Taranaki Regional Council

AGENDA
Policy & Planning

Tuesday 6 June 2023, 10.30am

Policy and Planning Committee

06 June 2023 10:30 AM

Whakataka te hau

Karakia to open and close meetings

Whakataka te hau ki te uru	Cease the winds from the west
Whakataka te hau ki te tonga	Cease the winds from the south
Kia mākinakina ki uta	Let the breeze blow over the land
Kia mātaratara ki tai	Let the breeze blow over the ocean
Kia hī ake ana te atakura	Let the red-tipped dawn come with a sharpened air
He tio, he huka, he hauhu	A touch of frost, a promise of glorious day
Tūturu o whiti whakamaua kia tina.	Let there be certainty
Tina!	Secure it!
Hui ē! Tāiki ē!	Draw together! Affirm!

Nau mai e ngā hua

Karakia for kai

Nau mai e ngā hua	Welcome the gifts of food
o te wao	from the sacred forests
o te ngakina	from the cultivated gardens
o te wai tai	from the sea
o te wai Māori	from the fresh waters
Nā Tāne	The food of Tāne
Nā Rongo	of Rongo
Nā Tangaroa	of Tangaroa
Nā Maru	of Maru
Ko Ranginui e tū iho nei	I acknowledge Ranginui above and
Ko Papatūānuku e takoto ake nei	Papatūānuku below
Tūturu o whiti whakamaua kia tina	Let there be certainty Secure it!
Tina! Hui e! Taiki e!	Draw together! Affirm!

Date 6 June 2023

Subject: **Policy and Planning Committee Minutes – 14 March 2023**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3175112

Recommendations

That the Taranaki Regional Council:

a) takes as read and confirms the minutes of the Policy and Planning Committee meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford on Tuesday 14 March 2023 at 10.30am

b) notes the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 4 April 2023.

Matters arising

Appendices/Attachments

Document: 3154919 Minutes Policy and Planning – 14 March 2023.

Date 14 March 2023

Venue: Taranaki Regional Council Boardroom, 47 Cloten Road, Stratford

Document: 3154919

Present	C S Williamson	*Committee Chairperson*
	D M Cram	
	D H McIntyre	
	S W Hughes	
	B J Bigham	
	C L Littlewood	*ex officio*
	N W Walker	*ex officio*
	E Bailey	Iwi Representative
	P Moeahu	Iwi Representative
	M Ritai	Iwi Representative
	G Boyde	Stratford District Council
	B Haque	New Plymouth District Council

Attending	Mr	S J Ruru	Chief Executive
	Mr	A D McLay	Director - Resource Management
	Ms	A J Matthews	Director – Environment Quality
	Mr	D R Harrison	Director - Operations
	Mr	M J Nield	Director – Corporate Services
	Ms	L Hawkins	Planning Manager
	Mr	C Woollin	Communications Adviser
	Mrs	M Jones	Governance Administrator
	Miss	N A Chadwick	Executive Assistant to CE

1 member of the media joined meeting at 10.40 - left meeting at 11.05am
No members of the public

Apologies Were received and sustained from, A L Jamieson, C Filbee, L Gibbs

1. Confirmation of Minutes Policy and Planning Committee 7 February 2023

Resolved

That the Taranaki Regional Council:

a) takes as read and confirms the minutes of the Policy and Planning Committee of the Taranaki Regional Council held at 10.30 on 7 February 2023 at Taranaki Regional Council 47 Cloten Road Stratford

b) noted the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 28 February 2023.

Walker/Littlewood

2. Freshwater Programme Review

2.1 Mr A D McLay, Director – Resource Management, Spoke to the memorandum to provide the Committee with an overview of the Essential Freshwater Programme.

2.2 The Committee members were advised the December 2024 deadline for the National Resources Plan is at risk and careful ongoing management will be required.

Resolved

That the Taranaki Regional Council:

a) received the memorandum *Freshwater Programme Overview*

b) noted the contents of the memorandum and the programme provided.

Williamson/Cram

10.55 M Nield joined meeting

3. Submission on the review of the Resource Management Infringement Offences Regulations

3.1 Mr A D McLay, Director – Resource Management, spoke to the memorandum to seek the Committee Members' endorsement of the *Review of the Resource Management Infringement Offences Regulations (Discussion Document)*.

Resolved

That the Taranaki Regional Council:

a) received the memorandum entitled, *Submission on the Review of the Resource Management Infringement Offences Regulations*

b) noted the attached Submission on the Review of the Resource Management Infringement Offences Regulations.

McIntyre/Boyde

4. Spatial Planning Gap Analysis

4.1 Mrs L Hawkins - Policy Manager, spoke to the Memorandum to provide an overview of the spatial planning analysis project, which is an important first step into spatial planning management.

Resolved

That the Taranaki Regional Council:

a) received the memorandum Spatial Planning Gap Analysis

b) noted the joint work being prepared with District Councils.

Hughes/Cram

5. Periphyton State of the Environment Monitoring Technical Report

5.1 A J Matthews, Director – Environment Quality, introduced Thomas McElroy, Team Leader of Freshwater and Coastal who spoke to the Memorandum to provide the Committee with an overview of the report: *Periphyton State of the Environment Monitoring Technical Report 2018-2021.*

Resolved

That the Taranaki Regional Council:

a) received the technical report, Periphyton State of the Environment Monitoring Technical Report 2018-2021 and noted the recommendations therein.

Littlewood/McIntyre

There being no further business the Committee Chairperson, Councillor C Williamson, declared the meeting of the Policy and Planning Committee closed at 11.40am. The meeting closed with a karakia.

Policy and Planning Chairperson: _____

C Williamson

Date 6 June 2023

Subject: **Freshwater Implementation Report March 2023**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3160764

Purpose

1. The purpose of this memorandum is to provide the Committee with a Freshwater implementation project update.

Recommendation

That the Taranaki Regional Council:

a) receives the update on Freshwater implementation programme.

Background

2. The Council has prepared an implementation programme of the Government's Freshwater programme. The purpose of this memorandum is to update Members on progress in implementing the project. The implementation programme has previously been presented to, and approved by, the Committee.

3. At the 14 March meeting a programme overview was presented and challenges identified. There were a number of risks and challenges presenting, compounded by the tight timeframe to meet NPS-FM requirements. There is a risk, given the resource constraints for the both Council and iwi, that a crunch point will be reached where the programme will need to continue to evolve and not all issues may have been able to be explored or resolved.

Financial considerations—LTP/Annual Plan

4. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

5. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

6. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Community considerations

7. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

8. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 3160604: Freshwater Implementation Report for 26 April 2023.

Freshwater Implementation Project Report to Policy & Planning Committee

26 April 2023

Document Number: 3160604

Executive Summary

Progress has continued, with all programme areas meeting schedule.

Focus for the past month has been on iwi engagement and background studies for science input and policy framework preparation for the National Objectives Framework (NOF).

Project Programme

Key project achievements during the last reporting period (note that a full update was last provided in November 2022)

- Specific implementation activities:
  - Policy and plan drafting continuing - with a review of the overall Natural Resources Plan project timeline. Specific focus has been on developing visions and values work and aligning with science work programme with regard to NOF.
  - Hui with TRC Council and iwi chairs and CE's held to provide an overview of the programme and an opportunity to continue to build the partnership.
  - The two Pou Taiao work programme has seen the competition of this first two Wānanga series focussing on FMU boundaries, Visions, Values, significant resource management issues and Te Mana o Te Wai.
  - Environment Quality has stood up science theme groups working on developing baselines for the compulsory values and associated attributes.
  - N-Cap reporting system has gone live. Compliance team focus for this year is on education and tuning systems for 2022-23.
  - Hill country plans covered approximately 12,000 ha – which is above target for the year. Result reflects effectiveness of communications programmes and on-the ground effort from the LM team.

Key upcoming activities and milestones in the next reporting period

- Review of the implementation plan for the six months post July 2023. A plan for the FY of 23/24 will be presented to the community in the future.
- Continue developing models and science for baselines and limit setting (including sediment, e-coli and phosphorus).
- Continue to support the 'theme groups' to guide input into the above work.
- Work with Pou Taiao to finalise FMU boundaries, visions and values.
- Commission economic and social impact analysis to support the engagement on limits. Baseline summary of profile due middle of the year.
- Begin working with hapū to discuss Te Mana o Te Wai.
- Consents team finalise development of an agreed compensation structure for iwi engagement on (smaller scale) consent applications – being developed with Ngāruahine.
- Close out of N-Cap engagement for this season and preparation to increase uptake and data provision for 2022-23 year, including supporting lookback on national tracking tool development.

HSE Updates

Nothing significant to report

Workstream Status Summary

Workstream	Tracking	Comments/Clarifications
Tangata whenua partnerships		• Commenced engagement with some hapū to focus hui / wānanga on Te Mana o Te Wai. Draft TOR in circulation. • Hui with Ngāti Maniapoto with policy team to discuss work programme going forward. • Engaging with and supporting iwi around the region to implement frameworks to assess and manage FW health – using tools such as Mauri Compass and other similar frameworks. Particular interest from Ngaa Rauru – and good work progressing with them.
Policy and Planning		• Plan drafting continues in accordance with overall implementation targets. • Pou Taiao have undertaken two wānanga and have begun drafting visions and values work and will work closely with policy staff to progress these to finalising these aspects. • Have completed draft set of Significant Resource Management Issues for the region, and pou taiao have prepared Resource Management Issues for iwi. Many issues are common. These have been presented to TRC Councillors and iwi Chairs and CEs. • Continue undertaking a review of key natural resources/FW issues and a resulting gap analysis of policy to ensure ultimately that NRP/FWP will deliver desired outcomes. Review results will be presented to this Committee in Q2, (calendar) 2023.
Science Services		• SoE programme review continuing. • Mitigations work underway in SCAMP nutrient model. Model handover/training done. • CLUES E. coli model build well underway - base model nearing completion and mitigation being scoped. • Continued working with specialist consultants to undertake the modelling work needed to inform baseline and limit setting activities. • Established and started working with cross organisational technical teams – designed to provide input on key elements of the EQ FW implementation programme. Baseline programme is progressing.
Consents		• Receiving applications for works in wetlands for specified infrastructure - work underway on defining TRC's position. • Continue to work on ESCP assessments (small scale). • Continued working through standard consent conditions with iwi. • Continued working with Compliance to review farm dairy effluent consent replacement processes. • Continued updating consent application forms. • Updated consent standard consent conditions for water takes. Working with EQ. • Working with Ngāruahine to develop an agreed cost model for consent applicants who need to engage with iwi,

Workstream	Tracking	Comments/Clarifications
Compliance		• N-Cap reporting - Farmers can still report on last year, so currently our numbers for last year's season are 452 have reported, initial assessment shows 5 exceeding the 190kg/ha/yr, however further verification is needed on these numbers. Reporting was from about 30% of our dairy farms in the region. Next year we will be striving to get 100% reporting form dairy farms. • Continued working with IT team with regard to how to store information to allow ongoing consistent monitoring of stockholding areas. No monitoring is being undertaken until this work is complete. • Regional sector work underway with regard to forestry slash, preparation of a specific report/presentation to Ops and Reg Committee underway.
Operations		• Fresh Water Farm Plan (FWFP) regulations are expected to be gazetted by end of April. Operations are co-ordinating input, response and readiness across the Council.
Engagement		• Working to deliver a close the loop engagement piece over the coming months, from the values, visions and FMU work undertaken at the end of 2022. • Supporting numerous teams with specific communications for elements of the overall FW Programme (eg., N-Cap, farm plans) • FW pages on TRC website remain in place, including using Social Pinpoint – an on-line engagement tool – to facilitate interaction and engagement with the general community.

Project Risk/Opportunity Management

Description	Risk Cause and Effect	Mitigation Strategy	Risk Rating (unmitigated)	Comments (including current actions)
Challenges in conducting effective engagement with tangata whenua as required under the NPS-FM.	Challenges in tangata whenua resourcing and the timelines that the TRC is required to meet may place pressure on the ability of staff to engage fully with iwi and hapū. Additionally, this pressure can lead to a misalignment between TRC and iwi/hapū that can create tension or can lead to requests for engagement that further test the relationships.	Where possible, seek to develop timelines that recognise the demands/requirements and limitations of all parties. Make use of the Pou Taiao as a voice for both iwi/hapū and Council. In doing so, look to increase the capacity of all parties to engage. Where it is not possible to accommodate other timelines, there will be a need for Council to find a pragmatic way forward that allows it to meet its obligations.	High	The reduced focus on covid, has let iwi authorities focus on other topics, including FW. With the on-boarding of Pou Taiao, a closer working relationship with iwi is being developed. Iwi Communications engagement with hapū will seek to engage on a range of topics and will endeavour to provide information to other FW leads functions in a timely fashion. Opportunities to work at a mana to mana level between Council and iwi will be explored. Hui held on 3 April is an example of this approach. Policy team are developing a process that will enable teams to engage with iwi and hapū more broadly on resource management issues. The desire is to enable a co-ordinated approach on multiple topics,that enables progress to be maintained in a way that meets project timelines, while recognising iwi and hapū needs. Register and record interactions for future reference. This step can save repeat engagements and also provides a record for FW Commissioners where timelines can't be compromised.

Description	Risk Cause and Effect	Mitigation Strategy	Risk Rating (unmitigated)	Comments (including current actions)
Maintaining a full complement of staff with the skills and experience needed to implement the FW Programme.	In current employment markets, there is a high demand for a number of the key roles needed for FW Implementation, which has meant that all employers have experienced higher than usual turnover rates. Examples include planners/policy analysts, scientists and land management professionals. As well as creating gaps or making new roles hard to fill, where there is a level of turnover, new staff take time to come up to full effectiveness. This period limits some team outputs, both due to the new staff and the need to devote experienced staff to training duties.	Recruit ahead of the LTP to get into the market early and continue with organisational development work. Maintain watching brief on key roles. Look also at retention strategies, including opening opportunities for people to work or move across teams. For some roles where there are limited opportunities to recruit, consultants may need to be used to maintain momentum.	High	On-going focus – including discussion and collaboration amongst FW Leads on ways to support each other's teams and needs.

Description	Risk Cause and Effect	Mitigation Strategy	Risk Rating (unmitigated)	Comments (including current actions)
Lack of clarity and guidance due to gaps in key Government advice or changes in the policy/legal framework.	Some FW Implementation elements need to be developed in the absence of clear guidance – which may result in changes later if Government position changes. This lack of guidance also increases risks of a need for rework. Examples of areas where there are gaps in clear guidance include: • Managing diffuse nitrogen loss risks (including the applicability of Overseer) • Managing climate change impacts on freshwater.	Recognise that some level of risk is unavoidable. Maintain strong presence on Government (especially MfE) and sector working groups. Maintain contacts with other regional council *Essential Freshwater* teams. Develop tools and processes that based on established or determined best practice.	High	This item has been identified as a key project risk since early in the project. There are no indications from government that TRC should expect this risk to change. To a large extent, the only approach available is to take the risk – and to be ready to respond. Current FW related risks that apply include: • Freshwater Farm Plans – content and timeline • Natural and Built Environments Act – timelines and content • Strategic Planning Act – timeline and content

Description	Risk Cause and Effect	Mitigation Strategy	Risk Rating (unmitigated)	Comments (including current actions)
Lack of strong processes and consistent record keeping tools means a reliance on multiple systems to generate the evidence needed for FW Commissioner review of FW Plan development.	TRC does not currently have a formalised CRM system to record (among other things) stakeholder engagement. Instead, staff rely on a number of different spreadsheet based systems that have links to relevant files. These spreadsheets are neither as reliable nor as secure as a dedicated CRM. Multiple systems also run the risk of inconsistencies or duplications in data entered. The overall result is a risk that TRC may struggle to provide key information needed to satisfy questions and inquiries from FW Commissioners on the FW Plan.	Until a CRM is established, the most that can be done is for staff to be careful in managing and maintaining the records. Discussions have been had about opportunities to standardise and integrate spreadsheet systems. The most complete mitigation strategy would be to implement and use a CRM. This type of tool is one of the upgrades being considered in the Digital Strategy implementation.	Medium - High	Supporting the Digital Strategy roll out – which includes in the project list, taking up the CRM modules in packages that are currently being implemented.

Description	Risk Cause and Effect	Mitigation Strategy	Risk Rating (unmitigated)	Comments (including current actions)
There are increasingly vocal sections of the community who are not aligned/in agreement with the overall direction of environmental management.	The community is not fully aligned with the direction proposed in the NRP and overall FW Implementation around a number of issues, (eg., wetland drainage and takes in over-allocated catchments). Officers are concerned that sectors of the community may look to put excessive/undue pressure on Councillors and staff.	Engage community as widely as possible, both on content of implementation and efforts to win 'hearts and minds'	High	Officers have presented to Councillors and iwi chairs and CEs an overview of key FW issues. This assists in consistent messaging being delivered. Continue to provide updates by way of this report – and to present key studies, milestones and other reports for review. Extensive engagement programme being undertaken and will continue to build through the programme – looking to ensure that communities are aware of what is being proposed, that they have their say and that, as far as possible, recommendations and reasons for decisions are transparent.

Date 6 June 2023

Subject: **Sediment contributions from natural land cover areas and impacts of climate change for freshwater planning in Taranaki**

Approved by: AJ Matthews, Director - Environment Quality

S J Ruru, Chief Executive

Document: 3175645

Purpose

1. The purpose of this memorandum is to provide the Committee with an overview of the findings of a recent report commissioned by Taranaki Regional Council *SedNetNZ modelling to assess sediment contributions from natural land cover areas and impacts of climate change in Taranaki* by Manaaki Whenua Landcare Research.
2. A copy of the report accompanies this memorandum, and is available on the Council's website. This item will also be accompanied by a presentation from Dr. Hugh Smith, lead author and Senior Researcher – Erosion and Sediment Processes at Manaaki Whenua Landcare Research.

Executive summary

3. Hill country erosion and soil loss remains one of the most significant management challenges for the region. Some land use activities exacerbate the risk of erosion of hill country soils, increasing the vulnerability of catchments to increased sedimentation and resulting in the degradation of water quality in freshwater and coastal receiving environments including rivers, lakes and estuaries.
4. Climate change is expected to exacerbate soil loss and present challenges to the future management of erosion-prone land. It is estimated that extreme storm events resulting in flooding and slips are likely to occur somewhere in Taranaki about once every five to six years. In coming years, the region is expected to experience more frequent and intense heavy rainfall events, increasing both the frequency and severity of storm events.
5. Significant efforts by the Council and community to prevent and minimise the effects of soil loss have resulted in the development of comprehensive farm plans, and the implementation of soil conservation projects through the South Taranaki and Regional Erosion Support Scheme (STRESS) with support from the Ministry for Primary Industries (MPI) Sustainable Land Management Hill Country Erosion Fund. Work by Neverman et al. (2021) and presented to this Committee in June 2021 estimated there had been a 29%

reduction in suspended sediment loads delivered to the Taranaki coast since soil conservation works, including riparian fencing and Whole Farm Plans, were first implemented in 1996.

6. The National Policy Statement for Freshwater Management 2020 (NPS-FM) requires councils and communities to set target states, identify limits and establish action plans to maintain and improve freshwater quality indicators (referred to as attributes) above minimum standards known as 'national bottom lines'. Actions may be required to reduce erosion, improve sediment control and/or adapt land use practices in order to achieve target states for sediment attributes.
7. Sound decision-making around implementing the NPS-FM and future land management requires that Council has a comprehensive understanding of the progress made to date, future reductions that can be achieved through the continued implementation of soil conservation works, and where novel mitigation approaches to erosion management will be necessary to achieve community visions for freshwater.
8. Manaaki Whenua Landcare Research was recently contracted by the Council to apply the SedNetNZ model to estimate the contribution of natural sources of sediment and the impact of climate change on sediment loads transported in river networks, to better understand what is necessary to achieve NPS-FM objectives in Taranaki and inform freshwater policy and land management decision-making.
9. The report presents the combined findings of two Envirolink-funded research projects to:
    - Provide estimates of mid and late century erosion and suspended sediment loads, and the load reductions necessary to achieve NPS-FM compliance, at 14 selected water quality monitoring sites in the Taranaki region, under different greenhouse gas scenarios known as representative concentration pathways or RCPs (ranging from RCP2.6 to RCP8.5).
    - Estimate the contribution of sediment from natural cover areas (such as native bush) versus non-natural cover areas (such as pasture).
10. Modelling found that fully implemented and mature soil conservation works may help offset the impacts of increased erosion driven by climate change under all modelled greenhouse gas pathways where they are fully implemented and mature by mid-century, compared to the pre-mitigation baseline loads set in 1996. By late century, fully implemented and mature soil conservation works may offset the effects of climate change on the total sediment load for greenhouse gas (GHG) pathways up to RCP6.0, when compared to the pre-mitigation baseline.
11. The positive impact of soil conservation works is identified by the model which shows that under the worst case GHG pathway (RCP8.5) for the late century, regional sediment loads could increase by between 4% and 28% compared to the pre-mitigation baseline loads. This projected increase is significantly less than the >70% load increase from the effects of climate change without implementing conservation measures.
12. Six of the seven monitoring sites with a baseline state in Band A are projected to remain in Band A under projected climate change, and one site is estimated to improve in attribute state for the lower GHG pathways modelled by mid century. By late century, four sites are projected to have lower sediment loads than their baseline state across all greenhouse gas emission pathways.
13. Declines in attribute bands are projected at four sites by mid-century and five sites by late century. By late century, three sites require additional reductions in sediment loads to maintain their baseline state under the three worst greenhouse gas emission pathways,

and three sites are projected to require further reductions in sediment loads to achieve national bottom line attribute states.

14. Proportional load contributions from natural and non-natural land covers were comparable under the baseline climate and projected climate change scenarios. Results suggest the load reductions required to maintain or improve the attribute state at all sites (with the exception of Whenuakura River at Nicholson Rd) are less than the load coming from non-natural cover areas. This means that it may be feasible to achieve NPS-FM objectives at the majority of monitoring sites by implementing mitigation strategies, which are only able to be adopted in non-natural land cover areas.
15. As with any model, there are several limitations in the SedNetNZ modelling undertaken. These limitations are largely related to the availability of input data associated with erosion processes and their occurrence, and soil conservations works implemented to date. However, addressing the currently limited spatial coverage of water quality monitoring data for hill country river catchments could also assist in improving our understanding of the effects of soil conservation and erosion control mitigations on in-stream sediment loads and ecosystem health.
16. The report sets out a number of recommendations including:
    - Modelling could be improved with regional data on the extent to which soil conservation works outlined in Whole Farm Plans have been completed, and their level of maturity.
    - Further work to update SedNetNZ model for Taranaki using regional LiDAR and new S-Map data, to enable better representation of erosion processes within the model.
    - Future load estimates may be updated when downscaled climate model projections utlilised in this model become available for New Zealand.
17. A number of these recommendations (for example, increasing soil mapping and regional LiDAR coverage) are already underway, while other recommendations will require further consideration and planning. Further detail around the findings and recommendations can be found in the report, a copy of which accompanies this memorandum.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Sediment contributions from natural land cover areas and impacts of climate change for freshwater planning in Taranaki* and accompanying report

b) receives the presentation by Manaaki Whenua Landcare Research; and

c) notes the recommendations of the authors and officers regarding future work.

Background

18. Erosion is a significant and on-going challenge in the Taranaki region with inland hill country and coastal sand country being particularly prone to erosion due to geology, soil type, slope angle and aspect, climate and vegetation cover. Certain land use activities exacerbate the risk of erosion in these areas, increasing the vulnerability of catchments to increased sedimentation. In addition to degrading water quality and aquatic habitats in rivers and lakes, an assessment of the region's estuaries (Robertson Environmental, 2020)

found that seven Taranaki river mouth estuaries are vulnerable to sediment and nutrient loading, which can threaten marine life, lead to habitat loss, and impact recreational use.

19. Key actions to address the risk of soil loss and environmental degradation resulting from erosion are set out in Taranaki Regional Council's Regional Policy Statement (RPS) and Regional Soil Plan (RSP). In addition to regulatory activities, these actions also include implementing Council's Sustainable Land Management Programme, and providing advice and guidance to land owners. Much work has been undertaken to support soil conservation projects that will reduce the risk of accelerated erosion in the eastern hill country and sedimentation of the region's waterways and marine environment.
20. In implementing the NPS-FM, regional councils are required to establish baseline and current attribute states for deposited and suspended fine sediments, and set limits and establish action plans to address freshwater quality degradation caused by excess sediment in rivers and lakes. Councils must notify new regional policy statements and regional plans that give effect to the NPS-FM, including proposed limits, no later than December 2024.
21. Previously, the Council contracted Manaaki Whenua – Landcare Research to estimate erosion, simulate sediment loads in river network and estimate the impact of soil conservation work using the SedNetNZ model. Results from previous modelling identified monitored sites requiring reductions in suspended sediment loads to achieve attribute states for suspended fine sediments described in the NPS-FM, and identified and prioritised areas within these catchments for soil conservation and erosion control work (Neverman et al., 2021). This report was shared with the Committee in June 2021.
22. Neverman et al. (2021) estimated there had been a 29% reduction in suspended sediment loads delivered to the Taranaki coast since soil conservation works were first implemented in 1996, including hill country Whole Farm Plans, and riparian fencing in 3rd order and greater hill country waterways, and all ring plain and coastal waterways. Additionally, the model estimated a total reduction of 40% in suspended sediment loads delivered to the coast could be achievable once all soil conservation works have been fully implemented and matured, although the potential effects of climate change on erosion and suspended sediment loads were not considered at that time.
23. Climate change projections for the Taranaki region (NIWA, 2022) suggest more frequent and intense heavy rainfall events, which are likely to increase the risk of erosion, landslides and flooding. It is therefore necessary to consider the potential impacts of climate change in informing the actions necessary to respond to the increased risk of erosion and sedimentation in the region.
24. It is necessary to take into account the impacts of climate change when considering the appropriate actions to take in response to the risks arising from increased erosion and sedimentation. Continuing to invest in soil conservation works is key to mitigating the effects of climate change in reducing the downstream impacts of erosion and soil loss. The report highlights that achieving freshwater outcomes sought by the NPS-FM will be achievable in some catchments, but challenging in others, particularly if global GHG emissions are not reduced. Council will need to consider these impacts as part of future planning, and when informing the development and implementation of new freshwater policy.

Discussion

SedNetNZ

25. SedNetNZ is an erosion model that predicts the generation and transport of sediment through river networks. The model is based on a relatively simple physical representation of hillslope and channel processes at small sub-catchment scale, and provides estimates of long-term average annual sediment load generated by different erosion processes (landslides, gullies, earthflows, surface, and bank erosion) and sediment deposition on floodplains.
26. The SedNetNZ model enables improved targeting of erosion mitigation to the key contributing processes, and analysis of the linkages between upstream sediment generation and downstream sediment loading. SedNetNZ is also well-suited to scenario analysis of changes in land management and implementation of erosion mitigation practices. Several regional councils have recently commissioned SedNetNZ analyses of large catchments to support land and water policy development.
27. Previous SedNetNZ modelling undertaken for Council (Neverman et al. 2021) provided insight into the gains made from erosion and sediment control works to date and further gains to be made upon the completion and maturation of additional works. To provide a greater understanding of the effect of projected climate change and contribution of natural sources of sediment in achieving NPS-FM outcomes for suspended fine sediment at selected water quality monitoring sites in the Taranaki region, modelling of mean annual suspended sediment loads using SedNetNZ was projected for:
    - Mid-century (the 2031–2050 period, represented by 2040) and late century (the 2080–2100 period, represented by 2090) under four climate change scenarios based on a range of potential greenhouse gas trajectories.
    - A contemporary baseline soil conservation scenario (2018 land cover and the extent and maturity of soil conservation works completed to date).
    - A future soil conservation scenario (fully implemented and matured soil conservation works).
    - Contribution of natural cover areas to suspended sediment loads at selected water quality monitoring sites for the contemporary baseline and future soil conservation scenarios.

Climate change

28. Climate change projections were provided for mid-century (the 2031–2050 period, represented by 2040), and late century (the 2080–2100 period, represented by 2090), using outputs from a combination of global and regional climate models. To account for the uncertainty in future CO2 concentrations, four scenarios using representative concentration pathways (RCPs) adopted by the Intergovernmental Panel on Climate Change (IPCC) were used to project a range of possible outcomes. Each RCP represents a different radiative forcing based on greenhouse gas trajectories:
    - RCP2.6 - a mitigation pathway (where emissions decline from 2020, with net zero emissions from 2100);
    - RCP4.5 and RCP6.0 - stabilisation pathways (where emissions peak mid-to late-21st Century, then decline); and
    - RCP8.5 - continual increase scenario (where emissions continue to rise throughout the 21st century).

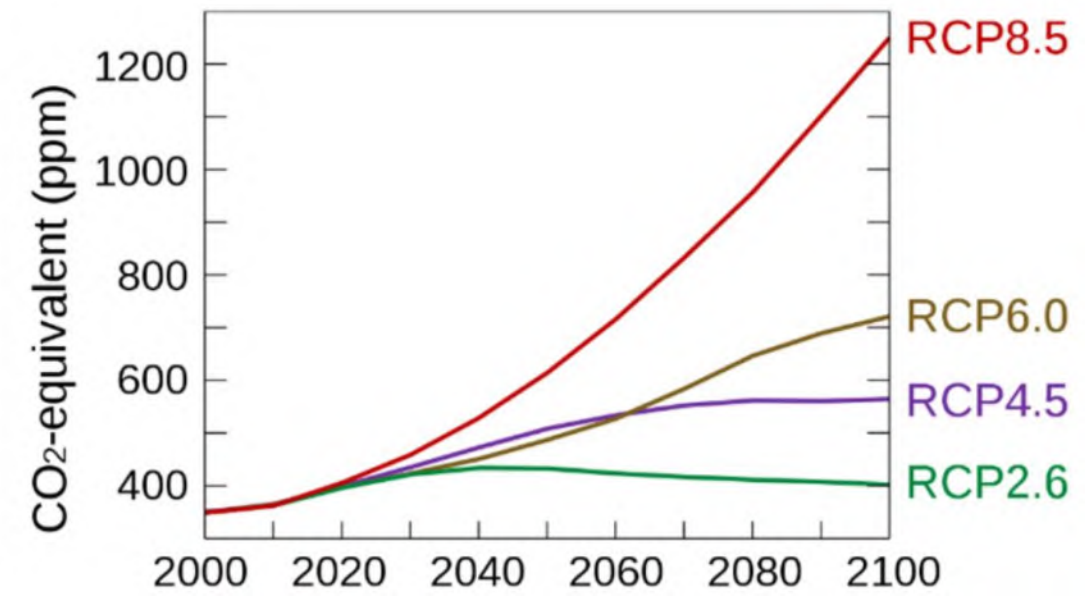

Figure 1 CO2-equivalent concentration pathways through time, referred to as representative concentration pathways (RCPs), based on the IPCC's fifth assessment report (IPCC, 2013).

29. It should be noted that variations between global climate models, greenhouse gas emission trajectories, and how climate change affects erosion processes, contribute to a high degree of uncertainty in projected changes in suspended sediment loads. There can be considerable difference between our lowest and highest projections, especially by late century. Modelled results are therefore presented as a range to communicate the scale of different outcomes that we might see in coming decades.
30. For the purposes of this report, model results, with and without the effect of climate change, were compared to determine the extent to which soil conservation measures mitigate soil erosion and suspended sediment loads under different climate change scenarios.
31. Under the contemporary soil conservation scenario (i.e. with no further conservation works), climate change could increase mean annual suspended sediment load delivered to the Taranaki coast by between 13% and 57% by mid century, and 7% and 108% by late century climate change.
32. Under the fully implemented and matured future soil conservation scenario (i.e. where all possible works are implemented), the sediment load delivered to the Taranaki coast is significantly reduced. Overall sediment load is projected to change by -32% to -3% by mid-century and -35% to +28% by late century compared to the pre-mitigation baseline loads (circa 1996). The greatest response is evident at hill country monitoring sites where catchments are dominated by shallow landslide erosion, which is projected to increase due to more frequent and higher magnitude storm rainfall under future climate.
33. Results indicate that fully implemented and mature soil conservation works, including works yet to be completed, may help offset the impacts of climate change under all modelled greenhouse gas pathways where they are fully implemented and mature by mid-century, compared to the pre-mitigation baseline.

