Expert Panel estimates of change to river water quality and ecological attributes under scenarios of climate change and land management

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Approved for release by

Name: Rob Donald

Date: 22 December 2023

Signature: ______________________________

Executive summary

Background

The National Policy Statement for Freshwater Management 2020 (NPSFM) establishes objectives and policies that direct regional councils' (and other local government authorities) approach to sustainable management of fresh water. A regional plan change that fully implements the NPSFM must be publicly notified by December 2024. Bay of Plenty Regional Council (BOPRC) is implementing an Essential Freshwater Policy Programme (EFPP) to deliver on the requirements of the NPSFM, and 10-year rolling reviews of the Regional Natural Resources Plan. Part of this implementation involves estimating: the baseline state of freshwater attributes[1], current state[2] and contaminant sources. It also involves predicting outcomes of the foreseeable impacts of climate change and alternative future land use and management scenarios to assist with policy decision-making. The NPSFM requires that the best information available at the time be used to make such assessments and this may include modelling as well as monitoring data[3](MfE, 2023).

As part of the EFPP, BOPRC identified immediate modelling needs required to support policy issues and options development and discussions with tangata whenua and communities. This included using existing models, where they were currently available or in development, and using an expert panel to assist with information and assessments not provided for by existing models. This approach allowed immediate information needs to be addressed within the required timeframe for NPSFM implementation. The Surface Water Quality and Ecology Panel (the Expert Panel) consisted of Ned Norton (LandWaterPeople), Joanne Clapcott (Cawthron), Alastair Suren (BOPRC), Paul Franklin (NIWA), Chris McBride (LimnoTrack) and Paul Scholes (BOPRC). Collectively the Expert Panel specialised in river and lake water quality, lake ecosystems, freshwater ecology, freshwater management and the science/policy interface.

The purpose of the Expert Panel was to provide expert advice and judgement on the state (past, present, and future) of water quality and ecological attributes across the Bay of Plenty (BOP) region. For monitored sites, baseline state and current state were assessed and reported by BOPRC in Zygadlo *et al.,* (2022). The Expert Panel was tasked with estimating baseline and current state where no, or limited, monitoring data existed in the BOP region. For this task the Expert Panel concluded that its estimates of current state (circa 2020) were also its best estimate of baseline state (i.e., the likely state in 2017)[4]. Hence, throughout this report the Panel's estimates of current state also mean baseline state. The Expert Panel estimated: i) current (and hence baseline) state; ii) state under a hypothetical natural land cover scenario; and iii) future state affected by climate change and hypothetical land use and management practice scenarios.

The Expert Panel's work has been documented in a series of six reports that are outlined below and should be considered together. The present report is the fourth in the series and builds on material provided in the first three reports:

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[1] NPSFM Clause 3.10 (3)

[2] NPSFM Clause 3.30 (2) (b)

[3] NPSFM Clause 1.6 (2)

[4] The reason for this is explained in more detail in the methods section and in Carter et al., (2023a) but is essentially because the Expert Panel could not distinguish meaningful differences in its state estimates between 2017 and 2020 given the data available and recognising that environmental state exhibits significant natural spatial and temporal (e.g., inter-annual) variability.

1 Expert Panel estimates of water quality and ecological attributes under Current State, Natural Land Cover and a hypothetical future land cover scenario (Carter et al., 2023). For ease, this is referred to as the 'State Report'.

2 Development of spatial classifications in the Bay of Plenty region (McBride 2023a). These classification systems were used by the Expert Panel to conduct and present their work. For ease, this is referred to as the 'Classifications Report'.

3 Expert Panel estimates of sources of key river contaminants in the Bay of Plenty region. (McBride et al., 2023b). For ease, this is referred to as the 'Sources Report'.

4 Expert Panel estimates of change to river water quality and ecological attributes under scenarios of climate change and land management (Zygadlo et al., 2023) – this report. For ease, this is referred to as the 'Scenarios Report'.

5 Expert Panel summaries of river water quality and ecological attribute states under different land cover, land management and climate scenarios for catchments in the Bay of Plenty region (Holland et al., 2023). For ease, this is referred to as the 'Catchments Report'.

6 Expert Panel estimates of lake water quality and ecological attribute states under different scenarios in the Bay of Plenty region (McBride et al., in prep). For ease, this is referred to as the 'Lakes Report'.

In addition, the work of the Expert Panel has been documented in an online interactive application that allows users to view and interact with the results spatially. Visit https://www.boprc.govt.nz/EXPERT.

The present report provides the Expert Panel's predictions of how river water quality and ecological attribute states might change under the three scenarios of Climate Change (CC), Good Management Practices (GMP), and Climate Change combined with Good Management Practice (CC + GMP). Predictions were made for each of these compared to the three cases of current land cover state (Current land cover), a natural land cover scenario state (Natural land cover), and a hypothetical future land cover scenario state (Hypothetical Future land cover), the state of all three of these having been reported separately in the State Report by Carter *et al.,* (2023a). This report therefore provides predictions of change for seven scenario combinations (noting that the GMP scenario is not applicable to the Natural land cover case) as follows:

- Current land cover + CC
- Current land cover + GMP
- Current land cover + CC + GMP
- Natural land cover + CC
- Hypothetical Future land cover + CC
- Hypothetical Future land cover + GMP
- Hypothetical Future land cover + CC + GMP

The present report provides predictions of change under each scenario for a set of biophysical and landcover classes that are described further in the methods below. The predictions of change in this report were then used to estimate effects of the scenarios for individual catchments in the separate fifth report listed above. All the work mentioned above was limited to river attributes because there was other information already available on lake attributes in the BOP region (reported separately in the Lakes Report, McBride *et al.*, 2023, in prep).

Methods

The Expert Panel's assessments used a range of measured environmental data, existing predictive models built for other projects in the region, local expert science knowledge and a considerable base of scientific literature. Combined, this was considered the best available information at the time of assessment (August 2021 – March 2022).

The Expert Panel provided estimates of change and effect under all scenarios, for all river attributes in Appendix 2 of the NPSFM with the four exceptions of periphyton, dissolved oxygen (below point source discharges), *E. coli* (primary contact sites) and planktonic cyanobacteria. A direct assessment of these four attributes was out of scope for the Expert Panel because other approaches were available, and they will be reported on separately (see methods description in Part 2). For the latter three attributes, the available monitoring data were considered the best available information, whereas for periphyton, the available national models were considered the best information and is reported separately. Despite not directly assessing change under scenarios for these four attributes the Panel did consider the available information and took account of the influence that change to these attributes may have on other assessed attributes (e.g., the linked effects of nutrients on periphyton which may then influence macroinvertebrate and fish communities).The Expert Panel also provided estimates of state for four regional river attributes: dissolved inorganic nitrogen (DIN), water temperature, copper and zinc).

For the Climate Change (CC) scenario assessments, the Intergovernmental Panel on Climate Change's (IPCC) Representative Concentration Pathway RCP4.5 scenario was used. While BOPRC often uses the RCP8.5 (business as usual) scenario for future planning, the RCP4.5 (stabilisation) scenario was deemed appropriate for this project. This was because there was little difference in predicted impacts between the two scenarios at the 2040 time horizon used in the Panel's scenario assessments, and the RCP4.5 scenario was considered to best reflect current emission reduction commitments. However, the Panel did make comments about the potentially greater effects of climate change beyond 2040.

The Good Management Practice (GMP) scenario was developed based on a range of information sources and applied only to agricultural and horticultural land uses. The GMP scenario assessed here reflects a more modest level of potential contaminant reduction (comparable to the M1 mitigation bundle in Matheson et al., 2018) than what might be possible from emerging and/or more advanced mitigation options. Reductions in total nitrogen, total phosphorus, and *E. coli* were estimated for each broad land use (e.g., dairy, sheep, and beef) based on various information sources detailed in the method section 2.3.4 of this report. Estimated sediment load reductions were based off SedNetNZ model results (Vale et al., 2021). Sediment load reduction estimates were then translated into estimated reductions in both water clarity (suspended fine sediment) using the Hicks et al., (2019) equation and deposited fine sediment using a coarsely assumed 1:1 relationship between sediment load reduction and deposited fine sediment reduction respectively.

The Current land cover scenario was defined as the conditions for 2020 and utilised the best land cover information available at the time which was from 2017 (see Carter *et al.,* 2023a). The Natural land cover scenario assumed natural land cover over the entire region (Figure 2). The Hypothetical Future land cover scenario explored possible future shifts in land use (nominally to 2040) from dairy to kiwifruit, increased exotic forestry in upper parts of catchments, and increased wetlands in low lying parts of catchments consistent with predicted sea level rise (Figure 3).

The Expert Panel used a classification system dividing the region into thirteen biophysical/land cover classes for assessing all river attributes except suspended fine sediment (SFS) and deposited fine sediment (DFS). These were addressed with their own bespoke sediment classification described further below. The biophysical/landcover classification was based on geology (as either broadly volcanic or non-volcanic), average upstream slope (>10° = high gradient, <10° = low gradient), and land use (as urban (U), indigenous forest (IF), exotic forest (EF), low-intensity pasture (PL), and high-intensity pasture (PI)). This produced thirteen biophysical/landcover classes as defined in Table 10 and shown on the map of the region in Figure 4.

For SFS and DFS, the Expert Panel derived a bespoke sediment classification using the existing sediment classes from Appendix 2C of the NPS-FM 2020 combined with the land cover categories used in the biophysical/land cover classification (IF, EF, PI, PL and U). This resulted in 15 combinations each for SFS and DFS as shown in Table 11 and Table 12. There were no Class 4 reaches in the BOP region for SFS, and no Class 1 reaches for DFS. These bespoke sediment classes were used for assessing current state and were also carried through to the scenario assessments.

The Expert Panel's scenario assessments were based on assigning a predicted degree of change to the estimated current state expressed as either A , B, C or D band state (1 = small change within a band, 2 = moderate change and shifting one band, 3 = high change and shifting two bands), a predicted level of effect on other attributes (1 = weak, 2 = moderate, 3 = strong) and an indication of the Panel's confidence in the assessment (1= low, 2 = moderate, 3 = high). The direction of change was assessed as either an improvement (positive) or a degradation (negative, indicated by "-"). When the Panel considered there was likely to be no change or negligible change (i.e. unlikely to be detectable), this was recorded as '0' (= no/negligible change).

Scenario results and key messages

Tables containing detailed results and notes justifying the Expert Panel's assessments are provided in Appendix 4. These detailed tables may be drawn on for various purposes in future but are not for general reading. Summary tables are presented below that will be sufficient for most readers (see Table 1, Table 2, Table 3 and Table 4).

In all four summary tables, the *change* and *effect* assessments are presented relative to current state; i.e., as a comparison against the Panel's estimates of *current* attribute state which were reported separately in similar tables in the State Report (Carter *et al.,* 2023a). The primary purpose of the summary tables in this report is to illustrate the nature of *change* predicted under each scenario.

To see the *endpoint state* of attributes under each scenario for all *biophysical classes*, the predicted changes under each scenario have been applied to the current attribute state reported previously in the State Report (Carter *et al.,* 2023a*).* The predicted end-point states are presented for all scenarios in Appendix 5.

To see the *endpoint state* of attributes under each scenario for *catchments*, it is necessary to refer to subsequent work presented in the Catchments Report (Holland et al., 2023). In that report the Panel's predictions of change for biophysical classes have been translated to produce estimates of *endpoint state* for catchments across the region.

Current land cover + CC scenario (Table 1 and Table 4)

Climate change is generally expected to bring negative effects for water quality and ecology (e.g., arising from increased water temperatures, more dry and hot days, increased extreme rainfall and associated flood and erosion intensities). This will especially be the case if negative effects are not offset by management to increase the resilience of freshwater ecosystems to climate change, as is assumed under the Climate Change scenario on its own.

The negative change and effects predicted by the Panel were assessed as generally negligible or small for most attributes (see scores of 0 and -1 respectively in Table 1), with the exceptions of water temperature and suspended fine sediment.

Water temperature was predicted to worsen by a whole attribute state band in the V-LG-P class (see single score of -2 in Table 1), while SFS worsened by a state band in two classes and by two state bands in four classes (see scores of -2 and -3 respectively in Table 4). For these latter six sediment classes, the more significant expected declines in the SFS attribute were driven by SedNetNZ modelling work predicting significantly increased erosion under climate change for those classes; the modelling predicted smaller increases in erosion for the nine other sediment classes.

Overall, the Panel concluded that climate change would:

- worsen most attributes at least slightly,
- worsen water temperature significantly in one biophysical class (V-LG-P), and
- worsen SFS significantly in six out of fifteen classes (1EF, 1P, 1PI, 2P, 2PI, 2U).

This assessment outcome was strongly influenced by the fairly short time horizon of 2040 assumed in the Climate Change scenario. The predicted physical impacts of climate change used by the Panel (e.g., temperature, rainfall, heavy rainfall, dry and hot days; see Table 7) are quite small to 2040 but increase out to 2090. In addition, the Panel considered climate changes may act in complex ways, usually negatively but sometimes positively and with conflicting effects on water quality and ecology attributes (see detailed assessment comments in tables in Appendix 4). For some attributes, uncertainty around whether the net effect of climate change would be positive or negative also contributed to the Panel's overall assessment of negligible or small changes to attribute state.

Notwithstanding the messages above, the Panel is confident that the climate is changing, and that effects on water quality and ecological attributes are likely to become generally worse and more detectable beyond 2040.

Current land cover + GMP scenario (Table 2 and Table 4)

Good Management Practices are generally expected to bring improvements for water quality and ecological attributes in waterbodies draining catchments where they are employed. However, the improvements predicted by the Panel were generally negligible or small (see mostly scores of 0 and +1 respectively in Table 2 and Table 4). The only attributes predicted to improve by a whole attribute state band were *E. coli* and dissolved reactive phosphorus (DRP), in the NV-PI and V-HG-P classes, DIN in the NV-PI and V-HG-PI classes and nitrate toxicity in the V-LG-PI class (see scores of +2 in Table 2) and SFS in two sediment classes (see scores of +2 and +3 in Table 4).

The GMP scenario results need careful consideration to avoid under-representing the potential benefits that can be achieved through good practice mitigations. There are several reasons why benefits of mitigations could potentially be greater than reflected by the results from this scenario (see discussion in section 3.2.2).Furthermore, the GMP scenario assumes mitigations apply to agricultural land uses only. There are additional mitigation possibilities that could deliver additional benefits, such as improved practices in forestry and urban land uses, and improvements to fish barriers and spawning habitat (see discussion in section 3.2.2). Such additional mitigations could be considered in future scenarios.

Current land cover + CC + GMP scenario (Table 1, Table 3 and Table 4)

The combined CC + GMP scenario showed the negative effects of climate change dominated over positive mitigations for some attributes (see scores of 0 and -1 for water temperature and macroinvertebrate attributes in Table 1; and see scores of -1 to -3 for SFS and DFS in Table 4). However, in many of these cases the Panel noted GMP mitigation was positive, albeit insufficient to offset negative effects of climate change, and the situation would be worse under climate change without any mitigations. Furthermore, mitigations either offset or dominated over climate change for the remaining attributes (see scores of mostly 0 and some +1 scores in Table 3). These findings point to the importance of at least a moderate level of GMP mitigations to at least compensate some of the detrimental effects of climate change. Further mitigations would help further increase the resilience of rivers in the BOP region to ‘hold ground’ (i.e., at least maintain current state for all attributes) under future climate change.

Table 1 *Summary of the predicted Climate Change Scenario assessment (RCP4.5 at year 2040), compared to current state (2020), for each river attribute in each biophysical/land cover class (V = Volcanic geology, NV = Non-Volcanic Geology, HG = high gradient slope in catchment upstream, LG = low gradient slope in catchment upstream, IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high). Effect is N/A where changes to these attributes will not have any effect on other higher order attributes (see methods section 3.2 for explanation of tiers of attributes).*

Class	Appendix 2A Attributes				Appendix 2B Attributes																Regional Attributes						Other	
	Ammonia Toxicity (NH_4-N)		Nitrate Toxicity (NO_3-N)		*E. coli*		Fish Index of Biotic Integrity (IBI)		Macroinvertebrate Community Index (MCI)		Quantitative MCI (QMCI)		Average Score Per Metric (ASPM)		Dissolved Oxygen (DO)		Dissolved Reactive Phosphorus (DRP)		Water Temperature		Copper (Cu)		Zinc (Zn)		Dissolved Inorganic Nitrogen (DIN)	
	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect
NV-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1	0^{2}	-	-	-	-	0^{2}	0^{2}
NV-EF	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
NV-P	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1	-1	-	-	-	-	0^{1}	0^{1}
NV-PI	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-HG-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{1}	0^{1}	-1^{2}	0^{2}	-	-	-	-	0^{2}	0^{2}
V-HG-EF	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-HG-P	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-HG-PI	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-LG-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1	0^{2}	-	-	-	-	0^{1}	0^{1}
V-LG-EF	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1	0^{2}	-	-	-	-	0^{1}	0^{1}
V-LG-P	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-2^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-LG-PI	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{2}	0^{2}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
U	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{11}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	-1^{1}	0^{1}	0^{1}	-1^{2}	-1^{2}	0^{1}	-1^{1}	0^{1}	-1^{1}	0^{1}	0^{1}

Table 2 *Summary of predicted* ***GMP Scenario*** *assessment, compared to current state (2020), for each river attribute in each biophysical/land cover class (V = Volcanic geology, NV = Non-Volcanic Geology, HG = high gradient slope in catchment upstream, LG = low gradient slope in catchment upstream, IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high). Effect is N/A where changes to these attributes will not have any effect on other higher order attributes (see methods section 3.2 for explanation of tiers of attributes).*

Class	Appendix 2A Attributes				Appendix 2B Attributes														Regional Attributes						Other	
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	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect
NV-IF	0^3	0^3	0^3	0^3	0^3	0^3	0^3	N/A	0^3	N/A	0^3	N/A	0^3	N/A	0^3	0^3	0^3	0^3	0^3	0^3	-	-	-	-	0^3	0^3
NV-EF	0^3	0^3	0^3	0^3	0^3	0^3	0^3	N/A	0^3	N/A	0^3	N/A	0^3	N/A	0^3	0^3	0^3	0^3	0^3	0^3	-	-	-	-	0^3	0^3
NV-P	0^2	0^2	0^2	0^2	1^2	0^2	0^2	N/A	0^1	N/A	1^1	N/A	1^1	N/A	1^2	0^2	1^1	0^1	1^1	0^1	-	-	-	-	0^1	0^1
NV-PI	1^2	1^2	1^2	0^2	2^2	0^2	0^2	N/A	0^1	N/A	1^1	N/A	1^1	N/A	1^1	0^1	2^1	1^1	1^1	0^1	-	-	-	-	2^1	1^1
V-HG-IF	0^3	0^3	0^3	0^3	0^3	0^3	0^3	N/A	0^3	N/A	0^3	N/A	0^3	N/A	0^3	0^3	0^3	0^3	0^3	0^3	-	-	-	-	0^3	0^3
V-HG-EF	0^3	0^3	0^3	0^3	0^3	0^3	0^3	N/A	0^3	N/A	0^3	N/A	0^3	N/A	0^3	0^3	0^3	0^3	0^3	0^3	-	-	-	-	0^3	0^3
V-HG-P	0^2	0^2	0^2	0^2	1^2	0^2	0^2	N/A	0^1	N/A	1^1	N/A	1^1	N/A	0^2	0^2	2^1	0^1	1^1	0^1	-	-	-	-	0^1	0^1
V-HG-PI	1^2	0^2	1^1	0^1	1^1	0^1	0^2	N/A	1^1	N/A	1^1	N/A	1^1	N/A	1^1	0^1	1^1	0^1	1^1	0^1	-	-	-	-	2^1	1^1
V-LG-IF	0^3	0^3	0^3	0^3	0^3	0^3	0^3	N/A	0^3	N/A	0^3	N/A	0^3	N/A	0^3	0^3	0^3	0^3	0^3	0^3	-	-	-	-	0^3	0^3
V-LG-EF	0^3	0^3	0^3	0^3	0^3	0^3	0^3	N/A	0^3	N/A	0^3	N/A	0^3	N/A	0^3	0^3	0^3	0^3	0^3	0^3	-	-	-	-	0^3	0^3
V-LG-P	0^2	0^2	0^2	0^2	1^2	0^2	0^2	N/A	0^1	N/A	0^1	N/A	0^1	N/A	1^1	0^1	1^2	0^2	1^1	0^1	-	-	-	-	0^2	0^2
V-LG-PI	1^2	1^2	2^2	1^2	2^2	0^2	0^2	N/A	1^1	N/A	1^1	N/A	1^1	N/A	1^1	0^1	1^2	0^2	1^1	0^1	-	-	-	-	1^2	1^2
U	1^2	0^2	0^2	0^2	0^2	0^2	0^2	N/A	0^2	N/A	0^2	N/A	0^2	N/A	0^2	0^2	0^2	0^2	0^2	0^2	0^3	0^3	0^3	0^3	1^2	0^2

Table 3 Summary of predicted Climate Change + GMP Scenario assessment, compared to current state (2020), for each river attribute in each biophysical/land cover class (V = Volcanic geology, NV = Non-Volcanic Geology, HG = high gradient slope in catchment upstream, LG = low gradient slope in catchment upstream, IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high). Effect is N/A where changes to these attributes will not have any effect on other higher order attributes (see methods section 3.2 for explanation of tiers of attributes).

Class	Appendix 2A Attributes				Appendix 2B Attributes														Regional Attributes						Other	
	Ammonia Toxicity (NH_4-N)		Nitrate Toxicity (NO_3-N)		*E. coli*		Fish Index of Biotic Integrity (IBI)		Macroinvertebrate Community Index (MCI)		Quantitative MCI (QMCI)		Average Score Per Metric (ASPM)		Dissolved Oxygen (DO)		Dissolved Reactive Phosphorus (DRP)		Water Temperature		Copper (Cu)		Zinc (Zn)		Dissolved Inorganic Nitrogen (DIN)	
	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect
NV-IF	0^2	0^2	0^2	0^2	0^1	0^1	0^1	N/A	-1^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	0^2	0^2	-1^2	0^2	-	-	-	-	0^2	0^2
NV-EF	0^1	0	0^2	0^2	0^1	0^1	0^1	N/A	-1^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	0^1	0^1	-1^1	0^1	-	-	-	-	0^1	0^1
NV-P	0^2	0^2	0^1	0^1	0^1	0^1	0^1	N/A	-1^1	N/A	0^1	N/A	-1^1	N/A	0^1	0^1	1^1	0^1	0^1	0^1	-	-	-	-	0^1	0^1
NV-PI	1^1	1^1	1^1	$\mathbf{0}^1$	1^1	0^1	0^1	N/A	-1^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	1^1	0^1	0^1	0^1	-	-	-	-	1^1	1^1
V-HG-IF	0^2	0^2	0^2	0^2	0^1	0^1	0^1	N/A	0^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	0^2	0^2	-1^2	0^2	-	-	-	-	0^2	0^2
V-HG-EF	0^1	0^1	0^2	0^2	0^1	0^1	0^1	N/A	0^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	0^2	0^2	-1^2	0^2	-	-	-	-	0^1	0^1
V-HG-P	0^2	0^2	0^1	0^1	1^2	0^2	0^1	N/A	-1^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	1^1	0^1	0^1	0^1	-	-	-	-	0^1	0^1
V-HG-PI	0^1	0^1	1^1	0^1	1^1	0^1	0^1	N/A	0^1	N/A	0^1	N/A	0^1	N/A	0^1	0^1	1^1	0^1	0^1	0^1	-	-	-	-	1^1	0^1
V-LG-IF	0^2	0^2	0^2	0^2	0^1	0^1	0^1	N/A	0^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	0^2	0^2	-1^2	0^2	-	-	-	-	0^1	0^1
V-LG-EF	0^1	0^1	0^2	0^2	0^1	0^1	0^1	N/A	0^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	0^2	0^2	-1^2	0^2	-	-	-	-	0^1	0^1
V-LG-P	0^2	0^2	0^1	0^1	1^1	0^1	0^1	N/A	-1^1	N/A	-1^1	N/A	-1^1	N/A	0^1	0^1	1^1	0^1	-1^1	0^1	-	-	-	-	0^1	0^1
V-LG-PI	1^2	$0/1^2$	2^1	1^1	1^2	0^2	0^1	N/A	0^1	N/A	0^1	N/A	0^1	N/A	0^1	0^1	1^2	0^2	0^1	0^1	-	-	-	-	1^1	0^1
U	1^1	0^1	0^1	0^1	0^1	0^1	0^1	N/A	-1^1	N/A	0^1	N/A	-1^2	N/A	-1^1	-1^1	0^1	0^1	-1^2	-1^2	0^1	-1^1	0^1	-1^1	0^1	0^1

Table 4 *Summary of predicted <u>Climate Change</u>, <u>GMP</u>, and <u>Climate Change + GMP</u> scenario assessments, compared to current state (2020), for each river attribute in each bespoke sediment classification for deposited and suspended sediment (numbers in classifications refer to the sediment classes in the NPSFM. IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high).*

Scenario	Climate Change				GMP				Climate Change + GMP			
	Appendix 2A		Appendix 2B		Appendix 2A		Appendix 2B		Appendix 2A		Appendix 2B	
	Suspended Fine Sediment (SFS)		Deposited Fine Sediment (DFS)		Suspended Fine Sediment (SFS)		Deposited Fine Sediment (DFS)		Suspended Fine Sediment (SFS)		Deposited Fine Sediment (DFS)	
Class	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**
1IF	-1^{2}	-1^{2}	-	-	0^{3}	0^{3}	-	-	-1^{2}	-1^{2}	-	-
1EF	-3^{1}	-2^{1}	-	-	0^{3}	0^{3}	-	-	-3^{1}	-2^{1}	-	-
1P	-3^{1}	-2^{1}	-	-	2^{1}	1^{1}	-	-	-3^{1}	-2^{1}	-	-
1PI	-3^{1}	-1^{1}	-	-	1^{1}	0^{1}	-	-	-3^{1}	-1^{1}	-	-
1U	-1^{1}	-1^{1}	-	-	0^{1}	0^{1}	-	-	-1^{1}	-1^{1}	-	-
2IF	-1^{2}	-1^{2}	-1^{1}	-1^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{2}	-1^{2}	-1^{1}	-1^{1}
2EF	-1^{1}	-1^{1}	-1^{1}	-2^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{1}	-1^{1}	-1^{1}	-2^{1}
2P	-3^{1}	-1^{1}	-1^{1}	-2^{1}	1^{1}	0^{1}	0^{1}	0^{1}	-3^{1}	-1^{1}	-1^{1}	-2^{1}
2PI	-2^{1}	-1^{1}	-1^{1}	-2^{1}	1^{1}	1^{1}	0^{1}	0^{1}	-2^{1}	-1^{1}	-1^{1}	-2^{1}
2U	-2^{1}	-1^{1}	-1^{1}	-1^{1}	0^{2}	0^{2}	0^{2}	0^{2}	-2^{1}	-1^{1}	-1^{1}	-1^{1}
3IF	-1^{1}	-1^{1}	-1^{1}	-1^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
3EF	-1^{1}	-1^{1}	-1^{1}	-1^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
3P	-1^{1}	-1^{1}	-1^{1}	-1^{1}	3^{1}	2^{1}	1^{1}	0^{1}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
3PI	-1^{1}	-1^{1}	-2^{1}	-1^{1}	1^{1}	1^{1}	1^{1}	0^{1}	-1^{1}	-1^{1}	-2^{1}	-1^{1}
3U	-1^{1}	-1^{1}	-1^{1}	-1^{1}	0^{2}	0^{2}	0^{2}	0^{2}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
4IF	-	-	-1^{1}	-1^{1}	-	-	0^{3}	0^{3}	-	-	-1^{1}	-1^{1}
4EF	-	-	-1^{1}	-1^{1}	-	-	0^{3}	0^{3}	-	-	-1^{1}	-1^{1}
4P	-	-	-2^{1}	-1^{1}	-	-	1^{1}	1^{1}	-	-	-1^{1}	0^{1}
4PI	-	-	-2^{1}	-1^{1}	-	-	0^{1}	0^{1}	-	-	-2^{1}	-1^{1}
4U	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA

Natural land cover + CC scenario (Table 1 and Table 4)

The Expert Panel used its estimate of current state in the biophysical/landcover classes dominated by indigenous vegetation (i.e., in classes V-HG-IF, V-LG-IF and NV-IF) as the main basis for predicting attribute states for the natural land cover scenario (without climate change initially), as described in detail in the State Report (Carter et al., 2023a).

