern	Native-Vagrant	Regional Vagrant	Shore bird	eBird
Sterna striata	White-fronted Tern	At Risk-Declining	Regionally Endangered	Shore bird	eBird, GWRC, iNaturalist
Anguilla dieffenbachii	New Zealand Longfin Eel	At Risk-Declining	Regionally Declining	Fish	GWRC, iNaturalist
Cheimarrichthys fosteri	torrentfish	At Risk-Declining	Regionally Declining	Fish	GWRC
Galaxias argenteus	giant kōkopu	At Risk-Declining	Regionally Vulnerable	Fish	GWRC, iNaturalist
Galaxias brevipinnis	koaro	At Risk-Declining	Regionally Declining	Fish	GWRC
Galaxias divergens	dwarf galaxias	At Risk-Declining	Regionally Declining	Fish	GWRC
Galaxias maculatus	īnanga	At Risk-Declining	Regionally Declining	Fish	GWRC
Galaxias postvectis	shortjaw kōkopu	Threatened-Nationally Vulnerable	Regionally Endangered	Fish	GWRC
Geotria australis	lamprey	Threatened-Nationally Vulnerable	Regionally Vulnerable	Fish	GWRC
Gobiomorphus gobioides	giant bully	At Risk-Naturally Uncommon	Regionally Declining	Fish	GWRC
Neochanna apoda	brown mudfish	At Risk-Declining	Regionally Vulnerable	Fish	GWRC
Retropinna retropinna	common smelt	Not Threatened	Regionally Declining	Fish	GWRC
Rhombosolea retiaria	black flounder	Not Threatened	Regionally Declining	Fish	GWRC
Latrodectus katipo	katipo	At Risk-Declining		Spider	iNaturalist
Mokopirirakau southern north island	Ngahere Gecko	At Risk-Declining	Regionally At Risk	Lizard	iNaturalist
Naultinus punctatus	barking gecko	At Risk-Declining	Regionally Threatened	Lizard	DOC bioweb
Bulbophyllum tuberculatum	None known	At Risk-Naturally Uncommon	Regionally Naturally Uncommon	Plant	Bioweb
Clavaria zollingeri	violet coral fungus	Data Deficient		Fungus	iNaturalist
Coprosma acerosa	Sand Coprosma	At Risk-Declining	Regionally Declining	Dune plant	iNaturalist
Ficinia spiralis	Pingao	At Risk – Declining	Regionally Vulnerable	Dune plant	KCDC Schedule 3
Juncus caespiticius	(blank)	At Risk-Declining		Plant	iNaturalist
Korthalsella salicornioides	(blank)	Threatened-Nationally Critical	Regionally Threatened	Plant	iNaturalist
Kunzea amathicola	rawiritoa, sand kānuka	Threatened–Nationally Vulnerable	Regionally Data Deficient	Dune plant	KCDC Schedule 1
Pimelea villosa	Sand pimelea	At Risk-Declining	Regionally Endangered	Dune plant	Bioweb
Ricciocarpos natans	fringed heartwort	At Risk-Declining		Liverwort	iNaturalist
Tetragonia tetragonoides	New Zealand spinach	At Risk-Naturally Uncommon	Regionally Naturally Uncommon	Dune plant	Bioweb

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 – All coastal dune habitat areas are currently at risk of experiencing erosion, with potential severe effects on Te Horo Gravel Beach. The Ōtaki River Estruary is currently exposed to minimal erosion. - Overall risk - Moderate	Future exposure: - 2050: Coastal dune habitat sites experience increased erosion, especially in mouths of waterways especially Waitohu Stream mouth, Te Horo Gravel Beach and Ōtaki beach – moderate risk overall. - 2070: Erosion for dune habitat areas will be similar to 2050 but increases in waterway mouths and dune systems. Potential for dunes to be completely eroded in some places. Moderate risk overall. - 2130: In places coastal dune habitats could be breached completely and affect habitat further inland. Effects on Ōtaki River mouth also increase and could affect more inland habitat. High risk overall.
Currently exposed to coastal flooding – Occasional flooding of coastal areas is expected and a natural occurance. Coastal areas (beaches and foredunes) and sites associated with waterways such as the Waitohu Stream, Ōtaki River Estuary and the dunes along the Peka Peka and Te Horo and Ōtaki coast are currently affected by flood or storm events. The estuary systems are more affected than the beach or dune systems. - Overall risk - moderate	Future exposure: - 2050: Water starts backing up in all wetlands and streams and there is an increased risk of coastal flooding. Ten sites providing habitat will be affected by varying heights of flooding. High risk overall. - 2070: Water starts backing up in all wetlands and streams and there is an increased risk of coastal flooding. Some sites with threatened plant species are starting to experience flooding. Eleven habitats will be affected by varying heights of flooding. High risk overall. - 2130: Water backs up in all wetlands and streams and in places extends quite some distance from the waterways and wetlands. Some wetland habitats are completely flooded and it is likely that vegetation types will be affected and changed through flooding, including potential loss of rare or threatened species. There is an increased risk of coastal flooding. Thirteen habitats will be affected by varying heights of flooding. High risk overall.

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

Notes:

- Exposure is based on the approximate area of each of the mapped ecological habitats potentially affected by erosion or flooding within the NAA. It is not possible to assess effects on fauna or flora populations as there is little information about rare and threatened species and their local populations 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.
- Adverse effects will be greater for species with less mobility such as lizards and plants, rather than seabirds or other birds.
- However, given that coastal erosion and flooding will likely affect more of the coastline than just within the NAA, alternative coastal habitat may be significantly reduced even for mobile species.
- Effects on the waterway estuaries and areas of dune and wetlands elevate the risk of loss of rare or threatened species.
- Beach erosion and coastal dune erosion and restricted space for habitat to 'migrate' inland (due to human occupation and built environment in Peka Peka, Te Horo and Ōtaki), coupled with sea level rise will likely overall reduce the size of habitats over time.
- Flooding can result in both loss of habitat due to areas being drowned, but could potentially also increase wetland areas and provide future fauna and flora habitat.
- This is based on total exposure percentage of the existing habitats to the hazard.
  I.e Low: 0-25%, Moderate: 25-50%, High: 50-75%, Extreme: >75%.

Erosion:

- Risk was assessed as the approximate area of ecological habitats potentially affected (only including those that will be affected by erosion).
- Coastal fauna and flora habitats are already affected by erosion, hence the current risk is considered to be Moderate.
- Erosion risk increases to high in 2070 as more than 50% of the habitats could be affected.

Flooding:

- Risk was assessed as the approximate area of ecological habitats potentially affected (only including those that will be affected by flooding).
- Coastal habitats and wetlands already affected by flooding, hence the current risk is considered to be moderate.
- This increases to high in 2050 as greater portions of the habitat are affected.

Sensitivity

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

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 NAA, alternative coastal habitat may be significantly reduced even for mobile species. Similarly, risk to wetland habitats increases over time and more wetland are flooded and/or to a greater depth.
- 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 would dissapear at the same rate as has been used for loss of mapped ecological sites.
- The increase to high in 2070 is because about 50% of coastal habitat could be affected.
- The increase to extreme in 2130 is due to the all coastal sites being affected by erosion within the NAA as well as ongoing loss of habitat in the wider Kāpiti Coast, which could have significant cumulative effects on populations of rare and treathened species.

Flooding:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat would dissapear at the same rate as has been used for loss of mapped ecological sites.

- Flooding may only be temporary, which would reduce the effects, and flooding could also result in additional/adjacent areas of 'wetland'.
- This increases to high in 2050 as greater portions of the habitats are affected.
- The increase to extreme in 2130 is due to nearly all habitats being affected by flooding which could have significant cumulative effects on populations of rare and treathened species.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	– A very large number of Threatened and At Risk species are known from the NAA, including international migrants with limited habitat options. – 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. – Limited space for habitat to 'migrate' inland to adjust for changes. - The total extent of area affected both within the NAA and the wider Kāpiti Coast could restrict where species can move to.
Coastal Flooding	L	– A very large number of Threatened and At Risk species are known from the NAA, including international migrants with limited habitat options.. – 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. – Limited space for habitat to 'migrate' inland to adjust for changes. – The total extent of area affected both within the NAA and the wider Kāpiti Coast could restrict where species can move to.

Notes:

- The adaptive capacity of coastal ecosystems could rely somewhat on effective and adaptive management, such as creating additional areas of habitat, translocation of species and pest plant and animal control.

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	M	H	H	E	L	M	H	H	E

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	H	E	M	M	H	E

	Exposure				Vulnerability				Risk			
Risk from Flooding	M	H	H	H	M	H	H	E	M	H	H	E

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 – All coastal dune habitat areas are currently at risk of experiencing erosion, with potential severe effects on Te Horo Grave Beach. The Ōtaki River Estruary is currently exposed to minimal erosion. - Overall risk - moderate	Future exposure: - **2050:** Coastal dune habitat sites experience increased erosion, especially in mouths of waterways especially Waitohu Stream mouth, Te Horo Gravel Beach and Ōtaki beach – moderate risk overall. - **2070:** Erosion for dune habitat areas will be similar to 2050 but increases in waterway mouths and dune systems. Potential for dunes to be completely eroded in some places. High risk overall. - 2130: In places coastal dune habitats could be breached completely and affect habitat further inland. Effects on Ōtaki River mouth also increase and flooding further upstream could affect more inland habitat. Extreme risk overall.
Currently exposed to coastal flooding – Occasional flooding of coastal areas is expected and a natural occurance. Coastal areas (beaches and foredunes) and sites associated with waterways such as the Waitohu Stream, Ōtaki River Estuary and the dunes along the Peka Peka and Te Horo and Ōtaki coast are currently affected by flood or storm events. The estuary systems are more affected than the beach or dune systems. - Overall risk - moderate	Future exposure: - **2050:** Water starts backing up in all wetlands and streams and there is an increased risk of coastal flooding. Ten sites providing habitat will be affected by varying heights of flooding. High risk overall. - **2070:** Water starts backing up in all wetlands and streams and there is an increased risk of coastal flooding. Some sites with threatened plant species are starting to experience flooding Eleven habitats will be affected by varying heights of flooding. High risk overall. - 2130: Water backs up in all wetlands and streams and in places extends quite some distance from the waterways and wetlands and collects behind dune systems. Some wetland habitats are completely flooded and it is likely that vegetation types will be affected and changed through flooding, including potential loss of rare or threatened species. There is an increased risk of coastal flooding. Fourteen habitats will be affected by varying heights of flooding. Extreme risk overall.

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

Notes:

- Exposure is based on the approximate area of each of the mapped ecological habitats potentially affected by erosion or flooding within the NAA. It is not possible to assess effects on fauna or flora populations as there is little information about rare and threatened species and their local populations 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.
- Adverse effects will be greater for species with less mobility such as lizards and plants, rather than seabirds or other birds.
- However, given that coastal erosion and flooding will likely affect more of the coastline than just within the NAA, alternative coastal habitat may be significantly reduced even for mobile species.
- Effects on the waterway estuaries and areas of dune and wetlands elevate the risk of loss of rare or threatened species.
- Beach erosion and coastal dune erosion and restricted space for habitat to 'migrate' inland (due to human occupation and built environment in Peka Peka, Te Horo and Ōtaki), coupled with sea level rise will likely overall reduce the size of habitats over time.
- Flooding can result in both loss of habitat due to areas being drowned, but could potentially also increase wetland areas and provide future fauna and flora habitat.
- This is based on total exposure percentage of the existing habitats to the hazard.
  I.e Low: 0-25%, Moderate: 25-50%, High: 50-75%, Extreme: >75%.

Erosion:

- Risk was assessed as the approximate area of ecological habitats potentially affected (only including those that will be affected by erosion).
- Coastal fauna and flora habitats are already affected by erosion, hence the current risk is considered to be moderate.
- Erosion risk increases to high in 2070 as more than 50% of the habitats could be affected.

Flooding:

- Risk was assessed as the approximate area of ecological habitats potentially affected (only including those that will be affected by flooding).
- Coastal habitats and wetlands already affected by flooding, hence the current risk is considered to be moderate.
- This increases to high in 2050 as greater portions of the habitat are affected.
- Flooding risk increases to extreme in 2130 as nearly all habitats could be affected by flooding and some areas are 100% flooded.

Sensitivity

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

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 NAA, alternative coastal habitat may be significantly reduced even for mobile species. Similarly, risk to wetland habitats increases over time and more wetland are flooded and/or to a greater depth.
- 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 would dissapear at the same rate as has been used for loss of mapped ecological sites.
- The increase to high in 2070 is because about 50% of coastal habitat could be affected.
- The increase to extreme in 2130 is due to the all coastal sites being affected by erosion within the NAA as well as ongoing loss of habitat in the wider Kāpiti Coast, which could have significant cumulative effects on populations of rare and treathened species.

Flooding:

- To estimate the potential effects on rare and threatened species it was assumed that their habitat would dissapear at the same rate as has been used for loss of mapped ecological sites.
- Flooding may only be temporary, which would reduce the effects, and flooding could also result in additional/adjacent areas of 'wetland'.
- This increases to high in 2050 as greater portions of the habitats are affected.
- The increase to extreme in 2130 is due to nearly all habitats being affected by flooding which could have significant cumulative effects on populations of rare and treathened species.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	– A very large number of Threatened and At Risk species are known from the NAA, including international migrants with limited habitat options. – 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. – Limited space for habitat to 'migrate' inland to adjust for changes. – The total extent of area affected both within the NAA and the wider Kāpiti Coast could restrict where species can move to.
Coastal Flooding	L	– A very large number of Threatened and At Risk species are known from the NAA, including international migrants with limited habitat options.. – 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. – Limited space for habitat to 'migrate' inland to adjust for changes. – The total extent of area affected both within the NAA and the wider Kāpiti Coast could restrict where species can move to.

Notes:

- The adaptive capacity of coastal ecosystems could rely somewhat on effective and adaptive management, such as creating additional areas of habitat, translocation of species and pest plant and animal control.

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	M	H	H	E	L	M	H	H	E

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	H	E	M	M	H	E
Risk from Flooding	M	H	H	E	M	H	H	E	M	H	H	E

A.3.6 Bird habitat

Domain	Element at Risk	Overview
Natural	Significant bird habitats	Significant bird habitats were classified in the 2019 report *preparing Coastal communities for climate change* by GWRC as one of three ecological criteria which were identified to be representative of components that would be affected by increases in sea level rise and coastal erosion. Three classes of significant bird habitats can be classified in the Wellington Region: lakes, rivers, and coastal marine areas. The coastal part of the NAA was surveyed for birds as indicated by the blue brackets on the map above. GWRC identified three coastal significant bird habitats; one at the Waitohu Stream Estuary, the Ōtaki River Estuary and the inland part of the Ōtaki River from the downstream end of Ōtaki River gorge to the coastal marine area boundary. These three areas combined are approximately 91 hectares. GWRC Schedule F2a: Significant habitats for indigenous birds in rivers includes: • Lower Ōtaki river where seven Threatened or At Risk species are resident or regular visitors to this site: Banded dotterel, pied stilt, black shag, pied shag, white-fronted tern, red-billed gull and NZ pipit. This site supports the largest breeding populations of both banded dotterels and black-fronted dotterels on the west coast of the North Island south of the Manawatu River. GWRC Schedule F2c - Significant habitats for indigenous birds in the coastal marine area includes: • Waitohu Stream mouth where five Threatened or At Risk species are known to be resident or regular visitors to this site: red-billed gull, variable oystercatcher, banded dotterel, pied stilt and Caspian tern. • Ōtaki River mouth where seven Threatened or At Risk species are known to be resident or regular visitors to this site: royal spoonbill, black shag, pied shag, banded dotterel, pied stilt, red-billed gull and white-fronted tern. eBird data for various areas in the NAA show that the number of Threatened or At Risk bird species could well be greater than reported in the GWRC Natural Resources Plan and that the beach areas also provide habitat for a range of indigenous bird species, including nationally or regionally threatened species, and national and regional migrants. Coastal nesting habitats are situated on dynamic ecosystems which are subject to disturbance through regular tidal cycles and storm events.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	- Erosion can affect beaches causing them to lower and providing less foraging and roosting space at high tide for shore birds. - Erosion will affect the dunes along the inland portions of the various estuaries and the beach and dune systems. Some of the bird species roost in the dunes or nest at the toe of the dunes, and northern blue penguins may also have burrows in the dunes. Erosion will reduce the area available for roosting and may erode nests and burrows during the breeding season causing mortality of eggs/chicks and potentially adult birds. Sea level rise induced hazards will threaten the stability and productivity of important breeding, feeding and resting habitats. - Erosion is likely to affect the waterway estuaries (especially the Waitohu Estuary) and result in a loss of intertidal feeding areas for shorebirds.

Hazard	Description of Consequence (note any cascading impacts)
	- Erosion and sea-level rise could over-deepen the water in the estuaries so that the area is no longer suitable for birds to wade and feed in. - Erosion could alter the near-shore environment resulting in reduction of 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. - Increasing sea level rise, coupled with erosion is likely to cause increased coastal squeeze for these coastal habitats as erosion inland reduces the amount of space available for bird habitats to 'migrate' due to human infrastructure and dense residential areas on the landward sides. - Erosion will have cascading effects for significant bird habitats as the erosion will not only occur within the NAA but also the wider Kāpiti Coast and surrounding environment putting further pressure on bird populations and bird habitats. - 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. - The NAA provides habitat for a very large range of Threatened and At Risk bird species, NZ and international migrants, and rarely seen species. This encourages tourism from wildlife photographers. Reduced habitat will affect the species and the numbers of birds returning for nesting will have cascading effects for tourism.
Coastal Flooding	- More frequent and extensive flooding of indigenous bird habitats will cause changes in the food availability due to increased diving depth, plants and habitats dying due to flooding, changes in waterflow patterns, and increased water velocity and sedimentation smothering benthic food sources (buried invertebrates in the sand). These changes will likely affect the prey species available in rivers, lagoons and coastal marine areas, reducing food availability for birds. - Higher and more extensive flooding could drown nests and burrows of species that nest adjacent or on waterways. This will have cascading effects on the size and genetic diversity of the affected bird populations. The issue will be that the whole or much of the coastline will be similarly affected, so not only reducing local habitat within the NAA but also reducing habitat for birds to move too. - Flooding can scour waterway beds resulting in altered river flows and loss or flooding of any islands. This would reduce areas of safer (less disturbance by humans and their pets) nesting and foraging areas. Such losses will reduce breeding and feeding success and will likely result in a decline in the populations of the affected species. - Inundation due to sea level rise will reduce tidal foraging area available to bird species especially because this habitat cannot 'migrate' inland due to surrounding topography and human infrastructure (such as sea walls, stormwater infrastructure, roading and bridges). - Nests of shorebirds and seabird species are regularly washed out with storm surges (Holle, et al., 2019). Birds may not continue to return to sites due to continued flooding creating unsuitable nesting habitats. This would cause a decline in populations of these species or perhaps even local extinctions. - The issue will be that flooding will affect the whole or much of the coastline, so not only reducing local habitat within the NAA but also reducing habitat for birds to move too. - Flooding may result in additional areas of wetland in more inland habitat allowing some species to extend their range, but only if these newly wetted areas are retained and protected as wildlife habitat. - The breeding success of a number of threatened river-dwelling bird species (such as wrybill plovers, black-fronter terns and blue ducks), that dwell in other districts, are already significantly impacted from flooding and predicted changes in the frequency and magnitude of floods may further significantly impact population viability (Death, Bowie & O'Donnell, 2016). - A loss of visiting sea birds will cause a lower cultural value for food gathering, feathers for craft and spiritual connection as taonga Māori, and reduced tourism opportunities.