34. By late century, fully implemented and mature soil conservation works may offset the effects of climate change for up to the second worst greenhouse gas pathway modelled in which CO2-equivalent concentrations stabilise around mid-century at ~570 ppm. Under RCP8.5 (worst case scenario), regional sediment loads could increase by between 4% and 28% compared to the pre-mitigation baseline loads. It is important to note however, that this is significantly less than the >70% increase in load expected from the effects of projected climate change in the absence of further reductions from conservation measures. This demonstrates the benefit of continuing to invest in soil conservation works, irrespective of which climate change scenario eventuates.

Achievement of NPS-FM (2020) attribute states

35. The report explored the feasibility of achieving the national bottom line and NOF attribute states for visual clarity (sediment measure) at selected monitoring sites under best practice soil conservation scenarios by identifying the contribution of sediments from natural cover areas.

36. Under the contemporary baseline (current conservation works at full maturity), seven of the 14 monitoring sites achieve band A (highest achievable state), two achieve band B, two achieve band C, and three do not achieve the national bottom line. Of the seven sites below band A for the baseline state, only the Mangaehu is predicted to see an improvement in attribute state with additional implementation and maturity of soil conservation works without the effects of climate change (Neverman et al. 2021).

37. Five of the seven monitoring sites with a baseline state in Band A are projected to remain in Band A under projected climate change at both mid- and late-century, with one further site (Hangatahua (Stony) River at Mangatete Rd) estimated to improve in attribute state for the lower greenhouse gas emission pathways. The Waingongoro River at SH45 is projected to improve from band C to band B by mid-century under lower emission scenarios, but could fail to achieve the national bottom line under a high emissions scenario.

38. Four sites (29%) representing three catchments (Mangaehu River, Punehu Stream and Waingongoro River) are projected to decline in attribute band by mid-century. An additional seven sites (50%) are projected to have a decline in visual clarity without crossing the attribute band threshold. As the NPS-FM does not allow for a deterioration below the baseline state, this will require further consideration as Council develops its new freshwater policy and plan provisions.

39. Table 1 shows the remaining contemporary sediment load that could be sourced from non-natural cover (i.e. areas where soil conservation works could still be carried out) and the future conservation scenario with climate change at mid-century. The baseline state is compared to the future state for the NOF visual clarity measure.

Table 1: Baseline state and contemporary load from non-natural cover areas, with future (mid-century) projected state arising from the future conservation scenario with climate change under RCP2.6 - RCP 8.5.

Site	Baseline state	Contemporary load from non-natural cover areas (t/yr)	Future conservation scenario with climate change at mid-century (t/yr)	Future state (circa 2040)
Mangaehu River at Raupuha Rd Bridge	C	180,000	164,000 - 234,000	C/D
Maketawa Stream at Tarata Rd	A	560	570 - 590	A
Mangaoraka Stream at Corbett Rd	A	750	480 - 560	A
Pātea River at Barclay Rd Bridge	A	140	100	A
Pātea River at Skinner Rd Bridge	A	2,000	830 - 890	A
Punehu Stream at Wiremu Rd	B	550	650 - 730	C/D
Punehu Stream at SH45	B	970	1,200 - 1,300	C/D
Hangatahua (Stony) River at Mangatete Rd	A	5,300	6,500 - 6,900	A/B
Waingongoro River at Eltham Rd Bridge	A	1,900	1,700 - 2,300	A-D
Waingongoro River at SH45	C	9,100	6,900 - 9,200	A-D
Waiwhakaiho River at SH3	A	2,700	2,700 - 3,000	A
Waiokura pumphouse	D	100	100 - 110	D
Whenuakura River at Nicholson Rd	D	63,000	61,000 - 85,000	D
Waitara River at Autawa Rd	D	265,000	245,000 - 352,000	D

Sediment contribution from natural cover areas

40. The report also highlights that generally, ongoing work will be successful in contributing toward mitigating the effects of climate change in terms of overall catchment sediment loads. Proportional load contributions from natural and non-natural land covers were found to be comparable between baseline climate and projected climate change scenarios. Results suggest the load reductions required to maintain or improve the attribute state at all sites (except Whenuakura River at Nicholson Rd) are less than the load coming from non-natural cover areas.

41. Upstream of the Whenuakura River at Nicholson Road site, 71% of the catchment is already under natural cover. The site has a contemporary sediment load of 144,000 t/yr, of which 63,000 t/yr (44%) comes from non-natural cover areas. The load reduction required to meet the national bottom line is 83,000 t/yr.

Next steps

42. As with any model, there are several limitations in the SedNetNZ modelling undertaken. These limitations are largely related to the availability of input data associated with erosion processes and their occurrence, and limited spatial coverage of water quality monitoring data for hill country river catchments which were noted in the previous SedNetNZ report.

43. The report sets out a number of recommendations including:

- Modelling could be improved with regional data on the extent to which soil conservation works outlined in Whole Farm Plans have been completed, and their level of maturity.
- Further work to update SedNetNZ model for Taranaki using regional LiDAR and new S-Map data, to enable better representation of erosion processes within the model.
- Future load estimates may be updated when downscaled climate model projections utlilised in this model become available for New Zealand.

44. A number of these recommendations (for example, increasing soil mapping and regional LiDAR coverage) are already underway, while other recommendations will require further consideration and planning. Further detail around the findings and recommendations can be found in the report *SedNetNZ modelling to assess sediment contributions from natural land cover areas and impacts of climate change in Taranaki*, a copy of which accompanies this memorandum.

Financial considerations—LTP/Annual Plan

45. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

46. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

47. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Community considerations

48. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

49. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

References

Neverman A J, Smith H G. 2023. *SedNetNZ modelling to assess sediment contributions from natural land cover areas and impacts of climate change in Taranaki*. Landcare Research Contract Report LC4258 prepared for Taranaki Regional Council.

Neverman A J, Smith H G, Herzig A. 2021. *Planning soil conservation for sediment load reduction in Taranaki*. Landcare Research Contract Report LC3942 prepared for Taranaki Regional Council.

Robertson, B. 2019. *Taranaki Regional Estuaries Ecological Vulnerability Assessment for Taranaki Regional Council*. Robertson Environmental client report prepared for Taranaki Regional Council, July 2019.

Appendices/Attachments

Document 3114573: *SedNetNZ modelling to assess sediment contributions from natural land cover areas and impacts of climate change in Taranaki*, Manaaki Whenua Landcare Research client report for Taranaki Regional Council, March 2023.

Manaaki Whenua
Landcare Research

SedNetNZ modelling to assess sediment contributions from natural land cover areas and impacts of climate change in Taranaki

Envirolink Grants: 2305-TRC004 and 2308-TRC005

Prepared for: Taranaki Regional Council

March 2023

SedNetNZ modelling to assess sediment contributions from natural land cover areas and impacts of climate change in Taranaki

Contract Report: LC4258

Andrew Neverman, Hugh Smith

Manaaki Whenua – Landcare Research

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Contents

Summary

Project and client

- Taranaki Regional Council (TRC) previously contracted Manaaki Whenua – Landcare Research (MWLR) to model mean annual suspended sediment loads under different land cover scenarios (Neverman et al. 2021).
- Reductions in mean annual suspended sediment load required to meet the National Policy Statement for Freshwater Management 2020 (NPS-FM (2020)) suspended fine sediment attribute states (visual clarity) were also modelled at selected water quality monitoring sites (Neverman et al. 2021), and the future attribute state estimated for the future soil conservation scenario consisting of fully implemented and mature Whole Farm Plans (WFPs).
- TRC subsequently requested MWLR estimate the impact of projected climate change on sediment loads at the selected water quality monitoring sites reported in Neverman et al. (2021) for the contemporary baseline and future soil conservation scenarios; and that they also estimate the contribution of natural land cover areas to modelled loads.
- The work on contributions from natural cover areas and climate change impacts was completed under Envirolink Medium advice grants 2305-TRC004 and 2308-TRC005, respectively.

Objectives

- Model the effects of climate change on erosion and suspended sediment loads for mid-century and late century for:
    a the contemporary baseline scenario (2018 land cover and the extent and maturity of soil conservation works completed to date)
    b the future soil conservation scenario (fully implemented and matured soil conservation works).
- Compare model results with and without the effect of climate change to assess the extent to which soil conservation measures mitigate projected impacts from climate change.
- Assess compliance with the NPS-FM (2020) for suspended fine sediment at selected water quality monitoring sites for the future soil conservation scenario under projected climate change.
- Estimate the contribution of natural cover areas to suspended sediment loads at selected water quality monitoring sites for the contemporary baseline and future soil conservation scenarios.
- Compare natural cover load contributions with the estimated load reductions required to achieve the NPS-FM (2020) attribute bands for suspended fine sediment reported in Neverman et al. (2021).

Methods

- The effect of projected climate change on region-wide erosion and suspended sediment loads was modelled for the contemporary baseline and future soil conservation scenarios using future rainfall and temperature estimates from six regionally downscaled climate models and four greenhouse gas trajectories (representative concentration pathways, RCPs) at mid-century and late century to adjust modelled erosion process rates under climate change and estimate future suspended sediment loads.
- Changes in sediment loads under projected climate change were assessed at selected water quality monitoring sites. The changes in load for the future soil conservation scenario were compared to the load reductions required to achieve the national bottom line (NBL) in the NPS-FM (2020), or improve the attribute state of the monitoring site, to assess potential future compliance with the NPS-FM (2020). Where monitoring sites are projected to degrade under future climate, load reductions required to maintain the baseline state are reported.
- Suspended sediment load contributions from natural cover areas were estimated at selected water quality monitoring sites for the contemporary baseline and future soil conservation scenarios described in Neverman et al. (2021). The land cover classes from the New Zealand Landcover Database (LCDBv5) were classified as natural or non-natural. The load derived from each class was accumulated downstream to monitoring sites, accounting for floodplain deposition and storage in lakes.

Results

- Climate change is projected to increase mean annual suspended sediment load delivered to the Taranaki coast by between 13% and 57% at mid-century, and 7% and 108% by late century, if no further reductions were achieved from soil conservation works under the contemporary scenario. This equates to an increase from the baseline 1.7 Mt/yr to 1.9–2.7 Mt/yr and 1.8–3.5 Mt/yr by mid-century and late century, respectively.
- Under the future soil conservation scenario, the load delivered to the Taranaki coast is projected to range from 1.6–2.3 Mt/yr by mid-century, and 1.6–3.0 Mt/yr by late century under projected climate change. This equates to a difference of -32% to -3% by mid-century and of -35% to +28% by late century, compared to the pre-mitigation baseline. It equates to a difference of -3% to +37% by mid- century and of -8% to +81% by late century, compared to the contemporary baseline.
- Six of the seven monitoring sites with a baseline state in band A are projected to remain in band A under projected climate change. The Waingongoro River at SH45 is estimated to improve in attribute state from band C to band A or B for lower greenhouse gas emission pathways. Four sites (29%) are projected to have declines in attribute band by mid-century, and five sites (35%) by late century.
- By late century, the Mangaoraka Stream at Corbett Rd, Pātea River at Barclay Rd Bridge, Pātea River at Skinner Rd Bridge, and Waiwhakaiho River at SH3 are projected to have lower sediment loads than their baseline state across all RCPs. Three sites (Mangaehu River at Raupuha Rd Bridge, Waingongoro River at Eltham Rd Bridge, and

Waingongoro River at SH45) require additional reductions in load to maintain their baseline state for RCPs 4.5, 6.0, and 8.5.

- Waiokura pumphouse, Whenuakura River at Nicholson Rd, and Waitara River at Autawa Rd are projected to have increases in load across all climate projections by late century and therefore require further reductions to achieve the NBL.
- Natural cover areas contribute less than 1%–56% of contemporary suspended sediment loads, and less than 1%–60% of future soil conservation scenario sediment loads under baseline climate conditions. At the monitoring sites, 44%–100% of contemporary suspended sediment loads are derived from non-natural cover areas. This suggests the load reductions required at most sites (except the Whenuakura River at Nicholson Rd) to improve their attribute state are less than the load coming from non-natural cover areas, where mitigations may be feasible. Proportional load contributions from natural and non-natural land covers are comparable under baseline climate and projected climate change.

Conclusions and recommendations

- Continued investment in soil conservation works for erosion mitigation will be required to reduce potentially significant impacts of climate change on suspended sediment loads by late century.
- Compared to the pre-mitigation baseline, fully implemented and mature soil conservation works may offset the effects of climate change at late century for greenhouse gas pathways up to RCP6.0 for the total load delivered to the coast across Taranaki. Soil conservation works may offset the impacts of climate change at 50% of monitoring sites across all climate projections by late century.
- Due to the extent of soil conservation works assumed to be implemented by 2018, additional conservation works from the contemporary baseline appear to have less impact, but do still offset climate change under some projections.
- It is likely the capacity for sediment load reductions in the future has been underestimated due to an overestimation of the extent and maturity of soil conservation works implemented in the contemporary baseline scenario. This modelling could be improved with regional data on the extent to which soil conservation works outlined in WFPs have been completed, and their level of maturity.
- The availability of regional LiDAR and S-Map data will enable better representation of erosion processes within SedNetNZ. Future work could update SedNetNZ using these data. Future load estimates may be updated when downscaled CMIP6 projections become available for New Zealand.

1 Introduction

Taranaki Regional Council (TRC) previously contracted Manaaki Whenua – Landcare Research (MWLR) to model mean annual suspended sediment loads under different land cover scenarios (Neverman et al. 2021). This included a) an initial baseline using 1996 land cover without specific representation of soil conservation works, representing a pre-mitigation state; b) a contemporary baseline using 2018 land cover and erosion mitigations implemented to date; c) a future soil conservation scenario consisting of fully implemented and matured best practice soil conservation works. Reductions in mean annual suspended sediment load required to meet the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) (Ministry for the Environment 2022) suspended fine sediment attribute states (visual clarity) were also modelled at selected water quality monitoring sites (Neverman et al. 2021); future attribute state was estimated for the future soil conservation scenario.

Subsequently, TRC requested MWLR estimate the impact of projected climate change at the selected water quality monitoring sites reported in Neverman et al. (2021) for the contemporary baseline and future soil conservation scenarios; and estimate the contribution of natural land cover areas to suspended sediment loads.

2 Background

Neverman et al. (2021) estimated there had been a 29% reduction in suspended sediment loads delivered to the Taranaki coast since soil conservation works were first implemented in 1996, and that a total reduction of 40% may be achievable once all soil conservation works have been fully implemented and matured. However, this analysis did not consider the potential effects of climate change on erosion and suspended sediment loads.

Since the completion of the previous work in the Taranaki region (Neverman et al. 2021), SedNetNZ has been updated to include the capability to model changes in erosion and sediment loads under projected climate change (Smith et al. 2022; Vale et al. 2022). SedNetNZ models the effect of climate change on erosion processes individually before combining the loads to route through the stream network. This allows erosion processes to respond in different directions and with different magnitudes depending on the response of their primary hydro-climatic driver to future climate. Spatial variation in the net effect of climate change on erosion is therefore reflected in catchment loads (Neverman et al. 2023).

3 Objectives

- Model the effects of climate change on erosion and suspended sediment loads at mid-century and late century for:
    a the contemporary baseline scenario (2018 land cover and the extent and maturity of soil conservation works completed to date)

b the future soil conservation scenario (fully implemented and matured soil conservation works).

- Compare model results with and without the effect of climate change to assess the extent to which soil conservation measures mitigate projected climate change impacts on soil erosion and suspended sediment loads.
- Assess compliance with the NPS-FM (2020) for suspended fine sediment at selected water quality monitoring sites for the future soil conservation scenario under projected climate change.
- Estimate the contribution of natural cover areas to suspended sediment loads at selected water quality monitoring sites for the contemporary baseline and future soil conservation scenarios.
- Compare natural cover load contributions with the estimated load reductions required to achieve the NPS-FM (2020) attribute bands for suspended fine sediment reported in Neverman et al. (2021).

4 Methods

The SedNetNZ model and land cover scenarios are described in Neverman et al. (2021). The same SedNetNZ model configuration was used for the contemporary baseline and future soil conservation scenarios but with additional functions to model the effects of climate change, and a spatial ruleset to determine the location of natural cover areas. These additions are described below.

4.1 Impacts of climate change

We modelled the effect of projected climate change on erosion and suspended sediment loads following Vale et al. (2022), Smith et al. (2022), and Neverman et al. (2023). Erosion and suspended sediment loads were modelled for mid-century (the 2031–2050 period, represented by 2040), and late century (the 2080–2100 period, represented by 2090) using climate outputs from CMIP5 (Coupled Model Inter-comparison Project) global climate models (GCMs) coupled with the New Zealand Regional Climate Model (NZRCM) (Sood 2014) for downscaling and bias correction (Ministry for the Environment 2018). The downscaled projections are referred to as regional climate models (RCMs). Downscaled CMIP6 projections are not yet available for New Zealand. Shrestha et al. (2013) and Eekhout & de Vente (2022) recommend using multiple GCMs to account for model uncertainty. We used outputs from six GCMs (BCC-CSM1.1, CESM1-CAM5, GFDL-CM3, GISS-E2-R, HadGEM2-ES, and NorESM1-M), chosen for their performance, availability of data, and difference in parent global models to represent the range of model sensitivity (Collins et al. 2018; Ministry for the Environment 2018).

To account for the uncertainty in future CO_2 concentrations, four scenarios (representative concentration pathways, or RCPs (van Vuuren et al. 2011)) from the IPCC's fifth assessment report (IPCC 2013) were used to drive each RCM. The RCPs represent different radiative forcing based on greenhouse gas trajectories (Table 1; Ministry for the Environment 2018). The RCPs represent total radiative forcing of 2.6 W/m^2 (a mitigation pathway), 4.5 W/m^2

and 6.0 W/m^2 (stabilisation pathways), and 8.5 W/m^2 (continual increase scenario), referred to as RCP2.6, RCP4.5, RCP6.0, and RCP8.5, respectively. Variations in the RCPs become more evident after mid-century (Figure 1). Each RCM-RCP pair is referred to as a 'climate projection'.

Table 1. Representative concentration pathways and their descriptions

Representative concentration pathway (RCP)	Description
2.6	Mitigation scenario, requiring removal of CO_2 from the atmosphere
4.5	Intermediate scenario where CO_2 concentrations stabilise
6.0	Intermediate scenario where CO_2 concentrations stabilise
8.5	Continual increase in CO_2 concentrations (representing a worst-case scenario)

Source: Based on Ministry for the Environment 2018.

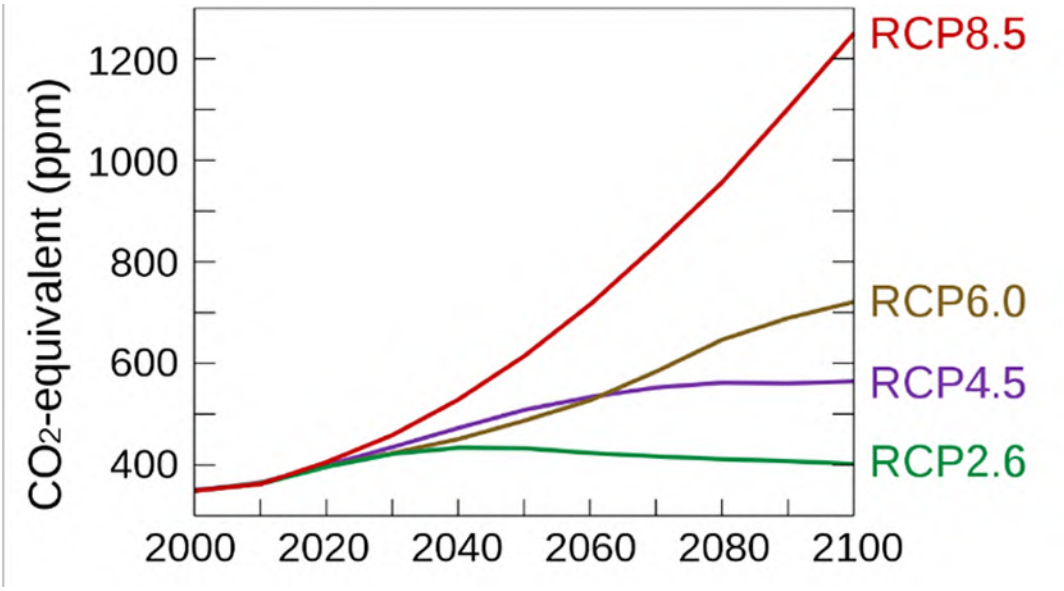

Figure 1. CO_2-equivalent concentration pathways through time, referred to as representative concentration pathways (RCPs), based on the IPCC's fifth assessment report (IPCC 2013).

The effect of climate change on erosion processes is represented in SedNetNZ using different hydro-climatic variables to drive changes in individual erosion processes following Neverman et al. (2023). In the hillslope domain, changes in surficial erosion are modelled for each climate projection using the estimated change in mean annual rainfall to directly adjust P in the NZUSLE (see Equation 1 in Neverman et al. 2021). In New Zealand's soft-rock hill country sediment loads are dominated by mass movement erosion, usually in the form of storm-triggered shallow landslides (Page et al. 1994; Trustrum et al. 1999; Basher 2013). Mass movement erosion (shallow landslides, gullies, and earthflows) is therefore assumed to change as a function of changes in storm rainfall depth resulting

from changes in the magnitude and frequency of landslide-triggering storm events, following the relationship between total storm rainfall and landslide density identified by Reid and Page (2003). Carey-Smith et al. (2018) recommend using a uniform augmentation factor based on change in temperature to estimate future storm rainfall for New Zealand. We therefore calculate future storm rainfall as:

$$R' = R(1 + \Delta T\, AF) \quad (1)$$

where R' is future rainfall (mm), R is historical rainfall (mm), ΔT is future change in temperature relative to baseline (°C), and AF is the augmentation factor. AF is derived from the estimated change in rainfall depth per 1°C increase in temperature for a 30-year average recurrence interval rainfall event of 48 hours duration, which is assumed to represent the dominant landslide-triggering event (Basher et al. 2020; Neverman et al. 2023), giving a value of 0.073 for AF (Ministry for the Environment 2018). Rain gauges with complete records for the last 50 years were selected from CliFlo (NIWA 2021) and used to represent historic rainfall. At each gauge, Equation 1 was used to calculate R' under a range of temperature increases.

Storm events were identified in the baseline and future rainfall records as consecutive days where rainfall exceeded a breakpoint of 10 mm/day. The storms were considered landslide producing events if >150 mm of rain fell in a 48-hour period during the event (Basher et al. 2020; Neverman et al. 2023). The density of shallow landslides produced in each rainfall record was estimated using the relationship between total storm rainfall and shallow landslide density identified by Reid and Page (2003):

$$LD = mP_s + b \quad (2)$$

where LD is the density of shallow landslides (n landslides/km^2), P_s is the total rainfall for the storm event (mm), m is the slope of the linear relationship between LD and P_s, set to 0.72 (Basher et al. 2020; Neverman et al. 2023), and b is the y-intercept of the relationship, calculated by solving for b under the assumption $LD = 0$ when $P_s \leq 150$ mm:

$$0 = 150m + b$$

$$b = -136.8 \quad (3)$$

Linear models were developed for the relationship between LD and ΔT at each rain gauge location:

$$LD' = a\Delta T + LD \quad (4)$$

where LD' is the future landslide density (n landslides/km^2), a is the slope of the linear relationship between ΔT and LD', and therefore the absolute change in landslide density per 1°C of temperature change; and LD is the landslide density for the baseline rainfall record, R.

The mass movement change factor, CF, was then determined at each rain gauge as the proportional increase in landslide density per 1°C of temperature change, calculated as:

$$CF = \frac{a}{LD} \quad (5)$$

CF was interpolated spatially using Sibson's (1981) natural neighbours interpolation.

Future rates of mass movement, MM', were calculated by augmenting the baseline mass movement rate, MM, by CF and the change in temperate, ΔT, such that:

$$MM' = MM(1 + CF\Delta T) \quad (6)$$

where MM represents the hillslope mass movement dominated processes, EL, EE, and EG, from Equations 8, 9, 10 in Neverman et al. (2021).

The effect of climate change on bank erosion was based on estimated changes in mean annual flood (MAF) for each climate projection per stream segment. Linear relationships between bank migration rates and discharge or stream power have been illustrated by empirical and modelling studies (Richard et al. 2005; Larsen et al. 2006; Nicoll & Hickin 2010; Hooke 2012, 2015). Mean annual flood has been used previously as a spatial predictor of bank erosion in New Zealand (Dymond et al. 2016; Smith et al. 2019; Neverman et al. 2023).

Future net suspended sediment loads from bank erosion (t/yr) for the *j*th stream segment under climate change (B_j') were estimated as

$$B_j' = B_j \Delta MAF_j \quad (7)$$

where B_j is the baseline net suspended sediment load from bank erosion (equation 11, Neverman et al. 2021) and ΔMAF_j is a dimensionless change factor based on the change in MAF between the baseline and future climate projections. This relationship assumes channel resistance and geometry remain constant (Neverman et al. 2023).

Future changes in MAF were estimated from hydrological modelling that simulated flows over successive 20-year periods for each RCM (Collins et al. 2018; Collins 2020) and computed proportional changes in future MAF relative to a historical baseline period (1986–2005). These predicted proportional changes in future MAF were available as the median across the six RCMs for each RCP but not for individual RCMs (Neverman et al. 2023). We therefore use these median values for each RCP.

Future mean annual suspended sediment loads were computed for mid-century (2031–2050, represented by 2040) and late century (2080–2100, represented by 2090) for each RCM and RCP. Projected changes in sediment loads for each RCP at mid-century and late century are reported as the upper, lower, and median across the six RCMs for each water quality monitoring site.

4.1.1 NPS-FM 2020 compliance at selected water quality monitoring sites

Future compliance with the NPS-FM (2020) suspended fine sediment bands ('attribute states') at selected water quality monitoring sites was assessed by comparing the projected change in sediment load with the estimated change in load required to achieve a different band. We use the approach developed by Hicks et al. (2019) to estimate the proportional change in sediment load required to change the band from the baseline

state. The approach of Hicks et al. (2019) is recommended by the Ministry for the Environment in their guidance for implementing the NPS-FM (2020) sediment requirements (Ministry for the Environment 2022), and directly informed development of the suspended fine sediment attribute for the NPS-FM (2020) (Hicks & Shankar 2020). The same approach was used in Neverman et al. (2021). As suspended sediment loads may increase under future climate conditions, with a decrease in visual clarity, we extended the work of Neverman et al. (2021) to also calculate the increase in suspended sediment load required for the attribute state to decline at each monitoring site.

Following Hicks et al. (2019) and Ministry for the Environment (2022), the proportional change in sediment load required to achieve a target visual clarity is a function of the ratio between the baseline visual clarity and the target visual clarity:

$$P_v = (V_o/V_b)^{1/a} - 1 \quad (8)$$

where P_v is the minimum proportional change in mean annual suspended sediment load required to achieve the target visual clarity, V_o is the target median visual clarity (measured in metres (m)), and V_b is the baseline median visual clarity (in m). We followed the recommendation of Ministry for the Environment (2022) and assumed a takes the national average reported by Hicks et al. (2019) of -0.76. To assess the minimum proportional change in sediment load required to improve the attribute band, we used the lower bound visual clarity for each band (Table 2) for V_o; the upper bound was used to assess the minimum change in load required for a decline in state from a higher band.

We also report the load reductions required under future climate to improve the attribute state from baseline. For sites with projected increases in load under future climate, and therefore a degraded visual clarity state, we report the reduction in future load required to return the site to the baseline visual clarity state. This reflects the NPS-FM (2020) policy which requires attribute targets to be set at or above the baseline state and therefore does not allow for deterioration below baseline visual clarity (Ministry for the Environment, 2022).

The numeric attribute states for suspended fine sediment are determined by the 'sediment class' associated with each River Environment Classification v2 (RECv2) digital river network segment (Table 2), as defined in Appendix 2C of the NPS-FM (2020). The sediment class of a given segment is determined by the climate, topography, and geology classification (as defined in the REC) of upstream segments predominately contributing flow to a given segment. Neverman et al. (2021) used the layer denoting suspended sediment class for the RECv2 digital stream network produced by Hicks & Shankar (2020)[1] to identify the sediment class of each monitoring site. The dominant suspended sediment class at monitoring sites in Taranaki is class 1, with a median visual clarity at the national bottom line (NBL) of 1.34 m (Table 2). The proportional change in mean annual suspended sediment load required to achieve the target visual clarity, P_v, was then applied to the

[1] Available from the MfE data portal at https://data.mfe.govt.nz/layer/103687-hydrological-modelling-to-support-proposed-sediment-attribute-impact-testing-2020/

contemporary mean annual sediment load to calculate the absolute change in load required to achieve the target attribute state.

Table 2. Attribute bands and associated numeric attribute states for suspended fine sediment, reproduced from the NPS-FM (2020). Note the use of visual clarity (m) as the attribute unit

Value (and component)	Ecosystem health (Water quality)			
Freshwater body type	Rivers			
Attribute unit	Visual clarity (metres)			
Attribute band and description	**Numeric attribute state by suspended sediment class**			
	1	2	3	4
A Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	≥1.78	≥0.93	≥2.95	≥1.38
B Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced.	<1.78 and ≥1.55	<0.93 and ≥0.76	<2.95 and ≥2.57	<1.38 and ≥1.17
C Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost.	<1.55 and >1.34	<0.76 and >0.61	<2.57 and >2.22	<1.17 and >0.98
National bottom line	**1.34**	**0.61**	**2.22**	**0.98**
D High impact of suspended sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	<1.34	<0.61	<2.22	<0.98

The minimum record length for grading a site is the median of 5 years of at least monthly samples (at least 60 samples).

Councils may monitor turbidity and convert the measures to visual clarity.

See Appendix 2C Tables 23 and 26 for the definition of suspended sediment classes and their composition.

The following are examples of **naturally occurring processes** relevant for suspended sediment:

- naturally highly coloured brown-water streams
- glacial flour affected streams and rivers
- selected lake-fed REC classes (particularly warm climate classes) where low visual clarity may reflect autochthonous phytoplankton production.

4.2 Contributions from natural cover areas

The 2018 land cover from the New Zealand Landcover Database (LCDB) version 5 (Newsome et al. 2008) was used for both the contemporary baseline and future soil conservation scenarios in Neverman et al. (2021). It was also used to classify areas of natural land cover in the present report. Table 3 lists the LCDB 2018 cover classes present in Taranaki, and whether they are classified as natural or non-natural cover. As this analysis aimed to identify the proportion of the sediment load that would not typically be reduced by erosion mitigation measures the natural cover classification includes areas of native woody vegetation, natural bare ground, and other land cover classes not routinely targeted for erosion mitigation.

The LCDB has a minimum mapping unit of 1 ha, thus natural or non-natural cover areas of <1 ha could not be classified in this analysis. For instance, areas of woody vegetation established on pastoral or cropland as part of Whole Farm Plans (WFPs) for erosion control that were <1 ha have not been included as natural cover. The spatial extent of natural and non-natural cover is illustrated in Figure 2.

