



# **APPENDICES MINUTES**

**Hui Poari ā-Hapori o Raumati |  
Raumati Community Board Meeting**

**Tuesday, 30 May 2023**



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Coastal Ratepayers United

## Comments on Jacobs's Methodology Report (Volume 1)

**Coastal Ratepayers United**  
**July 6 2021**

**Kāpiti Coast**  
**New Zealand**

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## INTRODUCTION

Jacobs have published *Kāpiti Coast Coastal Hazard Susceptibility and Vulnerability Assessment Volume 1: Methodology* to "update previous coastal hazard assessments undertaken along the Kāpiti Coast District shoreline" to assist the KCDC's "Takutai Kāpiti: Our community-led coastal adaptation project".

The scope was set out in the contract between Jacobs and KCDC and is described in this report.

Coastal Ratepayers United Inc. (CRU)<sup>1</sup> represents the part of the Kāpiti community directly affected by the immediate coastal hazards and has over a decade's experience dealing with the technical issues that arise with assessing these. While Jacobs' Assessment is a significant step forward on previous assessments, in our view a number of professional judgments and technical assumptions made in it detract from the report and its usefulness for KCDC and the community in supporting its stated purpose (1.1), particularly its use for Hazard Assessment under the NZCPS for planning purposes.

Given the amount of time that CRU has had to review Volume 1, we have limited ourselves to identifying the material issues without quantifying their impact in detail or necessarily suggesting what should be done. However, we consider these issues are sufficiently significant that they require either amendment of Volume 1 or comment on the reasons for the choices made and any consequent limitations before proceeding to Volume 2.

We also make clear this in the nature of a review only and should be read in the context of the time and resources available to it. It is possible that these issues stem from misunderstandings or lack of information e.g., key data, raw data and code that has not yet been published.

## KEY ISSUES

1. Pervasiveness of "conservative" Approaches in the Report.
2. Relationship between Global MSL and Local SL.
3. Trigger Points
4. Use of RCP 8.5H+ and de facto Adoption of RCP 8.0 for Sea-Level Rise (SLR).
5. Treatment of Vertical Ground-Level Movement.
6. Treatment of Accretion when it Outpaces SLR
7. Use of Bruun Rule and Lack of Validation.
8. Linear Model in Time for Historic Trends.
9. Treatment of Options for Sea Walls.
10. Uncertainty Distributions and Materiality.

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<sup>1</sup> See Appendix for more information about CRU

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## 1. Conservative Approaches

As a general comment, we have been struck by the pervasiveness of "conservative" approaches presented in the report. A partial list includes the Bruun Rule (section 6.4.3), coastal inlet migration (6.7.3), the bathtub model (7.2.2), extreme sea levels (7.3.1) and groundwater levels (7.3.3).

A strong conservative bias, like any other form of bias, is highly undesirable for planning purposes. By forcing the analyst's own risk preferences on to the decision-makers, it may lead the community to avoid selecting futures that would better accord with the community's own risk preferences.

**We strongly encourage Jacobs to review its conservative choices and to balance them with non-conservative estimates wherever possible, even if that must reflect unsupported expert judgement. This is necessary so that the Community Panel can better understand the uncertainties inherent in the analysis. Making a single conservative choice simply hides those uncertainties.**

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## 2. Relationship between Global MSL and Local SL.

The Report directly incorporates GMSL projections (adjusted for local relative movements) in its model to project Kāpiti coast's RSL, and from that the shoreline. While MfE (2017)<sup>2</sup> uses this approach in its Guidance (Section 5.6), its use in any specific location should be tested empirically to ensure that the local historic observations (without local relative movements) are material, are significantly correlated with GMSL<sup>3</sup>, and the parameters derived from this relationship are robust.

To achieve this the Report depends upon Bell et al. (2018) which is an update of Bell et al. (2012). The latter was subject to a review commissioned by CRU by de Lange<sup>4</sup> that addressed this specific issue<sup>5</sup> along with others that have largely been acknowledged in the Jacob's Report. While time has passed since de Lange was written the conclusions still should be addressed by any user of Bell et al. (2018) or MfE (2017).

Primarily de Lange suggests GMSL Projections may not be the dominant driver of Kāpiti coast's RSL and the historic relationship between them is weak.

Since 2012 the evidence has increased that other factors (e.g., tectonic processes) are even more significant and uncertain at Wellington. Consequently, if these factors are not being appropriately identified then analysis of the historic relationship of the residue (local absolute SLR) with GMSL will be unreliable, as is noted by the various references when discussing the statistical significance of this relationship. This then will impact on the parameters used in the projections of Kāpiti coast's RSL.

A particular aspect of this problem is that the historic time series of estimated absolute local SLR can have models other than a simple linear relationship with a particular breakpoint fitted to it. The breakpoint analysis used in Bell et al. (2012) is not particularly sophisticated in the face of known regime changes whether natural (IPO, ENSO) or man-made (measurement techniques).

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<sup>2</sup> References are to the corresponding reference in the Jacobs' report Volume 1.

<sup>3</sup> The problems of downscaling Global MSL projections to regional projections are well understood e.g., IPCC (2013a).

<sup>4</sup> <https://researchcommons.waikato.ac.nz/bitstream/handle/10289/9662/Comments%20on%20GWRC%20DCCS.pdf>

<sup>5</sup> We note that Bell et al. (2018) does not reference the issues raised by de Lange or his report itself.

This issue is potentially material and should be discussed in the Report to justify the judgements made, and with that, the parameters and error estimates used in the assessment of the Kāpiti coast's RSL.

### 3. Trigger Points

When managing hazard risks from an evolving process there are two distinct ways of identifying when a vulnerability might occur.

One is the use trigger points of physical events such as a particular amount of sea-level rise. This is encouraged by MfE (2017) and focuses on triggering actions to manage a risk by the physical proximity to the hazardous event. We strongly endorse it for this use, particularly where triggering regulatory action is involved. Residents can typically assess what is happening over time and by using that can judge the consequences and how far off they might be. It also gives greater certainty because the regulations do not need to change depending on the actual pathways that evolve.

But equally, interested parties want to understand the likely future risks with only today's knowledge. Risk assessment, particularly the consequences, is tightly tied up with estimates of how long before they will occur. They are interested in where the envelope of likely pathways ends up over a particular period, and over time which pathways are being eliminated (or added). In this case the trigger points for adaptive management have become the pathway that is evolving. This approach allows people to test the sensitivity of investment decisions to the pathways, and even to delay investment to achieve a better understanding of the pathway that is occurring.

So, both needs should be accommodated in any assessment (as per the caption of Figure 3.2).

Focusing scenario runs around the fixed shoreline triggers alone, as appears to be happening in Sections 4.2 and 6.1, runs the risk of losing information about the dynamic that is unfolding — the likely pathways, and the uncertainties that will get resolved by time. It is easy enough to derive physical trigger points from scenario-based pathway analysis, but more difficult the other way around, so we recommend this be the former be the used in the risk assessment (see next section).

### 4. Use of RCP 8.5H+ and de facto Adoption of RCP 8.0 for Sea-Level Rise

The NZCPS Policy 24 requires hazard identification and assessment to be done "taking into account national guidance and the best available information on the likely effects of climate change" i.e., it is to be based on the likely effects, and the usefulness of any guidance/information is constrained by this requirement<sup>6</sup>.

This requirement to be "likely" informs the remaining Policies including Policy 27 (1) and Policy 27 (2) (b) that references "the expected effects of climate change," back-referencing to the requirement to be "likely". Significantly, Policy 25's "In areas potentially affected by coastal hazards over at least the next 100 years ...", is defined by Policy 24, that is in turn based on the "likely effects of climate change". Thus MfE (2017)'s view that Policy 25 requires the use of more extreme, i.e., "potential", effects is based on a misinterpretation of the law.

SLR is the primary effect of climate change considered by the Report.

RSLR projections from IPCC (2019) and MfE (2017) are given in Table 3.1. These are adjusted by the extremes of VLM to give Table 3.2, then rounded to give a series of RSLR projections in Table 3.3. These are then added to the estimated extreme sea levels based on a 1% AEP to give the input (Table 4.2) into calculations of impact on shoreline giving "SL" that is used in the probabilistic assessments.

<sup>6</sup> See, Allin "The Kapiti Fiasco" <https://www.kapiticoast.govt.nz/media/29153/chapter-3-allin-appendix-1-allin-crozier-gwrc-pnrr-submission-received-14-july-2016-2.pdf>

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This methodology uses an RSLR projection from RCP 8.5H+ as the upper scenario, RCP 2.6 median as the lower, and de facto uses figures similar to RCP 8.5 for the 2120 "Intermediate Projection".

The assumed minimums and maximums applied to SL (or its components) in the probabilistic assessment are not given — they will not be published until Vol. 27.

These scenarios and the projections derived from them are unlikely<sup>8</sup>, and all the probabilistic analysis will give is the likely range of unlikely futures. This will not be particularly useful in any application of the NZCPS.

MfE (2017) is explicit about the function of RCP 8.5H+ — it is only there for the "purposes of stress-testing adaptation plans where the risk tolerance is low and/or future adaptation options are limited, and for setting an SLR for green-fields development where the foreseeable risk is to be avoided" (p. 100).

Hence RCP 8.5H+ clearly is not "national guidance ... on the likely effects of climate change". It is only going to be of use for cities like Wellington where a major port and much of the CBD might be at risk. Its application to Kāpiti is difficult to see.

In respect of the suggestion that it gives better coverage of ice sheet melt, IPCC (2019) postdates MfE (2017) and is a much broader-based review than it. Section 4.2.3.3.1 explicitly discusses the weaknesses in the alternative methods such as Kopp (2014) used by MfE (2017), and even MfE (2017) acknowledges this issue (Section 5.4.3)<sup>9</sup>.

IPCC (2019) explicitly says its projections are designed to capture the "likely range of RSL" (Section 4.2.3.3.4) with the implication that Kopp (2014) and other more recent contributions based on similar methodologies do not.

RCP8.5 is de facto used as approximately the 2100 intermediate projection. For that to be useful under the NZCPS, RCP8.5 would need to be a "likely" scenario, able to inform the "likely effects" of climate change.

A series of papers in Climate Change 109 (2011) describe the RCP scenarios and their construction, including an overview<sup>10</sup> and RCP8.5<sup>11</sup>. RCP8.5 is the highest of what was designed as the reference scenarios i.e., no policy action. It gives an upper bound on these (i.e., "Compared to the scenario

<sup>7</sup>There is some curious language in Section 6.1 that says the probability distributions for PFSP arise from "pre-determined increments of SLR" possibly implying that Table 4.4 is applied deterministically i.e., its uncertainty is excluded from the probabilistic calculations. This seems highly unlikely since the timing of any hazard arising is central to its management. The community will need to have this uncertainty quantified as best as possible, and this is essential for setting any triggers/adaption thresholds in adaptive planning. Regardless the problems of using "unlikely" RCP scenarios still apply.

<sup>8</sup>MfE (2017) is incorrect to state likelihoods cannot be assigned to these scenarios (5.7.1). They are a product of the assumptions that go into them, and assessments can be made of their likelihood. The lie to MfE (2017)'s assertion occurs with it saying in the next breath: "It will be challenging, however, to achieve the lowest RCP2.6 M scenario as described earlier, because of the rapid and large reductions in emissions required globally".

<sup>9</sup>Ironically CRU had raised the same objections citing similar literature when commenting on a draft of MfE (2017) but these were put aside by the authors.

<sup>10</sup><https://link.springer.com/article/10.1007%2Fs10584-011-0148-z>

<sup>11</sup><https://link.springer.com/article/10.1007/s10584-011-0149-y>



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literature RCP8.5 depicts thus a relatively conservative business as usual case ..."). For a fuller discussion see a recent article by Zeke Hausfather<sup>12</sup>

RCP8.5 assumes no policy interventions and along with other assumptions each of which is in the nature of "possible" not "likely". Jointly they become highly unlikely.

In fact, if countries reduce their emissions in line with the Paris targets, then there is no possible future in which the climate changes in accordance with RCP 8.5.

It would be remiss of Jacobs not to draw the inconsistency to the attention of the Community Panel and to provide the Panel with sea-level estimates which are consistent with plausible expectations of the future path of global emissions. This is not to say that such scenarios are the only ones that should be presented, but they should be emphasised as the "likely" future and as such should legally be the ones that inform our District Plans.

RCP6.0<sup>13</sup> includes a reference scenario based on "no-climate-policy" (and further, assumes any existing policies are retired when they expire). This scenario only reaches 7 Wm<sup>-2</sup> and would better represent the no-policy intervention scenario, although given the various international processes and agreements since AR5 (e.g., Paris) a reversion to "no policy" and 7 Wm<sup>-2</sup> by 2100 would be regarded by most as unlikely. This is particularly so considering technological innovations over the last decade<sup>14</sup> — these will not be rolled back. Thus RCP6.0 is a reasonable representation of an upper limit for likely emissions.

Based on this IPCC (2019) then gives projected SLRs that take account of more recent information on ice sheet melt, and its published likely ranges gives a distribution based on multiple different climate model runs (and hence climate sensitivities to GHGs)<sup>15</sup>. There seems no good reason to move from this for the purposes of applying the NZCPS.

However, there is good reason to expect a more aggressive policy response, and this will be increasingly likely as pathways consistent with RCP6.0 unfold.

Faced with this situation and the use of an adaptive framework, further scenario runs that cover the "likely" outcomes are needed. CRU would expect at least two runs, one based on RCP6.0<sup>16</sup> and another RCP4.5 (broadly as recommended by MfE (2017)). The probability distributions of the CED that result will show the likely (P66) and P90 extent of hazard vulnerability conditional upon the "likely" assumptions of SLR over the period.

This is the minimum required to allow the outputs to be used to give effect to the NZCPS in the District Planning processes.

This change will impact any of the other coastal hazards' assessment where SLR is treated as an input e.g., inundation.

<sup>12</sup> <https://www.carbonbrief.org/explainer-the-high-emissions-rcp8-5-global-warming-scenario>

<sup>13</sup> <https://link.springer.com/article/10.1007%2Fs10584-011-0150-5>

<sup>14</sup> E.g., unanticipated PV and wind generation cost reductions, LEDs, better batteries/EVs.

<sup>15</sup> Note the IPCC gives a distribution for SLR and we would expect that to be used instead of the simple triangular assumption.

<sup>16</sup> The issue of the IPCC sea-level projections ending at 2100 can be addressed in a variety of ways using IPCC projections.

## 5. Treatment of Vertical Ground-Level Movement.

The local VLM is independent of sea level rise. If the subsidence is 1-3mm/year, the expected effect is to raise the median RSLR by about 2mm/year. Since plate tectonics and climate change are uncorrelated, the effects on the upper and lower limits of RSLR will be less than the additional +/- 1mm/year, and should be estimated by simulation. The figures given in Table 3.2 are accordingly not correct.

## 6. Treatment of Accretion When it Outpaces SLR.

Section 6.8 makes the comment:

*For this mapping product, only the 'hazard' has been mapped, so that where accretion was projected to occur over a specified time frame (i.e., if the long term accretion rate is higher than the effect of SLR) then only the 'present day' hazard (short term and dune stability) has been mapped.*

It is unclear if this implies the reducing risk from the "present-day" hazard is not recognised as the shoreline progressively moves seaward over time. If so, any such projection will be incorrect.