This produced predicted attribute states for the Natural land cover scenario that were, unsurprisingly, almost entirely in near reference condition and mostly in A band state. The exceptions were:

- DRP in the NV-IF class which was predicted to be in D band due to naturally high DRP from geological sources,
- D band for SFS in class SFS-3-IF (also predicted to be due to natural causes), and
- D band for DFS in class DFS-3-IF (potentially due to discrepancies between the way soft-bottomed streams are classified in the NPSFM compared to BOP monitoring data).

Summary result tables showing predicted attribute states under Natural land cover (without climate change) are reported in the State Report (Carter et al., 2023a).

The Expert Panel used its previous estimate of climate change on current state for all indigenous vegetation ("IF") classes (as shown in Table 1 and Table 4) as a logical starting point to assess the effects of climate change on the natural land cover scenario. The Panel then undertook further analysis to corroborate this approach. Overall, the Expert Panel predicted the effects of climate change on the Natural land cover scenario state would be very similar to the effects of climate change on current state in indigenous vegetation classes. Hence the results and key messages about climate change given in the previous sub-section (including Table 1 and Table 4) are relevant where they apply to indigenous vegetation classes. Those results have been carried through to predict the endpoint states for river attributes in indigenous vegetation classes, as presented in Appendix 5. To understand the endpoint state for catchments under the Natural land cover + CC scenario, refer to the Catchments Report (Holland et al., 2023).

Hypothetical future land cover + CC, GMP and CC + GMP scenarios (Tables 1 to 4)

The Expert Panel used its estimates of current state for all attributes in all the biophysical/landcover classes as the direct basis for predicting attribute states for the equivalent classes under the Hypothetical Future Land Cover scenario (without CC or GMP initially), as described in detail in the State Report (Carter *et al.,* 2023a). This approach was considered logical because the Panel had identified catchment land cover as a dominant driver of river attribute state. For example, if an area of land currently in class V-LG-PI was assigned a change to V-LG-EF under the Hypothetical Future Land Cover scenario, then the current state estimate for V-LG-EF would provide the likely end point under this scenario, all other things being equal (i.e., assuming no change to current practices on the new land cover, or to mitigations or climate).

This approach produced predicted attribute states for the Hypothetical Future Land Cover scenario (without CC or GMP initially) that were identical, for each given biophysical/landcover class, to the Expert Panel's predictions for current state, as reported in the State Report (Carter *et al.,* 2023a). It followed logically that the important differences arising from the Hypothetical Future Land Cover scenario (without CC or GMP initially) would be the changed *proportions* of each biophysical/landcover class in each catchment. The effect of those changed *proportions* on predicted endpoint state in each catchment was subsequently assessed and is reported in the Catchments Report (Holland *et al.,* 2023).

The remaining task was to assess what effect climate change (CC) and good management practice (GMP) scenarios might have on the attribute states under the Hypothetical Future Land Cover scenario described above. For this the Expert Panel concluded that the results and key messages about climate change, GMP and combined CC + GMP scenario effects on current land cover (including all results in Table 1, Table 2, Table 3 and Table 4) apply equally to the three equivalent Hypothetical Future land cover scenarios. Those results have been carried through to predict the endpoint states for these three scenarios for all biophysical classes, as presented in Appendix 5. To understand the *endpoint* state for *catchments* under the Hypothetical Future land cover + CC, +GMP and CC + GMP scenarios, refer to the Catchments Report (Holland et al., 2023).

Contents

Part 1: **Introduction**

1.1 Context

The National Policy Statement for Freshwater Management 2020 (NPSFM) establishes objectives and policies that direct regional councils' (and other local government authorities) approach to sustainable management of fresh water. Regional councils must notify regional plan changes that fully implement the NPSFM by December 2024. Bay of Plenty Regional Council (BOPRC) has committed to notifying the Regional Natural Resources Plan (RNRP) change which fully implements the NPSFM as well as completing 10 year rolling review of the Regional Water and Land Plan sections of the RNRP by July 2024.

Bay of Plenty Regional Council is implementing an Essential Freshwater Policy Programme (EFPP) to deliver on the requirements in the NPSFM, and 10-year rolling reviews of the RNRP. Part of this implementation involves identifying the baseline state of attributes across the region[5], current state[6], estimating contaminant sources from within the catchment, and estimating outcomes of alternative future management scenarios to assist with policy decision-making. The NPSFM also requires that the best information available at the time is to be used to make such assessments, and this may include model outputs in the absence of monitoring data[7]. There is also a clear directive in the NPSFM not to delay any decisions due to uncertainty[8], although this uncertainty should be reduced where practicable and noted in any modelled assessments.

As part of the EFPP, Carter et al., (2021a) identified immediate modelling needs required to support policy issues and options development, as well as mid-long term modelling needs. The authors went on further to recommend the use of existing bespoke models where they are currently available or in development, and then use an Expert Panel in place of other detailed bespoke modelling to address immediate information needs.

The recommendation for mid-long term modelling needs was to have a coordinated approach to reviewing environmental, social, cultural, and economic modelling. This would involve thorough exploration of the various models (including cultural models) that could be used to meet not only modelling needs, but support water accounting, assessment and reporting (Carter et al., unpublished).

1.2 Purpose and objectives of the Expert Panel

A full description of the Expert Panel's process, timeframe and Terms of Reference are provided in Appendix 1 in Carter et al., (2023a). A summary is provided below.

The Expert Panel membership included external experts as well as internal experts from BOPRC. Two internal experts were part of the Expert Panel; BOPRC Senior Scientists Paul Scholes and Alastair Suren. Both these experts have over 20 years of experience in

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[5] NPSFM Clause 3.10(3)

[6] NPSFM Clause 3.30 (2) (b)

[7] NPSFM Clause 1.6 (2)

[8] NPSFM Clause 1.6 (3)

environmental science and resource management and extensive local knowledge. Paul Scholes specialises in river and lake water quality, geothermal systems and groundwater and Alastair Suren specialises in freshwater ecology.

Four external experts were part of the Expert Panel: Ned Norton (Land Water People), Joanne Clapcott (Cawthron Institute), Chris McBride (LimnoTrack) and Paul Franklin (NIWA). Three of these experts (Ned Norton, Joanne Clapcott and Paul Franklin) were part of the Greater Wellington Regional Council's Expert Panels in 2020 and brought significant experience from that process to BOPRC. Chris McBride has extensive knowledge of the Rotorua Te Arawa Lakes and expertise in data management and reporting which was a significant benefit to BOPRC and the Expert Panel. Collectively, these external experts specialised in water quality, lake ecosystems, freshwater ecology, freshwater management and the science/policy interface. Many of the external experts were also engaged in national initiatives to support implementation of the NPSFM, and where not bound by confidentiality any relevant information was shared with the Expert Panel to support their decision-making.

The purpose of the Surface Water Quality and Ecology Panel (the Expert Panel) was to provide expert advice and judgement on the state (past, present and future) of water quality and ecological attributes across the Bay of Plenty (BOP) region. This included estimating current state where no (or limited) monitoring data existed (reported in Carter et al., 2023), as well as estimating state under a natural land cover scenario, effects from a climate change scenario, a good management practice scenario, and a hypothetical future land cover scenario. The Expert Panel was also tasked with providing estimates of contaminant sources likely to be contributing to current attribute states. The focus of the Expert Panel was on land-based catchments. Work is already underway by BOPRC on many of the estuarine attributes (e.g., current state, susceptibility assessments, and contaminant load reductions required for healthy estuaries).

The Expert Panel was an alternative approach to developing bespoke catchment water quality and ecology models across the region to address immediate policy needs. It is acknowledged that impacts on Mahinga Kai will also need to be assessed, however this was not part of the Expert Panel role. Advice on cultural modelling, monitoring and assessment will be sought from Ngā Kaitohutohu and BOPRC's ongoing direct engagement with tangata whenua. Outcomes from this Expert Panel and all cultural assessments, evaluations or modelling will be jointly considered by BOPRC alongside other information available when evaluating issues and options.

The Expert Panel's work took place in three phases. Phase 1 assessed current state of river water quality and ecological attributes where there was no monitoring data and broad estimates of contaminant contributions for key river contaminants. Phase 2 estimated the likely change in state of river water quality and ecological attributes under natural land cover and estimated the impact on water quality and ecological attributes from hypothetical future scenarios including land use, climate change and full implementation of good management practice. Phase 3 estimated likely state of lake water quality and ecological attributes under natural land cover and estimated the change on water quality and ecological attributes from hypothetical future scenarios including land use, climate change and full implementation of good management practice. Phase 1 assessments started in August 2021 and phase 3 assessments were completed in October 2022. Reporting for all three phases was completed in 2023. Separate to the Expert Panel's work, baseline and current state for monitored sites was reported in Zygadlo et al., (2022).

The Expert Panel's objectives were to:

(a) Refine and agree on the general assessment methodology.

(b) Collate relevant technical information (journal articles, reports, monitoring data, modelling information and any other relevant publications) to add to a Resource Index to inform the work of the Expert Panel.

(c) Develop a shared understanding of the bio-physical state of surface water quality and ecology in the region (via information provided by BOPRC based on the NPSFM and additional regional attributes).

(d) Estimate current state (as defined in the NPSFM) for water quality and ecology attributes where there are no, or limited, monitoring data.

(e) Estimate attribute states under naturalised land cover for the region.

(f) Evaluate the impacts that different hypothetical land and water use scenarios are likely to have on water quality and ecology attributes (primarily related to NPSFM attributes, but not limited to these).

(g) Estimate the relative contributions from sources of contaminants by category of land use and point source discharges.

(h) Identify and explain situations where attribute states are below national bottom lines due to natural causes.

(i) Review Expert Panel summaries (drafted by BOPRC) for each assessment unit for each of the various attributes which includes:

- estimated state,
- comment on the effect and level of confidence in the assessment,
- identification of relative contributions of sources of contaminants (i.e., by land use or point source discharges), and
- high-level explanatory comments about the decision-making process.

1.3 Purpose and structure of this report, and relation to other reports

This report details the process, methods, and results of the Expert Panel's assessments of effects of selected scenarios on river attributes. This is the fourth report in a series of six reports outlined below that should be considered together. This fourth report builds on material provided in the first three reports:

1 Expert Panel estimates of water quality and ecological attributes under Current State, Natural Land Cover and a hypothetical future land cover scenario (Carter et al., 2023). For ease, this is referred to as the 'State Report'.

2 Development of spatial classifications in the Bay of Plenty region (McBride 2023a). These classification systems were used by the Expert Panel to conduct and present their work. For ease, this is referred to as the 'Classifications Report'.

3 Expert Panel estimates of sources of key river contaminants in the Bay of Plenty region. (McBride et al., 2023b). For ease, this is referred to as the 'Sources Report'.

4 Expert Panel estimates of change to river water quality and ecological attributes under scenarios of climate change and land management (Zygadlo et al., 2023) – this report. For ease, this is referred to as the 'Scenarios Report'.

5 Expert Panel summaries of river water quality and ecological attribute states under different land cover, land management and climate scenarios for catchments in the

Bay of Plenty region (Holland et al., 2023). For ease, this is referred to as the ‘Catchments Report’.

6 Expert Panel estimates of lake water quality and ecological attribute states under different scenarios in the Bay of Plenty region (McBride et al., in prep). For ease, this is referred to as the ‘Lakes Report’.

In addition, the work of the Expert Panel has been documented in an online interactive application that allows users to view and interact with the results spatially. Visit https://www.boprc.govt.nz/EXPERT.

The present report is structured to provide an introduction and background (Part 1), the methodology for assessing scenarios (Part 22.1), and a summary of scenario assessment results (Part 3). The report also has a set of appendices that contain details that may be drawn on for various purposes in future, but which are not for general reading.

Part 2: **Methodology**

2.1 Methodology

For a full description of the process and methodology of the Expert Panel see the earlier report presenting assessments of current state (Carter *et al.,* 2023a), and in particular Appendix 1 of that report which contains the Panel's Terms of Reference, administrative and timeframe details. The methodology described below provides the details most relevant for the scenario assessment work that is the subject of this report.

2.2 Attributes assessed

A full description of the attributes assessed by the Expert Panel is provided in Carter et al., (2023a). By way of summary, the list of river attributes used for the scenario assessment is shown in Table 5 below. These attributes include some of the nationally compulsory river-specific attributes in Appendices 2A and 2B in the NPSFM, as well as regionally recommended attributes (Carter et al., 2017, Scholes et al., *unpublished*). It is noteworthy that some nationally compulsory attributes were not assessed directly by the Expert Panel, including the attributes periphyton, dissolved oxygen (below point sources), *E. coli* (Primary Contact), Planktonic Cyanobacteria (Lake-fed Rivers) and Ecosystem Metabolism. For these attributes the available data, reports and other information were provided to the Expert Panel to support their assessment of other attributes where relevant. Specific explanations for each of these are:

- Periphyton (Table 2 in NPSFM) was not included for Expert Panel assessment because BOPRC had a regional Periphyton Model (Kilroy et al., 2020), and the national periphyton model (Snelder et al., 2021), supported by regional periphyton monitoring. This information was used to provide baseline and current state assessments for periphyton in the BOP region (Kilroy et al., 2020, Zygadlo et al., 2022). Baseline and current state from monitored data were also provided to the Expert Panel to support their assessments for other response attributes such as macroinvertebrates, fish and dissolved oxygen.
- Dissolved Oxygen (DO) below point sources (Table 7 in NPSFM) and *E. coli* for primary contact sites (Table 22 in NPSFM) were not included in the Expert Panel assessment given the site-specific nature of these attributes. It was agreed by BOPRC and the Expert Panel that monitoring site data was the best information available to assess these two attributes at those particular sites. These monitoring data were available to the Expert Panel but were not generally used to support their assessments of dissolved oxygen at locations without point discharges, or of *E. coli* beyond primary contact sites.
- Planktonic Cyanobacteria was not assessed in lake-fed rivers (Table 10 in NPSFM) as monitoring data provided the best available information to assess this attribute at specific sites.
- Bay of Plenty Regional Council has no monitoring data available for Ecosystem Metabolism (EM). While some EM data have been collected in the region for research projects (e.g., Clapcott et al., 2010), it was not collected in the years defining Current State. As such, the Expert Panel did not feel they had sufficient information to estimate Current State for EM, especially given there are no numeric attribute state bands. Instead, the Expert Panel recommended BOPRC commence

data collection of EM (which all Regional Councils and Unitary Authorities need to do as part of NPSFM implementation) to enable attribute state bands to be developed and to allow assessment of current state in future.

Assessed attributes were assigned into different tiers based on how directly they are affected by changes in land use, infrastructure and water allocation and their influence on other attributes. Within each tier, attributes were further ordered as needed to ensure that a specific attribute is not assessed before others that have a direct influence over them. The attribute tiers and the specific attributes are described below.

- Tier 1 attributes – Attributes that are directly affected by a change in land use, infrastructure and water allocation.
- Tier 2 attributes – Water quality and physical habitat attributes that are indirectly affected by a change in land use, infrastructure and water allocation (i.e., changes are the result of changes in Tier 1 attributes).
- Tier 3 attributes – Ecosystem and water quality attributes that quantify the response of higher trophic levels to Tier 1 and 2 (and other) changes.

Table 5 Attributes used for scenario assessments for rivers. Table numbers refer to the relevant table in Appendix 2 of the NPSFM.

Attributes Assessed by Expert Panel	Attributes not assessed by Expert Panel
Tier 1	**Tier 1**
Nitrate-Nitrogen (NO_3-N)	*Escherichia coli (E. coli) – Primary Contact*
Ammoniacal Nitrogen (NH_4-N)	
Dissolved Inorganic Nitrogen (DIN)	
Dissolved Reactive Phosphorus	
Suspended Fine Sediment (SFS)	
Sediment Copper (Cu) and Zinc (Zn)	
Escherichia coli (E. coli)	
Tier 2	**Tier 2**
Deposited Fine Sediment (DFS)	Planktonic Cyanobacteria (Lake-fed Rivers)
Tier 3	
Dissolved Oxygen	Dissolved Oxygen (Point Sources)
Macroinvertebrate Community Index (MCI)	Ecosystem Metabolism
Quantitative Macroinvertebrate Community Index (QMCI)	Periphyton
Average Score Per Metric (ASPM)	
Fish Index of Biotic Integrity (FishIBI)	

2.3 Scenarios assessed

The Expert Panel estimated the extent of change in river attribute state from current state under a supplied set of different scenarios[9]. The time horizon for future scenario assessments was 2040 to align with both available climate change predictions, and to cover a full period of future implementation and review of regional plans (Pearce *et al.,* 2019). The main scenarios are listed below and are described in the following sections 2.3.1 to 2.3.7 respectively:

- Climate change (CC)
- Good Management Practices (GMP)
- Combined CC + GMP
- Natural land cover
- Hypothetical Future land cover

The first three of these scenarios can be applied in combination with the Current land cover case, the Natural land cover case, or the Hypothetical Future land cover case, as illustrated in Table 6.

The Expert Panel's estimates of river attribute states under current land cover (i.e., Current State) and under the Natural and Hypothetical Future land cover cases are all detailed in Carter et al., (2023a). Those estimates formed the basis for comparison when evaluating the other scenarios in this report.

Hence there were seven possible scenario combinations that the Expert Panel was asked to assess for this report, as follows (noting that the GMP scenario is not applicable to the Natural land cover case):

- Current land cover + CC
- Current land cover + GMP
- Current land cover + CC + GMP
- Natural land cover + CC
- Hypothetical Future land cover + CC
- Hypothetical Future land cover + GMP
- Hypothetical Future land cover + CC + GMP

[9] The intention from BOPRC was to explore the impact of different land use change scenarios (e.g., natural land cover, possible future land cover), and to also include foreseeable impacts from climate change and some specified good management practice mitigations. These were exploratory scenarios only. At the time of assessment BOPRC's consultation with iwi and the wider community had not developed specific proposed solutions packages to test as scenarios.

Table 6 Scenario Terminology for scenarios assessed by the Expert Panel

Land Cover Scenarios	Farming/growing practices			Climate Change	Combined GMP and Climate Change
	None	Current Practice	Good Management Practice (GMP)		
A. Natural	Natural Land Cover	N/A	N/A	Natural + CC	N/A
B. Baseline	N/A	*	*	*	*
C. Current State	N/A	Current State	Current + GMP	Current + CC	Current + GMP + CC
D. Hypothetical Future	N/A	Future Land Cover	Future + GMP	Future + CC	Future + GMP + CC

**Assumed Baseline State = Current State*

2.3.1 Climate Change (CC) scenario

Assessing possible changes for our future climate due to human activity is difficult because climate projections depend strongly on estimates for future greenhouse gas concentrations. Those concentrations depend on global greenhouse gas (GHG) emissions that are driven by factors such as economic activity, population changes, technological advances and policies for sustainable resource use. In addition, for a specific future trajectory of global greenhouse gas emissions, different climate model simulations produce somewhat different results.

This range of uncertainty has been illustrated by the IPCC through consideration of four 'scenarios' that describe alternative possible future concentrations of greenhouse gases in the atmosphere. These are referred to as the Representative Concentrations Pathways or RCP scenarios and are abbreviated as RCP2.6, RCP4.5, RP6.0, and RCP8.5. The numbers refer to the 'radiative forcing' by greenhouse gases (in Watts per m^2) which is a measure of the energy absorbed and retained in the lower atmosphere; the higher the number the more radiant energy reaches the Earth. Each scenario represents a different pathway based on assumptions about economic activity, energy sources, population growth and other socio-economic factors which represent a range of 21st century climate policies:

- RCP2.6, also called the 'mitigation' scenario, requires strong mitigation efforts and leads to low greenhouse gas concentrations.
- RCP4.5 is an intermediate 'stabilisation' scenario where greenhouse gas emissions peak around 2040 and then decline, with greenhouse gas concentrations stabilising by 2100.
- RCP6.0 is also a 'stabilisation' scenario, where greenhouse gas emissions peak around 2080 and then decline, with greenhouse gas concentrations stabilising by 2100.
- RCP8.5, the 'business as usual' scenario has very high greenhouse gas concentrations, which is considered to be the likely outcome if society does not make concerted efforts to cut greenhouse gas emissions.

These scenarios are outlined in Figure 1.

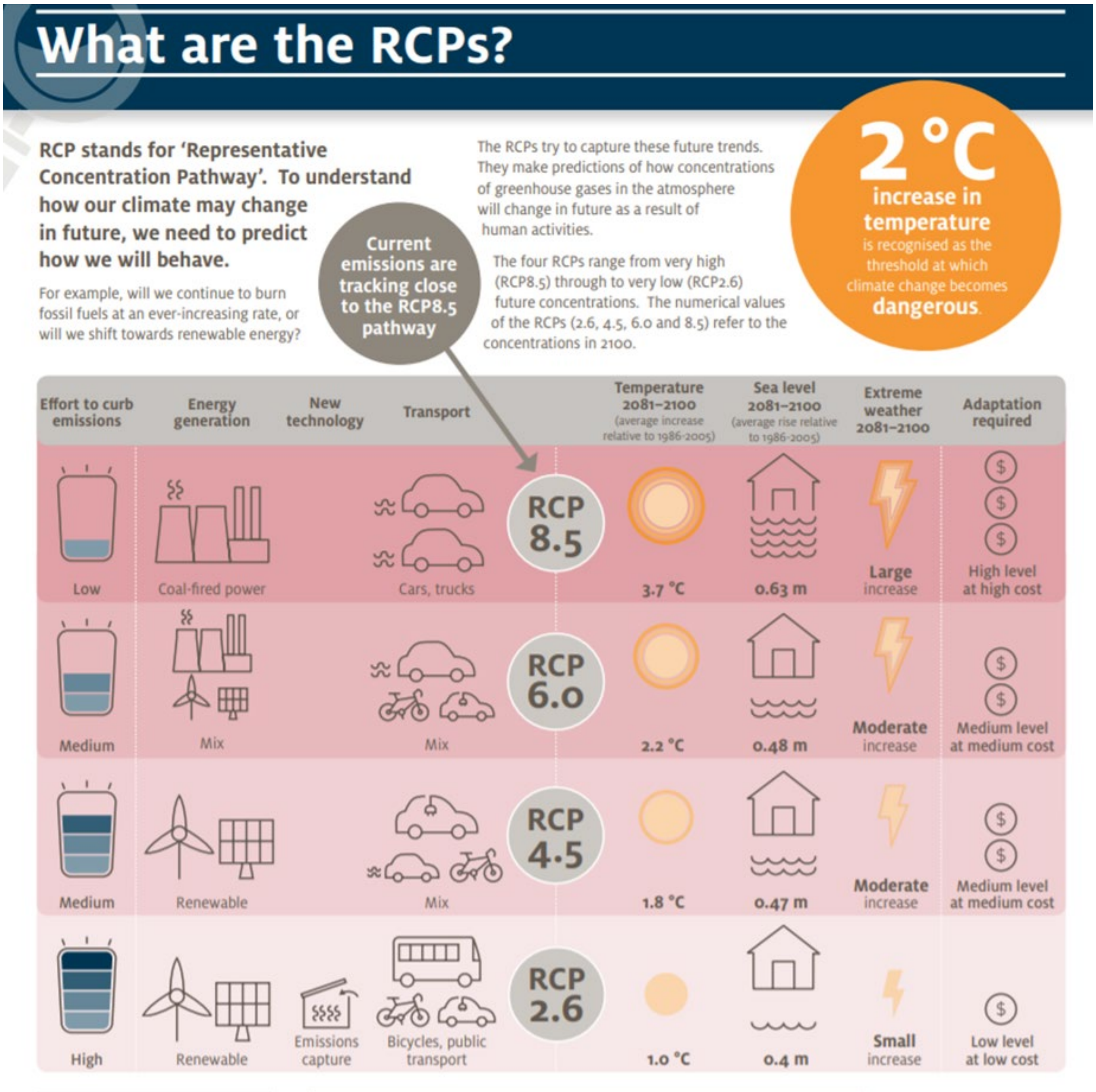

Figure 1 Representative Concentration Pathways summary

In 2019, BOPRC commissioned a NIWA report on [Climate Change Projections and Impacts for the Bay of Plenty Region] (Pearce et al., 2019; an update of their 2011 report). The report analyses projected climate changes for the Bay of Plenty Region for 24 different climate variables out to 2100 and draws on climate model simulations from the IPCC's Fifth Assessment Report, reported by MfE (2018). The report also addresses potential impacts of climate change on some of Bay of Plenty's environments and sectors including impacts on sea level rise, biosecurity and pests, drought and future pasture growth, horticulture, forestry, and health.

2.3.2 BOPRC climate change reference scenario

To ensure clarity and consistency across the organisation, BOPRC have a standard climate change reference scenario which should generally be used to inform all modelling and assessments, unless there is good reason to adopt a different set of assumptions. BOPRC's usual reference scenario draws on data from the 2019 NIWA report (Pearce et al., 2019) and is based on the RCP8.5 scenario as being the current 'business as usual' scenario. Using this scenario is a precautionary approach in that it prepares for a situation where global greenhouse gas emissions might continue on their current pathway (i.e., assuming no mitigations). An alternative is to assume that current government and international policy commitments to mitigations are met, such as generally illustrated by the RCP4.5 scenario.

Bay of Plenty Regional Council chose to set the RCP4.5 scenario as the basis for the Expert Panel's assessment of climate change in this report. The main justification for this choice was the time horizon for scenario assessments was set at the year 2040 and it was observed that the impacts predicted by Pearce et al., (2019) for the RCP8.5 and RCP4.5 scenarios were very similar for the relatively short time period to 2040. The projected impacts of these two scenarios diverge significantly by 2100, with the RCP8.5 scenario becoming worse than the RCP4.5 scenario with time. The changes predicted by Pearce et al., (2019) for the BOP region under RCP4.5 are shown in Table 7. See Pearce et al., (2019) for further detail including summaries of projected seasonal changes.

