BEFORE THE	**COASTAL HAZARDS VARIATION TO TE TAI O POUTINI PLAN HEARING COMMITTEE**
IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	Second-round hearing for Coastal Hazards Variation to Te Tai o Poutini Plan

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STATEMENT OF EVIDENCE BY CYPRIEN BOSSERELLE

Introduction

1 My name is Cyprien Bosserelle. I hold qualifications of environmental hazard scientist including a MSc in Geological Hazard for the University of Montpellier (France) and a PhD in coastal oceanography from the University of Western Australia (Australia).

2 I am currently the hydrodynamics scientist at the National Institute for Water and Atmospheric research (NIWA). I have held this position for 7.5 years. I have 18 years' experience in assessing coastal hazards, erosion and inundation in Aotearoa New Zealand and overseas.

3 I have been asked by the West Coast Regional Council to provide evidence at the second-round hearing for Coastal Hazards Variation to Te Tai o Poutini Plan a well as introduction statement in relation to coastal natural hazards science used in TTPP.

4 I confirm I have read the Code of Conduct for expert witnesses contained in the Environment Court New Zealand Practice Note 2023 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of

expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

5 **Opening Statement summary**

General introduction

Coastal hazard is often used to describe coastal inundation (also referred as coastal flooding) and coastal erosion. Tsunami hazard and groundwater flooding are also linked with the coastal environment but are often treated separately to coastal hazard and not addressed in this statement.

Coastal inundation is when high tide, storm surge (the combined effect of tide and storm surge is called storm-tide) and large waves coincide to flood the low-lying land adjacent to the coast. Waves flood the land intermittently with each wave and with each group of waves. The average height reached by the waves above the storm-tide is the wave setup. The combined storm-tide and wave setup elevation are a practical level to evaluate inundation and water level during extreme events.

Coastal erosion is the gradual (long-term) and/or rapid (short-term) retreat of the shoreline. The shoreline is defined by environment markers that are easy to track on historical aerial photography (e.g. vegetation line, toe of dunes or back of gravel barriers). Tracking shoreline retreat from historical aerial imagery is used to both estimate short term storm retreat and long-term shoreline movements.

West Coast region is exposed to coastal hazard, with ex-Tropical Cyclone Fehi the most recent significant extreme event. It caused significant inundation and erosion in parts of Westport, Punakaiki and Rapahoe. TC Fehi's return period was estimated to be between 1 in 30 years and 1 in 60 years. Historical erosion has been observed in various places along the coast and has led to installation of rock revetments. It is worth noting that coastal protection such as rock revetments do not completely remove the erosion hazard as these can fail.

Sea-level rise will worsen coastal hazards by increasing coastal inundation extreme level by the amount of sea level rise and by exacerbating (or initiating) long-term erosion.

Sea level on the West Coast is rising at a rate relatively similar to Lyttelton's, at about 2.7mm/y using the full record and 3.2 mm/y using the data from 1980 onward. The relative mean sea level data (sea level against land level benchmark) shows that the land is not rising relative to sea level.

Sea level is expected to continue to rise and accelerate its rate of rising in the future. This depends on economic and societal scenarios (that drive rates of CO_2 emissions): Shared Socioeconomic Pathways (SSP) and how fast polar caps will melt. Depending on the SSP and how quickly polar ice sheet melts, sea level could be 1m higher than the present by 2095 in the most pessimistic scenario and after 2200 in the most optimistic.

It is important to consider coastal hazards and the impact of sea level rise in planning. To do so in Te Tai o Poutini Plan, WCRC commissioned a coastal hazard analysis for the West Coast Region and in particular for a priority coastal hazard area (pCHA) previously identified. I and my colleagues made a coastal erosion analysis for the priority coastal hazard areas and a coastal inundation analysis for the region using the LiDAR survey as of 2022 (Jackson Bay to Granity).

Accurate topography data is important for coastal inundation assessment. Without the coastal LiDAR the coastal hazard assessment was not possible north of Granity. This section of the LiDAR has been released in 2025.

The NIWA assessment draft report was peer-reviewed by Tonkin+Taylor. The review found the methodologies are appropriate. Most of the comments are requests for clarifications on the methodologies and these have been addressed in the final version of the report. This revised version is the version made available to the public.

The coastal hazard analysis produced maps showing the inundation extent for a 1 in 100-year coastal inundation event at present sea level and 0.2m increments of sea-level rise up to 1.6m. The assessment also produced the 50-year outlook and 100-year outlook for coastal erosion hazard for the priority coastal hazard areas. The coastal inundation output with1.0m SLR has been used to produce the coastal alert overlay, and the 100-year outlook coastal erosion hazard has been used to produce the coastal severe overlay.

Coastal erosion methodology

Coastal erosion hazard analysis is built to account for long-term (historical) erosion rates, short-tern erosion due to storms and how rising sea level can accelerate erosion.

The historical rate is calculated based on the historical position of the shoreline. This was achieved by detecting the shoreline position in historical aerial and satellite images. From this shoreline position a rate of change was calculated as well as an estimation of the variabilities and uncertainties. Accounting for variabilities is important in places like Hannahs Clearing where cycles of erosion and accretion occur, and no clear trend can be seen. However, the erosion hazard needs to account for the fact that 20-50m of erosion is likely during an erosion cycle.

The erosion hazard zone is calculated using a probabilistic approach where the combined extent of historical erosion, short-term erosion and sea-level rise impact are calculated over 1,000 iterations. The final extent of the coastal erosion hazard is the 95^{th} percentile (950^{th} iteration) furthest from the coast. In cases where coastal protections are in place, only the short-term erosion is used. Where the erosion extent calculated is beyond known geological control, the location of the geological control is used (e.g. Ngakawau).

Coastal protection structures are only considered for large coastal structures with a significant extent alongshore. For example, revetement installed in front of a single property is not considered. Similarly gravel bunds and soil embankments are not considered long-term coastal erosion mitigation measures. It is worth noting that coastal protection such as rock revetments do not completely remove the erosion hazard as these can fail.

Coastal inundation methodology

Coastal inundation hazard combines sea-level rise, storm-tide and wave setup for a 100-year return period storm and calculates the inundation extent for the sea level rise increments.

The storm-tide level is derived from earlier research work, but the estimation of wave setup is more difficult. Wave hindcast are known to overestimate large wave events on the West Coast. This may be the reason why the wave setup statistical analysis from the same analysis as for the storm-tide produces unrealistic values of wave setup. Instead, a blanket value of 0.8m for wave setup has been selected as a practical and not unrealistic wave setup. The resulting extreme coastal inundation level ranges between 3.3 m and 2.75 m above the local vertical datum without sea-level rise.

This is then used in a static “bathtub” model for most of the Jacksons Bay to Granity area. A dynamic model is used in Westport (Hokitika and Greymouth maps are being evaluated too).

The dynamic model is better at estimating where the inundation reaches higher (near the coast) and accurately estimates how high the inundation reaches within a tidal cycle. The bathtub model is a simple intersection of the LiDAR and the extreme inundation level. It is conservative away from the coast but will not account for wave runup on the coast.

In Westport the dynamic model was available only for the right bank of the Buller and does not cover Carters Beach.

The dynamic model was verified by applying the methodology to TC Fehi with excellent results.

I have prepared slides presenting the results of both the coastal erosion and inundation for all the priority coastal hazard area to help answer any question from the panel.

Cyprien Bosserelle

14-03-2025