Table 3. The LCDBv5 2018 land cover classes present in Taranaki, and their classification as natural cover for this analysis

Class name	LCDB Class code	Natural cover
Built-up Area (settlement)	1	No
Urban Parkland/Open Space	2	No
Transport Infrastructure	5	No
Surface Mine or Dump	6	No
Sand or Gravel	10	Yes
Landslide	12	Yes
Alpine Grass/Herbfield	15	Yes
Gravel or Rock	16	Yes
Lake or Pond	20	Yes
River (water)	21	Yes
Estuarine Open Water	22	Yes
Short-rotation Cropland	30	No
Orchards, Vineyards or Other Perennial Crops	33	No
High Producing Exotic Grassland	40	No
Low Producing Grassland	41	No
Tall Tussock Grassland	43	Yes
Herbaceous Freshwater Vegetation	45	Yes
Herbaceous Saline Vegetation	46	Yes
Flaxland	47	Yes
Fernland	50	Yes
Gorse and/or Broom	51	Yes
Manuka and/or Kanuka	52	Yes
Broadleaved Indigenous Hardwoods	54	Yes
Sub Alpine Shrubland	55	Yes
Mixed Exotic Shrubland	56	Yes
Matagouri or Grey Scrub	58	Yes
Forest - Harvested	64	No
Deciduous Hardwoods	68	Yes
Indigenous Forest	69	Yes
Exotic Forest	71	No

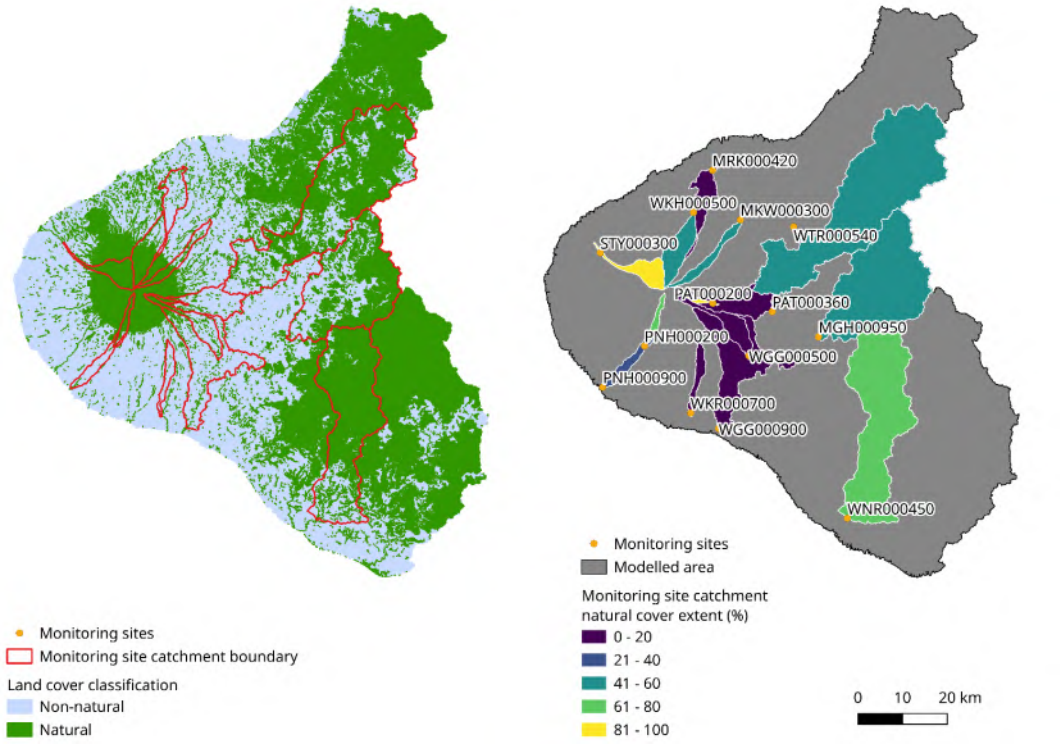

Figure 2. Extent of natural cover in Taranaki (left), and the proportion of upstream catchment area under natural cover at each monitoring site (right).

The mean annual suspended sediment load from hillslope erosion processes in natural and non-natural cover areas was calculated for each RECv2 watershed and routed through the RECv2 digital stream network, which accounted for floodplain deposition and lake trapping using the same procedure as Neverman et al. (2021).

As bank erosion was modelled at the reach scale (an individual RECv2 segment), it was not possible to apportion load from bank erosion to natural and non-natural cover areas at the sub-reach scale. We conservatively apportioned bank erosion to natural cover only for those RECv2 segments where 100% of the riparian buffer was natural cover in the LCDB. This was calculated by applying a 15 m buffer to the RECv2 stream network and intersecting with the land cover layer.

5 Results

5.1 Effects of climate change on suspended sediment loads

Changes in suspended sediment load under future scenarios are the product of both changes in land cover and changes in hydro-climatic drivers. To distinguish the impacts of climate change from the impacts of soil conservation works we compare a) loads under projected climate change with loads for baseline climate conditions using the same land cover, and b) loads for the future soil conservation scenario adjusted for climate change with both the pre-mitigation and contemporary sediment load baselines.

Comparing sediment loads with and without the impact of climate change for contemporary land cover provides an assessment of climate impacts independent from the effects of changes in land cover. Mean annual suspended sediment loads for this scenario are presented for the Taranaki region in Table 4, and for the selected water quality monitoring sites in Table 5 and Table 6. To visualise the spatial pattern in erosion rates, we present the sediment yield (t/km^2/yr) for selected RCMs in Figure 3. Sediment yield was calculated as the sum of sediment loads from all erosion processes present within each RECv2 watershed divided by the watershed area. This does not account for downstream storage of sediment in lakes and on floodplains.

For the Taranaki region, the mean annual suspended sediment load delivered to the coast under contemporary land cover is projected to increase from the baseline 1.7 Mt/yr to 1.9–2.7 Mt/yr and 1.8–3.5 Mt/yr by mid-century and late century, respectively, across the range of RCPs (Table 4). These changes correspond to increases of 13%–57% and 7%–108% (Table 4) compared to the baseline sediment load by mid-century and late century, respectively.

The climate change projections produce a wide range of predicted changes in suspended sediment loads. This reflects the variability between climate models and the diverging climate trajectories represented by each RCP (Figure 1). A smaller increase in load is projected by late century (median 20%) compared to mid-century (median 22%) under the mitigation pathway represented by RCP2.6 (Table 4). RCP4.5 and RCP6.0 are stabilisation pathways, and RCP8.5 represents a pathway with very high greenhouse gas emissions that results in the largest projected increases in sediment load (Table 4). Suspended sediment loads are expected to increase from RCP2.6 to RCP8.5 at mid-century and late century, with more pronounced differences between each RCP observed at late century relative to the mid-century projections.

Table 4. Net suspended sediment loads delivered to the coast for the Taranaki region under baseline climate conditions (from Neverman at al. 2021) and projected climate change at mid-century and late century for the contemporary land cover

RCP	Mid-century			Late century		
	Selected RCMs[1]	Load (Mt/yr)	Diff[2] (%)	Selected RCMs[1]	Load (Mt/yr)	Diff[2] (%)
	Baseline	1.68	-	Baseline	1.68	-
	Min [NorESM1-M]	1.90	13	Min [GISS-EL-R]	1.80	7
2.6	Median	2.06	22	Median	2.03	20
	Max [HadGEM2-ES]	2.22	32	Max [CESM1-CAM5]	2.23	32
	Min [GISS-E2-R]	2.06	23	Min [GISS-E2-R]	2.08	24
4.5	Median	2.22	32	Median	2.34	39
	Max [HadGEM2-ES]	2.42	44	Max [CESM1-CAM5]	2.62	56
	Min [NorESM1-M]	2.04	21	Min [NorESM1-M]	2.36	40
6.0	Median	2.2	30	Median	2.71	61
	Max [HadGEM2-ES]	2.48	47	Max [HadGEM2-ES]	2.92	73
	Min [GISS-EL-R]	2.31	37	Min [GISS-EL-R]	2.86	70
8.5	Median	2.40	42	Median	3.26	94
	Max [HadGEM2-ES]	2.65	57	Max [GFDL-CM3]	3.51	108

[1] RCMs were selected for inclusion in the table based on minimum, median, and maximum total erosion across the Taranaki region. The median is represented by the mid-point between the middle two RCMs.

[2] 'Diff refers to the percentage difference between the sediment load under climate change compared to the contemporary baseline load.

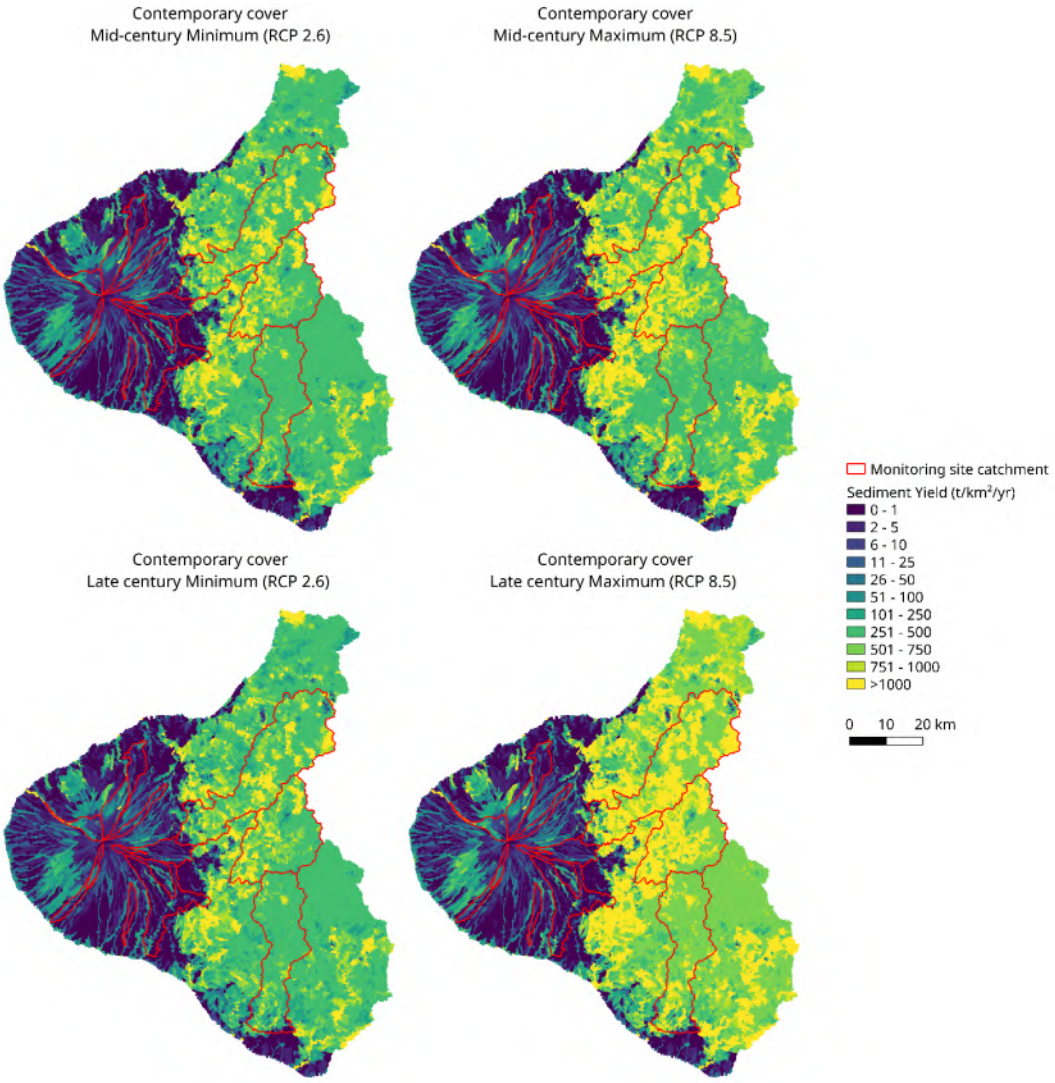

Figure 3. Modelled suspended sediment yield (t/km^2/yr) for each RECv2 watershed for selected RCMs across the Taranaki region under contemporary land cover.

Across the water quality monitoring sites the proportional changes in load under contemporary land cover ranged from -48% to +65% by mid-century (Table 5) and -48% to +123% (Table 6) by late century, compared to the baseline sediment load. The monitoring sites show similar patterns to the regional loads, where loads were typically lower for late century than mid-century under the mitigation pathway (RCP2.6), and the range in projected loads were greatest by late century due to divergence between the RCPs.

The hill-country water quality monitoring sites (Waitara River at Autawa Rd, Mangaehu River at Raupuha Rd Bridge, and Waitara River at Autawa Rd) exhibited the greatest range in response across the climate projections, with loads projected to increase between 8 to 123% by late century. These sites also experience the largest projected increases in load. In contrast, the Pātea River at Barclay Rd Bridge, Pātea River at Skinner Rd Bridge, and

Mangaoraka Stream at Corbett Rd (ring plain sites) exhibit load decreases under all climate projections. The largest proportional reductions in load occur at the Pātea River at Skinner Rd Bridge.

This contrast in response arises from differences in the erosion processes which dominate hill-country and ring plain catchments, and the directions of change in their hydro-climatic drivers. Hill-country catchments are dominated by shallow landslide erosion, which is projected to increase due to more frequent and higher magnitude storm rainfall under future climate. In ring plain catchments, changes in rainfall, evapotranspiration, and snowpack will drive changes in surficial erosion as well as streamflow which affects bank erosion. These erosion processes dominate fine suspended sediment loads in ring plain catchments. These hydro-climatic drivers have opposing trajectories across catchments and climate projections, leading to diverse responses in sediment loads for ring plain catchments.

Table 5. Net suspended sediment loads at monitoring sites for baseline climate (from Neverman at al. 2021) and projected climate change at mid-century for the contemporary land cover scenario

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Diff[1] (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)
Baseline			231	-	0.67	-	0.76	-	0.15	-	2.0	-	0.56	-	0.99	-	8.3	-	1.9	-	9.1	-	3.7	-	0.10	-	144	-	346	-
Mid-century	2.6	Min	262	13	0.72	7	0.53	-31	0.11	-30	1.1	-48	0.75	34	1.3	34	10	21	1.8	-7	7.3	-21	4.0	11	0.11	13	164	13	397	15
		Median	285	23	0.72	8	0.54	-29	0.11	-29	1.1	-48	0.76	35	1.3	35	10	22	1.9	-1	7.8	-15	4.1	13	0.11	13	177	23	433	25
		Max	307	33	0.73	9	0.56	-27	0.11	-29	1.1	-47	0.77	36	1.3	36	10	23	2.1	8	8.4	-8	4.3	17	0.11	14	193	33	468	35
	4.5	Min	287	24	0.73	9	0.56	-26	0.11	-28	1.1	-47	0.69	23	1.2	23	10	22	1.9	1	7.8	-15	4.2	14	0.11	10	179	24	438	27
		Median	312	35	0.74	10	0.57	-25	0.11	-28	1.1	-47	0.69	24	1.2	23	10	23	2.1	7	8.3	-9	4.3	16	0.11	10	193	34	474	37
		Max	338	46	0.74	11	0.59	-22	0.11	-28	1.1	-47	0.70	25	1.2	25	10	24	2.2	16	8.9	-2	4.4	20	0.11	11	211	46	520	51
	6.0	Min	284	23	0.75	12	0.55	-28	0.11	-25	1.1	-44	0.74	31	1.3	31	10	22	1.9	-1	7.7	-15	4.1	12	0.12	17	174	21	435	26
		Median	307	33	0.76	14	0.57	-25	0.11	-25	1.1	-44	0.74	32	1.3	32	10	23	2.0	7	8.3	-9	4.2	15	0.12	18	190	32	468	35
		Max	346	50	0.77	15	0.60	-22	0.12	-24	1.1	-44	0.75	34	1.3	34	10	25	2.3	18	9.1	1	4.4	20	0.12	20	215	49	533	54
	8.5	Min	323	40	0.76	14	0.58	-24	0.11	-27	1.1	-46	0.72	28	1.3	28	11	30	2.1	10	8.5	-6	4.4	20	0.11	14	198	37	495	43
		Median	337	46	0.77	14	0.59	-22	0.11	-27	1.1	-46	0.72	29	1.3	28	11	31	2.2	14	8.8	-3	4.4	21	0.11	14	207	43	515	49
		Max	371	60	0.78	16	0.61	-19	0.11	-26	1.1	-45	0.73	31	1.3	30	11	32	2.4	25	9.7	6	4.6	26	0.11	15	229	59	572	65

[1] 'Diff' refers to the percentage difference between the sediment load under baseline and future climate.

Table 6. Net suspended sediment loads at monitoring sites for baseline conditions (from Neverman at al. 2021) and projected climate change at late century for the contemporary land cover scenario

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Diff[1] (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)
Baseline			231	-	0.67	-	0.76	-	0.15	-	2.0	-	0.56	-	0.99	-	8.3	-	1.9	-	9.1	-	3.7	-	0.10	-	144	-	346	-
Late century	2.6	Min	249	8	0.70	4	0.50	-35	0.11	-30	1.0	-48	0.70	24	1.2	24	9.8	17	1.7	-10	7.0	-23	3.9	8	0.11	14	156	8	375	9
		Median	281	22	0.70	5	0.52	-32	0.11	-30	1.0	-48	0.71	26	1.2	26	9.9	19	1.9	-1	7.7	-15	4.1	12	0.11	14	176	22	427	24
		Max	312	35	0.71	6	0.54	-29	0.11	-30	1.0	-48	0.71	27	1.3	27	10	21	2.1	8	8.3	-9	4.2	16	0.11	14	193	34	478	38
	4.5	Min	291	26	0.72	8	0.54	-29	0.11	-28	1.1	-47	0.76	35	1.3	35	9.8	18	2.0	2	7.9	-13	4.1	11	0.11	11	181	25	443	28
		Median	328	42	0.73	9	0.57	-25	0.11	-28	1.1	-46	0.77	37	1.3	36	10	19	2.2	12	8.7	-5	4.2	16	0.11	12	202	40	504	46
		Max	368	59	0.74	11	0.60	-22	0.11	-28	1.1	-46	0.78	38	1.4	38	10	21	2.4	24	9.6	5	4.4	21	0.11	13	228	58	566	64
	6.0	Min	332	43	0.73	9	0.59	-23	0.11	-25	1.1	-44	0.78	40	1.4	39	11	30	2.1	12	8.7	-4	4.3	18	0.12	17	202	40	509	47
		Median	382	65	0.75	11	0.62	-19	0.12	-25	1.1	-44	0.80	42	1.4	42	11	32	2.4	26	9.8	7	4.6	24	0.12	18	236	63	587	70
		Max	407	76	0.76	13	0.65	-15	0.12	-24	1.1	-44	0.80	43	1.4	43	11	34	2.6	35	10	14	4.7	29	0.12	19	251	74	632	83
	8.5	Min	401	73	0.78	16	0.66	-13	0.11	-28	1.1	-46	0.86	53	1.5	52	12	39	2.5	32	10	12	4.8	32	0.12	17	246	70	621	80
		Median	459	98	0.79	19	0.70	-8	0.11	-28	1.1	-46	0.87	55	1.5	55	12	42	2.8	48	11	25	5.1	39	0.12	18	281	95	714	107
		Max	494	114	0.80	20	0.73	-5	0.11	-28	1.1	-46	0.88	57	1.5	56	12	44	3.0	58	12	33	5.3	44	0.12	19	302	109	770	123

[1] 'Diff' refers to the percentage difference between the sediment load under baseline and future climate.

Table 7 and Table 8 present the mean annual suspended sediment load delivered to the coast across the Taranaki region under projected climate change for the future soil conservation scenario and compare these loads to the pre-mitigation and contemporary baseline sediment loads from Neverman et al. (2021). The mean annual suspended sediment load delivered to the coast is projected to range from 1.6–2.3 Mt/yr by mid-century and 1.6–3.0 Mt/yr by late century across the range of RCPs. Compared to the contemporary baseline of 1.7 Mt/yr, these changes correspond to differences of -3% to +37% (Table 7) and -8% to +81% (Table 8) by mid-century and late century, respectively. Compared to the pre-mitigation baseline of 2.4 Mt/yr, these changes correspond to differences of -32% to -3% by mid-century (Table 7) and -35% to +28% by late century (Table 8). Sediment yields (t/km^2/yr) are presented for selected RCMs in Figure 4.

These results indicate that fully implemented and mature soil conservation works may offset the impacts of climate change under all modelled greenhouse gas pathways (represented by the RCPs) if they were to be fully implemented and mature by mid-century, compared to the pre-mitigation baseline. By late century, fully implemented and mature soil conservation works may offset the effects of climate change for greenhouse gas pathways up to RCP6.0. Under RCP8.5 regional loads may increase by between 4% and 28% compared to the pre-mitigation baseline loads. This is significantly less than the >70% increase in load expected from the effects of projected climate change without further reductions from conservation measures between baseline and late century under RCP8.5 (Table 4), demonstrating the benefit of soil conservation works.

Table 7. Comparison of net suspended sediment loads delivered to the coast for the Taranaki region under projected climate change for the future soil conservation scenario at mid-century with the pre-mitigation and contemporary baselines (from Neverman at al. 2021)

Time period	RCP	Selected RCMs[1]	Initial (pre-mitigation) baseline compared to future soil conservation works		Contemporary baseline compared to future soil conservation works	
			Load (Mt/yr)	Diff[3] (%)	Load (Mt/yr)	Diff (%)
Baseline[2]			2.38	-	1.68	-
Mid-century	2.6	Min [NorESM1-M]	1.63	-32	1.63	-3
		Median	1.77	-26	1.77	5
		Max [HadGEM2-ES]	1.92	-20	1.92	14
	4.5	Min [GISS-E2-R]	1.78	-25	1.78	6
		Median	1.92	-19	1.92	14
		Max [HadGEM2-ES]	2.10	-12	2.10	25
	6.0	Min [NorESM1-M]	1.75	-26	1.75	4
		Median	1.90	-20	1.90	13
		Max [HadGEM2-ES]	2.15	-10	2.15	28
	8.5	Min [GISS-EL-R]	1.99	-16	1.99	18
		Median	2.07	-13	2.07	23
		Max [HadGEM2-ES]	2.30	-3	2.30	37

[1] RCMs were selected for inclusion in the table based on minimum, median, and maximum total erosion across the Taranaki region. The median is represented by the mid-point between the middle two RCMs.

[2] 'Baseline' refers to the baseline climate state with either the pre-mitigation land cover or the contemporary land cover. The future loads are modelled for the future soil conservation scenario with the effects of climate change.

[3] 'Diff' refers to the percentage difference between the baseline and future sediment load.

Table 8. Comparison of net suspended sediment loads delivered to the coast for the Taranaki region under projected climate change for the future soil conservation scenario at late century with the pre-mitigation and contemporary baselines (from Neverman at al. 2021)

Time period	RCP	Selected RCMs[1]	Initial (pre-mitigation) baseline compared to future soil conservation works		Contemporary baseline compared to future soil conservation works	
			Load (Mt/yr)	Diff[3] (%)	Load (Mt/yr)	Diff (%)
Baseline[2]			2.38	-	1.68	-
Late century	2.6	Min [NorESM1-M]	1.55	-35	1.55	-8
		Median	1.75	-27	1.75	4
		Max [HadGEM2-ES]	1.93	-19	1.93	15
	4.5	Min [GISS-E2-R]	1.80	-24	1.80	8
		Median	2.03	-15	2.03	20
		Max [HadGEM2-ES]	2.28	-4	2.28	35
	6.0	Min [NorESM1-M]	2.04	-14	2.04	21
		Median	2.36	-1	2.36	40
		Max [HadGEM2-ES]	2.54	6	2.54	51
	8.5	Min [GISS-EL-R]	2.49	4	2.49	37
		Median	2.84	19	2.84	54
		Max [HadGEM2-ES]	3.06	28	3.06	81

[1] RCMs were selected for inclusion in the table based on minimum, median, and maximum total erosion across the Taranaki region. The median is represented by the mid-point between the middle two RCMs.

[2] 'Baseline' refers to the baseline climate state with either the pre-mitigation land cover or the contemporary land cover. The future loads are modelled for the future soil conservation scenario with the effects of climate change.

[3] 'Diff' refers to the percentage difference between the baseline and future sediment load.

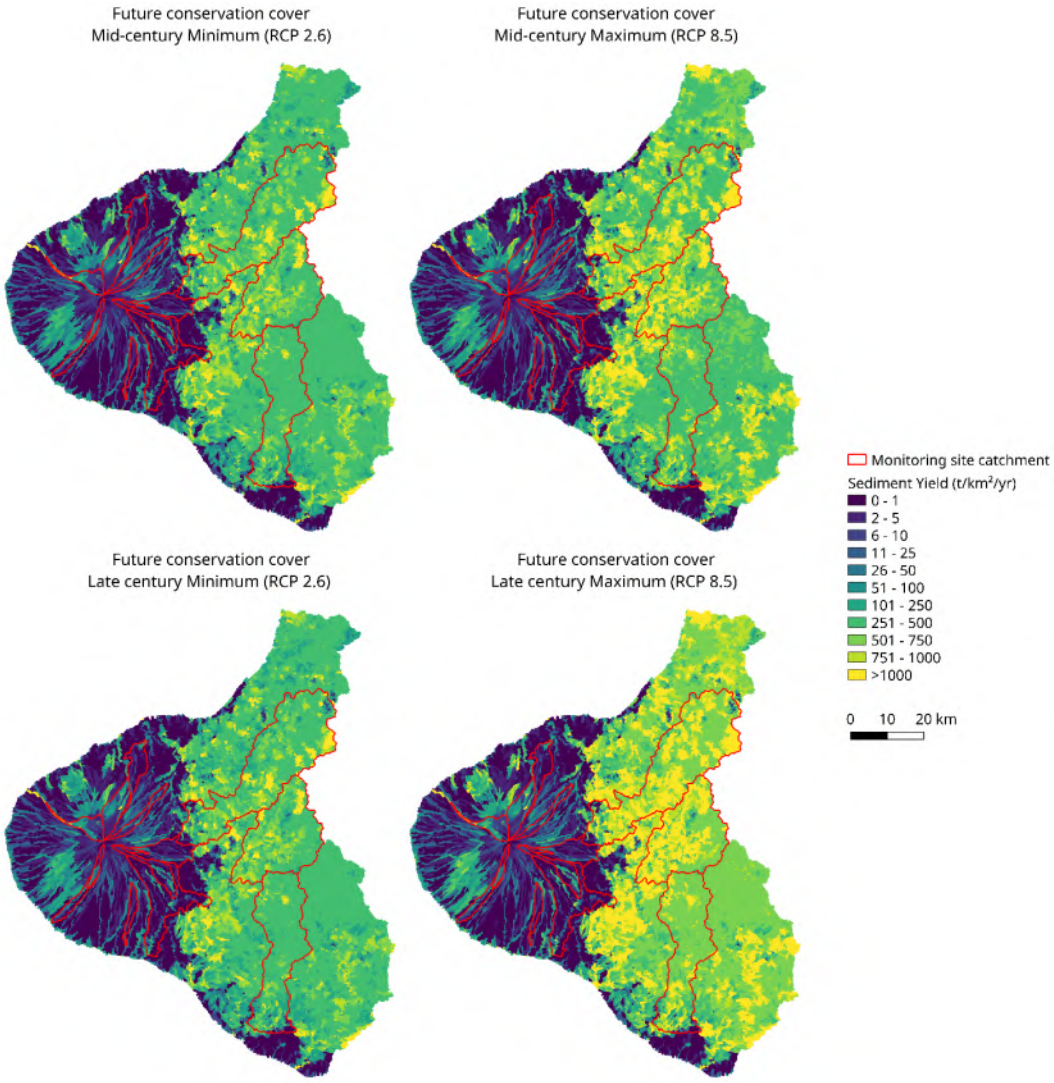

Figure 4. Modelled suspended sediment yield (t/km^2/yr) for each RECv2 watershed for selected RCMs across the Taranaki region under the future soil conservation scenario.

Across the selected water quality monitoring sites, proportional changes in load between the pre-mitigation baseline and the future soil conservation scenario with the effects of climate change ranged from -69% to +24% (Table 9) by mid-century, and -69% to +47% (Table 10) by late century. Comparing the future soil conservation scenario with the effects of climate change to the contemporary baseline (Table 11 and Table 13), changes in load ranged from -58% to +42% by mid-century and -59% to 98% by late century.

Loads at monitoring sites were typically lower for late century than mid-century under the mitigation pathway (RCP2.6), and the range in projected loads was greatest by late century due to greater divergence between the RCPs.

Similar to results which only consider the impacts of climate change (Table 5 and Table 6), the hill-country monitoring sites (Waitara River at Autawa Rd, Mangaehu River at Raupuha Rd Bridge, and Whenuakura River at Nicholson Rd) exhibited the greatest range in potential load changes by late century when the impact of future soil conservation works were included. The range in load changes by late century was less for these sites when future soil conservation loads were compared to the pre-mitigation baseline (Table 10) as opposed to the contemporary baseline. In addition, Waingongoro River at Eltham Rd Bridge and Waingongoro River at SH45 had similar ranges in load changes by late century when compared to the pre-mitigation scenario.

The Pātea River at Barclay Rd Bridge, Pātea River at Skinner Rd Bridge, and Mangaoraka Stream at Corbett Rd (ring plain sites) exhibited decreases in load under all climate change projections for the future soil conservation scenario when compared to both the contemporary and pre-mitigation baselines. In addition, the Maketawa Stream at Tarata Rd, Punehu Stream at SH45, Waingongoro River at SH45, and Waiokura pumphouse also exhibited decreases in load under all climate projections for the future soil conservation scenario when compared to the pre-mitigation baseline.

These results highlight the significant benefit of soil conservation works implemented since 1996, which offset the impacts of climate change at seven monitoring sites (50%) across all projections by late century, and reduce the range in impacts across the RCPs in hill-country catchments. Under the stabilisation pathways (RCP4.5 and RCP6.0), soil conservation works offset the impacts of climate change at 8 to 13 sites (57% to 93%), depending on the RCM.

Table 9. Net suspended sediment loads at selected water quality monitoring sites under projected climate change for the future soil conservation scenario at mid-century, compared with the pre-mitigation baseline loads (from Neverman at al. 2021)

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load	Diff[1]	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff	Load	Diff
			(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)
Baseline			370	-	1.2	-	1.1	-	0.17	-	2.7	-	0.74	-	1.7	-	8.9	-	2.2	-	13	-	4.3	-	0.13	-	194	-	539	-
Mid-century	2.6	Min	223	-40	0.69	-43	0.48	-54	0.11	-38	0.84	-69	0.73	-1	1.3	-25	10	13	1.8	-18	7.0	-47	3.8	-12	0.10	-20	154	-21	339	-37
		Median	244	-34	0.70	-43	0.50	-53	0.11	-38	0.84	-69	0.74	-1	1.3	-24	10	14	1.9	-12	7.4	-44	3.9	-9	0.10	-20	167	-14	370	-31
		Max	263	-29	0.71	-42	0.52	-51	0.11	-38	0.84	-69	0.75	1	1.3	-23	10	15	2.1	-5	8.0	-39	4.0	-6	0.10	-19	181	-7	400	-26
	4.5	Min	246	-33	0.70	-43	0.51	-52	0.11	-37	0.84	-69	0.67	-9	1.2	-31	10	14	1.9	-11	7.5	-43	3.9	-9	0.10	-22	169	-13	375	-31
		Median	267	-28	0.71	-42	0.53	-50	0.11	-37	0.85	-69	0.68	-9	1.2	-30	10	15	2.0	-5	8.0	-40	4.0	-7	0.10	-22	182	-6	406	-25
		Max	290	-22	0.72	-41	0.55	-48	0.11	-37	0.85	-68	0.68	-8	1.2	-30	10	16	2.2	2	8.6	-35	4.2	-4	0.10	-21	198	2	446	-17
	6.0	Min	244	-34	0.73	-41	0.51	-52	0.11	-34	0.89	-67	0.72	-3	1.3	-26	10	15	1.9	-12	7.4	-44	3.9	-11	0.11	-17	164	-16	372	-31
		Median	263	-29	0.73	-40	0.52	-51	0.11	-34	0.89	-67	0.72	-2	1.3	-26	10	16	2.0	-6	8.0	-40	4.0	-8	0.11	-17	179	-8	400	-26
		Max	297	-20	0.74	-39	0.55	-48	0.12	-33	0.90	-67	0.73	-1	1.3	-25	10	17	2.3	4	8.8	-34	4.2	-4	0.11	-15	202	4	457	-15
	8.5	Min	277	-25	0.74	-40	0.54	-49	0.11	-35	0.87	-68	0.70	-5	1.2	-28	11	22	2.1	-3	8.2	-38	4.1	-4	0.10	-20	187	-4	424	-21
		Median	289	-22	0.74	-40	0.55	-49	0.11	-35	0.87	-67	0.70	-5	1.2	-28	11	22	2.2	1	8.5	-36	4.2	-3	0.10	-19	195	1	441	-18
		Max	319	-14	0.75	-39	0.57	-46	0.11	-35	0.88	-67	0.71	-4	1.3	-26	11	24	2.4	11	9.3	-30	4.4	1	0.10	-18	216	11	490	-9

[1] 'Diff' refers to the percentage difference between the baseline and future sediment load.