Opportunities

Hazard	Opportunities
Coastal Erosion	Some of the areas, for instance the Ōtaki River estuary, Peka Peka Beach and Waitohu Stream have active current management and indigenous planting to restore the ecosystems and an intensive pest program has been initiated. Continuing and enhancing these activities will enhance stability of salt marshes and the bordering plant system and dunes can create additional bird habitat. Undertake pest animal and/or pest plant control to help retain rare and threatened species. Create inland bird habitat with excellent predator control and establish secure inland populations. Assist private landowners with predator control around lakes and ponds with high bird values. Create inland dune lakes with beaches as bird habitat. Some individuals of key species could be relocated to these secure sites from other salvage operations in the district (with appropriate management plan and/or Wildlife Permit). Create areas in suitable northern blue penguin habitat where dogs are excluded and predator control is undertaken to increase where and how many penguins can nest outside of the coastal hazard zones. Education to ensure that humans keep their dogs under control and allow birds to rest and recuperate. Dog exclusion areas to allow northern blue penguins and other coastal and seabirds to nest, breed, and rest undisturbed. Ongoing or increased monitoring by the GWRC and KCDC to monitor and record effects on bird species and populations.
Coastal Flooding	Some of the areas, for instance the Ōtaki River Estuary, Peka Peka Beach and Waitohu Stream have active current management and indigenous planting to restore the ecosystems and an intensive pest program has been initiated. Continuing and enhancing these activities will enhance stability of salt marshes and the bordering plant system and dunes can create additional bird habitat. Options to manage vehicle damage in the estuary and coastal bird habitats should be explored. Current access is technically restricted, however difficult to enforce and vehicles are often used irresponsibly in the areas. Undertake pest animal and/or pest plant control to help retain rare and threatened species. Create inland bird habitat with excellent predator control and establish secure inland populations. Assist private landowners with predator control around lakes and ponds with high bird values. Create inland dune lakes with beaches as bird habitat. Some individuals of key species could be relocated to these secure sites from other salvage operations in the district (with appropriate management plan and/or Wildlife Permit). Create areas in suitable northern blue penguin habitat where dogs are excluded and predator control is undertaken to increase where and how many penguins can nest outside of the coastal hazard areas. Education to ensure that humans keep their dogs under control and allow birds to rest and recuperate. Dog exclusion areas to allow northern blue penguins and other coastal and seabirds to nest, breed, and rest undisturbed. Ongoing or increased monitoring by the GWRC and KCDC to monitor and record effects on bird species and populations. Minimise the effects of the flood gates on the Ōtaki River Estuary and artificial opening of the river mouths on the higher quality estuarine areas associated with the Ōtaki River, Waitohu Stream and Mangaone Stream.

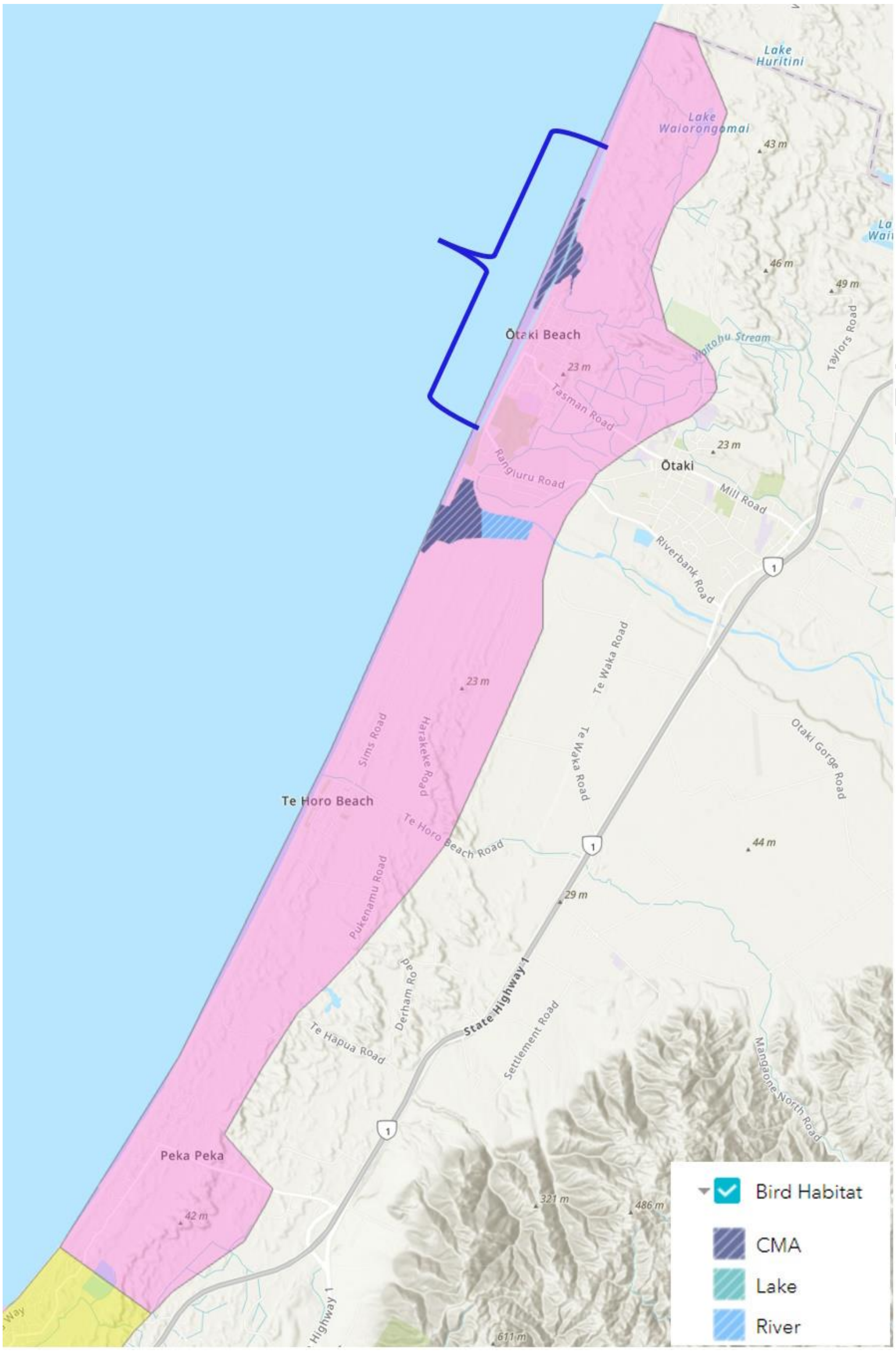

Figure A.3.7: Location of bird surveys in the NAA. GWRC identified three coastal significant bird habitats; one at the Waitohu Stream Estuary, the Ōtaki River Estuary and the inland part of the Ōtaki River from the downstream end of Ōtaki River gorge to the coastal marine area boundary. These three areas combined are approximately 91 hectares.

Table A.3.7: eBird data for various areas in the NAA. These data only include indigenous species

Location	All species	Nationally or regionally threatened
Waitohu Stream Mouth	59	44
Ōtaki River Estuary	46	32
Peka Peka Beach	32	19
Te Horo Beach	32	20
Ōtaki Beach	23	12
Ōtaki Riverbed	19	9
Total	**62**	**47**

Table A.3.9: eBird lists for various birding hotspot locations in the NAA. The number of birds per species refers to the latest observation and is not necessarily a total of species seen during all surveys.

Scientific name	Common name	National Threat Category	GWRC Threat Category	Waitohu stream mouth	Ōtaki River estuary	Ōtaki Riverbed	Ōtaki Beach	Peka peka beach	Te Horo Beach
Anarhynchus frontalis	Wrybill	Threatened-Nationally Increasing	Regionally Critical	1	1		1		
Anas chlorotis	Brown Teal	Threatened-Nationally Increasing	Regionally Critical	1					
Anas gracilis	Grey Teal	Not Threatened	Regionally Recovering	2	5			9	
Anas superciliosa	Grey Duck	Not Threatened	Regionally Critical	1	1				
Anthus novaeseelandiae	New Zealand Pipit	At Risk-Naturally Uncommon	Regionally Vulnerable	1	2	1	1	1	1
Ardea ibis coromanda	Eastern Cattle Egret	Rare vagrant	Regional Vagrant	2					
Ardea modesta	White Heron	Threatened-Nationally Critical	Regional Migrant	1	1	1			
Arenaria interpres	Ruddy Turnstone	Native--Migrant	Regional Vagrant		1				
Aythya novaeseelandiae	New Zealand Scaup	Not Threatened	Regionally Vulnerable	1	1				
Botaurus poiciloptilus	Australasian Bittern	Threatened-Nationally Critical	Regionally Critical	1	1				
Calidris acuminata	Sharp-tailed Sandpiper	Native--Migrant	Regional Vagrant	1					
Calidris canutus	Red Knot	At Risk-Declining	Regionally Critical	2	1				
Calidris ruficollis	Red-necked Stint	Native--Migrant	Regional Vagrant	1					
Charadrius bicinctus	Banded Dotterel	At Risk-Declining	Regionally Vulnerable	2	3	16		1	1
Charadrius obscurus aquilonius	New Zealand Dotterel	Threatened-Nationally Increasing	Regionally Critical	1					
Chlidonias albostriatus	Black-fronted Tern	Threatened-Nationally Endangered	Regional Migrant	1	2			1	
Chroicocephalus bulleri	Black-billed Gull	At Risk-Declining	Regionally Critical	1	4		7	1	2
Egretta sacra	Reef Heron	Threatened-Nationally Endangered	Regionally Critical	1					
Elseyornis melanops	Black-fronted Dotterel	At Risk-Naturally Uncommon	Regionally Vulnerable	2	1	8		4	4
Falco novaeseelandiae	New Zealand Falcon	At Risk-Recovering	Regionally Critical		1			1	
Fulica atra	Eurasian Coot	At Risk-Naturally Uncommon	Regionally Critical	2					
Gallirallus philippensis	Banded Rail	At Risk-Declining	Regional Vagrant	1	1				
Haematopus finschi	South Island Pied Oystercatcher (SIPO)	At Risk-Declining	Regional Migrant	1	1		1	2	2
Haematopus unicolor	Variable Oystercatcher	At Risk-Recovering	Regionally Vulnerable	4	4		2	1	17
Himantopus himantopus	Pied Stilt	Not Threatened	Regionally Vulnerable	2	6	10	2	2	4
Hydroprogne caspia	Caspian Tern	Threatened-Nationally Vulnerable	Regionally Critical	1	1	1	6	2	
Larus novaehollandiae scopulinus	red-billed gull	At Risk-Declining	Regionally Vulnerable	17	20		27	3	5
Limosa lapponica	Bar-tailed Godwit	At Risk-Declining	Regionally Critical	1	2				1
Microcarbo melanoleucos	Little Shag	At Risk-Relict	Regionally Vulnerable	1	2	8		1	
Morus serrator	Australasian Gannet	Not Threatened	Regional Migrant	1	31		1	1	6

Scientific name	Common name	National Threat Category	GWRC Threat Category	Waitohu stream mouth	Ōtaki River estuary	Ōtaki Riverbed	Ōtaki Beach	Peka peka beach	Te Horo Beach
Pachyptila turtur	Fairy Prion	At Risk-Relict	Regionally Critical						5
Phalacrocorax carbo	Black Shag	At Risk-Relict	Regionally Critical	1	2	2			
Phalacrocorax punctatus	Spotted Shag	Threatened-Nationally Vulnerable	Regionally Endangered	2	1				1
Phalacrocorax sulcirostris	Little Black Shag	At Risk-Naturally Uncommon	Regionally Vulnerable	2	4		11	1	1
Phalacrocorax varius	Pied Shag	At Risk-Recovering	Regionally Vulnerable	2	1		2	1	4
Platalea regia	Royal Spoonbill	At Risk-Naturally Uncommon	Regional Coloniser	1	2			1	3
Pluvialis fulva	Pacific Golden-Plover	Native--Migrant	Regional Migrant	1					
Poliocephalus rufopectus	New Zealand Dabchick	Threatened-Nationally Increasing	Regionally Vulnerable	1	1				1
Poodytes punctatus	New Zealand Fernbird	At Risk-Declining	Regionally Critical	1					
Porzana tabuensis	Spotless Crake	At Risk-Declining	Regionally Endangered	1					
Pterodroma gouldi	Grey-faced Petrel	Not Threatened	Regional Migrant	1					
Puffinus gavia	Fluttering Shearwater	At Risk-Relict	Regionally Critical	1	10			1	13
Puffinus griseus	Sooty Shearwater	At Risk-Declining	Regionally Critical	2					2
Puffinus huttoni	Hutton's Shearwater	Threatened-Nationally Vulnerable	Regional Migrant	1					
Stercorarius parasiticus	Arctic Skua	Native--Migrant	Regional Migrant	1	1				1
Sterna hirundo	Common Tern	Native-Vagrant	Regional Vagrant	1					
Sterna striata	White-fronted Tern	At Risk-Declining	Regionally Endangered	416	20		17	5	1

A.3.6.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion - Erosion could affect the Waitohu Stream Estuary and the coastal margin of the Ōtaki River Estuary. - All three beach and dune habitats (Ōtaki, Te Horo and Peka Peka) can suffer from erosion. - The more inland Lower Ōtaki Riverbed area is less likely to be affected by coastal erosion. - Overall risk: moderate.	Future exposure: 2050: - Waitohu Stream mouth will face further erosion up the stream (approx 1.5 hectares total). - Ōtaki River mouth habitat will experience between 0.7 hectares of erosion total on the northern and southern sides of the river mouth which will begin to cut part of the habitat off. The beach and dune habitats are all at moderate risk of erosion. 2070: - Not much change to erosion along Waitohu Stream mouth (approx 1.5 hectares total) but a significant increase within Ōtaki River mouth (up to 1.2 hectares total on the north and southern sides of the river mouth). Erosion risk of the Ōtaki and Te Horo beach and dune habitats remains at moderate but increases to high for Peka Peka. 2130: - Not much additional erosion for Waitohu Stream mouth but Ōtaki River mouth will lose much of the northern bank to erosion (up to 10.2 hectares) and may have some coastal erosion on the south side of the river. Some coastal erosion is also expected within the Ōtaki Riverbed (approximately 0.27 hectares). Ōtaki and Peka Peka beach and dune habitat could be subject to high levels of coastal erosion, with more moderate erosion at Te Horo.
Currently exposed to coastal flooding - Waitohu Stream mouth habitat will experience flooding across approximately 75% of the habitat - Ōtaki River mouth habitat will experience flooding across approximately >90% of the habitat - Ōtaki River habitat will experience flooding across approximately 75% of the habitat. - Ōtaki beach and dune habitat: Low risk of flooding, <25% of dunes. - Te Horo beach and dune habitat: Low flooding risk (<10%) for dunes - Peka Peka beach and dune habitat: Moderate flooding risk (25-50%) for dunes	Future exposure: 2050: All three estuary habitats and the beach and dune habitats will continue to experience similar levels of flooding. 2070: Both Ōtaki River mouth and Ōtaki River habitats will continue to experience similar levels of flooding. Waitohu Stream mouth will experience flooding across >90% of the habitat. The dune habitats continue to experience similar levels of flooding. 2130: Ōtaki River mouth will be completely inundated, with Waitohu Stream mouth and Ōtaki River experiencing extreme (95%) flooding across the habitat. Peka Peka beach and dune habitat will be at high risk of flooding and Ōtaki and Te Horo at moderate risk.

Hazard	Present	2050	2070	2130
Coastal Erosion	M	M	H	E

Hazard	Present	2050	2070	2130
Coastal Flooding	H	H	E	E

Note:

- There may be inland areas where wetlands could be planted or established after flooding or other bird habitat created. This could moderate some of the effects.
- Changes to salinity and duration and depth of flooding will change plant species composition. This will have knock-on effects on fauna and bird habitat types.

Erosion

- Estimated as the proportion of the identified bird habitat affected by erosion.
- The current risk is moderate exposure for coastal beaches, dunes and estuaries The coastal systems and the species living in them are somewhat adapted to erosion processes. Hence moderate overall.
- Erosion could result in seawater penetrating further inland in groundwater systems and changing salinity of other bird habiats.
- The risk increases to high in 2070 as all coastal bird habitat will be affected to some extent.
- Increases to extreme in 2130 is due to the potential for significant loss of estuarine and beach and dune habitat in all six areas.

Flooding

- Estimated as the proportion of the bird habitats affected by flooding. Includes flooding of adjacent areas as this may increase the area of wetland bird habitat over time.
- Current flooding risk is high, as flooding of the coastal and saline bird habitats occurs already (and is expected), but it is likely that the entire Kāpiti coastline will be experiencing similar effects, reducing the availability of possible alternative habitat.
- Flood risk increases to extreme from 2070 on as low-lying areas adjacent to the bird habitat also flood, beach and dune habitat is badly affected and the frequency and depth of flooding continues to increase. This would severly limit bird habitat availability and could affect bird populations and potentially even local extinctions. Flooding may result in additional areas of wet land which could provide alternative bird habitat, but this would need to be secured through planting, (legal) protection, and predator control.