Table 7 RCP 4.5 summary impacts (medium effort to reduce emissions), from Pearce et al. (2019). (Note that ranges illustrate the differences that may occur across different parts of the region)

	Historic	2040	2090	General direction of change
Annual mean temp	14-15°C	0.5°C -1.0°C increase	1.0°C -1.5°C increase	Increase
Maximum temperature	Central / coastal: 19°C -20°C Inland: 15-16°C	0.5°C -1.0°C increase	1.0°C -1.5°C increase	Increase
Minimum temperature	Central / coastal: 9°C -11°C Inland: 5°C -6°C	0.5°C -1.0°C increase	1.0°C -1.5°C increase	Increase
# Hot days (>25°C)	25-45 days	1-25 days increase	20-40 days increase	Increase
Extreme hot days (>30°C)	0-1 days	0-2 days increase	0-4 days increase	Increase
Annual rainfall	1,000-3,500 mm/year	± 0-4 %	2-4 % decrease	Decrease
Extreme rainfall average of 240 mm over 24 hours	1 in 100-year event	1 in 70-year event	1 in 57-year event	Increase
Sea level (above Moturiki Vertical Datum 1953)	0.09 m (current)	0.27 m	0.57 m	Increase
Diurnal temperature range	Central: 1°C 1-12°C Inland: 8°C -9°C	± 0-0.5°C	0°C -1°C increase	Increase
Heatwave days	1-35 days	0.1-30 days increase	2-30 days increase	Increase
Frost days	5-70 days	1-10 days decrease	1-15 days decrease	Decrease
Growing degree days	600-1,900 days	200-300 days increase	300-500 days increase	Increase
Wet days (> 1 mm rainfall)	100-220 days	2-8 days decrease	2-15 days decrease	Decrease
Heavy rain days (>25 mm daily rainfall)	7-40 days	±0-1 day	1-3 days decrease	Decrease
Maximum 1 day rainfall	60 mm-160 mm	0 mm-10 mm decrease	0 mm-35 mm increase	Increase
Dry days (< 1 mm rainfall)	120-240 days	Inland: 4-6 days increase Coastal: 2-6 days decrease	Inland: 8-15 days increase Coastal: 0-4 days increase	Increase
Potential evapotranspiration deficit	20 mm-300 mm	60 mm-120 mm increase	80 mm-140 mm increase	Increase
Soil moisture deficit days	60-240 days	Inland: 8-15 days increase Coastal: 4-8 days decrease	Inland: 15-25 days increase Coastal: 0-6 days increase	Increase
Annual mean wind speed	-	0-2% reduction	0-2% reduction	Decrease
Relative humidity	-	0-1% reduction	0-1.5% reduction	Decrease

2.3.3 Specific climate data used in Expert assessments

Given all the climate data available from the NIWA modelling, the Expert Panel identified five spatial layers that were considered the most important for the change assessments:

- Dry Days
- Heavy Rain Days
- Rainfall
- Temperature
- Hot days.

For these five layers, the change from current for both annual and summer results were summarised for each biophysical/landcover or bespoke sediment classification classes to provide a generic indication of the likely trends for that class (e.g., relative change in temperature, frequency or intensity of rain or dry events). Summer data statistics were chosen in addition to the annual data statistics because summer is generally the period of highest stress on freshwater ecosystems (through highest water temperatures, lowest flows, highest abstraction for irrigation) and is likely the most limiting period for ecological attributes. Examining the annual data allowed consideration of significant rain events during the year, while the summer data allowed consideration of temperature, dry days and hot days at the time of year when these are most likely to have significant impact on ecological attributes.

Whilst Sea Level Rise (SLR) is an important consideration for estimating impacts from climate change, the location-specific nature of SLR did not lend itself to incorporation into the Expert Panel's biophysical/landcover classification used for climate change assessments. The Expert Panel agreed that consideration of SLR was best addressed when considering land use change scenarios using the catchment cluster classification analysis (reported separately in Holland et al., (2023*)*. This would allow direct consideration of where the anticipated SLR is likely to occur and the likely impacts on relevant catchment clusters.

For SedNetNZ modelling data, the change in sediment load and yield for RCP4.5 were summarised for the bespoke sediment classifications. No seasonal information was available for SedNetNZ modelling. The predicted changes in sediment loads were then translated into water clarity (for SFS) and DFS attribute bands using equations from the literature as described for the GMP scenario below.

2.3.4 Good Management Practice (GMP) scenario

Although several attempts were made by BOPRC to source current practice data from industry groups covering dairy, horticulture, forestry and sheep and beef, in general information was either non-existent or not provided by these groups. Information that was provided is summarised in various e-mails and meeting notes. However, discussions with the Expert Panel in late 2021 determined that the Panel would not have been able to process 'raw' current practice (input) information anyway. The Expert Panel members are experts at assessing freshwater state and change due to lesser or greater amounts of contaminants, physical stressors and/or water quantity stressors. The Panel members are not experts in estimating the effectiveness of various on-farm mitigation measures to reduce contaminant losses. As such, the Panel sought the best estimate of effectiveness (percentage contaminant reductions) available from people with the expertise and/or experience to be able to do that. The Panel acknowledged that such estimates are difficult to make and typically span a broad range across different settings.

Summary and recommended approach

This section describes recommended assumptions about the effectiveness of 'Good Management Practice' (GMP) mitigation in reducing contaminant losses from productive land. The recommended approach is summarised in Table 8 below.

Table 8 Recommended approach for GMP effectiveness, expressed as the percentage change in losses for nitrogen (% Δ N), phosphorus (% Δ P), E. coli, and sediment in each of four land use classes. Note that Dairy and Kiwifruit/horticulture are equivalent to the PI landuse classification, while Drystock and Arable are equivalent to the P classification.

	GMP effectiveness							
	% Δ N			% Δ P			% Δ *E. coli*	% Δ Sediment
	Max	Mid	Min	Max	Mid	Min		
Dairy	-28%	-25%	-13%	-22%	-15%	-7%	-38%	Use SedNetNZ model
Drystock	-10%	-5%	0%	-38%	-20%	-6%	-24%	
Kiwifruit/horticulture		-9%	-5%		0%		0%	
Arable		-10%			-8%		0%	

The Expert Panel initially requested a single effectiveness figure per land use (as shown in the Mid column for nutrients in Table 8), as opposed to different figures for different land use typologies. However, the Panel acknowledged that effectiveness would vary in different settings and asked for that to be provided as range estimates. The range of estimates for different land use typologies is included under the Max and Min columns in Table 8 and the literature sources used are summarised in Appendix 1.

The nutrient loss effectiveness figures are the rounded average of those reported in Matheson *et al*., (2018) (for the M1 or 'GMP' bundle of mitigations), and/or of relevant dairy and sheep & beef typologies reported in McDowell *et al.,* (2021) (for the 2015 potential scenario). Note these only reflect changes in base flow leaching losses, as estimated in OVERSEER[10]. A proportion of nutrient losses also occurs through quick flow or surface flow; this is not considered.

Baseline uptake of mitigation practices was dealt with differently in Matheson et al., (2018) and McDowell et al., (2021). Matheson et al., (2018) assumed nil baseline uptake of the modelled mitigation practices. In contrast, McDowell et al., (2021) assumed a baseline (but unreported) level of implementation as of 2015 and estimated effectiveness for a potential scenario where full uptake of existing mitigation practices, as of 2015, was in place. There is generally a high level of uncertainty about baseline uptake of mitigation practices. There are also occasional anecdotal reports of deliberately poor practices (e.g., highly inefficient use of fertiliser in the Pongakawa Catchment) which could effectively cancel out (at least some of) the benefit of baseline uptake of mitigation. Therefore, baseline uptake of mitigation is not addressed in the nutrient columns in Table 8.

[10] BOPRC recognises the issues recently highlighted in regard to the use of OVERSEER. However, it is considered the best available information at this time and its use therefore reflects the direction of the NPSFM.

Mitigation effectiveness figures for *E. coli* come from Muirhead (2017) and are only relevant to dairy and drystock land areas. These were modified to account for baseline implementation levels (particularly given the high baseline implementation level for riparian fencing for dairy land) and the cumulative effect of various mitigation practices.

No explicit consideration of the cost or viability of mitigation practices was made. Matheson et al, (2018) assessed two higher cost mitigation bundles (called M2 and M3) but these were considered by those authors to be unaffordable for most of the farm system types considered. Likewise, McDowell et al., (2021) presented a 2035 potential scenario including "emerging" mitigations but again, no consideration was made of cost or viability. For example, N-inhibitors like DCD that were included in the McDowell et al., (2021) potential 2035 scenario have long been considered unviable, although there is ongoing research on the development of new ones. Likewise, detention bunds (also included in the potential 2035 scenario) were assessed by Matheson et al, (2018) as being prohibitively expensive in the BOP region and viable only in catchments with favourable characteristics for their construction. Given the uncertainty around cost viability of the M2, M3 and McDowell et al., (2021) mitigation bundles, BOPRC made the decision to define the GMP scenario as more or less the M1 bundle (as reflected in Table 8). Therefore, the GMP scenario assessed here reflects a more modest level of potential contaminant reduction than what might be possible from more emerging mitigation options in the future.

SedNetNZ Best Practice modelling

For sediment, the Expert Panel used the outputs from the 2021 SedNetNZ model of the region (Vale et al., 2021), which included a "good practice erosion mitigation scenario" that included riparian fencing and planting, setbacks and detainment bunds. This best practice scenario does not completely line up with the BOPRC GMP scenario as the two scenarios were developed at different times for different purposes. When the mitigation bundles were created, detainment bunds were not included in the GMP (M1) bundle because they are only effective in some locations and for the BOP region were considered to be a higher cost mitigation (Matheson et al., 2018) as described in the previous section. Consequently, the best practice results from SedNetNZ are not directly comparable to the GMP (M1) scenario that is used by the Expert Panel. However, given the SedNetNZ modelling was considered to be the best available information, the Expert Panel used these results to support their assessments acknowledging this key difference between best practice management for erosion-sourced sediment (affecting both SFS and DFS attributes) and the M1 level GMP mitigation applied to assess the remaining attributes.

Suspended Fine Sediment – Applying mitigation information to the bespoke sediment classes

The Expert Panel discussed several options for translating the mitigation effectiveness information from the SedNetNZ modelling report (Vale *et al*., 2021) into the Panel's bespoke sediment classes. These included: i) taking a weighted average of the modelled mitigation effectiveness estimates for each class; ii) attributing reductions in sediment losses to overall load; iii) only assessing classes where mitigation effectiveness data were available; and iv) using the catchment clusters as the spatial class to allow proportioning of mitigation effectiveness into load, then converting to estimated effects on water clarity.

The Panel agreed that the most technically feasible way to apportion the mitigation effectiveness figures to the spatial classifications would be to apportion them to estimate reductions in load for each catchment, then translate the adjusted catchment loads into new estimates of water clarity using relationships from available literature. Manaaki Whenua Landcare Research could undertake this process based off the SedNetNZ model. However, the timeframe required for them to undertake this analysis was unlikely to meet assessment timelines. The Expert Panel therefore opted to provide 'interim' assessments and made these at the bespoke sediment classification scale to enable the use of the current state estimates in Carter et al. (*in prep*).

To estimate water clarity, the Panel used the equation from Hicks et al., (2019) and applied changes in sediment loading estimated from the SedNetNZ model:

$$V_o = \frac{V_b}{(PR_v - 1))^a}$$

Where V_o is the new visual clarity; V_b is the midpoint visual clarity (in metres) of the NOF band defined by the Expert Panel in the current state assessment for each bespoke sediment class; PR_v is the proportional load change for each bespoke sediment class using the median from the SedNetNZ results. The coefficient *a* was a numeric value of 0.76 as from the national average reported in Hicks et al., (2019).

Results when the coefficient *a* varies by a single standard deviation were also calculated to assist in illustrating potential error in model predictions. For example, if the resulting range in estimated visual clarity was all in the same attribute state band, more confidence could be given in the likely change in response to the scenario. However, if the range in estimates resulted in visual clarity states that spanned multiple bands, then there would be much less confidence in change in response to the scenario.

The resulting visual clarity estimates were used to inform the Expert Panel's assessment of change, under the GMP scenario, for each bespoke sediment class (i.e., for each combination of landcover category and NOF sediment class). The Expert Panel acknowledged the inability to capture spatially explicit and catchment-specific information with this method might influence clarity estimates in individual catchments. It was agreed that comments on potential catchment-specific considerations would be captured, where relevant and to the extent possible, in the justification for each bespoke sediment class assessment. Additionally, when the Expert Panel's sediment class assessments were translated into catchment clusters in a subsequent methodological step (see Holland et al., 2023), there was another opportunity to evaluate any spatially explicit rationale for refinement of any individual catchment cluster assessments.

To support the Expert Panel in their assessments, a regional breakdown of the broad patterns from the contaminant sources assessments was provided. The Expert Panel acknowledged the non-linear relationship between load and concentration, and the equally challenging non-linear relationship between TSS and visual clarity (Hicks et al., 2019). Despite these limitations, the Expert Panel used what it considered the best information possible at the time and made expert judgements about the likely change and effect on the state of sediment attributes (i.e., SFS and DFS).

The Expert Panel recognised that broad assumptions were made for the sources estimates (McBride *et al.,* 2023b), and that building on those estimates to apportion sediment load and use literature equations to translate load reduction estimates to visual clarity improvements introduced several layers of uncertainty into the assessments. However, in the absence of bespoke region-wide catchment models that could more accurately account for spatial variability in environmental drivers, attenuation and lag time, land cover and land practices, and the non-linear relationship between load and concentration, the Expert Panel agreed this was the best available information to use. Results from the method described above are presented in Appendix 3.

Deposited Fine Sediment - Applying mitigation information to the bespoke sediment classes

Unlike the case for SFS attribute described above, the Expert Panel could find no equation available in the literature to convert changes in sediment load to changes in deposited fine sediment (DFS). Attempts have been made to fit conceptual models to do this (Hicks et al 2016; Hicks *et al.,* 2019), but efforts have not resulted in a reliable result. These references identified that any relationship between sediment load and deposited sediment is going to be significantly variable dependent on slope, flood frequency/flashiness, channel size and bedform, geology and land use.

As a starting point, the Expert Panel followed the approach of using the SedNetNZ model (Vale et al., 2021) predictions for sediment load reductions under mitigations (as was used for SFS) and making the transparently coarse assumption of a 1:1 relationship (% change in load:% change in deposited sediment). The percentage change in load was taken for the median and applied to the current state assessment for deposited sediment in Carter et al. (2023a). The percentage change was applied to the midpoint of the current state band or to the numeric threshold value in the case of current state A or D bands. The same approach was applied to the standard deviations for SedNetNZ model-predicted percentage load reductions; this provided a range of predicted DFS attribute state change, similar to the approach used for the SFS attribute.

The Expert Panel recognised that the 1:1 relationship used as a starting point was a very coarse assumption and modified this for some sediment and land use classes based on local understanding of the factors predicted to affect this relationship (i.e., slope, flood frequency/flashiness, channel size and bedform, geology and land use). The raw results presented in Appendix 3 are based on the coarse assumption starting point; these informed the Panel's assessments but do not necessarily reflect the Panel's final assessment results for each class and catchment cluster.

As for SFS, the Panel recognised that broad assumptions were made for the sources estimates (McBride *et al.,* 2023b), and that building on that work to translate SedNetNZ model estimates of sediment load reductions into benefits for DFS introduces several layers of considerable uncertainty into the assessments. However, in the absence of bespoke region-wide catchment models that could more accurately account for spatial variability in environmental drivers, attenuation and lag time, land cover and land practices, and the non-linear relationship between load and deposition, the Expert Panel agreed this was the best information available at the time to make estimates of change under the GMP/mitigation scenario.

Forestry Practices

Matheson et al., (2018) did not include any specific mitigations for the forestry sector in their M1 bundle, which became the basis for the GMP scenario assumed here (i.e., no specific forestry mitigations were applied). This is because at the time it was assumed that implementation of the National Environmental Standards for Plantation Forestry meant GMP would have already been achieved in the forestry sector when complying with that regulation. There was no information available at the time of assessment to suggest otherwise. Additional mitigations for the forestry sector could be considered in the future.

Urban Practices

The mitigation practices described thus far have been focused on the rural sectors given their spatial dominance in the BOP region. At the time of the Matheson et al., (2018) assessments, urban areas in the two water management areas included in the report were considered relatively small and no urban mitigations were assessed for the M1 bundle as it was out of scope for that work.

Nonetheless there are significant urban areas in the region that will at some point need consideration in terms of their contribution to environmental health and the potential improvements that could be made. At the time of the Panel's work here BOPRC did not have any clear information for Tauranga (and other smaller towns other than Rotorua) of what GMP constitutes in these urban areas, or how close these areas are currently to implementing such GMP. Whilst research has been done on urban GMP practices in other parts of the country (e.g., Wellington and Auckland) it is not yet clear how transferable those are to the BOP region. In addition, Tauranga City Council is currently developing a Freshwater Management Tool (FWMT) that will be used to identify urban mitigation actions required to meet future water quality and quantity targets. The timeframe for completion of this FWMT meant it was not available for the Expert Panel's consideration.

In summary, the GMP scenario defined for this work did not include any urban mitigations. The Expert Panel and BOPRC are aware that many different types of mitigation actions exist for urban development and, like further practice improvements for the forestry sector, this is something for consideration in future scenarios.

2.3.5 Combined Climate Change (CC) and Good Management Practice (GMP) scenario

The description and assumptions for the combined climate change and good management practices scenario (the CC + GMP scenario) are simply the combined descriptions for CC and GMP scenarios in sections 2.3.1 and 2.3.4 above respectively. The Expert Panel assessed the CC + GMP scenario against current attribute state in the first instance, and then subsequently also assessed it against current attribute state under both the natural land cover and hypothetical future land cover scenarios described next.

2.3.6 Natural land cover scenario

The natural land cover scenario and the estimated current state of river attributes under that scenario are described in detail in Carter *et al.,* (2023a). Briefly, this scenario assumes natural land cover over the entire BOP region (Figure 2) and no anthropogenic inputs from land. This scenario includes existing river modifications (e.g., dams, stopbanks, channel straightening, floodgates etc.) assumed to be still in place, so is not a full representation of what the *natural state* would have been. The intention of including these river modifications in this scenario was to provide a 'book-end' in terms of representing the lowest level of contaminants lost from land that could be achieved under the current hydrological regime and river morphology.

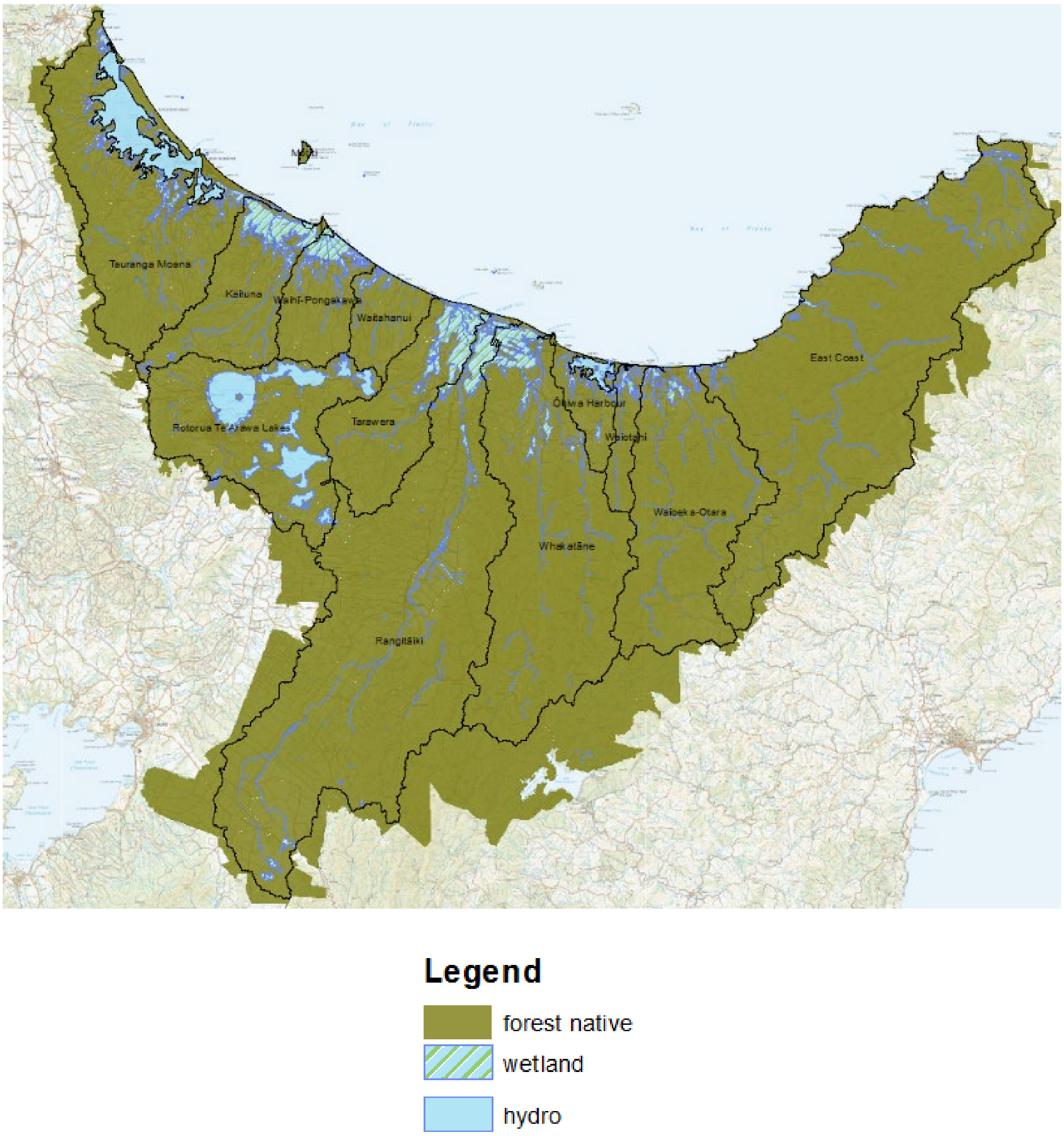

Figure 2 *Natural land cover extent for Bay of Plenty. Hydro refers to rivers, streams, and lakes.*

2.3.7 Hypothetical future land cover scenario

The hypothetical future land cover scenario and the estimated state of river attributes under that scenario are described in detail in Carter *et al.,* (2023a). Briefly, this scenario explores the likely impact of possible future changes to land cover, nominally to 2040. These hypothetical future changes were generated from multiple information sources including existing credible future scenarios modelled in parts of the BOP region (Carter *et al.,* 2021b), advice from community and industry groups, predicted sea level rise, and predicted economics and market drivers (Bermeo, 2022a). The hypothetical land cover change includes shifts from dairy to kiwifruit, increased exotic forestry in upper parts of catchments, and increased wetlands in low lying parts of catchments consistent with predicted sea level rise, as shown in Figure 3.

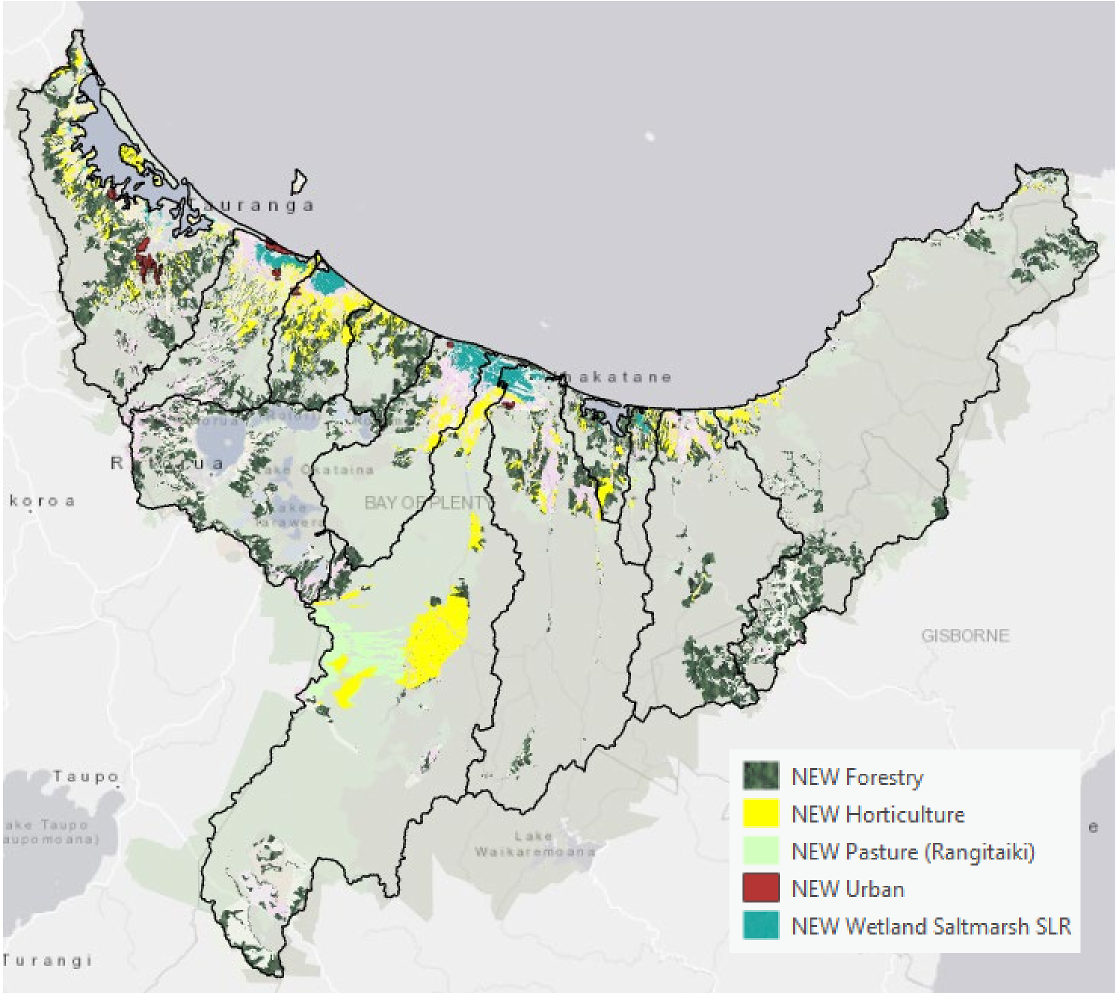

Figure 3 Hypothetical future land cover scenario for the BOPRC region.

2.4 Assessment units

The panel selected a biophysical-landcover classification as a basis for Current State and Scenario assessments for all river attributes excluding Suspended Fine Sediment (SFS) and Deposited Fine Sediment (DFS). A bespoke sediment classification was developed for SFS and DFS for Current State and Scenario assessments. Catchment clusters were created for the Sources Report assessment, and these were used to bring the different assessments (climate change, GMP, natural land cover) together to evaluate the cumulative impact for a specific catchment cluster. These are each outlined below and in Table 9 showing the spatial scale used for each assessment.