## 7. Use of Bruun Rule and Lack of Validation.

Despite all the warnings about the Bruun rule not applying to accreting, eroding or protected shorelines (i.e., the Kāpiti coast) this is used as if it has the status of a physical model i.e. that with some adjustments it can independently (i.e., a priori) project the impact of sea-level rise on the coastline.

Given the nature of the Kāpiti coastline, this is most unlikely, particularly given the sediment movement on the coast. As the report correctly notes, referencing Morton (2003), sediment budgets are inherently hard to measure. However, the longshore movements are a critical example of the kind of thing that needs to be estimated to apply a physical model.

In light of this, the minimum CRU would expect is some empirical validation of the results from the Bruun analyses by way of hind-casting. This will raise the issue of separating the impacts of longshore sediment movements from sea level rise in the historic records. Doing this is an important issue that is concealed by the current methodology.

We make some suggestions for how to address this in the next section.

We would add that the Bruun rule and adjustments end up with a linear model with multiple parameters and assumptions. This model appears hard to justify based on the level and quality of information available. A simpler model should also be tested perhaps along the lines suggested below, or even simpler still where just the slope of the beach is fitted to the historic record for each transcript within each cell.

## 8. Linear Model in Time for Historic Trends.

The past long-term rates of shoreline movement are derived from analysis using DSAS to derive annual rates of movement at 50m spaced transcripts using the endpoints and the linear trend in time<sup>17</sup>.

These are used to derive parameters for the long-term trends.

<sup>17</sup>There is an inherent bias in using the vegetation line for measurement — it responds immediately for erosion, but with a lag for accretion. This should be tested and corrected for if significant.

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An alternative approach that could be used within each of the coastal cells (Fig. 6.6) is to test a simpler but still physical-based model of the change in shoreline position (known independently) being based on a linear combination of (1) longshore addition/subtraction over each time period (not known independently), (2) the accretion/erosion impact of SLR (known independently) at each transept, and a residue covering the processes that are independent of these.

On this approach, longshore changes for any period would be a function of the distance into the cell, and the sea level affects a function of the shape of the transept.

Such a linear model could be fitted to test if it is possible to partial out the two effects on these assumptions and to test the parameters derived from the Bruun Rule.

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### 9. Treatment of Options for Sea Walls.

The assignment of likelihoods to the options for the future of sea walls is inappropriate. It is quite wrong to simply assume that existing structures will be abandoned at the end of their useful lives. That is a possible decision, but for many of the structures being considered, it is not at all a likely one. (Consider, for example, KCDC's current work to renew the Paekakariki seawall.)

These are decisions that will need to be taken and potentially planned for. The consequences of each for the hazard risks need to be understood, along with the options analysis envisaged by Policy 27 of the NZCPS. CRU would therefore expect all three to be modelled to allow the NZCPS to be given effect.

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### 10. Uncertainty Distributions and Materiality.

The minimum, mean and maximum values used to determine the distribution of the parameters in the projections of the CED are yet to be published. An important issue for hazard management is the materiality of each of the uncertainties in the analysis i.e., their contribution. These need to be reported.

#### FINAL NOTE

The report suffers from poor proofreading. Inadvertently repeated passages of text, spelling errors and the like raise concerns in the reader's mind about whether some aspects of the analysis may also contain inadvertent errors. Generally, the errors do not impair the reader's ability to understand what is being said, except that on pp. 57-58 the authors twice say "perpendicular" when what they seem to mean is "parallel".

## APPENDIX

Coastal Ratepayers United, Inc (CRU) is an incorporated society, most of whose members are ratepayers living on the Kāpiti Coast. CRU was incorporated in 2012, in response to coastal hazard provisions of Kāpiti Coast District Council's (KCDC's) Proposed District Plan (PDP) and the imposition of alarmist and unsupported risk statements which KCDC had decided to place on the LIMs of coastal properties. The Objects of CRU are set out in its Rules:

- a) Take whatever steps are necessary to have reviewed the imposition of hazard lines on LIMs or any other documents;
- b) Make representations to Councils concerning the coastline, including the rights and interests of property owners along or near the coastline;
- c) Undertake scientific, engineering, legal and other research relating to the coastline and provisions to govern activities along or near the coastline;
- d) Make representations, gather evidence and make submissions and appeals concerning any consultative or statutory document, including any Regional/District Plan or draft or proposed Regional/District Plan;
- e) Take any appropriate legal or other action required to further the objectives of the Society;
- f) Do anything necessary or helpful to the above purposes.

Legal action supported by CRU was successful in getting the LIM information fixed. Legal and political action succeeded in getting KCDC to appoint scientific and planning panels to review the PDP and its processes. The science panel found that the coastal hazard information used for the PDP and the LIMs was not fit for purpose, and the planning panel advised that the PDP was so flawed that it was nearly a toss-up whether to withdraw it and start again or try to fix it through the hearings process.

KCDC then withdrew all coastal hazard provisions from the PDP, with a promise to develop suitable new provisions by way of variation to the proposal by 2020 (a promise which was not honoured).

Regarding submissions on the PDP, a case was taken to the Environment Court about the way in which coastal hazard matters were being dealt with, and an appeal against the final approved version, all led to significant other improvements in the Plan.

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## Addendum to:

“Comments on Jacobs’s Methodology Report (Volume 1)”

## Consequent upon the publication of:

IPCC, 2021: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* August 2021

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## INTRODUCT IO N

In July 2021 Coastal Ratepayers United Inc. (CRU) prepared a review (the “CRU Review”) of a report by Jacobs NZ Ltd for the Kapiti Coast District Council: *Kapiti Coast Coastal Hazard Susceptibility and Vulnerability Assessment Volume 1: Methodology*. The Jacobs Report was to “update previous coastal hazard assessments undertaken along the Kapiti Coast District shoreline” to assist the KCDC’s “Takutai Kāpiti: Our community-led coastal adaptation project”.

The *CRU Review* addresses a number of professional judgments and technical assumptions made in the report that detracted from its usefulness for KCDC and the community in supporting its stated purpose (1.1), particularly its use for Hazard Assessment under the NZCPS for planning purposes.

Since then then the IPCC, has published *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* August 2021, providing a major update on the climate related aspects of the Kapiti coastal processes.

We have therefore reconsidered the *CRU Review* in light of the IPCC AR6 WG1 report and have prepared this brief addendum addressing two areas where AR6 provides additional insights<sup>1</sup>:

- 2 Relationship between Global MSL and Local SL.
4. Use of RCP 85H+ and de facto Adoption of RCP 80 for Sea-Level Rise (SLR).

This addendum should be read in conjunction with the *CRU Review*. In particular, we draw attention to the disclaimers made in the *CRU Review* that also apply to this addendum.

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## 2. Relationship between Global MSL and Local SL.

The *CRU Review* drew attention to the weaknesses in Bell et al. (2018) as used by the Jacobs Report for adjusting the Global MSL rise to give the Wellington Relative SLR. This is needed to assess the impact of GMSL rise on the Kāpiti coast.

The Jacobs Report used Bell et al, 2018 to estimate an average historic rate of RSLR from 1900 to 2017 at  $2.28 \pm 0.15$  mm/yr, compared with a global average rate of rise of  $1.7 \pm 0.2$  mm/yr from 1901 to 2010 (IPCC, 2014). This would suggest applying an adjustment of  $\sim 0.6$  mm/yr to GMSL projections to get an estimate of Wellington RSL projection, but Jacobs instead applies 1 to 3 mm/yr adjustment into the future, not carrying forward several sources of local change on the basis that they are unpredictable.

Jacobs therefore overstates projected RSLR by using the worst case possible.

IPCC AR6 WG1 (2.3.3.3) revisits its estimates of the 1901 to 2010 global average rate of SLR adopting  $1.5 \pm 0.1$  mm/yr (Table 2, Palmer et al (2021)<sup>2</sup>, the basis for IPCC’s revision). This change would marginally increase the adjustment to AR6 projections needed to give RSLR at Wellington ( $\sim 0.8$  mm/yr). This is slightly closer to what Jacobs assume, but it still overstates the projections rather than incorporating the uncertainty into the overall projection uncertainty.

Denys et al. *Sea Level Rise in New Zealand: The Effect of Vertical Land Motion on Century-Long Tide Gauge Records in a Tectonically Active Region* (2020)<sup>3</sup> gives a more extensive analysis of these issues than Bell et al. (2018), and Table 6 shows closure across the country (1891–2013) to within the margin of error of the IPCC AR6 global average 1901 to 2010 rates of increase. This would argue for the use of an average adjustment of only  $\sim 0.6$  mm/yr (2.18 mm/yr less 1.56 mm/yr) to ASLR projections, and also provide the basis for

<sup>1</sup> Carrying forward the *CRU Review* numbering on the two points.

<sup>2</sup> <https://doi.org/10.1088/1748-9326/abdaeac>

<sup>3</sup> <https://doi.org/10.1029/2019JB018055>



estimating the uncertainties for use of this adjustments in the Monte Carlo simulations as set out in the *CRU Review*.

#### 4. Use of RCP 8.5H+ and de facto Adoption of RCP 8.5 for Sea-Level Rise

The CRU Review made the point that the use of RCP 8.5H+ and de facto adoption of RCP 8.5 for Sea-Level Rise did not give effect to NZCPS Policy 24 because these scenarios didn't represent the "likely effects" of climate change. Our comments were based on the literature describing the AR5 RCP scenarios and their construction, and more recent comment along the same lines from Zeke Hausfather.

This has been further reinforced by IPCC AR6.

AR6 has developed the scenarios further, adding different socio-economic development pathways (SSP) to the earlier representative concentration pathways (RCP). Where AR5 had been silent on issues around scenario likelihood AR6 now explicitly addresses it (1.6.1.4). It states:

"In general, no likelihood is attached to the scenarios assessed in this Report. ...

"... However, the likelihood of high emission scenarios such as RCP8.5 or SSP5-8.5 is considered low in light of recent developments in the energy sector (Hausfather and Peters, 2020a, 2020b)<sup>4</sup>. ..."

This is further discussed in Section 4.2.2 where it notes:

"... The high-end scenarios RCP8.5 or SSP5-8.5 have recently been argued to be implausible to unfold (e.g., (Hausfather and Peters, 2020); ... . However, where relevant we show results for SSP5-8.5, for example to enable backwards compatibility with AR5, for comparison between emission-driven and concentration-driven simulations, and because there is greater data availability of daily output for SSP5-8.5. When presenting low-likelihood high-warming storylines we also show results from the high-end SSP5-8.5 scenario.

Thus, the Jacobs' projections are "implausible", and they are basically only used by the IPCC for comparative reasons.

Further Section 1.6.1.4 then goes on to say:

"... SSP3-7.0 and SSP5-8.5 are explicit 'no-climate-policy' scenarios (Gidden et al., 2019; Cross-Chapter Box 1.4, Table 1), assuming a carbon price of zero. These future 'baseline' scenarios are hence counterfactuals that include less climate policies compared to 'business-as-usual' scenarios – given that 'business-as-usual' scenarios could be understood to imply a continuation of existing climate policies.... Studies that consider possible future emission trends in the absence of additional climate policies, such as the recent IEA 2020 World Energy Outlook 'stated policy' scenario (International Energy Agency, 2020), project approximately constant fossil and industrial CO2 emissions out to 2070, approximately in line with the medium RCP4.5, RCP6.0 and SSP2-4.5 scenarios (Hausfather and Peters, 2020b) and the 2030 global emission levels that are pledged as part of the Nationally Determined Contributions (NDCs) under the Paris Agreement (Section 1.2.2; (Fawcett et al., 2015; Rogelj et al., 2016; UNFCCC, 2016; IPCC, 2018))."

The world is likely to see more serious emissions mitigation efforts in the future, and so the likely future pathways will be below the current 'business-as-usual'. Thus, adaptation planning should consider SSP2-4.5 as the upper limit of what is likely. While higher scenarios are not impossible, they are very far from

<sup>4</sup> References as per AR6 WG1 Report.

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being likely, and should not be central to adaptation planning. Thus, based on IPCC AR6 WG1, the high end of the “likely effects” of climate change would be best represented by the SSP2-4.5 scenarios.



**IN THE MATTER OF**

Resource Management Act 1991,  
Subpart 6 concerning Intensification  
Streamlined Planning Process

**AND**

**IN THE MATTER**

of Plan Change 2,  
Proposed plan change to the Kāpiti  
Coast District Plan under  
The Resource Management Act 1991,  
Schedule 1 Subpart 6.

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**STATEMENT OF EVIDENCE OF  
SEAN EDWARD RUSH  
REGARDING THE PROPOSED CQMP**

On behalf of  
**COASTAL RATEPAYERS UNITED Inc**

**March 2023**

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Coastal Ratepayers United Inc.

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### Introduction

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1. My full name is Sean Edward Rush.
2. I qualified as a lawyer in 1992 and have spent most of my career advising clients in the petroleum industry.
3. I obtained a Masters Degree in Petroleum Law and Policy in 2012, with distinction, studying post-graduate geology in the process, and was the Todd Group's asset manager for the Maui pipeline which exposed me to soil movement analysis and technology.
4. In 2019 I went back to University full time to study climate science, which included the physical science, adaptation and mitigation strategies, and post-graduate legal training on the Resource Management Act 1991 which supplemented my working knowledge of planning rules gained whilst at the Todd Group.
5. I graduated with a Masters Degree in Climate Change Science and Policy from Victoria University of Wellington ("VUW"), with merit, in 2021 and was an Expert Reviewer for the IPCC, contributing to the recent Sixth Assessment Report (Working Group 1, The Physical Science Basis) ("IPCC 2021" or "AR6").
6. In 2019 I was elected to the Wellington City Council and was the Chair of its Infrastructure Committee, portfolio lead for Low Carbon Energy and its representative for several committees and trusts. Due to my climate studies, I familiarized myself with climate reports prepared by the likes of NIWA, GNS and the MfE regarding the Wellington region and regularly corresponded with experts regarding such reports. I took a particular interest in the sea-level literature and measurement techniques affecting the Wellington region.
7. I did not stand for re-election.
8. In preparation for this Statement of Evidence, I have read aspects of the following dealing with sea-level rise and vertical land movement:
  - i. Kāpiti Coast Coastal Hazard Susceptibility and Vulnerability Assessment Volume 1: Methodology (Jacobs 1);
  - ii. the Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volume 2: Results report (Jacobs 2);
  - iii. the Ministry for the Environment's July 2022 *Interim guidance on the use of new sea-level rise projection* (MfE, 2022);
  - iv. the New Zealand Coastal Policy Statement 2010 (NZCPS 2010);
  - v. the Coastal Erosion Hazard Assessment for the Kāpiti Coast: Review of the Science and Assessments Undertaken for the Proposed Kāpiti Coast District Plan 2012 (Shand Review);
  - vi. the Kāpiti Coast coastal hazard assessment, Dr Willem de Lange, Department of Earth and Ocean Science, the University of Waikato, (November 2013) ("De Lange 2013");

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### Code of Conduct

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9. I have read the Code of Conduct for expert witnesses in the Environment Court Practice Note 2023 and I have complied with it when preparing this evidence. Except when I state that 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.
10. I am not a member of CRU, I do own a coastal property in Otaki but have not submitted on PC2. My property is within the proposed CQMP although this was only communicated to me after I agreed to provide this evidence. I support the use of natural hazard mapping and adaptive management within hazard zones. However, for reasons I will outline in my evidence, I am of the view that the Jacobs 2 report does not provide a sound basis for the proposed CQMP.