Sensitivity

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

Notes:

- Ministry for the Environment (2020a) identifies that that degree of sensitivity for migratory, coastal and river-nesting birds will be largely dictated by environmental factors rather than physiological and behavioural senstivities with pressure on seabird and river-nestiving birds from human disturbance and other changes in landscape likely to increase aswell as climate change.
- One of the problems is that is it likely that the bird habitat in NAA will be affected as well as a much larger area, potentially even areas outside of the Kāpiti Coast for NZ migrants and international migrants. Hence bird population will be experiencing multiple reductions in habitat area with cumulative effects on bird populations. The frequency of such events will likely also increase that will further undermine the ability of bird populations to recover.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	- The estuaries (Waitohu Stream, Ōtaki River) and Ōtaki Riverbed have been habitable bird environments for a considerable time and have continued to adjust and accommodate for changes in sea level and erosion of intertidal and sand banks. - Erosion of coastal and dune habitat in Ōtaki, Te Horo and Peka Peka will gradually increase over time. - However, the scale of future erosion, and the lack of suitable alternative habitat will put bird species at risk. - There is a limited degree of adaptive capacity that can be expected for most coastal, migratory and river nesting birds due to the high pressure they already experience from predation, habitat loss and human disturbance. - Migratory and dispersal ability can be high however the ability to adapt to climate induced hazards is limited by the number of available and suitable alternative habitats, feeding areas and breeding sites (Ministry for the Environment, 2020a). Alternative areas will likely decrease in size/suitability over increasingly larger areas. - Sites that are exposed to erosion that do not exist in typical dynamic riverine systems will be permanently lost once eroded.
Coastal Flooding	L	- A limited degree of adaptive capacity can be expected for most coastal, migratory and river-nesting birds, with nationwide shorebird already counts showing shorebird populations declining on average (Lukies, Gaskin, Whitehead, 2021) - Human activities such as harvesting, habitat clearance and fragmentation have already substantially reduced the adaptive capacity of indigenous species, which has reduced their ability to adapt and more to other suitable habitat. - Management of introduced species is necessary to maintain adequate and health populations of species at particular risk of decline. - Majority of land within the indentified significant bird sites are expected be affected by inundation. The ability of bird species to adapt or adopt alternative habitat is also limited by the human development in the vicinity.

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	H	H	E	E	L	H	H	E	E

Overall Risk Score

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

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

A.3.6.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - Erosion could affect the Waitohu Stream Estuary and the coastal margin of the Ōtaki River Estuary. - All three beach and dune habitats (Ōtaki, Te Horo and Peka Peka) can suffer from erosion. - The more inland Lower Ōtaki Riverbed area is less likely to be affected by coastal erosion. - Overall risk: moderate.	Future exposure: 2050: - Waitohu Stream mouth will face further erosion up the stream (approx 1.5 hectares total). - Ōtaki River mouth habitat will experience between 0.7 hectares of erosion total on the northern and southern sides of the river mouth which will begin to cut part of the habitat off. The beach and dune habitats are all at moderate risk of erosion. 2070: - Not much change to erosion along Waitohu Stream mouth (approx 1.5 hectares total) but a significant increase within Ōtaki River mouth (up to 1.2 hectares total on the north and southern sides of the river mouth). Erosion risk of the Ōtaki and Te Horo beach and dune habitats remains at moderate but increases to high for Peka Peka. 2130: Not much additional erosion for Waitohu Stream mouth but Ōtaki River mouth will lose much of the northern bank to erosion (up to 10.2 hectares) and may have some coastal erosion on the south side of the river. Some coastal erosion is also expected within the Ōtaki Riverbed (approximately 0.27 hectares). Ōtaki and Peka Peka beach and dune habitat could be subject to high levels of coastal erosion, with more moderate erosion at Te Horo.
Currently exposed to coastal flooding - Waitohu Stream mouth habitat will experience flooding across approximately 75% of the habitat - Ōtaki River mouth habitat will experience flooding across approximately >90% of the habitat - Ōtaki River habitat will experience flooding across approximately 75% of the habitat. - Ōtaki beach and dune habitat: Low risk of flooding, <25% of dunes. - Te Horo beach and dune habitat: Low flooding risk (<10%) for dunes - Peka Peka beach and dune habitat: Moderate flooding risk (25-50%) for dunes	Future exposure: 2050: All three estuary habitats and the beach and dune habitats will continue to experience similar levels of flooding. 2070: Both Ōtaki River mouth and Ōtaki River habitats will continue to experience similar levels of flooding. Waitohu Stream mouth will experience flooding across >90% of the habitat. The dune habitats continue to experience similar levels of flooding. 2130: Ōtaki River mouth will be completely inundated, with Waitohu Stream mouth and Ōtaki River experiencing extreme (95%) flooding across the habitat. Peka Peka beach and dune habitat will be at high risk of flooding and Ōtaki and Te Horo at moderate risk.

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

Note:

- There may be inland areas where wetlands could be planted or established after flooding or other bird habitat created. This could moderate some of the effects.
- Changes to salinity and duration and depth of flooding will change plant species composition. This will have knock-on effects on fauna and bird habitat types.

Erosion

- Estimated as the proportion of the identified bird habitat affected by erosion.
- The current risk is moderate exposure for coastal beaches, dunes and estuaries The coastal systems and the species living in them are somewhat adapted to erosion processes. Hence moderate overall.
- Erosion could result in seawater penetrating further inland in groundwater systems and changing salinity of other bird habiats.
- The risk increases to high in 2070 as all coastal bird habitat will be affected to some extent.
- Increases to extreme in 2130 is due to the potential for significant loss of estuarine and beach and dune habitat in all six areas.

Flooding

- Estimated as the proportion of the bird habitats affected by flooding. Includes flooding of adjacent areas as this may increase the area of wetland bird habitat over time.
- Current flooding risk is high, as flooding of the coastal and saline bird habitats occurs already (and is expected), but it is likely that the entire Kāpiti coastline will be experiencing similar effects, reducing the availability of possible alternative habitat.
- Flood risk increases to extreme from 2070 on as low-lying areas adjacent to the bird habitat also flood, beach and dune habitat is badly affected and the frequency and depth of flooding continues to increase. This would severly limit bird habitat availability and could affect bird populations and potentially even local extinctions. Flooding may result in additional areas of wet land which could provide alternative bird habitat, but this would need to be secured through planting, (legal) protection, and predator control.

Sensitivity

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

Notes:

- Ministry for the Environment (2020a) identifies that that degree of sensitivity for migratory, coastal and river-nesting birds will be largely dictated by environmental factors rather than physiological and behavioural senstivities with pressure on seabird and river-nestiving birds from human disturbance and other changes in landscape likely to increase aswell as climate change.
- One of the problems is that is it likely that the bird habitat in NAA will be affected as well as a much larger area, potentially even areas outside of the Kāpiti Coast for NZ migrants and international migrants. Hence bird population will be experiencing multiple reductions in habitat area with cumulative effects on bird populations. The frequency of such events will likely also increase that will further undermine the ability of bird populations to recover.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	- The estuaries (Waitohu Stream, Ōtaki River) and Ōtaki Riverbed have been habitable bird environments for a considerable time and have continued to adjust and accommodate for changes in sea level and erosion of intertidal and sand banks. - Erosion of coastal and dune habitat in Ōtaki, Te Horo and Peka Peka will gradually increase over time.

Domain	Adaptive Capacity	Key Assumptions
		- However, the scale of future erosion, and the lack of suitable alternative habitat will put bird species at risk. - There is a limited degree of adaptive capacity that can be expected for most coastal, migratory and river nesting birds due to the high pressure they already experience from predation, habitat loss and human disturbance. - Migratory and dispersal ability can be high however the ability to adapt to climate induced hazards is limited by the number of available and suitable alternative habitats, feeding areas and breeding sites (Ministry for the Environment, 2020a). Alternative areas will likely decrease in size/suitability over increasingly larger areas. - Sites that are exposed to erosion that do not exist in typical dynamic riverine systems will be permanently lost once eroded.
Coastal Flooding	L	- A limited degree of adaptive capacity can be expected for most coastal, migratory and river-nesting birds, with nationwide shorebird already counts showing shorebird populations declining on average (Lukies, Gaskin, Whitehead, 2021) - Human activities such as harvesting, habitat clearance and fragmentation have already substantially reduced the adaptive capacity of indigenous species, which has reduced their ability to adapt and more to other suitable habitat. - Management of introduced species is necessary to maintain adequate and health populations of species at particular risk of decline. - Majority of land within the indentified significant bird sites are expected be affected by inundation. The ability of bird species to adapt or adopt alternative habitat is also limited by the human development in the vicinity.

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	H	H	E	E	L	H	H	E	E

Overall Risk Score

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

A.3.7 Fish habitat

Domain	Element at Risk	Overview
Natural	Fish habitat	Important fish habitat identified by GWRC within the NAA include (Schedule F1) the mainstem and tributaries of the Waitohu Stream, Ōtaki River, Mangaone Stream, and parts of the Waimeha Stream (blue lines as shown on above map). These waterways provide habitat for indigenous Threatened/At Risk fish species and habitat for six or more migratory indigenous fish species. The mouths of these waterways (Schedule F1b) are also known to provide spawning habitat for Īnanga. Waitohu Estuary provides seasonal or core habitat for eight threatened indigenous migratory fish species: longfin eel, giant kōkopu, shortjaw kōkopu, Īnanga, kōaro, redfin bully, torrentfish and lamprey. The Estuary is one of only a few providing estuarine wetland habitats in the district. And Ōtaki River mouth estuary provides seasonal or core habitat for seven threatened indigenous fish species: longfin eel, giant kōkopu, shortjaw kōkopu, kōaro, Īnanga, redfin bully and torrentfish (Schedule F4). The Ōtaki River and Waitohu Stream are also important trout fishery rivers and spawning waters (Schedule I). Fish species known from the NAA include: Threatened-Nationally Vulnerable - shortjaw kōkopu and lamprey; At Risk-Naturally Uncommon – giant bully; At Risk-Declining - New Zealand longfin Eel, torrentfish, giant kōkopu, koaro, dwarf galaxias, īnanga and brown mudfish; Regionally Declining - common smelt and black flounder; and Not Threatened - shortfin eel, Banded kōkopu, upland bully, common bully and redfin bully.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	- Coastal erosion could alter the habitat, including any saline wetlands, within the waterway mouths and make it less appropriate habitat for indigenous fish species. - It could alter how the waterways connect to more upstream portions (e.g. fish passage barriers). - Rapid erosion could at times temporarily block the stream with sediment. - The estuaries cannot re-establish upstream due to existing human infrastructure. - Increased sediment in the waterways (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). - Increasing sea level rise, coupled with erosion is likely to cause increased coastal squeeze for these coastal habitats as erosion inland reduces the amount of space available for habitats to extend into due to infrastructure and dense residential areas on the landward sides.
Coastal Flooding	- Salt water would penetrate further upstream and could potentially kill freshwater species (especially plants). These could be areas where īnanga spawn. - The depth of the water in the estuaries and waterways 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 waterways would be flooded creating additional temporary habitat for freshwater fish which are known to 'graze' flooded paddocks and sometimes also spawn. - Flooding may result in additional areas of wetland that could provide limited (or more permanent habitat for fish).

Opportunities

Hazard	Opportunities
Coastal Erosion	The ongoing management of the Ōtaki River Estuary seeks to restore the ecosystems and includes intensive pest program. This effort should be continued. The Friends of the Ōtaki River Group also undertakes planting to enhance the stability of the salt marshes and the bordering ecosystems to prevent further erosion inland into residential dwellings. Where possible, plant the banks of the waterways 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	The ongoing management of the Ōtaki River Estuary seeks to restore the ecosystems and includes intensive pest program. This effort should be continued. The Friends of the Ōtaki River Group also undertakes planting to enhance the stability of the salt marshes and the bordering ecosystems to prevent further erosion inland into residential dwellings. Where possible, plant the banks of the waterways 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. 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 waterways with suitable indigenous species to create 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. Consider establishing additional areas of wetland (including deeper trenches) in future flood-prone areas to maintain or even increase habitat for indigenous fish. Look into options to manage vehicle damage in the estuary to better protect fish habitat. Current access is technically restricted, however difficult to enforce and vehicles are often used irresponsibly in the areas. Minimising the effects of the flood gates on the Ōtaki River Estuary and artificial opening of all of the river mouths to minimize any potential adverse effects on the estuarine habitat and fish passage.

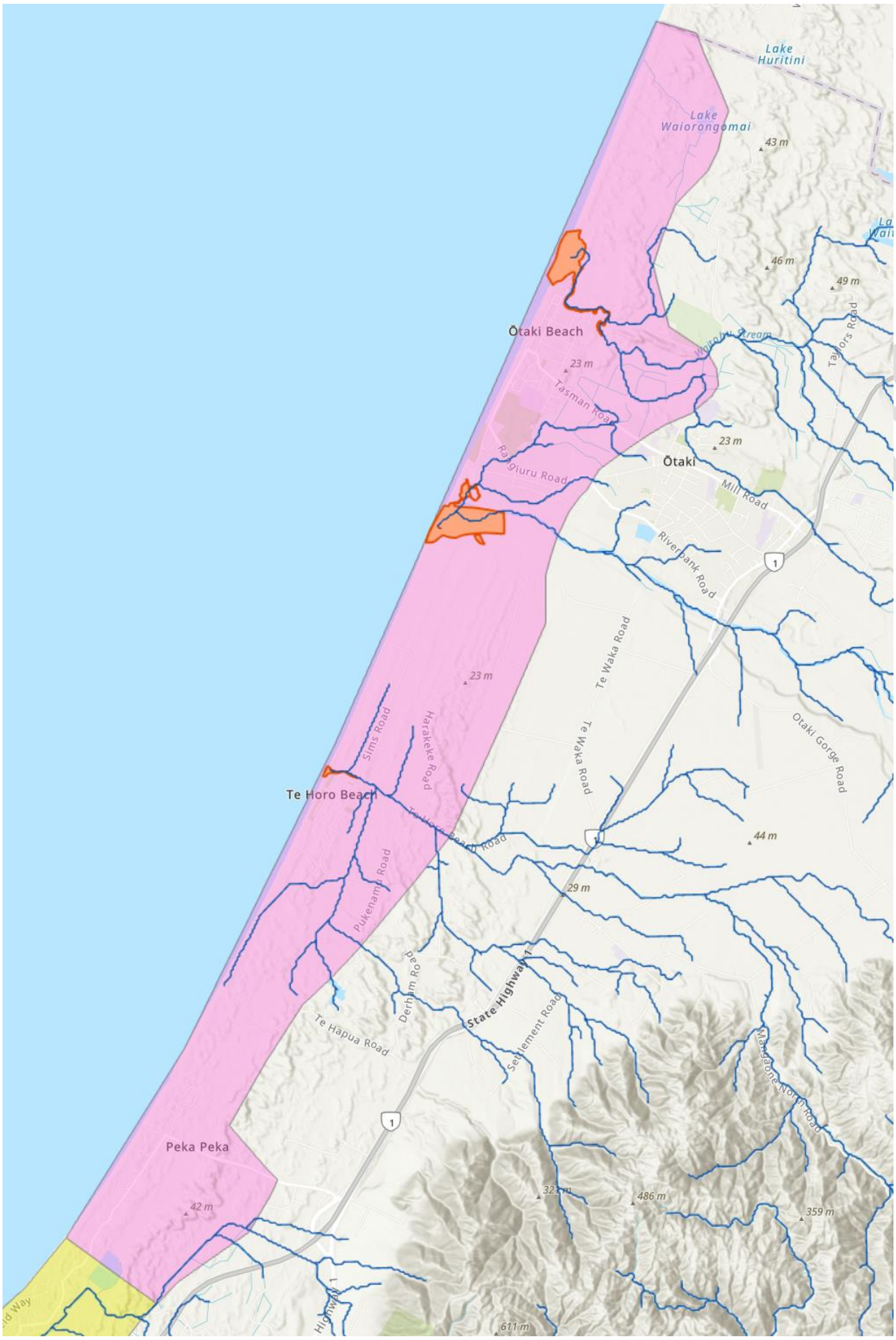

Figure A.3.8: Location of important fish habitats (orange) and waterways (blue).

Table A.3.8: Fish species identified in NAA.

Scientific Name	Common Name	National Threat Category	GWRC Threat Category	Mangaone Stream	Ōtaki River	Waithohu Stream	Waimeha Stream (Ngarara Stream)
Anguilla dieffenbachii	New Zealand longfin eel	At Risk-Declining	Regionally Declining	Yes	Yes	Yes	Yes
Cheimarrichthys fosteri	torrentfish	At Risk-Declining	Regionally Declining		Yes	Yes	
Galaxias argenteus	giant kōkopu	At Risk-Declining	Regionally Vulnerable		Yes	Yes	Yes
Galaxias brevipinnis	koaro	At Risk-Declining	Regionally Declining	Yes	Yes	Yes	
Galaxias divergens	dwarf galaxias	At Risk-Declining	Regionally Declining		Yes		
Galaxias maculatus	īnanga	At Risk-Declining	Regionally Declining	Yes	Yes	Yes	Yes
Neochanna apoda	brown mudfish	At Risk-Declining	Regionally Vulnerable			Yes	
Anguilla australis	shortfin eel	Not Threatened	Regionally Not Threatened	Yes	Yes	Yes	Yes
Galaxias fasciatus	Banded kōkopu	Not Threatened	Regionally Not Threatened	Yes	Yes	Yes	Yes
Gobiomorphus breviceps	upland bully	Not Threatened	Regionally Not Threatened	Yes		Yes	
Gobiomorphus cotidianus	common bully	Not Threatened	Regionally Not Threatened	Yes	Yes	Yes	Yes
Gobiomorphus huttoni	redfin bully	Not Threatened	Regionally Not Threatened	Yes	Yes	Yes	Yes
Retropinna retropinna	common smelt	Not Threatened	Regionally Declining			Yes	
Rhombosolea retiaria	black flounder	Not Threatened	Regionally Declining			Yes	
Gobiomorphus basalis	Cran's bully	Not Threatened	Regionally Not Threatened				Yes
Galaxias postvectis	shortjaw kōkopu	Threatened-Nationally Vulnerable	Regionally Endangered	Yes	Yes	Yes	
Geotria australis	lamprey	Threatened-Nationally Vulnerable	Regionally Vulnerable			Yes	
Gobiomorphus gobioides	giant bully	At Risk-Naturally Uncommon	Regionally Declining				Yes
	Total species			9	11	15	9
	Threatened or rare species			4	7	10	5

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 of stream mouths as measured in metres from current seaward beach edge: - Waitohu Stream 0m - Ōtaki River 140 m - Mangaone Stream 150 m - Waimeha Stream (addressed in CAA)	Future exposure: 2050: - Waitohu Stream 725 m - Ōtaki River 170 m - Mangaone Stream 150 m 2070: - Waitohu Stream 725 m - Ōtaki River 175 m - Mangaone Stream 165 m 2130: - Waitohu Stream 725 m - Ōtaki River 630 m - Mangaone Stream 165 m
Coastal flooding Present day flooding penetrates inland up the main-stems and tributaries – maximum inland reach measured in metres. - Waitohu Stream 3600 m - Ōtaki River 2700 m - Mangaone Stream 2330 - Waimeha Stream (no flood effects)	Future exposure: 2050: - Waitohu Stream 3650 m - Ōtaki River 2990 m - Mangaone Stream 2970 m 2070: - Waitohu Stream 3730 m - Ōtaki River 3040 m - Mangaone Stream 3330 m 2130: - Waitohu Stream 4070 m - Ōtaki River 3650 m - Mangaone Stream 3630 m.