Table 10. Net suspended sediment loads at monitoring sites under projected climate change for the future soil conservation scenario at late century, compared with the pre-mitigation baseline loads (from Neverman at al. 2021)

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Diff[1] (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)
Baseline			370	-	1.2	-	1.1	-	0.17	-	2.7	-	0.74	-	1.7	-	8.9	-	2.2	-	13	-	4.3	-	0.13	-	194	-	539	-
Late century	2.6	Min	213	-42	0.67	-45	0.46	-57	0.11	-38	0.83	-69	0.68	-8	1.2	-30	9.8	10	1.7	-21	6.7	-49	3.7	-14	0.10	-19	147	-24	320	-41
		Median	241	-35	0.68	-45	0.48	-55	0.11	-38	0.84	-69	0.69	-7	1.2	-29	9.9	12	1.9	-12	7.4	-44	3.9	-11	0.10	-19	166	-14	365	-32
		Max	267	-28	0.69	-44	0.50	-52	0.11	-38	0.84	-69	0.70	-6	1.2	-28	10	13	2.1	-5	8	-39	4.0	-7	0.10	-19	182	-6	409	-24
	4.5	Min	249	-33	0.70	-43	0.50	-53	0.11	-37	0.86	-68	0.74	-1	1.3	-24	9.8	10	1.9	-10	7.6	-43	3.8	-11	0.10	-21	170	-12	379	-30
		Median	281	-24	0.71	-42	0.53	-50	0.11	-37	0.86	-68	0.75	1	1.3	-23	9.9	12	2.1	-1	8.4	-37	4.0	-7	0.10	-21	190	-2	432	-20
		Max	316	-14	0.72	-42	0.56	-48	0.11	-36	0.86	-68	0.76	2	1.3	-22	10	14	2.4	10	9.2	-30	4.2	-3	0.10	-20	215	11	486	-10
	6.0	Min	284	-23	0.71	-42	0.54	-49	0.11	-34	0.89	-67	0.76	3	1.3	-21	11	22	2.1	-1	8.4	-37	4.1	-5	0.11	-17	191	-2	436	-19
		Median	328	-11	0.72	-41	0.57	-46	0.12	-33	0.89	-67	0.78	5	1.4	-20	11	24	2.4	11	9.4	-29	4.3	1	0.11	-16	222	15	503	-7
		Max	350	-5	0.73	-40	0.60	-43	0.12	-33	0.90	-66	0.78	6	1.4	-19	11	26	2.6	20	10	-24	4.5	4	0.11	-15	237	22	543	1
	8.5	Min	345	-7	0.75	-39	0.61	-42	0.11	-36	0.86	-68	0.84	13	1.5	-14	12	31	2.5	17	9.9	-26	4.6	6	0.11	-17	232	20	533	-1
		Median	395	7	0.77	-37	0.65	-39	0.11	-36	0.87	-68	0.85	15	1.5	-13	12	33	2.8	31	11	-17	4.8	12	0.11	-16	265	37	614	14
		Max	426	15	0.78	-36	0.68	-36	0.11	-36	0.87	-68	0.86	16	1.5	-12	12	35	3.0	40	12	-11	5.0	16	0.11	-16	285	47	662	23

[1] 'Diff' refers to the percentage difference between the baseline and future sediment load.

Table 11. Net suspended sediment loads at monitoring sites under projected climate change for the future soil conservation scenario at mid-century, compared with the contemporary baseline loads (from Neverman at al. 2021)

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Diff[1] (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)
Baseline			231	-	0.67	-	0.76	-	0.15	-	2.0	-	0.56	-	0.99	-	8.3	-	1.9	-	9.1	-	3.7	-	0.10	-	144	-	346	-
Mid-century	2.6	Min	223	-3	0.69	3	0.48	-36	0.11	-30	0.84	-58	0.73	31	1.3	30	10	20	1.8	-7	7.0	-24	3.8	4	0.10	3	154	6	339	-2
		Median	244	5	0.70	4	0.50	-34	0.11	-29	0.84	-58	0.74	32	1.3	31	10	21	1.9	-1	7.4	-18	3.9	7	0.10	3	167	15	370	7
		Max	263	14	0.71	6	0.52	-32	0.11	-29	0.84	-58	0.75	33	1.3	33	10	23	2.1	7	8.0	-12	4.0	10	0.10	4	181	26	400	16
	4.5	Min	246	7	0.7	5	0.51	-32	0.11	-28	0.84	-58	0.67	20	1.2	19	10	22	1.9	1	7.5	-18	3.9	7	0.10	-1	169	17	375	8
		Median	267	16	0.71	6	0.53	-31	0.11	-28	0.85	-58	0.68	21	1.2	20	10	23	2.0	7	8.0	-12	4.0	10	0.10	1	182	26	406	18
		Max	290	25	0.72	7	0.55	-28	0.11	-28	0.85	-58	0.68	22	1.2	22	10	24	2.2	15	8.6	-6	4.2	14	0.10	1	198	37	446	29
	6.0	Min	244	5	0.73	8	0.51	-33	0.11	-25	0.89	-56	0.72	28	1.3	28	10	22	1.9	-1	7.4	-19	3.9	5	0.11	7	164	13	372	8
		Median	263	14	0.73	10	0.52	-31	0.11	-25	0.89	-56	0.72	29	1.3	29	10	23	2.0	6	8.0	-13	4.0	8	0.11	7	179	24	400	16
		Max	297	29	0.74	11	0.55	-27	0.12	-24	0.90	-55	0.73	31	1.3	30	10	25	2.3	18	8.8	-4	4.2	14	0.11	10	202	40	457	32
	8.5	Min	277	20	0.74	10	0.54	-29	0.11	-27	0.87	-57	0.70	25	1.2	25	11	30	2.1	10	8.2	-10	4.1	13	0.10	3	187	29	424	23
		Median	289	25	0.74	10	0.55	-28	0.11	-27	0.87	-56	0.70	26	1.2	25	11	30	2.2	14	8.5	-7	4.2	14	0.10	4	195	35	441	28
		Max	319	38	0.75	12	0.57	-25	0.11	-26	0.88	-56	0.71	27	1.3	27	11	32	2.4	25	9.3	2	4.4	19	0.10	5	216	49	490	42

[1] 'Diff' refers to the percentage difference between the baseline and future sediment load.

Table 12. Net suspended sediment loads at monitoring sites under projected climate change for the future soil conservation scenario at late century, compared with the contemporary baseline loads (from Neverman at al. 2021)

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Diff[1] (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)	Load (kt/yr)	Diff (%)
Baseline			231	-	0.67	-	0.76	-	0.15	-	2.0	-	0.56	-	0.99	-	8.3	-	1.9	-	9.1	-	3.7	-	0.10	-	144	-	346	-
Late century	2.6	Min	213	-8	0.67	1	0.46	-40	0.11	-30	0.83	-59	0.68	21	1.2	21	9.8	17	1.7	-11	6.7	-26	3.7	1	0.10	3	147	2	320	-7
		Median	241	4	0.68	2	0.48	-37	0.11	-30	0.84	-58	0.69	23	1.2	22	9.9	19	1.9	-1	7.4	-18	3.9	6	0.10	4	166	15	365	6
		Max	267	16	0.69	3	0.50	-34	0.11	-30	0.84	-58	0.70	24	1.2	24	10	20	2.1	7	8	-12	4.0	10	0.10	4	182	26	409	19
	4.5	Min	249	8	0.70	4	0.50	-34	0.11	-28	0.86	-57	0.74	32	1.3	31	9.8	18	1.9	2	7.6	-17	3.8	5	0.10	1	170	18	379	10
		Median	281	22	0.71	5	0.53	-31	0.11	-28	0.86	-57	0.75	33	1.3	33	9.9	19	2.1	12	8.4	-8	4.0	10	0.10	2	190	32	432	25
		Max	316	37	0.72	7	0.56	-27	0.11	-28	0.86	-57	0.76	35	1.3	35	10	21	2.4	24	9.2	1	4.2	15	0.10	3	215	49	486	41
	6.0	Min	284	23	0.71	6	0.54	-29	0.11	-25	0.89	-56	0.76	36	1.3	36	11	30	2.1	11	8.4	-8	4.1	12	0.11	6	191	32	436	26
		Median	328	42	0.72	8	0.57	-25	0.12	-25	0.89	-55	0.78	38	1.4	38	11	32	2.4	26	9.4	3	4.3	18	0.11	7	222	54	503	46
		Max	350	51	0.73	9	0.60	-21	0.12	-24	0.90	-55	0.78	40	1.4	40	11	34	2.6	35	10	10	4.5	23	0.11	9	237	64	543	57
	8.5	Min	345	49	0.75	13	0.61	-19	0.11	-28	0.86	-57	0.84	49	1.5	49	12	39	2.5	32	9.9	8	4.6	25	0.11	7	232	61	533	54
		Median	395	71	0.77	15	0.65	-14	0.11	-28	0.87	-57	0.85	51	1.5	51	12	42	2.8	48	11	21	4.8	32	0.11	8	265	84	614	78
		Max	426	84	0.78	16	0.68	-11	0.11	-28	0.87	-57	0.86	53	1.5	52	12	43	3.0	58	12	29	5.0	37	0.11	8	285	98	662	92

[1] 'Diff' refers to the percentage difference between the baseline and future sediment load.

5.2 NPS-FM 2020 compliance under projected climate change

Compliance with the NPS-FM (2020) at the selected water quality monitoring sites is assessed against the change in contemporary baseline loads required to achieve a target attribute state. Table 13 presents the proportional and absolute reductions in load required for improvement in attribute state. Based on the change in load between the contemporary baseline and the future soil conservation scenario with the effects of climate change, the future attribute states are presented in Table 14 and Table 15.

Under the contemporary baseline, 7 of the 14 monitoring sites achieve band A (highest achievable state), 2 achieve band B, 2 achieve band C, and 3 do not achieve the national bottom line (NBL) (Neverman et al. 2021). Of the seven sites below band A for the baseline state, only the Mangaehu is predicted to see an improvement in attribute state with additional implementation and maturity of soil conservation works without the effects of climate change (Neverman et al. 2021).

With the effects of climate change, 6 of the 7 sites achieving band A at baseline state remain in band A for all projections by mid-century (Table 15) and late century (Table 14 and Table 15), with the exception of the Hangatahua (Stony) River at Mangatete Rd under the maximum RCP 8.5 projection (Figure 5). The Waingongoro River at SH45 is projected to improve from band C to band B by mid-century for some projections between RCPs 2.6 to 6.0, and by late century under RCPs 2.6 and 4.5. Under the minimum RCP2.6 this site is projected to achieve band A by late century.

Four sites (29%) (Mangaehu River at Raupuha Rd Bridge, Punehu Stream at Wiremu Rd, Punehu Stream at SH45, Waingongoro River at Eltham Rd Bridge) representing three catchments are projected to have declines in attribute band by mid-century. An additional seven sites (50%) are projected to have increases in load under one or more RCPs which would result in a decline in visual clarity without crossing a band threshold. As the NPS-FM (2020) does not allow for deterioration below the baseline state (Ministry for the Environment, 2022), these sites would require load reductions to return to baseline visual clarity.

Five sites (36%) (Mangaehu River at Raupuha Rd Bridge, Punehu Stream at Wiremu Rd, Punehu Stream at SH45, Waingongoro River at Eltham Rd Bridge, and Waingongoro River at SH45) representing three catchments are projected to decline in band by late century under more than one RCP. The Hangatahua (Stony) River at Mangatete Rd is projected to decline for the maximum RCP8.5 projection. An additional five sites (36%) are expected to remain in their baseline band but have degraded visual clarity, requiring a reduction in load to return to baseline state.

Table 13. Proportional and absolute changes from contemporary baseline sediment load required for the attribute band to improve at selected water quality monitoring sites (Neverman et al. 2021). A negative value indicates a reduction in load is required to achieve an increase in visual clarity, while '-' indicates the attribute band has already been achieved

Site Code	Location	Required proportional change in load (%)[1]			Required absolute change in load (kt/yr)[2]		
		NBL	B band	A band	NBL	B band	A band
MGH000950	Mangaehu River at Raupuha Rd Bridge	-	-11	-28	-	-24.4	-64.8
MKW000300	Maketawa Stream at Tarata Rd	-	-	-	-	-	-
MRK000420	Mangaoraka Stream at Corbett Rd	-	-	-	-	-	-
PAT000200	Pātea River at Barclay Rd Bridge	-	-	-	-	-	-
PAT000360	Pātea River at Skinner Rd Bridge	-	-	-	-	-	-
PNH000200	Punehu Stream at Wiremu Rd	-	-	-6	-	-	-0.033
PNH000900	Punehu Stream at SH45	-	-	-13	-	-	-0.129
STY000300	Hangatahua (Stony) River at Mangatete Rd	-	-	-	-	-	-
WGG000500	Waingongoro River at Eltham Rd Bridge	-	-	-	-	-	-
WGG000900	Waingongoro River at SH45	-	-11	-26	-	-0.994	-2.35
WKH000500	Waiwhakaiho River at SH3	-	-	-	-	-	-
WKR000700	Waiokura pumphouse	-60	-67	-72	-0.060	-0.067	-0.072
WNR000450	Whenuakura River at Nicholson Rd	-57	-68	-75	-82.6	-98.1	-109
WTR000540	Waitara River at Autawa Rd	-43	-57	-67	-147	-197	-232

[1] For sites with a baseline state below the national bottom line (NBL), C band will be achieved if the decrease in load is greater than that required for the NBL and less than that required for B band.

[2] Note: absolute reductions required were incorrectly reported in Table 7 of Neverman et al. (2021), although proportional reductions were correctly reported. This did not affect subsequent analysis in Neverman et al. (2021).

Table 14. Proportional change in suspended sediment loads at selected water quality monitoring sites between the contemporary baseline and future loads under projected climate change with future soil conservation works at mid-century, and the associated attribute state

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Diff[1] (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State
Baseline			-	C	-	A	-	A	-	A	-	A	-	B	-	B	-	A	-	A	-	C	-	A	-	D	-	D	-	D
Mid-century	2.6	Min	-3	C	3	A	-36	A	-30	A	-58	A	31	C	30	D	20	A	-7	A	-24	B	4	A	3	D	6	D	-2	D
		Median	5	C	4	A	-34	A	-29	A	-58	A	32	C	31	D	21	A	-1	A	-18	B	7	A	3	D	15	D	7	D
		Max	14	D	6	A	-32	A	-29	A	-58	A	33	C	33	D	23	A	7	B	-12	B	10	A	4	D	26	D	16	D
	4.5	Min	7	C	5	A	-32	A	-28	A	-58	A	20	C	19	C	22	A	1	A	-18	B	7	A	-1	D	17	D	8	D
		Median	16	D	6	A	-31	A	-28	A	-58	A	21	C	20	C	23	A	7	B	-12	B	10	A	1	D	26	D	18	D
		Max	25	D	7	A	-28	A	-28	A	-58	A	22	C	22	C	24	A	15	B	-6	C	14	A	1	D	37	D	29	D
	6.0	Min	5	C	8	A	-33	A	-25	A	-56	A	28	C	28	D	22	A	-1	A	-19	B	5	A	7	D	13	D	8	D
		Median	14	D	10	A	-31	A	-25	A	-56	A	29	C	29	D	23	A	6	B	-13	B	8	A	7	D	24	D	16	D
		Max	29	D	11	A	-27	A	-24	A	-55	A	31	C	30	D	25	A	18	B	-4	C	14	A	10	D	40	D	32	D
	8.5	Min	20	D	10	A	-29	A	-27	A	-57	A	25	C	25	C	30	A	10	B	-10	C	13	A	3	D	29	D	23	D
		Median	25	D	10	A	-28	A	-27	A	-56	A	26	C	25	C	30	A	14	B	-7	C	14	A	4	D	35	D	28	D
		Max	38	D	12	A	-25	A	-26	A	-56	A	27	C	27	D	32	A	25	C	2	C	19	A	5	D	49	D	42	D

[1] 'Diff' refers to the percentage difference between the baseline and future sediment load.

Table 15. Proportional change in suspended sediment loads at selected water quality monitoring sites between the contemporary baseline and future loads under projected climate change with future soil conservation works at late century, and the associated attribute state

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Diff[1] (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State	Diff (%)	State
Baseline			-	C	-	A	-	A	-	A	-	A	-	B	-	B	-	A	-	A	-	C	-	A	-	D	-	D	-	D
Late century	2.6	Min	-8	C	1	A	-40	A	-30	A	-59	A	21	C	21	C	17	A	-11	A	-26	A	1	A	3	D	2	D	-7	D
		Median	4	C	2	A	-37	A	-30	A	-58	A	23	C	22	C	19	A	-1	A	-18	B	6	A	4	D	15	D	6	D
		Max	16	D	3	A	-34	A	-30	A	-58	A	24	C	24	C	20	A	7	B	-12	B	10	A	4	D	26	D	19	D
	4.5	Min	8	C	4	A	-34	A	-28	A	-57	A	32	C	31	D	18	A	2	B	-17	B	5	A	1	D	18	D	10	D
		Median	22	D	5	A	-31	A	-28	A	-57	A	33	C	33	D	19	A	12	B	-8	C	10	A	2	D	32	D	25	D
		Max	37	D	7	A	-27	A	-28	A	-57	A	35	C	35	D	21	A	24	C	1	C	15	A	3	D	49	D	41	D
	6.0	Min	23	D	6	A	-29	A	-25	A	-56	A	36	C	36	D	30	A	11	B	-8	C	12	A	6	D	32	D	26	D
		Median	42	D	8	A	-25	A	-25	A	-55	A	38	D	38	D	32	A	26	C	3	C	18	A	7	D	54	D	46	D
		Max	51	D	9	A	-21	A	-24	A	-55	A	40	D	40	D	34	A	35	C	10	D	23	A	9	D	64	D	57	D
	8.5	Min	49	D	13	A	-19	A	-28	A	-57	A	49	D	49	D	39	A	32	C	8	D	25	A	7	D	61	D	54	D
		Median	71	D	15	A	-14	A	-28	A	-57	A	51	D	51	D	42	A	48	D	21	D	32	A	8	D	84	D	78	D
		Max	84	D	16	A	-11	A	-28	A	-57	A	53	D	52	D	43	B	58	D	29	D	37	A	8	D	98	D	92	D

[1] 'Diff' refers to the percentage difference between the baseline and future sediment load.

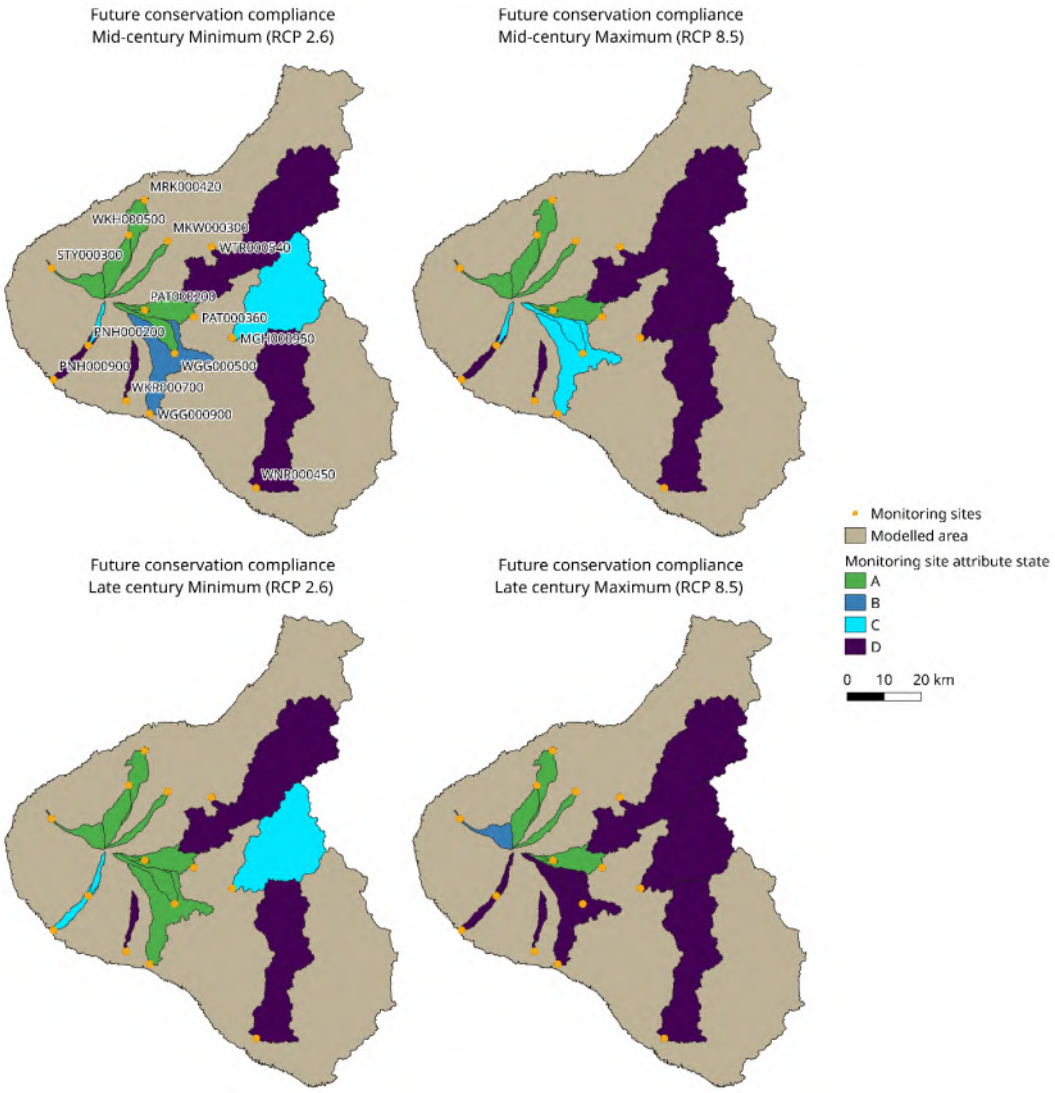

Figure 5. Range in compliance across the 14 selected water quality monitoring sites under the future soil conservation scenario for selected RCMs at mid-century and late century. Note: the attribute state only applies to the RECv2 segment of the monitoring site; it may not apply to upstream segments. Catchment polygons are used for display purposes only.

The load reductions required to achieve an improvement in attribute band under projected climate change with future soil conservation works by mid- and late century are provided in Table 16 and Table 17. As the NPS-FM (2020) does not allow for deterioration below the baseline state (Ministry for the Environment 2022), we also report the reduction required to maintain baseline state (baseline median visual clarity) where a site is projected to degrade. The required reductions apply to the future load.

Under projected climate change with future soil conservation works by mid-century the Mangaoraka Stream at Corbett Rd, Pātea River at Barclay Rd Bridge, and Pātea River at Skinner Rd Bridge are projected to have improved above their baseline visual clarity across all projections and already achieve A band so require no further load reductions (Table 16). Waingongoro River at SH45 also requires no further reduction to maintain baseline state under all projections except for the maximum RCP8.5 (Table 16), but may require further reductions to achieve a higher attribute band.

Waiokura pumphouse, Whenuakura River at Nicholson Rd, and Waitara River at Autawa Rd have a baseline state below the NBL and therefore require reductions to improve their state to at least the NBL. These sites are projected to have increases in load across all RCPs by mid-century compared to the contemporary baseline and therefore require further reductions to achieve the NBL. The remaining seven sites require further load reductions at mid-century to maintain their baseline visual clarity.

By late century, Mangaoraka Stream at Corbett Rd, Pātea River at Barclay Rd Bridge, Pātea River at Skinner Rd Bridge, and Waiwhakaiho River at SH3 are projected to improve above their baseline visual clarity across all projections and require no further reduction (Table 17). The Mangaehu River at Raupuha Rd Bridge, Waingongoro River at Eltham Rd Bridge, and Waingongoro River at SH45 also improve under lower greenhouse gas emissions, but require further reductions in load to maintain their baseline state for RCPs 4.5, 6.0, and 8.5.

Waiokura pumphouse, Whenuakura River at Nicholson Rd, and Waitara River at Autawa Rd are projected to have increases in load across all RCPs by late century and therefore require further reductions to achieve the NBL. The remaining four sites require further load reductions at late century to maintain their baseline state.

Table 16. Proportional changes in mean annual suspended sediment load required to maintain or improve the baseline attribute state at selected water quality monitoring sites under projected climate change with future soil conservation works by mid-century. Negative values indicate a reduction in load is required. "-" indicates no further load reduction required to achieve the target, or the target is below baseline state and thus non-compliant with the NPS-FM (2020). "Base" refers to the baseline visual clarity

		Site name	Mangaehu River at Raupuha Rd Bridge				Maketawa Stream at Tarata Rd				Mangaoraka Stream at Corbett Rd				Pātea River at Barclay Rd Bridge				Pātea River at Skinner Rd Bridge				Punehu Stream at Wiremu Rd				Punehu Stream at SH45			
		Site code	MGH000950				MKW000300				MRK000420				PAT000200				PAT000360				PNH000200				PNH000900			
Baseline State			C				A				A				A				A				B				B			
Time period	RCP	Target	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A
Mid-century	2.6	Min	-	-	-7	-25	-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-24	-	-	-28	-23	-	-	-33
		Median	-5	-	-15	-32	-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-24	-	-	-29	-24	-	-	-34
		Max	-12	-	-21	-37	-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-25	-	-	-29	-25	-	-	-35
	4.5	Min	-6	-	-16	-32	-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-16	-	-	-21	-16	-	-	-27
		Median	-14	-	-23	-38	-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-17	-	-	-22	-17	-	-	-28
		Max	-20	-	-29	-43	-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-18	-	-	-23	-18	-	-	-29
	6.0	Min	-5	-	-15	-32	-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-22	-	-	-26	-22	-	-	-32
		Median	-12	-	-21	-37	-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-23	-	-	-27	-22	-	-	-32
		Max	-22	-	-30	-44	-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-24	-	-	-28	-23	-	-	-33
	8.5	Min	-17	-	-25	-40	-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-20	-	-	-25	-20	-	-	-30
		Median	-20	-	-28	-42	-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-20	-	-	-25	-20	-	-	-31
		Max	-27	-	-35	-48	-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-21	-	-	-26	-21	-	-	-32

Table 16 (continued)

	Site name	Hangatahua (Stony) River at Mangatete Rd				Waingongoro River at Eltham Rd Bridge				Waingongoro River at SH45				Waiwhakaiho River at SH3				Waiokura pumphouse				Whenuakura River at Nicholson Rd				Waitara River at Autawa Rd			
	Site code	STY000300				WGG000500				WGG000900				WKH000500				WKR000700				WNR000450				WTR000540			
Baseline State		A				A				C				A				D				D				D			
Time period	RCP Target	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A
Mid-century	Min	-17	-	-	-	-	-	-	-	-	-	-	-3	-4	-	-	-	-	-61	-68	-73	-	-60	-70	-77	-	-41	-56	-66
	2.6 Median	-18	-	-	-	-	-	-	-	-	-	-	-9	-6	-	-	-	-	-61	-68	-73	-	-63	-72	-79	-	-46	-60	-69
	Max	-19	-	-	-	-7	-	-	-	-	-	-	-16	-9	-	-	-	-	-61	-68	-73	-	-66	-74	-80	-	-50	-63	-72
	Min	-18	-	-	-	-1	-	-	-	-	-	-	-10	-7	-	-	-	-	-60	-67	-72	-	-63	-73	-79	-	-47	-60	-70
	4.5 Median	-18	-	-	-	-6	-	-	-	-	-	-	-15	-9	-	-	-	-	-60	-67	-72	-	-66	-75	-80	-	-51	-63	-72
	Max	-19	-	-	-	-13	-	-	-	-	-	-5	-21	-12	-	-	-	-	-60	-67	-73	-	-69	-77	-82	-	-56	-67	-74
	Min	-18	-	-	-	-	-	-	-	-	-	-	-9	-5	-	-	-	-	-62	-69	-74	-	-62	-72	-78	-	-47	-60	-69
	6.0 Median	-19	-	-	-	-6	-	-	-	-	-	-	-15	-8	-	-	-	-	-63	-69	-74	-	-66	-74	-80	-	-50	-63	-72
	Max	-20	-	-	-	-15	-	-	-	-	-	-8	-23	-12	-	-	-	-	-63	-70	-75	-	-69	-77	-82	-	-57	-67	-75
	Min	-23	-	-	-	-9	-	-	-	-	-	-1	-18	-12	-	-	-	-	-61	-68	-73	-	-67	-75	-81	-	-53	-65	-73
	8.5 Median	-23	-	-	-	-12	-	-	-	-	-	-4	-20	-12	-	-	-	-	-61	-68	-73	-	-68	-76	-82	-	-55	-66	-74
	Max	-24	-	-	-	-20	-	-	-	-2	-	-13	-27	-16	-	-	-	-	-62	-68	-74	-	-71	-79	-84	-	-60	-70	-77

Table 17. Proportional changes in mean annual suspended sediment load required to maintain or improve the baseline attribute state at water quality monitoring sites under projected climate change with future soil conservation works for late century. Negative values indicate a reduction in load is required. "-" indicates no further load reduction required to achieve the target, or the target is below baseline state and thus non-compliant with the NPS-FM (2020). "Base" refers to the baseline visual clarity

		Site name	Mangaehu River at Raupuha Rd Bridge				Maketawa Stream at Tarata Rd				Mangaoraka Stream at Corbett Rd				Pātea River at Barclay Rd Bridge				Pātea River at Skinner Rd Bridge				Punehu Stream at Wiremu Rd				Punehu Stream at SH45			
		Site code	MGH000950				MKW000300				MRK000420				PAT000200				PAT000360				PNH000200				PNH000900			
		Baseline State	C				A				A				A				A				B				B			
Time period	RCP	Target	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A
Late century		Min	-		-3	-22	-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-18	-	-	-22	-17	-	-	-28
	2.6	Median	-4		-14	-31	-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-19	-	-	-23	-18	-	-	-29
		Max	-13		-23	-38	-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-19	-	-	-24	-19	-	-	-30
		Min	-7		-17	-33	-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-24	-	-	-29	-24	-	-	-34
	4.5	Median	-18		-26	-41	-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-25	-	-	-29	-25	-	-	-35
		Max	-27		-35	-47	-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-26	-	-	-30	-26	-	-	-35
		Min	-19		-27	-41	-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-27	-	-	-31	-26	-	-	-36
	6.0	Median	-30		-37	-49	-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-28	-	-	-32	-28	-	-	-37
		Max	-34		-41	-52	-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-28	-	-	-33	-28	-	-	-38
		Min	-33		-40	-52	-11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-33	-	-	-37	-33	-	-	-42
	8.5	Median	-41		-48	-58	-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-34	-	-	-38	-34	-	-	-42
		Max	-46		-51	-61	-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-35	-	-	-38	-34	-	-	-43

Table 17 (continued)

		Site name	Hangatahua (Stony) River at Mangatete Rd				Waingongoro River at Eltham Rd Bridge				Waingongoro River at SH45				Waiwhakaiho River at SH3				Waiokura pumphouse				Whenuakura River at Nicholson Rd				Waitara River at Autawa Rd			
		Site code	STY000300				WGG000500				WGG000900				WKH000500				WKR000700				WNR000450				WTR000540			
Baseline State			A				A				C				A				D				D				D			
Time period	RCP	Target	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A	Base	NBL	B	A
Late century	2.6	Min	-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-1	-	-61	-68	-73	-	-58	-69	-76	-	-38	-54	-64
		Median	-16	-	-	-	-	-	-	-	-	-	-9	-	-	-	-	-5	-	-61	-68	-73	-	-63	-72	-79	-	-46	-59	-69
		Max	-17	-	-	-	-7	-	-	-	-	-	-16	-	-	-	-	-9	-	-61	-68	-73	-	-66	-75	-80	-	-52	-64	-72
	4.5	Min	-15	-	-	-	-2	-	-	-	-	-	-11	-	-	-	-	-5	-	-60	-67	-73	-	-64	-73	-79	-	-48	-61	-70
		Median	-16	-	-	-	-11	-	-	-	-	-3	-19	-	-	-	-	-9	-	-60	-67	-73	-	-68	-76	-81	-	-54	-66	-74
		Max	-18	-	-	-	-19	-	-	-	-1	-12	-26	-	-	-	-	-13	-	-61	-68	-73	-	-71	-78	-83	-	-59	-69	-77
	6.0	Min	-23	-	-	-	-10	-	-	-	-	-3	-19	-	-	-	-	-11	-	-62	-69	-74	-	-68	-76	-81	-	-54	-66	-74
		Median	-24	-	-	-	-20	-	-	-	-3	-14	-28	-	-	-	-	-15	-	-63	-69	-74	-	-72	-79	-84	-	-61	-71	-77
		Max	-25	-	-	-	-26	-	-	-	-9	-19	-33	-	-	-	-	-19	-	-63	-69	-75	-	-74	-80	-85	-	-63	-73	-79
	8.5	Min	-28	-	-	-	-24	-	-	-	-7	-17	-31	-	-	-	-	-20	-	-62	-69	-74	-	-73	-80	-85	-	-63	-72	-79
		Median	-29	-	-	-	-32	-	-	-	-17	-26	-39	-	-	-	-	-24	-	-63	-69	-74	-	-77	-83	-87	-	-68	-76	-81
		Max	-30	-	-	-	-37	-	-	-	-22	-31	-42	-	-	-	-	-27	-	-63	-69	-74	-	-78	-84	-88	-	-70	-78	-83

5.3 Sediment load contributions from natural cover areas

Table 18 summarises the proportion of land under natural cover within the selected water quality monitoring site catchments, and the proportion of the total suspended sediment load coming from natural cover areas for the contemporary baseline and future soil conservation scenarios under contemporary climate from Neverman et al. (2021). Natural cover extents range from <1% to 93% of catchment areas, which is constant for all land cover and climate scenarios.