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### Scope of Evidence

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11. My evidence covers the following areas:
  - i. A review of relative sea-level rise (**RSLR**) over the 20<sup>th</sup> century shows there has been no acceleration of RSLR across the 20<sup>th</sup> century. NIWA scientists previously confirmed that rising sea levels in New Zealand, as assessed by tide gauges, showed no statistically significant acceleration through to the early 21<sup>st</sup> century, although more recent literature suggests otherwise;
  - ii. A review of Jacobs 1 leads to my view that the authors have not looked closely at some of the peer-reviewed literature, relied on some literature that has been superseded, and have underestimated the uplift associated with the vertical land movement (**VLM**) component of relative sea-level rise (**RSLR**) and accordingly over-estimated the likely RSLR projections;
  - iii. How the use of representative concentration pathway<sup>1</sup> 8.5 (RCP 8.5) (and its 83<sup>rd</sup> percentile derivative RCP 8.5H+) should not be used to predict coastal hazard lines, because it is now described as not a likely or plausible scenario by the latest IPCC report (AR6);
  - iv. A critique of MfE 2022 is the interim coastal guidance that is underpinned by the "SeaRise"<sup>2</sup> project's satellite estimates of vertical land movement. In particular, how the SeaRise team's work has not passed the peer review process, was fast-tracked into policy anyway and has caused controversy amongst the geoscience community;
  - v. A response to the Statement of Evidence of Derek John Todd.

<sup>1</sup> Representative concentration pathways are an estimate of the amount of emissions that would occur given certain assumptions around fossil fuel and other high emitting activities. The numeric value is the amount of warming in 'watts per square metre, so RCP 8.5 denotes an expected increase in warming of 8.5 watts per square metre.

<sup>2</sup> The SeaRise project is led by Victoria University scientists with others from GNS and other NZ and international institutions. The project used satellite data between 2003-2011 to measure land uplift and subsidence around the NZ coastline. This work has been incorporated into MfE 2022 as the vertical land movement component of sea-level rise projections.

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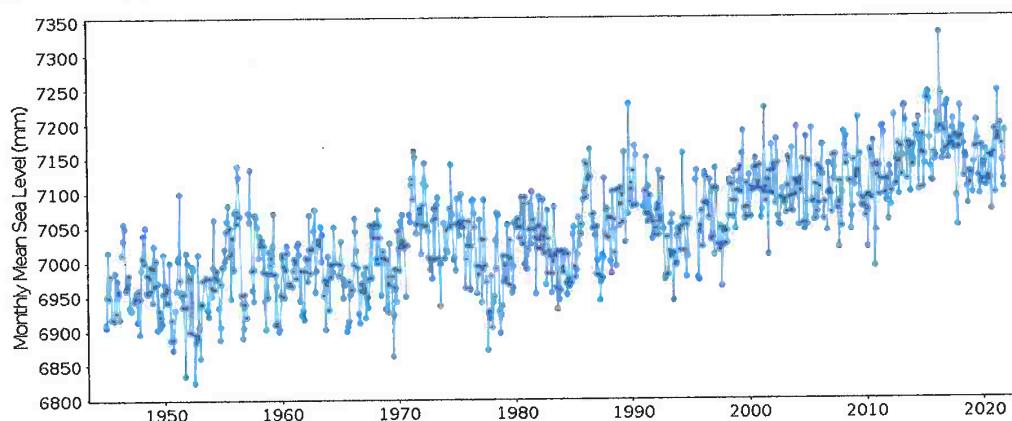
12. My main conclusions are that Jacobs 1:
  - i. does not utilise the best available information on the likely effects of climate change (per NZCPS Policy 24) on the region or district;
  - ii. omits reference to the latest science about important aspects of coastal planning relating to vertical land movement and tide gauge measurements;
  - iii. is inconsistent with IPCC 2021; and
  - iv. utilises conservative and in my view, unlikely scenarios that, when aggregated, have a compounding effect on the likelihood of their occurrence;
13. My evidence relates to the spatial extent of the “**Coastal Qualifying Matter Precinct**” proposed by the Council under Proposed Plan Change 2 (Intensification) (**PPC2**) to the Operative Kāpiti Coast District Plan 2021. The spatial extent of the “**Coastal Qualifying Matter Precinct (CQMP)**” was informed by the methodology set out in Jacobs 1. As explained in my evidence this report did not incorporate the latest, best available information, including guidance on the likely effects of climate change, with the result that, in my opinion, Jacobs 2 overestimates the inland extent of coastal erosion and inundation over the planning time horizon of 100 years compared with what is required by the NZCPS Policy 24 when assessing coastal hazards under the RMA.
14. Consequently, in my view, Jacobs 2 does not provide a sound basis for determining the location and extent of likely coastal erosion in Kāpiti and is therefore unsuitable as a basis for determining the proposed CQMP.

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### Relative Sea -Level Rise across the 20<sup>th</sup> century

15. There are two ways of expressing sea-level rise ("SLR"):
- (i) Absolute or eustatic<sup>3</sup> SLR is the rise in sea-level relative to the centre of the Earth and is essentially the actual rate of rise in ocean water level. It is measured by altimeters on board satellites, with orbits measured relative to the centre of the Earth, and
  - (ii) Relative sea-level rise (**RSLR**) is the local SLR, which includes both the absolute SLR plus changes (up or down) in land elevation for the relevant coastal area. RSLR is determined from tide gauge measurements, as the gauge is subject to both changes in ocean level as well as vertical land movement (**VLM**). It is RSLR that communities need to adapt to.<sup>4</sup>
16. Below is the tide gauge record from Queen's Wharf in Wellington since 1944. It will be observed that the sea level peaked in 2016, with the sharp drop likely due to the El Niño Southern Oscillation (**ENSO**) weather pattern and land uplift associated with the Kaikoura earthquake.

**Figure 1:** *Queen's Wharf (station 221) tide gauge from the Permanent Service for Mean Sea Level (2 March 2023)*



17. The oscillation of the sea-level trends can be attributed to the influences of local and regional meteorological effects (including storm surges), modes of climate variability (for example the El Niño-Southern Oscillation) and long-term trends (from both the ocean surface and land movements), including the impact of anthropogenic climate change (Church and White 2011)<sup>5</sup>
18. Undoubtedly sea-level is rising and an acceleration may be occurring, but (as set out in paragraph

<sup>3</sup> "Eustatic" sea-level changes relate to changes due to the volume of water, rather than land movement or oceanic currents.

<sup>4</sup> Bell et al 2018, page 7.

<sup>5</sup> Church, J.A., White, N.J. Sea-Level Rise from the Late 19th to the Early 21st Century. *Surv Geophys* 32, 585–602 (2011). <https://doi.org/10.1007/s10712-011-9119>

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23 below) more time is needed to identify any accelerating trend that is outside the bounds of periodic, long-term, oscillations.

#### SATELLITE VS. TIDE GAUGES

19. Sea-level changes are predominantly measured by two systems, the satellites<sup>6</sup> and tide gauges but they measure different things and each has strengths and weaknesses.
20. For coastal planning purposes, it is the relative sea-level that is important and the go-to tool has traditionally been the tide gauge.
21. Satellite altimeters have measured sea level since 1992. They measure an average response over an area of ocean (the Global Mean Sea-level or **GMSL**), while tide gauges measure the sea level relative to the land at a specific location.
22. Any land within the satellite's footprint affects the reliability of the sea level estimate, with current systems unable to reliably measure sea level closer than 15-20 km from the coast (Centre National d'Études Spatiales (CNES), 2018<sup>7</sup>). In other words, satellites cannot measure relative sea-level with the same accuracy as a tide gauge but can give a less accurate measurement over a wider, spatial area.
23. Sea level varies in response to many factors over different time scales and in different regions. It is accepted international practice to determine rates of sea-level rise based on data series longer than 60 years to average out the effects of shorter duration oscillations (Chambers et al, 2012, Jevrejava et al 2008<sup>8</sup>). The satellite's 30-year data set is consequentially too short, hence the need for more time.
24. This caution was the key finding of Bâki et al 2020<sup>10</sup> whose concluding remark stated:
 

*"Until the uncertainty of a recent **GMSL** [global mean sea level] acceleration is established in the context of "total evidence", i.e. in the light of systematic global sea level variations during the 20<sup>th</sup> century revealed by TG measurements together with the available **SA** [satellite altimeter] time series, any prediction of a **GMSL** rise ought to be made with extreme prudence."*
25. This caution was echoed in MfE 2017 which noted that the 23-year satellite record showed a near 'doubling' from the prior record. But then went on to state: *"To ensure the separation of decadal-scale variability from the regional trends, and definitively assess long-term climate shift, a longer time series from the satellite altimetry is still required."*<sup>11</sup>

#### LATEST SCIENCE ON THE NEW ZEALAND TIDE GAUGES

26. An analysis of New Zealand's five long-term tide gauges was recently completed (Denys et al 2020)<sup>12</sup>; resulting in an overall VLM at the tide gauge benchmark of  $-0.62 \pm 0.40$  mm/y.

<sup>6</sup> The satellites that measure global mean sea level (GMSL) should not be confused with the GPS satellites that are part of the Global Navigation Satellite System ("GNSS") that are important to the evaluation of land movement.

<sup>7</sup> CNES, 2018. Jason-3 Products Handbook. Centre national d'Études Spatiales (National Centre for Space Studies), Paris, France, Report SALP-MU-M-OP-166118-CN.

<sup>8</sup> Chambers DP, Merrifield MA, & Nerem RS, 2012. Is there a 60-year oscillation in global mean sea level? Geophysical Research Letters 39: L18607.

<sup>9</sup> Jevrejava et al 2008, "Recent global sea-level acceleration started over 200 years ago?" <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2008GL033611>

<sup>10</sup> İz, H. Bâki and Shum, C.K. "The certitude of a global sea level acceleration during the satellite altimeter era" Journal of Geodetic Science, vol. 10, no. 1, 2020, pp. 29-40. <https://doi.org/10.1515/jogs-2020-0101>

<sup>11</sup> MfE 2017 page 78.

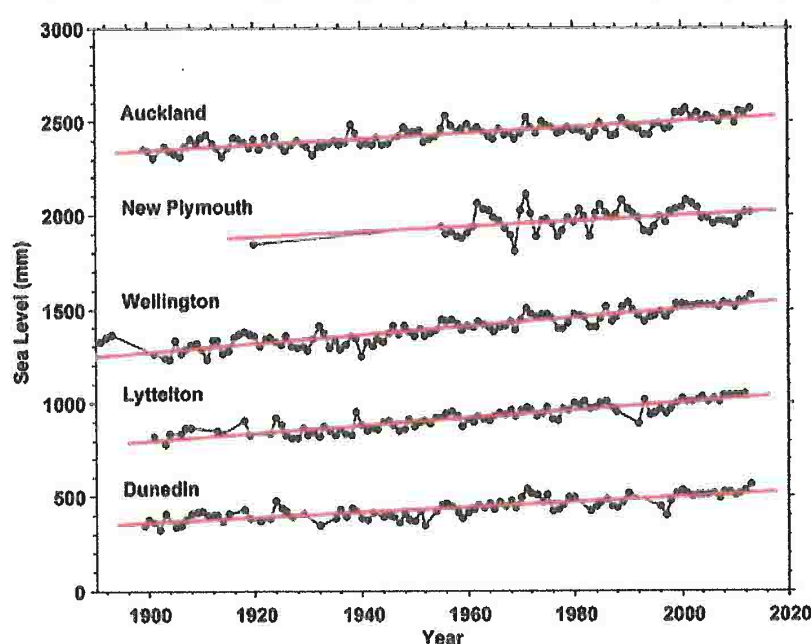
<sup>12</sup> Denys et al (2020) "Sea Level Rise in New Zealand: The Effect of Vertical Land Motion on Century-Long Tide Gauge Records in a Tectonically



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27. Their results indicate an average rate of eustatic sea-level rise of  $1.45 \pm 0.36$  mm.y-1, and they did not detect any acceleration in the rate over time, which agrees with an earlier assessment by Fadil et al (2013)<sup>13</sup> that found an average rate over 1900- 2011 of  $1.46 \pm 0.10$  mm.y-1.
28. Denys et al (2020) did report that splitting the Auckland data at 1961 indicated a higher rate of sea-level rise for 1961-2013 but noted that internal variability (specifically Interdecadal Pacific Oscillation) could explain the apparent increase in trends.
29. Their analysis of RSL and VLM are plotted in figure 2 showing Wellington's sea-level rise, combined with subsidence, averaged +2.18 mm/year. Other long-term tide gauges show a similar trend.

Figure 2: RSL trends with an arbitrary vertical offset applied to each sea-level record from Figure 2, Denys et al (2020)



30. The lower rates of VLM that are implied by the tide gauges resulted in the following caution from the authors of Denys et al 2020:

*"It also implies that unknown and unmodeled VLM is likely to occur at other global long record TG sites and is currently not being taken into account and therefore leading to bias GMSL [Global Mean Sea-Level] estimates. Thus, more work is needed to understand the physical processes responsible for lower rates of VLM-corrected sea level change in NZ when compared with GMSL."*

31. Coastal planners have traditionally relied on tide gauges that have been reasonably consistent throughout the anthropogenic global warming period. An improvement would be to install such gauges along the Kapiti Coast shoreline.

Active Region."

<sup>13</sup> Fadil A, Denys P, Tenzer R, Grenfell HR, & Willis P, 2013. New Zealand 20th century sea level rise: Resolving the vertical motion using space geodetic and geological data. Journal of Geophysical Research: Oceans 118: 6076-6091

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### COMMENTS ON JACOB'S 1

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32. I have reviewed the comments made in Jacob's 1 Section 3.3 *Projections of Local Vertical Land Movements* and found the authors had confused 'net' subsidence with 'gross' subsidence.

#### **Section 3.3: Projections of [some] Vertical Land Movements [but not all]**

33. I was struck by the considerable difference Jacobs 1 ascribes for VLM measured by Beaven and Litchfield (2012), Bell and Hannah (2012) and the more recent measurements stated by the authors Bell et al (2018). Jacob's 1 states that:

*"the lower North Island had subsided at average rates of 1 – 3 mm/yr over the previous 10 years, with the average rate for the Wellington region being 1.8 mm/yr, with the Kapiti coast being closer to 1 mm/yr. A more recent analysis by Bell et al (2018) notes that in general, the Wellington region is subsiding at rates of between 2-5 mm/yr over the last 20 years, with the Kāpiti Coast site averaging 5.15 mm/yr and Paekākāriki site averaging 3.45 mm/yr."* (emphasis added)

The discrepancy between 1 mm/yr and 5.15 mm/yr for Kapiti and 3.45 for Paekākāriki seemed considerable and worthy of review as did the inference that the Kapiti site's VLM was averaged over 20 years. Bell et al 2018 reported on only the prior 10 years for the Kapiti site. Paekākāriki subsided by 3.45 mm/yr seemingly over the first and second 10-year periods of its record. Neither peer-reviewer appears to have investigated these discrepancies.