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

Note:

Under GWRC NRP Rule R214: River, stream and lake mouth cutting – permitted activity

- Waitohu Stream mouth can be reshaped when erosion causes the channel outlet within the coastal marine area to migrate either north or south of the area defined by the projected lines 250m north (restricted to mean high-water springs) and 900m north of Konini Street (restricted to mean high-water springs) or the channel outlet migrates inside the backshore trigger lines (shown on a GWRC map), around the area of greatest vulnerability from erosion and to maintain the core of the dunes. The area can also be cut when the water flood level increases 500mm or more above normal river levels adjacent to Mahoe Street.
- Ōtaki River mouth can be cut when erosion causes the channel outlet in the coastal marine area to migrate either 300m south or 300m north of the centreline of the river measured 700m upstream and/or during flooding when the river mouth closes or the Rangiuru flood gates are unable to effectively operate due to high water levels.

- Mangaone Stream mouth can be cut when erosion causes the channel outlet within the coastal marine area migrates either 100m south or 300m north of the Te Horo Beach Road and/or when flooding causes the water level to increase 300mm or more above normal river levels at the Sims Road bridge.
- Hadfield/Te Kowhai Stream mouth can be cut when erosion causes the channel outlet within the coastal marine area to migrate either south or north to an extent where it undermines sand dunes and creates a vertical scarp in the sand dunes which exceeds 1.5m in height and/or when flooding causes the stream mouth to close and the stream is unable to flow over the sand bar in normal flow.
- Therefore, fish habitat within the waterway mouths already experiences occasional perturbations.

Erosion:

- Erosion was estimated by measuring inland from the seaward edge of the beach (from outer edge of inundation hazard which is presumed to be outer edge of beach as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) for both waterway mouths/estuaries.
- 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 low as there are small overall areas of erosion at two of the three affected waterways and none at Waitohu Stream.
- The increase to moderate in 2050 is because erosion increases significantly in all waterway mouths/estuaries.
- The increase to high in 2130 is due to the significant increase of erosion in the Ōtaki River.

Flooding:

- Flooding was estimated by measuring inland from the seaward edge of the beach (from outer edge of inundation hazard which is presumed to be outer edge of beach as shown on the topographic base map) to the inland edge of the various flood hazard modelling lines (present day, 2050, 2070, and 2130) along the mainstem and main tributaries to the maximum inland reach inundated.
- 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.
- Therefore flooding was set as moderate for the current scenario as flooding already penetrates a goodly distance inland and floods surrounding areas.
- Flood risk increases to high in 2070 as flood waters penetrate furhter inland and extreme in 2130 as much of the area between the Waitohu Stream and Ōtaki River will be inundated.

Sensitivity

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

Note:

- 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. Changes the the bed of the waterway, increased flow, sediment smothering the waterway bed and plants and increased sediment in the water column can reduce habitat suitability. 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	– 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.

Domain	Adaptive Capacity	Key Assumptions
Coastal Flooding	M	– 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. For 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	M	M	M	M	M	M
Flooding	M	M	M	M	M	M	M	M	M

Overall Risk Score

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

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 measured as metres from current seaward beach edge: - Waitohu Stream 0m - Ōtaki River 140 m - Mangaone Stream 150 m - Waimeha Stream (addressed in CAA)	Future exposure: 2050: - Waitohu Stream 725 m - Ōtaki River 170 m - Mangaone Stream 150 m 2070: - Waitohu Stream 725 m - Ōtaki River 177 m - Mangaone Stream 165 m 2130: - Waitohu Stream 725 m - Ōtaki River 630 m - Mangaone Stream 165 m
Coastal flooding Present day flooding penetrates inland up the main-stems and tributaries – maximum inland reach measured in metres. - Waitohu Stream 3600 m - Ōtaki River 2700 m - Mangaone Stream 2330 - Waimeha Stream (no flood effects)	Future exposure: 2050: - Waitohu Stream 3650 m - Ōtaki River 2990 m - Mangaone Stream 2970 m 2070: - Waitohu Stream 3915 m - Ōtaki River 4110 m - Mangaone Stream 3380 m 2130: - Waitohu Stream 4325 m - Ōtaki River 4150 m - Mangaone Stream 3830 m

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

Note:

Under GWRC NRP Rule R214: River, stream and lake mouth cutting – permitted activity

- Waitohu Stream mouth can be reshaped when erosion causes the channel outlet within the coastal marine area to migrate either north or south of the area defined by the projected lines 250m north (restricted to mean-high water springs) and 900m north of Konini Street (restricted to mean-high water springs) or the channel outlet migrates inside the backshore trigger lines (shown on a GWRC map), around the area of greatest vulnerability from erosion and to maintain the core of the dunes. The area can also be cut when the water flood level increases 500mm or more above normal river levels adjacent to Mahoe Street.
- Ōtaki River mouth can be cut when erosion causes the channel outlet in the coastal marine area to migrate either 300m south or 300m north of the centreline of the river measured 700m upstream and/or during flooding when the river mouth closes or the Rangiuru flood gates are unable to effectively operate due to high water levels.

- Mangaone Stream mouth can be cut when erosion causes the channel outlet within the coastal marine area migrates either 100m south or 300m north of the Te Horo Beach Road and/or when flooding causes the water level to increase 300mm or more above normal river levels at the Sims Road bridge.
- Hadfield/Te Kowhai Stream mouth can be cut when erosion causes the channel outlet within the coastal marine area to migrate either south or north to an extent where it undermines sand dunes and creates a vertical scarp in the sand dunes which exceeds 1.5m in height and/or when flooding causes the stream mouth to close and the stream is unable to flow over the sand bar in normal flow.
- Therefore, fish habitat within the waterway mouths already experiences occasional perturbations.

Erosion:

- Erosion was estimated by measuring inland from the seaward edge of the beach (from outer edge of inundation hazard which is presumed to be outer edge of beach as shown on the topographic base map) to the inland edge of the various hazard modelling lines (present day, 2050, 2070, and 2130) for both waterway mouths/estuaries.
- 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 low as there are small overall areas of erosion at two of the three affected waterways and none at Waitohu Stream.
- The increase to moderate in 2050 is because erosion increases significantly in all waterway mouths/estuaries.
- The increase to high in 2130 is due to the significant increase of erosion in the Ōtaki River.

Flooding:

- Flooding was estimated by measuring inland from the seaward edge of the beach (from outer edge of inundation hazard which is presumed to be outer edge of beach as shown on the topographic base map) to the inland edge of the various flood hazard modelling lines (present day, 2050, 2070, and 2130) along the mainstem and main tributaries to the maximum inland reach inundated.
- 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.
- Therefore flooding was set as moderate for the current scenario as flooding already penetrates a goodly distance inland and floods surrounding areas.
- Flood risk increases to extreme in 2070 as much of the area between the Waitohu Stream and Ōtaki River will be inundated.

Sensitivity

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

Note:

- 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. Changes the the bed of the waterway, increased flow, sediment smothering the waterway bed and plants and increased sediment in the water column can reduce habitat suitability. 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	– 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.

Domain	Adaptive Capacity	Key Assumptions
Coastal Flooding	M	– 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. For 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	M	M	M	M	M	M
Flooding	M	M	M	M	M	M	M	M	M

Overall Risk Score

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

A.3.8 Coastal indigenous biodiversity

Domain	Element at Risk	Overview
Natural	Coastal indigenous biodiversity	GWRC Natural Resources Plan Schedule F4: Sites with significant indigenous biodiversity values in the coastal marine area includes the following in the NAA. Waitohu Estuary provides seasonal or core habitat for eight threatened indigenous migratory fish species: longfin eel, giant kōkopu, shortjaw kōkopu, Īnanga, kōaro, redfin bully, torrentfish and lamprey. The Estuary is one of only a few providing estuarine wetland habitats in the district. Ōtaki River Mouth Estuary provides seasonal or core habitat for seven threatened indigenous fish species: longfin eel, giant kōkopu, shortjaw kōkopu, kōaro, Īnanga, redfin bully and torrentfish. Mangaone Estuary provides seasonal or core habitat for five threatened indigenous fish species: longfin eel, shortjaw kōkopu, kōaro, Īnanga and redfin bully. All three estuaries are known to be Īnanga spawning site, and Ōtaki Estuary is especially important. Additionally, these areas are important for a range of birds and other species – refer to bird habitat (Appendix A.3.6) and rare and threatened species (Appendix A.3.5) for more information. Schedule J: Significant geological features in the coastal marine area also lists the Ōtaki River as a Nationally Significant Site due to the hapua, barrier spit and lagoon system.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	- Erosion can affect beaches causing them to lower and providing less foraging and roosting space at high tide for shore birds. - Coastal erosion could alter the habitat, including any saline wetlands, within the waterway mouths and make it less appropriate habitat for indigenous fish, bird and plant species and too deep to be suitable for shorebirds and wading birds. - Erosion would widen the mouth of the waterways thus these would become more exposed to waves and tides and currents. This will make it less suitable for fish, shorebirds and wading birds. - Erosion will affect some of the dunes which could affect bird roosting or nesting habitat and loss of indigenous plant species. - Erosion is likely to affect the waterway estuaries (especially the Waitohu Stream) and result in a loss of intertidal feeding areas for shorebirds. - Erosion could alter the near-shore environment resulting in reduction of 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. - Increasing sea level rise, coupled with erosion is likely to cause increased coastal squeeze for these coastal habitats as erosion inland reduces the amount of space available for bird habitats to 'migrate' due to human infrastructure and dense residential areas on the landward sides.
Coastal Flooding	- More frequent and extensive flooding of indigenous bird and fish habitats will cause changes in the food availability due to increased diving depth, plants and habitats dying due to flooding, changes in waterflow patterns, and increased water velocity and sedimentation smothering benthic food sources (buried invertebrates in the sand). These changes will likely affect the prey species available in rivers, lagoons and coastal marine areas, reducing food availability for birds and fish. - Salt water would penetrate further upstream and could potentially kill freshwater species (especially plants). These could be areas where īnanga spawn. - The depth of the water in the estuaries and waterways would be progressively deeper from present day to the 2130 modelling.

Hazard	Description of Consequence (note any cascading impacts)
	- Higher and more extensive flooding could drown Indigenous plants, lizards, invertebrates and nests and burrows of species that nest adjacent or on waterways. This will have cascading effects on the size and genetic diversity of the affected populations. - Flooding can scour waterway beds resulting in altered river flows and loss or flooding of any islands. This would reduce areas of safer (less disturbance by humans and their pets) nesting and foraging areas. Such losses will reduce breeding and feeding success and will likely result in a decline in the populations of the affected species. - Inundation due to sea level rise will reduce tidal foraging area available to bird species especially because this habitat cannot 'migrate' inland due to surrounding topography and human infrastructure (such as sea walls, stormwater infrastructure, roading and bridges). - Flooding may result in additional areas of wetland in more inland habitat allowing some species to extend their range, but only if these newly wetted areas are retained and protected as wildlife habitat.

Opportunities

Hazard	Opportunities
Coastal Erosion	The ongoing management of the Ōtaki River Estuary seeks to restore the ecosystems and includes an intensive pest program. This effort should be continued. The Friends of the Ōtaki River Group also undertakes planting to enhance the stability of the salt marshes and the bordering ecosystems to prevent further erosion inland. Where possible, plant the banks of the waterways 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	The ongoing management of the Ōtaki River Estuary seeks to restore the ecosystems and includes an intensive pest program. This effort should be continued. The Friends of the Ōtaki River Group also undertakes planting to enhance the stability of the salt marshes and the bordering ecosystems to prevent further erosion inland. Where possible, plant the banks of the waterways 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. 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 waterways with suitable indigenous species to create 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. Consider establishing additional areas of wetland (including deeper trenches) in future flood-prone areas to maintain or even increase habitat for indigenous fish. Look into options to manage vehicle damage in the estuary to better protect habitat. Current access is technically restricted, however difficult to enforce, and vehicles are often used irresponsibly in the areas. Minimising the effects of the flood gates on the Ōtaki Estuary and artificial opening of any of the stream or rivers mouth to minimize any potential adverse effects on the uses and values of the various estuaries.

A.3.8.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion : - Erosion can affect the beach, estuary and more inland wetted areas of estuaries - Waitohu Estuary – low risk - Ōtaki Estuary – low risk - Mangaone Estuary – low risk	Future exposure: 2050: - Waitohu Estuary is widened and scoured out exposing it more to the elements, reducing available habitat – extreme risk - Ōtaki Estuary some effects on the northern bar – low risk - Mangaone Estuary is widened and scoured out exposing it more to the elements – extreme risk 2070: - Waitohu Estuary is widened and scoured out exposing it more to the elements, reducing available habitat – extreme risk - Ōtaki Estuary greater effects on the northern bar – low risk - Mangaone Estuary is widened and scoured out exposing it more to the elements – extreme risk 2130: - Waitohu Estuary is widened and scoured out exposing it more to the elements, reducing available habitat – extreme risk - Ōtaki Estuary the lagoons on the northern side and the dunes on the southern side would be eroded – extreme risk - Mangaone Estuary is widened and scoured out exposing it more to the elements – extreme risk
Currently exposed to coastal flooding: - Flooding is an expected occurrence in estuaries, but the length of time and the depth of water retained will affect biodiversity values. - Additional areas of wetland could increase the amount of habitat available. - Waitohu Estuary: Currently totally inundated, and area inland of the estuary also floods– moderate risk - Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk - Mangaone Estuary: Entire estuary and part of upstream area flooded – moderate risk	Future exposure: 2050: - Waitohu Estuary: Totally inundated, and area inland of the estuary also floods – moderate risk - Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk - Mangaone Estuary: Entire estuary and part of upstream area flooded – moderate risk 2070: - Waitohu Estuary: Totally inundated, and area inland of the estuary also floods – moderate risk - Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk - Mangaone Estuary: Entire estuary and part of upstream area flooded – moderate risk 2130: Waitohu Estuary: Significantly greater and deeper flooding – extreme risk Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk Mangaone Estuary: Significantly greater and deeper flooding – extreme risk

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

Notes:

- Mapping how much of the feature was affected by erosion or flooding was not informative as pretty much all of the feature was affected in all of the scenarios.
- Average risk across the three sites.

Erosion:

- Landward shift - how far inland the erosion scenario is compared to the innermost part of the mapped estuary.
- Narrowest width of estuarine mouth - measured from the 'shoulders' of the innermost erosion area for each of the scenarios.
- In combination these two elements illustrate that the estuary bays become more shallow (less bay-shaped) over progressive scenarios.
- Present-day risk set to low.
- Significant (extreme) erosion of the estuaries will occur for both Waitohu and Mangaone estuaries from 2050, but erosion continues to be low in Ōtaki Estuary – hence overall risk igh from 2050.
- This shifts to extreme in 2130 because the the lagoons on the northen side of Ōtaki Estuary and the dunes on the southern side of Ōtaki would be eroded.

Flooding:

- Compare the area flooded in the present day with future flood scenarios and identify the increased area flooded.
- However, these systems are habituated to some degree of flooding (tidal after all).
- Present-day risk set to moderate as flooding is already occuring. This shifts to extreme in 2130 due to the greater depth of flooding and the additional areas flooded.
- However, these additional areas may also convey some benefits in providing additional (temporary) habitat for fauna.

Sensitivity

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

Notes:

- Waitohu and Ōtaki Estuaries are very important areas of coastal indigenous biodiversity The range and rarity of the species and habitats that occur here make it an especially sensitive area.
- 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. Additionally, habitat along the entire Kāpiti Coast will be affected by similar climatic changes, reducing althernative habitat for species.

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 currents and tidal movement. Species will stop using an area if it has frequent perturbations or becomes unsuitable habitat.

Domain	Adaptive Capacity	Key Assumptions
Coastal Flooding	L	Flooding can be a more temporary perturbation; however, an estuary provides relatively shallow habitat and flooding would increase the depth of the water. Once that happens it will be less suitable fauna habitat. Additional flooded areas may offset some of these effects.