Table 9 Spatial scales used for each assessment by the Expert Panel

<table>
<tr><th colspan="2"></th><th colspan="2">Phase 1 (refer Carter et al., *in prep*)</th><th colspan="7">Phase 2</th></tr>
<tr><th colspan="2"></th><th colspan="9">Scenario</th></tr>
<tr><th colspan="2"></th><th>Sources</th><th>Current State (C1)</th><th>Climate Change (C3)</th><th>Mitigation (GMP) (C2)</th><th>Mitigation (GMP) + Climate Change (C4)</th><th>Natural Land Cover (A0)</th><th>Natural and Cover + Climate Change (A3)</th><th>Credible Future Land Cover (D0)</th><th>Credible Future Land Cover + Climate Change + Mitigation (D3)</th></tr>
<tr><th>Tier</th><th>Attribute</th><th colspan="9">Spatial Classification</th></tr>
<tr><td rowspan="9">1</td><td>NO3-N</td><td rowspan="3">Catchment Clusters (as TN)</td><td rowspan="8">Biophysical/ landcover</td><td rowspan="8">Biophysical/ landcover</td><td rowspan="8">Biophysical/ landcover</td><td rowspan="8">Biophysical/ landcover</td><td rowspan="8">Catchment Clusters</td><td rowspan="8">Catchment Clusters</td><td rowspan="8">Catchment Clusters</td><td rowspan="8">Catchment Clusters</td></tr>
<tr><td>NH4-N</td></tr>
<tr><td>DIN</td></tr>
<tr><td>DRP</td><td>Catchment Clusters (as TP)</td></tr>
<tr><td>*E. coli*</td><td>Catchment Clusters</td></tr>
<tr><td>Water Temperature</td><td rowspan="3">Not Assessed by EP</td></tr>
<tr><td>Copper</td></tr>
<tr><td>Zinc</td></tr>
<tr><td>SFS</td><td>Catchment Clusters (as TSS)</td><td>Bespoke SFS Classification</td><td>Bespoke SFS Classification</td><td>Bespoke SFS Classification</td><td>Bespoke SFS Classification</td><td>Catchment Clusters</td><td>Catchment Clusters</td><td>Catchment Clusters</td><td>Catchment Clusters</td></tr>
<tr><td>2</td><td>DFS</td><td rowspan="7"></td><td>Bespoke DFS Classification</td><td>Bespoke DFS Classification</td><td>Bespoke DFS Classification</td><td>Bespoke DFS Classification</td><td>Catchment Clusters</td><td>Catchment Clusters</td><td>Catchment Clusters</td><td>Catchment Clusters</td></tr>
<tr><td rowspan="6">3</td><td>DO</td><td rowspan="6">Biophysical/ landcover</td><td rowspan="5">Biophysical/ landcover</td><td rowspan="5">Biophysical/ landcover</td><td rowspan="5">Biophysical/ landcover</td><td rowspan="5">Catchment Clusters</td><td rowspan="5">Catchment Clusters</td><td rowspan="5">Catchment Clusters</td><td rowspan="5">Catchment Clusters</td></tr>
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<tr><td>QMCI</td></tr>
<tr><td>ASPM</td></tr>
<tr><td>FishIBI</td></tr>
<tr><td>Ecosystem Metabolism</td><td colspan="8">Not Assessed (as no current state estimate)</td></tr>
</table>

2.4.1 Biophysical/landcover classification

The biophysical/landcover classification included geology (either volcanic or non-volcanic), slope (either high gradient or low gradient) and land cover (either indigenous forest, exotic forest, intensive pasture, low-intensity pasture, urban and other). The proportion of each biophysical classification in the BOP region is shown in Table 10 and Figure 4 below. Full details on how this classification was derived can be found in McBride (2023a).

Table 10 Biophysical/landcover categories, their abbreviations, and the proportion of the Bay of Plenty region in each category.

Biophysical classification	Landcover classification	Abbreviation	Proportion of BOP region		Proportion of full catchments	
			%	Area (ha)	%	Area (ha)
Volcanic-Steep	Indigenous Forest	V-HG-IF	4.27	50,484	3.93	51,162
	Exotic Forest	V-HG-EF	4.28	50,538	3.88	50,615
	High intensity land use	V-HG-PI	0.76	9,001	0.70	9,168
	Low intensity land use	V-HG-P	2.74	32,355	2.54	33,077
Volcanic-Gentle	Indigenous Forest	V-LG-IF	3.92	46,267	3.66	47,746
	Exotic Forest	V-LG-EF	14.1	166,945	13.1	170,101
	High intensity land use	V-LG-PI	7.93	93,667	7.26	94,553
	Low intensity land use	V-LG-P	7.37	87,068	6.75	88,007
Non-volcanic	Indigenous Forest	NV-IF	38.9	459,705	40.0	521,664
	Exotic Forest	NV-EF	3.59	42,384	3.67	47,770
	High intensity land use	NV-PI	6.05	71,510	5.74	74,821
	Low intensity land use	NV-P	3.51	41,524	6.45	84,024
N/A	Urban	U	2.18	25,767	1.98	25,819
N/A	Other	O	0.37	4,364	0.35	4,554

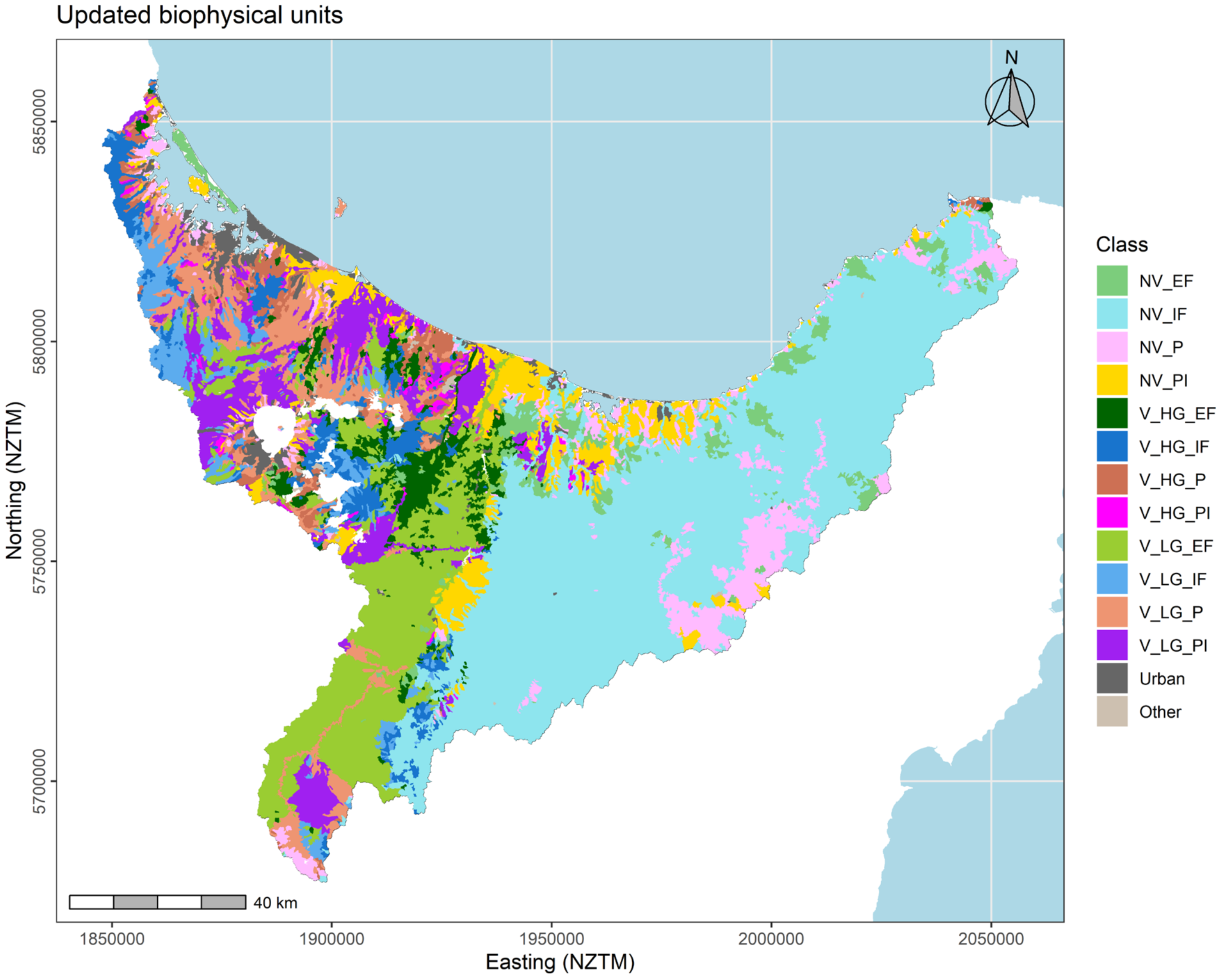

Figure 4 Biophysical/landcover classification for the Bay of Plenty region used by the Expert Panel for Current State and scenario assessments.

2.4.2 Bespoke sediment classification

The Expert Panel derived a bespoke[11] sediment classification for the Current State and scenarios assessments that included the sediment class from Appendix 2C of the NPSFM and then the landcover categories used in the biophysical/landcover classification (IF, EF, PI, PL and U). This resulted in 15 combinations each for SFS (Table 11) and DFS (Table 12) because there were no Class 4 reaches in the BOP region for SFS (Table 23 in NPSFM), and no Class 1 reaches for DFS (Table 24 in NPSFM). The proportions of SFS and DFS classes occurring in each biophysical class are presented in Table 13 and Table 14 respectively. Full details on how this classification was derived can be found in McBride (2023a).

[11] While we use the term 'bespoke' here, it simply refers to the combination of the NPSFM sediment classifications and landcover categories. The geology portion of the NPSFM sediment classifications was updated to reflect more accurately what is observed. This, however, did not resolve all the issues with the contradictions between observed substrate vs. modelled. For further detail, refer to Zygadlo *et al.,* (2022).

Table 11 Bespoke Suspended Fine Sediment Class (SFS) used for Current State and scenario assessments by the Expert Panel and the proportion of the Bay of Plenty region covered by each class.

Sediment Class (Table 23)	Landcover	Abbreviation	Proportion of Region		Proportion of full catchments	
			%	Area (ha)	%	Area (ha)
1	IF	SFS-1-IF	9.31	110,032	9.88	128,723
	EF	SFS-1-EF	18.2	214,861	16.8	219,228
	PI	SFS-1-PI	9.25	109,334	8.54	111,264
	P	SFS-1-P	10.1	119,755	9.93	129,446
	U	SFS-1-U	0.71	8,353	0.64	8,354
2	IF	SFS-2-IF	7.94	93,782	7.85	102,254
	EF	SFS-2-EF	3.00	35,401	2.84	37,027
	PI	SFS-2-PI	4.95	58,539	4.49	58,539
	P	SFS-2-P	2.36	27,840	2.65	34,484
	U	SFS-2-U	1.41	16,662	1.28	16,662
3	IF	SFS-3-IF	29.8	352,642	29.9	389,595
	EF	SFS-3-EF	0.81	9,605	0.94	12,231
	PI	SFS-3-PI	0.53	6,305	0.67	8,738
	P	SFS-3-P	1.13	13,350	3.16	41,176
	U	SFS-3-U	0.06	752	0.06	803

Table 12 Bespoke Deposited Fine Sediment Class (DFS) used for Current State and scenario assessments by the Expert Panel and the proportion of the Bay of Plenty region covered by each class.

Sediment Class (Table 24)	Landcover	Abbreviation	Proportion of Region		Proportion of full catchments	
			%	Area (ha)	%	Area (ha)
2	IF	DFS-2-IF	14.2	167,433	13.1	170,766
	EF	DFS-2-EF	20.4	241,369	18.9	245,858
	PI	DFS-2-PI	9.70	114,615	8.88	115,687
	P	DFS-2-P	10.8	127,153	10.3	133,851
	U	DFS-2-U	0.69	8,176	0.63	8,177
3	IF	DFS-3-IF	0.70	8,308	1.17	15,196
	EF	DFS-3-EF	0.64	7,504	0.58	7,510
	PI	DFS-3-PI	1.61	19,053	1.46	19,053
	P	DFS-3-P	0.48	5,713	0.45	5,929
	U	DFS-3-U	0.11	1,300	0.10	1,300
4	IF	DFS-4-IF	32.1	379,422	33.3	433,316
	EF	DFS-4-EF	0.60	7,064	0.86	11,189
	PI	DFS-4-PI	0.37	4,407	0.59	7,698
	P	DFS-4-P	1.07	12,686	3.83	49,934
	U	DFS-4-U	0.03	375	0.03	427

Table 13 Proportion of each Suspended Fine Sediment Class (SFS) occurring in each biophysical class (as proportion of river network segments).

Biophysical Class	Proportion (%) of each SFS class occurring in each biophysical class		
	SFS Class 1	SFS Class 2	SFS Class 3
NV-IF	8	19	74
NV-EF	5	74	21
NV-P	24	38	39
NV-PI	13	77	10
V-HG-IF	95	0	5
V-HG-EF	96	0	4
V-HG-P	96	0	4
V-HG-PI	99	0	1
V-LG-IF	96	0	4
V-LG-EF	99	0	1
V-LG-P	93	0	7
V-LG-PI	96	0	4
U	32	60	8

Table 14 Proportion of each Deposited Fine Sediment Class (DFS) occurring in each biophysical class (as proportion of river network segments). Note there is negligible DFS Class 1 in the BOP region. (Note: *NSB means* "naturally soft bottomed" and so excluded from the other DFS classes).

Biophysical Class	Proportion (%) of each DFS class occurring in each biophysical class			
	DFS Class 2	DFS Class 3	DFS Class 4	NSB
NV-IF	13	3	84	0
NV-EF	52	16	26	6
NV-P	16	8	61	13
NV-PI	17	27	11	44
V-HG-IF	98	0	1	0
V-HG-EF	99	0	0	0
V-HG-P	100	0	0	0
V-HG-PI	99	0	0	0
V-LG-IF	97	0	2	0
V-LG-EF	99	0	0	0
V-LG-P	94	0	2	0
V-LG-PI	99	0	0	0
U	34	6	2	55

2.5 Resource index

To develop a shared understanding of the BOP region, monitoring programmes and results, and relevant literature/research, all relevant and available information was compiled in a Resource Index which formed the base technical library the Expert Panel used in all of their assessments. The index was established and maintained by BOPRC and housed in Microsoft Teams, so all Expert Panel members had access. Any information shared by the Expert Panel was also added to the Resource Index. This Resource Index formed the best available information for Expert Panel's assessments.

2.6 Assessment methodology

2.6.1 Individual assessments

For the CC, GMP and combined CC + GMP scenarios, each Expert Panel member completed individual assessments for each attribute in the biophysical/landcover classification, and bespoke sediment classification. Each panel member's assessment was based on the shared understanding of current state, the scenario assumptions and the relevant information in the Resource Index, as well as their own expert knowledge. Accordingly, assessments were justified through a narrative citing relevant documents in the Resource Index, as well as an indication of the level of confidence in their assessment.

Each panel member provided a qualitative/semi-quantitative assessment of the likely change of each attribute state in each assessment class by filling out the template presented in Table 15 for discussion at the next workshop.

The assessment template required the panel to consider three factors:

- Change – How much an attribute will improve or degrade under the scenario,
- Effect – The influence that this change will likely have on other attributes, and
- Confidence – The level of certainty the panel member has with their "change" and "effect" assessment. To be consistent with the NPSFM, the lowest of the two was applied where confidence differed between the "change" and "effect" assessments.

The criteria for assessing change and effect are provided in Table 16 (criteria for confidence in below Table 16).

Table 15 Scenario Assessment table template. Sourced from GWRC Expert Panel Report (Greer & Norton, 2020).

<table>
<tr><th colspan="4">Attribute X, Area Y.</th></tr>
<tr><th>Change</th><th>Effect</th><th>Confidence</th><th>Justification</th></tr>
<tr><td>☐ -3 (large -)</td><td>☐ -3 (strong -)</td><td>☐ 0 (not assessed)</td><td rowspan="7"><u>Change:</u>
<u>Effect:</u>
<u>Justification:</u></td></tr>
<tr><td>☐ -2 (moderate -)</td><td>☐ -2 (moderate -)</td><td rowspan="2">☐ 1 (low)</td></tr>
<tr><td>☐ -1 (small -)</td><td>☐ -1 (weak -)</td></tr>
<tr><td>☐ 0 (no/negligible)</td><td>☐ 0 (no/negligible)</td><td rowspan="2">☐ 2 (moderate)</td></tr>
<tr><td>☐ +1 (small +)</td><td>☐ +1 (weak +)</td></tr>
<tr><td>☐ +2 (moderate +)</td><td>☐ +2 (moderate +)</td><td rowspan="2">☐ 3 (high)</td></tr>
<tr><td>☐ +3 (large +)</td><td>☐ +3 (strong +)</td></tr>
<tr><td colspan="2">Is attribute state below bottom line?</td><td colspan="2">☐ Y
☐ N</td></tr>
<tr><td colspan="2">Main causes of effect (for multi-stressor attributes):</td><td colspan="2"></td></tr>
</table>

Table 16 Individual assessment criteria for Confidence (sourced from GWRC Expert Panel Report (Greer & Norton, 2020)

Confidence	Reasons
0 (not assessed)	Not assessed as outside of scope or area of expertise.
1 (low)	Limited research available on the response of attributes to the changes applied in the scenario. Relationships between attribute and key drivers not well understood or predictable (e.g., deposited sediment and sediment load).
2 (moderate)	Effects of scenario changes on attributes partially transferable from proxy catchments or other research. Relationships between attribute and key drivers well documented but not predictable (e.g., invertebrates).
3 (high)	Effects of scenario changes on attributes reliably transferable from proxy catchments or other research. Relationships between attribute and key drivers well understood and predictable (e.g., metal toxicity).

Table 17 Individual assessment criteria for Change and Effect (adapted from Greer & Norton, 2020)

Change	Narrative
-3 (large -)	A significant degradation in concentration/state. A two attribute state decline likely (where applicable).
-2 (moderate -)	A noticeable degradation in concentration/state. A one attribute state decline likely (where applicable).
-1 (small -)	A detectable degradation in concentration/state. However, a decline in attribute state is unlikely (where applicable).
0 (no/negligible)	Changes in concentration/state non-existent or unlikely to be detectable.
+1 (small +)	A detectable improvement in concentration/state. However, an improvement in attribute state is unlikely (where applicable).
+2 (moderate +)	A noticeable improvement in concentration/state. A one attribute state improvement likely (where applicable).
+3 (large +)	A significant improvement in concentration/state. A two attribute state improvement likely (where applicable).
Effect	**Narrative**
-3 (strong -)	Changes in attribute are likely to result in a significant degradation of one or more response attributes.
-2 (moderate -)	Changes in attribute are likely to result in a noticeable degradation of one or more response attributes.
-1 (weak -)	Changes in attribute are likely to result in a small but detectable degradation of one or more response attributes.
0 (no/negligible)	Changes in attribute unlikely to have a detectable effect on response attributes.
+1 (weak +)	Changes in attribute are likely to result in a small but detectable improvement for one or more response attributes.
+2 (moderate +)	Changes in attribute are likely to result in a noticeable improvement for one or more response attributes.
+3 (strong +)	Changes in attribute are likely to result in a significant improvement for one or more response attributes.

2.6.2 Group assessments

For the CC, GMP and combined CC + GMP scenarios, all panel members sent their individual assessments to BOPRC, and these were collated into a master spreadsheet for ease of undertaking group assessments. At the workshops, the Expert Panel worked through each attribute in relevant classes, reviewed the individual assessments made, discussed any differences, made any changes to assessments based on the discussion or any new information shared and then agreed on a Group Assessment for each scenario. If there was disagreement amongst panel members, this was noted and the assessment continued.

Notes from individual assessments and the group discussion and assessment were taken by the facilitator and presented back to the panel for approval as a summary panel assessment.

During the Group Assessments, there were several key discussion points which impacted the way in which assessment decisions were made. These points are discussed in the following subsections.

Confidence when there was negligible GMP

It was assumed that no new or changed actions applied to the GMP scenario for indigenous forest, exotic forestry and urban land uses. The reasoning for this is discussed in section 2.3.4. This meant that under the GMP scenario, GMP was often equal to the current state. Before assigning GMP = current state to these classes, the proportion of land use that was subject to GMP was considered (i.e., the landcover classes are representative of the dominant land use. As such, the IF, EF and U classes will also often have proportions of P and PI, which the GMP scenario were relevant for). If this proportion was negligible i.e., <5%, then the approach of GMP = current state was adopted.

The Expert Panel discussed whether the confidence in this assessment should reflect that of the change (i.e., the confidence in the above circumstance would be 3 (High) as there is no change), or whether the confidence should also reflect the confidence in the current state assessment. It was decided that for GMP scenario assessments the confidence would reflect only the confidence in the change. This enables the results to be presented clearly and if at any point the confidence in the current state needs to be incorporated, the current state assessment can be referred to. This is reflected in the criteria for confidence in Table 15.

Uncertainty around Climate Change

The Expert Panel thought it important to highlight that interpretating the effects of climate change on water quality and ecological attributes is difficult and highly uncertain for at least two reasons. Firstly, there was recognition of the uncertainty associated with possible world emissions futures and the climate model predictions of effects of these in general, but also particularly with the downscaling of these predictions to the regional and sub-regional scale.

Secondly, there is much uncertainty in what physical and biological processes would dominate to produce ecosystem effects in a climate change scenario. These processes could work synergistically or counteract each other, making it hard to determine what the direction of change would be for some attributes. For example, reduced rainfall decreases stream dilution, which could increase N. However, reduced rainfall also reduces the soil-water level, which may lead to less soil water entering the stream, hence less N entering streams. There is also less direct runoff from the land during times of low rainfall. The limited literature on these processes, and which might dominate in different circumstances, is contradictory. The Expert Panel considered that the possible outcomes for climate change spanned a broader range than the possible outcomes from GMP scenarios, the latter generally expected to be only in a neutral or positive direction. The level of uncertainty was considered much higher for climate change than for GMP.

As a result, the Expert Panel sometimes had contrasting individual assessments on the direction of change under Climate Change. In these situations, the approach for the Group Assessment was to reflect this uncertainty as a change score of ‘0’. As such, a ‘0’ does not necessarily indicate no change due to climate change, but more the uncertainty about the proportional contributions of different processes and therefore the net direction of change and effect.

Uncertainty in suspended and deposited fine sediment assessment

The Expert Panel shared concerns around the large assumptions made in the assessments for visual clarity (suspended fine sediment, SFS) and DFS. As described in section 2.3.4 the assessments relied on use of modelled mitigation and climate-induced changes in sediment loads (from SedNetNZ), which were then inputted into another model (Hicks et al., 2019) equation to coarsely predict change in visual clarity (i.e., the attribute class for SFS). Finally, we then used a simplistic 1:1 relationship between percentage load change and change in deposited fine sediment (DFS). The Panel acknowledged the likely large uncertainties with predictions made using this approach but had no alternative justifiable way to estimate the effect of the scenarios on SFS and DFS. The Panel therefore considered the approach pragmatic in using the best information available at the time.

The large magnitude of change in sediment loads predicted under climate change in the SedNetNZ report (Vale et al., 2021) initially caused some discomfort for the Panel as this appeared to contrast with the relatively smaller changes predicted for the year 2040 under the RCP4.5 climate scenario (as summarised in Table 8) based on results from Pearce et al. (2019). This led to a further interrogation and comparison of the assumptions used in the two reports. It was identified that the climate model inputted into the SedNetNZ model used the same RCP4.5 climate scenario that was used from the Pearce et al., (2019) report to guide assessments for the other attributes (Table 8). The timeframes for the predictions were slightly different in the two reports, but close enough to be considered the same in this circumstance. The key difference appears to be that the SedNetNZ report (Vale et al., 2021) captures predictions of significant effects on sediment load of infrequent but extreme events (e.g., 'storminess'), whereas the climate data summaries in Table 7 portray changes in extreme events (e.g., 'Extreme rainfall' and 'Heavy rain days') that appear relatively small but could have significant effects. The Panel's interpretation is this seems to highlight that predicted small changes in climate do not necessarily mean predicted small changes to sediment loading. The distribution of sediment delivery to streams is not even in time and space, and a small increase in the intensity of rainfall and extreme events could significantly increase sediment loads. The Panel also considered that out of all the Tier 1 attributes, the largest changes would be expected to be observed in sediment (and as a result, the water clarity attribute) under the Climate Change scenario.

Ultimately the NPSFM directs councils to use the best available information at the time and the SedNetNZ model was considered the best source. Whilst predicted increases in sediment load seemed initially high, the Expert Panel have accepted these estimates and don't have any reason to conclude they are unrealistic. However, to reflect the use of a 'chain of models' and the 'assumptions on top of assumptions' approach that this assessment required, the confidence level for most of the assessments for sediment attributes was set as low (i.e., a confidence score of 1).

Consistencies

In addition to the discussion points above, a number of decisions were made throughout the panel workshops to maximise consistency of approach through the assessments. Key decisions are listed below and commentary is made in the 'Justification' column of the assessment tables if the approach differed from these.

- The combined scenario (Climate Change plus GMP) was assessed based on the group assessments of Climate Change and GMP separately and not individual Panel member's combined scenario assessments. The degree of change, effect and confidence for the combined scenario generally reflected that of the scenario deemed to be the dominant one.
- An arbitrary threshold of an estimated 10% or greater reduction in contaminant load was often used as a guide for estimating whether change under the GMP scenario would be 'detectable' (i.e., a change score of 1), versus 'unlikely to be detectable' (i.e., a change score of 0) when estimated reduction in contaminant load was less than 10%. This was used as a starting point to ensure consistency across the classes and attributes. There are times where this 10% threshold guide was not adhered to, and the reasoning in those cases was noted in the justification.
- For simplicity's sake, it was assumed that GMPs will be fully implemented promptly under the GMP scenario, to allow time for GMP to have an effect, e.g., riparian vegetation to grow by 2040 (the assessment period). This also assumes that stream geomorphology has largely adjusted to the application of GMP by this timeframe, particularly with respect to any GMP-induced temporary bank erosion having stabilised.

2.6.3 Final assessment output

After completing the individual and group assessments, the BOPRC facilitator compiled the summary Panel assessment for each attribute for each biophysical/landcover class and each bespoke sediment class. The Panel reviewed the summary panel assessments before these were published.

Part 3:
Scenario assessment results

3.1 Overview of scenarios assessed

Results for the seven scenario combinations are presented in three separate sub-sections below according to which of the three land cover cases applies:

Current land cover (see section 3.2)

- Current land cover + CC
- Current land cover + GMP
- Current land cover + CC + GMP

Natural land cover (see section 3.3)

- Natural land cover + CC

Hypothetical Future land cover (see section 3.4)

- Hypothetical Future land cover + CC
- Hypothetical Future land cover + GMP
- Hypothetical Future land cover + CC + GMP

3.2 Current land cover combined with the CC, GMP and CC + GMP scenarios

These three scenarios occupied a majority of the Expert Panel's scenario assessment time. The Panel systematically assessed the effects of the climate change (CC), good management practice (GMP), and CC + GMP scenarios, as compared against the current state for each attribute, for each relevant biophysical/landcover and/or sediment class. The Panel members each assessed these scenarios individually first, and then came together to develop the Panel's agreed group assessment.