The mixing up of different data measurements across different timescales is confusing. The most important measurement for decision-makers was not highlighted. That both Kapiti and Paekakariki have been subject to net uplift of 21mm and 19 mm respectively across the last 10 years.

#### **THE IMPORTANCE OF SLOW SLIP EVENTS TO SEA-LEVEL**

34. The two values are measurements of different things. The former value (1 mm/yr) is the net movement after slow slip events and other uplifting movement has been factored in. The latter values are the "secular" subsiding trend, with the balancing uplift removed. Bell et al 2018 (Table 4.1), from where Jacobs 1 has sourced their data, clarifies how their measurements were compiled:

*"tectonic components such as slow slip events, coseismic offsets, and post-seismic responses have been removed to isolate the underlying trend without tectonic events."*

In other words, all uplifting events were removed leaving the subsiding trend. It is unclear what is the scientific justification for this other than to examine the subsiding trend for academic purposes. It has no practical utility.

35. Bell et al 2018 went on to include the uplifting trends to reflect the observational record and went on to conclude:

*"The net effect is that the subsidence due to the subduction of the Pacific plate under the Australian plate and coseismic displacement to date was mostly cancelled out by the current day Kaikoura earthquake post-seismic deformation and the upwards ratcheting effect of the SSEs [slow slip events]."*

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36. That is an important finding that has not been identified in Jacobs 1. Jacobs 1 does not address these uplifting effects even though they are well documented in the peer review (e.g. Wallace and Beaven 2010<sup>14</sup>, Wallace 2020<sup>15</sup>, Beaven and Litchfield 2012<sup>16</sup>, King et al 2020<sup>17</sup>).
37. Due to their tectonic origins, these events have occurred and are certain to occur again. A detailed explanation of these uplifting movements resulting from the tectonic events is given in Bell et al (2012) who cites Denys et al. (2012)<sup>18</sup> which was an early draft of Denys' et al 2020:  
*"Denys et al. (2012) are of the view that it is the outcome of two related tectonic events. One is the coupling between the Pacific and Australian plates on the subduction interface that underlies Wellington (Wallace et al. 2004), and the other the outcome of slow slip events (SSEs) that have twice been observed in the region since 1997 (Wallace and Beaven, 2010)."*
38. In simple terms, the Australian plate upon which most of New Zealand lies, is being dragged down by the subducting Pacific plate, but periodically there is a ratcheting backup of the Australian plate as it decouples from the subducting Pacific plate. This ratcheting can manifest as an episodic earthquake or as a more subtle gradual uplift over longer periods, as slow slip events (SSEs). Bell et al 2012 note how these SSEs have almost certainly reduced the subsiding trend over the longer term. The tide gauges do not record subsidence at the higher values Jacobs 2 suggests should be adopted by policymakers. The authors caution:  
*"The fact that the cGPS trend estimates are derived from data collected between 2000-2009 i.e., between the two SSEs is likely to result in regional ground motion that is quite different from the overall average for the 1891-2011 period of the tide gauge record."*
39. These events have now been observed and documented four times (King et al 2020, Wallace 2020) and almost certainly occurred before the start of the GNSS record.

#### THE LATEST SCIENCE OF SLOW SLIP EVENTS

40. Slow slip events, and their effect on RSL, are explained in detail in Beaven and Litchfield 2012, "Vertical land movement around the New Zealand coastline: implications for sea-level rise." Whilst this study informed the MfE's Coastal Guidance (MfE, 2017, section 5.3) no reference is made to SSEs in the guidance – an important omission which, given subsequent verification of the recurring nature of these events, should be corrected. Requests to MfE for clarification have gone unanswered.
41. Beaven and Litchfield's 2012 figure 8 illustrates the effect of SSEs and the importance of measuring the uplifting VLM over several SSE cycles:

<sup>14</sup> Wallace and Beaven 2010 "Diverse slow slip behavior at the Hikurangi subduction margin, New Zealand" <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2010JB007717>

<sup>15</sup> Wallace Laura M., "Slow Slip Events in New Zealand" Annual Review of Earth and Planetary Sciences Vol. 48:175-203 (Volume publication date May 2020) First published as a Review in Advance on January 7, 2020 <https://doi.org/10.1146/annurev-earth-071719-055104>

<sup>16</sup> Beaven and Litchfield 2012 Vertical land movement around the New Zealand coastline: implications for sea-level rise. GNS 2012/29.

<sup>17</sup> King, D., Newnham, R., Gehrels, R Clark, K. (2020). Late Holocene sea-level changes and vertical land movements in New Zealand, New Zealand, Journal of Geology and Geophysics, DOI: 10.1080/00288306.2020.1761839.

<sup>18</sup> Note Denys et al 2012 was never published and was subsequently superseded by Denys et al 2020 who make the same point on page 14 of their study (pers comm P. Denys 7 March 2023).

Figure 3: Figure 8 from Beaven and Litchfield 2012.

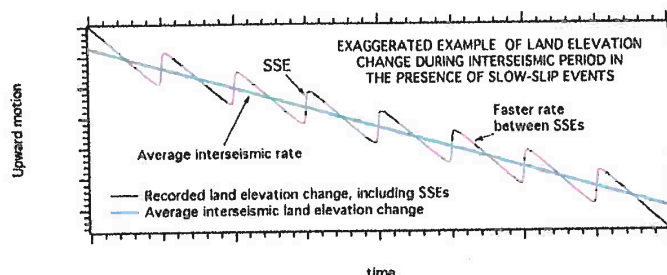


Figure 8 Slow-slip events (SSEs) have been recorded along the North Island east coast and at sites around the Wanganui Basin since the installation of cGPS units in the region. These are slow earthquake-like events that are observed to take place over days to weeks along the east coast, and over periods of a year or more along the Kapiti coast. They modulate the interseismic vertical motion, so that a measurement of land elevation change between two SSEs may be quite different from the rate averaged through many events (which is the rate of most interest for RSL predictions). In the idealised example above, the subsidence rate measured between two SSEs is substantially faster than the rate averaged through many SSEs.

42. Bell et al 2018 suggest SSEs provide 0-45 mm<sup>19</sup> uplift, with the biggest uplift on the Kapiti Coast. They state:

*"The east coast of the North Island, Kāpiti Coast and top of the South Island are all affected by periodic slow slip events (SSE) that have, so far, uplifted the land over the period of GPS/GNSS measurements (approximately 20 years). The largest events occurred in 2003, 2008 and 2013.*

*In this case, the Kapiti Coast 2013 SSE was active for approximately 12 months.*

*Based on the long record of cGNSS sites (WGTN, WGTI, PAEK), these events appear to occur every 6–8 years and can last for up to one year. The SSE progressively become larger from the east coast to the west coast, which represents the transition from the Pacific to the Australian plates."*

43. At the GNSS site, WGTI (at Te Papa) SSEs have caused 17 mm of uplift in the decade before the study. With the trend being for higher uplift further west away from the Hikurangi zone (Bell et al 2018, Jacob 1), then the uplifting trend on the Kapiti coast is likely to be higher. Table 4.2 in Bell et al 2018 shows this to be the case with the following uplift by SSEs for three sites over the prior 10-year period:

- PAEK (Paekākāriki): 54 mm
- KAPT (Kapiti): 72 mm
- LEVN (Levin): 44 mm

Bell et al 2018 concluded that: *"It is evident, for the 10-year period 2008–2018, that there is a pattern of net uplift on the Kāpiti Coast of ~20 mm, decreasing to the east where the net subsidence is ~30 mm."*

44. It is important to note that GNSS sites may not be on the coast and their measurements may not be an accurate proxy for what's happening at the shoreline. For example, the Paekākāriki site is on

<sup>19</sup> Bell et al 2018, page 26. Note at section 4.5 this is stated to be 6-8 years.

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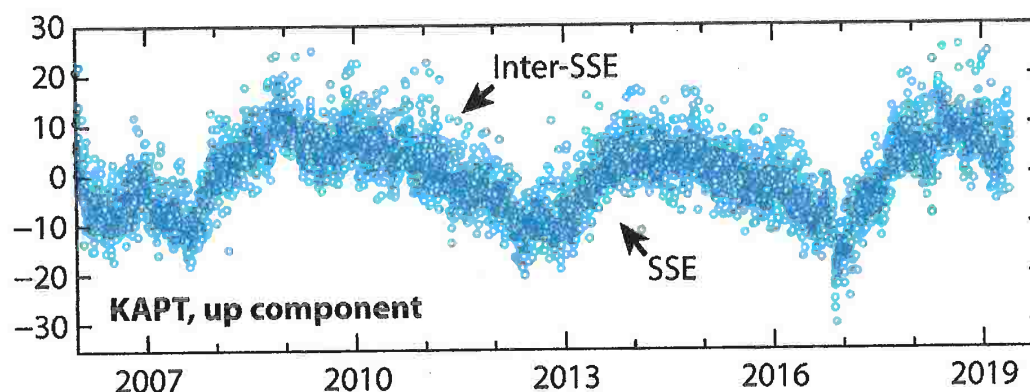
Paekākāriki Hill a dozen or more kms from the coast and elevated ~200 metres above it.

45. Whilst comparisons between GNSS sites can be useful, the rocks beneath each can be completely different and subject to different fault systems. They very much provide a local view of VLM.
46. The impact of SSEs on the Wellington area's rates of subsidence and its effect on the relative sea-level rise was explained carefully, with supporting literature, in King et al 2020. Similarly, Wallace 2020<sup>20</sup> reported that regarding the Kapiti Coast:

*"past Kapiti SSEs have occurred in 2003, 2008, 2013, and late 2016–2018—the latter was triggered by the November 14, 2016, Mw 7.8 Kaikōura earthquake (Wallace et al. 2018), which appears to have brought the Kapiti SSE recurrence forward in time by a couple of years."*

Figure 4 of Wallace 2020 shows the effect on the GNSS site at Kapiti.

**Figure 4:** Extracted from Wallace 2020, figure 3, shows the uplifting effects of SSE's and the subsiding effects of subsidence during the 'inter-SSE' phase as measured at the Kapiti GNSS site.



47. Despite Jacobs 1's publication in June 2021 (and the peer reviewers' comments from May 2021), the published work by Denys et al 2020, Wallace 2020 and King et al 2020 is not referenced or otherwise addressed. The most recent reference dealing with VLM is to Bell and Hannah 2018 who note how subsidence has been cancelled out.
48. Jacobs 1 is accordingly an incomplete analysis of the subject and leads to a biased assessment of the coastal hazards in terms of Policy 24 of the NZCPS 2010.
49. For example, Jacobs 1 concludes:
 

*"While it is possible to estimate the secular subsidence (long-term) and estimate with less certainty the SSE rate; it is not possible to estimate the displacement of future earthquake events, and therefore is difficult to incorporate into long-term projections of RSLR."*
50. The difficulty is that Jacobs 1 does not attempt to estimate the SSE rate even though they are predictable and have a significant impact on VLM and consequently, RSLR. In my view, this should be addressed before the RSLR projections can be used to predict the likely inland extent of coastal erosion and inundation over various time frames.

<sup>20</sup> Wallace, L. M. (2020). Slow slip events in New Zealand. Annual Review of Earth and Planetary Sciences, 48, 175-203.

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51. Denys et al 2020<sup>21</sup> concluded that:

*“Because there is clear nonlinearity in the VLM history at Wellington, and because this cannot be reliably documented prior to 1997, we can only determine the cumulative effect of the SSEs as indicative of the long-term trend.”*

In my opinion, this long-term uplifting trend needs to be identified and included in RSLR projections so that the *most likely* trend can be projected.

### EARTHQUAKES

Jacobs 1 states in regards to the vertical land movement (VLM):

*“The recent analysis from Bell et al (2018) concludes that it is difficult to provide a definitive long-term trend of VLM for any site in the Wellington region. This is largely due to the effects of, and ongoing influences on, crustal movement of the recent earthquake events since 2013, and that the complex deformation pattern in the region is likely to remain in the future. There is no reason to expect that the regional long-term trend of subsidence being driven by the Australian-Pacific Plate subduction is going to stop, and this is therefore included in the resulting RSLR projects in Section 3.4”*

52. As a clarification, the final sentence *“There is no reason to expect that the regional long-term trend of subsidence being driven by the Australian-Pacific Plate subduction is going to stop,”* is not from Bell et al 2018. Instead, Bell et al 2018 make clear that subsidence has been balanced by uplift.
53. The actual long-term trend is one of uplift. This is not controversial. Beaven and Litchfield 2012 cite studies examining the long-term VLM applying to New Zealand using 125,000-year markers. They all find the long-term trend is for New Zealand to be rising out of the sea.<sup>22</sup> Figure 3 from Beaven and Litchfield 2012 shows this trend with the Kapiti coast rising at 0.1 mm/yr.
54. Other studies<sup>23</sup> show that Wellington, and its surrounds, have an uplifting trend: up to 8 metres in Miramar over the last few thousand years and uplift from faults offshore along the Kapiti-Manawatu coast faults providing uplift (Nodder et al., 2007).<sup>24</sup> Bell and Hannah 2012 reported that there has been long-term tectonic uplift west of the Ohariu fault over the Holocene, citing a parallel study, Gibb, 2012.<sup>25</sup>
55. Numerous such studies, as recent as Ninis et al, in the January 2022 issue of the New Zealand Journal of Geology and Geophysics, have deduced net uplift over 200,000 years in the greater Wellington area.<sup>26</sup> It is unlikely that this trend would reverse, given the well-documented tectonic behaviour of this section of the plate boundary.
56. Jacobs 1's comment was presumably about the comparatively short-term data set provided by GNSS (10 – 20 years) that shows a subsiding trend during the 'inter-seismic' phase of the seismic

<sup>21</sup> Denys et al 2020, page 16.

<sup>22</sup> Pilans, 1986, 1990; Berryman and Hull, 2003; Berryman et al 2000; Litchfield, 2008.

<sup>23</sup> E.g. Pilans et al 1995 *“Interpreting coseismic deformation using Holocene coastal deposits, Wellington, New Zealand”* where Miramar and its surrounds was shown to have lifted by 8 metres over the last 6,500 years.

<sup>24</sup> Nodder, S.D., Lamarche, G., Proust, J.-N., and Stirling, M., 2007. Characterizing earthquake recurrence parameters for offshore faults in the low-strain, compressional Kapiti-Manawatu Fault System, New Zealand. *Journal of Geophysical Research: Solid Earth* 112(B12): B12102.

<sup>25</sup> Gibb J.G. 2012. Local relative Holocene sea-level changes for the Porirua Harbour area, greater Wellington region. Kerikeri: Coastal Management Consultancy Ltd. Report No.: C.R.2012/1.

<sup>26</sup> Ninis et al, 2022. *“Pleistocene marine terraces of the Wellington south coast – their distribution across multiple active faults at the southern Hikurangi subduction margin, Aotearoa New Zealand”*. *New Zealand Journal of Geology and Geophysics* 65: 242-263.