Vulnerability Score

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

Overall Risk Score

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

A.3.8.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion : - Erosion can affect the beach, estuary and more inland wetted areas of estuaries - Waitohu Estuary – low risk - Ōtaki Estuary – low risk - Mangaone Estuary – low risk	Future exposure: 2050: - Waitohu Estuary is widened and scoured out exposing it more to the elements, reducing available habitat – extreme risk - Ōtaki Estuary some effects on the northern bar – low risk - Mangaone Estuary is widened and scoured out exposing it more to the elements – extreme risk 2070: - Waitohu Estuary is widened and scoured out exposing it more to the elements, reducing available habitat – extreme risk - Ōtaki Estuary greater effects on the northern bar – low risk - Mangaone Estuary is widened and scoured out exposing it more to the elements – extreme risk 2130: - Waitohu Estuary is widened and scoured out exposing it more to the elements, reducing available habitat – extreme risk - Ōtaki Estuary the lagoons on the northern side and the dunes on the southern side would be eroded – extreme risk - Mangaone Estuary is widened and scoured out exposing it more to the elements – extreme risk
Currently exposed to coastal flooding: - Flooding is an expected occurrence in estuaries, but the length of time and the depth of water retained will affect biodiversity values. - Additional areas of wetland could increase the amount of habitat available. - Waitohu Estuary: Currently totally inundated, and area inland of the estuary also floods – moderate risk. - Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk - Mangaone Estuary: Entire estuary and part of upstream area flooded – moderate risk	Future exposure: 2050: - Waitohu Estuary: Totally inundated, and area inland of the estuary also floods – moderate risk - Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk - Mangaone Estuary: Entire estuary and part of upstream area flooded – moderate risk. 2070: - Waitohu Estuary: Totally inundated, and area inland of the estuary also floods – moderate risk - Ōtaki Estuary: Entire estuary and part of upstream area flooded – moderate risk - Mangaone Estuary: Entire estuary and part of upstream area flooded – moderate risk 2130: - Waitohu Estuary: Significantly greater and deeper flooding – extreme risk - Ōtaki Estuary: Entire estuary and part of upstream area flooded, wider area affected – high risk - Mangaone Estuary: Significantly greater and deeper flooding – extreme risk

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

Notes:

- Mapping how much of the feature was affected by erosion or flooding was not informative as pretty much all of the feature was affected in all of the scenarios.
- Average risk across the three sites.

Erosion:

- Landward shift - how far inland the erosion scenario is compared to the innermost part of the mapped estuary.
- Narrowest width of estuarine mouth - measured from the ‘shoulders’ of the innermost erosion area for each of the scenarios.
- In combination these two elements illustrate that the estuary bays become more shallow (less bay-shaped) over progressive scenarios.
- Present-day risk set to low.
- Significant (extreme) erosion of the estuaries will occur for both Waitohu and Mangaone estuaries from 2050, but erosion continues to be low in Ōtaki Estuary – hence overall risk high from 2050.
- This shifts to extreme in 2130 because the the lagoons on the northen side of Ōtaki Estuary and the dunes on the southern side of Ōtaki would be eroded.

Flooding:

- Compare the area flooded in the present day with future flood scenarios and identify the increased area flooded.
- However, these systems are habituated to some degree of flooding (tidal after all).
- Present-day risk set to moderate as flooding is already occuring. This shifts to extreme in 2130 due to the greater depth of flooding and the additional areas flooded.
- However, these additional areas may also convey some benefits in providing additional (temporary) habitat for fauna.

Sensitivity

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

Notes:

- Waitohu and Ōtaki Estuaries are very important areas of coastal indigenous biodiversity The range and rarity of the species and habitats that occur here make it an especially sensitive area.
- 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. Additionally, habitat along the entire Kāpiti Coast will be affected by similar climatic changes, reducing althernative habitat for species.

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 currents and tidal movement. Species will stop using an area if it has frequent perturbations or becomes unsuitable habitat.

Domain	Adaptive Capacity	Key Assumptions
Coastal Flooding	L	Flooding can be a more temporary perturbation; however, an estuary provides relatively shallow habitat and flooding would increase the depth of the water. Once that happens it will be less suitable fauna habitat. Additional flooded areas may offset some of these effects.

Vulnerability Score

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

Overall Risk Score

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

A.4 Natural Character Risk Assessment Templates

A.4.1 CTA1: Ōtaki (Coastal Terrestrial Area)

Domain	Element at Risk	Overview
Natural Character	CTA1: Ōtaki: Coastal Terrestrial Area	Coastal Terrestrial Area 1: Ōtaki is predominantly characterised by an open beach and extensive dune system and is the least populated area along the Kāpiti Coast. In this area, the coastal environment fringes areas of farmland, lifestyle blocks and the small coastal townships of Ōtaki Beach and Te Horo Beach with increasing levels of apparent modification. Much of this coastal environment is comprised of Holocene sand dunes which are part of the broader Waitere Dune phase extending approximately 4 km inland. The Ōtaki Beach and Te Horo Beach Natural Dunelands extend along this area of coastline and remain some of the most intact areas along the mainland within the Kāpiti Coast District, impacted from sediment from the Ōtaki River. Notwithstanding this, the Ōtaki River and mouths of the Mangaone and Waitohu Streams express ongoing levels of modification associated with flood management. Most vegetation is exotic, particularly pastoral grasses in farmland with marram grass and other colonising weed species in dunelands, most typically within areas beyond more active beach berms. Pine forestry and shelterbelts occur in some areas, as do areas of native duneland vegetation, particularly pingao and spinifex. Bank slumping is apparent along the Ōtaki River and Waitohu Streams with reduced riparian cover. Whilst water quality and macroinvertebrate health are high in the Ōtaki River, water quality of Mangaone and Waitohu Streams is poor because of upstream agricultural and forestry land uses. Waterways all provide habitat for a diversity of native freshwater and marine fish species whose assemblages are relatively unmodified. The river mouths, while modified, still function to provide foraging and nesting habitat for coastal avifauna including the biggest pied stilt colony in the Wellington region and important banded dotterel breeding sites. Overall, this broader area of coastal terrestrial environment has been assessed as having a **moderate** level of natural character.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion will primarily impact areas of beach berm and foredunes alongside the inherently more dynamic mouths of rivers and streams. Formed during the Waitarere Dune phase, these natural dunelands primarily contain colonizing exotic grasses and scrub with more isolated populations of native vegetation, including spinifex and pingao along relatively more dynamic parts of the coastal edges with high natural character. Broader areas of natural duneland and gentle sandy beaches form existing natural buffers between coastal hazards and settlement. Built coastal protection and associated human induced changes in response to coastal erosion has potential to adversely impact natural elements, patterns and processes and therefore reduce natural character. Such built influences are presently limited within the NAA and adjoining Coastal Marine Area (CMA).

Hazard	Description of Consequence (note any cascading impacts)
Coastal Flooding	Coastal flooding will have impacts associated with some streams, rivers, and estuaries, and their margins within the Northern Adaption Area. This primarily encompasses areas adjoining Waitohu Stream, Ōtaki River and Mangaone Stream and extends into more modified areas supporting existing rural land use and some coastal settlement. Existing elements support a range of ecological values including uncommon ecosystem types (e.g. coastal turfs, shingle beaches), native coastal plants (e.g. knobby clubrush, sand sedge, patches of pingao, remuremu, bachelor's button) and native avifauna and fish species. The responses to flood hazard and potential construction of flood defences with increased presence of built form also has potential to reduce natural character.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reinforce and restore native vegetation along riparian margins and within natural dunelands. Identify and maintain natural patterns and processes within areas impacted by natural hazards, including dynamic dune areas. Ensure built development and modification is sympathetic to and supports underlying natural characteristics and qualities. Develop and utilise nature-based solutions which preserve and restore natural character.
Coastal Flooding	Reinforce indigenous margins and associated habitat opportunities at the mouths of streams, including to reduce or remedy slumping. Limit and remove built influences which may otherwise impact the natural character along active streams, riverbeds and their margins. Identify opportunities to enhance and restore ecological connectivity between the coastal environment and its context / catchment. Develop and utilise nature-based solutions which restore natural character where possible.

A.4.1.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune at Ōtaki Dunes, Ōtaki Beach, Te Horo Dunes and Te Horo Beach - The mouths of Waitohu and Mangaone Streams and the Ōtaki River.	Future exposure: 2050: - Erosion is expected to impact the existing beach berm and foredunes in the following areas: o North Ōtaki Beach Natural Duneland (up to 9 m); o South Ōtaki Beach Natural Duneland (up to 22 m); o North Te Horo Beach Natural Duneland (up to 16 m); and o South Te Horo Beach Natural Duneland (up to 10 m). - More substantial areas of erosion occur at the inherently more dynamic mouths of rivers and streams, as follows: o Waitohu Stream – 150 m o Ōtaki River – 40 m o Mangaone Stream -132 m 2070: - There is a very slight increase in erosion of natural dune lands including parts of south Ōtaki Natural Dunelands and Te Horo Natural Dunelands (>5 m), - Minimal increased erosion at stream mouths with exception of either side of the mouth of the Ōtaki River (up to 55 m). 2130: - Coastal erosion continues to impact areas of natural duneland at Ōtaki Beach (47 m) and Te Horo Beach Beach north of Mangaone Stream (35 m) - More significant erosion is expected north of the Ōtaki River mouth in the context of the existing estuary (up to 366 m)
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the margins of the Waitohu and Mangaone Streams and Ōtaki River as well as parts of low-lying developed swales beyond foredunes at Te Horo Beach. - Some additional areas of flooding continue inland of the identified coastal environment, particular north of the Ōtaki River and along tributaries and more modified field drains associated with Waitohu, Manganoe and Te Kowhai Streams.	Future exposure: 2050: - Coastal flooding primarily occurs in association with the lower lying and inherently more dynamic mouths of streams and continues inland of the identified coastal environment beyond the margins of the Ōtaki River, as well as more modified parts of Waitohu, Mangaone and Te Kowhai Streams. 2070: - Some additional flooding occurs within dune swales adjoining the Mangaone Stream and beyond established dunes adjoining Waituhu Stream. - Additional more substantial flooding occurs inland of the current coastal environment, particularly beyond

Details of exposure	
	the margins of the Ōtaki River and additional field drains and minor tributaries associated with Waitohu and Mangaone Streams. 2130: - Additional flooding extends within low lying dune swales to the north of Ōtaki Beach and within the Te Horo Beach natural dunelands. - Substantial additional flooding occurs inland of the coastal environment, particularly areas of back dunes and beyond the margins of more highly modified field drains and tributaries near the mouth of the Ōtaki River and along Waitohu, Mangaone and Te Kowhai Streams.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management.

As areas of the coastal environment and inland areas are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change will be an important aspect to consider when assessing longer term sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of changes in land management practices.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	• Most erosion occurs in more dynamic coastal environments which may support the reestablishment of riparian planting and suitable native dune vegetation. • Coastal settlement inland of natural dunelands typically remains sparse and may support opportunities for foredunes to migrate inland. Such opportunities may be more limited when adjoining coastal settlement at Ōtaki Beach and Te Horo.

Risk	Adaptive Capacity	Key Assumptions
Coastal Flooding	M	• Within the coastal environment, most coastal flooding occurs in the context of dynamic beach berms and at the mouths of rivers and streams within which periodic inundation is a natural process to which existing natural elements and patterns respond. • Flooding extends across more modified areas of farmland Inland of the coastal environment.

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

Vulnerability Score

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

Overall Risk Score

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

A.4.1.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion - Areas of beach berm and foredune at Ōtaki Dunes, Ōtaki Beach, Te Horo Dunes and Te Horo Beach - The mouths of Waitohu and Mangaone Streams and the Ōtaki River.	Future exposure: 2050: - Erosion is expected to impact the existing beach berm and foredunes in the following areas: o North Ōtaki Beach Natural Duneland o (up to 9 m); o South Ōtaki Beach Natural Duneland (up to 22 m); o North Te Horo Beach Natural Duneland (up to 16 m); and o South Te Horo Beach Natural Duneland (up to 10 m). - More substantial areas of erosion occur at the inherently more dynamic mouths of rivers and streams, as follows: o Waitohu Stream – 150 m o Ōtaki River – 40 m o Mangaone Stream -132 m 2070: - Erosion continues to impact coastal dunes at Ōtaki Beach (up to 33 m) and Te Horo Beach (up to 25 m) and along the Peka Peka Dunes (up to 30 m). - Minimal increased erosion at stream mouths with exception of either side of the mouth of the Ōtaki River (up to 55 m). 2130: - Coastal erosion is expected to continue to impact and largely remove existing dunes adjoining the settlement at Ōtaki Beach (up to 80 m) and reduce the extent of existing dunes to the north of Mangaone Stream (up to 69 m) resulting in these areas of coastline culminating along a modified built edge. - A more substantial area of erosion occurs north of Ōtaki River mouth and impacts the existing estuary (up to 366 m)
Currently exposed to coastal flooding - Parts of the coastal environment adjoining the margins of the Waitohu and Mangahone Streams and Ōtaki River as well as parts of low-lying developed swales beyond foredunes at Te Horo Beach. - Some additional areas of flooding continue inland of the identified coastal environment, particular north of the Ōtaki River and along tributaries and more modified field drains associated with Waitohu, Manganoe and Te Kowhai Streams.	Future exposure: 2050: - Coastal flooding primarily occurs in association with the lower lying and inherently more dynamic mouths of streams and continues inland of the identified coastal environment beyond the margins of the Ōtaki River as well as more modified parts of Waitohu, Mangaone Streams and Te Kowhai Streams. 2070: - Some additional flooding occurs within dune swales adjoining the Mangaone Stream and beyond established dunes adjoining Waituhu Stream.

Details of exposure	
	- Additional more substantial flooding occurs inland of the current coastal environment, particularly beyond the margins of the Ōtaki River and additional field drains and minor tributaries associated with Waitohu and Mangahone Streams. 2130: - Additional flooding occurs within low lying dune swales to the north of Ōtaki Beach and within the Te Horo Beach natural dunelands. - Substantial additional flooding occurs inland of the identified coastal environment, particularly areas of back dunes beyond the more highly modified margins of field drains and minor tributaries associated with the Ōtaki River and Waitohu, Mangahone and Te Kowhai Streams.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management.

As areas of the coastal environment and inland areas are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are also expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change will be an important aspect to consider when assessing longer term sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of changes in land management practices.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	• Most erosion occurs in more dynamic coastal environments which may support the reestablishment of riparian planting and suitable native dune vegetation. • Coastal settlement inland of natural dunelands remains relatively sparse and may support opportunities for foredunes to migrate inland in combination with appropriate modification and built development. • Areas of natural duneland adjoining coastal settlements at Ōtaki Beach and Te Horo are subjected to erosion and which may restrict opportunities for adaptation.

Risk	Adaptive Capacity	Key Assumptions
Coastal Flooding	M	• Within the coastal environment, most coastal flooding occurs in the context of dynamic beach berms which remain exposed at the mouths of rivers and streams. In such contexts periodic inundation is a natural process to which existing natural elements and patterns respond. • Substantial flooding extends inland of the coastal environment and beyond the margins of wetlands and streams across more modified areas of farmland and settlement within the coastal context.

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

Vulnerability Score

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

Overall Risk Score

Hazard	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.4.2 CMA A. Innershelf and nearshore marine (Coastal Marine Area)

Note: This is included for information only as this area falls outside the Northern Adaption Area. 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 the NAA 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 m, between approximately 3 and 5.5km offshore. The regional tidal range is up to approximately 2 m. A small patch of muddy sand calc-gravels occurs offshore of the Ōtaki River mouth. 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. This area of coastal environment reflects a **moderate** level of natural character overall.

A.4.3 Ōtaki Dunes (High Natural Character)

Domain	Element at Risk	Overview
Natural Character	Ōtaki Dunes: High Natural Character (HNC)	Part of the northern Ōtaki Beach Natural Dunelands and mouth of Waitohu Stream: - Intact dunes formed during the Waitarere Dune phase. - Abiotically, the Waitohu Stream and wetland remain in reasonably good condition around the estuary. - Native spinifex is the dominant vegetation in the beach berm. Elsewhere there is a mosaic of native and exotic vegetation. - Expansive views of Kāpiti Island and the Rauoterangi Channel. - Opportunities to experience the sounds and smells of the open ocean with limited structures

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion will primarily impact the more dynamic areas of beach berm and foredunes as well as the mouth of Waitohu Stream within which areas of high natural character have been identified. Formed during the Waitarere Dune phase, these broader natural dunelands primarily contain colonizing exotic grasses and scrub with more isolated populations of native vegetation, including spinifex and pingao along relatively more dynamic coastal edges with corresponding increased levels of natural character. The broader areas of natural duneland and gentle sandy beaches within which such components form a part create existing natural buffers between coastal hazards and settlement. Built coastal protection and associated human induced changes in response to coastal erosion has potential to adversely impact natural elements, patterns and processes and therefore reduce natural character. Such built influences are presently limited within the NAA and adjoining CMA.
Coastal Flooding	Coastal flooding will have impacts associated with Waitohu Stream and extends into more modified areas supporting existing rural land use and some coastal settlement. Existing elements support a range of ecological values including uncommon ecosystem types (e.g. coastal turfs, shingle beaches), native coastal plants (e.g. knobby clubrush, sand sedge, patches of pingao, remuremu, bachelor's button) and native avifauna and fish species. The responses to flood hazard and potential construction of flood defences with increased presence of built form also has potential to reduce natural character.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reinforce and restore native vegetation along riparian margins and within natural dunelands along which components of high natural character form an integral part. Maintain natural patterns and processes within areas impacted by natural hazards, including dynamic dune areas. Ensure built development and modification is sympathetic to and supports underlying natural characteristics and qualities.
Coastal Flooding	Reinforce indigenous margins and associated habitat opportunities at the mouth of Waitohu Stream, including to reduce or remedy slumping.

Hazard	Opportunities
	Limit and remove built influences which may otherwise impact the natural character along active streams, riverbeds and their margins and ensure any necessary built development and modification is sympathetic to and supports underlying natural characteristics and qualities. Identify opportunities to enhance and restore ecological connectivity between the coastal environment and its context / catchment.

A.4.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune with native vegetation along the broader Ōtaki Beach natural dunelands dunes. - Parts of the mouth of Waitohu Stream which support a mosaic of native and exotic vegetation. - The exposed coastline supports expansive views of Kāpiti Island and the Rauoterangi Channel and opportunities to experience the sounds and smells of the open ocean with limited structures.	Future exposure: 2050: - Erosion is not expected to impact the existing beach berm and foredunes with high natural beyond the existing situation. - Areas of erosion will occur at the inherently more dynamic mouth of Waitohu Stream and encompassing much of the identified extent of high natural character. 2070: - Erosion is not expected to impact the existing beach berm a beyond the existing situation. - There is no additional change in erosion within the context of the mouth of Waitohu Stream. 2130: - With the exception of a slight increase in erosion in areas of dunes to the south of Waitohu Stream, there is no expected change in erosion.
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the margins of the Waitohu Stream. - Some additional areas of flooding continue inland of the identified high natural character and coastal environment. - Exposed areas of coastline support expansive views of Kāpiti Island and the Rauoterangi Channel and opportunities to experience the sounds and smells of the open ocean.	Future exposure: 2050: - Coastal flooding primarily occurs in association with the lower lying and inherently more dynamic mouth of Waitohu Stream. - Some additional flooding occurs in association within swales adjoining the mouth of Waituhu Stream. 2070: - A small increase in flooding occurs in association within dune swales adjoining Waituhu Stream. - More substantial flooding occurs inland of the coastal environment and existing active dunes, most typically across modified farmland. 2130: - Additional flooding occurs at the mouth of Waituhu Stream and adjoining swales, - More substantial flooding extends inland of the coastal environment including some adjoining areas of coastal development.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs.