The detailed results from these three scenarios are presented in numerous tables containing detailed notes justifying the Expert Panel's assessment. There is a table for every attribute within the scope of assessment and each table contains the estimated current state and its variability, and the change, effect, and level of confidence for every scenario and every biophysical/landcover class or sediment class combination. These detailed tables occupy approximately 220 pages provided in Appendix 4. These tables constitute detailed results data; they may be drawn on for various purposes in future but are not for general reading.

Summary tables are presented below that will be sufficient for most readers. There is a one-page summary table for each of the three scenarios, presenting change, effect and confidence results for all non-sediment attributes in all thirteen biophysical/landcover classes (Table 18, Table 19 and Table 20). There is a fourth one-page summary table that presents change, effect and confidence results for sediment attributes across all three scenarios and sediment classes for SFS and DFS (Table 21).

In all four summary tables the change and effect assessments are presented relative to current state; i.e., as a comparison against the Panel's estimates of current attribute state, which were reported separately in similar tables in Carter *et al.,* (2023a). The primary purpose of the summary tables presented in this report is to illustrate the nature of *change* predicted under each scenario.

To see the *endpoint state* of attributes under each scenario for all *biophysical classes*, the predicted changes under each scenario were applied to the current attribute state estimates reported in the State Report (Carter *et al.,* 2023a*).* These are presented for all scenarios in Appendix 5.

To understand the *endpoint state* of attributes under each scenario for *catchments*, it is necessary to refer to subsequent work presented in the Catchments report (Holland et al., 2023). In that report the Panel's predictions of change for biophysical classes have been translated to produce estimates of *endpoint state* for catchments across the region.

Key messages about the change expected under each scenario are provided below.

3.2.1 Climate change scenario

Climate change is generally expected to bring negative effects for water quality and ecology (e.g., arising from increased temperatures, more dry and hot days, increased extreme rainfall and associated flood and erosion intensities). This will especially be the case if negative effects are not offset by management to increase the resilience of freshwater ecosystems to climate change, as is assumed under the Climate Change scenario on its own.

The negative change and effects predicted by the Panel were generally negligible or small for most attributes (see scores of 0 and -1 respectively in Table 18), with the exceptions of water temperature and suspended fine sediment. Water temperature was predicted to worsen by a whole state band in the V-LG-P class (see single score of -2 in Table 18), while SFS worsened by a state band in two classes and by 2 state bands in four classes (see scores of -2 and -3 respectively in Table 21). For these latter six sediment classes the more significant expected declines in the SFS attribute were driven by SedNetNZ modelling work predicting significantly increased erosion under climate change for those classes; the modelling predicted smaller increases in erosion for the other nine sediment classes.

Overall, the Panel concluded that climate change would (see Table 18 and Table 21):

- worsen most attributes at least slightly,
- worsen water temperature significantly in one biophysical class (V-LG-P), and
- worsen SFS significantly in six out of fifteen classes (1EF, 1P, 1PI, 2P, 2PI, 2U).

This assessment outcome was strongly influenced by the fairly short time horizon of 2040 assumed in the Climate Change scenario. The predicted physical impacts of climate change used by the Panel (e.g., temperature, rainfall, heavy rainfall, dry and hot days; see Table 7) are quite small to 2040 but increase out to 2090. In addition, the Panel considered climate changes may act in complex ways, usually negatively but sometimes positively and with conflicting effects on water quality and ecology attributes (see detailed assessment comments in tables in Appendix 4). For some attributes, uncertainty around whether the net effect of climate change would be positive or negative also contributed to the Panel's overall assessment of negligible or small changes to attribute state.

Notwithstanding the messages above, the Panel is confident that the climate is changing, and that effects on water quality and ecological attributes are likely to become generally worse and more detectable beyond 2040.

3.2.2 Good Management Practices (GMP) scenario

Good Management Practices are generally expected to bring improvements in water quality and ecological attribute states in waterbodies draining catchments where they are employed. However, the improvements predicted by the Panel were generally negligible or small (see mostly scores of 0 and +1 respectively in Table 19 and Table 21). The only attributes predicted to improve by a whole attribute state band were *E. coli* and dissolved reactive phosphorus (DRP) in the NV-PI and V-HG-P classes, DIN in the NV-PI and V-HG-PI classes and nitrate toxicity in the V-LG-PI class (see scores of +2 in Table 19) and SFS in two sediment classes (see scores of +2 and +3 in Table 21).

These GMP scenario results need careful explanation to avoid under-representing the potential benefits that can be achieved through GMP implementation. Aspects to note include:

(i) The predicted environmental improvements are modest partly because the GMP scenario assumptions represent only a moderate level of mitigation practices (comparable to the M1 mitigation bundle as opposed to the more advanced M2 and M3 mitigation bundles in Matheson et al., 2018; see section 2.3.4). Further improvements would be likely under scenarios with more advanced and emerging technology mitigations in future, although these may cost more.

(ii) Only some benefits of mitigations are captured by the assessments of NPSFM river attributes. Other benefits not captured by these assessments could still assist in improving freshwater values. For example, the Fish IBI attribute is based on species diversity and so is sensitive only to the introduction or loss of a species, which is unlikely to arise from the GMP mitigations. However, GMP mitigations could improve habitat quality and quantity, hence improving fish abundance that was not captured in the Panel's attribute assessments. Another example is GMP mitigations would be expected to reduce *E coli* concentrations and, therefore, to some extent reduce health risk for human contact, even though some of the NPSFM *E. coli* attribute statistics are insensitive to state band shifts unless improvements are substantial. These two examples and others were recorded in the Panel's detailed results tables in Appendix 4.

Furthermore, the Panel only assessed the benefits from mitigations for agricultural land uses under the GMP scenario. There are additional mitigation possibilities that could deliver benefits and be considered in future scenarios. For example:

- No new mitigation benefits were assumed in the scenarios for forestry landuse (see section 2.3.4). It is possible that improvements could come from practice improvements required under the National Environmental Standards for Plantation Forestry and other improvements beyond these.
- No new mitigation benefits were assumed in the scenarios for urban areas (see section 2.3.4). There are potential mitigations to attenuate urban contaminant runoff (e.g., *E. coli*, sediment, copper, zinc), attenuate accelerated flow from urban impervious surfaces (e.g., water sensitive urban design and rainfall retention systems), and to improve urban riparian and in-stream physical habitat, that could all improve water quality and ecological attributes and be considered in future scenarios.

- No mitigations were assumed in the scenarios for improving barriers to fish passage (e.g., perched culverts, dams etc) or enhancement of fish spawning areas (e.g., inanga intertidal spawning areas); both could produce benefits for fish.

3.2.3 Combined CC + GMP scenario

The combined CC + GMP scenario showed the negative effects of climate change dominated over positive mitigations for some attributes (see scores of 0 and -1 for water temperature and macroinvertebrate attributes in Table 20; and see scores of -1 to -3 for SFS and DFS in Table 21). However, in many of these cases the Panel noted GMP mitigation was positive, albeit insufficient, and the situation would be worse under climate change without any mitigations. Furthermore, mitigations either offset or dominated over climate change for the remaining attributes (see scores of mostly 0 and some +1 scores in Table 20). These findings point to the importance of at least a moderate level of GMP mitigations to at least compensate some of the detrimental effects of climate change. Further mitigations would help further increase the resilience of BOP river ecosystems to ‘hold ground’ (i.e., at least maintain current state for all attributes) under future climate change.

Table 18 *Summary of predicted Climate Change Scenario assessment (RCP4.5 at year 2040), compared to current state (2020), for each river attribute in each biophysical/land cover class (V = Volcanic geology, NV = Non-Volcanic Geology, HG = high gradient slope in catchment upstream, LG = low gradient slope in catchment upstream, IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high). Effect is N/A where changes to these attributes will not have any effect on other higher order attributes (see methods section 3.3 for explanation of tiers of attributes).*

Class	Appendix 2A Attributes				Appendix 2B Attributes														Regional Attributes						Other	
	Ammonia Toxicity (NH_4-N)		Nitrate Toxicity (NO_3-N)		*E. coli*		Fish Index of Biotic Integrity (IBI)		Macroinvertebrate Community Index (MCI)		Quantitative MCI (QMCI)		Average Score Per Metric (ASPM)		Dissolved Oxygen (DO)		Dissolved Reactive Phosphorus (DRP)		Water Temperature		Copper (Cu)		Zinc (Zn)		Dissolved Inorganic Nitrogen (DIN)	
	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect
NV-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{2}	0^{2}
NV-EF	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
NV-P	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{2}	-1	-	-	-	-	0^{1}	0^{1}
NV-PI	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-HG-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{1}	0^{1}	-1^{2}	0^{2}	-	-	-	-	0^{2}	0^{2}
V-HG-EF	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-HG-P	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-HG-PI	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-LG-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-LG-EF	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-LG-P	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{1}	0^{1}	-2^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
V-LG-PI	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	0^{1}	0^{2}	0^{2}	-1^{1}	-1^{1}	-	-	-	-	0^{1}	0^{1}
U	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	-1^{1}	0^{1}	0^{1}	-1^{2}	-1^{2}	0^{1}	-1^{1}	0^{1}	-1^{1}	0^{1}	0^{1}

Table 19 *Summary of predicted <u>GMP Scenario</u> assessment, compared to current state (2020), for each river attribute in each biophysical/land cover class (V = Volcanic geology, NV = Non-Volcanic Geology, HG = high gradient slope in catchment upstream, LG = low gradient slope in catchment upstream, IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high). Effect is N/A where changes to these attributes will not have any effect on other higher order attributes (see methods section 3.3 for explanation of tiers of attributes).*

Class	Appendix 2A Attributes				Appendix 2B Attributes														Regional Attributes						Other	
	Ammonia Toxicity (NH_4-N)		Nitrate Toxicity (NO_3-N)		*E. coli*		Fish Index of Biotic Integrity (IBI)		Macroinvertebrate Community Index (MCI)		Quantitative MCI (QMCI)		Average Score Per Metric (ASPM)		Dissolved Oxygen (DO)		Dissolved Reactive Phosphorus (DRP)		Water Temperature		Copper (Cu)		Zinc (Zn)		Dissolved Inorganic Nitrogen (DIN)	
	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect
NV-IF	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	-	-	-	-	0^{3}	0^{3}
NV-EF	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	-	-	-	-	0^{3}	0^{3}
NV-P	0^{2}	0^{2}	0^{2}	0^{2}	1^{2}	0^{2}	0^{2}	N/A	0^{1}	N/A	1^{1}	N/A	1^{1}	N/A	1^{2}	0^{2}	1^{1}	0^{1}	1^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
NV-PI	1^{2}	1^{2}	1^{2}	0^{2}	2^{2}	0^{2}	0^{2}	N/A	0^{1}	N/A	1^{1}	N/A	1^{1}	N/A	1^{1}	0^{1}	2^{1}	1^{1}	1^{1}	0^{1}	-	-	-	-	2^{1}	1^{1}
V-HG-IF	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	-	-	-	-	0^{3}	0^{3}
V-HG-EF	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	-	-	-	-	0^{3}	0^{3}
V-HG-P	0^{2}	0^{2}	0^{2}	0^{2}	1^{2}	0^{2}	0^{2}	N/A	0^{1}	N/A	1^{1}	N/A	1^{1}	N/A	0^{2}	0^{2}	2^{1}	0^{1}	1^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
V-HG-PI	1^{2}	0^{2}	1^{1}	0^{1}	1^{1}	0^{1}	0^{2}	N/A	1^{1}	N/A	1^{1}	N/A	1^{1}	N/A	1^{1}	0^{1}	1^{1}	0^{1}	1^{1}	0^{1}	-	-	-	-	2^{1}	1^{1}
V-LG-IF	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	-	-	-	-	0^{3}	0^{3}
V-LG-EF	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	N/A	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	0^{3}	-	-	-	-	0^{3}	0^{3}
V-LG-P	0^{2}	0^{2}	0^{2}	0^{2}	1^{2}	0^{2}	0^{2}	N/A	0^{1}	N/A	0^{1}	N/A	0^{1}	N/A	1^{1}	0^{1}	1^{2}	0^{2}	1^{1}	0^{1}	-	-	-	-	0^{2}	0^{2}
V-LG-PI	1^{2}	1^{2}	2^{2}	1^{2}	2^{2}	0^{2}	0^{2}	N/A	1^{1}	N/A	1^{1}	N/A	1^{1}	N/A	1^{1}	0^{1}	1^{2}	0^{2}	1^{1}	0^{1}	-	-	-	-	1^{2}	1^{2}
U	1^{2}	0^{2}	0^{2}	0^{2}	0^{2}	0^{2}	0^{2}	N/A	0^{2}	N/A	0^{2}	N/A	0^{2}	N/A	0^{2}	0^{2}	0^{2}	0^{2}	0^{2}	0^{2}	0^{3}	0^{3}	0^{3}	0^{3}	1^{2}	0^{2}

Table 20 Summary of predicted <u>Climate Change + GMP Scenario</u> assessment, compared to current state (2020), for each river attribute in each biophysical/land cover class (V = Volcanic geology, NV = Non-Volcanic Geology, HG = high gradient slope in catchment upstream, LG = low gradient slope in catchment upstream, IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high). Effect is N/A where changes to these attributes will not have any effect on other higher order attributes (see methods section 3.3 for explanation of tiers of attributes).

Class	Appendix 2A Attributes				Appendix 2B Attributes														Regional Attributes						Other	
	Ammonia Toxicity (NH_4-N)		Nitrate Toxicity (NO_3-N)		*E. coli*		Fish Index of Biotic Integrity (IBI)		Macroinvertebrate Community Index (MCI)		Quantitative MCI (QMCI)		Average Score Per Metric (ASPM)		Dissolved Oxygen (DO)		Dissolved Reactive Phosphorus (DRP)		Water Temperature		Copper (Cu)		Zinc (Zn)		Dissolved Inorganic Nitrogen (DIN)	
	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect	Change	Effect
NV-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{2}	0^{2}
NV-EF	0^{1}	0	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{1}	0^{1}	-1^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
NV-P	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	1^{1}	0^{1}	0^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
NV-PI	1^{1}	1^{1}	1^{1}	**0^{1}**	1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	1^{1}	0^{1}	0^{1}	0^{1}	-	-	-	-	1^{1}	1^{1}
V-HG-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{2}	0^{2}
V-HG-EF	0^{1}	0^{1}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-HG-P	0^{2}	0^{2}	0^{1}	0^{1}	1^{2}	0^{2}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	1^{1}	0^{1}	0^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
V-HG-PI	0^{1}	0^{1}	1^{1}	0^{1}	1^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	0^{1}	N/A	0^{1}	N/A	0^{1}	0^{1}	1^{1}	0^{1}	0^{1}	0^{1}	-	-	-	-	1^{1}	0^{1}
V-LG-IF	0^{2}	0^{2}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-LG-EF	0^{1}	0^{1}	0^{2}	0^{2}	0^{1}	0^{1}	0^{1}	N/A	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	0^{2}	0^{2}	-1^{2}	0^{2}	-	-	-	-	0^{1}	0^{1}
V-LG-P	0^{2}	0^{2}	0^{1}	0^{1}	1^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	-1^{1}	N/A	0^{1}	0^{1}	1^{1}	0^{1}	-1^{1}	0^{1}	-	-	-	-	0^{1}	0^{1}
V-LG-PI	1^{2}	$0/1^{2}$	2^{1}	1^{1}	1^{2}	0^{2}	0^{1}	N/A	0^{1}	N/A	0^{1}	N/A	0^{1}	N/A	0^{1}	0^{1}	1^{2}	0^{2}	0^{1}	0^{1}	-	-	-	-	1^{1}	0^{1}
U	1^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	0^{1}	N/A	-1^{1}	N/A	0^{1}	N/A	-1^{2}	N/A	-1^{1}	-1^{1}	0^{1}	0^{1}	-1^{2}	-1^{2}	0^{1}	-1^{1}	0^{1}	-1^{1}	0^{1}	0^{1}

Table 21 *Summary of predicted Climate Change, GMP, and Climate Change + GMP scenario assessments, compared to current state (2020), for each river attribute in each bespoke sediment classification for deposited and suspended sediment (numbers in classifications refer to the sediment classes in the NPSFM. IF = Indigenous Forest, EF = Exotic Forest, PI = high-intensity pasture, P = low-intensity pasture, U = Urban. Change: 1-small, 2-moderate, 3-large. Effect: 1-weak, 2-moderate, 3-strong. Superscript numbers represent the level of confidence in change and effect assessments (1 = low, 2 = moderate, 3 = high).*

Scenario	Climate Change				GMP				Climate Change + GMP			
	Appendix 2A		Appendix 2B		Appendix 2A		Appendix 2B		Appendix 2A		Appendix 2B	
	Suspended Fine Sediment (SFS)		Deposited Fine Sediment (DFS)		Suspended Fine Sediment (SFS)		Deposited Fine Sediment (DFS)		Suspended Fine Sediment (SFS)		Deposited Fine Sediment (DFS)	
Class	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**	**Change**	**Effect**
1IF	-1^{2}	-1^{2}	-	-	0^{3}	0^{3}	-	-	-1^{2}	-1^{2}	-	-
1EF	-3^{1}	-2^{1}	-	-	0^{3}	0^{3}	-	-	-3^{1}	-2^{1}	-	-
1P	-3^{1}	-2^{1}	-	-	2^{1}	1^{1}	-	-	-3^{1}	-2^{1}	-	-
1PI	-3^{1}	-1^{1}	-	-	1^{1}	0^{1}	-	-	-3^{1}	-1^{1}	-	-
1U	-1^{1}	-1^{1}	-	-	0^{1}	0^{1}	-	-	-1^{1}	-1^{1}	-	-
2IF	-1^{2}	-1^{2}	-1^{1}	-1^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{2}	-1^{2}	-1^{1}	-1^{1}
2EF	-1^{1}	-1^{1}	-1^{1}	-2^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{1}	-1^{1}	-1^{1}	-2^{1}
2P	-3^{1}	-1^{1}	-1^{1}	-2^{1}	1^{1}	0^{1}	0^{1}	0^{1}	-3^{1}	-1^{1}	-1^{1}	-2^{1}
2PI	-2^{1}	-1^{1}	-1^{1}	-2^{1}	1^{1}	1^{1}	0^{1}	0^{1}	-2^{1}	-1^{1}	-1^{1}	-2^{1}
2U	-2^{1}	-1^{1}	-1^{1}	-1^{1}	0^{2}	0^{2}	0^{2}	0^{2}	-2^{1}	-1^{1}	-1^{1}	-1^{1}
3IF	-1^{1}	-1^{1}	-1^{1}	-1^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
3EF	-1^{1}	-1^{1}	-1^{1}	-1^{1}	0^{3}	0^{3}	0^{3}	0^{3}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
3P	-1^{1}	-1^{1}	-1^{1}	-1^{1}	3^{1}	2^{1}	1^{1}	0^{1}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
3PI	-1^{1}	-1^{1}	-2^{1}	-1^{1}	1^{1}	1^{1}	1^{1}	0^{1}	-1^{1}	-1^{1}	-2^{1}	-1^{1}
3U	-1^{1}	-1^{1}	-1^{1}	-1^{1}	0^{2}	0^{2}	0^{2}	0^{2}	-1^{1}	-1^{1}	-1^{1}	-1^{1}
4IF	-	-	-1^{1}	-1^{1}	-	-	0^{3}	0^{3}	-	-	-1^{1}	-1^{1}
4EF	-	-	-1^{1}	-1^{1}	-	-	0^{3}	0^{3}	-	-	-1^{1}	-1^{1}
4P	-	-	-2^{1}	-1^{1}	-	-	1^{1}	1^{1}	-	-	-1^{1}	0^{1}
4PI	-	-	-2^{1}	-1^{1}	-	-	0^{1}	0^{1}	-	-	-2^{1}	-1^{1}
4U	-	-	NA	NA	-	-	NA	NA	-	-	NA	NA

3.3 Natural land cover combined with the CC scenario

The Expert Panel used its estimate of current state in the biophysical/landcover classes dominated by indigenous vegetation (i.e., in classes V-HG-IF, V-LG-IF and NV-IF) as the main basis for predicting attribute states for the natural land cover scenario (without climate change initially), as described in detail in Carter *et al.,* (2023a).

This produced predicted attribute states for the Natural land cover scenario that were, unsurprisingly, almost entirely in near reference condition and mostly in A band state. The exceptions were:

- DRP in the NV-IF class which was predicted to be in D band due to naturally high DRP from geological sources,
- SFS in class SFS-3-IF (predicted to be D band due to natural causes), and
- DFS in class DFS-3-IF (also D band, potentially due to discrepancies between the way soft-bottomed streams are classified in the NPSFM compared to BOP monitoring data).

Summary results tables showing predicted attribute states under Natural land cover (without climate change) are reported in Carter *et al.,* (2023a).

The task that remained for the Expert Panel was to assess what effect climate change (CC) and good management practice (GMP) scenarios might have on the attribute states under the natural land cover scenario described above. The Panel agreed that the GMP scenario could be ignored based on the logical assumption that no change would arise given no GMP practices apply to natural land cover. To assess the effect of climate change on the natural land cover scenario the Expert Panel used its previous estimate of climate change on current state for all indigenous vegetation ("IF") classes (as shown in Table 18 and Table 21 above) as a logical starting point. However, it was recognised that the climate change assessment on current land cover made predictions for indigenous vegetation classes that were dominated by, but not necessarily 100%, indigenous vegetation cover. Therefore, the Expert Panel systematically considered each attribute and class combination to assess whether the predicted effects of climate change might be different for the assumed 100% natural land cover scenario. The Panel did not identify significant differences and ultimately concluded it was reasonable in the circumstances to rely on its previous estimates of effects of climate change on indigenous vegetation classes.

Overall, the Expert Panel predicted the effects of climate change on the Natural land cover scenario state would be very similar to the effects of climate change on current state in indigenous vegetation classes. Hence the results and key messages about climate change given in section 3.2.1 above (including Table 18 and Table 21) are relevant where they apply to indigenous vegetation classes. Those results have been carried through to predict the endpoint states for river attributes in indigenous vegetation classes, as presented in Appendix 5. To understand the *endpoint state* for *catchments* under the Natural land cover + CC scenario, refer to the Catchments report (Holland et al., 2023).

3.4 Hypothetical future land cover combined with the CC, GMP and CC + GMP scenarios

The Expert Panel used its estimates of current state for all attributes in all the biophysical/landcover classes as the direct basis for predicting attribute states for the equivalent classes under the Hypothetical Future Land Cover scenario, as described in detail in Carter *et al.,* (2023a). This approach was considered logical because the Panel had identified catchment land cover as a dominant driver of river attribute state. For example, if an area of land currently in class V-LG-PI was assigned a change to V-LG-P or V-LG-EF under the Hypothetical Future Land Cover scenario, then the current state estimate for V-LG-P or V-LG-EF, respectively, would provide the likely end point under this scenario, all other things being equal (i.e., assuming no change to current practices on the new land cover, or to mitigations or climate).

This approach produced predicted attribute states for the Hypothetical Future Land Cover scenario (without CC or GMP initially) that were identical, for each given biophysical/landcover class, to the Expert Panel's predictions for current state, as reported in Carter *et al.,* (2023a). It followed logically that the important differences arising from the Hypothetical Future Land Cover scenario (without CC or GMP initially) would be the changed *proportions* of each biophysical/landcover class in each catchment. The effect of those changed *proportions* on predicted endpoint state in each catchment was subsequently assessed and reported separately in the Catchments report (Holland *et al., 2023*).

The remaining task for the Expert Panel was to assess what effect climate change (CC) and good management practice (GMP) scenarios might have on the attribute states under the Hypothetical Future Land Cover scenario described above. For this the Expert Panel agreed to simply use the previous estimates of effects of CC and GMP on current state, as the basis for concluding that the effects on each given biophysical/landcover class would be the same under the Hypothetical Future Land Cover scenario.

Overall, the Expert Panel concluded the results and key messages about CC, GMP and combined CC + GMP scenarios given in section 3.2 above (including all results in Table 18, Table 19, Table 20 and Table 21) apply equally to the three equivalent Hypothetical Future land cover scenarios. Those results have been carried through to predict the endpoint states for these three scenarios for all biophysical classes, as presented in Appendix 5. To understand the *endpoint state* for *catchments* under the Hypothetical Future land cover + CC, +GMP and CC + GMP scenarios, refer to the Catchments report (Holland et al., 2023).

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Appendices

Appendix 1
Compiled mitigation effectiveness estimates

Appendix 1(a): Estimates of percentage contaminant reductions achieved by mitigations for different land use types

The 'best available information' was:

For **sediment** loss outputs, it was determined that the 2021 SedNetNZ modelling, and the mitigation effectiveness assumed in the modelled scenarios reported (Vale et al., 2021) provides the best output data. Details on the specific use of this data is presented below.

For ***E. coli*** losses, monitoring at the Kaiate Falls and attempted validation of the SOURCE model results, have shown that it is very difficult to accurately model and predict *E. coli* concentrations. The best information available was that contained in the Ministry for the Environment report providing regional information for setting draft targets for swimmable lakes and rivers (MfE, 2018b).

For **nutrients**, the best baseline information available was for parts of the Rotorua Lakes FMU covered by PC10 and former 'Rule 11' (now RL R1-R9), given that BOPRC had access to property level OVERSEER files for this area. BOPRC's Nutrient Management Officer analysed the Nutrient Discharge Management System Rule Monitoring dataset to establish the range and mid/median/average nutrient losses for different land uses in this area.

For other parts of the region there is very little actual information available on **nutrients** that is accessible to BOPRC. In the absence of this information, the following assumptions were made:

1. For native and exotic forestry, the standard OVERSEER N and P losses were applied.
2. For kiwifruit, the reported N losses from the Zespri/Plant & Food Research lysimeter-based study on N losses from kiwifruit provided by Zespri were applied (noting Zespri/PFR have never actually shared a full technical report on this work with BOPRC), and P losses estimated in OVERSEER by Matheson et al (2018) were applied.
3. For other horticulture (assuming this is mainly avocado), N losses from Australia and California were applied (Lovatt & Witney 2001, Dirou & Nuett 2001), as summarised by AvocadoNZ. There is no information on P losses.
4. For the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs, the N and P losses from the SOURCE model calibration based on the broad general current practice assumptions applied (WWLA, 2020).
5. For the Pongakawa Catchment, N and P loss information from OVERSEER files were applied, as completed by the Waikokopu Catchment Group.[12]

[12] Mainly from a Wai kokopu presentation to BOPRC on 20 October 2021 and Land Management Officer feedback. The Waikokopu Catchment Group has also kindly provided OVERSEER information summarised by block. However, the Expert Panel did not operate at block level but rather just by catchment/land use. BOPRC requested that Waikokopu information be summarised by land use instead but unfortunately this was not provided.