Natural cover areas contribute <1% to 56% of contemporary suspended sediment loads, and <1% to 60% of future soil conservation scenario sediment loads under baseline climate conditions. Under the future soil conservation scenario, the suspended sediment load from non-natural cover areas and the total load decrease, while the absolute load from natural cover areas remains unchanged. This produces an increase in the proportion of total load from natural cover areas while the absolute load contribution remains the same.

Variation between catchments in the proportion of suspended sediment load from natural cover areas generally reflects variation in the extent of natural cover. The Hangatahua (Stony) River at Mangatete Rd, Punehu Stream at Wiremu Rd, and Pātea River at Barclay Rd Bridge show relatively low suspended sediment load contributions from natural cover (2%–37%) compared with the extent of natural cover in their catchments (29%–93%). These catchments primarily drain the flanks of Mt Taranaki within the national park. The sediment from these steep natural areas is likely to include a substantial coarse sediment component that typically does not travel in suspension and is not represented by SedNetNZ, which models fine suspended sediment. This is supported by the relatively high baseline visual clarity states at these sites, as coarse sediment has little impact on visual clarity (Davies-Colley & Smith 2001).

Contemporary attribute state and mean annual sediment loads at the selected water quality monitoring sites are reported in Table 19, along with the proportion of load from non-natural cover areas, and reductions in load required to achieve NPS-FM (2020) attribute states. Across the monitoring sites, 44%–100% of contemporary suspended sediment loads are derived from non-natural cover areas. The results suggest that at most sites (except the Whenuakura River at Nicholson Rd) the load reductions required to improve the site attribute state are less than the load coming from non-natural cover areas, where mitigations may be feasible.

Table 20 and Table 21 summarise the proportion of the total suspended sediment load derived from non-natural cover areas for the future soil conservation scenario under projected climate change. Contributions from natural and non-natural land cover are similar as under baseline climate, with 39%–100% of suspended sediment loads derived from non-natural cover areas under projected climate change by both mid-century and late century. Five sites (36%) (Mangaehu River at Raupuha Rd Bridge, Maketawa Stream at Tarata Rd, Waiwhakaiho River at SH3, Whenuakura River at Nicholson Rd, and Waitara River at Autawa Rd) have decreases of ≥5 percentage points in the proportion of load from non-natural cover areas under projected climate change compared to baseline climate (Table 21).

Table 18. Summary of the upstream catchment area under natural cover, and the load proportions from natural cover areas for selected water quality monitoring sites for the contemporary baseline and future soil conservation scenarios under baseline climate from Neverman et al. (2021)

Site Code	Location	Upstream catchment area under natural cover (%)	Load from natural cover* - both scenarios (t/yr)	Contemporary baseline		Future soil conservation	
				Total load (t/yr)	Proportion from natural cover (%)	Total load (t/yr)	Proportion from natural cover (%)
MGH000950	Mangaehu River at Raupuha Rd Bridge	46	52,000	231,000	22	196,000	26
MKW000300	Maketawa Stream at Tarata Rd	44	110	670	17	640	18
MRK000420	Mangaoraka Stream at Corbett Rd	4	6	760	<1	660	<1
PAT000200	Pātea River at Barclay Rd Bridge	85	12	150	8	150	8
PAT000360	Pātea River at Skinner Rd Bridge	11	14	2,000	<1	1,600	<1
PNH000200	Punehu Stream at Wiremu Rd	78	16	560	3	550	3
PNH000900	Punehu Stream at SH45	29	17	990	2	960	2
STY000300	Hangatahua (Stony) River at Mangatete Rd	93	3,100	8,300	37	8,300	37
WGG000500	Waingongoro River at Eltham Rd Bridge	18	43	1,900	2	1,900	2
WGG000900	Waingongoro River at SH45	7	64	9,100	<1	8,500	<1
WKH000500	Waiwhakaiho River at SH3	59	990	3,700	27	3,400	29
WKR000700	Waiokura pumphouse	<1	<1	100	<1	91	<1
WNR000450	Whenuakura River at Nicholson Rd	71	81,000	144,000	56	135,000	60
WTR000540	Waitara River at Autawa Rd	51	80,000	346,000	23	293,000	27

Table 19. Summary of the baseline attribute state and mean annual suspended sediment load from non-natural cover for the contemporary baseline, as well as load reductions required to achieve NPS-FM (2020) attribute states, and load reduction achieved relative to the contemporary baseline under the future soil conservation scenario at the selected water quality monitoring sites

Site Code	Location	Contemporary attribute band	Contemporary total load (t/yr)	Contemporary load from non–natural cover		Load reduction required to achieve attribute state (t/yr)			Load reduction achieved by future soil conservation scenario (t/yr)
				Absolute (t/yr)	Proportion of total (%)	NBL	B band	A band	
MGH000950	Mangaehu River at Raupuha Rd Bridge	C	231,000	180,000	78	0	24,000	65,000	36,000
MKW000300	Maketawa Stream at Tarata Rd	A	670	560	83	0	0	0	25
MRK000420	Mangaoraka Stream at Corbett Rd	A	760	750	99	0	0	0	97
PAT000200	Pātea River at Barclay Rd Bridge	A	150	140	92	0	0	0	0
PAT000360	Pātea River at Skinner Rd Bridge	A	2,000	2,000	99	0	0	0	400
PNH000200	Punehu Stream at Wiremu Rd	B	560	550	97	0	0	33	14
PNH000900	Punehu Stream at SH45	B	990	970	98	0	0	130	25
STY000300	Hangatahua (Stony) River at Mangatete Rd	A	8,300	5,300	63	0	0	0	17
WGG000500	Waingongoro River at Eltham Rd Bridge	A	1,900	1,900	98	0	0	0	29
WGG000900	Waingongoro River at SH45	C	9,100	9,100	99	0	990	2,300	660
WKH000500	Waiwhakaiho River at SH3	A	3,700	2,700	73	0	0	0	220
WKR000700	Waiokura pumphouse	D	100	100	100	60	67	72	9
WNR000450	Whenuakura River at Nicholson Rd	D	144,000	63,000	44	83,000	98,000	109,000	8,900
WTR000540	Waitara River at Autawa Rd	D	346,000	265,000	77	147,000	197,000	232,000	53,000

Table 20. Proportion of monitoring site catchment total load derived from non-natural cover areas under the future soil conservation scenario with the effects of climate change at mid-century compared to the contemporary baseline. 'Prop' is the proportion (%) of the total load derived from non-natural cover areas

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)
Baseline			180	78	0.56	83	0.75	99	0.14	92	2.0	99	0.55	97	0.97	98	5.3	63	1.9	98	9.1	99	2.7	73	0.10	100	63	44	265	77
Mid-century	2.6	Min	164	73	0.57	82	0.48	99	0.10	91	0.83	99	0.72	98	1.3	98	6.5	64	1.7	98	6.9	99	2.7	71	0.10	100	61	40	245	72
		Median	179	73	0.57	81	0.49	99	0.10	91	0.83	99	0.72	97	1.3	98	6.5	64	1.9	98	7.4	99	2.8	71	0.10	100	66	40	267	72
		Max	193	73	0.57	80	0.51	99	0.10	90	0.83	99	0.73	97	1.3	98	6.5	63	2.0	98	8	99	2.8	70	0.10	100	72	40	288	72
	4.5	Min	181	73	0.57	81	0.51	99	0.10	91	0.83	99	0.65	97	1.2	98	6.5	64	1.9	98	7.4	99	2.8	70	0.10	100	67	40	270	72
		Median	196	73	0.57	80	0.52	99	0.10	91	0.84	99	0.66	97	1.2	98	6.5	63	2.0	98	7.9	99	2.8	70	0.10	100	72	40	293	72
		Max	213	73	0.57	79	0.54	99	0.10	90	0.84	99	0.66	97	1.2	98	6.5	62	2.2	98	8.5	99	2.9	69	0.10	100	79	40	321	72
	6.0	Min	179	73	0.59	82	0.50	99	0.10	91	0.88	99	0.70	97	1.2	98	6.5	64	1.8	98	7.3	99	2.7	70	0.11	100	65	40	268	72
		Median	193	73	0.59	81	0.52	99	0.10	91	0.88	99	0.70	97	1.2	98	6.5	63	2.0	98	7.9	99	2.7	69	0.11	100	71	40	288	72
		Max	218	73	0.59	80	0.54	99	0.10	90	0.89	99	0.71	97	1.3	98	6.5	62	2.2	98	8.7	99	2.8	68	0.11	100	80	40	328	72
	8.5	Min	203	73	0.59	80	0.53	99	0.10	91	0.86	99	0.68	97	1.2	98	6.9	64	2.1	98	8.1	99	2.9	70	0.10	100	74	39	305	72
		Median	212	73	0.59	80	0.54	99	0.10	90	0.86	99	0.68	97	1.2	98	6.9	63	2.1	98	8.4	99	2.9	69	0.10	100	77	39	318	72
		Max	234	73	0.59	79	0.56	99	0.10	90	0.87	99	0.69	97	1.2	98	6.9	62	2.3	98	9.2	99	3.0	68	0.10	100	85	40	352	72

Table 21. Proportion of monitoring site catchment total load derived from non-natural cover areas under the future soil conservation scenario with the effects of climate change at late century compared to the contemporary baseline. 'Prop' is the proportion (%) of the total load derived from non-natural cover areas

Time period	RCP	Site name	Mangaehu River at Raupuha Rd Bridge		Maketawa Stream at Tarata Rd		Mangaoraka Stream at Corbett Rd		Pātea River at Barclay Rd Bridge		Pātea River at Skinner Rd Bridge		Punehu Stream at Wiremu Rd		Punehu Stream at SH45		Hangatahua (Stony) River at Mangatete Rd		Waingongoro River at Eltham Rd Bridge		Waingongoro River at SH45		Waiwhakaiho River at SH3		Waiokura pumphouse		Whenuakura River at Nicholson Rd		Waitara River at Autawa Rd	
		Site code	MGH000950		MKW000300		MRK000420		PAT000200		PAT000360		PNH000200		PNH000900		STY000300		WGG000500		WGG000900		WKH000500		WKR000700		WNR000450		WTR000540	
			Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)	Load (kt/yr)	Prop (%)
Baseline			180	78	0.56	83	0.75	99	0.14	92	2.0	99	0.55	97	0.97	98	5.3	63	1.9	98	9.1	99	2.7	73	0.10	100	63	44	265	77
Late century	2.6	Min	156	73	0.55	82	0.45	99	0.10	91	0.82	99	0.66	97	1.2	98	6.3	64	1.7	98	6.7	99	2.7	72	0.10	100	59	40	232	72
		Median	177	73	0.55	81	0.47	99	0.10	91	0.82	99	0.67	97	1.2	98	6.3	63	1.9	98	7.4	99	2.7	70	0.10	100	66	40	264	72
		Max	196	73	0.55	80	0.50	99	0.10	90	0.83	99	0.68	97	1.2	98	6.3	63	2.0	98	8.0	99	2.8	69	0.10	100	72	40	295	72
	4.5	Min	183	73	0.56	81	0.49	99	0.10	91	0.85	99	0.72	97	1.3	98	6.2	63	1.9	98	7.5	99	2.7	70	0.10	100	67	40	273	72
		Median	206	73	0.56	80	0.52	99	0.10	90	0.85	99	0.73	97	1.3	98	6.2	62	2.1	98	8.3	99	2.7	68	0.10	100	75	40	311	72
		Max	232	73	0.56	78	0.55	98	0.10	90	0.85	99	0.74	97	1.3	98	6.2	61	2.3	98	9.1	99	2.8	67	0.10	100	85	40	349	72
	6.0	Min	208	73	0.56	80	0.53	99	0.10	91	0.88	99	0.74	97	1.3	98	6.9	63	2.1	98	8.3	99	2.8	69	0.11	100	75	39	314	72
		Median	240	73	0.56	78	0.56	99	0.10	90	0.88	99	0.75	97	1.3	98	6.9	62	2.4	98	9.3	99	2.9	67	0.11	100	88	40	362	72
		Max	256	73	0.56	77	0.59	98	0.10	90	0.89	99	0.76	97	1.4	98	6.9	61	2.5	98	10	99	3.0	66	0.11	100	94	40	389	72
	8.5	Min	252	73	0.59	78	0.60	99	0.10	90	0.85	99	0.81	97	1.4	98	7.2	62	2.5	98	9.8	99	3.1	68	0.11	100	91	39	383	72
		Median	289	73	0.59	76	0.64	98	0.10	90	0.86	99	0.82	97	1.5	98	7.2	61	2.8	98	11	99	3.2	66	0.11	100	105	39	440	72
		Max	311	73	0.59	75	0.67	98	0.10	89	0.86	99	0.83	97	1.5	98	7.2	60	3.0	98	12	99	3.3	65	0.11	100	112	39	474	72

6 Model Limitations

6.1 Climate change projections

Variations between Global Climate Models (GCMs), greenhouse gas emission trajectories (RCPs), and how climate change affects erosion processes, contribute to a high degree of uncertainty in projected changes in suspended sediment loads. This range of variations means there can be considerable difference between our lowest and highest projections, especially by late century. We attempt to account for the range of uncertainty by presenting results from climate projections derived from six GCMs and four RCPs, which were selected to represent the range of uncertainties (Collins et al. 2018; Ministry for the Environment 2018; Collins 2020).

Simplifications and assumptions are required to relate changes in hydro-climatic drivers to changes in erosion processes and sediment loads. For example, the prediction of future mass movement erosion on hillslopes assumes that all mass movement processes increase proportionately with shallow landslides, and will be driven by changes in storm rainfall. As shallow landslide erosion is the dominant mass movement process in Taranaki (Basher 2013) we expect the model outputs to have a low sensitivity to this assumption. Rainfall events exceeding 150 mm in a 48-hour period have been assumed to represent the triggering threshold for shallow landslides, with an average recurrence interval (ARI) of 30 years. This uniform triggering threshold has been used to estimate future changes in landslide density, and erosion from other mass movement processes, but this threshold may vary for different terrains, land covers, and mass movement processes (e.g. Reid & Page 2003; Basher et al. 2020).

Basher et al. (2020) noted that only a few studies have addressed the potential impacts of climate change on erosion in New Zealand, and most of these consisted of general statements about likely trends rather than quantifying change. For instance, Crozier (2010) reviewed the basis for assessing the impact of climate change on landslides and found that although there is a strong theoretical basis for increased landslide activity in response to predicted climate change, there is a high level of uncertainty resulting from the uncertainty inherent in downscaling GCMs spatially and temporally. Due to the high uncertainty, the results of the climate change projections should be interpreted as indicative of trends rather than absolute values (Basher et al. 2020).

6.2 Achievement of NPS-FM (2020) attribute states

There are several areas which contribute to uncertainty in estimating the change in suspended sediment load required to achieve target median visual clarity.

We estimated the proportional changes in sediment load required to achieve target visual clarity states using empirical models relating changes in visual clarity to changes in suspended sediment fitted to a national dataset (including sites from Taranaki, see Hicks et al. 2019), as recommended by Ministry for the Environment (2022). This should result in the models being fit to a wide range of catchment variables and therefore representing the variability across Taranaki. However, this may lead to under- or over-estimation of

required reductions at any one site due to local variability in the relationship between suspended sediment concentration and visual clarity. This variability arises due to variations in sediment characteristics between sites, such as differences in the proportion of fine-grained clay minerals which dominate light attenuation by sediments (Davies-Colley & Smith 2001). This relationship assumes visual clarity at any given site is primarily affected by suspended sediment and does not account for the potential influence of other matter, such as tannins or waste discharges, on visual clarity.

We also assumed the relationship between suspended sediment concentration and flow remains consistent at a site. Warrick (2015) and Hicks et al. (2016) illustrated that changes in sediment load may not affect the shape of the relationship between suspended sediment concentration and flow, particularly when catchment hydrology is unaltered. However, changes in catchment land cover, land use, or climate may alter the relationship between flow and suspended sediment concentration due to changes in either catchment hydrology or sediment supply dynamics. As data are not presently available to model the effects of these changes on the relationship between suspended sediment concentration and flow, we assume the associated relationships remain constant across the mitigation and climate scenarios.

Current state median visual clarity was derived from monthly fixed-interval sampling. Fixed-interval sampling likely results in visual clarity predominantly being measured at or near baseflow, when most of the suspended sediment load may be derived from within-channel sources (e.g. remobilisation from channel bed or from bank erosion). In contrast, the modelled mean annual suspended sediment loads also capture storm event-driven erosion and sediment loads, with shallow landslide erosion being a dominant sediment source in hill country areas of Taranaki over multi-decadal timescales. Hence, the link between reductions in storm-generated sediment loads and increases in visual clarity at generally low flows may depend in part on a reduction in the storage and subsequent remobilisation of storm-derived fine sediment in the channel network. The present modelling assumes that the relationship between erosion, storage, and transport remain constant across scenarios.

One of the key limitations of the analysis presented in this report is the assumption that WFPs are fully implemented in their first year (Neverman et al. 2021). This assumption likely results in underestimation of the capacity for load reductions under future scenarios where WFPs have not been fully implemented in their first year. This could result in an underestimation in the achievable attribute state at monitoring sites under future climate projections for catchments where a significant number of WFPs have not been implemented as extensively as assumed. Information on the extent of soil conservation works implemented on farms through time, and the associated proportion of the WFP completed, would allow us to better constrain this model parameter.

7 Conclusions and recommendations

- Fully implemented and mature soil conservation works may offset the effects of climate change at late century on the total sediment load delivered to the coast across Taranaki for greenhouse gas pathways up to RCP6.0 when compared to the pre-mitigation baseline.
- Soil conservation works implemented since 1996 may offset the impacts of climate change on sediment loads at 50% of monitoring sites by late century. Under the stabilisation pathways (RCP4.5 and RCP6.0), soil conservation works offset the impacts of climate change at 57% to 93% of monitoring sites.
- Due to the extent of soil conservation works assumed to be implemented by 2018, future soil conservation works appear to have less impact when compared to the 2018 contemporary baseline.
- The Waingongoro River at SH45 is projected to improve in attribute state under lower greenhouse gas emissions. Four sites (29%) are projected to have declines in attribute band by mid-century, and five sites (35%) by late century.
- By late century, four sites are projected to have lower sediment loads than their baseline state across all projections. The Mangaehu River at Raupuha Rd Bridge, Waingongoro River at Eltham Rd Bridge, and Waingongoro River at SH45 tend to require additional reductions in load to maintain their baseline state for RCPs 4.5, 6.0, and 8.5.
- The Waiokura pumphouse, Whenuakura River at Nicholson Rd, and Waitara River at Autawa Rd are projected to require further reductions to achieve the NBL.
- Between 44% and 100% of contemporary suspended sediment loads are derived from non-natural cover areas at the selected water quality monitoring sites. This suggests the load reductions required to improve their attribute state are less than the load coming from non-natural cover areas, where mitigations may be feasible. Contributions from non-natural land cover are similar under projected climate change.
- Information on the extent of soil conservation works implemented on farms through time, and the associated proportion of the WFP completed, would allow better representation of the effectiveness of conservation measures implemented to date and the potential reductions achievable in future. This would improve the estimation of future compliance with the NPS-FM (2020).
- Future applications of SedNetNZ in the Taranaki region may incorporate regional LiDAR data to better represent erosion processes. This could be supported by capturing data on erosion processes, such as building a database of storm-driven shallow landslides for use in modelling landslide susceptibility at higher resolution (e.g. Smith et al. 2021), or through improved representation of the channel network and riparian vegetation using LiDAR. This would enable better calibration of the erosion process components for future applications of SedNetNZ in the Taranaki region.
- Climate impacts may be updated when downscaled CMIP6 projections become available for New Zealand.

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Date 6 June 2023

Subject: **Strengthening National Direction on Renewable Electricity Generation and Electricity Transmission**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3173330

Purpose

1. The purpose of this memorandum is to seek Members' endorsement of the Councils submission on the *Strengthening national direction on renewable electricity generation and electricity transmission consultation document* (the Consultation Document).
2. The deadline for submissions on 1 June precluded the submission being presented to this meeting. A draft submission was circulated for councillor feedback ahead of submitting. A copy of the submission is attached.

Executive summary

3. The Ministry of Business, Innovation and Employment (MBIE) and the Ministry for the Environment (MFE) have released proposals to facilitate the increase of renewable electricity generation and its transmission. The core proposals are changes to the existing National Policy Statement (NPS) on Renewable Electricity Generation (REG) and the NPS on Electricity Transmission (ET).
4. The overall purpose of the proposals is laudable. Changes to facilitate much more renewable electricity are needed if New Zealand is to successfully decarbonise. The proposals will help make a more permissive and nationally consistent regime.
5. However, this comes at the cost of increased complexity and limited scope to require the avoidance of significant adverse effects. To avoid the burden of managing that complexity falling on local government, there is a need for additional guidance on how to apply the new processes. It is also important to retain a robust ability to avoid adverse effects in key circumstances, such as where a wāhi tapu site is threatened.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum entitled *Strengthening National Direction on Renewable Electricity Generation and Electricity Transmission*;

b) notes the attached *Submission on strengthening national direction on renewable electricity generation and electricity transmission;*

c) endorses the submission made on the Consultation Document;

d) determines that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002*

e) determines that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

6. New Zealand needs to increase its supply of renewable electricity significantly to meet its goal of being net carbon zero by 2050 (excluding methane). The Climate Commission estimates that beyond 2030, this will require wind, solar and geothermal generation to increase by over 1 terawatt-hour every year. That is the equivalent of building a windfarm over twice the size of the Waipipi Wind Farm in South Taranaki every year.

7. Renewable electricity development is a potential pathway for economic development in Taranaki. The current regional policy statement facilitates a permissive approach. The key policy states, "the use and development of renewable energy resources will be promoted whistle avoiding, remedying or mitigating adverse effects on the environment as far as practicable."

Issues

8. This principle issue dealt with in the Consultation Document is ensuring New Zealand has sufficient supply of renewable electricity generation and associated transmission to successfully decarbonise. Additional issues for TRC in considering the Consultation Document is how the changes would be implemented in practice and the rapid pace of regulatory change for local government.

The Consultation Document

9. The main objective of the Consultation Document is to provide for a significant increase in renewable electricity generation and transmission through more consistent and efficient consenting processes. It also seeks to better manage competing interests and provide for Māori interests.

10. To do this, the Consultation Document proposes changes to the existing NPS on REG and the NPS on ET. It also seeks feedback on proposed national environmental standards on these matters to be developed in slower time. The changes focus primarily on wind and solar generation.

11. The attached summary of proposed changes provides a good overview of the Consultation Document. Key changes include:

- Creating a bespoke consenting pathway for REG and ET development in areas with significant environment value[1]. The Consultation Document proposes two preferred options to do this:

  Option One

  - adverse effects on these areas to be avoided, minimised, remedied, offset or compensated to the extent practicable, and in that order of priority;
  - if there are still significant adverse effects on any type of area with significant environment value after that, the activity is avoided;
  - if the residual adverse effects are not significant, the activity is enabled if the national significance of the activity outweighs the residual adverse effects.

  Option Two

  - adverse effects on these areas to be avoided, minimised, remedied, offset or compensated to the extent practicable, and in that order of priority;
  - if there are still significant adverse effects on a significant natural area, the activity is avoided;
  - if the residual adverse effects on the significant natural area are not significant, the activity is enabled if the national significance of the activity outweighs the residual adverse effects;
  - in all other areas with significant environment values, activities are enabled if the national significance of the activity outweighs the residual adverse effects.
- In areas without significant environment values, a regime that enables REG and ET development as long as effects are avoided, remedied or mitigated to the extent practicable.
- New policy direction to recognise and provide for Māori interests in relation to REG and ET activities. This includes through early engagement, the protection of sites of significance, and through enabling small-scale and community-scale REG activities.
- New policy direction to enable small-scale and community-scale REG activities as long as adverse effects are avoided, remedied or mitigated to the extent practicable. The Consultation Document also includes an initial draft of rules to provide for this through a future national environmental standard.
- Limiting the ability to oppose development on amenity grounds through recognising that changes that some people might oppose others might like, and that REG and ET development is likely to have wider well-being benefits.

Discussion

12. The changes set out in the Consultation Document will likely help provide national consistency. They set a maximum level of restriction to apply across local government. A council can still adopt rules that are more permissive.
13. The changes are more permissive in part through the frequent use of 'practicable'. With the exception of REG and ET development within areas with significant environment

[1] The definition of 'areas with significant environment values' includes areas with natural character in the coastal environment; outstanding natural features and landscapes; areas with historic heritage, including sites of significance to Māori and wāhi tapu; and significant natural areas.

values, avoidance, remediation and mitigation is limited to the extent practicable. This largely presupposes the activity will occur. That is an applicant must do what they can to manage adverse effects, as long as that does not undermine the viability of the activity itself.

14. In areas with significant environment value, the proposed regime still allows avoidance (e.g. stopping an activity from going ahead at all) in select circumstance. Option 1 provides significantly more scope for this to occur by applying the avoidance requirement to all types of areas with significant environment values. It does this without having to first weight the effects against potential national benefits.
15. The changes are likely to support the scale-up of renewable electricity generation and transmission. However, they also introduce more complexity. The introduction of new tests in a REG and ET context (e.g. determining what is practicable and how to balance national benefit against residual adverse effects) places a significant interpretive burden on local government. For the reforms to succeed, additional clarity is needed in the NPSs themselves or accompanying non-statutory guidance.
16. The attached submission supports the overall objectives of the Consultation Document, while highlighting the key matters outline above. It also covers some technical planning matters.

Where to from here?

17. Consultation on the Discussion Document closed on 1 June 2023. The submission noted that any additional comments or amendments would be provided to MBIE following the Policy and Planning Committee Meeting.
18. If rolled out as proposed in the Consultation Document, once the NPS REG and NPS ET are in force – likely to occur sometime in the second half of 2023 – TRC would have six months to amend its regional policy statement. This would be done by simply inserting the required policies and notifying the public this has been done. From that date, the policies would need to be applied by Taranaki councils in considering REG and ET consents.
19. To give effect to the NPS REG and NPS ET, consequential amendments to other planning documents would be required. This does not need to occur until the next plan review.

Options

20. The options are:
    1. Endorse the submission as submitted.
    2. Endorse the submission subject to officials preparing an amended submission based on committee feedback and submit this to MBIE.
    3. Not endorse the submission and direct officials to request MBIE withdraw the submission.
21. With the draft submission having been circulated to committee members out of session for comment, option 1 is recommended. Option 2 is workable but there are no guarantees MBIE would accept the additional comments. Option 3 is not recommended. If Taranaki wants to ensure a robust regime that promotes investment in the region, it is important to be active in national consultation processes.

Significance

22. Officials have assessed that the decision to endorse the submission as not significant under the Significance and Engagement Policy.

Financial considerations—LTP/Annual Plan

23. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

24. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

25. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Community considerations

26. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

27. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 3173731: Summary on strengthening national direction on renewable electricity generation and electricity submission

Document 3172520: Submission on strengthening national direction on renewable electricity generation and electricity submission

Strengthening National Direction on Renewable Electricity Generation and Electricity Transmission

A SUMMARY OF PROPOSED CHANGES
APRIL 2023

ONLINE: ISBN 978-1-99-106977-1

Renewable electricity generation is critical to our future wellbeing and prosperity.

Climate change is the most significant environmental challenge of our time. If we are to meet our emission reduction targets, this will require a rapid expansion of renewable electricity generation and transmission infrastructure, which is vital for Aotearoa New Zealand's shift to a low-emissions economy.

New Zealand is fortunate to have access to significant renewable energy sources, but our current planning settings are not fit for purpose to meet the challenge faced.

The Ministry of Business, Innovation and Employment (MBIE) and the Ministry for the Environment (MfE) are proposing changes to strengthen national direction on renewable electricity generation (REG) and electricity transmission (ET) as the most effective way to improve consenting under the Resource Management Act 1991 (RMA). This is an important transitional measure prior to the new Resource Management system taking full effect in the next 7-10 years.

What national direction is in scope?

These proposals relate to a package of national direction instruments under the RMA: This covers the existing:

- National Policy Statement on Renewable Electricity Generation (or 'NPS-REG')
- National Policy Statement on Electricity Transmission (the 'NPS-ET').
- National Environmental Standards for Electricity Transmission Activities (NES-ETA).

And new:

- National Environmental Standards for Renewable Electricity Generation (NES-REG).

In this summary we first explain why the changes are needed and then we summarise the proposed changes themselves.

Why are changes to the existing national direction needed?

Rapid and efficient investment in renewable electricity and the national grid is needed for New Zealand to reach its emissions reduction targets and renewable electricity goals. Current national direction for renewable electricity generation and electricity transmission was developed before emissions reduction targets were incorporated into New Zealand law and are no longer fit for purpose to support the pace and scale of development that is required.

The proposed changes would help ensure current planning settings enable New Zealand to significantly expand its renewable electricity generation and transmission capacity.

Why are changes proposed under the RMA and not through the proposed resource management reform?

While the Government intends for the resource management reform bills to be passed by mid-2023, significant investment in renewable electricity generation and electricity transmission projects needs to occur under the current RMA framework for around 7-10 years before the new resource management (RM) system becomes fully operative.

The proposals would amend national direction instruments under the RMA to recognise the need for strengthened national direction to influence consenting decisions on renewable electricity infrastructure during this transition period. The policy intent of the proposals will also be translated into the National Planning Framework (NPF) which will provide national direction for the new RM system.

What are the proposed changes?

The main objectives of the proposals are to:

1. Provide more enabling policy direction for renewable electricity generation and electricity transmission projects to significantly increase generation output to support New Zealand's emissions reduction targets and renewable electricity goals.
2. Better manage competing interests with other Part 2 RMA matters through nationally consistent consenting pathways.
3. Provide for Māori interests and incorporating the principles of te Tiriti o Waitangi.

The proposals to achieve these objectives are set out below, and include changes to existing national direction, and a new national environmental standard for renewable electricity generation. Other policy options which have been considered for achieving the objectives are outlined in the consultation document.

National policy statement proposals

The proposals focus on strengthening, as a priority, the current national policy statements (NPS-REG and NPS-ET), to provide a consenting process that is more efficient, certain and environmentally sustainable.

The proposals would not require local authorities to initiate plan changes ahead of resource management reform but are instead intended to influence consenting decisions during the transitional period. Feedback is also being sought on whether some provisions should be directly inserted into plans.

Some of the new provisions are expected to improve the consenting environment for renewables, while broader changes will be progressed through the National Planning Framework as part of the resource management reforms.

Amendments to the NPS-REG

- **Recognising and providing for the national significance of renewable electricity generation**, by providing stronger and more directive policy on the important role renewable electricity generation activities in meeting emissions reduction targets and helping to address climate change, making sure planning decisions give greater with greater weight to the national significance and benefits of these activities and clarifying the meaning of 'operational need' and 'functional need' in relation to the location of these activities. This is covered in Section 1 of the consultation document.
- **Enabling renewable electricity generation activities in areas with significant environment values**, by providing three options for addressing current issues. The preferred option is for new consenting pathways ("gateway tests" and effects management approaches) to enable renewable electricity generation activities in areas with significant environment values when their benefits outweigh residual remaining adverse effects.

  The preferred option will provide a single consenting pathway that acts as a 'one stop shop' for the consideration of projects where they are proposed to be located in areas with significant environment values. This is covered in Section 2 of the consultation document.
- **Enabling renewable electricity generation activities in other areas**, including providing new direction on enabling these activities where there are potential adverse effects on local amenity values, so long as effects are avoided, remedied or mitigated to the extent practicable. The proposal also requires consideration that effects on local amenity can be positive, have wider benefits, are not in and of themselves an adverse effect and must be considered in light of the national standards for wind farm noise (NZS 6808:2010). This is covered in Section 3 of the consultation document.
- **Recognising and providing for Māori interests**, by introducing new policy direction on early, meaningful engagement, protection of sites of significance, and enabling small and community-scale renewable electricity generation activities to support tangata whenua aspirations. This is covered in Section 4 of the consultation document.
- **Strengthening direction on existing wind and solar renewable electricity generation**, by providing more direction on recognising the importance of maintaining existing generation output, the efficiencies of upgrading existing renewable electricity generation activities (including through repowering[1]), and the environmental benefits of increasing the capacity and output of existing activities. This is covered in Section 5 of the consultation document.