To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas within and adjoining areas of high natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses and modification occurs in this context expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of broader changes in land management practices encompassing the characteristics and qualities of the broader coastal environment.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	• The beach berm and foredune form a dynamic edge adjoining a wider established dune sequence with limited adjoining coastal settlement. • The ability for dunes to migrate at the mouth of Waitohu may be constrained by adjoining settlement within Ōtaki Beach.
Coastal Flooding	M	• Most coastal flooding occurs in the context of dynamic aspects of foredunes. • Additional flooding occurs inland beyond the stream mouth of the Waitohu Stream and into more modified areas.

Notes:

- The natural adaptive capacity of areas with high natural character can be impacted by the availability of space within which natural elements, patterns and processes can adapt and continue to operate.
- Increased exposure of built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

Vulnerability Score

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

Overall Risk Score

Hazard	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Erosion	M	M	M	M	M	M	M	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.4.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune with native vegetation along the broader Ōtaki Beach natural dunelands dunes. - Parts of the mouth of Waitohu Stream which support a mosaic of native and exotic vegetation. - The exposed coastline supports expansive views of Kāpiti Island and the Rauoterangi Channel and opportunities to experience the sounds and smells of the open ocean with limited structures.	Future exposure: 2050: - Erosion is not expected to impact the existing beach berm and foredunes with high natural beyond the existing situation. - Areas of erosion will occur at the inherently more dynamic mouth of Waitohu Stream and encompassing much of the identified extent of high natural character. 2070: - Erosion is anticipated to extend approximately 16 m inland and remains similar to the situation. - There is no additional change in erosion within the context of the mouth of Waitohu Stream. 2130: - Erosion is expected to continue to erode areas of natural duneland up to 42 m and substantially impacts areas which accommodate native duneland vegetation and contribute to high natural character. - With the exception of a slight increase in erosion in areas of dunes to the south of Waitohu Stream, there is no expected change in erosion.
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the margins of the Waitohu Stream. - Some additional areas of flooding continue inland of the identified high natural character and coastal environment. - Exposed areas of coastline support expansive views of Kāpiti Island and the Rauoterangi Channel and opportunities to experience the sounds and smells of the open ocean.	Future exposure: 2050: - Coastal flooding primarily occurs in association with the lower lying and inherently more dynamic mouth of Waitohu Stream. - Some additional flooding occurs within swales adjoining the mouth of Waituhu Stream. 2070: - A small increase in flooding occurs in association within dune swales adjoining Waituhu Stream. - More substantial flooding occurs inland of the coastal environment and existing active dunes, most typically impacting modified farmland. 2130: - Additional flooding occurs at the mouth of Waituhu Stream and adjoining swales. - More substantial flooding extends inland of the coastal environment, including areas of adjoining coastal development.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs.

To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas within and adjoining areas of high natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses and modification occurs in this context expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of broader changes in land management practices encompassing the characteristics and qualities of the broader coastal environment.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	• The beach berm and foredune form a dynamic edge adjoining a wider established dune sequence with limited adjoining coastal settlement. • The ability for dunes to migrate at the mouth of Waitohu may be constrained by adjoining settlement within Ōtaki Beach.
Coastal Flooding	M	• Most coastal flooding occurs in the context of dynamic aspects of foredunes. • Additional flooding occurs inland beyond the stream mouth of the Waitohu Stream and into more modified areas.

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased exposure of built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

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	H	H	M	M	M	M	M

Overall Risk Score

Hazard	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.4.4 Te Horo Dunes (High Natural Character)

Domain	Element at Risk	Overview
Natural Character	Te Horo Dunes: High Natural Character (HNC)	Part of the southern Te Horo Beach Natural Dunelands: - Intact dunes formed during the Waitarere Dune phase. - Native duneland species still present, however exotic species are dominant. - Expansive views of Kāpiti Island and the Rauoterangi Channel. - Opportunities to experience exposure from the open ocean.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion will primarily impact areas of beach berm and foredunes similar to the existing situation. Formed during the Waitarere Dune phase, these natural dunelands, include areas of spinifex and pingao along relatively more dynamic coastal edges within the context of broader natural duneland most typically colonized with exotic grasses and scrub. Broader areas of natural duneland and gentle sandy beaches form existing natural buffers between coastal hazards and settlement. Built coastal protection and associated human induced changes in response to coastal erosion has potential to adversely impact natural elements, patterns and processes and therefore reduce natural character.
Coastal Flooding	Coastal flooding is expected to have minimal impacts in the context of more dynamic beach berms and foredunes identified with high natural character. The responses to flood hazard and potential construction of flood defences with increased presence of built form has potential to reduce natural character along this isolated and exposed coastal edge.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reinforce and restore native vegetation along dynamic foredunes and broader natural duneland areas. Ensure built development remains extremely limited and modification is sympathetic to and supports underlying natural characteristics and qualities.
Coastal Flooding	Reinforce and restore native vegetation along dynamic foredunes and broader natural duneland areas. Develop and utilise nature-based solutions which restore natural character where possible. Ensure appropriate built development and modification along the broader natural duneland is sympathetic to and supports underlying natural characteristics and qualities.

A.4.4.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune consistent with dynamic parts of the broader Te Horo Natural Duneland. - This coastline supports expansive open views of Kāpiti Island and the Rauoterangi Channel and opportunities to experience exposure from the open ocean.	Future exposure: 2050: - The extent of erosion is expected to remain similar to today. 2070: - The extent of erosion is expected to remain similar to today. 2130: - The extent of erosion is expected to remain similar to today.
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the beach berms and foredunes remain subject to inundation along this dynamic coastal edge.	Future exposure: 2050: - The extent of inundation is expected to remain similar to today with some slight increase in inundation within back dunes. 2070: - The extent of inundation impacting areas of duneland with high natural character is expected to remain similar to today with a slight increase of inundation inland. 2130: - The extent of inundation is expected to remain similar to today with a further increase in flooding within inland more modified back dune areas.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas of higher natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of broader changes in land management practices which encompass the characteristics and qualities of the broader coastal environment.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	• The beach berm and foredune form a dynamic edge adjoining a wider established dune sequence. • Dunes may have greater potential to migrate inland given limited adjoining coastal settlement.
Coastal Flooding	H	• Coastal flooding occurs in the context of dynamic aspects of foredunes and along the existing beach

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

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

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

A.4.4.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune consistent with dynamic parts of the broader Te Horo Natural Duneland. - This coastline supports expansive open views of Kāpiti Island and the Rauoterangi Channel and opportunities to experience exposure from the open ocean.	Future exposure: 2050: - The extent of erosion is expected to remain similar to today. 2070: - The extent of erosion is expected to slightly increase (up to 19 m) but remains broadly similar to today. 2130: - The extent of erosion is expected to extend up to 50 m inland and impact a more considerable part of the natural duneland identified with high natural character and adjoining more stable dune areas.
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the beach berms and foredunes remain subject to inundation along this dynamic coastal edge.	Future exposure: 2050: - The extent of inundation is expected to remain similar to today with some slight increase in inundation within back dunes. 2070: - The extent of inundation impacting areas of duneland with high natural character is expected to remain similar to today with a slight increase of inundation inland. 2130: - The extent of inundation is expected to remain similar to today with a further increase in flooding within inland more modified back dune areas.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas of higher natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of broader changes in land management practices which encompass the characteristics and qualities of the broader coastal environment.

Adaptive Capacity

Hazard	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	• The beach berm and foredune form a dynamic edge adjoining a wider established dune sequence. • Dunes may have greater potential to migrate inland given limited adjoining coastal settlement.
Coastal Flooding	H	• Coastal flooding occurs in the context of dynamic aspects of foredunes and along the existing beach

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

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

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

A.4.5 Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)

Domain	Element at Risk	Overview
Natural Character	Part of CTA2: Waikanae and Paraparaumu: Coastal Terrestrial Area (Note: assessment of effects occurs within NAA)	Coastal Terrestrial Area 2: Waikanae and Paraparaumu extends south from Ngawhakangutu Reserve and encompasses the northern extent of the cuspate (tapering) foreland which extends outwards at Paraparaumu Beach and creates the sweeping form of Waikanae and Raumati Beach. Due to subdivision, particularly nearer the settlements of Paraparaumu Beach and Waikanae Beach, the dune systems have largely been modified to accommodate housing and urban development. Nevertheless, the cuspate foreland remains a legible feature within this Coastal Terrestrial Area. The dunes which remain throughout this Coastal Terrestrial Area vary in age. Peka Peka Beach is dominated by a mixture of Waitarere-Motuiti dunes. The Motuiti dunes contain a large amount of Taupo Pumice lapilli which is likely to have accumulated at the time of the Taupo eruption approximately 1,800 years ago. Historically, the 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 little native vegetation remains because of extensive land use changes (farming and subsequently residential development). The Peka Peka dunes are a component of the Peka Peka coast key native ecosystem. This supports several native species, including At Risk and Threatened coastal plant and bird species (e.g. pingao, shore spurge, Threatened-Nationally Vulnerable-Caspian tern, Threatened-Nationally Vulnerable-red-billed gull, longfin eel, inanga). The broader terrestrial coastal environment encompasses the most populated area in the Kāpiti Coasts Coastal Environment and adjoining Coastal Context and is assessed as having **low-moderate** level of natural character overall within which an area of **high** natural character has been identified encompassing the Peka Peka dunes in the Northern Adaption Area, described further below.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion will primarily impact areas of beach berm and foredunes. Formed during the Waitarere Dune phase, these natural dunelands primarily contain colonizing exotic grasses and scrub with more isolated populations of native vegetation, including spinifex and pingao along relatively more dynamic coastal edges. Broader areas of natural duneland and gentle sandy beaches form existing natural buffers between coastal hazards and settlement. Built coastal protection and associated human induced changes in response to coastal erosion has potential to adversely impact natural elements, patterns and processes and therefore reduce natural character. Such built influences are presently limited within the NAA and adjoining CMA.
Coastal Flooding	Coastal flooding encompasses the more dynamic mouth of Te Kowhai Stream and extends into back dune areas frequently adjoining recent coastal development further south. These areas support a range of natural elements including uncommon ecosystem types (e.g. coastal turfs, shingle beaches), native coastal plants (e.g. knobby clubrush, sand sedge, patches of pingao, remuremu, bachelor's button) and native avifauna and fish species. The responses to flood hazard and potential construction of flood defences with increased presence of built form also has potential to reduce natural character.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reinforce and restore native vegetation along riparian margins and within natural dunelands. Maintain natural patterns and processes within areas impacted by natural hazards, including dynamic dune areas. Ensure built development and modification is sympathetic to and supports underlying natural characteristics and qualities. Develop and utilise nature-based solutions which preserve and restore natural character.
Coastal Flooding	Reinforce indigenous margins and associated habitat opportunities at the mouths of streams, including to reduce or remedy slumping. Limit and remove built influences which may otherwise impact the natural character along active streams, riverbeds and their margins. Identify opportunities to enhance and restore ecological connectivity between the coastal environment and its context / catchment. Develop and utilise nature-based solutions which restore natural character where possible.

A.4.5.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune at Peka Peka Beach. - Parts of the mouth of Te Kowhai Stream.	Future exposure: 2050: - Erosion is expected to impact the existing beach berm and foredunes along North Peka Peka Beach Natural Duneland (up to 19 m) and the inherently more dynamic mouths of rivers and streams (up to 146 m) 2070: - There is a very slight increase in erosion of the Peka Peka natural dunelands (>5 m). - No apparent change in erosion at Kowhai Stream mouth. 2130: - Coastal erosion continues to impact areas of Peka Peka natural duneland (40 m). - No apparent change in erosion at Kowhai Stream mouth.
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the mouth and margins of Te Kowhai Stream and ponding within dune swales - Some additional areas of localised flooding continue inland of the identified coastal environment along more modified ponds and tributaries and field drains of Te Kowhai Stream.	Future exposure: 2050: - Coastal flooding primarily occurs in association with the lower lying and inherently more dynamic mouth of Te Kowhai Stream and increases with areas of dune swales in proximity to coastal development. 2070: - Some additional flooding occurs within dune swales in close proximity of coastal settlement and extends into back dunes along modified tributaries of Te Kowhai Stream beyond the identified coastal environment. 2130: - Within the coastal environment, additional more substantial flooding occurs within low lying dune swales amongst existing costal settlement. - Coastal flooding extends further inland into back dunes and along tributaries and field drains of Te Kowhai Stream beyond the identified coastal environment.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas of higher natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of changes in land management practices.

Adaptive Capacity for coastal erosion:

Hazard	Adaptive Capacity	Key Assumptions
Coastal erosion	M	• Much of the erosion occurs in dynamic coastal environments which may support the reestablishment of native dune vegetation in this context. • The ability for dunes to migrate inland may be limited by the proximity of adjoining coastal settlement at Peka Peka Beach.
Coastal flooding	M	• Within the coastal environment, most coastal flooding occurs in the context of mouths of streams, foredunes and swales within which it is assumed periodic inundation may be accommodated in modified dune ponds. • Some coastal flooding begins to extend into back dunes and along swales beyond the costal environment. Such areas retain some capacity to absorb areas of flooding through ponding in the context of existing coastal development.

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

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	H	H	L	M	M	H	H

Overall Risk Score

Hazard	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Flooding	M	M	M	H	M	M	H	H	M	M	M	H

A.4.5.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune at Peka Peka Beach. - Parts of the mouth of Te Kowhai Stream.	Future exposure: 2050: - Erosion is expected to impact the existing beach berm and foredunes along North Peka Peka Beach Natural Duneland (up to 19 m) and the inherently more dynamic mouths of rivers and streams (up to 146 m) 2070: - There is an apparent increase in erosion of the Peka Peka natural dunelands (up to 31 m). - No apparent change in erosion at Kowhai Stream mMouth. 2130: - Coastal erosion results in more substantial impact on areas of Peka Peka natural duneland (up to 74 m). In some instances, such erosion impacts the entire extent of natural duneland which remains between the coastal edge and coastal settlement. - No apparent change in erosion at Kowhai Stream mouth.
Currently exposed to coastal flooding: - Parts of the coastal environment adjoining the mouth and margins of Te Kowhai Stream and ponding within dune swales - Some additional areas of localised flooding continue inland of the identified coastal environment along more modified ponds and tributaries and field drains of Te Kowhai Stream.	Future exposure: 2050: - Coastal flooding primarily occurs in association with the lower lying and inherently more dynamic mouth of Te Kowhai Stream and ponding areas within dune swales in proximity to coastal development. 2070: - Some additional flooding occurs within dune swales in close proximity of coastal settlement and extends into back dunes along modified tributaries of Te Kowhai Stream beyond the identified coastal environment. 2130: - More substantial flooding occurs within low lying dune swales, often inundating existing coastal settlement. - Substantial coastal flooding extends inland of the coastal environment into back dunes and field drains formed along Te Kowhai Stream and encompassing oxidation ponds at Pharazyn Reserve.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas of higher natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of changes in land management practices.
- The increased exposure of built elements and infrastructure to coastal hazards within and adjoining the coastal environment further reduces opportunities for natural adaptive capacity.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	• Much of the coastal erosion occurs in dynamic coastal environments subject to existing exposure to the coastal processes. • The ability for dunes to migrate inland becomes increasingly limited when approaching adjoining coastal settlement at Peka Peka Beach.
Coastal Flooding	L	• Within the coastal environment, most coastal flooding occurs in the context of mouths of streams, foredunes characteristic of these more dynamic areas of the coastal environment. • Coastal flooding extends into dune swales and back dunes and beyond the costal environment. Such areas retain some capacity to absorb areas of flooding through ponding in the context of existing coastal development. Where this extends in the immediate context of coastal development, there is more limited capacity to adapt.

Notes:

- The natural adaptive capacity of natural character within these areas is further reduced by the availability of space within which natural elements, patterns and processes can continue to operate.
- Increased exposure of built form and infrastructure may further restrict any capacity for natural elements, patterns and processes to successfully adapt.

Vulnerability Score

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

Overall Risk Score

Hazard	Exposure	Vulnerability	Risk

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

A.4.6 Peka Peka Dunes (High Natural Character)

Domain	Element at Risk	Overview
Natural Character	Peka Peka Dunes: High Natural Character (HNC)	Part of the northern Peka Peka Beach Natural Dunelands and mouth of Te Kowhai Stream: - Largely intact coastal dunes containing Taupo Pumice lapilli. - Native vegetation cover reduced but present. - Peka Peka beach provides opportunities for swimming, walking, blow-carting, boating, and surfing in a relatively open and undeveloped context. - Expansive views of Kāpiti Island and the Rauoterangi Channel.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion.	Coastal erosion will primarily impact areas of beach berm and foredunes and the margins adjoining the mouth of Te Kowhai Stream. Formed by a mixture of Waitarere-Motuiti dunes, these contain a large amount of Taupo Pumice lapilli and support remaining populations of native duneland vegetation including spinifex and pingao amongst broader colonizing exotic grasses and scrub. Broader areas of natural duneland and gentle sandy beaches form existing natural buffers between coastal hazards and settlement. Built coastal protection and associated human induced changes in response to coastal erosion has potential to adversely impact natural elements, patterns and processes and therefore reduce natural character.
Coastal Flooding	Coastal flooding will have impacts beyond dunes with high natural and associated with dunes swales and the margins of Te Kowhai Stream. The responses to flood hazard and potential construction of flood defences with increased presence of built form also has potential to reduce natural character.

Opportunities

Hazard	Opportunities
Coastal Erosion	Reinforce and restore native vegetation along riparian margins and within natural dunelands. Maintain natural patterns and processes within areas impacted by natural hazards, including dynamic dune areas. Ensure built development and modification is sympathetic to and supports underlying natural characteristics and qualities.
Coastal Flooding	Reinforce indigenous margins and associated habitat opportunities at the mouth Te Kowhai Stream, including to reduce or remedy slumping. Limit and remove built influences which may otherwise impact the natural character along active streams, riverbeds and their margins. Identify opportunities to enhance and restore ecological connectivity between the coastal environment and its context / catchment. Develop and utilise nature-based solutions which restore natural character where possible.