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cycle when the uplifting effects of SSE and co-seismic and post-seismic deformation have been removed. But that trend is frequently punctuated with uplifting episodic events (near and far away earthquakes, such as Seddon, Kaikoura, Christchurch, Napier 1931 and Wellington, 1855) or longer-term slow slip events which ratchet the Kapiti coast back from the subducting Pacific plate.

57. The net result over the 'long-term' is uplift and this should properly feature in hazard assessments such as Jacobs 1 and 2.
58. In my opinion, the concluding remarks of Bell et al 2018 that recommend ongoing monitoring and review are worthy of consideration:

*"the previous recommendation (Bell & Hannah, 2012) to update the analyses of RSLR and VLM a 5-yearly intervals is justified by the findings of this report and should continue at similar intervals with a more rigorous assessment undertaken every 10 years."*

59. MfE's 2017 Coastal Planning Guidance<sup>27</sup> (MfE 2017) cautioned against factoring in future occurrences of earthquake-generated uplift, other than in those areas with a clear geological history of uplift, citing Beaven and Litchfield 2012. The Kapiti Coast has a clear history of uplift which should be factored into coastal planning documents (and which should incorporate the revised National Seismic Hazard Model that was only released by GNS in late 2022).
60. Jacobs 1 has not followed MfE 2017 Guidance and considered the clear trend for uplift affecting the Kapiti Coast and consequently has produced a report on Kapiti Coast VLM that has focused on subsidence across a short period at the expense of the longer-term information that shows uplift over time. This has resulted in an exaggerated trend for sea-level rise going forward and overly conservative scenarios for coastal erosion and coastal inundation.

#### NO CONSIDERATION OF THE TIDE GAUGES

61. Jacobs 1 relies on a sea-level rise model that has been artificially constructed by piecing together:
  - i. the short-term ~10 - ~20-year GNSS VLM estimates (or SeaRise's even shorter 7-year InSar dataset); and
  - ii. the global eustatic mean sea level measurements from the comparatively short-term satellite ~30-year data set,

It ignores the seemingly consistent trends from the four/five long-term tide gauges that account for local effects of VLM, oceanic current changes and impacts of atmospheric weather patterns.

This approach is adding complication and uncertainty to an already complicated and uncertain task.

62. At a minimum, it would seem a missed opportunity not to use the tide gauge record to test the VLM findings from GNSS and InSar and the satellite altimetric data on sea level to ensure they correlate over the historic record. As Denys et al 2020 show, they have not done this.

<sup>27</sup> MfE Coastal Hazards and Climate Change: Guidance for Local Government, 2017, page 86. <https://environment.govt.nz/assets/Publications/Files/coastal-hazards-guide-final.pdf>



### RCP 8.5 – “Unlikely”, “Implausible” under IPCC AR6

63. Jacobs 1 (table 3.2) provides projections using some of the IPCC emissions pathways.<sup>28</sup> The highest emission pathway is known as RCP 8.5 and Jacobs 1 makes projections using its median. There is also a non-IPCC pathway constructed by the MfE known as RCP 8.5H+ which is an even higher emission pathway (83<sup>rd</sup> percentile of the RCP 8.5 projection i.e. if RCP 8.5 occurs there is a 17% chance RCP 8.5H+ occurs).
64. MfE 2022, now uses shared socio-economic pathways (SSPs) introduced by the IPCC 2021 report. The MfE claim that these “span a wide range of plausible societal and climatic futures and replace the previous representative concentration pathways (RCPs) used in the 2017 guidance.”<sup>29</sup>
65. MfE 2022 goes on to refer to SSP5-8.5 as “low confidence” out to 2300 and that it covers: “the upper range of plausible sea-level rise by incorporating an additional ice-sheet instability process.”<sup>30</sup>
66. However, the IPCC 2021 report does not deem RCP 8.5’s replacement, SSP5-8.5, as ‘plausible’ and nor does it consider sea-level rise due to ice-sheet instability plausible in the event of *likely* SSPs.
67. IPCC AR6 WG1 scientists have moved to clarify the status of the higher emissions scenarios (called ‘SSP3-7.0’ and ‘SSP5-8.5’), making it clear that they are not likely:

“... However, the likelihood of high emission scenarios such as ... SSP5-8.5 is considered low in light of recent developments in the energy sector ...” [IPCC AR6 WG1 Section 1.6.1.4]

“... SSP3-7.0 and SSP5-8.5 are explicit ‘no-climate-policy’ scenarios ... , assuming a carbon price of zero. These future ‘baseline’ scenarios are hence counterfactuals that include less climate policies compared to ‘business-as-usual’ scenarios – given that ‘business-as-usual’ scenarios could be understood to imply a continuation of existing climate policies...” [IPCC AR6 WG1 Section 1.6.1.4]

“The high-end scenarios RCP8.5 or SSP5-8.5 have recently been argued to be implausible to unfold ... . However, where relevant we show results for SSP5-8.5, for example to enable backwards compatibility with AR5, for comparison between emission-driven and concentration-driven simulations, and because there is greater data availability of daily output for SSP5-8.5.” [IPCC AR6 WG1 Section 4.2.2]
68. That RCP8.5 and SSP5-8.5 are no longer deemed plausible in IPCC (2021) is supported by recent literature including Hausfather and Peters (2020a<sup>31</sup>; 2020b<sup>32</sup>), Pielke and Ritchie (2021<sup>33</sup>), and

<sup>28</sup> The IPCC have determined that the rate of sea level rise is linked to human activities and associated emissions that act to warm the surface. The highest value is RCP 8.5 where the ‘8.5’ in RCP 8.5 refers to 8.5 W/m2 with similar convention for the other RCPs.

<sup>29</sup> MfE 2022 page 10.

<sup>30</sup> MfE 2022, page 14.

<sup>31</sup> Hausfather Z, & Peters GP, 2020a. Emissions – the ‘business as usual’ story is misleading. Nature 577(7792): 618– 620.

<sup>32</sup> Hausfather Z, & Peters GP, 2020b. RCP8.5 is a problematic scenario for near-term emissions. Proceedings of the National Academy of Science 117(45): 27791-27792.

<sup>33</sup> Pielke Jr R, & Ritchie J, 2021. Distorting the view of our climate future: The misuse and abuse of climate pathways and scenarios. Energy Research and Social Science 72: 101890.

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Burgess *et al* (2021<sup>34</sup>), none of which are referred to in Jacobs 1. It is also important to note that medium scenarios (RCP4.5, RCP6.0 (discontinued) and SSP2-4.5) are more plausible and consistent with current global policies and emissions. Figure 4 illustrates the “low-likelihood, high impact” storyline that describes SSP5-8.5.

Figure 5: Figure 4 from IPCC AR6

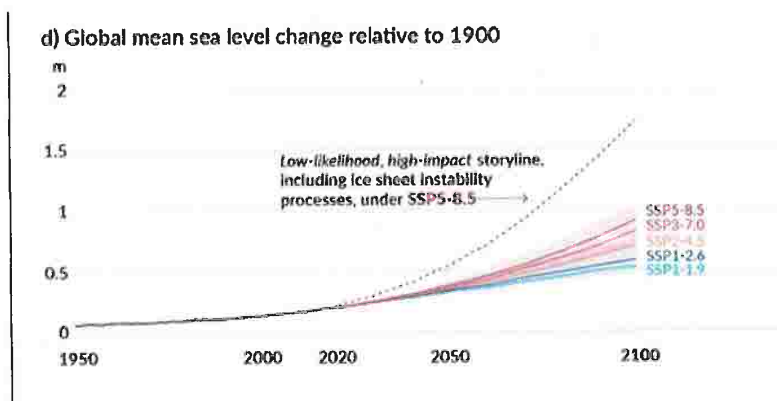


Figure 4: From IPCC AR6 WGI (SPM.8) projected eustatic sea level changes relative to AD 1900 for 5 scenarios (IPCC, 2021). The data for 1950-1992 are from tide gauges, satellite altimetry for 1992-2014, and CMIP6 models from 2014. Data are adjusted upwards to allow for 0.158 m sea level rise from 1900 to the 1995-2014 baseline used for simulations.

69. Regarding policy, the IPCC concluded that “*High-end scenarios (like RCP8.5) can be very useful to explore high-end risks of climate change but are not typical ‘business-as-usual’ (BAU) projections and should therefore not be presented as such.*”<sup>35</sup> (emphasis added)
70. MfE 2017 advised planners that for Category ‘A’ development, they should use the RCP 8.5H+ scenario. This has been walked back in the MfE’s Interim Guidance (MfE 2022) on the use of new sea level rise projections assuming a Dynamic Adaptive Planning Process (DAPP)<sup>36</sup> strategy is available. It states:
 

*“Use the five updated “medium confidence” scenarios out to 2150 to undertake risk and vulnerability assessments and stress-test proposals, strategies, project designs, policies, rules, statutory coastal hazard overlays, and emerging spatial plans.”*
71. MfE 2017 suggests the exact scenario chosen to apply to a district plan is at the discretion of the Council, based on what it considers (based on expert advice) to be the “most likely” scenario and how the DAPP strategy may operate in the event new information arises.

<https://www.sciencedirect.com/science/article/abs/pii/S2214629620304655>

<sup>34</sup> Burgess MG, Ritchie J, Shapland J, & Pielke Jr R, 2021. IPCC baseline scenarios have over-projected emissions and economic growth. Environmental Research Letters 16: 014016. <https://iopscience.iop.org/article/10.1088/1748-9326/abcdd2>

<sup>35</sup> IPCC AR6 WGIII Chapter 3, FAQ 3.3, page 386.

<sup>36</sup> The Dynamic Adaptive Policy Pathways (DAPP) approach develops a series of actions over time (pathways). It is based on the idea of making decisions as conditions change, before severe damage occurs, and as existing policies and decisions prove no longer fit for purpose. Source: Auckland City Council.

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72. Jacobs 1 does not reference a DAPP strategy as either in existence or as a recommendation for one to be developed. A DAPP strategy is likely to provide alternative options to the recommendations provided in Jacobs 2.
73. However, in any event, the requirements for any coastal hazard assessment are set out in Policy 24 of the NZ Coastal Policy Statement 2010, and that makes it clear that for any advice such as MfE 2017 to be taken into account in assessing hazards it must address the “likely effects” of climate change. Using high-end scenarios does not.
74. About ice-sheet instability, Jacobs 2 continues:
- “Dr Rob Bell (pers com Nov 2021), has indicated that there is no plan to drop RCP8.5 (or SSP5-8.5 equivalent) scenarios from the updated New Zealand SLR projections to be released in mid-2022 as this scenario and RCP8.5H+ represents the runaway polar ice sheet instabilities, which are now accepted as having a tipping point somewhere approaching a 2° C rise in temperature since the pre-Industrial era. It is noted that for RCP8.5 sea level rise scenario, this temperature rise is predicted by IPCC AR6 (2021) to occur around 2050 under a mid-range SSP2-4.5 scenario.”*
75. Dr Bell’s comments on ‘runaway polar ice sheet instabilities’ are repeated in MfE 2022, which is consistent with Dr Bell’s co-authorship of that document. MfE 2022 cite Schellnhuber et al 2016<sup>37</sup> in support of this claim.
76. A careful read of that paper, and figure 1 that addresses “Tipping elements”, discloses that the biggest ice sheet, the East Antarctic ice sheet, is not included in the ~2°C tipping point and most of the Western Antarctic ice sheet survives well beyond the Paris range of 2°C. In this paper, a ‘tipping point’ does not mean ‘irreversibility’ so a different definition to that of the IPCC is used. Accordingly, caution should be exercised when considering its projections in the context of IPCC recommendations.
77. The paper is not cited by the IPCC in its AR6 2021. Instead, the IPCC notes that projections up to 2050 are similar irrespective of scenario.<sup>38</sup> Chapter 9 (Oceans and Cryosphere) regarding 2050 warming, RCP 8.5 and ice sheet instability, states:
- “GMSL [global mean sea level] will rise by 2050 between 0.18 [0.15 to 0.23, likely range] m (SSP1-1.9) and 0.23 [0.20 to 0.29, likely range] m (SSP5-8.5), and by 2100 between 0.38 [0.28 to 0.55, likely range] m (SSP1-1.9) and 0.77 [0.63 to 1.01, likely range] m (SSP5-8.5). This GMSL rise is primarily caused by thermal expansion and mass loss from glaciers and ice sheets, with minor contributions from changes in land-water storage. These likely range projections do not include those ice-sheet-related processes that are characterized by deep uncertainty. {9.6.3}”*
- Table 9.9 of AR6 (page 1302) references the SSP2-4.5 median scenario with a projection of 20 cm of global sea level rise by 2050 – there is no mention of “runaway polar ice sheet instabilities” or “tipping points.”
78. The IPCC AR6 examined the potential for ice-sheet instability. The MfE (2022) (and Dr Bell) found “the prospect of runaway polar-ice sheet instabilities and very long response time-lags (multi-decadal to centuries) in sea-level rise. But the IPCC conclusions were equivocal due to the many uncertainties.

<sup>37</sup> Schellnhuber, H., Rahmstorf, S. & Winkelmann, R. Why the right climate target was agreed in Paris. Nature Climate Change 6, 649–653 (2016). <https://doi.org/10.1038/nclimate3013> [Why the right climate target was agreed in Paris | Nature Climate Change](https://www.nature.com/articles/nclimate3013)

<sup>38</sup> IPCC AR6, Section 9.6.3.3.



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Its Summary for Policy Makers says:

*“There is limited evidence for low-likelihood, high-impact outcomes (resulting from ice-sheet instability processes characterized by deep uncertainty and in some cases involving tipping points) that would strongly increase ice loss from the Antarctic Ice Sheet for centuries under high GHG emissions scenarios.”<sup>39</sup>*

The IPCC clarify (footnote 34) that “Low-likelihood, high-impact outcomes are those whose probability of occurrence is low or not well known (as in the context of deep uncertainty) but whose potential impacts on society and ecosystems could be high.”

And in the main text:

*“The largest uncertainties in future sea level and cryosphere change are related to the Greenland and Antarctic ice sheets (Sections 9.4.1.3, 9.4.1.4, 9.4.2.5 and 9.4.2.6). While the ISMIP6 and LARMIP-2 protocols provide simulations permitting uncertainty estimation and probabilistic inferences, remaining deep uncertainty relates to ice-sheet processes and the atmospheric and oceanic conditions simulated by CMIP models in polar regions (Sections 9.4.2.3 and 9.4.2.4). ISMIP6 and LARMIP-2 have not been simulated beyond 2100, which greatly reduces the amount and variety of state-of-the-art projections available to make ice-sheet and sea level projections beyond 2150. After 2150, limited agreement causes us to consider all projections as low confidence. Critically, the uncertainty in ice-sheet projections is the leading uncertainty in projections of future global sea level for the second half of this century and beyond (Section 9.6.3).”<sup>40</sup>*

79. In short, there is low confidence and a high level of uncertainty surrounding the instability of the Antarctic ice sheet, and in the NZ context, these can be put aside because they rely upon the SSP5-8.5 scenario that is regarded as not likely/implausible. The IPCC does not dismiss the possibility that sea levels might be dramatically affected by Antarctic ice-sheet instability – of course, they can - but there is no suggestion of a ‘runaway polar ice-sheet’ instability that has a tipping point somewhere around the 2°C increase in 2050. Accordingly, in my view, MfE has not used the best available data to support its guideline.
80. The world is likely to see more serious emissions mitigation efforts in the future, and so the likely future pathways will be below the current 'business-as-usual'. Thus, adaptation planning should in my view, consider SSP2-4.5 as the upper limit of what is *likely*. While higher scenarios are not impossible, they are very far from being likely, and in my opinion, should not be central to adaptation planning. In my view, based on IPCC AR6 WG1, the high end of the “likely effects” of climate change would be best represented by projections based on the SSP2-4.5 scenarios.