[1] Repowering is a specific type of upgrade that involves comprehensively replacing generation components.

- **Retain existing direction in relation to reconsenting existing hydro and investigating further options under the National Planning Framework.** Given the National Policy Statement on Freshwater Management 2020, and forthcoming work on a new resource management regime on freshwater allocation, no changes are proposed to the existing direction relevant to reconsenting hydro. Any necessary changes to this direction will be considered through the development of the National Planning Framework as part of resource management system reform. This is covered in Section 6 of the consultation document.
- **Enabling small and community scale and generation**, by strengthening existing direction to be more enabling of these activities, to recognise and provide for the significant cumulative contribution of these activities in meeting emissions reduction targets, and recognising and providing for the local benefits of these activities.

  A new definition of small and community scale renewable electricity generation activities is proposed. There are options to define this based on the activities primary purpose or based on the activity's generation capacity. This is covered in Section 7 of the consultation document.
- **Battery storage:** There is an option to broaden the scope of the NPS-REG to apply to grid/distribution connected battery storage and better recognise the national significance of these activities. This is covered in Section 8 of the consultation document.
- **Consent lapse periods:** No options are proposed, however we are seeking feedback on applying pro-competitive considerations when decision makers determine an appropriate lapse date for consents for renewable generation (effective "use it or lose it" conditions). This is covered in Section 8 of the consultation document.

Amendments to the NPS-ET

- **Recognising and providing for the national significance of electricity transmission**, by providing stronger and more directive policy on the national significance of the electricity transmission network. This would include more specific recognition of technical, operational and functional needs, better reflecting the activities and infrastructure that form part of the operation of these activities (including access tracks associated with routine maintenance), greater recognition of national, regional and local benefits and requiring decision makers to recognise linkages with the NPS-REG and the role of the network to support a timely and significant increase in renewable electricity generation capacity.

  This is covered in Section 9 of the consultation document.
- **Managing environmental effects of electricity transmission**, by enabling minor activities without restriction provided adverse effects are avoided or mitigated where practicable, and to enable these to occur in a timely and efficient way. A new definition of minor electricity transmission network activities would be included in the NPS-ET. This is covered in Section 10 of the consultation document.

  Options are also provided for providing clearer consenting pathways for development of the electricity transmission network and 'more than minor upgrades' in different environments. The preferred option is to enable these to be located in areas with 'significant environmental values' if the benefits of the activity outweigh its adverse effects, provided there are no significant residual adverse effects.
- **Broadening the scope of the NPS-ET to apply to all high voltage electricity networks.** We are seeking feedback on include broadening the scope of the NPS-ET to cover high voltage electricity networks not owned or operated by Transpower. This is covered in Section 12 of the consultation document.

National environmental standard proposals

Nationally consistent standards for infrastructure are also being developed for the National Planning Framework. Developing standards is complex and it requires a different, and more lengthy regulatory process.

As a result, the Government will determine how to sequence and progress proposals for new or amended NESs in the most effective and efficient way; whether this is through the current Resource Management Act, the new National Planning Framework, or both.

Subject to this, a further round of consultation will be undertaken on the draft NESs, giving stakeholders another chance to provide a view on the detailed provisions and their technical aspects.

Amendments to the NES-ETA

Improving the workability and scope of the NES-ETA, through updated definitions, rules and conditions. This could be achieved through enabling activities with mainly visual effects, aligning the regulations with updated standards and definitions, and proposing other minor alterations to definitions to improve workability of the regulations.

Developing a new NES-REG

- The consultation document proposes a new National Environmental Standard for Renewable Electricity Generation, while still enabling councils to set more permissive rules and standards for these activities.
- **Enabling the upgrade and repowering of existing wind and solar generation**, by developing national standards for upgrading and repowering existing onshore wind and solar. This would specifically provide for minor, intermediate and major upgrades and repowering activities. Subject to standards, minor upgrades would be permitted activities, intermediate upgrades would be controlled activities and major upgrades and repowering would be restricted discretionary. This is covered in Section 5 of the consultation document.
- **Developing new national standards for small and community scale onshore wind and solar PV generation projects,** to improve national consistency in the management of these activities. The proposals include permitted activity standards for roof-mounted and free-standing wind turbines and solar photo-voltaic (PV) panels, with a controlled or restricted discretionary activity status where the standards are not met. It would also provide, subject to standards, a controlled activity status for community scale renewable electricity generation activities, with a restricted discretionary activity status where the controlled standards are not met. Some general standards are proposed to apply to all of these activities. This is covered in Section 7 of the consultation document.
- **Nationally consistent rules for new large-scale wind and solar PV generation**. There is also an option for the NES to include a nationally consistent activity status (e.g. restricted discretionary) to address current inconsistencies at a regional level. This is covered in Section 8 of the consultation document.

Out of scope

Issues that are outside of the scope of the consultation are:

- Renewable energy more broadly (e.g. biofuels)
- The regulatory framework for offshore renewable generation.
- Waste from decommissioning and repowering renewable electricity infrastructure

When would the proposed changes take effect?

Proposal Timeframes

We believe changes to the two existing **national policy statements** should be progressed as a priority, so that they would come into force (through being published in the Gazette) in 2023.

Proposals for changes to existing or **new national environmental standards** would be progressed later in 2023 to be brought into effect as regulations after 2023.

Certain aspects of the standards will be progressed as infrastructure content of the National Planning Framework, which is the replacement national direction in the new resource management system.

Table 1: Policy development for proposed amendments

	NPS-REG	NPS-ET	NES-REG	NES-ETA
2023	Report on submissions and policy recommendations (section 46A report)	Report on submissions and policy recommendations (section 46A report)	Consideration of issues and options under the RMA and the National Planning Framework	Consideration of issues and options under the RMA and the National Planning Framework
	Further drafting of NPS	Further drafting of NPS		
	Exposure draft consultation (TBC, if substantive changes to drafting from earlier consultation)	Exposure draft consultation (TBC, if substantive changes to drafting from earlier consultation)		
	Final government approval of final NPS	Final government approval of final NPS	Summary of submissions and policy recommendations (section 46A report)	Summary of submissions and policy recommendations (section 46A report)
	Gazettal (NPS takes effect 28 days after gazettal)	Gazettal (NPS takes effect 28 days after gazettal)		
2024			Cabinet approval of policy and drafting instructions	Cabinet approval of policy and drafting instructions
			Exposure draft consultation	Exposure draft consultation
			Cabinet approval of final NES	Cabinet approval of final NES
			Gazettal / standards come into force	Gazettal / standards come into force

How to have your say

The Government welcomes your feedback on this consultation document. The questions in this document are a guide only. You do not have to answer all the questions, and all comments are welcome.

To ensure others clearly understand your point of view, you should explain the reasons for your views and give supporting evidence if needed.

You can make a submission in two ways:

1. Use our online submission tool, available at https://www.research.net/r/ElectricityRMAConsultation. This is our preferred way to receive submissions.

2. Write your own submission.

When writing your own submission, please state "I have read and acknowledge the Privacy Statement." (below)

Please post it to: Electricity RMA Project Team, MBIE Energy & Resource Markets, 25 The Terrace, Wellington 6011.

Include:

• the title of the consultation

• your name or organisation

• your postal address

• your email address.

Submissions close at 5 pm, 1 June 2023.

Privacy Statement

We collect your personal information including full name, email address and place of employment (optional) in order to contact you if needed and understand the nature of your specific feedback. Personal information also relates to the opinions given in the survey, especially in free-text boxes. Providing some information is optional, you do not need to identify your place of work, however if you do not provide this information, we may not be able to understand your specialisation, if any, for the feedback given. We advise caution on the use of free-text boxes, please do not provide more personal information than is required for the purposes of this survey.

Besides MBIE staff, we may share this information with the Ministry for Environment, in line with the Privacy Act 2020 or as otherwise required or permitted by law. We keep your information safe by storing your responses in our secure, cloud-managed document management system. If this information is shared or published, we may need to edit comments to remove personal information. This information will be held by MBIE.

You have a right to ask for a copy of any personal information we hold about you as a result of this

survey, and to ask for it to be corrected if you think it is wrong. If you'd like to ask for a copy of your information, or to have it corrected, please contact us at ElectricityRMA@mbie.govt.nz.

12 May 2023
Document: 3172520

Electricity RMA Project Team
MBIE Energy & Resource Markets
25 The Terrace, Wellington 6011

Submission on strengthening national direction on renewable electricity generation and electricity transmission

The Taranaki Regional Council (TRC) supports the overarching intent of the proposals. This includes providing a more consistent and efficient consenting process, better management of competing interests, and better provision for Māori interests. It is undeniable that the country needs to significantly expand its renewable electricity generation and accompanying transmission if we are to meet our climate change mitigation goals.

Further, we support providing this improved framework through priority amendments to the National Policy Statement (NPS) on Renewable Electricity Generation (REG) and the NPS on Electricity Transmission (ET). We agree accompanying National Environmental Standards should be progressed in slower time.

Overall, we consider the changes proposed would provide a more consistent and efficient consenting process in many regards. Most notably through the high-level application of the effects management hierarchy and a policy framework that would flow through to consistent activity statuses and matters of control or discretion.

However, the proposed framework is complex, requiring multiple tests and assessments where sufficient detail or guidance is currently lacking. Without such detail or guidance, the changes risk placing a significant interpretive burden on local government, which would likely be applied differently council to council. This undermines the intent of more consistent and efficient consenting processes. This detail or guidance could either be provided through further detail in the NPSs themselves, or through the release of non-statutory guidance prior to when regional policy statements must be updated.

Key matters needing further clarification include:

- Where the burden falls for demonstrating a given step in the management hierarchy has been applied to 'the extent practicable' and what must be considered when determining if this test has been passed. Defining what is and is not economically practicable is particularly important.

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- If consideration of 'operational or functional need' requires consideration of alternative development locations outside the district or region, and if so, how to do this.
- How to determine the national significance of an activity and balance this against residual adverse effects.

While these considerations are not necessarily novel, it is important to guide their application specifically in the context of REG and ET.

Noting the importance of facilitating increased renewable electricity generation and associated transmission, TRC supports the application of a bespoke effects management hierarchy on these matters. But we note that this comes at the cost of a more complex overall resource management regime. Such carve outs cannot become the norm.

On the two options for a bespoke hierarchy, Option 2A or Option 2B, TRC supports the former and opposes the latter. Irrespective of potential national benefits, councils should retain the ability to avoid adverse effects on all areas with significant environmental values, not just significant natural areas. The importance of this is demonstrated particularly with regard to sites of significance to Māori. It is difficult to see how Option 2B, where REG or ET activities could potentially be enabled even where they would destroy a wāhi tapu site, would be consistent with proposed Policy 3 and its requirement to protect sites of significance to Māori. It is appropriate that the development of any more permissive approach in a district or region go through a Schedule 1 process.

Finally, TRC supports the proposed implementation approach. This is that policies must be included in regional policy statements under section 55(2A) within six months, but consequential changes in other planning documents will occur when they are next reviewed. This approach balances the need to start the ball rolling on scaling up the provision of renewable electricity generation, while not overly burdening local government with additional requirements at an already challenging time.

Detailed comments, including some matters not raised in this letter, are included in Appendix One.

This content of this submission will be formally considered by the TRC Planning and Policy Committee on 6 June 2023. Any comments or amendments from the Committee will be provided to the Electricity RMA Project Team after that meeting.

Yours faithfully

S J Ruru
Chief Executive

Appendix One: Detailed Comments

Proposed National Policy Statement for Renewable Electricity Generation			
#	**Section**	**Rationale**	**Remedy Sort**
1	Community and small-scale REG definitions, Policy 6 and 3.8	The current interaction between these definitions, Policy 6, and the draft rule structure set out creates an inconsistency: • the intent stated in the document is that some community or small scale REG generation should not be a permitted or controlled activity; e.g., wind turbines over 30m high or where there are more than three turbines on a site; • Policy 6 (and associated policy 3.8) requires avoidance, mitigation and remediation only to the extent practicable; • 'extent practicable' presupposes that an activity can still occur even if there are remaining adverse effects; • therefore, an example wind turbine over 30m high would likely have to be effectively treated as a controlled activity, even if it had a restricted discretionary rule classification. This inconsistency may be able to be addressed by amending the definitions of community and small-scale REG to include specific technical limits (e.g. wind turbines must be no higher than 30m). However this would result in a highly technical definition. Alternatively, consideration generally needs to be given to a policy framework that will allow for restricted discretionary status for some community and small-scale REG activities.	Consideration be given to those matters raised in the rationale.
2	1.4(1) and 1.4(2)	There are situations where the development of wind or solar facilities could impact natural inland wetlands and thus bring this NPS into	Amend 1.4(1) as follows:

		conflict with the NPS for freshwater management. In these situations, the freshwater NPS should prevail.	In relation to the development, operation, maintenance, and upgrade of hydroelectricity generation assets, or potential loss of natural inland wetlands from any REG activity, the National Policy Statement for Freshwater Management 2020 prevails over the provisions of this National Policy Statement if there is conflict between them.
3	2.2 Policy 4	We support the intent of the policy but note it does not adequately reflect the requirement to avoid REG activities that have residual significant adverse effects after applying the effects management hierarchy set out in 3.6(1). Further, we note that any amendment to address this would have to be drafted depending on if Option 2A or 2B are adopted under clause 3.6(1).	Insert the below policy above the current Policy 4: If Option 2A: REG activities are avoided if, after applying the effects management hierarchy, the residual adverse effects on areas with significant environmental values are significant. If Option 2B: REG activities are avoided if, after applying the effects management hierarchy, the residual adverse effects on a significant natural area are significant.
4	2.2 Policy 4	Current drafting does not specifically capture situations where a REG activity would affect an area with significant environmental values without the activity itself occurring in those areas. It potentially creates a regime where development within an area is more permissive than an area adjacent to it.	Consideration be given to amended drafting that ensures adverse effects on areas with significant environmental values from nearby REG activities are not excluded.
5	Policy 5	To reflect #4 above, consequential amendments are also required to Policy 5.	Refer #4.
6	3.4(c)	It is unclear if the reference to future REG activities in 3.4(c) refers to potential activities specific to those REG assets under consideration or all potential REG activities that might take place in a district or region	Clarification be provided on what REG assets 3.4(c) applies to and consideration be given to

		in the future. Regardless, both are broad and problematic considerations where it would be particularly difficult to determine how much land is required to give effect to future REG development (operation, maintenance or upgrading is more manageable).	how the requirement to assess future REG development could be given effect to.
7	3.6(1)	Refer #4.	Refer #4.
8	3.6(1)(a)	It is unclear if in determining what constitutes an operational or functional need, councils must consider potential alternative locations outside the region or district. For any given REG asset there is likely a rationale that it *could* be located at an alternative location in the country. If that is the case, it is hard to argue that it *needs* to be located where they have applied.	Further consideration be given to how (1)(a) would be determined in practice and the potential for guidance to clarify this.
9	3.6(1)(f)	TRC supports Option 2A. Councils should retain the ability to decline an activity if it has significant adverse effects on all matters included in the definition of areas with significant environmental values. Only Option 2A provides for this. The imperative of this is demonstrated particularly with regard to sites of significance to Māori. It is difficult to see how Option 2B, where REG activities could potentially be enabled even where they would destroy a wāhi tapu site, would be consistent with Policy 3 and its requirement to protect sites of significance. It is important to note that a council could still adopt a more permissive policy more akin to Option 2B, but such a decision should go through a schedule 1 process.	Adopt Option 2A.

10	3.7(1)	Refer #4.	Refer #4.

Proposed National Policy Statement on Electricity Transmission			
#	**Section**	**Rationale**	**Remedy Sort**
10	1.4	There is the potential for conflict between this NPS and the freshwater NPS where the development of transmission infrastructure could lead to the loss of natural inland wetlands. In this circumstance, the freshwater NPS should prevail. Refer #2.	Include a new 1.4(2) as follows: In relation to the potential loss of any natural inland wetland from any ETN activity, the National Policy Statement for Freshwater Management 2020 prevails over the provisions of this National Policy Statement if there is conflict between them.
11	Policy 5	Refer #4.	Refer #4.
12	Policy 6	Refer #4.	Refer #4.
13	3.8(1)	Refer #4.	Refer #4.
14	3.8(1)	Refer #8.	Further consideration be given to how (1)(a) would be determined in practice and the potential for guidance to clarify this.
15	3.8(1)(f)	Refer #9.	Adopt Option 2A.
16	3.9(1)	Refer #4.	Amend 3.9(1) as follows: Refer #4.

Date 6 June 2023

Subject: **The Minister for the Environment's request for information on providing for vegetable production through regional plans**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3174168

Purpose

1. The purpose of this memorandum is to inform the Taranaki Regional Council (TRC) of the new requirement, under section 27 of the Resource Management Act 1991 (RMA), to carry out annual reporting to the Minister for the Environment on the Council's intention to provide for vegetable production within its review of the Freshwater Regional Plan.

Executive summary

2. On 4 April 2023, TRC received a letter from the Minister for the Environment, requesting annual reporting on Council's intentions to provide for vegetable production when developing a freshwater planning instrument that give effect to the National Policy Statement for Freshwater Management 2020 (NPS-FM).
3. The letter stipulates that the first annual report is to be provided to the Minister by 19 May 2023 and indicates that the reporting requirement is intended to cease after the submission of the final report in May 2025. This will also be after the Council has notified the Natural Resources Plan, including the regional plan for water.
4. The Minister has requested the same or similar information from other regional councils.
5. The report has been prepared by staff and submitted by the Chief Executive to the Minister in accordance with requirements.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum.

b) notes that the Minister for the Environment has requested annual reporting on the Taranaki Regional Councils intentions to provide for vegetable production when implementing the National Policy Statement for Freshwater Management 2020.

c) notes that the first report to the Minister has been prepared and submitted by the Chief Executive.

Background

6. On 4 April, TRC received a letter from the Minister, requesting information on Council's intentions to provide for vegetable production in Taranaki when developing regional plans that give effect to the NPS-FM. This letter is included as Attachment 1.
7. This information request, stems from growing uncertainty around how regional plans currently being developed will enable continuity and/or expansion for vegetable growing. The Minister expresses interest in developing greater understanding of the resilience of New Zealand's food production system in the face of population growth and climate change, while also recognising the potential impacts of these activities on the health of freshwater.
8. The first annual report is to be provided to the Minister by 19 May 2023, with annual reporting to be continued until May 2025.
9. The letter also details the expectations with respect to the type of information and level of detail that is to be provided within the annual reports. The reports are expected to:
   a) be brief;
   b) outline the rationale for any planning approaches and/or mechanisms developed by Council to manage or enable vegetable growing;
   c) explain how these approaches and/or mechanisms will enable:
      i. Vegetable growers to practice crop rotation; and
      ii. Expansion of the total production area.
10. Given the considerable work programme to implement the requirements of the NPS-FM and the likelihood that Council is still developing a policy approach, the letter acknowledges that the first annual report is not expected to outline any details on possible plan provisions. Further, the letter stipulates that any information provided to the Minister will not be shared beyond Ministry for the Environment and Ministry for Primary Industries officials (except where needed to meet statutory requirements).
11. Staff understand that the Minister has requested the same or similar information from other regional councils.

Discussion

12. Vegetable production is not currently a significant industry in Taranaki, our most dominate agricultural industry is dairy. However, it is an industry that is gaining interest as the region investigates ways to diversify and deliver sustainable land use practices. Venture Taranaki has recently developed a blueprint for the industry titled – *Grains, Legumes and Vegetables – the opportunity for Taranaki New Zealand*[1]. In this blueprint the opportunities, risk and sensitives to the establishment of the new industry are set out.

[1] Venture Taranaki – Branching Out, Grains, Legumes and Vegetables: The opportunity for Taranaki, June 2022

13. Whilst there is interest and suitability for vegetable production in Taranaki, it is not presenting as an immediate pressure, and a number of constraints will need to be investigated further before it becomes a more dominant industry.
14. The Council's Freshwater Planning process is well underway, however decisions on how different industries, such as vegetable production are dealt with within the future plan have not yet been finalised. As such, Council are unable to provide the Minister with a clear direction on what mechanisms will be applied.
15. There are key considerations when developing planning mechanisms that seek to manage land uses that will have potential impacts on water quality and quantity. These include those below, and are guiding policy development in this space:
    15.1. Work with key stakeholders which are looking to promote the production of vegetables. This will include the work that has already been done by Venture Taranaki.
    15.2. Managing impacts on water quality and water quantity to include the following aspects of Freshwater management:
    15.2.1. The fundamental concept of Te Mana o te Wai requires that the health and well-being of the water is protected, and human health needs are provided for before enabling other uses of water.
    15.2.2. Avoiding over-allocation in water quality and quantity and any existing over-allocation or degradation must be reversed or phased out.
    15.2.3. Land uses can be enabled provided they occur within the limits on resource use, the environmental flows and the take limits set within NPS-FM compliant planning instruments.
    15.3. The Freshwater Management Units that are likely to have the best soils for vegetable production are those with volcanic soils, namely the Volcanic Ring Plain and parts of Waitara and Patea FMU. Within these FMUs the impacts of nutrient enrichment and loads must be considered in stepping through the NOF process and achieving the national bottom line. Land use practice within these FMU will need to occur within the limits set to achieve or exceed the bottom line. Over the past 10 years nitrate concentrations have increased at state of the environment monitoring sites across Taranaki, and this will need to be addressed in implementing the NPS-FM.
    15.4. The role of global consents and management plans, as currently applied to other industries, may provide a way of managing and providing for the practice of crop rotation and moving production and associated discharges from one property to another.
16. In addition to the specific considerations identified above, staff are also working through whether there is value in managing particular industries separately or whether the most effective approach is to bundle a number of like activities together.
17. The first report to the Minister has been prepared by staff and submitted by the deadline of 19 May, which was prior to this June Committee meeting (Attachment 2). The correspondence to the Minister reflects the considerations outlined in this report and confirms the second report due, May 2024, will provide the Minister with clearer direction on the mechanisms being proposed. This is entirely a result of the policy development programme being further progressed at that point.

18. Whilst this is an additional reporting requirement for the Council, staff do not consider this to be an overly onerous task and future reporting can be adequately accommodated within the existing work programmes.

Financial considerations—LTP/Annual Plan

19. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.
20. The additional reporting is considered to be accommodated within existing work programme and resourcing.

Policy considerations

21. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.
22. The request from the Minister is made under section 27 of the RMA.

Iwi considerations

23. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.
24. The development of policy, of which will be the subject of future reporting requirements, is being undertaken with input from iwi supported by the Heads of Agreement for the Pou Taiao positions.

Community considerations

25. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

26. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 3175425: Letter from the Minister requesting reports on Vegetable production in future Freshwater Plans

Document 3173610 and 3172329: Letter and response report to Minister.

Hon David Parker BCom, LLB
Attorney-General
Minister for the Environment
Minister of Revenue
Associate Minister of Finance

COR4118

Chair and Councillors of Taranaki Regional Council

CC: Steve Ruru, CEO, Taranaki Regional Council

charlotte.littlewood@trc.govt.nz
steve.ruru@trc.govt.nz

Dear Charlotte Littlewood and Councillors

Information request – Taranaki Regional Council intentions to provide for vegetable production when implementing the National Policy Statement for Freshwater Management 2020 (NPS-FM)

Thank you for the recent Te Uru Kahika Progress Report on regional planning implementation of the NPS-FM. I am pleased to see steady progress is still being made towards notifying your plan no later than December 2024, despite the challenges outlined in the report.

Among other issues, this summer's extreme weather has highlighted the importance of a wide geographic distribution of fresh vegetable production so that New Zealanders can continue to access healthy food options at a reasonable cost. The resilience of our food system will no doubt continue to be tested as the effects of climate change gain severity.

There is uncertainty as to how plans currently in development under the NPS-FM will enable continuity for vegetable growing and expansion of the domestic supply in line with future growth of New Zealand's population. New Zealand's population is forecasted to grow 8% between 2023 and 2033.[1]

I am therefore requesting information on Taranaki Regional Council's intentions to provide for vegetable production in your region through your NPS-FM freshwater management planning instruments (land and water plans). Please include the rationale for your approach.

The information provided should include details about any mechanisms the Council is developing that enable:

- vegetable growers to practice crop rotation, moving their production (and associated discharges) from one property to another – for example allowing a grower to lease land in different properties within a freshwater management unit;
- an expansion of the total area of production – noting this will almost certainly lead to an increase in Nitrogen-related discharges, and potentially other discharges, from new land brought into vegetable production.

[1] StatsNZ projections 2022 - 2073 - available at https://www.stats.govt.nz/information-releases/national-population-projections-2022base2073/#:~:text=New%20Zealand's%20population%20(5.13%20million,and%205.85%20million%20in%202033.

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I would like to keep the reporting burden to a minimum. My expectation is that the information will be brief, but specific enough to understand whether and how the Council is intending to provide for the matters outlined above.

I acknowledge that the first report date is too early in plan development for specific details on possible plan provisions and understand any proposals need to be thoroughly tested with your community. However, please respond with your intended approach on the basis of currently available knowledge. If the Council has any queries about what reporting is required, please contact Bryan Smith through email bryan.smith@mfe.govt.nz or phone 027 5183327.

My request is in accordance with section 27 of the Resource Management Act 1991 (RMA). The first report is required by 19 May 2023, with reporting to continue on annual basis until 19 May 2025, with a view to capturing any further decisions and their rationale made in the intervening period. Officials will follow up with Council staff after reports are received should any clarification be needed.

I appreciate the sensitivities involved in this early phase of your regional freshwater management planning process. The information will not be shared beyond the cross-agency project team (Ministry for Environment and Ministry for Primary Industries officials), except where needed to meet statutory requirements, such as under the Official Information Act 1982.

Yours sincerely

Hon David Parker
Minister for the Environment

17 May 2023
Document: 3173610

Hon David Parker, Minister for the Environmnet
Private Bag 18041
Parliament Buildings
Wellington 6160
NEW ZEALAND

Dear Minister

Taranaki Regional Council response to request for vegetable production policy provisions

Please refer to your letter received on 4 April 2023 (ref:COR4118) requesting the Council to provide you with a report on how vegetable production is being provided for in the implementation of the NPS-FM.

As the Council are still in the process of investigating policy options for implementing the NPSFM, we are unable to provide clear direction as to the mechanisms which will be part of any update to the Regional Plan for Water. However, attached is a short report providing an overview of the small vegetable production industry in Taranaki and the considerations which are being explored in our potential policy development options.

Should you require any further information on this matter please contact Lisa Hawkins Policy Manager – lisa.hawkins@trc.govt.nz

Yours faithfully

S J Ruru
Chief Executive

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Taranaki Regional Council

Approach to provide for vegetable production when implementing National Policy Statement Freshwater Management 2020

May 2023

Introduction

This report has been prepared in response to the request from the Minister for the Environment, the Hon David Parker, to Council to identify the approach being taken to provide for vegetable production in future freshwater management.

We note the request for this information is in response to questions around the resilience of New Zealand's' food system in light of recent natural disaster events. The resilience will no doubt continue to be tested as the effects of climate change gain severity.

Overview

Vegetable production is not currently a significant industry in Taranaki, our most dominate agricultural industry is dairy. However, it is an industry that is gaining interest as the region investigates ways to diversify and deliver sustainable land use practices.

A blueprint titled – *Grains, Legumes and Vegetables – the opportunity for Taranaki New Zealand*[1], was prepared in 2022 by Venture Taranaki. This included partners – Ministry for Primary Industries, New Plymouth District Council, South Taranaki District Council and Stratford District Council. The blue print investigates options and potential best practice approaches to support diversifying into grains, legumes and vegetables. The blue print acknowledges the climate, soils and topography of Taranaki do lend themselves favourably to the establishment of the industry in selected areas, but there are a number of risks and sensitivities to the establishment of the new industry. These include:

- Ensuring a sustainable crop system is achieved – ie the right crop for the right location and rotation.
- Ensuring infrastructure provision to support, store and handle any crop is in place. There are limited existing facilities in the region, and this will likely require significant investment.
- Challenges to support labour demand and requirements across the seasons.

Whilst there is interest and suitability for vegetable production in Taranaki, it is not presenting as an immediate pressure, and a number of constraints will need to be investigated further before it becomes a more dominant industry.

Policy response

The information provided below is done within the context that Council is in the process of implementing the NPS-FM through policy development. The current work programme is largely focussed around setting baselines, attributes and target attribute states in line with the National Objective Framework (NOF). The Council are therefore at an early stage of developing policy and investigating approaches which may to apply to any specific industry.

[1] Venture Taranaki – Branching Out, Grains, Legumes and Vegetables: The opportunity for Taranaki, June 2022

As such, Council is are unable to provide specific details about any mechanisms we are progressing, rather the following considerations can be identified as guiding policy development:

- Work with key stakeholders which are looking to promote the production of vegetables. This will include the work that has already been done by Venture Taranaki.
- Managing impacts on water quality and water quantity to include the following aspects of Freshwater management:
    - The fundamental concept of Te Mana o te Wai requires that the health and well-being of the water is protected, and human health needs are provided for before enabling other uses of water.
    - Avoiding over-allocation in water quality and quantity and any existing over-allocation or degradation must be reversed or phased out.
    - Land uses can be enabled provided they occur within the limits on resource use, the environmental flows and the take limits set within NPS-FM compliant planning instruments.
- The Freshwater Management Units that are likely to have the best soils for vegetable production are those with volcanic soils, namely the Volcanic Ring Plain and parts of Waitara and Patea FMU. Within these FMUs the impacts of nutrient enrichment and loads must be considered in stepping through the NOF process and achieving the national bottom line. Land use practice within these FMU will need to occur within the limits set to achieve or exceed the bottom line. Over the past 10 years nitrate concentrations have increased at state of the environment monitoring sites across Taranaki, and this will need to be addressed in implementing the NPS-FM.
- The role of global consents and management plans, as currently applied to other industries, may provide a way of managing and providing for the practice of crop rotation and moving production and associated discharges from one property to another.

In addition to the specific considerations identified above, consideration is being given to whether there is value in managing particular industries separately or whether the most effective approach is to bundle a number of like activities together.

Annual reporting

At the next reporting cycle requested by the Minister (May 2024) Council will be further progressed in its policy development. Therefore, Council anticipates being able to provide a much clearer response as to the policy approach being taken as it applies to vegetable production in Taranaki.

Date 6 June 2023

Subject: **Regional Policy Statement – Resource management issues**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3169513

Purpose

1. The purpose of this memorandum is to present the draft Regional Policy Statement issues for the region, which informs the development of the *Regional Policy Statement for Taranaki* and the broader *Natural Resources Plan*.

Executive summary

2. The development of the RPS and the Natural Resources Plan requires two resource management issues chapters to be drafted in accordance with the National Planning Standards:

   - 'SRMR – Significant resource management issues for the region'; and
   - 'RMIA – Resource management issues of significance to iwi authorities'.

3. Existing issues statements in the current RPS have been reviewed and require updating to fit current planning practice and to align with requirements under the National Planning Standards.
4. The policy team and the Pou Taiao have undertaken respective issues identification and development processes, including internal and external workshopping to draft updated issues statements which are included at attachment 1 and 2.
5. The updated issues statements are framed as problem statements to highlight the resource management challenges. Their purpose is to identify the issue and to not identify resource management solutions or desired outcomes. The issue statements are supported by explanations that provide the regional context and background.
6. The issues will be further socialized during engagement and plan development. As a result, the statements may be further refined during the development of the Natural Resources Plan.
7. Any revisions will be brought back to Council for endorsement and approval as part of the final policy package prior to notification at the end of 2024.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum titled *Regional Policy Statement – Resource management issues*;

b) notes that these issues are draft until the Natural Resources Plan is notified by the Council (end 2024) and are subject to refinement through the Councils plan development process and feedback from stakeholders;

c) notes that issues are mandatory provisions for the RPS under the RMA and have been prepared in accordance with RMA, National Planning Standards and current plan drafting practice;

d) notes that the issues of significance to iwi authorities has been prepared by Ngā Iwi o Taranaki through the Pou Taiao under the Heads of Agreement;

e) notes that the Council will be presented these issues, and any updates to them, for their endorsement in 2023 prior to consultation on the draft Natural Resources Plan and again prior to formal notification of the Proposed Natural Resources Plan.