A.4.6.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune at Peka Peka Beach. - Parts of the mouth of Te Kowhai Stream. - Expansive views of Kāpiti Island and the Rauoterangi Channel provide some sense of reducing exposure to the open ocean.	Future exposure: 2050: - Erosion is expected to impact the existing beach berm and foredunes by up to 19 m and remain broadly consistent with the existing situation. - More substantial areas of erosion occur at the inherently more dynamic mouth of Te Kowhai Stream (up to 146 m) 2070: - There is a very slight increase in erosion of foredunes (>5 m). - There is no apparent change in erosion at the inherently more dynamic mouth of Kowhai Stream mouth. 2130: - Erosion continues to impact areas of duneland (up to 40 m) and begins to reduce the extent to which dunes with high natural character remain. - There is no apparent change in erosion at the inherently more dynamic mouth of Kowhai Stream mouth.
Currently exposed to coastal flooding: - Parts of the existing beach berm and foredune and within the context of the inherently more dynamic mouth of Te Kowhai Stream.	Future exposure: 2050: - A slight increase in coastal flooding occurs at the mouth of Kowhai Stream and within foredunes along these existing inherently more dynamic areas of the costal environment. - Some additional flooding begins to occur within adjoining dune swales beyond dunes retaining high natural character. 2070: - No apparent increase in flooding occurs along coastal dunes nor at the mouth of Te Kowhai Stream. - Additional flooding continues in association within dune swales beyond dunes retaining high natural character. 2130: - A slight increase in flooding occurs at the mouth of the Kowhai Stream - More substantial additional flooding occurs beyond dunes which retain high natural character, including in close proximity of adjoining settlement and along the more highly modified field drains and minor tributaries of Te Kowhai Stream.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas of higher natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of broader changes in land management practices which encompass the characteristics and qualities of the broader coastal environment.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	• The beach berm and foredune form a dynamic edge adjoining a wider established dune sequence. • Dunes may have more limited potential to migrate inland given proximity of adjoining coastal settlement.
Coastal Flooding	M	• Most coastal flooding occurs in the context of dynamic aspects of foredunes. Some flooding begins to extend into back dune areas ad coastal development and therefore more limited adaption capacity.

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

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	H	H	M	M	M	M	M

Overall Risk Score

Hazard	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Erosion	M	M	M	H	M	M	M	M	M	M	M	M
Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.4.6.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Currently exposed to coastal erosion: - Areas of beach berm and foredune at Peka Peka Beach. - Parts of the mouth of Te Kowhai Stream. - Expansive views of Kāpiti Island and the Rauoterangi Channel provide some sense of reducing exposure to the open ocean.	Future exposure: 2050: - Erosion is expected to impact the existing beach berm and foredunes by up to 19 m and remain broadly consistent with the existing situation. - More substantial areas of erosion occur at the inherently more dynamic mouth of Te Kowhai Streams (up to 146 m). 2070: - There is an increase in erosion of foredunes (up to 31 m). - There is no apparent change in erosion at the inherently more dynamic mouth of Kowhai Stream mouth. 2130: - Erosion continues to impact areas of duneland (up to 74 m) and impacts most of the extent of dunes identified with high natural character. - Erosion extends further inland at the mouth of Kowhai Stream and in close proximity of adjoining costal settlement.
Currently exposed to coastal flooding: - Parts of the existing beach berm and foredune and within the context of the inherently more dynamic mouth of Te Kowhai Stream.	Future exposure: 2050: - A slight increase in coastal flooding occurs at the mouth of Kowhai Stream and within foredunes along these existing inherently more dynamic areas of the costal environment. - Some additional flooding begins to occur within adjoining dune swales beyond dunes retaining high natural character. 2070: - No apparent increase in flooding occurs along coastal dunes nor at the mouth of Te Kowhai Stream. - Additional flooding continues in association within dune swales beyond dunes retaining high natural character. 2130: - A slight increase in flooding occurs at the mouth of the Kowhai Stream - More substantial additional flooding occurs beyond dunes which retain high natural character, including in close proximity of adjoining settlement and along the more highly modified field drains and minor tributaries of Te Kowhai Stream.

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

Sensitivity

The hazards created by coastal erosion and inundation also express natural processes which will continue to shape the characteristics and qualities of the coastal environment and therefore contribute to natural character. Such processes are not therefore sensitive to natural hazards per se. More often it is the human response to coastal hazards that sensitivity to natural character occurs. To preserve natural character, responses should ensure that natural elements, patterns and processes will continue to operate through appropriate human intervention and management. As areas of higher natural character are exposed to more frequent and greater coastal hazards in the future, sensitivity to ensuring appropriate responses are expected to increase.

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

Notes:

- Natural elements and patterns express natural character through the continued operation of natural processes which may encompass times of flooding and erosion.
- The trajectory of change is an important aspect to consider when assessing sensitivity, i.e. whether the area's natural character is decreasing or increasing as a result of broader changes in land management practices which encompass the characteristics and qualities of the broader coastal environment.

Adaptive Capacity

Risk	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	• The beach berm and foredune form a dynamic edge adjoining a wider established dune sequence. • Erosion begins to impact the extent of duneland which remains relatively intact and results in more limited potential to migrate inland given proximity of adjoining coastal settlement.
Coastal Flooding	M	• Most coastal flooding occurs in the context of dynamic aspects of foredunes. Some flooding begins to extend into back dune areas ad coastal development and therefore more limited adaption capacity.

Notes:

- The natural adaptive capacity of natural character within an area can be impacted by the availability of space within which natural elements, patterns and processes can operate.
- Increased built modification may reduce natural character and therefore restrict any adaptive natural character capacity.

Vulnerability Score

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

Erosion	M	M	H	H	L	M	M	H	H
Flooding	M	M	H	H	M	M	M	M	M

Overall Risk Score

Hazard	Exposure				Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130	Present	2050	2070	2130
Erosion	M	M	M	H	M	M	H	H	M	M	M	H
Flooding	M	M	M	H	M	M	M	M	M	M	M	M

A.5 Cultural Risk Assessment Templates

A.5.1 Ancestral Landscape

Domain	Element at Risk	Overview
Cultural	Ancestral landscapes	With no adaptation efforts increasing sea level rise predictions show coastal erosion and inundation impacts along the coast will likely increase the risk of damage through to permanent loss of culturally significant sites and negative impacts on associated knowledge and traditions. Colonisation has had a huge impact on these ancestral landscapes so retaining what remains is very important to mana whenua. A level of protection and respect is also afforded these locations. Coastal low-lying areas have numerous culturally significant sites to mana whenua ancestors that become increasing impacted upon as scenarios rise, such as historic battle grounds, urupā and other wāhi tapu. This also includes.pā, papakainga, wāhi tapu.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Could lead to partial and/or permanent loss of culturally significant historic sites along our coastline and around river and stream outlets. Accumulated gradual loss of associated knowledge and cultural practices with sites, resulting in loss of connection by mana whenua and deterioration of wellbeing of mana whenua.
Coastal Flooding	Increased exposure to rain and flood will damage sites physically. Impacts on ancestral landscape in respect to mauri and wairua (spiritual aspects) are very important to Māori but are not included within this western knowledge-based framework.

Opportunities

Hazard	Opportunities
Coastal Erosion	As coastal erosion predictions impact our ancestral landscape mana whenua are identifying and researching economic and cultural opportunities. One example is He Huringa Āhuarangi wānanga with rangatahi (climate change workshops with youth).
Coastal Flooding	Mana whenua are involved in restoration projects throughout the district as well as beyond. Working with atua and forces of nature is paramount to the wellbeing of the environment and our communities. As historic wetlands are predicted to return into our ancestral landscape mana whenua are identifying and researching economic and cultural opportunities. One example is establishing native plant nurseries with coastal and wetland species.

A.5.1.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
▪ Current exposure for culturally significant historic sites have been relatively stable for a number of years.	▪ Given the sea level rise projections, future exposure of significant cultural sites will increase over time and will be compounded by inequalities from other domains.
▪ Mana whenua historically had many significant sites along the coastline. Since the signing of Te Tiriti o Waitangi for numerous reasons including the 1855 earthquake occupation moved inland.	▪ Access to cultural heritage sites in the future will remain important to mana whenua.

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

Sensitivity

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

Notes: Coastal erosion has increased exposure for ancestral lands due to the severity of damage and potential of loss into the realm of Tangaroa (ocean). Coastal flooding is considered to be lower during the 100 year period because although wetlands and swamps might increase in the low lying areas the sites would still exist.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Historic sites cannot physically be relocated. If for example mauri stones were placed there these could be relocated with associated cultural practices.
Coastal Flooding	L	Again historic sites cannot be physically moved but the kaupapa and purpose can be. Our tupuna moved for practical reasons and seasonally. Following traditional practices would be important. Ensuring rangatiratanga (self-determination) of mana whenua guaranteed by Te Tiriti o Waitangi is essential. Mana whenua must lead any decision making in regards to ancestral landscapes.

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	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	L	L	H	L	L	L	M
Risk from Flooding	L	L	L	M	L	L	L	L	L	L	L	L

A.5.1.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
Current exposure for culturally significant historic sites have been relatively stable for a number of years.	Future exposure will be greater under SSP5-8.5 than SSP2-4.5 and will increase over time and compounded by inequalities from other domains.
Mana whenua historically had many significant sites along the coastline. Since the signing of Te Tiriti o Waitangi for numerous reasons including the 1855 earthquake occupation moved inland.	Access to cultural heritage sites in the future will remain important to mana whenua.

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

Note:

Sensitivity

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

Notes: Coastal erosion has increased exposure for ancestral lands due to the severity of damage and potential of loss into the realm of Tangaroa (ocean). Coastal flooding is considered to be lower during the 100 year period because although wetlands and swamps might increase in the low lying areas the sites would still exist.

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	L	Historic sites cannot physically be relocated. However, if for example urupa are at risk of coastal erosion koiwi (bones) could be relocated with associated cultural practices.
Coastal Flooding	L	Again historic sites cannot be physically moved but the kaupapa (purpose) could reluctantly be shifted. Our ancestors moved for practical reasons and seasonally. Following traditional practices would be important. Ensuring rangatiratanga (self-determination) of mana whenua guaranteed by Te Tiriti o Waitangi is essential. Mana whenua must lead any decision making in regards to ancestral landscapes.

Vulnerability Score

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

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Erosion	L	L	L	H	L	L	L	L	M
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	L	L	H	L	L	L	M
Risk from Flooding	L	L	M	M	L	L	L	L	L	L	L	L

A.5.2 Marae

Domain	Element at Risk	Overview
Cultural	Marae	Katihiku and Te Pou o Tainui marae are within the NAA and Te Marae o Hine is just outside the area. Both the SSP2-4.5 and SSP5-8.5 scenarios projects coastal erosion and in particular coastal inundation that may in the long-term impact on the ancestral home of Katihiku Tamatehura, the dining room Te Rongorito, other buildings, and surrounding lands. Maintaining existing marae will always be very important to mana whenua.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Katihiku marae is the closest marae to the coast within the adaptation area and is situated to the south of the Ōtaki River mouth. The projections do not currently put Katihiku marae at risk of coastal erosion. Te Pou o Tainui is located well away from the coast and current predictions do not put it at risk of being impacted by coastal erosion.
Coastal Flooding	Projections of increased coastal flooding and inundation at SSP2-4.5 could have moderate impacts on the physical location of Katihiku marae in the long term, whilst the SSP5-8.5 scenario could have severe impacts. Damage to buildings could have severe consequences especially for wharenui carvings and tukutuku paneling. Te Pou o Tainui surrounding lands and car park could be at risk of flooding from the Mangapouri Stream in the long term – outside the predictions of this project. Impacts on mauri and wairua (spiritual aspects) are very important to Māori but are not included within this western knowledge-based framework.

Opportunities

Hazard	Opportunities
Coastal Erosion	Shellfish beds and coastal fishing could get closer to marae.
Coastal Flooding	Mana whenua are involved in restoration projects throughout the district including around Te Pou o Tainui, Te Marae o Hine and significant planting near Katihiku marae. A historic wetland remains near Katihiku with extensive recent planting. There is the opportunity for further planting projects encouraging the return of taonga species such as eels and whitebait.

A.5.2.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
• Current existing marae have not been exposed to coastal erosion hazards and isn't anticipated to be in a significant storm.relatively stable for a number of years.	• Future exposure under SSP2-4.5 will increase over time with predictions showing risk at 2130 and compounded by inequalities from other domains.
• Marae buildings (in particular Katihiku) are exposed to future coastal climate impacts.	• Access to marae in the future will remain important to mana whenua. Access to marae within the adaptation area are already at risk presently during 1 in 100 year flooding events. Marae are often used in emergency response situations.

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

Note:

Sensitivity

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

Notes:

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Our ancestors moved for practical reasons and seasonally. Deciding and actively determining adaptations together is mana enhancing.
Coastal Flooding	M	Our ancestors moved for practical reasons and seasonally. Deciding and actively determining adaptations together is mana enhancing.

Vulnerability Score

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

A.5.2.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
• Current exposure for marae have been relatively stable for a number of years.	• Future exposure will be greater under SSP5-8.5 than SSP2-4.5 and will increase over time and compounded by inequalities from other domains.
• Marae buildings (in particular Katihiku) are exposed to future coastal climate impacts in the long-term.	• Access to marae in the future will remain important to mana whenua. Marae are often used in emergency response situations.

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

Note:

Sensitivity

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

Notes:

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Our ancestors moved for practical reasons and seasonally. Deciding and actively determining adaptations together is mana enhancing.
Coastal Flooding	M	Our ancestors moved for practical reasons and seasonally. Deciding and actively determining adaptations together is mana enhancing.

Vulnerability Score

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

A.5.3 Mahinga Kai

Domain	Element at Risk	Overview
Cultural	Mahinga kai	Mahinga kai are culturally significant sites for mana whenua to gather food. They are in the ocean, waterways and forests. Future climate impacts are likely to affect these areas along the coast negatively as well as positively. Many have been negatively affected by human activities in the past. Ensuring that adaptation options do not put further strain on these areas in the future will be very important to mana whenua.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	Coastal erosion processes which drive erosion (e.g. severe storms and wave surges) can damage shellfish bed populations and impact coastal fishing areas. Having access to less food gathering areas and reduced opportunities to gather in the future may decrease the wellbeing of mana whenua. This will also impact on the manaaki of visitors and hospitality. The loss of taonga species (e.g. pipi, tuatua, tamure/snapper) leads to the loss of associated knowledge and cultural practices such as local techniques for gathering.
Coastal Flooding	Severe flooding and long periods of inundation could damage taonga species populations and ephemeral wetland areas. Having access to less food gathering areas and opportunities in the future could decrease the wellbeing of mana whenua. This will also impact on the manaaki of visitors and hospitality. The loss of taonga species (e.g. inanga population and habitat, eels) leads to the loss of associated knowledge and cultural practices such as local techniques for gathering.

Opportunities

Hazard	Opportunities
Coastal Erosion	Outlets for waterways could increase in size and increase species availability such as the Ōtaki River mouth returning to a harbour (that it was historically before the 1855 earthquake) and stream mouths could change to have lagoon areas. Increased mahinga kai habitats and associated species (e.g. kahawai and kanae/mullet).
Coastal Flooding	Ephemeral wetlands could change to permanent lagoons or dune lakes. Increased mahinga kai habitats and associated species (e.g. whitebait and koura).

A.5.3.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
• Outlets for waterways could increase in size and increase species availability such as the Ōtaki River mouth returning to a harbour (that it was historically before the 1855 earthquake) and stream mouths could change to have lagoon areas. Increased mahinga kai habitats and associated species (e.g. kahawai and kanae/mullet).	• Traditional mahinga kai sites in the coastal area will remain exposed to the elements of weather and sea level rise. Beach narrowing due to coastal erosion may impact on shellfish populations.
• Mahinga kai will be further exposed to future coastal inundation climate impacts that may be severe.	• Protecting traditional mahinga kai areas are important. By 2050 there is an increase in exposure of sites to flood hazards. Access to mahinga kai in the future will also remain important to mana whenua.

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	L
Coastal Flooding	L	L	L	L

Notes:

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	As natural areas it is assumed that te taiao and climate impacts if left unmodified by human intervention (mana whenua preference) then these areas will remain although locations, habitats and species might differ over time.
Coastal Flooding	H	As natural areas it is assumed that te taiao and climate impacts if left unmodified by human intervention or low levels of modification (mana whenua preference) then these areas will remain although locations, habitats and species might differ over time. Potentially they will increase with further wetlands and swamps.

Vulnerability Score

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

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Flooding	L	L	L	L	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.5.3.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
• Outlets for waterways could increase in size and increase species availability such as the Ōtaki River mouth returning to a harbour (that it was historically before the 1855 earthquake) and stream mouths could change to have lagoon areas. Increased mahinga kai habitats and associated species (e.g. Kahawai, mullet).	• Traditional mahinga kai sites in the coastal area will remain exposed to the elements of weather and sea level rise. Beach narrowing due to coastal erosion may impact on shellfish populations.
• Mahinga kai will be further exposed to future coastal inundation climate impacts that may be severe.	• Access to mahinga kai in the future will remain important to mana whenua. Protecting where traditional mahinga kai areas are also important.

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	L
Coastal Flooding	L	L	L	L

Notes:

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	H	As natural areas it is assumed that te taiao and climate impacts if left unmodified by human intervention (mana whenua preference) then these areas will remain although locations, habitats and species might differ over time.
Coastal Flooding	H	Mahinga kai sites inland along the coast are natural sites with no to low temporary infrastructure. They are likely to naturally adjust although habitats and species might differ over time.

Vulnerability Score

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
	Present	2050	2070	2130		Present	2050	2070	2130
Erosion	L	L	L	L	H	L	L	L	L
Flooding	L	L	L	L	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.5.4 Whānau/Hapū/Iwi Whare and Whenua

Domain	Element at Risk	Overview
Cultural	Whānau/hapū/iwi whare and whenua	Whānau/hapū/iwi whenua such lands in trust and personally owned homes along our coastline will be at risk according to sea level rise projections. Ture whenua lands are only a small percentage of the adaptation area; thus they have become more valuable in time and a number of Māori land trusts are within the Northern Adaptation Area.