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**The Ministry for the Environment's July 2022 Interim guidance on the use of new sea-level rise projection (MfE 2022)**

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81. MfE 2022 was prompted by new data coming out of the “SeaRise” project team with whom I have corresponded in my capacity as a Wellington City Councillor with thousands of affected coastal constituents, since their findings were broadcast on national television on 1 May 2022. The Interim Guidance (MfE 2022) was fast-tracked into policy with minimal consultation or

<sup>39</sup> IPCC AR6 WG1 Summary for Policy Makers, B.5.2.

<sup>40</sup> IPCC AR6, Section 9.7, page

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enquiry.

## 82. In summary:

- (i) the results have not passed the peer review yet. It was submitted in July 2022 and is still in the peer review process.
- (ii) It uses a short-term data set, between 2003 - 2011 (7 years) chosen for its 'inter-seismic' (and therefore subsiding) nature, and extrapolates the subsiding trend forward by decades and centuries to find enhanced but unrealistic RSLR. Like Jacobs 1, it ignores uplifting slow-slip-events and other uplifting trends that have caused Kapiti to rise out of the sea over the long term. There are acknowledged problems with the collection of the (descending) satellite data which means parts of the New Zealand coastline have been obscured from the line-of-sight radar.
- (iii) As with MfE 2017, it continues to use the unlikely RCP8.5-based scenarios targeting areas "potentially affected" (MfE 2022 p. 13), basing this on a misreading of Policy 24 of NZCPS. Areas potentially affected are still assessed taking into account "the best information on the **likely** effects of climate change" (emphasis added). RCP8.5-based scenarios do not provide this.
- (iv) Like GNSS, the InSar satellites measure VLM 'near' the coast but not at the coast. Instead, it takes a 5 km average of earth movement. Due to data collection issues, the team had to source data as far away as 40 km from the coast.
- (v) CRU's 2013 adviser, Dr Willem De Lange (Waikato University) and former Christchurch City Council coastal planner, Dr Ian Wright and Tonkin+Taylor expert, Richard Reinen-Hamill<sup>41</sup>, have all expressed concern with elements of the SeaRise model. Other leading scientists, including those from GNS and Canterbury University, have done so directly to me privately.
- (vi) At the Geoscience Society's 2022 conference's 'poster' session Victoria University's Professor Tim Stern (a SeaRise project team member) and Professor Simon Lamb with Otago University's, Professor Paul Denys, presented their findings on the benefits of utilising tide gauges for coastal planning<sup>42</sup> noting that the short-term GNSS/InSar satellite data sets may have significant variances to long-term trends.
- (vii) Documents disclosed under the Official Information Act show that:
  - a. The SeaRise results were destined to be published and implemented into policy irrespective of whether the findings had passed peer review and publication;
  - b. Dr Laura Wallace, New Zealand's foremost expert on slow slip events, described how experts in the geoscience community had reached out to her expressing concerns she had previously relayed and that the SeaRise model had "major holes" that would need to be addressed;<sup>43</sup>

<sup>41</sup> See <https://www.tonkintaylor.co.nz/news/2022/5/nz-searise-through-an-alternative-lens/> last visited 21 February 2023

<sup>42</sup> See Stern et al 2022, "Do tide gauge records from New Zealand provide a reliable picture of relative sea level change over the past 100 years?" GSNZ 2022 Conference poster session 2b Abstracts available at <https://az659834.vo.msecnd.net/eventsairsasiaproduct/production-confer-public/7ce4a83973de4441a7e6e92be3f8ebce>

<sup>43</sup> Email exchange Wallace – Naish/Levy September 2022 sourced via the OIA.

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- (viii) I have requested official information from Victoria University seeking the dissenting opinions of scientists involved in the peer review process but have been declined. A complaint has been made to the Ombudsman;
- (ix) Recent exchanges<sup>44</sup> between myself and Professor Tim Naish, the SeaRise Project Lead, confirm that the team are taking many of the points I have made on board and they will be addressed in the published manuscript once it passes the peer review. There was no discussion about how MfE 2022 might be amended;
- (x) Questions associated with this work and MfE 2022 have been raised by me with MfE but without substantive response.
- (xi) The 'interim' guidance (MfE 2022) is due to be finalized in 2023 when many of the issues raised can be addressed. In the meanwhile, in my opinion, MfE 2022 is unsafe to use for policy making.

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#### Response to the Evidence of Derek Todd

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83. Many of the matters I would address in response to Mr Todd's Statement of Evidence ("SoE") have been addressed previously but I would make the following comments:

#### PURPOSE AND METHOD – PARAGRAPHS 8 - 27

84. The Purpose of the Jacobs 1 and 2 reports and the intended use of Assessment Results (paragraphs 8 – 12 of the SoE) seems to have been undermined by an overly cautious interpretation of the NZCPS (2010), MfE 2017 and guided by government planning documents prepared by NIWA (e.g. Bell et al (2018)) as 'client reports' for MfE and regional or city councils, rather than peer-reviewed publications that are published in respected international scientific journals.
85. We know that the ground beneath Kapiti is not subsiding at the rates described by the GNSS sites (or the SeaRise team). Tide gauges nearby show this and the science on SSEs from Wallace 2020 etc explains why. Further, 80% of the coastline is accreting and there is no evidence of that trend reversing. IPCC 2021 has said that the most intensive emission profile, RCP 8.5, is not 'plausible.'
86. I do not understand why Mr Todd is maintaining that RCP 8.5 should be modelled to determine the sea-level component for "Coastal Erosion Distance" (paragraph 22) with the result that the "very unlikely scenario" (the 'P10') is proposed to determine the CQMP (paragraph 25. b)) in contravention to the "most likely" approach required under the RMA?
87. I note that NZCPS (2010) Policy 24 has been partially reproduced in Mr Todd's SoE. It is missing the qualifying language designed to allow planners to adopt some common sense and broaden their analysis.
88. The missing words are the phrase in the first sentence of Policy 24:

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<sup>44</sup> Email exchange Rush – Naish Feb/March 2023.

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*“giving priority to the identification of areas at high risk of being affected”*

and the final sentence:

*“taking into account national guidance and the best available information on the likely effects of climate change on the region or district.”*

89. More recently the latest available information on VLM documents the ameliorating effects of slow slip events (SSEs) that are ongoing, recurring and likely to have prevailed before the GNSS sites were installed and across the long-term tide gauge record.
90. The SoE (paragraph 20) ignores two of three of the GNSS sites located on the Kapiti Coast that show significant uplift over the last 10 years. Rather it reports from three sites “along or close to” the Kapiti Coast i.e. “close to” are: Te Papa at Wellington and Wellington Airport which is at least two major fault systems away, with many other unknown faults in-between, and is entirely irrelevant to the Kapiti Coast. Whereas sea level is ubiquitous so I am surprised there was no consideration of the tide gauge data.
91. Furthermore, the one GNSS site described as “along” the Kapiti coast is located at Paekākāriki Hill, several kms from the coast and well above sea level which, given the millimetre precision we expect in this exercise, calls into question how the land beneath the coast at Paekākāriki beach is behaving compared to the bedrock beneath Paekākāriki Hill.
92. In my view, more consideration should have been given to the ameliorating effects of SSEs that have shown to have some predictability, the long-term uplifting trend in Kapiti, the accretion trend despite decades of anthropogenic global warming and what the New Zealand tide gauges say over the longer term.
93. In summary, in my opinion, Mr Todd’s approach has been overly cautious:
- i. It did not involve the latest science relating to the likelihood of RCP 8.5,
  - ii. It omitted reference to the leading New Zealand sea-level study (Denys et al 2020) that used tide gauges to evaluate sea level rise in New Zealand;
  - iii. It omits the latest science (Wallace 2020) showing uplifting ground movement that slows the rate of sea-level rise along the Kapiti Coast.

**PEER REVIEW PROCESS (PARAGRAPH 28)**

94. As an initial concern, both reviews pre-date:
- (i) the release of IPCC AR6 and so neither had the benefit of assessing RCP 8.5 in the light of comments describing that scenario as ‘implausible’; and
  - (ii) MfE 2022,
- and lose considerable utility as a consequence.
95. Both reviewers have confirmed Jacobs 1 is in line with various planning documents but, with due respect, neither has considered whether such planning documents, strictly (and conservatively) applied as they have in Jacobs 1, will achieve its stated purpose which is to: *“update previous coastal hazard assessments ... along ... the shoreline involving the identification of areas susceptible to current and future*

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*coastal erosion and inundation hazards....*<sup>45</sup>

96. Identification of unrealistic hazards based on unlikely scenarios is not within the stated purpose.
97. With respect, neither reviewer has considered matters outside the various planning documents that are important to achieving the stated purpose, such as:
- (i) Do SSE's and other longer-term uplifting events mean the hazard assessment is overstated?
  - (ii) Whilst modelling RCP 8.5 and RCP 8.5H+ is appropriate, is its adoption to determine the CQMP as the most likely scenario consistent with the IPPC analysis and the description in Mr Todd's SoE that it is a 'very unlikely' scenario?
  - (iii) Do the projections for RSLR square with the trends observed from the tide gauge measurements?
98. Neither reviewer picked up the error of mixing up net subsidence with gross subsidence that Jacobs 1 referred to or that a long-term trend of subsidence prevails when it is well established that uplift has prevailed in the long term.
99. Neither thought that ameliorating effects of SSEs, or the steady rise of sea level observed by the regional tide gauges, nor the latest scientific publications by the likes of Denys et al 2020 and Wallace 2020, were omissions. And yet each is an important aspect of the 'latest' information on the likely effects of climate change on the region (per NZCPS Policy 24).

Overall, it seems the reviewers took the same approach as the authors of Jacobs 1.

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### Conclusions

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100. In conclusion Jacobs 1:
- (i) applies the various planning documents, conservatively, to achieve its purposes i.e. for present purposes, the inland extent of the coastal erosion line does not in my view represent what is likely during the planning horizon.
  - (ii) adopts RCP 8.5 and RCP 8.5H+ as its baseline for the spatial extent of the CQMP whereas such scenarios are regarded as no longer 'plausible'.
  - (iii) assumes a need to assume Antarctic ice sheet instability when that is not likely over planning horizons;
  - (iv) does not take account of more recent science about sea level and the known events of recurring land uplift on the Kapiti Coast that reduce the rate of sea-level rise and defer the projected sea-level rise and consequent coastal erosion and potential inundation;
  - (v) has used novel satellite data, with comparatively short-term measurements, that are not designed to measure either sea-level rise, or vertical land movement, at the shoreline;

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<sup>45</sup> Section 1.1 Jacobs 1.

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- (vi) has ignored the tide gauge data in its forecast which is a tool designed to measure the sea-level rise and vertical land movement at the shoreline.
101. In my opinion, considerably more observational analysis, peer review and updates for the latest science are required before Kapiti Coast District Council (and this Panel) is in a position to propose hazard location lines such as those used to generate the CQMPs.



INTEREST.CO.NZ

Managed Retreat – May 2023

<https://www.interest.co.nz/public-policy/121439/sean-rush-katharine-moody-say-nz-needs-be-more-realistic-when-it-comes-policy>

The government could be said to be ‘screwing the scrum’ by [ignoring the most recent findings of the IPCC](#) and persisting in using extreme climate change projections. The IPCC is clear: its high-end, worse-case scenario, Shared Socioeconomic Pathway (SSP5-8.5), is “not likely” and “implausible to unfold”,<sup>[1]</sup> with the government’s higher-end of that high-end scenario (called 8.5H+) only having a 1 in 14 chance of happening on top of that!

To continue the rugby analogy, screwing the scrum is sneaky, opportunistic, and not really legal.

So, what advantage is being gained by inflating sea-level rise and other climate change effects to the extent of implausibility? And who benefits from this “over-egging” of these effects?

It is a particularly important question to ask today, given those affected by current weather events [are being told](#) these events are the result of climate change, but there will be [no compensation](#) until;

*...they [Government] form a national policy response to the places severely affected by flooding and land instability, including managed retreat.*

So, let’s follow the money, given it’s not getting to those affected (yet).

#### The research community

Central government has poured plenty of money into research into climate change, for example: [here](#), [here](#), and [here](#).

But a key tenet of the scientific method is that novel claims have to be published in a credible, peer reviewed journal. Only then should such scientific findings be relied upon, particularly by regulators.

So, a disturbing feature of the current managed retreat policy discourse and coastal planning guidance generally, is the emergence of novel estimates of New Zealand-specific sea-level rise that have not passed the required academic peer review.

Readers may recall new claims, [popularised by the media in May 2022](#) that large parts of coastal New Zealand are subject to a disturbing subsidence trend. The claims were that sea-level rise was happening twice as fast as previously thought. Projections showed infrastructure and homes in Auckland and Wellington – as well as many other places – at risk of inundation decades earlier than previously expected.

The study, known as the ‘SeaRise Project’, is a collaborative effort led by scientists at Victoria University, NIWA and GNS funded to the tune of \$20 million by the Government. The projections relied on a short 7-year satellite dataset (2003-2011) measuring subsidence and uplift along coastal New Zealand. These projections were fast-tracked into policy via the ‘[SeaRise tool](#)’, an interactive map specifically designed to target the public, the media, and regulators. One headline projection

<sup>[1]</sup> IPCC, AR6 WG1, Chapter 4, section 4.4.2. p. 13

was that parts of Wellington's coast would subside up to 30 centimetres within the next 10 to 20 years.

Coastal residents and regulators have been holding regular meetings ever since to discuss the study's implications and next steps.

The findings were so inconsistent with what [the much longer-term tide gauges](#) showed, that their publication warranted closer scrutiny. What was omitted from the media coverage was that despite submitting a [manuscript](#) to the American Geophysical Union's, *Earth's Future*, in July 2022, it was not published (and still has not been) as it did not pass the peer review process.

This should not be unexpected. Several conclusions drawn by SeaRise are at odds with the peer reviewed and published works of several of the co-authors. Colleagues of the group, with established credentials in the world of land subsidence, pointed out that the short-term subsiding trends should not be extrapolated forward, particularly when they do not incorporate the often-balancing effects of earthquakes and slower, more subtle rises in land, known as 'slow slip events' (SSEs). These events are well documented in the peer review and can completely cancel out subsidence. Despite these warnings, the SeaRise tool went live on 2 May 2022 and remains online.