6 For all other areas and land uses, N and P losses from Matheson et al 2018 were assumed, based on where biophysical characteristics were most similar to those of farming systems modelled.

A spreadsheet summarising all this information and assumptions on nutrient losses by land use and spatial unit was compiled. The Land Management Team and Lee Matheson were asked to review this spreadsheet. Minor feedback was received, which generally agreed that the percentage reductions predicted from mitigations were plausible and other matters were addressed within the spreadsheet below.

Table 22 Compiled mitigation effectiveness estimates for nitrogen, phosphorus, E. coli and sediment.

Source: PerrinAg & Landcare (Matheson et al 2018); Carter et al (2018) - Appendix 2

		M1 Baseflow gross effectiveness (PerrinAg)		M1 Quick/surface flow net effectiveness (Carter et al - Appendix 2)			
Land use	**Farm system**	**% Δ N**	**% Δ P**	**% Δ N**	**% Δ P**	**% Δ E. coli**	**% Δ Sediment**
Dairy	Lower KPW	-25%	-18%	-51.2%	-39.4%	-31.2%	-17.2%
	Mid KPW	-26%	-7%	-34.3%	-32.3%	-24.5%	-10.8%
	Upper KPW	-28%	-15%	-30.7%	-31.6%	-23.9%	-9.7%
	Lower Rangitāiki	-27%	-8%	-37.0%	-31.7%	-15.0%	-11.6%
	Mid-Upper Rangitāiki (unirrigated)	-25%	-22%	-29.2%	-29.4%	-13.2%	-8.6%
	Mid-Upper Rangitāiki (irrigated)	-21%	-9%	-29.2%	-29.4%	-13.2%	-8.6%
Drystock	KPW Dairy Support	0%	-10%	-3.7%	-20.6%	-5.4%	-6.5%
	KPW Sheep & Beef	0%	-19%	-3.9%	-21.9%	-4.2%	-5.1%
	Rangitāiki Sheep & Beef	-3%	-6%	-2.4%	-19.1%	-2.5%	-4.5%
	Rangitāiki Deer	0%	-8%	-1.9%	-17.6%	-0.5%	-3.1%
Arable	KPW Maize	-10%	-8%	-17.4%	-19.9%	NA	-53.6%
	Rangitāiki Maize			-18.5%	-33.8%	NA	-61.6%
Kiwifruit	Gold	-9%	0%	-4.9%	-14.9%	NA	-26.4%
	Green	-5%	0%			NA	

		N loss (kg/ha/year)				P loss (kg/ha/year)			
Land use	**Farm system**	**Base**	**M1**	**M3**	**Base to M3**	**Base**	**M1**	**M3**	**Base to M3**
Dairy	Lower KPW	51	38	23	-55%	3.4	2.8	2.6	-24%
	Mid KPW	54	40	32	-41%	1.4	1.3	1.2	-14%
	Upper KPW	68	49	30	-56%	4	3.4	3.1	-23%
	Lower Rangitāiki	67	49	36	-46%	1.2	1.1	1	-17%
	Mid-Upper Rangitāiki (unirrigated)	53	40	30	-43%	0.9	0.7	0.7	-22%
	Mid-Upper Rangitāiki (irrigated)	62	49	35	-44%	1.1	1	0.9	-18%
Drystock	KPW Dairy Support	28	28	18	-36%	2	1.8	1.2	-40%
	KPW Sheep & Beef	25	25	17	-32%	2.7	2.2	1.7	-37%
	Rangitāiki Sheep & Beef	36	35	31	-14%	1	0.94	0.9	-10%
	Rangitāiki Deer	25	25	22	-12%	1.2	1.1	1.1	-8%
Arable	KPW Maize	63	57	59	-6%	2.4	2.2	2.3	-4%
Kiwifruit	Gold	23	21			0.5	0.5		
	Green	19	18			0.5	0.5		

McDowell et al 2020

				Effectiveness (2015 current to potential)		Effectiveness (2015 current to 2035 potential)		
				% Δ N	% Δ P	% Δ N	% Δ P	% Δ Sediment
SHEEP & BEEF								
	Reported in supplementary tables							
	6. Hard hill country (Northland-Waikato-BOP)			-10%	-38%			
	9. Hill country (Northland-Waikato-BOP)			-3%	-27%			
	12. Intensive finishing (Northland-Waikato-BOP)			-1%	-24%			
	From loads							
	6. Hard hill country (Northland-Waikato-BOP)			-10%	-41%	-30%	-57%	-72%
	9. Hill country (Northland-Waikato-BOP)			-5%	-26%	-22%	-40%	-69%
	12. Intensive finishing (Northland-Waikato-BOP)			1%	-24%	-26%	-32%	-66%
DAIRY								
Temperature	**Slope**	**Drainage**	**Wetness**					
Cool	*Flat*	*Poor*	*Moist*	-24%	-8%	-64%	-40%	-17%
Cool	*Flat*	*Well*	*Moist*	-13%	-14%	-41%	-40%	-49%
Cool	*Flat*	*Well*	*Wet*	-27%	-14%	-44%	-39%	-26%
Cool	*Moderate*	*Well*	*Wet*	-27%	-18%	-55%	-46%	-62%
Warm	Flat	Light	Moist					-62%
Cool	Flat	Light	Moist					-19%
Cool	Moderate	Well	Moist					-66%
Cool	Steep	Well	Moist					-61%

Muirhead (2017)

Effectiveness of riparian fencing, planting and improved FDE management on E. coli losses					
(Numbers for Northern North Island)	Fencing	Assumed baseline implementation	Riparian planting	Improved FDE management	Assumed baseline implementation
Dairy	-62%	97%	-10%	-60%	25%
Dairy support ("run-off")	-62%	60%	-10%	NA	NA
Sheep & beef (intensive, hill and high)	-53%	60%	-10%	NA	NA
Deer	-62%	65%	-10%	NA	NA

	Pre fencing	*Fencing*	*Planting*	*FDE improvement*	*Net cumulative effectiveness*
Dairy - no base implementation	*1000*	*380*	*342*	*136.8*	*-86%*
Dairy - with base implementation	*1000*	*989*	*890*	*622.8*	*-38%*
Dairy support ("run-off") – with base implementation	*1000*	*848*	*763*		*-24%*
Sheep & beef (intensive, hill and high) – with base implementation	*1000*	*812*	*731*		*-27%*
Deer – with base implementation	*1000*	*867*	*780*		*-22%*

		GMP effectiveness							
		% Δ N			% Δ P			% Δ E. coli	% Δ Sediment
		Max	Mid	Min	Max	Mid	Min		
Recommended approach	Dairy	-28%	-25%	-13%	-22%	-15%	-7%	-38%	Use SedNetNZ model
	Drystock	-3%	-5%	0%	-38%	-20%	-6%	-24%	
	Kiwifruit/horticulture		-9%	-5%		0%		0%	
	Arable		-10%			-8%		0%	

Appendix 1(b): Estimates of weighted nutrient load reductions achieved by GMP mitigations for each biophysical class.

For each biophysical class, nutrient reduction estimates provided for land use types in Appendix 1(a) above have been used, in combination with estimates of the proportion of each land use type in each biophysical class, to produce area-weighted estimates of nutrient load reductions achieved by GMP (M1). It is emphasised these are coarse high-level estimates of GMP effectiveness involving numerous assumptions. Both the proportion of land use types in each class and the performance of mitigation actions would be expected to vary among catchments and locations.

It is noted that these weighted estimates have not accounted for the riparian planting component of GMP only being assumed applicable to streams of width greater than 1 m; rather the GMP reduction estimates from Appendix 1(a) have been assumed to apply to all productive land areas. In this respect these weighted estimates may over-represent the benefit of the riparian planting component of GMP, although riparian planting is only part of the GMP mitigations that would be expected to reduce loads of nutrient, sediment and micro-organism contaminants. However, the Expert Panel took this into account when it considered the benefit of riparian planting on water temperature, dissolved oxygen, macroinvertebrate indices (MCI, QMCI and ASPM) and the fish index (Fish IBI). The Panel did this by estimating the proportion of stream length in each class with land use subject to GMP as well as stream width greater than 1 m (i.e., the proportion of stream length assumed subject to riparian planting under the GMP scenario), as presented in Appendix 1(c) below (Table 24).

Table 23 Estimates of weighted nutrient load reductions achieved by GMP mitigations for each biophysical class.

Biophysical Class	TN load (t/y)	Mitigated TN load (t/y)	Percent TN reduction	TP load (t/y)	Mitigated TP load (t/y)	Percent TP reduction
NV-IF	1328	1292	3	96	94	2
NV-EF	159	151	5	9	8	4
NV-P	789	741	6	34	30	12
NV-PI	1423	1111	22	82	71	13
V-HG-IF	384	380	1	19	19	2
V-HG-EF	513	502	2	23	22	2
V-HG-P	444	412	7	30	27	11
V-HG-PI	190	154	19	11	10	12
V-LG-IF	256	251	2	16	16	2
V-LG-EF	723	705	3	34	33	3
V-LG-P	1052	983	7	64	57	11
V-LG-PI	1981	1586	20	119	103	13
U	216	193	11	14	13	6
Other	26	24	6	1	1	7

Appendix 1(c): Estimates of stream width and the proportion of stream length in each biophysical class subject to riparian planting under the GMP scenario.

When the Expert Panel considered the benefit of riparian planting on water temperature, dissolved oxygen, macroinvertebrate indices (MCI, QMCI and ASPM) and the fish index (Fish IBI), it took account of an estimated length of stream that would benefit from riparian planting.

For example, water temperature is affected by shading of the stream reach by riparian vegetation. Larger streams (>5 m wide) are generally not fully shaded by the planting of riparian vegetation under a GMP scenario. Furthermore, under the GMP scenario, reaches <1 m are not planted. To inform assessments of the effectiveness of GMP at managing water temperature, invertebrate and fish indices, the Expert Panel therefore estimated the proportion of stream length in each biophysical/landcover class that fits into <1 m, 1 m to 3 m, and >3 m stream width categories (*Table 24*).

Table 24 Estimates of proportion of stream length in each biophysical class with stream width less than 1 m, between 1 m and 3 m, and greater than 3 m. Estimates are provided using two separate methods; i) estimates based on stream order[1]; and ii) estimates based on width modelled by NIWA's NZriverMaps (NZRM).

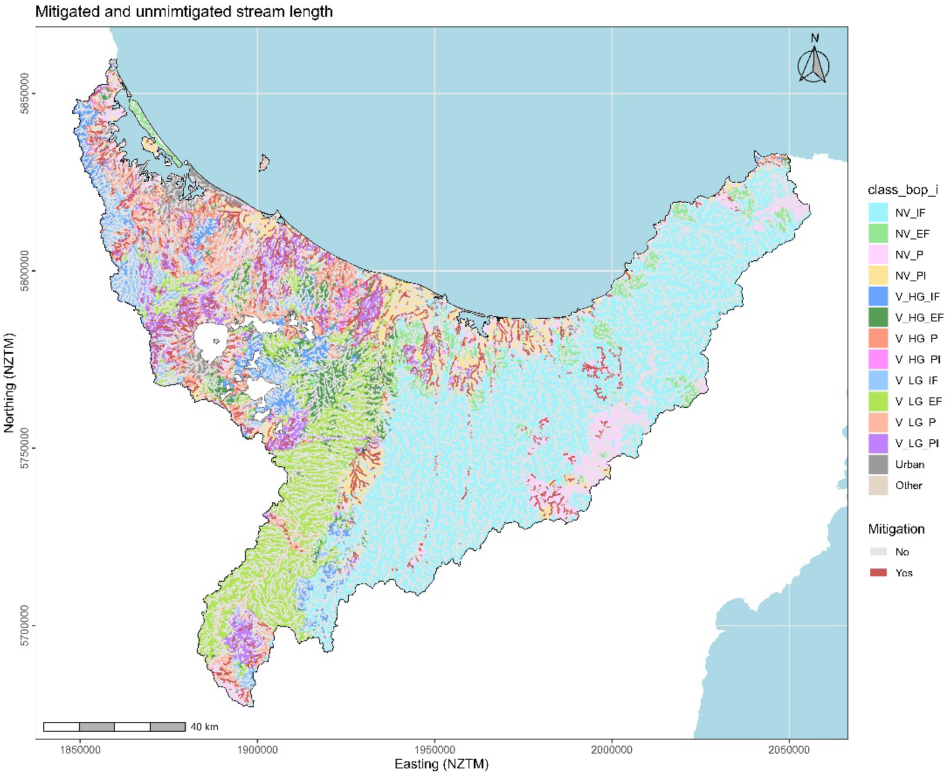
Biophysical Class	Proportion of each DFS class occurring in each biophysical class (%)					
	Estimate based on stream order			Estimate based on NZRM		
	<1 m	1 m-3 m	>3 m	<1 m	1 m-3 m	>3 m
NV-IF	35	39	26	60	38	3
NV-EF	61	33	6	75	25	0
NV-P	46	31	24	61	37	3
NV-PI	61	28	11	69	30	1
V-HG-IF	46	39	16	66	33	1
V-HG-EF	55	29	16	65	32	3
V-HG-P	44	28	28	58	42	0
V-HG-PI	53	35	12	65	35	0
V-LG-IF	38	40	22	65	34	2
V-LG-EF	51	31	18	62	35	3
V-LG-P	35	30	34	51	44	5
V-LG-PI	42	35	23	59	41	0
U	73	20	6	80	20	0

1 = Estimates based on stream order were made according to the following assumptions: First order streams assumed to be <1 m, 50% of second order streams assumed to be <1 m and 50% >1 m. Third to fifth order streams assumed to be between 1 m and 3 m. Sixth order and greater streams were assumed to be >3 m in width.

The Expert Panel then also considered the proportion of stream length in each biophysical class with a land use type subject to GMP mitigations, and then estimated the proportion of that stream length with width greater than 1 m that would be subject to riparian planting under the assumed GMP mitigations scenario (see Table 25 and Figure 5).

Table 25 Estimates of proportion of stream length in each biophysical class subject to riparian planting mitigation under the GMP scenario. River network segments were assumed to have riparian planting mitigation if the segment width is greater than 1 m (as modelled by NIWA's NZRiverMaps (NZRM)) and the land use in the Bay of Plenty LU2016 layer is one of "lifestyle block or mixed landuse", "dairy", "sheep and beef", "deer", "dairy support", "arable", "orchard or permanent horticulture".

Biophysical Class	Proportion of biophysical class subject to riparian planting mitigation (%)	
	Mitigated by riparian planting (%)	Not mitigated by riparian planting (%)
NV-IF	3	97
NV-EF	6	94
NV-P	16	84
NV-PI	24	76
V-HG-IF	5	95
V-HG-EF	3	97
V-HG-P	22	78
V-HG-PI	27	73
V-LG-IF	3	97
V-LG-EF	2	98
V-LG-P	22	78
V-LG-PI	28	72
U	7	93
Other	3	97



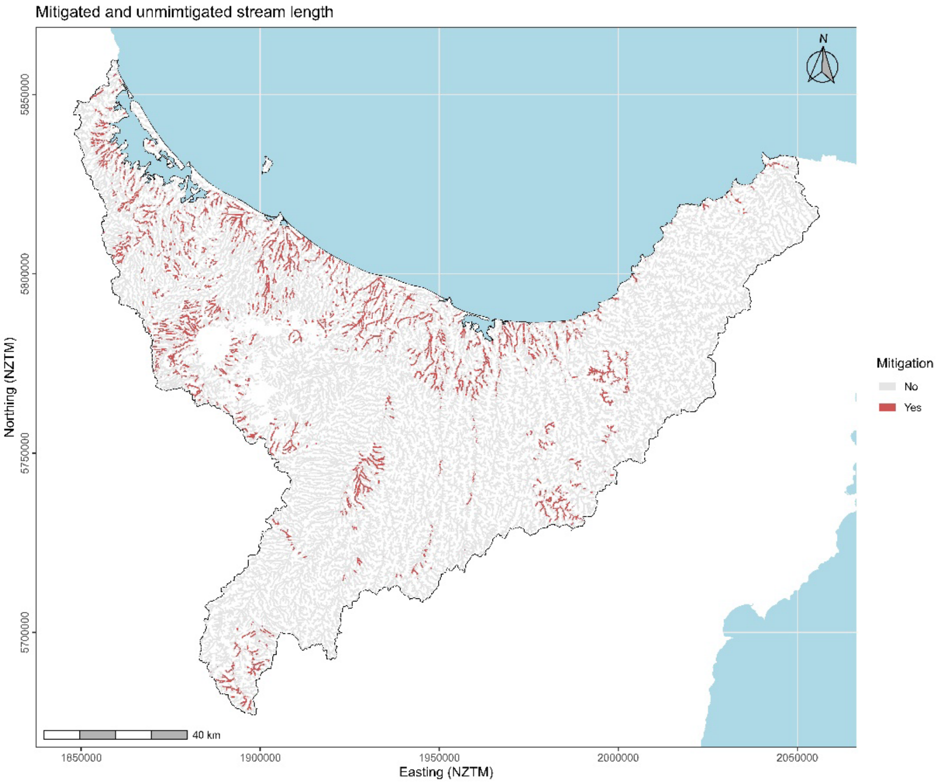


Figure 5 *Maps showing estimated extent of stream length subject to riparian planting mitigation under the GMP scenario (red river segment lines) overlaying the biophysical classes (top map) and for the whole Bay of Plenty region (bottom map).*

Appendix 2
Regional attributes

Table 26 Dissolved Inorganic Nitrogen (DIN) attribute state assessment criteria (from the Draft NPSFM 2019 Consultation Document issued by the Minister for the Environment 2019)

Value (and type)	**Ecosystem Health (Water Quality)**	
Freshwater body type	**Rivers**	
Attribute unit	**DIN mg/L (milligrams per litre)**	
Attribute band and description	**Numeric Attribute State**	
	Median	**95th Percentile**
A Ecological communities and ecosystem processes are similar to those of natural conditions. No adverse effects attributable to DIN enrichment are expected.	≤ 0.24	≤ 0.56
B Ecological communities are slightly impacted by minor DIN elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.	> 0.24 and ≤ 0.50	> 0.56 and ≤ 1.10
C Ecological communities are impacted by moderate DIN elevation above natural reference conditions, but sensitive species are not experiencing nitrate toxicity. If other conditions also favour eutrophication, DIN enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate and fish taxa, and high rates of respiration and decay.	> 0.5 and ≤ 1.0	> 1.10 and ≤ 2.05
National Bottom Line	**1.0**	**2.05**
D Ecological communities impacted by substantial DIN elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DIN enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia and nitrate toxicity are lost.	> 1.0	> 2.05
Groundwater concentrations also need to be managed to ensure resurgence via springs and seepages does not degrade rivers through DIN enrichment. Numeric attribute state must be derived from the rolling median of monthly monitoring over five years.		

Table 27 Attribute state table for temperature regime in rivers and streams in 'Eastern Dry' regions of New Zealand (Davies-Colley et al., 2013).

Value (use)	Ecological Health	
Attribute	**Temperature Regime**	
Environment (river, lake, GW, estuary, wetland)	Rivers (Eastern Dry Climates)	
Measurement Unit	Degrees Celsius (°C)	
Summary Statistic	Summer period measurement of the Cox-Rutherford Index, averaged over the five (5) hottest days (from inspection of a continuous temperature record)	
Band descriptors (narrative – what will people notice as the impact on the value)	A	No thermal stress on any aquatic organisms that are present at matched reference (near-pristine) sites.
	B	Minor thermal stress on occasion (clear days in summer) on particularly sensitive organisms such as insects and fish.
	C	Some thermal stress on occasion, with elimination of certain sensitive insects and absence of certain sensitive fish.
	D (unacceptable/does not provide for value)	Significant thermal stress on a range of aquatic organisms. Risk of local elimination of keystone species with loss of ecological integrity.
Band boundaries (numeric)	A/B	≤ 19°C
	B/C	≤ 21°C
	C/D	≤ 25°C
	D (unacceptable/does not provide for value)	**> 25**

Table 28 Thresholds for sediment Cu and Zn based on ANZECC (2018) guidelines – based on whole sediment sample analysis, see Crawshaw (2021).

Metal (mg/kg dry weight)	Cu	Zn
Very Good	<32.5	≤100
Good	32.5 - 65	100 - 200
Fair	66 - 249	201 - 409
Poor	>250	>410

Appendix 3
Results from sediment methodology

Table 29 Suspended fine sediment (SFS, as Visual Clarity) state predictions based on results from the SedNetNZ model and the use of the Hicks et al. (2019) equation as described in Section 2.4. Predicted attribute state bands colour scheme: Green shading = band improvement, orange shading = band deterioration, blue shading = no change.

SFS.Bespoke.Class	SCENARIO	Current visual clarity (From Carter et al. (2022))	Midpoint clarity of band (metres)	% change in Load (This is the median from Resource 167)	Predicted visual clarity	Showing range in *a* as per Hicks	Showing range in *a* as per Hicks	Predicted Band median	Predicted Band upper	Predicted Band lower
SFS-1-EF	GMP	B	1.67	0.00	1.67	1.67	1.67	B	B	B
SFS-1-EF	CC	B	1.67	79.70	1.07	1.15	0.99	D	D	D
SFS-1-EF	CC+GMP	B	1.67	79.30	1.07	1.16	0.99	D	D	D
SFS-1-IF	GMP	A	2.40	0.00	2.40	2.40	2.40	A	A	A
SFS-1-IF	CC	A	2.40	43.90	1.82	1.91	1.74	C	A	B
SFS-1-IF	CC+GMP	A	2.40	42.10	1.84	1.92	1.76	C	A	B
SFS-1-P	GMP	B	1.67	-8.80	1.79	1.77	1.81	A	B	A
SFS-1-P	CC	B	1.67	72.90	1.10	1.18	1.03	D	D	D
SFS-1-P	CC+GMP	B	1.67	55.00	1.20	1.27	1.13	D	D	D
SFS-1-PI	GMP	B	1.67	-6.50	1.76	1.74	1.77	B	B	B
SFS-1-PI	CC	B	1.67	79.10	1.07	1.16	0.99	D	D	D
SFS-1-PI	CC+GMP	B	1.67	65.70	1.14	1.21	1.07	D	D	D

SFS.Bespoke.Class	SCENARIO	Current visual clarity (From Carter et al. (2022))	Midpoint clarity of band (metres)	% change in Load (This is the median from Resource 167)	Predicted visual clarity	Showing range in *a* as per Hicks	Showing range in *a* as per Hicks	Predicted Band median	Predicted Band upper	Predicted Band lower
SFS-1-U	GMP	D	1.34	-3.10	1.37	1.37	1.38	C	C	C
SFS-1-U	CC	D	1.34	66.40	0.91	0.97	0.85	D	D	D
SFS-1-U	CC+GMP	D	1.34	54.70	0.96	1.02	0.91	D	D	D
SFS-2-EF	GMP	A	1.50	0.00	1.50	1.50	1.50	A	A	A
SFS-2-EF	CC	A	1.50	50.70	1.10	1.16	1.04	C	A	A
SFS-2-EF	CC+GMP	A	1.50	47.70	1.12	1.17	1.06	C	A	A
SFS-2-IF	GMP	A	1.60	0.00	1.60	1.60	1.60	A	A	A
SFS-2-IF	CC	A	1.60	44.20	1.21	1.27	1.16	C	A	A
SFS-2-IF	CC+GMP	A	1.60	42.30	1.22	1.28	1.17	C	A	A
SFS-2-P	GMP	A	0.93	-12.20	1.03	1.01	1.04	A	A	A
SFS-2-P	CC	A	0.93	62.90	0.64	0.68	0.60	C	C	D
SFS-2-P	CC+GMP	A	0.93	44.50	0.70	0.74	0.67	C	C	C
SFS-2-PI	GMP	A	0.93	-15.00	1.05	1.03	1.07	A	A	A
SFS-2-PI	CC	A	0.93	67.40	0.63	0.67	0.59	C	C	D
SFS-2-PI	CC+GMP	A	0.93	41.60	0.71	0.75	0.68	C	C	C
SFS-2-U	GMP	A	0.93	-5.00	0.97	0.96	0.97	A	A	A

SFS.Bespoke.Class	SCENARIO	Current visual clarity (From Carter et al. (2022))	Midpoint clarity of band (metres)	% change in Load (This is the median from Resource 167)	Predicted visual clarity	Showing range in *a* as per Hicks	Showing range in *a* as per Hicks	Predicted Band median	Predicted Band upper	Predicted Band lower
SFS-2-U	CC	A	0.93	17.80	0.82	0.84	0.80	B	B	B
SFS-2-U	CC+GMP	A	0.93	10.00	0.87	0.88	0.85	B	B	B
SFS-3-EF	GMP	D	2.22	0.00	2.22	2.22	2.22	D	D	D
SFS-3-EF	CC	D	2.22	51.10	1.62	1.71	1.54	D	D	D
SFS-3-EF	CC+GMP	D	2.22	48.10	1.65	1.73	1.57	D	D	D
SFS-3-IF	GMP	D	2.22	0.00	2.22	2.22	2.22	D	D	D
SFS-3-IF	CC	D	2.22	55.30	1.59	1.68	1.50	D	D	D
SFS-3-IF	CC+GMP	D	2.22	52.90	1.61	1.70	1.52	D	D	D
SFS-3-P	GMP	D	2.22	-28.40	2.86	2.74	2.99	B	B	A
SFS-3-P	CC	D	2.22	56.50	1.58	1.67	1.49	D	D	D
SFS-3-P	CC+GMP	D	2.22	22.50	1.90	1.95	1.85	D	D	D
SFS-3-PI	GMP	D	2.22	-8.90	2.38	2.35	2.41	C	C	C
SFS-3-PI	CC	D	2.22	76.40	1.44	1.55	1.34	D	D	D
SFS-3-PI	CC+GMP	D	2.22	66.80	1.50	1.61	1.41	D	D	D
SFS-3-U	GMP	D	2.22	-6.40	2.33	2.31	2.35	C	C	C
SFS-3-U	CC	D	2.22	63.00	1.53	1.63	1.44	D	D	D
SFS-3-U	CC+GMP	D	2.22	52.50	1.61	1.70	1.52	D	D	D

Table 30 *Deposited Fine Sediment (DFS) state predictions based on results from the SedNetNZ model and the use of the Hicks et al (2019) equation as described in Section 2.4. Predicted attribute state band colour scheme: Green shading = band improvement, orange shading = band deterioration, blue shading = no change.*