Consequence

Hazard	Description of Consequence (note any cascading impacts)
Coastal Erosion	The potential consequences of losing further Māori owned lands will be devastating. Many whānau and hapū/iwi members still feel the impacts of colonisation that drastically reduced mana whenua lands and are still being addressed in Te Tiriti o Waitangi Settlement claims in the district. Losing land to coastal erosion from Ōtaki to Peka Peka due to the forces of Tangaroa and the ocean is likely to be permanent.
Coastal Flooding	Coastal inundation appears to cover large areas within the Northern Adaptation Area especially behind Ōtaki Beach, a lot of the area includes the Porirua Trust Board lands.

Opportunities

Hazard	Opportunities
Coastal Erosion	As coastal erosion projections impact our whānau/hapū/iwi whenua, whare and other buildings economic and cultural opportunities. One example is He Huringa Āhuarangi wānanga with rangatahi (climate change workshops with youth).
Coastal Flooding	Mana whenua are involved in restoration projects throughout the district as well as beyond. Working with atua and forces of nature is paramount to the wellbeing of the environment and our communities. As historic wetlands are predicted to return into our ancestral landscape mana whenua are identifying and researching economic and cultural opportunities. One example is eco-cultural tourism tours through wetlands.

A.5.4.1 SSP2-4.5

Sea level rise scenario:	
SSP2 4.5 ☒	SSP5 8.5 ☐

Exposure

Details of exposure	
• Current erosion exposure for whānau/hapū/iwi lands and buildings have been relatively stable for a number of years. Although more precipitation has increased flooding events putting more sites at risk in recent times.	• Given the sea level rise projections, future exposure of Māori lands and buildings will increase over time and will be compounded by inequalities from other domains.
• Mana whenua historically held all the lands along the coastline. Since the signing of Te Tiriti o Waitangi for numerous reasons including the 1855 earthquake occupation moved inland. A large area of the Northern Adaptation Area is low lying and vulnerable to inundation with trust lands such as Porirua Trust Board and Katihiku X at higher risk.	• Retaining Māori land assets in the future will remain important to mana whenua.

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

Note:

Sensitivity

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

Notes:

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Mana whenua indicated in wānanga the desire to work with taiao and Ātua. Mana whenua and community groups are engaged in dune planting and re-introducing native species into coastal ecosystems are desired which builds resilience. It is noted that ocean forces can be very strong thus moderately limiting the capacity of land and whare to adapt.
Coastal Flooding	H	Mana whenua indicated in wānanga the desire to work with taiao and Ātua. Mana whenua and community groups are engaged in wetland restoration and riparian projects. It is acknowledged that more is required to extend green corridors along our whenua, reserves, parks etc. Te Ao Māori frameworks to conduct such work is known to be successful. The return of waterscapes and historic wetlands is a natural phenomenon and in certain circumstances this may be seen as desirable. The land will remain although submerged in water.

Vulnerability Score

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

A.5.4.2 SSP5-8.5

Sea level rise scenario:	
SSP2 4.5 ☐	SSP5 8.5 ☒

Exposure

Details of exposure	
▪ Current erosion exposure for whānau/hapū/iwi lands and buildings have been relatively stable for a number of years.	▪ Given the sea level rise projections, future exposure of Māori lands and buildings will increase over time and will be compounded by inequalities from other domains.
▪ Mana whenua historically held all the lands along the coastline. Since the signing of Te Tiriti o Waitangi for numerous reasons including the 1855 earthquake occupation moved inland. A large area of the Northern Adaptation Area is low lying and vulnerable to inundation with trust lands such as Porirua Trust Board and Katihiku X at higher risk.	▪ Retaining Māori land assets in the future will remain important to mana whenua.

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

Note:

Sensitivity

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

Notes:

Adaptive Capacity

Domain	Adaptive Capacity	Key Assumptions
Coastal Erosion	M	Mana whenua indicated in wānanga the desire to work with taiao and Ātua. Mana whenua and community groups are engaged in dune planting and re-introducing native species into coastal ecosystems are desired which builds resilience.
Coastal Flooding	H	Mana whenua indicated in wānanga the desire to work with taiao and Ātua. Mana whenua and community groups are engaged in wetland restoration and riparian projects. It is acknowledged that more is required to extend green corridors along our whenua, reserves, parks etc. Te Ao Māori frameworks to conduct such work is known to be successful.

Vulnerability Score

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

Hazard	Sensitivity				Adaptive Capacity	Vulnerability			
Erosion	L	L	L	H	M	L	L	L	M
Flooding	L	L	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	M	L	L	L	M	L	L	L	M
Risk from Flooding	L	L	M	H	L	L	L	L	L	L	L	M

Appendix B: Risk Matrices

Coastal Erosion Hazard

SSP2-4.5

Element	Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk			
	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	M	M	M	L	L	M	M	M	L	L	L	L
Properties - Ōtaki Beach	L	L	L	L	L	E	E	E	L	L	E	E	E	L	M	M	M
Properties - Te Horo Beach	L	L	L	L	L	E	E	E	L	L	E	E	E	L	M	M	M
Properties - Peka Peka	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L
Water Supply Infrastructure	L	L	L	L	L	E	E	E	L	L	E	E	E	L	M	M	M
Wastewater Infrastructure	L	L	L	L	L	E	E	E	L	L	E	E	E	L	M	M	M
Stormwater Infrastructure	L	L	M	M	L	M	H	H	L	L	M	H	H	L	L	M	M
Roads and Bridges	L	L	L	L	L	M	M	H	L	L	M	M	H	L	L	L	L
Electrical Transmission and supply infrastructure	L	L	L	L	L	L	L	E	L	L	L	L	E	L	L	L	M
Natural gas supply mains	No Exposure																
Ecological																	
Coastal Dunes	M	M	H	H	M	M	H	H	L	M	M	H	H	M	M	H	H
Wetlands	L	M	M	H	L	M	M	H	L	L	M	M	H	L	M	M	H
Mapped Ecological Sites	M	M	H	E	M	M	H	E	L	M	M	H	E	M	M	H	E
Indigenous trees	No Exposure																
Rare and threatened species	M	M	H	H	M	M	H	E	L	M	M	H	E	M	M	H	E
Bird habitat	M	M	H	E	M	M	H	E	L	M	M	H	E	M	M	H	E
Fish habitat	L	M	M	H	M	M	M	M	M	M	M	M	M	L	M	M	M
Indigenous biodiversity (coastal)	L	H	H	E	H	H	H	E	VL	E	E	E	E	M	E	E	E
Human																	
Physical Human	L	L	L	M	M	M	M	M	M	M	M	M	M	L	L	L	M
Mental health and wellbeing	L	L	L	M	H	H	H	H	L	H	H	H	H	L	L	L	M
Conflict, disruption and loss of trust in government	M	H	H	H	H	H	H	H	M	M	M	M	M	M	M	M	M
Exacerbating inequities	L	L	M	M	M	M	M	M	L	M	M	M	M	L	L	M	M
Community cohesion and social wellbeing	L	L	M	M	M	M	M	M	L	M	M	M	M	L	L	M	M
Social infrastructure and amenity	L	L	L	L	H	H	H	H	M	M	M	M	M	L	L	L	L
Natural Character																	
CTA1: Ōtaki (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	H	L	L	L	L	L	L	L	M
Ōtaki Dunes (High Natural Character)	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Te Horo Dunes (High Natural Character)	M	M	M	M	M	M	M	M	H	L	L	L	L	L	L	L	L
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Peka Peka Dunes (High Natural Character)	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Cultural																	
Ancestral Landscape	L	L	L	M	L	L	L	H	L	L	L	L	H	L	L	L	M
Marae	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Mahinga Kai	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L
Whānau/hapū/iwi whare and whenua	L	L	L	M	L	L	L	H	M	L	L	L	M	L	L	L	M

SSP5-8.5

Element	Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk			
	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	M	M	H	L	L	M	M	H	L	L	L	L
Properties - Ōtaki Beach	L	L	L	M	L	E	E	E	L	L	E	E	E	L	M	M	H
Properties - Te Horo Beach	L	L	L	M	L	E	E	E	L	L	E	E	E	L	M	M	H
Properties - Peka Peka	L	L	L	H	L	L	L	M	L	L	L	L	M	L	L	L	M
Water Supply Infrastructure	L	L	L	M	L	E	E	E	L	L	E	E	E	L	M	M	H
Wastewater Infrastructure	L	L	L	M	L	E	E	E	L	L	E	E	E	L	M	M	H
Stormwater Infrastructure	L	L	M	H	L	M	H	H	L	L	M	H	H	L	L	M	H
Roads and Bridges	L	L	L	M	L	M	M	H	L	L	M	M	H	L	L	L	M
Electrical Transmission and supply infrastructure	L	L	L	M	L	L	L	E	L	L	L	L	E	L	L	L	H
Natural gas supply mains	No Exposure																
Ecological																	
Coastal Dunes	M	M	H	E	M	M	H	H	L	M	M	H	H	M	M	H	E
Wetlands	L	M	M	H	L	M	M	H	L	L	M	M	H	L	M	M	H
Mapped Ecological Sites	M	M	H	E	M	M	H	E	L	M	M	H	E	M	M	H	E
Indigenous trees	No Exposure																
Rare and threatened species	M	M	H	H	M	M	H	E	L	M	M	H	E	M	M	H	E
Bird habitat	M	M	H	E	M	M	H	E	L	M	M	H	E	M	M	H	E
Fish habitat	L	M	M	H	M	M	M	M	M	M	M	M	M	L	M	M	M
Indigenous biodiversity (coastal)	L	H	H	E	H	H	H	E	VL	E	E	E	E	M	E	E	E
Human																	
Physical Human	L	L	L	M	M	M	M	M	M	M	M	M	M	L	L	L	M
Mental health and wellbeing	L	L	M	M	H	H	H	H	L	H	H	H	H	L	L	M	M
Conflict, disruption and loss of trust in government	M	H	H	E	H	H	E	E	M	M	M	H	H	M	M	H	E
Exacerbating inequities	L	L	M	M	M	H	H	H	L	M	H	H	H	L	L	M	M
Community cohesion and social wellbeing	L	L	M	M	M	M	M	M	L	M	M	M	M	L	L	M	M
Social infrastructure and amenity	L	L	L	M	H	H	H	H	M	M	M	M	M	L	L	L	M
Natural Character																	
CTA1: Ōtaki (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	M	M	M	M	M	M	M	M	M
Ōtaki Dunes (High Natural Character)	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Te Horo Dunes (High Natural Character)	M	M	M	H	M	M	M	M	H	L	L	L	L	L	L	L	M
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	L	M	M	H	H	M	M	M	H
Peka Peka Dunes (High Natural Character)	M	M	M	H	M	M	H	H	L	M	M	H	H	M	M	M	H
Cultural																	
Ancestral Landscape	L	L	L	M	L	L	L	H	L	L	L	L	H	L	L	L	M
Marae	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Mahinga Kai	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L
Whānau/hapū/iwi whare and whenua	L	L	L	M	L	L	L	H	M	L	L	L	M	L	L	L	M

Coastal Flood Hazard

SSP2-4.5

Element	Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130		Present	2050	2070	2130	Present	2050	2070	2130
Built Environment																	
Properties - Whole Adaptation Area	L	L	M	M	M	M	H	H	L	M	M	H	H	L	L	M	M
Properties - Ōtaki Beach	L	L	L	M	M	M	H	E	L	M	M	H	E	L	L	L	H
Properties - Te Horo Beach	L	L	M	M	L	M	M	H	L	L	M	M	H	L	L	M	M
Properties - Peka Peka	L	M	M	H	L	L	L	M	L	L	L	L	M	L	L	L	M
Water Supply Infrastructure	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Wastewater Infrastructure	M	M	M	M	L	L	L	L	M	L	L	L	L	L	L	L	L
Stormwater Infrastructure	L	L	L	H	L	L	L	M	M	L	L	L	M	L	L	L	M
Roads and Bridges	L	L	L	H	L	M	M	H	L	L	M	M	H	L	L	L	H
Electrical Transmission and supply infrastructure	L	L	L	L	L	L	M	H	M	L	L	M	M	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
Ecological																	
Coastal Dunes	L	L	M	M	L	L	M	M	M	L	L	M	M	L	L	M	M
Wetlands	M	M	H	H	M	M	M	M	M	M	M	M	M	M	M	M	M
Mapped Ecological Sites	M	H	H	E	M	H	H	E	L	M	H	H	E	M	H	H	E
Indigenous trees	L	L	L	M	L	L	L	M	L	L	L	L	M	L	L	L	M
Rare and threatened species	M	H	H	H	M	H	H	E	L	M	H	H	E	M	H	H	E
Bird habitat	H	H	E	E	H	H	E	E	L	H	H	E	E	H	H	E	E
Fish habitat	M	M	H	E	M	M	M	M	M	M	M	M	M	M	M	M	H
Indigenous biodiversity (coastal)	M	M	M	E	M	M	H	E	L	M	M	H	E	M	M	M	E
Human																	
Physical health	M	H	H	E	H	H	H	H	M	M	M	M	M	M	M	M	H
Mental health and wellbeing	M	H	H	E	H	H	H	H	M	M	M	M	M	M	M	M	H
Conflict, disruption and loss of trust in government	M	M	H	E	M	M	H	H	M	M	M	M	M	M	M	M	H
Exacerbating inequities	M	H	H	E	M	H	H	H	L	M	H	H	H	M	H	H	E
Community cohesion and social wellbeing	M	M	H	H	M	M	M	M	L	M	M	M	M	M	M	M	M
Social infrastructure and amenity	L	M	M	H	H	H	H	H	M	M	M	M	M	L	M	M	M
Natural Character																	
CTA1: Ōtaki (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	M	M	M	M	M	M	M	M	M
Ōtaki Dunes (High Natural Character)	M	M	M	H	M	M	M	H	M	M	M	M	M	M	M	M	M
Te Horo Dunes (High Natural Character)	M	M	M	M	M	M	M	M	H	L	L	L	L	L	L	L	L
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	L	M	M	H	H	M	M	M	H
Peka Peka Dunes (High Natural Character)	M	M	M	H	M	M	H	H	M	M	M	M	M	M	M	M	M
Cultural																	
Ancestral Landscape	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L
Marae	L	L	L	M	L	L	L	E	M	L	L	L	H	L	L	L	M
Mahinga Kai	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L
Whānau/hapū/iwi whare and whenua	L	L	M	M	L	L	M	M	H	L	L	L	L	L	L	L	L

SSP5-8.5

Element	Exposure				Sensitivity				Adaptive Capacity	Vulnerability				Risk			
	Present	2050	2070	2130	Present	2050	2070	2130		Present	2050	2070	2130	Present	2050	2070	2130
Built Environment																	
Properties - Whole Adaptation Area	L	L	M	H	M	M	H	E	L	M	M	H	E	L	L	M	E
Properties - Ōtaki Beach	L	L	M	H	M	M	H	E	L	M	M	H	E	L	L	M	E
Properties - Te Horo Beach	L	L	M	M	L	M	M	H	L	L	M	M	H	L	L	M	M
Properties - Peka Peka	L	M	M	H	L	L	L	M	L	L	L	L	M	L	L	L	M
Water Supply Infrastructure	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
Wastewater Infrastructure	M	M	M	E	L	L	L	L	M	L	L	L	L	L	L	L	H
Stormwater Infrastructure	L	L	L	H	L	L	L	E	M	L	L	L	H	L	L	L	H
Roads and Bridges	L	L	L	H	L	M	M	E	L	L	M	M	E	L	L	L	E
Electrical Transmission and supply infrastructure	L	L	L	M	L	L	H	H	M	L	L	M	M	L	L	L	M
Natural gas supply mains	L	L	L	M	L	L	L	M	L	L	L	L	M	L	L	L	M
Ecological																	
Coastal Dunes	L	L	M	H	L	L	M	M	M	L	L	M	M	L	L	M	M
Wetlands	M	M	H	E	M	M	M	M	M	M	M	M	M	M	M	M	H
Mapped Ecological Sites	M	H	H	E	M	H	H	E	L	M	H	H	E	M	H	H	E
Indigenous trees	L	L	L	H	L	L	L	H	L	L	L	L	H	L	L	L	H
Rare and threatened species	M	H	H	E	M	H	H	E	L	M	H	H	E	M	H	H	E
Bird habitat	H	H	E	E	H	H	E	E	L	H	H	E	E	H	H	E	E
Fish habitat	M	M	E	E	M	M	M	M	M	M	M	M	M	M	M	H	H
Indigenous biodiversity (coastal)	M	M	M	E	M	M	H	E	L	M	M	H	E	M	M	M	E
Human																	
Physical health	M	H	H	E	M	M	H	H	M	M	M	M	M	M	M	M	H
Mental health and wellbeing	M	H	H	E	H	H	H	H	M	M	M	M	M	M	M	M	H
Conflict, disruption and loss of trust in government	M	H	H	E	M	M	H	E	M	M	M	M	H	M	M	M	E
Exacerbating inequities	M	H	H	E	M	H	H	E	L	M	H	H	E	M	H	H	E
Community cohesion and social wellbeing	M	M	H	E	M	M	M	M	L	M	M	M	M	M	M	M	H
Social infrastructure and amenity	L	M	H	E	H	H	H	H	M	M	M	M	M	L	M	M	H
Natural Character																	
CTA1: Ōtaki (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	M	M	M	M	M	M	M	M	M
Ōtaki Dunes (High Natural Character)	M	M	M	H	M	M	H	H	M	M	M	M	M	M	M	M	M
Te Horo Dunes (High Natural Character)	M	M	M	M	M	M	M	M	H	L	L	L	L	L	L	L	L
Part of CTA2: Waikanae and Paraparaumu (Coastal Terrestrial Area)	M	M	M	H	M	M	H	H	L	M	M	H	H	M	M	M	H
Peka Peka Dunes (High Natural Character)	M	M	M	H	M	M	H	H	M	M	M	M	M	M	M	M	M
Cultural																	
Ancestral Landscape	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L
Marae	L	L	L	M	L	L	L	E	M	L	L	L	H	L	L	L	M
Mahinga Kai	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L
Whānau/hapū/iwi whare and whenua	L	L	M	H	L	L	M	M	H	L	L	L	L	L	L	L	M