The project's communications plan shows that publication of the online tool was agreed to go ahead *irrespective* of whether the manuscript had passed the peer review process. The timing of the publication coincided with the commencement of Minister Shaw's consultation on proposed managed retreat legislation and was subject to a carefully orchestrated, week-long series of media coverage, interviews with the Prime Minister, Minister Shaw and other stakeholders.

Concerns about the utility of the projections for policy making are ongoing. For example, tide gauge measurements for sea level around Wellington have not materially changed since the end of the SeaRise data set in 2011. [Individual scientists](#) have pointed out that the SeaRise measurements of subsidence are in direct contrast with their own measurements. Even [GNS have acknowledged](#) that the Kāpiti Coast, which is shown by the SeaRise tool to be subsiding, was uplifted by a full centimetre during this year alone.

The ~\$20 million funding for this project was sourced from the MBIE 'Endeavour' fund with an initial tranche of \$7.1. million and a more recent tranche of \$13 million. The more recent tranche will be applied to refining the coastal data points (from the current 2 kilometre spacing to 100 metres) along with solving, if they can, the issues raised in the peer review process. But it is entirely possible that broad spatial satellite measurements will never be as accurate as local tide gauge measurements.

This brings into question the value for money of this ongoing expenditure.

In the meantime, significant caveats should be applied to the SeaRise tool pending either its correction or abandonment. It should certainly not feature in the managed retreat debate and cannot be used in formal coastal policy planning processes.

#### Private sector consultants

Every local authority is required, under [New Zealand Coastal Policy Statement](#) (NZCPS Policy 24), to identify coastal hazards, taking into account "the likely effects of climate change on the region or district". This work, commonly referred to as a coastal hazard risk assessment, is normally contracted out to consultants. The output is used to define boundary lines, or coastal hazard zones, for



restrictive planning purposes – i.e., to determine rules about what one can and cannot do with their property if it is identified as being within a coastal hazard zone.

Anecdotal evidence suggests these reports cost in the vicinity of \$200,000 – \$400,000 depending on the length of the coastline and the nature of the geomorphological characteristics. Multiply that (at the low end) by our 57 local authorities with a coastline, gives a total in excess of \$11m ratepayer funded dollars. And, if private property owners believe the results of such assessments are “over-egged” (referred to as ‘conservative’ in technical terms), then challenges to the associated Council plans have to be taken to the Environment Court for legal compliance and scientific merit review.

Hence, the cost of defending these often found to be overly ‘conservative’ findings, falls solely on the ratepayer – as, more often than not, the same firm providing the science underpinning the planning rules has to be hired/paid further for affidavit preparation and appearances associated with court processes.

It therefore makes little sense for central government to persist in recommending the use of the “implausible” IPCC sea-level rise projections (i.e., SSP5-8.5 and 8.5H+) in any coastal guidance material, as this simply adds unnecessary costs to local authorities, and cost and stress to the residents inappropriately caught up in this process.

Moreover, NZCPS Policy 24 requires that Councils give “priority to the identification of areas at high risk of being affected”. As one pragmatic scientist explained, there is nothing complex or difficult about this – the most high-risk areas of coastline can be identified by simple observation of existing protective measures.

Communities know their coasts, but there is no money in following the historic/observational record, or in using local knowledge of coastal and estuarine processes as understood by residents and property owners. The ‘money’ is in the production of complex and yet inadequate technical models, purported to predict the future via weighty output reports, unable to be interpreted and/or easily understood by general public.

#### **Public sector bureaucrats**

As many readers will realise, nearly every government entity (including, the [RBNZ](#)) are busy developing their own unique climate change strategies. That bureaucratic expense aside, the main public service benefactor of these [unfolding declarations](#) of climate emergencies in our communities, is the Ministry for the Environment (MfE).

When resource management was reformed during the 1980’s, Department of Conservation (DOC) was set up to manage the very large conservation estate, and MfE to give even handed policy advice on the environment. Some would say MfE is going well beyond that into advocacy, supporting these exaggerated positions on climate change. We can see this trend reflected in growth in the Environment budget over recent years.

[MfE](#) output expenses rose from \$114m in 2017/18 to \$410m in 2022/23 whereas over the same period, [DOC](#) went from \$386m to \$720m – a near quadrupling of costs for advice on the environment versus not quite a doubling of costs for getting actual work done in the environment.

#### **Where to from here?**

Much more time, effort and expense is on the cards regarding the future [Climate Adaptation Act](#). Already, councils are busying themselves with making adaptation plans, even though they are not a regulatory requirement at this stage. [Hawkes Bay residents](#) (view oral submission at 53 minutes 19 seconds) have been going through the gruelling process of coastal adaptation planning for 9 years now, with little action to show for all the talk.

The Environmental Defence Society (EDS) has commissioned [a series of reports](#) on the topic of public funding for managed retreat from climate-related hazards. These are big volumes of work, but for an enthusiast, worth reading. The emphasis is on publicly-funded compensation to residential property owners for moving away from the hazard as a *preventative*, or proactive measure, as opposed to an EQC-type, event-driven, or reactive measure.

From the author's perspectives, we have not formed an opinion on the need, but foremost, we consider that any such considerations must not stray beyond planning for *likely*, if not near certain, climate change futures. Compensation can only be costly, and weather events (slips and floods) are more likely to threaten lives and properties far sooner than sea-level rise.

This means not using "conservative" or "novel" or "implausible" or "precautionary" methods and outputs from our coastal scientists and consultants. Instead, it means a far greater emphasis on observational data and a pragmatic application of it, responding to *present-day* events and what can be reasonably seen in the future.

In the end residents want to understand the likelihood of them being at risk in the future, based on a reasonable set of assumptions. That is what the law says should happen, but it is being ignored.

The Kāpiti Coast, for example recently mapped what they refer to as '[Adaptation Areas](#)' – determined using the "implausible" SSP5-8.5 (H+) scenario. An estimated one quarter of all properties in the district are 'caught' by the lines drawn.

There will be consequences in the planning processes, but insurers are using this information today. While insurers generally write one-year policies, and slow progressive risks (such as sea-level rise) should be by and large, irrelevant, anecdotal evidence suggests they are already applying risk premiums to coastal properties in areas like those in Kāpiti's adaption areas. Similarly, [some banks](#) are modelling climate risk, again, based on these "implausible" scenarios.

We need to be [more realistic](#) when it comes to policy development regarding sea-level rise projections and managed retreat. 'Screwing the scrum' with the use of unlikely and implausible climate change scenarios (SSP5-8.5 and 8.5H+) needs to be yellow carded.

INTEREST.CO.NZ

Adaptation Planning – August 2022

<https://www.interest.co.nz/public-policy/117081/katharine-moody-says-we-should-tackle-climate-adaptation-planning-clear>

Last week the Government released a [National Adaptation Plan](#) (NAP) covering actions to be taken in the years 2022-28, to build resilience to hazards arising from changing climate. As a non-statutory plan, nothing in it binds anyone to doing anything by law, although the Government has signalled as part of the reform of the resource management system, a new Climate Adaptation Act is to be written. And it is likely that that Act will specify a legal process and mechanism for the implementation of the adaptation option of [managed retreat](#) (moving away from the risk).

A vitally important matter when considering this option in law, is robust (and legally defensible) assessment of coastal hazard risks. If such a future law envisages the compulsory abandonment of private property, getting the science right, for projecting the likelihood of future events, is critical.

Presently the assessment of coastal hazard risks is prescribed in law under the [New Zealand Coastal Policy Statement](#) (NZCPS 2010) Policy 24, Identification of coastal hazards. Once a coastal hazard risk to an area of land is identified, the management of those risks is undertaken through provisions set out in Policy 25 (relating to subdivision, use and development) and Policy 27 (relating to the protection of significant existing development).

Implementing this aspect of the NZCPS has met a few speed bumps along the way. Perhaps the most notable being Kāpiti Coast District Council's attempt at hazard assessment some years ago, which saw a High Court challenge that resulted in the removal of the newly identified coastal hazard areas from Land Information Memorandum (LIMs) and subsequently, a [withdrawal of all coastal hazard provisions](#) which set regulatory rules aligned to them in the proposed district plan.

In the interim judgment on the High Court case (*Weir v Kapiti Coast District Council* [2013] NZHC 3522), Justice Williams concluded that there was "a good argument" for describing the result of the coastal hazard assessment as the "very worst case scenario" – whereas the law requires a very different assessment from coastal scientists doing this work (emphasis mine);

***New Zealand Coastal Policy Statement 2010***

***Policy 24 Identification of coastal hazards***

*(1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunamis), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:*

*[matters a-h];*

*taking into account national guidance and the best available information on the likely effects of climate change on the region or district*

Dr Jan Wright, Parliamentary Commissioner for the Environment subsequently investigated the issue of the technical assessment of coastal hazard risks in New Zealand practice. She reported that,

*"During this investigation, it has become clear that precaution is being embedded into scientific assessments of coastal hazards, sometimes to an extreme extent."*

*"The standard results of running a coastal hazard model should be probability distributions with most likely values and ranges of potential values expressed with a level of confidence",*

And recommended to the Minister of the Environment that;

*"In revising central government direction and guidance on sea level rise, specify that 'best estimates' with uncertainty ranges for all parameters be used in technical assessments of coastal hazards."*

Unfortunately, neither the Minister nor the industry have taken this advice onboard.

The international advice on the likely effects of climate change, on which all our national guidance is based, is provided by the Intergovernmental Panel on Climate Change (IPCC). It uses scenarios to project future sea level rises, the main climate-related source of coastal hazards. In the most recent IPCC Assessment Report (AR6), *Climate Change 2021: The Physical Science Basis* it advises policy makers not to use its high scenario (SSP5-8.5) calling it "not likely" and "implausible to unfold" (IPCC, AR6 WG1, Chapter 4, section 4.4.2. p. 13).

Despite this the Ministry for the Environment's interim updated guidance for local authorities following the publication of AR6, persists in recommending the use of SSP5-8.5 in coastal hazard assessments, explaining;

***Should SSP5-8.5 scenario still be used in coastal planning?***

*The upper-range scenario SSP5-8.5 (and its upper likely range of 8.5 H+) should continue to be used, given we are currently on a similar emissions trajectory, combined with the prospect of runaway polar-ice sheet instabilities and very long response time-lags (multi-decadal to centuries) in sea-level rise. This means impacts from sea-level rise will be distinctly different compared with other climate impacts that are more directly tied to global heating and therefore SSP scenarios (eg, heatwaves, precipitation, wind, etc.). These latter effects are also more responsive to cuts in global emissions and involve relatively short response times (decades), unlike sea-level rise.*

That's half right (in that all IPCC scenarios run on a "similar emissions trajectory" in the near-term) and half wrong – in that "runaway polar ice sheet instabilities" are only projected by modelling using scenarios that are found to be running ["too hot" and thus, exaggerate the impacts of global warming](#). As one of the climate researchers in that article explains;

*As more city planners and outside scientists turn to these projections, they should first be sure to consult a climate model expert. "Given that these results guide climate adaptation and investments of billions of dollars, that seems like an effort worth doing," Knutti says.*

We have many outstanding climate experts in New Zealand advising the Minister of Climate Change. However, I worry that much of that advice might support the 'too hot' end of the spectrum. The justification for the continued use of the SSP5-8.5 does not express an uncertainty range, or probability related to the "runaway polar ice-sheet" assertion, as was recommended by the Parliamentary Commissioner for the Environment.

NZCPS 2010, Policy 24 – the law in New Zealand on hazard risk assessment – is (to my mind) clear: regulators are to assess the *likely* (not the unlikely) effects of climate change over at least 100 years. The reason is straightforward, the flipside of the sea level rise risk is that residents unnecessarily have the enjoyment of their property curtailed today based on unlikely events as much as a 100 years away.

Hon James Shaw, Minister of Climate Change was questioned on update of the guidance manual to take into account the recent IPCC AR6 advice on use of the SSP5-8.5 scenario. He responded;

*"Understanding the climate risks that we face goes beyond what the "likely" impacts of climate change will be".*

[INSERT MINISTERS LETTER OF RESPONSE HERE]

From a planning perspective this concerns me, particularly as we are now moving toward the preparation of adaptation plans and legislation that could introduce [regulatory takings](#) associated private property. Adaptation planning is a policy path we must face, but I only ask that we face it with a clear understanding of the *likelihood* of the events unfolding, as opposed to the "full range of possibilities" (another phrase used in justification by the Minister) with *no likelihoods* attached.

My point being: it is within the full range of possibilities that I am struck by lightning during my lifetime, but I am not planning for it by never walking in the rain.

# Raumati Seawall Renewal Project

Status as of May 2023





# History

- 1976 storm significantly eroded Raumati Coastline
- 3km of Seawall was built by Borough of Kapiti funded by public and private money.
- 1981 – *Beachfront Owners Association argued that the maintenance should be paid for by the District.*
- 20 May 1999 – Council resolution
  - *“Council will maintain the existing seawalls and rock toe protection as long as it is reasonable to do so.”*



# History – 1978

Less than 2 years after construction



Duration	Action Completed/Planned
2016 and 2021	Condition assessment of the seawalls completed. Undertook a coastal asset inventory of the primary [public] and secondary walls [private].
2021	Raumati Seawall renewal project added to the 2021 Long Term Plan to be built in stages. Stage 1 ~ 1km in poor condition with no rock protection Stage 2 ~ 1.5km in moderate condition with limited rock protection Stage 3 ~ 500m in moderate condition with rock protection [as and when required] LTP Budget allocated ~17 million dollars – however with construction inflation it is estimated to be equivalent of 22-23 million dollars in today's dollars.
Oct 2021 to Jan 2022	Professional Services Contract advertised, and tender awarded to BECA for “like for like” replacement for design life of 25 years.
Jan 2022 to present	Design and construction risks and mitigations identified.
Estimated June 2023	Design completed for replacement of the primary wall.
July 2023/24	Commence application for Building Consent and physical works tender for stage 1.
2024 onwards	Construction of wall in stages.



## Council's current coastal strategy and future plans

- Council will provide and maintain coastal protection structures to protect public assets only.
  - Roads, 3 waters infrastructure and any other public assets
- In 2019 Council engaged in a Coastal Adaptation Programme [Takutai Kapiti] with the community.
  - This seeks to work through what our future looks like on the coast and provide recommendations to Council.



## So what does that mean for now?

- We have an asset in need of renewal.
- It is well beyond its original design life 20-25 years.
- We are proposing a “like for like” replacement of the asset while the coastal adaptation process is agreed and fully implemented.