Background

8. In September 2020, the Council approved the review of the Regional Policy Statement for Taranaki 2010 (the RPS). The RPS will form part of the combined Natural Resources Plan (NRP), which will also include the Regional Freshwater Plan, the Regional Soil Plan and the Regional Air Quality Plan. The Coastal Plan will sit as a separate document from the Natural Resources Plan.

9. Section 59 of the Resource Management Act 1991 (RMA) sets out that:

   The purpose of a regional policy statement is to achieve the purpose of the Act by providing an overview of the resource management issues of the region and policies and methods to achieve integrated management of the natural and physical resources of the whole region.

10. Section 62 of the RMA provides explicit direction to identify issues within the RPS:

    (1) A regional policy statement must state–

    (a) the significant resource management issues for the region; and

    (b) the resource management issues of significance to iwi authorities in the region; and [...]

11. All regional and district plans are required to 'give effect' to the RPS.

12. As noted in the purpose of the RPS, a key element is the identification of resource management issues for the region. Other regional and district plans are not required to identify issues.

13. Direction for the preparation of RPS issues is included in the National Planning Standards, which was introduced in 2019 to enable national consistency for the structure, content and form of council plans.

14. Under the National Planning Standards, the Council is required to include two chapters addressing issues of regional significance:

    - 'SRMR – Significant resource management issues for the region'; and
    - 'RMIA – Resource management issues of significance to iwi authorities'.

15. The 'SRMR – Significant resource management issues for the region' are generally comparable with issues traditionally included in RPS documents. The current RPS does

contain issues of significance to iwi, however the directions of the planning standards and current planning practice elevates issues of significance to iwi so that they stand separately but alongside the other resource management issues for the region.

Drafting approach

16. The current RPS identifies 27 issues for the region and 7 issues of significance to iwi. A number of existing regional plans also identify additional issues that do not directly align with the existing RPS issues and the relationship between these provisions can create confusion.
17. Some of the benefits sought with the review of issues includes:
    - a reduction in the duplication of provisions across different planning documents;
    - the opportunity for more directive reflection of challenges to resource management in Taranaki;
    - elevation of issues of iwi authorities which is located in Part C of the current RPS and generally separate from the regional issues and provisions to address those issues; and
    - enhanced expression of te ao Māori perspectives in the RPS through the identification and drafting of RMIA issues.
18. As such, the drafting approach for the NRP is to only identify issues at the RPS level, and to, where appropriate, reduce the number of issues by bundling like and interrelated issues together. Further, what is meant by 'regional significance' has been clarified with the use of a regional significance criteria which has been employed in the development of each issue statement. The majority of the draft issues trigger multiple significance criteria.
19. Issues of regional significance include issues that are:
    - regionally specific;
    - of widespread public interest;
    - related to resources that are of an elevated local significance or are locally rare;
    - related to cross boundary issues;
    - related to the views of tangata whenua;
    - related to a significant resource use; and/or
    - related to cumulative effects.
20. As assessment of the existing issues statements against current planning theory and recently notified RPS's of other regional councils has resulted in the adoption of a more direct drafting. In some instances, the current RPS issues set out the management approach as the issue. The problem with this is that it does not enable appropriate exploration of the drivers and connections contributing to an issue to inform a subsequent management approach. The draft issues exclusively identify the resource management problem and interrelated issues without eluding to a management approach or desired outcome. As a result, the draft issues read very differently from those in the operative RPS and are inherently 'problem statements' to put the spotlight on the issue in advance of providing a management solution.
21. Issues are structured to set out a 'issues statement' that clearly and concisely summarises the resource management issue, this is supported by the 'explanation of the issues' which provides the context, background and other flow on effects or concerns associated with the issue.

22. Key to the preparation of a reduced number of issues statements is the recognition that the statements across both issues chapters are interrelated and that all issues need to be read together as a suite. This aligns with the integrated management approach and recognises the principle of 'ki uta ki tai' (from source to sea).

SRMR – Significant Resource Management Issues for the Region

23. The policy team, with assistance from internal technical experts, Pou Taiao and the Local Government Working Group[1], have prepared a first draft of 'SRMR – Significant Resource Management Issues for the Region' (included at attachment 1). The issues statements were presented and discussed with iwi planners and representatives of the freshwater wananga group run by the Pou Taiao as well as presented at a combined information session of Policy and Planning committee members and Iwi Chairs on the 3rd of April.

24. There are 12 'SRMR - Significant Resource Management Issues for the Region' identified for the Draft RPS:

- **SRMR–I1 Rate and complexity of change** – The well-being of communities is under pressure from the rate and complexity of regulatory, environmental, economic and social change.
- **SRMR–I2 Tangata whenua relationship with te taiao** – The relationship of tangata whenua with te taiao (the environment) including their ancestral lands, waters, sites, waahi tapu and other taonga has been negatively impacted.
- **SRMR–I3 Climate change** - Climate change and its impacts, including increasing natural hazards, are occurring and will increase over time.
- **SRMR–I4 Management within limits** - The use and development of resources without environmental bottom lines has resulted in cumulative and significant adverse effects on the environment.
- **SRMR–I5 Freshwater availability -** Freshwater use exceeds availability in localised areas, resulting in insufficient quantities of freshwater to provide for the health and well-being of the environment and risking water security for human health.
- **SRMR–I6 Contaminants to land and freshwater** - Discharges of contaminants to land and freshwater have resulted in significant degradation of the environment, risks to human health and subsequent restrictions on use and enjoyment.
- **SRMR–I7 Coastal water quality** - Coastal water quality has become degraded in localised areas and is under threat in other areas resulting in environmental and human health impacts and subsequent restrictions on use.
- **SRMR–I8 Development -** Constraints on development are creating additional pressures on housing, business, industry and infrastructure for meeting current and future needs of our region.
- **SRMR–I9 Biodiversity -** Biodiversity is fragmented and degraded and some species, habitats and ecosystems are at risk of being lost.

[1] Liam Dagg and Jessica Sorensen (South Taranaki District Council); Blair Sutherland (Stratford District Council); Juliet Johnson and Denise Young (New Plymouth District Council).

- **SRMR–I10 Wetlands** - Once prevalent wetland habitats have become significantly reduced and remaining wetlands continue to experience a loss of values and extent.
- **SRMR–I11 Historic heritage** - Historic heritage and associated values are not consistently identified and are at risk of being damaged, destroyed or lost.
- **SRMR–I12 Outstanding natural features and landscapes -** The outstanding and significant natural values of the region are not consistently identified and have been degraded or are under threat.

25. A number of issues statements and their explanations may need to be refined or updated over the course of the plan development as more information becomes available or through feedback from engagement. For example in relation to water availability, the issue reflects existing limits and bottom lines, however, over the course of working through updated limit and target setting under the National Objectives Framework, additional catchments may be identified as being under pressure and require acknowledgement in the issues statements.

RMIA – Resource management issues of significance to iwi authorities

26. Ngā Iwi o Taranaki through the Pou Taiao under the Heads of Agreement have prepared a first draft for the 'RMIA – Resource Management Issues of Significance to Iwi Authorities' (included at attachment 2). The issues of significance to iwi authorities were informed by existing iwi environmental management plans and conversations with iwi authorities. Draft issues statements drafted by Pou Taiao were circulated with and refined by iwi authorities' kaimahi before being shared with council officers in a position statement under the Heads of Agreement.
27. The 'RMIA – Resource management issues of significance to iwi authorities' are bundled into 6 main headings:

Wai Māori

- **RMIA-WAI–I1** The loss and degradation of water resources through drainage, abstraction, pollution, modification, and damming has resulted in material and cultural deprivation for tangata whenua.
- **RMIA-WAI-I2** Current water management does not adequately address tangata whenua values and interests.
- **RMIA-WAI-I3** The effects of land and water use activities on freshwater habitats have resulted in adverse effects on the diversity and abundance of mahinga kai resources and harvesting activity.
- **RMIA-WAI-I4** Effective participation of tangata whenua in freshwater management is hampered by poor recognition of Mātauranga.
- **RMIA-WAI-I5** Poor integration of water management, across agencies and across a catchment, hinders effective and holistic freshwater management.

Mahinga kai and biodiversity

- **RMIA-MKB-I1** The diversity and abundance of terrestrial and aquatic indigenous species has been reduced due to adverse effects of resource use and development.
- **RMIA-MKB-I2** Regulatory and physical barriers (including barriers to fish passage) have impeded the ability of tangata whenua to access mahinga kai and to undertake customary harvest.

- **RMIA-MKB-I3** Impacts of climate change on both species/habitat viability and increasing pest (flora/fauna) encroachments.
- **RMIA-MKB-I4** Shortage of protected and secure areas for biodiversity.
- **RMIA-MKB-I5** Inconsistent approaches to biodiversity protection amongst regulatory authorities.
- **RMIA-MKB-I6** Lack of information on species health and viability.
- **RMIA–MKB-I7** The preference toward ecological criteria and the lack of provision for Mātauranga Māori criteria to identify significant natural areas.

Wāhi Tupuna

- **RMIA–WTU-I1** The values of wāhi tūpuna are poorly recognised in resource management in Taranaki.

Wāhi tapu and wāhi taonga

- **RMIA-WTA-I1** Land use activities have resulted in disturbance and degradation of wāhi tapu and wāhi taonga sites and the values associated with these areas.
- **RMIA-WTA-I2** Access to wāhi tapu and wāhi taonga and the ability of tangata whenua to undertake activities on these sites has been impeded.

Air and atmosphere

- **RMIA-AA-I1** The impacts of discharges to air are poorly recognised in resource management.

Coastal environment (Taku tai moana me te wai Māori)

- **RMIA-CE-I1** Mahinga kai and coastal systems are adversely affected by lack of integrated management across the land-water interface.
- **RMIA-CE-I2** Discharges into coastal waters and marine dumping of waste degrade mahinga kai and the mauri of the waters.
- **RMIA-CE-I3** The ability for tangata whenua to access and harvest kaimoana has been impeded by the effects of activities in the coastal and marine environment.
- **RMIA-CE-I4** Habitat disturbance and modification has contributed to decline in populations of indigenous marine species, including marine mammals.
- **RMIA-CE-I5** Wāhi tapu and wāhi tūpuna values in the coastal environment are poorly recognised and protected.

Governance, partnership and decision-making

- **RMIA-GOV-I1** Wāhi tapu and wāhi tūpuna values in the coastal environment are poorly recognised and protected.
- **RMIA-GOV-I2** Duplication, inconsistencies, and siloed approaches do not result in desired outcomes.

28. Many of the issues identified in this chapter align with or reflect elements identified in the 'SRMR - Significant Resource Management Issues for the Region' chapter. The inclusion of this chapter provides an opportunity for the Natural Resources Plan to ensure that tangata whenua views and perspectives are recognised in the planning

context, assists in enabling kaitiakitanga, and assists the Council in giving effect to the principles of Te Tiriti.

29. Despite being in separate chapters, as required under the National Planning Standards, there is considerable alignment and overlap between the two sets of issues statements.

Next steps

30. Both sets of issues statements will guide the development of provisions (both regulatory and non-regulatory) within the RPS. This will in turn guide the development of the air land and freshwater rules and policies to assist consenting activities. The development and refinement of provisions, including issues statements, in the Natural Resources Plan will be ongoing until notification at the end of 2024.
31. Council officers will be adding this agenda memorandum, including its attachments, to the Natural Resources Plan website and feedback on the issues statements can be provided to the policy team during the plan development process. In addition, Council officers will be drawing on these issue statements during targeted consultation across 2023 and gathering and responding to any feedback received on the statements. As such, the issues statements and explanations may be refined over time.
32. Likewise, the 'RMIA – Resource management issues of significance to iwi authorities' may be updated or amended by Ngā Iwi o Taranaki through the Pou Taiao in a similar manner.
33. Both sets of issues statements, including any refinements will be brought back to the Policy and Planning Committee for endorsement and approval prior to public notification towards the end of 2024.

Financial considerations—LTP/Annual Plan

34. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

35. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

36. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.
37. The work undertaken by Pou Taiao with ngā iwi o Taranaki is a specific deliverable under clause K of the Heads of Agreement [Agreements Under this Heads of Agreement] to facilitate iwi participation and collaboration on the development of the

Natural Resources Plan and build partnership relationships between the Council and tangata whenua.

Community considerations

38. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

39. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 3172739: SRMR – Significant resource management issues for the region

Document 3173713: RMIA – Resource management issues for iwi authorities

SRIR – Significant Resource Management Issues for the Region

This section identifies the Significant Resource Management Issues for the Region which are responded to in the objectives, policies and methods in the domains and topics sections of Part 2 of the Plan.

Introduction

The RPS identifies 12 issues of regional significance that are impacting Taranaki and which the objective, policies and methods will provide direction on. Many of these issues have been prepared from an integrated perspective that brings together a number of interrelated and complex problems, while others are limited to specific resource management topics.

Despite each issue being set out individually, the Natural Resources Plan considers and responds to the suite of issues in a joined-up manner as part of a complex system. None of these issues should be read in isolation and the suite should be considered as a package including the issues identified in RMIA - Resource Management Issues of Significance to Iwi authorities (link). Likewise, no specific chapter sets out all of the management responses required to address a single issue.

The issues have been prepared to set out:

- an issue statement that summarises the problem facing Taranaki; and
- an explanation of the statement which provides the broader context and expression of the issue in Taranaki.

Significant Resource Management Issues for the Region

SRMR-I1 Rate and complexity of change

The well-being of communities is under pressure from the rate and complexity of regulatory, environmental, economic and social change.

Explanation of the issue

Taranaki is within a period of significant adjustment which is being driven by a number of regulatory, environmental, economic and social change factors. At one level, legislative reforms are driving changes to the way resource management is undertaken and the values underpinning resource management decisions. This has wide ranging implications from environmental changes as new expectations and targets are set, to economic changes as industries and regulators respond to new resource management requirements including an expected new system going forward. Legislative change also flows through to the social and economic well-beings of communities as the changes ultimately affect how people make a living, support their families and make decisions on where to live according to the job availability, housing availability, physical and social infrastructure availability (including transport networks) and other lifestyle choices.

At the social level, industries are being encouraged to shift towards more sustainable options and there is greater social demand for positive environmental outcomes to be achieved in the operation of industries. As a result of changing social values, some industries and activities no longer have, or are losing social licence to operate within the region. Significant changes are ahead for one of the region's most dominant industries, oil and gas production, and sustainably managing future use will need to be addressed. These challenges are likely to induce additional economic uncertainty which will create additional challenges as the region progresses towards an equitable and just transition in response to climate change adaptation.

Changes are also expected of individuals across other areas of their lives as people are being encouraged to cut down on personal emissions, reduce vehicle kilometres travelled, shift to low-emission transport modes and consider more efficient use of natural resources in response to climate change. Awareness of climate change impacts and increasing natural hazard risks is also creating a shift. As a result, more rigorous measure to minimise risks to people and the environment are coming into play and affecting where and how activities can take place.

Change is unlikely to be felt in a consistent way across the region or across society. For some communities or industries, this period of transition is compounded where a number of change factors are occurring concurrently and/or together within

localised areas. The other SRMR issues and resulting policy directions will also affect different communities and areas of society at different rates and at different time scales as a result of vulnerability and change intensity. This issue recognises that for change to be meaningful and not cause undue harm across multiple well-beings, it must be tempered to the tolerances of and ability of communities (including opportunities of assistance) to move with and implement change.

SRMR-I2 Tangata whenua relationship with te taiao

The relationship of tangata whenua with te taiao (the environment) including their ancestral lands, waters, sites, waahi tapu and other taonga has been negatively impacted.

Explanation of the issue

Tangata whenua have a long held relationship with all elements of te taiao. This relationship has been damaged and eroded through the effects of colonisation and a lack of awareness and understanding for te Ao Māori (the Māori worldview) in resource management. As such, the right to be involved in, or influence decision making through Rangatiratanga and the ability to exercise and practice Kaitiakitanga in relation to te taiao has been prevented.

Activities and use of resources across the region have contributed to negative impacts on the relationship of tangata whenua with te taiao through the degradation of mauri, loss of access to resources and sites and areas of significance to Māori and the resulting loss of cultural knowledge and Mātauranga Māori practices. Sites and areas of significance to Māori and the associated values have been damaged and destroyed, and are continuing to be under threat due to a lack of awareness, identification and direction for protection. The broader cultural landscapes and features within which these sites are located are not recognised or provided for. Taonga species and the habitats of indigenous flora and fauna are damaged, degraded or destroyed.

SRMR-I3 Climate change

Climate change and its impacts, including increasing natural hazards, are occurring and will increase over time.

Explanation of the issue

Climate change is one of the defining issues of our time. Over the next years and decades, the region will be faced with exceptional environmental change resulting from global warming.

For Taranaki, climate change is expected to bring about an increase in hot days and a decrease in frost days with annual average maximum temperatures expected to increase between 0.5 and 1.5°C by 2040. Over the next several decades, effects on human, animal, flora and fauna health are expected to be seen as a result of increasing temperatures and changes in weather patterns.

Drought potential is expected to increase across the region with more frequent and severe drought conditions putting increased pressure on primary industries. Increased fire risk and longer fire seasons are also projected due to amplified fire ignition conditions.

Despite warming trends, rainfall is expected to increase for most of the region with increasing seasonal variation and more extreme rainfall events projected. The increase in rainfall intensity is likely to cause soil saturation resulting in issues for the agricultural sector and an increase in soil erosion and landslide risk in the Taranaki Hill Country. Increased rainfall intensity will also increase the risk of flooding and associated damage to infrastructure. In many areas of the region, structures such as culverts and piped streams may not be able to safely withstand extreme rainfall events and high stream flows and existing flood control mechanisms will be put under increasing pressure.

Mean annual low flow (MALF) magnitudes in rivers and streams are expected to decrease for most catchments. A decrease in MALF of up to 50% is expected for most of the river systems across the region adding further pressures on indigenous biodiversity, ecosystems and industry as less water becomes readily available during the summer months.

The regions highly sensitive Wetlands will be amongst the most threatened ecosystems. The combined effects of changes to rainfall patterns, drought and surface and groundwater hydrology will further threaten wetlands and the species dependent on these habitats. Forests (both native and agricultural forestry species) will be impacted by either shorter or longer growing seasons, changes in forest biodiversity (including macro and microbiota), pests and disease dynamics as well as increased

bushfire frequency. Pest species are likely to move to new habitat areas, and insect pest species may become more prolific due to increased temperatures and a reduction in cold stress.

At the coast, rising sea levels are already being observed with an average increase of 4.0 mm/year, just slightly below the national average of 4.4 mm/year. Ongoing sea-level rise is likely to increase the exposure of infrastructure and coastal communities to extreme coastal flooding, as well as cause habitat loss at the coastal margins where ecosystems are not able to move further inland (coastal squeeze). Coastal wetlands will be at risk from inundation and erosion, and changes in groundwater salinity which may impact the distribution and assemblage of species.

Ocean acidification and warming seas is a global issue and will ultimately degrade the quality of our coastal waters and have long-term detrimental effects on environmental well-being, biodiversity and food security.

Climate change may also have a reducing effect on existing and future mitigations to address environmental degradation, meaning that additional work and funding may be required going forward.

SRMR-I4 Management within limits

The use and development of resources without environmental bottom lines has resulted in cumulative and significant adverse effects on the environment.

Explanation of the issue

Effects management approaches have traditionally been the main tool employed in the management of the region's air, freshwater, land and coastal resources. Under this framework, objectives identify the environmental and developmental goals for the region which are supported by policies that set out the directions expected to achieve the objective.

Generally, effects based management practices consider whether and how an activity should be undertaken on a case-by-case basis, and is typically enabling of use and development. However this approach does not easily account for the holistic nature of people and the environment, set limits for protection or manage cumulative effects. As a result, key values susceptible or sensitive to certain activities have been negatively impacted and the regions receiving environments across all environmental domains are degraded, degrading or at risk of future degradation. Some of these impacts are a result of legacy issues, and may continue to be so for future generations.

The long term environmental, economic and social well-being of the region relies on a policy framework that provides strategic direction for use, development and protection of resources, and with this, clear outcomes that are supported and endorsed by the community.

Many of the subsequent issues in this chapter speak to and identify key elements which can be traced back to this overarching issue.

SRMR-I5 Freshwater availability

Freshwater use exceeds availability in localised areas, resulting in insufficient quantities of freshwater to provide for the health and well-being of the environment and risking water security for human health.

Evidence of the Issue

The collective impact of permitted and consented freshwater takes amasses pressure upon surface water and groundwater quantity throughout the region. Freshwater is taken for a range of purposes including public supply, irrigation, stock and farm use, hydroelectric power generation, industrial manufacturing and processing and for other purposes.

In Taranaki only 4% of consented surface water takes are used for consumptive purposes where the water taken is not returned to the waterway. Although this may seem minimal, water takes, consumptive and non-consumptive, are commonly sourced from the same six catchments placing localised pressure on these rivers and streams. The catchments under the greatest pressure are Waiwhakaiho, Waitara, Tāngāhoe, Kaūpokonui, Waitōtara and Pātea Rivers. These six catchments provide 49% of all the surface water consented for consumptive use.

For river management purposes river flows are described using statistics known as mean annual low flow (MALF) which is the lowest flow recorded each year at a site averaged across recorded years. Low flow generally occurs during the summer months

when pressures placed on surface water quantity are at their greatest due to dry conditions and increased consumptive water use. If the flow becomes too low, the catchment will not be able to maintain its natural character, ecosystem health or provide for the health, economic or social needs of people.

Regionally, surface water use has increased over time, placing greater pressure on river flows and MALF. The resilience and well-being of each river or stream is placed under greater jeopardy each time a percentage of its MALF is allocated for the taking of water. There is an increasing number of catchments where a significant percentage of MALF has been allocated for consented surface water takes. Trends like this indicate mounting pressure is being placed upon water availability throughout the region.

Additionally, water allocation data held by the Council for both surface water and groundwater excludes any record of permitted water takes or their cumulative impact on each catchment or aquifer. The Council is therefore unable to reliably estimate the total number of surface and groundwater takes or the accumulative magnitude of these abstractions. It is expected that the cumulative impact of permitted and non-consented water takes abstract a significant additional percentage of surface water MALF during the summer months where water take demand is high yet rainfall is low.

Going forward, climate change will exacerbate and multiply water allocation challenges. By the late century surface water MALF is expected to reduce by up to 50% for most river systems in Taranaki placing additional pressure on surface water and groundwater availability for all uses.

SRMR-I6 Contaminants to land and freshwater

Discharges of contaminants to land and freshwater have resulted in significant degradation of the environment, risks to human health and subsequent restrictions on usef and enjoyment.

Explanation of the Issue

Contaminants entering or being released onto land, into groundwater or into freshwater bodies have had a significant impact on the health of the environment, particularly on the quality of freshwater. This has resulted in declining ecosystem health across a number of measures and freshwater being unsafe for swimming, contact recreation, drinking, fishing and mahinga kai purposes across a significant proportion of the region. In some instances, people are reticent to participate in recreation activities including non-contact activities due to unpleasant colours, odours, residues, growths, tastes or perceptions of freshwater.

These impacts are largely the result of intensive land use, from rural, urban and industrial activities. Discharges occur throughout a catchment creating cumulative impacts across its length with the most significant effects felt at the lower catchment reaches including, estuaries and the coastal environment. Many catchments are subject to simultaneous discharges from rural, urban and industrial areas.

Stormwater discharges, particularly those from urban areas entrain a variety of contaminants from transport, roading, residential and industrial areas. Industrial discharges are predominantly sourced from cleanfills, landfills, oil and gas activities, food processing facilities and manufacturing and commercial areas.

Discharges of effluent, the runoff of animal faecal matter from pasture, and overflow discharges from urban wastewater treatment facilities contaminate freshwater with harmful pathogenic microorganisms. This is indicated by a high presence of *E. coli* in the majority of Taranaki waterways.

Pasture runoff from animal waste and excess fertilisers, wastewater, urban stormwater and industrial discharges accumulatively elevate freshwater nutrient concentrations and may also increase the level of heavy metals and volatile compounds in receiving environments. Increased concentrations of nutrients such as nitrate, ammonia and phosphorous can lead to excessive algae growth, oxygen depletion and eutrophication reducing water clarity which can lead to declines in fish populations and reduced biodiversity. In some cases resulting algal blooms can be harmful to humans and animals.

Deforestation and the conversion of erodible land to pasture exacerbates slip potential and predisposes rivers, lakes and estuaries to discharges of sediment. Clear-fell forestry, earthworks and hoof damage from cattle on unfenced streams and destabilised banks also increase sediment loads. Sediment elevates phosphorous levels, muddies the water, smothers streambeds, reduces the amount of habitat available for insects and fish, impacts swimmability and decreases flood carrying capacity. Elevated concentration of sediment is particularly an issue for the Northern and Southern Hill country, the Waitara River catchment, and the Pātea River catchment.

A number of impacts are expected to continue to affect the environment despite improvements to inappropriate practices due to the compounding effects of climate change or slow environmental responses to change practice.

SRMR-I7 Coastal water quality

Coastal water quality has become degraded in localised areas and is under threat in other areas resulting in environmental and human health impacts and subsequent restrictions on use.

Explanation of the issue

Coastal water, as the final receiving environment of the land and freshwater system, is at risk of becoming degraded from land based activities and effects of run off into streams and rivers. Fortunately, the energetic Tasman Sea and the result of the many short and fast flowing river catchments as well as landscape gradients at the coast, means that the Taranaki coastal marine area is generally well equipped to assimilate and disperse contaminants when they enter the coastal environment. However, this does not mean that the coastal environment is not adversely affected by both direct and diffuse discharges.

Three localised areas are identified and monitored for water quality degradation where discharges are resulting in restrictions being placed over them affecting people's ability to participate in contact recreation as well as collect mahinga kai and seafood resources. These areas are:

- at the Waitara embayment where, during (infrequent) high flow events at the Waitara Pump Station, screened but otherwise untreated municipal wastewater is discharged to the coast through the Waitara Marine Outfall, 1250 m offshore of the Waitara river mouth;
- between the Waiwhakaiho River mouth to the Mangatī Stream mouth where the New Plymouth Wastewater Treatment Plant discharges through a marine outfall structure 450m offshore north of the Waiwhakaiho River Mouth; and
- between the Waihī Stream (Hāwera) to the Tāngāhoe River where the municipal waste generated in the Hāwera and Eltham townships, including treated meat processing and dairy industry wastes, is discharged through a combined marine outfall, 1845 m offshore, near Hāwera.

Seven of the region's larger estuaries are vulnerable to the impacts of sedimentation. These are the Mohakatino, Tongaporutu, Urenui, Mimi, Waitara, Patea and Waitotara Estuaries, which all have high modelled suspended sediment catchment loads, and a high proportion of soft mud intertidal habitat in the estuary already. Generally speaking, Taranaki estuaries are well flushed by the riverine outflows, and are therefore less impacted by nutrients. However, some of the region's estuaries and smaller beach streams are susceptible to eutrophication from excess nutrients under certain conditions. The sites that are most susceptible to these impacts are those estuaries and stream mouths with lower river flows which can close and pool during dry summer periods, as well as those estuaries where there is poorly flushed intertidal habitat which could potentially support algal blooms.

River and stream mouth discharges at the coast can impact recreational water quality in the surrounding waters due to elevated concentrations of faecal bacteria, particularly after rainfall. The Council is yet to establish a State of the Environment coastal water quality programme which would enable a more robust assessment of broader coastal water quality issues, though observations point to sediment inputs from large rivers and cliff erosion as having a considerable effect on coastal water quality.

The effects of climate change, including warmer sea surface temperature and ocean acidification are likely to compound existing coastal water quality issues.

SRMR-I8 Development

Constraints on development are creating additional pressures on housing, business, industry and infrastructure for meeting current and future needs of our region.

Explanation of the issue

Development encompasses a range of activities such as the establishment and growth of urban and residential areas to service housing and business needs; the delivery maintenance and upgrading of critical infrastructure; and the operation of key industries. Development is important because it stimulates economic growth, provides for community needs, enables population growth, supports employment and fosters other social benefits.

Over the next 30 years, Taranaki is projected to experience population growth and changes to major industries meaning that the development needs of the region are changing. Not only are the development needs of the region changing, but the way that development is undertaken is changing due to additional restrictions being placed on natural resources and increasing demands for positive environmental and social outcomes to be achieved. In addition, new opportunities being explored as greater emphasis is placed on clean energy and associated technologies.

Development activities includes their own constraints, such as functional and operational needs which may limit the location, timing and approach to undertaking development activities. However the location, form and/or extent of development activities is further challenged by the constraints and limitations presented for values that require protective management of the environment.

Protection of highly productive land has limited where urban areas may expand which will likely result in greater pressure being put on infill development and limit rural lifestyle housing in many locations.

Freshwater regulations will impact future development and a number of key industries such as agriculture, forestry, mining (including oil and gas), utility providers (including regionally important infrastructure) and emerging industries by placing tighter controls on sediment, discharges of contaminants, the taking of freshwater and the loss or damage of freshwater habitat and biodiversity values.

Other values that require protective management such as natural features and landscapes, indigenous biodiversity and historic heritage, will also affect the location, form and/or extent of development activities.

Responding and adapting to climate change and the increased risk of natural hazards will continue to have a significant impact on development decisions. Additional constraints or risk management requirements may be necessary in the future to ensure human health and safety, to minimise disruptions to everyday life, and avoid damage or destruction of vulnerable assets and critical infrastructure.

There are significant challenges to local government, industry and infrastructure providers for providing from development demands within these limitations and constraints to ensure the future needs of the environment, people and communities are being met.

SRMR-I9 Biodiversity

Biodiversity is fragmented and degraded and some species, habitats and ecosystems are at risk of being lost.

Explanation of the issue

Taranaki is biologically unique with a wide variety of native species, habitats and natural features. Biodiversity, or biological diversity, describes the variety of biological life including plants, animals, fungi and micro-organisms. Native forests, shrub land, rivers, streams, wetlands and the coastal environment provide significant habitats for indigenous flora and fauna. Biodiversity is valued by Taranaki communities and tangata whenua for their ecological, cultural and social values.

Prior to human settlement and the introduction of pest species much of the region would have been covered in native vegetation, today around only 40% of native forest and bush habitat remain. Large tracts of forest can still be found in the northern and southern hill country, which contains about 55% of the regions remaining native vegetation cover. The volcanic ring plain contains much smaller fragmented and scattered habitats which retains less than 5% of its native vegetation. Many of these remnant areas are geographically isolated and surrounded by highly modified intensive agricultural environments. This makes their long term ecological viability uncertain unless ecological linkages with other areas can be maintained or enhanced.

At least 40 Taranaki land and shorebird species are considered threatened or at risk, along with two species of native bat, 10 reptiles and 90 native plants. The number of native plants considered threatened or at risk has also increased, several plants and trees were added to the national lists in 2018 after the discovery of myrtle rust, including swamp maire/waiwaka and ramarama.

Effects on biodiversity can occur as direct effects to the biodiversity or through damage, destruction, isolation of key habitats and ecosystems. Land use activities including subdivision, landscaping, pasture optimization agricultural productivity, vegetation clearance, discharges of contaminants into waterways, placement of structures in rivers and streams, impacts of cattle traffic in and around rivers, streams and lakes and wetlands, wetland drainage, and impacts from plantation forestry as well as others have all contributed to the loss and degradation of biodiversity. Point and diffuse source discharges reduce water quality effecting the habitats of biodiversity such as wetlands and riparian margins.

A significant number of structures have been installed into waterways to provide access across the many short and fast flowing catchments within the region. These structures are interrupting the natural flow of rivers, restricting or preventing fish passage, and causing disturbances to beds and margins. Barriers to fish passage can diminish and partially or wholly obstruct the passage of indigenous and desirable fish species to accessing critical habitats or migrating through the catchment. The works within and disturbance of river and lake bed during installation can also degrade or destroy critical habitats such as spawning locations. The adverse effects of these activities can result in the following impacts for biodiversity:

- decline in the size and viability of populations of indigenous flora and fauna species;
- reduction in the distribution of indigenous flora and fauna species across their natural range;
- decline or disruption of sequences, mosaics, properties and functions of ecosystems and habitats;
- fragmentation and loss of connectivity within and between habitats; and
- reduction in the resilience and adaptability of ecosystems and habitats

Threats to indigenous biodiversity include the destruction of habitat by unwanted organisms and pest species. The Regional Pest Management Plan for Taranaki identifies 20 pest animal and plant species. Possums, mustelids, feral cats and rodents are still present in relatively high numbers across the region, but more so in the Hill country. They destroy forest canopies and prey on the eggs and chicks of native birds, lizards and insects. Pest plants displace native vegetation and lead to modified ecosystems that do not support native species. Pest plants are particularly an issue in the terrestrial coastal environment, wetlands and regenerating bush margins.