DFSS.Bespoke.Class	SCENARIO	Current deposited sediment (From Carter et al (2022))	Current DFS variability (From Carter et al (2022))	Midpoint DFS of band OR threshold value for A and D bands (%)	% change in Load (This is the median from Resource 167)	% change in Load (This is the Std Dev from Resource 167)	Predicted median deposited sediment (%)	Predicted deposited sediment -SD (%)	Predicted deposited sediment +SD (%)	Predicted Band median	Predicted band -SD	Predicted band + SD
DFS-2-EF	GMP	D	A-D	29	0	4.3	29.00	27.75	30.25	D	C	D
DFS-2-EF	CC	D	A-D	29	77.6	16	51.50	46.86	56.14	D	D	D
DFS-2-EF	CC+GMP	D	A-D	29	76.9	17.2	51.30	46.31	56.29	D	D	D
DFS-2-IF	GMP	A	A-D	10	0	8.5	10.00	9.15	10.85	A	A	B
DFS-2-IF	CC	A	A-D	10	43.8	22.3	14.38	12.15	16.61	B	B	B
DFS-2-IF	CC+GMP	A	A-D	10	40.5	22.6	14.05	11.79	16.31	B	B	B
DFS-2-P	GMP	D	A-D	29	-8.9	18.3	26.42	21.11	31.73	C	C	D
DFS-2-P	CC	D	A-D	29	71.7	15.6	49.79	45.27	54.32	D	D	D
DFS-2-P	CC+GMP	D	A-D	29	53.3	20.8	44.46	38.43	50.49	D	D	D
DFS-2-PI	GMP	D	B-D	29	-7.7	15.7	26.77	22.21	31.32	C	C	D
DFS-2-PI	CC	D	B-D	29	77.8	14.6	51.56	47.33	55.80	D	D	D
DFS-2-PI	CC+GMP	D	B-D	29	63.2	21.3	47.33	41.15	53.51	D	D	D
DFS-2-U	GMP	D	C-D	29	-4.6	10.8	27.67	24.53	30.80	C	C	D
DFS-2-U	CC	D	C-D	29	66.5	23.1	48.29	41.59	54.98	D	D	D

DFSS.Bespoke. Class	SCENARIO	Current deposited sediment (From Carter et al (2022))	Current DFS variability (From Carter et al (2022))	Midpoint DFS of band OR threshold value for A and D bands (%)	% change in Load (This is the median from Resource 167)	% change in Load (This is the Std Dev from Resource 167)	Predicted median deposited sediment (%)	Predicted deposited sediment -SD (%)	Predicted deposited sediment +SD (%)	Predicted Band median	Predicted band -SD	Predicted band + SD
DFS-2-U	CC+GMP	D	C-D	29	54.3	24.9	44.75	37.53	51.97	D	D	D
DFS-3-EF	GMP	C	B-D	23	0	8.7	27.00	24.65	29.35	B	B	B
DFS-3-EF	CC	C	B-D	23	41.2	24.5	38.12	31.51	44.74	C	B	C
DFS-3-EF	CC+GMP	C	B-D	23	40.1	23.2	37.83	31.56	44.09	C	B	C
DFS-3-IF	GMP	C	B-D	23	0	6.5	27.00	25.25	28.76	C	C	D
DFS-3-IF	CC	C	B-D	23	42.3	12.1	38.42	35.15	41.69	D	D	D
DFS-3-IF	CC+GMP	C	B-D	23	41.6	11.9	38.23	35.02	41.45	D	D	D
DFS-3-P	GMP	D	C-D	27	-13.7	41.1	23.30	12.20	34.40	C	C	D
DFS-3-P	CC	D	C-D	27	71.8	22.6	46.39	40.28	52.49	D	D	D
DFS-3-P	CC+GMP	D	C-D	27	48.1	29	39.99	32.16	47.82	D	D	D
DFS-3-PI	GMP	C	C-D	23	-16.6	83.7	22.52	-0.08	45.12	C	A	D
DFS-3-PI	CC	C	C-D	23	68.6	34.2	45.52	36.29	54.76	D	D	D
DFS-3-PI	CC+GMP	C	C-D	23	34.9	46.9	36.42	23.76	49.09	D	D	D
DFS-3-U	GMP	D	C-D	27	-1.8	50.9	26.51	12.77	40.26	C	B	D
DFS-3-U	CC	D	C-D	27	56	33.2	42.12	33.16	51.08	D	D	D
DFS-3-U	CC+GMP	D	C-D	27	49.3	43.2	40.31	28.65	51.98	D	D	D

DFSS.Bespoke. Class	SCENARIO	Current deposited sediment (From Carter et al (2022))	Current DFS variability (From Carter et al (2022))	Midpoint DFS of band OR threshold value for A and D bands (%)	% change in Load (This is the median from Resource 167)	% change in Load (This is the Std Dev from Resource 167)	Predicted median deposited sediment (%)	Predicted deposited sediment -SD (%)	Predicted deposited sediment +SD (%)	Predicted Band median	Predicted band -SD	Predicted band + SD
DFS-4-EF	GMP	A	A-B	13	0	9.8	13.00	11.73	14.27	A	A	B
DFS-4-EF	CC	A	A-B	13	44.2	24.6	18.75	15.55	21.94	B	B	C
DFS-4-EF	CC+GMP	A	A-B	13	41.8	25.9	18.43	15.07	21.80	B	B	C
DFS-4-IF	GMP	A	A-B	13	0	6.5	13.00	12.16	13.85	A	A	B
DFS-4-IF	CC	A	A-B	13	53.4	25.8	19.94	16.59	23.30	C	B	C
DFS-4-IF	CC+GMP	A	A-B	13	51.6	26.9	19.71	16.21	23.21	C	B	C
DFS-4-P	GMP	C	B-D	23	-30.7	44.8	15.94	5.64	26.24	B	A	C
DFS-4-P	CC	C	B-D	23	58.5	18.7	36.46	32.15	40.76	D	D	D
DFS-4-P	CC+GMP	C	B-D	23	18.2	35.4	27.19	19.04	35.33	D	C	D
DFS-4-PI	GMP	C	B-D	23	-9.5	25.1	20.82	15.04	26.59	C	B	C
DFS-4-PI	CC	C	B-D	23	73.1	16	39.81	36.13	43.49	D	D	D
DFS-4-PI	CC+GMP	C	B-D	23	59.3	28.8	36.64	30.02	43.26	D	D	D
DFS-4-U	GMP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DFS-4-U	CC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DFS-4-U	CC+GMP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix 4
Detailed results tables – for CC, GMP and CC+GMP scenarios

Tier 1 attributes

Nitrate Toxicity (NO_3-N)

Nitrogen occurs naturally and cycles through different forms as it moves through the environment. The concentrations of nitrogen (and phosphorus) in water give an indication of the potential for undesirable biological growths. Excessive concentrations of these nutrients can lead to prolific growths of periphyton (attached algae), phytoplankton (free-living algae) and macrophytes (attached aquatic plants).

Nitrate-nitrogen (NO_3-N) is one form of nitrogen that is highly soluble in water and is an important nutrient for plant growth. Anthropogenic sources of NO_3-N in the environment include fertilisers, leaking sewage systems, and animal wastes. At high concentrations, nitrate is also toxic to aquatic organisms and humans. It is often reported as nitrate-nitrite-nitrogen (NNN). NNN is the sum of nitrate (NO_3) and nitrite (NO_2). NO_2 concentrations are normally low in comparison to NO_3 concentrations in rivers, and this is often why NO_3 is analysed and reported as approximating NNN.

While increases in NO_3-N may have effects on higher order attributes indirectly e.g., through increasing periphyton and macrophyte growth, these effects were instead captured in the assessment of dissolved inorganic nitrogen (DIN). This discussion is also embedded in parts of the 'effect' assessments in the DIN results tables.

Coarse estimates of nutrient load reductions achieved by GMP mitigations for each biophysical class were derived from the percentage reduction estimates for each land use type provided in Appendix 1(a). The estimated load reductions were weighted by the estimated area of each land use type in each biophysical class and are presented for total nitrogen in Appendix 1(b). These were used to assist with the GMP assessments for all three nitrogen attributes (NO_3-N, NH_4-N and DIN).

The assessments in Table 31 should be read in conjunction with the discussions in section **2.6.2** and the comments above.

Table 31 Panel Summary for Scenario assessment of nitrate-nitrogen. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. The likelihood of detecting any measurable change in the way we currently monitor and within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Moderately confident that there will be changes in the climate, but also that these changes would not result in a detectable change. This has been assessed as moderate rather than low due to the IF land cover class providing more certainty around smaller climate changes than compared to other land cover classes.
Mitigation (GMP)	NV_IF	A (A)	0	0	3	No	**Degree of Change** Only 3% of this spatial class subject to GMPs, as this is <5%, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	A (A)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during harvest for the EF land cover class. However, with current monitoring regime requirements, this is unlikely to be detectable. **Effect:** As the degree of change is negligible, the effect is also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects – although it is expected that harvesting effects would average out across this biophysical/landcover class as this class is well distributed across the East Coast FMU. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment being assessed as 1-low. However, the Expert Panel notes that three panel members were more confident with an assessment of 2-moderate.
Mitigation (GMP)	NV_EF	A (A)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. A lot of this biophysical/landcover class is outside of our regional boundary, so there is currently little monitoring. Pasture monitoring sites in this biophysical/landcover class and other biophysical/landcover classes are mainly in the A band, so low likelihood of any state change. As discussed in section 3.5.2, there could be small change in either direction, but with the uncertainty around climate change effects on nitrogen and which processes would dominate, the Expert Panel made the decision to reflect this with an assessment of 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 3.5.2.
Mitigation (GMP)	NV_P	A (A-B	0	0	2	No	**Degree of change** The majority of this class (65%) is subject to GMPs. However, as the majority of this is low intensity P, the weighted average load reduction in TN is estimated as only ~6%. This is below the nominal 10% change predicted to be needed for any detectable change0. There may be better gains in the alluvial plains compared to the high country, but overall, unlikely any change would be detected. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							There is consensus that GMP will lead to a reduction in TN and it was acknowledged that some areas (e.g., the top of the Motu River) may have a detectable change. Overall, there is moderate confidence that no change would be detected at the class scale.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	A (A-B)	0	0	1	No	**Degree of change** As both Climate Change and GMP scenarios were both 0, the combined can only be 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go and either reinforcing or counteracting the GMP reduction in TN.
Climate Change (RCP4.5)	NV_PI	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some change may be detected in discrete areas, but overall, the degree of change is assessed as 0 reflecting the discussion in section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The PI land classes do not provide any more certainty than the starting position of a confidence of 1-low for Climate Change. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2. The low confidence also reflects the uncertainty around a degree of change as 0 or -1/+1.
Mitigation (GMP)	NV_PI	A (A-B)	1	0	2	No	**Degree of Change** The majority (80%) of this class is subject to GMP, and 60% of this is dairy. It is widespread across the alluvial pastoral plains particularly on Galatea, Rangitāiki and Kaituna Plains. The weighted average load reduction for TN is estimated as 22%. This reduction in load provides reason for probable detectable improvement. However, as the state is already in the A band, a band shift is not possible. It is recognised that some sites that are in the B band could improve to the A band. **Effect** Overall, no change in toxicity (which this attribute measures), but possible benefits for biota from this level of reduction. There may be some benefits without changing overall state. There is some disagreement with

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							the Panel around the effect this level of load reduction could have on higher order attributes. While recognising there may not be an improvement on fish and macroinvertebrates, there are higher order attributes that are not currently monitored by BOPRC, such as DO and ecosystem metabolism, that may benefit from this load reduction. However, when considering that this is a toxicity-based attribute and that it is already in the A band, any improvements from a toxicity perspective is not going to have any particular benefit to higher order attributes. **Confidence** Moderately confident given the understanding of GMP benefits for these land uses.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	A (A-B)	1	0	1	No	**Degree of Change** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. It is not clear whether the Climate Change or GMP scenario would have the dominant influence. The direction of change for Climate Change is very uncertain. Therefore, the degree of change of 1 is reflective of the assumption that the GMP scenario would dominate. This assumption is based on the higher confidence associated with the GMP scenario. It is noted that some EP members were more inclined to a 0 degree of change. **Effect** As no effect in Climate Change or GMP scenarios, there is also no effect for this combined scenario. **Confidence** The low confidence is reflective of the Climate Change direction uncertainty and the range in individual assessments
Climate Change (RCP4.5)	V_HG_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decrease ~4%-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. The likelihood of detecting any measurable change in the way we currently monitor and within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							<u>Confidence</u> Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. This has been assessed as moderate rather than low due to the IF land cover class providing more certainty around smaller climate changes than compared to other land cover classes.
Mitigation (GMP)	V_HG_IF	A (A)	0	0	3	No	**<u>Degree of Change</u>** <5% of this class is subject to GMPs, as such, GMP = current state as per section 2.6.2. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the biophysical unit (BPU).
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A)	0	0	2	No	**<u>Degree of Change</u>** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **<u>Effect</u>** As per Climate Change assessment **<u>Confidence</u>** As per Climate Change assessment
Climate Change (RCP4.5)	V_HG_EF	A (A)	0	0	1	No	**<u>Degree of Change</u>** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decreases ~4%-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during harvest for the EF land cover class. However, with current monitoring regimes, this is unlikely to be detectable. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment being assessed as 1-low.
Mitigation (GMP)	V_HG_EF	A (A)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decrease of ~ 4%-10%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Pasture sites in this class and other classes are mainly in the A band, so a low likelihood of any state change. As per the discussion in section 2.6.2, the direction of change would likely be small but in either direction. The assessment of 0 reflects this. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_HG_P	A (A-B)	0	0	2	No	**Degree of change** 49% of this biophysical/landcover class is subject to GMPs. The weighted average load reduction of TN is estimated as 7%, which is below the nominal 10% expected to be required for detectable change. Therefore, unlikely any change would be detected. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. Moderate confidence that no change would be detected given the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	A (A-B)	0	0	1	No	**Degree of Change** As both Climate Change and GMP scenarios were both 0, the combined can only be 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go and either reinforcing or counteracting the GMP reduction in TN.
Climate Change (RCP4.5)	V_HG_PI	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 10-15 days increase in annual hot days, mostly 8% summer rainfall decrease, <1-degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. A small amount of the region is in this class, but it is well distributed throughout the pastoral landscape in lower order streams. Overall, the degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							<u>Confidence</u> The PI land classes do not provide any more certainty than the starting position of a confidence of 1-low for Climate Change. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2. The low confidence also reflects the uncertainty around a degree of change as 0 or -1/+1.
Mitigation (GMP)	V_HG_PI	A (A-B)	1	0	1	No	**<u>Degree of Change</u>** The majority (62%) of this biophysical/landcover class is subject to GMP. This is biophysical/landcover class is a small part of the region but well distributed throughout the pastoral landscape in lower order streams. The weighted average load reduction for TN is estimated as 19%. This reduction in load provides reason for probable detectable improvement. However, as the state is already in the A band, a band shift is not possible. It is recognised that some sites that are in B could improve to A band. **<u>Effect</u>** Overall, no change in toxicity (which this attribute measures), but possible benefits for biota from this level of reduction. There was some disagreement with the Panel around the effect this level of load reduction could have on higher order attributes. While recognising there may not be an improvement on fish and macroinvertebrates, there are higher order attributes that are not currently monitored by BOPRC, such as DO and ecosystem metabolism, that may benefit from this load reduction. In summary, there may be some benefits without changing overall state. However, when considering that this attribute is a toxicity-based attribute and that it is already in the A band, any improvements from a toxicity perspective is not going have any particular benefit to higher order attributes. **<u>Confidence</u>** The 1-low confidence here reflects the uncertainty around the level of effect, noting that the confidence in the direction of change (i.e., positive/improvement) is high.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	A (A-B)	1	0	1	No	**<u>Degree of Change</u>** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. It is not obvious whether Climate Change or GMP would have the dominant influence. The direction of change for Climate Change is very uncertain and while Climate Change is assessed as a 0, there can still be a direction within that 0. However, given a direction is clear for GMP, the combined assessment reflects the GMP assessment. **<u>Effect</u>**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As no effect in Climate Change or GMP scenarios, there is also no effect for this combined scenario. **Confidence** Low confidence reflective of the split in opinions and confidence levels for GMP and Climate Change scenarios.
Climate Change (RCP4.5)	V_LG_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., increase in annual hot days by 5-20, summer rainfall decrease ~4%-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. The likelihood of detecting any measurable change in the way we currently monitor and within a 20-year timeframe is low. As such, a degree of change of 0 is applied as detailed in section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. This has been assessed as moderate rather than low due to the IF land cover class providing more certainty around smaller climate changes than compared to other land cover classes.
Mitigation (GMP)	V_LG_IF	A (A)	0	0	3	No	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence defaults to 3-high when GMPs area applied to <5% of the BPU.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-20 increase in annual hot days, summer rainfall decrease ~4%-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during harvest for the EF land cover class. However, with current monitoring regimes, this is unlikely to be detectable. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment staying at the default of 1-low.
Mitigation (GMP)	V_LG_EF	A (A-B)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	A (A-B)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	V_LG_P	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Pasture sites in this biophysical/landcover class and other biophysical/landcover classes are mainly in the A band, so low likelihood of any state change. As outlined in the discussion in section 2.6.2, the uncertainty in the direction of any change is reflected in the assessment of 0 for the degree of change. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 3.5.2.
Mitigation (GMP)	V_LG_P	A (A-B)	0	0	2	No	**Degree of change** 40%-50% of this biophysical/landcover class is subject to GMPs. However, as the majority of this is low intensity P, the weighted average load reduction in TN is estimated as only ~7%. This is a widespread class, more intensely in southern Tauranga Moana, Kaituna and upper Pongakawa, Rotorua, and upper Rangitāiki. Any change would be localised, but unlikely to have change at the class level due to the variability of this class. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. Moderate confidence that no change would be detected given the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	A (A-B)	0	0	1	No	**Degree of Change** As both Climate Change and GMP scenarios were both 0, the combined can't be anything but 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							The low confidence reflects the uncertainty of what direction the Climate Change scenario would go and either reinforcing or counteracting the GMP reduction in TN.
Climate Change (RCP4.5)	V_LG_PI	B (A-C)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 0%-2% change in annual rainfall, 2-4 increase in summer dry days, <1 degree summer temp increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Impacts of Climate Change on agricultural land management will play a role in determining the magnitude/direction of change. On balance, the degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The PI land classes do not provide any more certainty than the default position of a confidence of 1-low for Climate Change. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2. The low confidence also reflects the uncertainty around a degree of change as 0 or -1/+1.
Mitigation (GMP)	V_LG_PI	B (A-C)	2	1	2	No	**Degree of Change** This biophysical/landcover class has 54% in dairy, of which GMPs will reduce TN loads by about 25%. The other large land use (drystock) occupies a further 12% but is predicted to get a 5% reduction. The weighted average load reduction for TN is estimated as 20%. This reduction in load provides reason for probable detectable improvement and has the potential to move state bands with a load reduction this high. **Effect** A substantial reduction that may pull this class up to an A band for toxicity will likely have benefits for biota. Range could change from A-C to A-B. The reason for the level of effect being different to the V-HG-PI class is the potential for a band shift in this biophysical/landcover class from a B to an A band. A B-band in the NPSFM suggests some toxicity effects, so the shift up to an A band will result in some positive effects on higher order attributes. **Confidence**

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							High confidence that the direction of change is positive/improving. The moderate confidence overall reflects that most (69%) of the class being subject to GMP and the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	B (A-C)	2	1	1	No	**Degree of Change** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. The degree of change of 2 reflects the assumption that GMP scenario would dominate. This assumption is based on the higher confidence associated with the GMP scenario. The change from Climate Change would become the variability in this scenario. **Effect** The level of effect is consistent with the GMP scenario, as this is considered to be the dominant driver for this combined scenario and biophysical/landcover class. **Confidence** The low confidence is reflective of CC acting in the opposite direction to GMP, but uncertainty in the magnitude of that.
Climate Change (RCP4.5)	Urban	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 0-2% change in annual rainfall, 5-10 increase in annual hot days, summer rainfall decrease ~4%-10%, <1 degree summer temp increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Given the close links between urban water quality and rainfall, it is unlikely these changes will cause significant differences in urban stream water quality conditions. Note that the urban classes include a substantial amount of pasture. Rotorua urban streams are in A band and likely to remain in this as spring fed. Therefore, on balance, the degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The Urban land classes do not provide any more certainty than the default position of a confidence of 1-low for Climate Change. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 3.4.2.

Scenario	Spatial Classification	EP estimate for Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	Urban	A (A-B)	0	0	2	No	**Degree of Change** While there is minimal GMP effect in urban areas, there is potential for some improvement as a large proportion of load in this biophysical/landcover class is from pasture (which is also intensive dairying). There is therefore 25% GMP on 46% area and 5%-10% GMP on 15% area, resulting in a weighted average load reduction of TN of approximately 11%. While potential for measurable change (because >10%), there is more confidence in no detectable change due to A state. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** High confidence that the direction of change is positive/improving. The moderate confidence overall is reflective of the general confidence in understanding GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	A (A-B)	0	0	1	No	**Degree of Change** As both Climate Change and GMP scenarios were both 0, the combined can only be 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go. There was a lot of uncertainty in the direction of change for this biophysical/landcover class.

Ammonia Toxicity (NH4-N)

Ammoniacal-nitrogen (NH4-N) covers two forms of nitrogen: ammonia (NH3) and ammonium (NH4). NH4-N is an important nutrient for plant growth. At high concentrations it is also toxic to aquatic organisms and humans. Anthropogenic sources of ammoniacal-nitrogen in the environment include point source discharges (e.g., domestic, agricultural and industrial wastewater).

As for NO3-N, it is important to recognise this attribute is a toxicity attribute and therefore the level of effect assessed is reflective of this. Also as for NO3-N, estimates of weighted load reductions achieved by GMP mitigations for total nitrogen were used to assist with the GMP assessments (see explanation provided at the beginning of the NO3-N attribute table above and weighted load reduction estimates in Appendix 1(b)). However, the Panel also took account of the likelihood that point discharges are the most common source of ammonia rather than diffuse sources and that predicted GMP reductions in total nitrogen would not necessarily closely relate to reductions in ammonia; the Panel considered the likelihood that GMP practices would also result in some improvement to ammonia from point sources.

The assessments in Table 32 should be read in conjunction with the discussions in section 2.6.2.

Table 32 Panel Summary for Scenario assessment of ammonia. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. (2018) modelled this using SWAT (a semi distributed hydrological model), but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. Current ammonia concentrations are low. The likelihood of detecting any measurable change within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect As the degree of change is negligible, the effect also negligible. **Confidence** Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. This has been assessed as moderate rather than low due to the IF land cover class providing more certainty around smaller climate changes than compared to other land cover classes.
Mitigation (GMP)	NV_IF	A (A)	0	0	3	No	**Degree of Change** Only 3% of this spatial class subject to GMPs, as this is <5%, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	A (A)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. (2018) modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							harvest for the EF land cover class. Possible increase ammonia release with sediment mobilisation three to five years after harvest, so if increased rainfall coincides with that it may lead to pockets of increased toxicity and possibly detectable degradation and effects. However, with current monitoring regimes, this is unlikely to be detectable. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Although it is expected that harvesting effects would average out across this class as this classification is well distributed across the East Coast FMU. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment assessed as 1-low.
Mitigation (GMP)	NV_EF	A (A)	0	0	3	No	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the BPU.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	A (A)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. (2018) modelled this using SWAT, but

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. A lot of this biophysical/landcover class is outside of our regional boundary, so there is little monitoring. Pasture sites in this biophysical/landcover class and other biophysical/landcover classes are mainly in A, so low likelihood of any state change. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes does not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	NV_P	A (A-B)	0	0	2	No	**Degree of change** The majority of this class (65%) is subject to GMPs. However, as the majority of this is low intensity P, the weighted average load reduction in TN is estimated as only ~6%. There may be better gains in the alluvial plains compared to the high country. But overall, unlikely small gains in dominant land use would be detected. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. The moderate confidence reflects that there may be some localised areas that detect improvements.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	A (A-B)	0	0	2	No	**Degree of change** As both Climate Change and GMP scenarios were both 0, the combined can only be 0. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Confidence at 2-moderate reflects the confidence around both Climate Change and GMPs resulting in small changes.
Climate Change (RCP4.5)	NV_PI	A (A-C)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1-degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. (2018) modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some change may be detected in discrete areas, but overall, the degree of change is assessed as 0 as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The PI land classes do not provide any more certainty than the starting position of a confidence of 1-low for Climate Change. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	NV_PI	A (A-C)	1	1	2	No	**Degree of Change** The majority (80%) of this BPU is subject to GMP, 60% of this is dairy. It is widespread across the alluvial pastoral plains particularly on Galatea, Rangitāiki and Kaituna Plains. The weighted average load reduction for TN is estimated as 22%. This reduction in load provides reason for probable detectable improvement in ammonia. However, as the state is already in the A band, a band shift is not possible. It is recognised that some sites that are in B could improve to A band, but overall, the level of effect is assessed as 1. **Effect** Overall, no change in the average toxicity, but possible benefits for biota from this level of reduction when looking across the range of A-C bands in this class. Any positive effects are mostly likely to be seen in streams in the B and C band.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Moderately confident given the understanding of GMP benefits for these land uses.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	A (A-C)	1	1	1	No	**Degree of Change** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. The direction of change for Climate Change is very uncertain. The degree of change of 1 is reflective of the assumption that GMP scenario would dominate. This assumption is based on the higher confidence associated with the GMP scenario. **Effect** Consistent with GMP as the dominant scenario. **Confidence** The low confidence is reflective of the Climate Change direction uncertainty and level of change.
Climate Change (RCP4.5)	V_HG_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decrease ~4%-8%, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. 2018 modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. Current ammonia concentrations are low. The likelihood of detecting any measurable change within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. This has been assessed as moderate rather than low due to the IF land cover class providing more certainty around smaller climate changes than compared to other land cover classes.
Mitigation (GMP)	V_HG_IF	A (A)	0	0	3	No	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the BPU.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	A (A)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decreases ~4%-8%, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang et al. 2018 modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during harvest for the EF land cover class. Possible increase ammonia release with sediment mobilisation three to five years after harvest so if increased rainfall coincides with that it may lead to pockets of increased toxicity and possibly detectable degradation and effects. However, with current monitoring regimes, this is unlikely to be detectable. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As the degree of change is negligible, the effect is also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment assessed as 1-low.
Mitigation (GMP)	V_HG_EF	A (A)	0	0	3	No	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the BPU.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	A (A)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	A (A)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decrease of ~ 4%-10%, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al.* (2018) modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Pasture sites in this biophysical/landcover class and other biophysical/landcover class are mainly in A, so low likelihood of any state change. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_HG_P	A (A)	0	0	2	No	**<u>Degree of change</u>** 49% of this biophysical/landcover class is subject to GMP. The weighted average load reduction of TN is estimated as 7%, which is below the nominal 10% expected for any change to be detectable. Therefore, unlikely any change would be detected. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** There is no question as to what direction the change would be in, i.e., it will be improved. Moderate confidence that no change would be detected given the understanding of GMP effects on load reductions
Climate Change (RCP4.5)+ Mitigation (GMP)	V_HG_P	A (A)	0	0	2	No	**<u>Degree of Change</u>** As both Climate Change and GMP scenarios were both 0, the combined can only be 0. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** Moderately confident that changes in both Climate Change and GMP is small, so the combined will also be small and not detectable.
Climate Change (RCP4.5)	V_HG_PI	A (A)	0	0	1	No	**<u>Degree of Change</u>** While confident the climate will change, the key climate drivers show relatively little change (e.g., 10-15 days increase in annual hot days, mostly 8% summer rainfall decrease, <1-degree summer temperature effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. A small amount of the region is in this class, but it is well distributed throughout the pastoral landscape in lower order streams. Overall, the degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The PI land classes do not provide any more certainty than the starting position of a confidence of 1-low for Climate Change. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_HG_PI	A (A)	1	0	2	No	**Degree of Change** The majority (62%) of this biophysical/landcover class is subject to GMP. This class is a small part of the region but well distributed throughout the pastoral landscape in lower order streams. The weighted average load reduction for TN is estimated as 19%. This reduction in load provides reason for probable detectable improvement. However, as the state is already in the A band, a band shift is not possible. **Effect** Overall, no change in the toxicity, so unlikely to have benefits on higher order attributes. **Confidence** Moderately confident given the understanding of GMP benefits for these land uses.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	A (A)	0	0	1	No	**Degree of Change** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. It is not clear whether Climate Change or GMP would have the dominant influence. The direction of change for Climate Change is very uncertain and while Climate Change is assessed as a 0, there can still be a direction within that 0. Overall, a 0 is considered to reflect the small change in GMP scenario and the variability caused by Climate Change. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Low confidence reflective of the uncertainty in Climate Change scenario
Climate Change (RCP4.5)	V_LG_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., increase in annual hot days by 5-20, summer rainfall decrease ~4%-8%, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. (2018) modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again. Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. Current ammonia concentrations are low. The likelihood of detecting any measurable change within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. This has been assessed as moderate rather than low due to the IF land cover class providing more certainty around smaller climate changes than compared to other land cover classes.
Mitigation (GMP)	V_LG_IF	A (A)	0	0	3	No	**Degree of Change** <5% of this class is subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As per section 2.6.2, confidence defaults to 3-high when GMPs area applied to <5% of the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A)	0	0	2	No	**<u>Degree of Change</u>** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **<u>Effect</u>** As per Climate Change assessment. **<u>Confidence</u>** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	A (A)	0	0	1	No	**<u>Degree of Change</u>** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-20 increase in annual hot days, summer rainfall decrease ~4%-8%, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al*. (2018) modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again. Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Concentrated coverage in this class in Rangitāiki but distribution through Rotorua and upper Tarawera areas. Spring fed smaller streams likely to moderate stream temperatures. The Rangitāiki mainstem impoundments could result in summer ammonia releases, but this could also potentially be offset by uptake. Some added uncertainty around effects during harvest for the EF land cover class. Possible increase ammonia release with sediment mobilisation three to five years after harvest. So, if increased rainfall coincides with that it may lead to pockets of increased toxicity and possibly detectable degradation and effects. On balance, negligible change expected. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment assessed as 1-low.
Mitigation (GMP)	V_LG_EF	A (A)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	A (A)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	A (A)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al.* (2018) modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Pasture sites in this biophysical/landcover class and other biophysical/landcover class are mainly in A, so low likelihood of any state change. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_LG_P	A (A)	0	0	2	No	**Degree of Change** 40%-50% of this biophysical/landcover class is subject to GMPs. However, as the majority of this is low intensity P, the weighted average load reduction in TN is estimated as only ~7%, which is below the nominal 10%. This is a widespread class, more intensely in southern Tauranga Moana, Kaituna and upper Pongakawa, Rotorua, and upper Rangitāiki. Any change would be localised. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. Moderate confidence that no change would be detected given the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	A (A)	0	0	2	No	**Degree of Change** Small improvements from GMP unlikely to be enough to combat estimated effects from climate change. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The moderate confidence is reflective of the confidence in GMPs not being enough to combat estimated effects from climate change.
Climate Change (RCP4.5)	V_LG_PI	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 0%-2% change in annual rainfall, 2-4 increase in summer dry days, <1 degree summer temp increase). Although some indications that ammonia would have moderate increases with Climate Change (Wang *et al.* (2018)