# The current proposed design

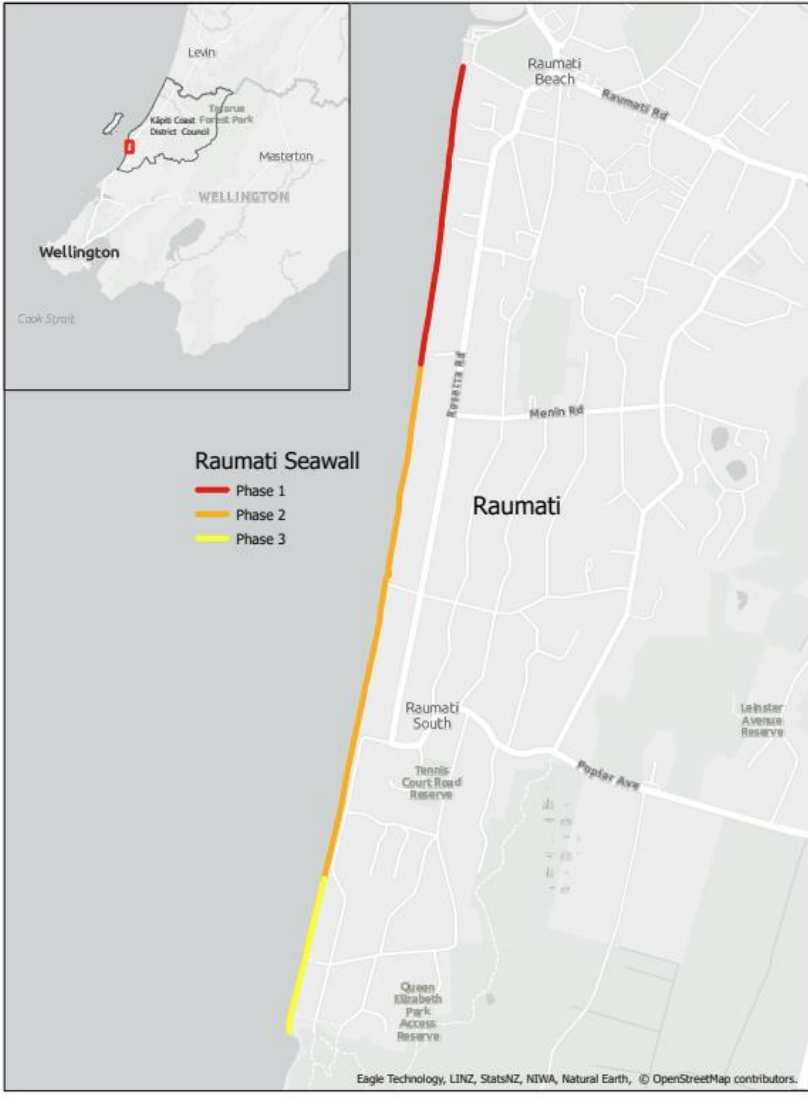
- Like for like – timber and rocks
- 25 year design life
- Modular and standardised to allow for ease of maintenance/emergency repair.
  - Provides for 3 levels of wall height
    - 1.2m, 1.8m and 2.4m
- Removing consenting risks
- Can be built and maintained by local contractors





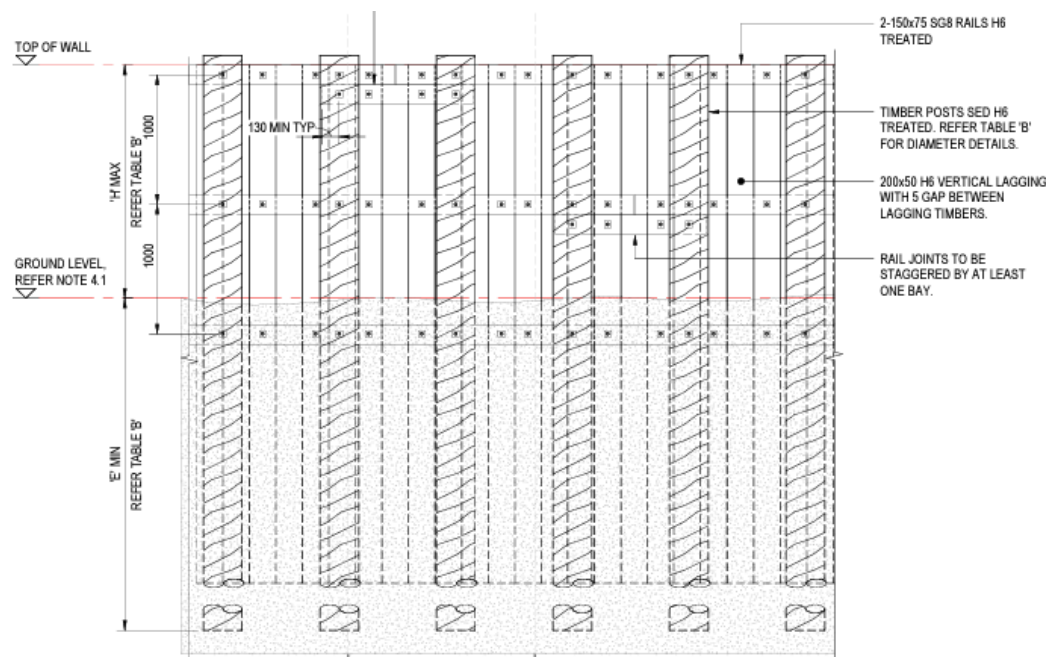
# The proposed staging

Start of QE Park

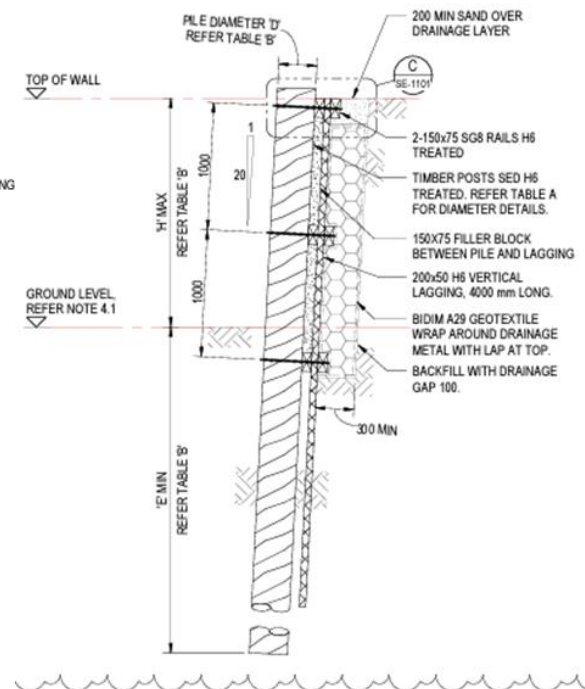


South of Marine Gardens

# The current proposed design

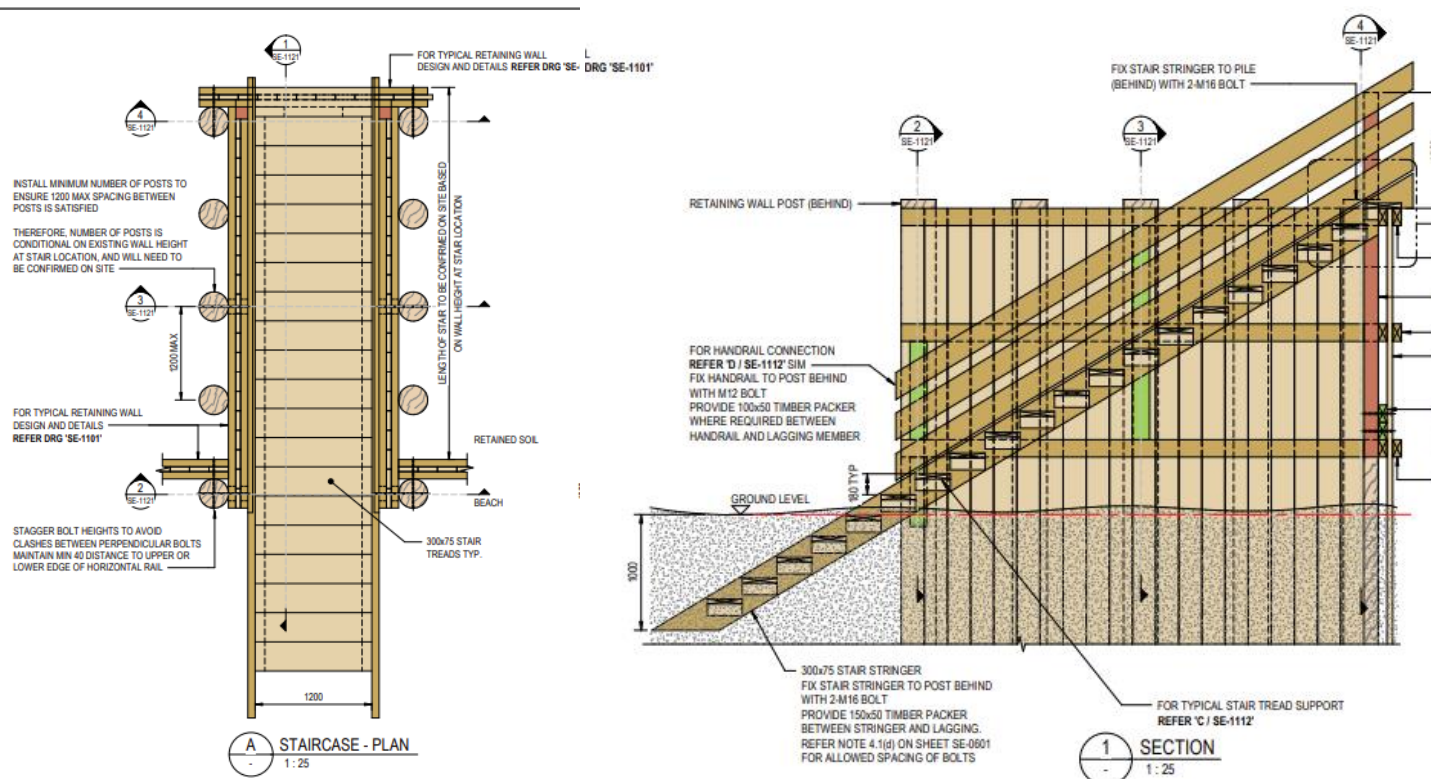


**B** SEAWALL - PART ELEVATION TYPICAL  
1:25

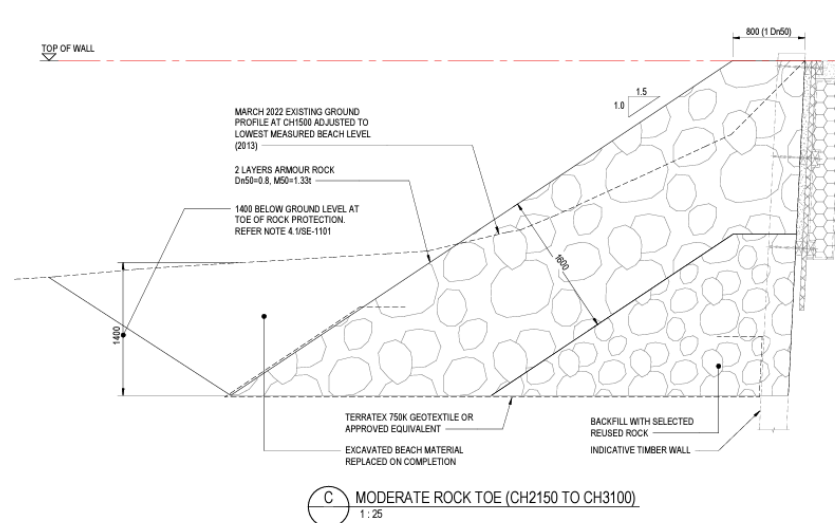
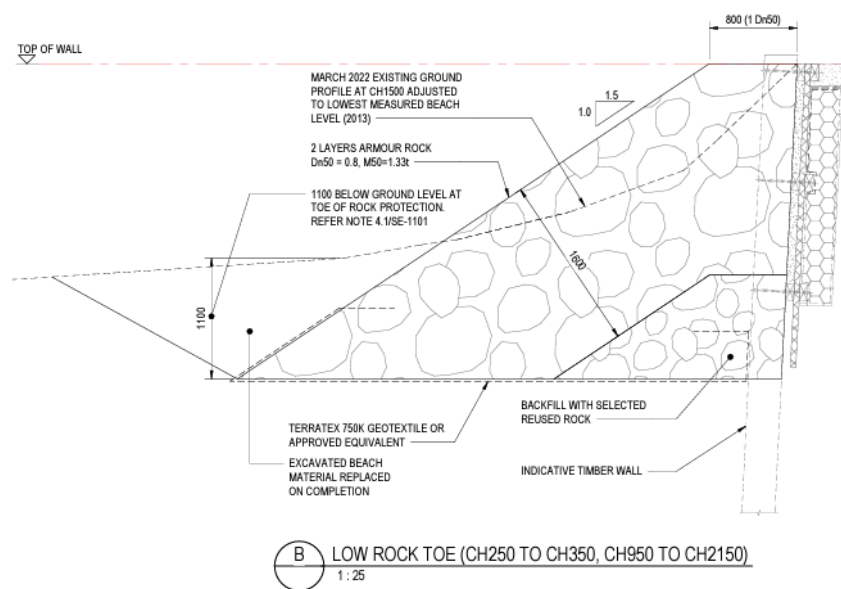


**1** SECTION AT POST  
SE-1101 1:25

# The current proposed design



# The current proposed design



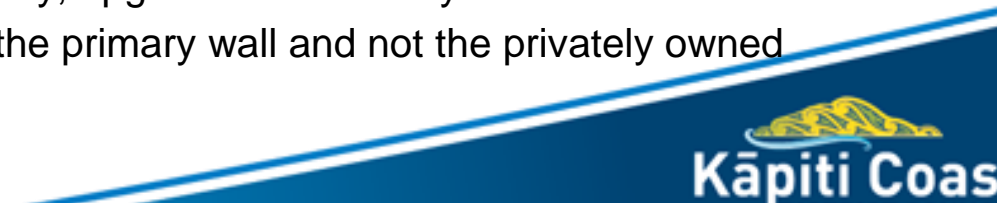
# The current proposed design

- Assessments at the southern end [500m stage 3] have noted KCDC may be able to achieve the design life required with maintenance and supplementary rock.
- Middle section [1.5km stage 2] need current rock recycling and supplementation as well as wall replacement
- Northern section [1km stage 1] we may be able to delay adding rock protection providing new replacement wall is installed and subject to ongoing asset management.
- The design is to provide for solutions along the whole length of the wall in case needed in order to prevent delays in repairing the wall should there be a failure at anytime.



# Risks and mitigations

- Regulatory risks around “like for like” replacement. Don’t want to trigger the requirement of resource consents if possible.
- Maintenance will still be required and needs to be budgeted for.
  - The design provides for cost effective maintenance.
- The future for coastal adaptation is unknown.
  - This stage installation allows for the renewal of the asset to be in line with any future coastal adaptation decisions.
- Community expectation
  - This project has not been funded to provide for additional levels of service such as walkways, amenity, upgraded accessways etc
  - This renewal is for only the primary wall and not the privately owned secondary wall.





## Current Approved Budgets

- 2023/24 - \$500,000
  - 2024/25 - \$2,900,000
  - 2025/26 - \$2,000,000
  - 2026/27 - \$800,000
  - 2027/28 - \$2,000,000
  - 2028/29 - \$2,000,000
  - 2029/30 - \$2,000,000
  - 2030/31 - \$1,700,000
  - 2031/32 - \$2,800,000
  - Total \$16,700,000
- We know construction costs have increased since 2021 LTP
  - Approximately 5-6 million dollars additional funding will be requested as part of the 2024 LTP