In recent years, Taranaki has showed great effort in enhancing biodiversity values, however, initiatives and interventions to enhance biodiversity outcomes are costly and rely heavily on voluntary community involvement and participation leading to ad hoc implementation. As a result, these programs are often which can lead to less effective outcomes and diminish community resolve.

Ensuring positive outcomes for biodiversity is made difficult due to its complexity and the overlapping impacts and drivers of its decline. Understanding the link between activities and cumulative effects on biodiversity values is particularly challenging and significant amounts of information and regional data is required to unravel this issue.

SRMR-I10 Wetlands

Once prevalent wetland habitats have become significantly reduced and remaining wetlands continue to experience a loss of values and extent.

Explanation of the Issue

A wetland is an area that is permanently or intermittently wet, and is characterised by unique vegetation and soils adapted to the wet environment which provide vegetation and habitat critical for biodiversity and the conservation of many rare and threatened species. They also provide important ecological linkages between terrestrial and aquatic ecosystems. In addition, wetlands provide an integral hydrological function by storing and regulating water flows during heavy rains, and offsetting low flows during dry periods.

In Taranaki it is estimated that just 8% of naturally occurring wetlands remain, covering a total of 3,538ha. The loss of wetland habitats has been primarily attributed to historical land drainage practices. This has occurred in both urban and rural areas where drier soil conditions are desirable to enable subdivision and the intensification of agricultural production. Other activities have removed or destroyed wetland habitats resulting in soggy low quality pasture.

Five yearly reassessment data indicates that of the small number of monitored wetlands, 23% have degraded in ecological condition. It is estimated that a much higher proportion of sites not monitored are also degraded. Despite regulations to restrict certain activities in proximity to wetlands, remaining wetlands continue to be at risk of further decline.

Wetlands are vulnerable to both rural and urban pressures. Increased nutrient and sedimentation loads, discharges of contaminants, the introduction of weed and pest species and the alteration of wetland hydrological function (changes to over land flow and ground water) continue to degrade the health of wetlands. As a result, remaining wetlands experience reduced water clarity, lower flows and a loss of indigenous flora and fauna.

In the urban environment, residential, commercial and industrial runoff, stormwater discharges and sediment from earthworks can introduce contaminants to wetland areas. In the rural environment, runoff from pasture and industrial facilities can

introduce contaminants such as nitrates, phosphorous and ammonia. Both sediment and slash from plantation forestry act as pollutants when they reach wetlands by exacerbating eutrophication, blocking channels and introducing exotic plant species.

Both urban and rural wetlands are at risk of weeds, pests and degraded riparian margins. Weedy species can smother wetlands, cause eutrophication and alter habitat for threatened species. Destruction of habitat at the margins of wetlands either by livestock or through intentional removal is particularly devastating to biodiversity values and in particular affects threatened or at risk species that depend on wetland habitats at critical life stages.

The healthy hydrological functioning of wetlands is essential for gross water balance, ground and surface water flows and flood responses however it can be affected by drainage, damming and diversion of wetlands and connected river and groundwater systems. It is also affected by soil disturbances and gravel extractions near and within wetlands, as well as erosion that may take place higher in the catchment. Takes of groundwater can alter the hydrological functioning of wetlands by affecting the groundwater system that the wetland is associated with.

All of these can have significant adverse effects on wetland ecosystems and each wetland will have specific vulnerabilities and tolerances to each of these activities.

SRMR-I11 Historic heritage

Historic heritage and associated values are not consistently identified and are at risk of being damaged, destroyed or lost.

Explanation of the issue

Taranaki has a diverse range of historic heritage that are of importance to the community and tangata whenua. Historic heritage includes archaeological sites, sites and areas of significance to Māori (SASM's), heritage buildings, memorials and precincts. Historic heritage is unique to the region, holding significant historical, cultural, spiritual, aesthetic and architectural values and is important to people and their sense of place.

Historic heritage and associated values in Taranaki are under pressure from two key drivers: subdivision, use and development activities; and neglect and lack of maintenance.

Subdivision, use and development activities can result in the damage, destroy, alter, demolition and relocation of heritage sites and negatively impact on associated values. Activities include those associated with urban growth, farming, and hydrocarbon exploration and development.

Many archaeological sites and heritage buildings are also in a state of deterioration due to neglect and restrictions for adaptive re-use and urban renewal. This is particularly relevant for historic buildings subject to heightened sensitivity to earthquake risk and strict requirements for seismic strengthening. This can increase the possibility of heritage sites being unused or demolished.

Contributing to this problem is the poor and inconsistent representation of historic heritage in regional and district planning instruments, Māori heritage has traditionally been under-represented in these plans and continues to be an issue in some areas. It is expected that there could be over 2,000 sites and areas of significance to Māori, each with historical and cultural value to iwi, hapū and whānau. Unidentified heritage is at risk from adverse effects because their presence may not be known and their values accounted for in the consenting process resulting in damage or destruction.

SRMR-I12 Outstanding natural features and landscapes

The outstanding and significant natural values of the region are not consistently identified and have been degraded or are under threat.

Explanation of the Issue

Outstanding natural features and landscapes (ONFLs) are identifiable areas that exhibit an array of outstanding natural value characteristics. Landscape refers to an areas full biophysical form (air, water, and land) and people's perceptions, beliefs, values, relations and use of that area while features are the distinctive and characteristic landmarks that sit within a landscape and which contribute to the value of the locality. Amongst other natural values, ONFLs often have pristine indigenous biodiversity, unique and rare ecosystems, unique or distinct geology and high level of naturalness. The combination of these various natural

values and the exceptional quality of these values is what determines whether an area is considered an ONFL. Significant natural features and landscapes (SNFL's) are less regionally important than ONFL's due to not meeting the criteria for 'outstanding', however still hold significant natural values that require management. SNFL's largely face the same challenges as ONFL's and can both be highly sensitive to many resource management activities.

There are a variety of ONFLs within Taranaki. Some are highly recognisable such as Taranaki Maunga, while others are currently unknown and may be harder to delineate and identify. Where an ONFL remains unrecognised or unidentified, its outstanding or significant natural value is afforded minimal protection, and is therefore vulnerable to resource management activities that may destroy or degrade those outstanding and significant character values.

Subdivision, quarrying, mining, forestry harvesting, land farming, land clearance, grazing, and road and infrastructure development can and have had significant adverse effects on both ONFL's and SNFL's, relative to their scale, visual dominance, design, and location.

In Taranaki, many ONFL's are popular visitor and tourist attractions for example Taranaki Mounga and the Pouakai and Kaitake Ranges. The intensification of recreational activities and associated auxiliary development has and continues to jeopardise the natural value of these localities. Taranaki ONFL's are vulnerable to activities with a functional or operational need to traverse or occur within their boundaries, in particular, energy activities, hydrocarbon exploration and production, network utilities and regionally important infrastructures. Paritūtū, Ngā Motu (Sugar Loaf Islands) and Tapuae are impacted by industrial processes and Port activities which is further exacerbated erosion from foot traffic. ONFLs are also vulnerable to coastal erosion and to a lesser extent, coastal subdivision. While a number of ONFL's in the coastal environment have high natural values resulting from coastal erosion and the formation of spectacular coastal cliffs. for example between Waihī Stream to Pariokariwa Point, Paraninihi and Waverley Beach, these formations are ultimately vulnerable to exacerbated erosion rates from storm surge and sea level rise associated with climate change.

Appendix Two

'Resource Management Issues of Significance to Iwi Authorities' chapter as recommended by Pou Taiao

Note: The wording provided is open to amendment by ngā iwi o Taranaki.

RMIA–WAI – Wai Māori

Context

Water plays a significant role in tangata whenua spiritual beliefs and cultural traditions. Tangata whenua have an obligation through whakapapa to protect wai and all the life it supports. Whānau have observed the health of water degrade through time and consider it is crucial that this degradation is reversed.

RMIA–WAI–I1 – The loss and degradation of water resources through drainage, abstraction, pollution, modification, and damming has resulted in material and cultural deprivation for tangata whenua

The drainage of wetlands, water abstraction, degraded water quality, barriers to fish passage and changes to flow regimes as a result of damming have had significant negative impacts on tangata whenua. These activities degrade the mauri of the water and the habitats and species it supports, therefore also degrading mahinga kai and taonga species and places.

These changes to the environment have meant that tangata whenua have had to adapt and change their use of the environment. As traditional mahinga kai places and taonga species including (but not limited to) pīharau, īnanga, kākahi, and tuna have declined, there has been a reduction in the intergenerational transfer of knowledge. Without this knowledge, the mātauranga associated with traditional mahinga kai species and places cannot be passed on, and the intergenerational transfer of knowledge that has occurred for over 800 years is broken. Place names that carry tribal history are no longer reflective of their places and the stories associated with some place names have been lost.

RMIA–WAI–I2 – Current water management does not adequately address tangata whenua values and interests

Tangata whenua values and interests are not properly considered in current land and water resource management. The well-being of mahinga kai and taonga and protection of other values is rarely given effect to in environmental policy or decision-making processes and these considerations are often compromised in favour of other values, including economic values. The mana of tangata whenua and of the water is not recognised because water quality and quantity have been allowed to be degraded. Resource management in Taranaki has failed to meet its obligation to recognise tangata whenua values and provide for the relationship of tangata whenua with the water bodies within their rohe. The understanding of tangata whenua values by many is still developing and, as a result, tangata whenua values and interests are often not well represented in plans and decision-making.

RMIA–WAI–I3 – The effects of land and water use activities on freshwater habitats have resulted in adverse effects on the diversity and abundance of mahinga kai resources and harvesting activity

Mahinga kai is the gathering of foods and other resources, the places where they are gathered, and the practices used in doing so. Mahinga kai is an intrinsic part of ngā iwi o Taranaki identity and economic well-

being. Tangata whenua fishing rights were explicitly protected by the Treaty of Waitangi. Not only was the right to engage in mahinga kai activity confirmed, so too was the expectation that such activity will continue to be successful as measured by reference to past practice. However, as described in evidence provided to the Waitangi Tribunal in the claims of the iwi of Taranaki, there has been a dramatic loss of mahinga kai resources and places of procurement since the Treaty was signed. This loss is greater than the loss of kai. It is a loss of culture of and for tangata whenua, as it affects the intergenerational transfer of mātauranga handed down from tūpuna over hundreds of years. It represents a loss of rangatiratanga and of mana. Mahinga kai continues to be degraded through the effects of land and water use activities on freshwater habitats. Activities such as the construction of barriers to fish passage, drainage, altered flow regimes, reduced water quality and removal of riparian vegetation all impact on access to and use of resources.

RMIA–WAI–I4 – Effective participation of tangata whenua in freshwater management is hampered by poor recognition of mātauranga

The term 'mātauranga Māori' includes all branches of Māori knowledge, past, present and still developing. It involves observing, experiencing, studying, and understanding the world from an indigenous cultural perspective. It is a tool for thinking, organising information, considering the ethics of knowledge, and informing us about our world and our place in it. Incorporation of mātauranga in resource management decision-making is important to ensure that tangata whenua interests are appropriately recognised and provided for. Resource managers do not always appreciate the depth and value of mātauranga held by tangata whenua. Even where mātauranga is valued there may be difficulty in determining how best to apply the knowledge.

RMIA–WAI–I5 – Poor integration of water management, across agencies and across a catchment, hinders effective and holistic freshwater management

Tangata whenua place emphasis on the holistic management of resources. Cultural values such as whakapapa and concepts such as ki uta ki tai recognise the interconnectedness of all things, and that effects on one part of the whole will be felt throughout the whole. Historic and current management of water in Taranaki is not holistic. Catchments are often managed by multiple councils. Regional councils are responsible for managing land use effects on land and at sea up to 12 nautical miles offshore, but beyond that the Environmental Protection Authority manages effects through a separate piece of legislation. District councils, although not specifically responsible for managing freshwater, are responsible for managing activities that affect freshwater.

In Taranaki there are separate plans for freshwater and the coastal area, and they are not consistent with each other. These divisions in the management of the environment fail to recognise that all water, in rivers and lakes, underground, in the air and in the ocean is connected, and what occurs in the headwaters and on land will have an impact in the ocean. This lack of holistic freshwater management also makes it difficult to understand and address the cumulative effects of different activities and decisions on tangata whenua values.

Specific concerns related to RMIA-WAI-I1 to RMIA-WAI-I5 are interrelated, and include:

- Water quality concerns:

- Deterioration in water quality resulting from poor land management practices.
- The cultural and water quality impacts of point and non-point source discharge of human waste and other contaminants to water. Whānau cannot gather kai from places where human waste (whether treated or not) has been discharged, or where herbicides and pesticides have been used. Reliance on dilution rates to mitigate the effects of discharges is culturally inappropriate.
- The water quality impacts of discharges from intensive farming; extractive industries (oil and gas, mining, and quarrying); urban and coastal development and industrial activities.

- Water allocation concerns:
  - Tangata whenua consider that many of the waterways in the region are over-allocated from a cultural perspective.
  - Abstractions of greater volumes of water than are required, lack of water harvesting and continuation of inefficient methods of water use.
  - The implications of increased water demand for domestic use which will put additional pressure on the already scarce water resource.
  - The effects of long durations for water take consents which lock in a pattern of resource use for a long time, limiting the ability for tangata whenua to exercise kaitiakitanga responsibilities.
  - The impact of cross mixing of water from different catchments on the distinctive mauri of the water bodies.
  - The lack of understanding of the interactions between groundwater and surface water.
- Concerns about channel modification and river works:
  - The effects of damming, draining and diversion on the disruption of natural flow patterns, loss of freshwater habitats, and migration of indigenous fish species.
  - The effects on the mauri of the water body from diversion of watercourses upstream and downstream of mines, oil and gas and other industrial activities.
  - Impacts of activities such as channel maintenance and channel cleaning on water quality and on disruption of species living in the channel and their habitat.
  - Impacts of channel reshaping, in particular straightening, on river flow and habitats, and the mauri of the water body.
  - The effects of bed disturbance, including suction dredging and gravel extraction, on stream morphology and habitats.
  - Impacts of willow removal on water quality, water temperature and mahinga kai habitat.
  - Introduction of exotic weeds through poorly cleaned machinery, and the subsequent impact on bank habitat and water ecosystems.
  - The effects of changes in vegetation cover, including clearance of indigenous vegetation and exotic afforestation on the water retention capacity of land and consequent flow patterns, which can negatively affect mahinga kai and taonga species through a reduction in their habitat.

RMIA–MKB – Mahinga kai and biodiversity

Context

Mahinga kai customs and practises are central to tangata whenua cultural identity. The rich soil, forests and fisheries enabled us to establish permanent settlements and the abundance of kai from crops, the ngahere (forests), awa (rivers/streams), repo (wetlands) and moana (sea) were a great source of mana for tangata whenua which enabled us to show manaakitanga (respect) to our manuhiri (visitors). All indigenous species

and habitats are treasured by tangata whenua as taonga in their own right, as well as for the mahinga kai values associated with some species.

RMIA–MKB–I1 – The diversity and abundance of terrestrial and aquatic indigenous species has been reduced due to adverse effects of resource use and development

Resource use and development in Taranaki has led to degradation of taonga and mahinga kai places. This has occurred in a myriad of ways, contributing to a significant negative cumulative effect on many species and habitats. The decrease in diversity and abundance of indigenous species causes a negative impact on the mauri and health of the natural environment.

The perspectives of tangata whenua recognises that species within ecosystems are connected, and effects on one species will be felt throughout the rest of the system. Effects on mahinga kai and taonga species diversity and abundance affect the relationship of tangata whenua with these species. Whānau are unable to access traditional mahinga kai and taonga species and places because in many cases they no longer exist, or no longer provide resources that were once abundant there.

Specific concerns include:

- Degradation of mahinga kai due to the impacts of contaminants from both point and non-point source discharges, including human waste disposal to mahinga kai areas.
- The effects of soil contamination from poorly managed landfills, industrial sites, and waste disposal sites.
- Continued urban spread encroaching on mahinga kai sites.
- Genetic modification of indigenous flora and fauna, which represents deliberate alteration of whakapapa.
- The impact on mahinga kai and indigenous biodiversity from weed and pest invasion.
- Loss of indigenous fish species, many of which are taonga and mahinga kai, through displacement and predation.
- Loss of indigenous flora and fauna remnants and lack of co-ordinated management of habitat corridors.
- Impacts on mahinga kai and aquatic ecosystems from a lack of effective catchment-wide riparian management.
- Loss of recruitment of indigenous flora in remnant bush areas due to continuous stock grazing.
- The impact of inappropriate forestry developments, land conversions and other intensification of farming on indigenous flora and fauna values, including ecological disturbance and displacement of species.

RMIA–MKB–I2 – Regulatory and physical barriers have impeded the ability of tangata whenua to access mahinga kai and to undertake customary harvest.

The ability of tangata whenua to exercise customary rights to mahinga kai has been impeded by obstacles to accessing mahinga kai sites. Obstacles include lack of physical access and the sites no longer being safe to access due to the site becoming polluted, or a change in the flow velocity and/or depth.

RMIA–MKB–I3 – Impacts of climate change on both species/habitat viability and increasing pest (flora/fauna) encroachments

Climate change is now affecting and will continue to affect habitat availability and suitability for species in Taranaki. In some cases, this will mean that species will be able to increase their distribution, which will encourage spread and abundance of pest/weed species. Climate change will also reduce habitat and distributions for some species and affect habitat quality. These effects may also accumulate; for example, a native species may have worse quality and less habitat and its pest/predator's distribution and population may increase due to climate change effects. Where possible, these effects should be planned for in environmental management.

RMIA–MKB–I4 – Shortage of protected and secure areas for biodiversity

Currently there are not enough protected and secure areas for biodiversity in Taranaki. To ensure the long-term survival of our region's threatened species, a series of protected areas must be established, ideally in a network connected by corridors so that each individual population is more resilient as well as the species' overall population.

RMIA–MKB–I5 – Inconsistent approaches to biodiversity protection amongst regulatory authorities

Biodiversity is managed by several entities who have different approaches and powers through their separate governing legislation. For example, regional and district councils have obligations under the Resource Management Act and the Department of Conservation has obligations under the Conservation Act. Different pieces of legislation are not always consistent with each other. There can also be confusion about who is responsible for different aspects of biodiversity management as it is not managed by one entity.

RMIA–MKB–I6 – Lack of information on species health and viability

In many instances there is a lack of information on species. This absence of information on matters such as life histories, current and previous distributions and habitat preferences makes it difficult to make decisions about how best to manage these species.

RMAI-MKB-I7 – The preference toward ecological criteria and the lack of provision for mātauranga Māori criteria to identify significant natural areas

Throughout Taranaki there is an ad-hoc approach to the protection of indigenous biodiversity. Where district councils and regional councils have mechanisms in place for identifying sites of significant indigenous biodiversity value there is a preference toward ecological western science identification criteria and a lack of provision for mātauranga Māori to inform the identification of significant natural areas.

RMIA–WTU – Wāhi tūpuna

Context

Wāhi tūpuna (ancestral landscapes) across Taranaki are made up of interconnected sites and areas reflecting the history and traditions associated with the long settlement of tangata whenua in Taranaki. Areas of significance that form part of wāhi tūpuna include, but are not limited to:

- Wāhi tapu and wāhi taonga
- Kāinga (settlements/villages)

- Pā (fortified settlements)
- Wāhi ingoa (place names)
- Ara tawhito (traditional travel routes)
- Maunga (mountains)

It is important that resource management recognises the wider cultural setting by considering effects of activities on the broader wāhi tūpuna rather than just on discrete sites.

RMIA–WTU–I1 – The values of wāhi tūpuna are poorly recognised in resource management in Taranaki

Land management regimes have failed to adequately provide for tangata whenua interests in wāhi tūpuna. Attention has been too narrowly focused on the cultural redress components of Treaty settlements (statutory acknowledgements, place names, sites) and on archaeological evidence toward sites and areas of significance to Māori whereas wāhi tūpuna are considerably broader than the areas described in the legislation and in plans. The values of these areas can be adversely affected by inappropriate land use and development.

Specific concerns include:

- Changes to the recognisable character of wāhi tūpuna resulting from intensified land use, spread of exotic wilding trees and other woody weeds, forestry, subdivision, development of buildings and structures.
- Impacts on the integrity of wāhi tūpuna from extension and maintenance of infrastructure such as transport, telecommunications and other utility networks.
- Modification of landforms by earthworks, particularly on ridgelines and upper slopes and near waterways.
- Impacts on wāhi tapu and archaeological sites from earthworks.
- Sedimentation of water bodies within wāhi tupuna from earthworks.
- Poor land management and inappropriate land use degrades the whenua itself.
- Failure to recognise tangata whenua connections to the land through use of traditional names for landscape features and sites.

RMIA–WTA – Wāhi tapu and wāhi taonga
Context
Tribal land was not just the source of economic well-being. For Māori it was also the burial ground of the placenta and of the bones of ancestors, the abode of tribal atua and a storybook through place names and traditions. This is reflected in Te Reo Māori, as the word ‘whenua’ means both ‘placenta’ and ‘land’. Ancestral lands were therefore regarded with deep veneration. For tangata whenua, wāhi tapu and wāhi taonga refers to the places that hold the respect of the people in accordance with tikanga or history including (but not limited to):

- Maunga (mountains)
- Urupā (burial places)
- Mauri/mouri kōhatu (stones imbued with spiritual significance)
- Umu (ovens)
- Kāinga and papakāinga (villages/settlements)

- Pā (fortified settlements)

RMIA–WTA–I1 – Land use activities have resulted in disturbance and degradation of wāhi tapu and wāhi taonga sites and the cultural and spiritual values associated with these areas

Wāhi tapu and wāhi taonga sites are vulnerable to disturbance or destruction from the direct effects of resource use and development. This is through activities that require earthworks as well as from natural or human-induced changes to biophysical processes such as coastal erosion. Wāhi tapu and wāhi taonga values can also be adversely affected by the encroachment of culturally offensive activities e.g., it is inappropriate to have a wastewater treatment plant at or near a wāhi tapu or wāhi taonga.

Specific concerns include:

- Disturbance, modification or destruction of wāhi tapu or wāhi taonga by earthworks.
- Degradation of the cultural value and integrity of wāhi tapu or wāhi taonga through contamination by discharges, inappropriate development, and culturally inappropriate activities such as mining/quarrying, landfills or wastewater disposal.
- The resurfacing of kōiwi tangata (human remains) through natural and human-induced processes and ensuring that these are kept safe and returned to tangata whenua so that they can be reinterred in accordance with tikanga.
- Ineffective management of effects due to inappropriate and inaccurate recording of wāhi tapu and wāhi taonga, and misinterpretation of the status and importance of sites.

RMIA–WTA–I2 – Access to wāhi tapu and wāhi taonga and the ability to undertake customary activities on these sites has been impeded

Access to culturally important sites has been impeded in many ways, affecting the ability of tangata whenua to carry out customary activities. Many sites are privately owned and cannot be accessed. Some sites no longer exist, or the customary activities associated cannot be undertaken – for example, sites associated with mahinga kai gathering cannot be used if the mahinga kai is no longer there.

RMIA–AA – Air and atmosphere
Context
The air and atmosphere are resources of significance to tangata whenua. In ngā iwi o Taranaki traditions, air and atmosphere emerged through the creation traditions and Te Ao Marama. The air is an integral part of the environment that must be valued, used with respect, and passed on intact to the next generation. Pollution of the atmosphere adversely affects the mauri of this taonga and other taonga such as plants and animals.

RMIA–AA–I1 –The impacts of discharges to air are poorly recognised in resource management

The impacts of air pollution and discharges to air on tangata whenua values and relationships are poorly understood and seldom recognised. Discharges to air can adversely affect health and can be culturally

offensive. Clean air is important to the health of mahinga kai and people, and odour and other emissions impact on the tapu of wāhi tapu sites. Air emissions can also reduce the visibility of tangata whenua landscape features and of the moon, stars, and rainbows.

Specific concerns include:

- Potential impacts of climate change which could potentially negatively affect wai Māori, mahinga kai and biodiversity, wāhi tūpuna, wāhi tapu, the coastal environment and the well-being of all people.
- Insufficient data has been collected and distributed about the effects of discharges to air.
- The effects of discharges to air on the health of people and mahinga kai, including discharges from industrial or trade premises, agrichemical spray drift, vehicle emissions and emissions from domestic fires in built up areas prone to inversion layers.
- Culturally offensive discharges from crematoriums, if located in close proximity to mahinga kai and wāhi taonga.
- Adverse effects of vegetation burning on the integrity and the tapu of wāhi tapu sites.
- Impacts of odour on wāhi tapu, mahinga kai sites and sites and areas of significance to Māori.
- Impacts of urban settlement and discharges to air on the visibility of the sky and wāhi tupuna.

RMIA–CE – Coastal environment (Taku tai moana me te wai Māori)
Context
The coastal environment is particularly significant for many of the iwi in Taranaki. The spiritual and cultural significance of taku tai moana me te wai māori (saltwater and freshwater) and the interconnection between land and sea environments are not always well recognised in management of the coastal environment.

RMIA–CE–I1 – Mahinga kai and coastal systems are adversely affected by lack of integrated management across the land-water interface

Management of mahinga kai species and their habitats varies and is not holistic. Many important indigenous mahinga kai fish species are diadromous and move between freshwater and the ocean during different parts of their life cycle. The interconnection between land and marine environments needs to be carefully considered in order to manage effects that cross the coastal marine area boundary.

Specific concerns include:

- Effects on the coastal environment and natural systems resulting from modifications to waterways, such as damming, diversions, piping, channelling, flood protection schemes and artificial openings of river mouths, estuary and lagoon systems.
- The effects of reductions in river flows on ingress of saltwater to river systems and conditions for īnanga spawning.

- Barriers to species migration, and hence lifecycles, created by changes to river mouths from reductions in river flow and structures in river and streambeds.
- Impacts of changes in sediment transport on coastal ecosystems.
- The effects of land reclamation on water quality and flow in enclosed harbours and estuarine ecosystems.
- Effects of land use activities and poor management of coastal margins on coastal water quality.
- Climate change effects occur across the land-water interface and the freshwater-saltwater interface, and cause changes to mahinga kai species distribution and the quality and locations of mahinga kai habitat.

RMIA–CE–I2 – Discharges into coastal waters and marine dumping of waste degrade mahinga kai and the mauri of the waters

The practice of using the marine environment as a sink for disposal of waste from both land development and marine vessels is culturally offensive and has resulted in degradation of kaimoana resources. Leaching, discharges and overland runoff of contaminants from activities occurring near the coast have also contributed to the adverse effects on the marine area.

Specific concerns include:

- Point source industrial discharges to the coastal environment.
- Contamination of coastal waters by leachate from inappropriately sited landfills and other waste disposal sites and runoff from coastal subdivisions.
- Discharges of sewage from marine outfalls, poorly designed or inadequate coastal sewerage infrastructure and freedom camping.
- The effects of contaminants such as oil and carbon particles in discharges of stormwater from urban roads.
- Discharges of sewage and contaminated bilge and ballast water from ships.
- Proliferation of rubbish in the coastal environment, including materials such as lengths of rope from boats and moorings, plastic packaging strips, farming rubbish, discarded and lost fishing gear, glass and plastic bottles as well as other dumped material.
- Discharge or disposal of waste products from the processing of marine species.
- Oil and chemical spills negatively affecting the natural environment
- Indiscriminate discharge of human ashes in sensitive areas such as kaimoana areas, or without the knowledge of tangata whenua.

RMIA–CE–I3 – The ability for tangata whenua to access and harvest kaimoana has been impeded by the effects of activities in the coastal and marine environment

Parts of the coastal environment in Taranaki have been heavily modified since the arrival of settlers. Many parts of the coast around New Plymouth and other towns have been reclaimed to establish the city and towns, traditional reefs were destroyed, and the harbour has been dredged to enable the growth of the port. This has limited the ability for whānau to carry out customary harvest of kaimoana

resources and to access sites of significance for customary fishing. Whānau are often unable to physically access the foreshore and seabed for the collection of kaimoana, find that kai is no longer safe to eat due to pollution, or that there is no kai due to unsustainable overharvesting and habitat destruction.

Specific concerns include:

- Impacts on kaimoana and associated habitats from the effects of waterway modifications on estuarine systems and the freshwater/saltwater interface.
- Modification or loss of marine habitats as a result of reclamation, dredging and dumping.
- Disturbance of intertidal habitats by vehicle access along beaches.
- Potential for modification and displacement of habitats by aquaculture activities.
- The negative effects of point and non-point source discharges on water quality.
- The introduction and spread of exotic species through ballast, hull cleaning, and other shipping activities.
- Loss of access due to development of coastal land.

RMIA–CE–I4 – Habitat disturbance and modification has contributed to decline in populations of indigenous marine species, including marine mammals

Indigenous marine species, including marine mammals, are regarded as taonga by tangata whenua, and in some cases, these are recognised through Treaty settlements. The health and abundance of marine species populations are threatened by modification and loss of natural habitat as a result of the impacts identified in RMIA-CE-I2 and RMIA-CE-I3.

RMIA–CE–I5 – Wāhi tapu and wāhi tūpuna values in the coastal environment are poorly recognised and protected

The coastal environment is the domain of Tangaroa and includes the coastal waters of Te Tai o Rehua as well as the adjoining land. Tauranga waka (waka landing places) occur up and down the coast in their hundreds and wherever a tauranga waka is located there is also likely to be a tauranga ika, or fishing ground, kaimoana resource, or rimurapa (seaweed) with the sea trail linked to a land trail or mahinga kai resource. Burial sites and other wāhi tapu are also associated with these wāhi tūpuna. Seascapes such as reef systems also form part of wāhi tūpuna.

Wāhi tapu and the broader wāhi tūpuna can be adversely affected by inappropriate activities and developments on coastal land and in the coastal marine areas.

Specific concerns include:

- Damage to and disturbance of wāhi tapu resulting from coastal erosion, earthworks associated with subdivisions, and development of coastal walkways.
- The effects of land fragmentation on access to sites of significance.

- Loss of the integrity of cultural landscapes by reclamation and the inappropriate location of structures and activities associated with commercial and recreational fishing, aquaculture, tourism activities, infrastructure, and vessel moorings.
- Disturbance from mining of the seabed and foreshore.
- Restriction of access to tauranga waka and associated trails due to land development.
- The cumulative effect of incremental, uncoordinated subdivisions, land use change and building within the coastal environment.
- Failure to recognise and provide for the effects of changing sea levels on coastal landscapes.

RMIA–GOV– Governance, Partnership and Decision-making

Context

The rights, responsibilities, and obligations of tangata whenua affirmed in Te Tiriti o Waitangi have been ignored and precluded by national and local authorities. The result of this disregard has been decades of negative environmental and social outcomes for Taranaki, with Māori experiencing disenfranchisement and disconnection from their lands, language, ways of being and doing. The actions and inactions of governments/authorities have hindered and frustrated the ability of tangata whenua to fully and appropriately exercise their rights, responsibilities and obligations guaranteed by Te Tiriti.

The complex regulatory and management landscape has resulted in cross management, duplication, inconsistencies in implementation and outcomes, engagement fatique and reduced agency for tangata whenua across multiple domains, including but not limited to freshwater, wāhi tapu, wāhi tūpuna, wāhi taonga, historic heritage, the coastal environment, biodiversity, threatened species and species (including fisheries) management, and biosecurity.

RMIA–GOV–I1 – Tangata whenua and their Tiriti rights, responsibilities and obligations have not been appropriately recognised

Many historic breaches of Te Tiriti have been addressed through a settlement process and tangata whenua continue to exercise their rights, responsibilities, and obligations as tangata whenua. The partnership promised in Te Tiriti has not been provided for in resource management and environmental governance and decision-making.

RMIA–GOV–I2 – Duplication, inconsistencies, and siloed approaches do not result in desired outcomes

The involvement of multiple government entities with different governing legislation, scope and areas of influence results in tangata whenua being inundated with requests for engagement, consultation, feedback, and/or ‘cultural input’. The cross management and duplication often results in inconsistent implementation and outcomes and is an inefficient use of resources for tangata whenua.

AGENDA AUTHORISATION

Agenda for the Policy and Planning Committee meeting held on Tuesday 6 June 2023

Confirmed:

26 May, 2023 4:16:46 PM GMT+12

A D McLay

Director Resource Management

Approved:

29 May, 2023 2:15:28 PM GMT+12

S J Ruru

Chief Executive