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							modelled this using SWAT, but for a 2090 horizon so changes to 2040 are likely to be less again), effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Impacts of Climate Change on agricultural land management will play a role in determining the magnitude/direction of change. On balance, the degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_LG_PI	A (A-B)	1	1	2	No	**Degree of Change** This biophysical/landcover class has 54% in dairy, of which GMPs will reduce N loads by about 25%. The other large land use type (drystock) occupies a further 12% but is predicted to get a 5% reduction. The weighted average load reduction for TN is estimated as 20%. This reduction in load provides reason for probable detectable improvement. Source results for yield change in Pongakawa also supportive of a degree of change of 1. **Effect** Overall, no change in the average toxicity, but possible benefits for biota from this level of reduction are likely to be observed more in B streams. **Confidence** High confidence that the direction of change is positive/improving. The moderate confidence overall is reflective of the majority of the class (69%) being subject to GMP and the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	A (A-B)	1	1	2	No	**Degree of Change** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. The direction of change for Climate Change is very uncertain. The degree of change of 1 is reflective of the assumption that GMP scenario would dominate. This assumption is based on the higher confidence associated with the GMP scenario.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect GMP scenario dominates resulting in positive effects especially in B streams. **Confidence** Moderate confidence rather than low confidence as there is moderate confidence that it is either 0 or 1 for effect.
Climate Change (RCP4.5)	Urban	B (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 0%-2% change in annual rainfall, 5-10 increase in annual hot days, summer rainfall decrease ~4%-10%, <1 degree summer temp increase). Relative abundance of ammonia at these sites means its possible Urban sites could exceed bottom line under future climate (current state is near the border as-is). These systems are dominated by groundwater, stormwater runoff is the main delivery of contaminants. As there is a reduction in rainfall days predicted, there could be less dissolved contaminants because of reduced runoff. On the other hand, less runoff = low flows. Urban areas are generally more affected by point sources, so the reduced dilution would be more important. However, this is not the case so much in the BOP region, point source discharges are minimal. Note that the urban classes include a substantial amount of pasture (over half). The urban component of TN load is <20%, if the load was more attributed to the urban land use, then would be leaning towards a -1 direction. But given the pasture component and consistency with the other P/PI biophysical/landcover classes, a 0 is more appropriate. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The Urban land class does not provide any more certainty than the default position of a confidence of 1-low for Climate Change. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	Urban	B (A-B)	1	0	1	No	**Degree of Change** While there is minimal GMP effect in urban areas, there is potential for some improvement as a large proportion of load in this biophysical/landcover class is from pasture (which is also intensive dairying).

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							There is therefore 25% GMP on 46% area and 5%-10% GMP on 15% area, resulting in a weighted average load reduction of TN of approximately 11%, which is above the nominal 10% expected to cause detectable change. **Effect** Many other major stresses in urban areas, minor reduction not going to have effects on higher order attributes. **Confidence** High confidence that the direction of change is positive/improving. The moderate confidence overall is reflective of the general confidence in understanding GMP effects on load reductions
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	B (A-B)	1	0	1	No	**Degree of Change** Assuming GMP will dominate but recognise that Climate Change could negate any GMP change. **Effect** The low level of change is not expected to result in improvements to higher order attributes. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go.

Dissolved Inorganic Nitrogen (DIN)

Dissolved Inorganic Nitrogen (DIN) includes all soluble inorganic forms of nitrogen (e.g., NH_4-N, NO_3-N), and as such DIN represents the portion of nitrogen that is readily available for plant uptake. Unlike the NPSFM NH_4-N and NO_3-N attribute state bands that relate to aquatic toxicity, DIN thresholds are based on eutrophication of a stream and this provides a good indication of the eutrophication aspect of ecosystem health along with the periphyton and ecosystem metabolism attributes. This means that the level of effect assessed here may not be the same as that assessed for NO_3-N or NH_4-N through a toxicity effect lens. Both eutrophication and toxicity are relevant aspects of ecosystem health. The DIN attribute is not currently an NPSFM compulsory attribute.

As was the case for the NO_3-N and NH_4-N attributes, the Expert Panel used estimates of load reductions achieved by GMP mitigations derived from the percentage reduction estimates for each land use type provided in Appendix 1(a). Those reduction estimates were then weighted by the estimated area of each land use type in each biophysical class and are presented in Appendix 1(b). These were used to assist with the GMP assessments for all three nitrogen attributes (NO_3-N, NH_4-N and DIN).

Table 33 Panel Summary for Scenario assessment of dissolved inorganic nitrogen. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	A (A)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects. The current state is comfortably in the A band. The likelihood of detecting any measurable change in the way we currently monitor and within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As the degree of change is negligible, the effect also negligible. **Confidence** Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. Although the IF classes are made up of other land covers within it, the IF land cover class still provides the most stable and predictable relationships of all the biophysical/landcover class. As such, a confidence level of 2-moderate is considered appropriate.
Mitigation (GMP)	NV_IF	A (A)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	A (A)	0	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	B (A-C)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during harvest for the EF land cover class. High nutrient run-off is likely three to five years after harvest. If increased rainfall coincides with harvest it may lead to pockets of increased concentrations and possibly detectable degradation and effects on inverts via food conditioning and ecosystem metabolism via nutrient availability. However, there is likely reasonable canopy cover and

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							shade with exception of smaller streams immediately after harvest. Overall, change is likely to be negligible and could increase or decrease, hence the assessment of 0. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment assessed as 1-low.
Mitigation (GMP)	NV_EF	B (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	B (A-C)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	NV_P	B (A-C)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 increase in annual hot days, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Any potential

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							increases in DIN in these rivers (in the upper Motu) would have only a very small effect on the Motu. Moreover, any increases could quickly be assimilated by periphyton. Current state is in the B band. This band is quite narrow, so a change in state is possible, but changes in NO_3 and NH_4 may offset one another. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	NV_P	B (A-C)	0	0	1	No	**Degree of change** The majority of this class (65%) is subject to GMPs. However, as the majority of this is low intensity P, the weighted average load reduction in TN is estimated as only ~6%, which is below the nominal 10% expected to be required for detectable change. There may be better gains in the alluvial plains compared to the high country. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. The low confidence also reflects that some areas (e.g., the top of the motu) may have a detectable change but others may not.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	B (A-C)	0	0	1	No	**Degree of Change** Both climate change and GMPs will only have a minimal effect. Climate drivers show relatively little change, thus small improvements from GMP likely. Given the location of this class in the top of the Motu with lower order streams, the relatively small percentage reduction likely from GMP (6%) in high country could result in better gains on alluvial plains. On balance, Climate Change is expected to dominate and therefore the assessment is reflective of the Climate Change assessment. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							<u>Confidence</u> The low confidence reflects the uncertainty of what direction the Climate Change scenario would go and either reinforcing or counteracting the GMP reduction in DIN. GMP change is also marginal, the Climate Change direction uncertainty overrides the GMP marginal change to a 0 for change. This is all reflected in the low confidence.
Climate Change (RCP4.5)	NV_PI	C (A-D)	0	0	1	No	**<u>Degree of Change</u>** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4-15% summer rainfall decrease, <1-degree summer temperature. Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Changes in NO_3 and NH_4 may offset one another. Some lower gradient low flow, potential for NH_4 release from sediments, but could be balanced by uptake. Some change may be detected in discrete areas, but overall, the degree of change is assessed as 0. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** The PI land classes do not provide any more certainty than the starting position of a confidence of 1-low for Climate Change. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section **2.6.2**. The low confidence also reflects the uncertainty around the direction of change.
Mitigation (GMP)	NV_PI	C (A-D)	2	1	1	No	**<u>Degree of Change</u>** The majority (80%) of this class is subject to GMP, 60% of this is dairy. It is widespread across the alluvial pastoral plains particularly on Galatea, Rangitāiki and Kaituna Plains. The weighted average load reduction for TN is estimated as 22%. This reduction in load provides reason for probable detectable improvement and potential for a band change, particularly if the current state is close to the B/C boundary. **<u>Effect</u>** This reduction may have some effect on periphyton growth, but this effect is not expected to be very large, as many of the streams around the Rangitāiki and Waiotahe plains are soft-bottomed. May possibly affect streams in Galatea, as some of these are hard-bottomed. Overall positive effect on higher order attributes (e.g., macroinvertebrates and ecosystem metabolism).

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Moderately confident in the degree of change, but overall confidence is a 1-low because of the low confidence in the effect level.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	C (A-D)	1	1	1	No	**Degree of Change** Climate change was assessed as being minimal, so changes would be due to GMPs only. GMPs results in reduction with potential band improvement, strengthened in summer as increased uptake of DIN through algal and macrophyte growth. However, an improvement in band due to GMPs may be hindered by Climate Change, although the direction for the Climate Change scenario is uncertain. Therefore, the overall degree of change is assessed as 1. **Effect** Any positive effect on higher trophic levels would be small, at best. **Confidence** Low confidence based on uncertainty of climate change impacts.
Climate Change (RCP4.5)	V_HG_IF	A (A-B)	0	0	2	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decrease ~4-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. The IF land cover would also buffer these climate effects as well as the steeper gradients in this HG class. As increase in temperature is under 1°C, unlikely to be much increase in water temperature in these spring fed systems and will be further moderated by smaller faster flow and shaded waterways. The likelihood of detecting any measurable change in the way we currently monitor and within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							<u>Confidence</u> Moderately confident that there will be changes in the climate, but that these would not result in a detectable change. Although the IF classes are made up of other land covers within it, the IF land cover class still provides the most stable and predictable relationships of all the biophysical/landcover class.
Mitigation (GMP)	V_HG_IF	A (A-B)	0	0	3	No	**<u>Degree of Change</u>** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A-B)	0	0	2	No	**<u>Degree of Change</u>** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **<u>Effect</u>** As per Climate Change assessment. **<u>Confidence</u>** As per Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	B (A-C)	0	0	1	No	**<u>Degree of Change</u>** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decreases ~4-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Some added uncertainty around effects during harvest for the EF land cover class. High nutrient run-off is likely three to five years after harvest. If increased rainfall coincides with harvest it may lead to pockets of increased concentrations and possibly detectable degradation and effects on inverts via food conditioning and ecosystem metabolism via nutrient availability. However, there is likely reasonable canopy cover and

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							shade with exception of smaller streams immediately after harvest. Overall, 1ith current monitoring regimes, change is unlikely to be detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment assessed as 1-low.
Mitigation (GMP)	V_HG_EF	B (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	B (A-C)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	C (A-D)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-10 increase in annual hot days, summer rainfall decrease of ~ 4-10%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Pasture sites in this class and other classes are mainly in A, so low likelihood of any state change.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_HG_P	C (A-D)	0	0	1	No	**Degree of change** 49% of this biophysical/landcover class is subject to GMPs. The weighted average load reduction of TN is estimated as 7%. Therefore, probable improvement but unlikely to be detectable at the class scale. **Effect** Any reductions are unlikely to affect higher order attributes given the relatively small degree of change to DIN. However, noting that any reductions in DIN are likely to have cumulative positive effects on receiving environments (e.g., lakes and estuaries). **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. Low confidence that a change would be detected.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	C (A-D)	0	0	1	No	**Degree of Change** Small improvements from GMP unlikely to be enough to combat estimated effects from climate change. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go and either reinforcing or counteracting the GMP reduction in N.
Climate Change (RCP4.5)	V_HG_PI	C (A-D0	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 10-15 days increase in annual hot days, mostly 8% summer rainfall decrease, <1-degree summer temperature).

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. A small amount of the region is in this class, but it is well distributed throughout the pastoral landscape in lower order streams. Overall, the degree of change is assessed as 0. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** The PI land classes do not provide any more certainty than the starting position of a confidence of 1-low for Climate Change. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2. The low confidence also reflects the uncertainty around a degree of change as 0 or -1/+1.
Mitigation (GMP)	V_HG_PI	C (A-D)	2	1	1	No	**<u>Degree of Change</u>** The majority (62%) of this biophysical/landcover class is subject to GMP. This biophysical/landcover class is a small part of the region but well distributed throughout the pastoral landscape in lower order streams. The weighted average load reduction for TN is estimated as 19%. This reduction in load provides reason for probable detectable improvement and for band change from C to B. **<u>Effect</u>** When considering effect for DIN there are a few consistent aspects discussed; the relationship between nutrients and macroinvertebrates and fish, other higher order attributes such as DO and ecosystem metabolism, and effects on receiving environments (e.g., lakes and estuaries). While recognising there may not be an improvement in fish and macroinvertebrate attributes, there are higher order attributes that are not currently monitored by BOPRC, such as DO and ecosystem metabolism, that may benefit from this load reduction. Research is starting to show that a significant level of reduction in loads (i.e., potentially larger than ~25%) is required to get an ecological response. As such, the effect assessed here as 1 reflects that DO and ecosystem metabolism likely to have a detectable change. **<u>Confidence</u>** The 1-low confidence here reflects the uncertainty around the level of effect and potential for a state band change, noting that the confidence in the direction of change (i.e., positive/improvement) is high.
Climate Change (RCP4.5) +	V_HG_PI	C (A-D)	1	0	1	No	**<u>Degree of Change</u>** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. It is considered that the GMPs would dominate effects given the

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							level of load reduction. However, the potential negative effect of Climate Change, while very uncertain, is considered likely to somewhat counteract the positive effect of GMP. **Effect** A degree of change of 1 is unlikely to be enough to result in effects in higher order attributes. **Confidence** Low confidence reflective of both the Climate Change and GMP scenarios having low confidence.
Climate Change (RCP4.5)	V_LG_IF	A (A-B)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., increase in annual hot days by 5-20, summer rainfall decrease ~4-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Changes in NO_3-Nand NH_4-N may also offset one another. The IF land cover would also buffer these climate effects. The likelihood of detecting any measurable change in the way we currently monitor and within a 20-year timeframe is low. As such, a degree of change of 0 is considered appropriate. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low confidence in the climate change model and effects in nitrogen forms are complex. Less confident in this class (compared to V-HG and NV) due to the range and potential temperature effects.
Mitigation (GMP)	V_LG_IF	A (A-B)	0	0	3	No	**Degree of Change** <5% of this class is subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence defaults to 3-high when GMPs area applied to <5% of the BPU.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A-B)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	B (A-C)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 5-20 increase in annual hot days, summer rainfall decrease ~4-8%, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Streams in this biophysical/landcover class are largely in the Kaingaroa forest, with pumice substrate and highly permeable streams, so a lot are ephemeral. Some added uncertainty around effects during harvest for the EF land cover class. High nutrient run-off likely three to five years after harvest so if increased rainfall coincides with that it may lead to pockets of degradation and relevant effect. However, with current monitoring regimes, this is unlikely to be detectable. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment staying at the default of 1-low.
Mitigation (GMP)	V_LG_EF	B (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	B (A-C)	0	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	C (A-D)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, <1 degree summer temperature). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Widespread class, more intensely in southern Tauranga Moana, Kaituna & upper Pongakawa, Rotorua, and upper Rangitāiki. Some regional difference in concentration data distribution. Direction of change uncertain and changes in NO_3 and NH_4 may offset one another. On balance, negligible change is expected as per the discussion in section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The P land classes do not provide any more certainty than the default 1-low level of confidence for Climate Change scenarios. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2.
Mitigation (GMP)	V_LG_P	C (A-D)	0	0	2	No	**Degree of change** 40%-50% of this biophysical/landcover class is subject to GMPs. However, as the majority of this is low intensity P, the weighted average load reduction in TN is estimated as only ~7%. This is a widespread class, more intensely in southern Tauranga Moana, Kaituna & upper Pongakawa, Rotorua, and upper

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Rangitāiki. Any change would be localised, but unlikely to have change at the class level due to the variability of this class. **Effect** Any reductions are unlikely to affect higher order attributes given the relatively small degree of change to DIN. However, noting that any reductions in DIN are likely to have cumulative positive effects on receiving environments (e.g., lakes and estuaries). **Confidence** There is no question as to what direction the change would be in, i.e., it will be improved. Moderate confidence that no change would be detected given the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	C (A-D)	0	0	1	No	**Degree of Change** Small improvements from GMP unlikely to be enough to combat estimated effects from climate change. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go and either reinforcing or counteracting the GMP reduction in N.
Climate Change (RCP4.5)	V_LG_PI	D (B-D)	0	0	1	Yes	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 0-2% change in annual rainfall, 2-4 increase in summer dry days, <1 degree summer temp increase). Effects on nitrogen forms are also likely complex and can be positive and negative, (e.g., increased denitrification rates from higher temperatures; reduced dilution because of lower flows, but potentially less nutrient inputs due to lower water table and less surface runoff), with the net effect difficult to predict. Impacts of Climate Change on agricultural land management will play a role in determining the magnitude/direction of change. Annual hot days may increase by two weeks around streams flowing into Waihi estuary (Pongakawa/Kaikokopu/Puanene/Wharere). However, Waihi estuary catchment streams are strongly groundwater dominated and shaded in the headwaters. Other streams near Rotorua have less climatic effects. On balance, the degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence The PI land classes do not provide any more certainty than the default position of a confidence of 1-low for Climate Change. Therefore, the group assessment stays at 1-low in accordance with the method outlined in section 2.6.2. The low confidence also reflects the uncertainty around a degree of change as 0 or -1/+1.
Mitigation (GMP)	V_LG_PI	D (B-D)	1	1	2	Yes	**Degree of Change** This biophysical/landcover class has 54% in dairy, of which GMPs will reduce N loads by about 25%. The other large land use type (drystock) occupies a further 12% but is predicted to get a 5% reduction. The weighted average load reduction for TN is estimated as 20%. This reduction in load provides reason for probable detectable improvement. However, current state is so far into the D band that you wouldn't get an improvement in band even with a 20% reduction in concentrations. Source model results for yield change in Pongakawa also supportive of a degree of change of 1. **Effect** When considering effect for DIN there are a few consistent aspects discussed; the relationship between nutrients and macroinvertebrates and fish, other higher order attributes such as DO and ecosystem metabolism, and effects on downstream receiving environments such as lakes and estuaries. While recognising there may not be an improvement on fish and macroinvertebrates, there are higher order attributes that are not currently monitored by BOPRC, such as DO and ecosystem metabolism, which may benefit from this load reduction. Although research is starting to show that a significant level of reduction in loads (i.e., potentially larger than ~25%) is required to get an ecological response, some improvement of downstream receiving environments (lakes and estuaries) is expected here. As such, the effect assessed here as 1 reflects that DO and ecosystem metabolism are likely to have a detectable change and that there would be improvements in receiving environments (lakes and estuaries). **Confidence** High confidence that the direction of change is positive/improving. The moderate confidence overall is reflective of the majority of the class (69%) being subject to GMP and the understanding of GMP effects on load reductions.
Climate Change (RCP4.5) +	V_LG_PI	D (B-D)	1	0	1	Yes	**Degree of Change** The degree of change for this combined assessment is dependent on the mix of the scenarios counteracting or reinforcing each other. It is considered that the GMPs would dominate effects given the

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							level of load reduction. However, the direction of change for Climate Change is very uncertain and while Climate Change is assessed as a 0, there can still be a direction within that 0. The degree of change being 1 rather than 2 (as it is in the GMP assessment) reflects the potential plusses and minuses of the Climate Change scenario. **Effect** A degree of change of 1 is unlikely to be enough to result in effects in higher order attributes. **Confidence** Low confidence reflective of Climate Change direction uncertainty.
Climate Change (RCP4.5)	Urban	C (B-D)	0	0	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., 0-2% change in annual rainfall, 5-10 increase in annual hot days, summer rainfall decrease ~4-10%, <1 degree summer temp increase). Relative abundance of NH_4 at these sites means its possible Urban sites could exceed bottom line under future climate (near the border as-is). These systems are dominated by groundwater, stormwater runoff is the main delivery of contaminants. As there is a reduction in rainfall days predicted, there could be less dissolved contaminants because of reduced runoff. On the other hand, less runoff = low flows. Note that this state is close to the C/D threshold. Urban areas are generally more affected by point sources, so the reduced dilution is potentially more important. However, this is not the case so much in the BOP region where there are minimal point source discharges. The urban classes include a substantial amount of pasture (over half). The urban component of TN load is <20%, if the load was more attributed to the urban land use, then would be leaning towards a -1 direction. But given the pasture component and consistency with the other P/PI biophysical/landcover classes, a 0 is more appropriate. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The Urban land classes do not provide any more certainty than the default position of a confidence of 1-low for Climate Change. Therefore, the Group Assessment remained at 1-low in accordance with the method outlined in section 3.4.2.
Mitigation (GMP)	Urban	C (B-D)	1	0	2	No	**Degree of Change** While there is minimal GMP effect in urban areas, there is potential for some improvement as a large proportion of load in this biophysical/landcover class is from pasture (which is also intensive dairying).

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							There is therefore 25% GMP on 46% area and 5-10% GMP on 15% area, resulting in a weighted average load reduction of TN of approximately 11%. While there is potential for measurable change (i.e., just above the 10% threshold guide) especially given the current impacted C state, the improvement is small and so confident insufficient to cause a change in state. **Effect** Many other major stresses in urban areas, minor reduction not going to have effects on higher order attributes. **Confidence** High confidence that the direction of change is positive/improving. The moderate confidence overall is reflective of the general confidence in understanding GMP effects on load reductions.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	C (B-D)	0	0	1	No	**Degree of Change** Recognising that Climate Change may counteract GMP improvements. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** The low confidence reflects the uncertainty of what direction the Climate Change scenario would go.

Dissolved Reactive Phosphorus (DRP)

Like nitrogen, phosphorus occurs naturally in the environment and is an essential plant nutrient. Anthropogenic sources of phosphorus include fertiliser, and agricultural, urban and industrial wastewater. Phosphorus (as phosphate) enters waterways attached to soil particles that are transported from the land, usually via runoff. As the sediments remain in waterways, the phosphate dissolves and becomes DRP which feeds plant and algal growth.

Dissolved Reactive Phosphorus (DRP) is included in the NPSFM as an attribute to gauge and target riverine eutrophication, primarily through increased algal and plant growth. In the BOP region, elevated levels of DRP are attributed to enrichment of groundwater through porous volcanic geology. As such, monitoring data may give the appearance that the region's rivers are suffering from excessive enrichment derived from anthropogenic activity. This issue has previously been reported on internally by Scholes (2021) and Dare (2019). These investigations and assessments concluded that based on the geology and spring survey data (Scholes, 2021), elevated DRP ('D' band) in many BOP rivers is essentially naturally occurring and can be at or near a reference state. Algal plant growth or eutrophication in these streams is not likely to be limited by DRP at these concentrations, and in many cases throughout the central BOP, substrate will be a limiting factor to plant growth. It was recommended that application of the DRP attribute bands should factor in the natural contribution of DRP for the site and at the appropriate scale. This therefore identified areas in the Tauranga FMU (where Kaimai andesite is the source of flow) as the main area where application of the DRP attribute table is appropriate (Scholes, 2021). Zygadlo et al., (2022) presented the DRP attribute bands for all river water quality NERMN sites and identified where the higher DRP concentrations are from natural causes. Further explanation and analysis can be found in Scholes (2021) and Zygadlo et al., (2022). The scenario assessment is particularly useful for predictions in Kaimai andesite areas but is also relevant for where DRP concentrations are naturally high. Changes in DRP delivery may impact downstream environments and in-stream nutrient dynamics.

The assessments in Table 34 should be read in conjunction with the discussions in section 2.6.2 and the comments above.

To assist with assessments of the GMP scenario the Expert Panel used estimates of phosphorus load reductions achieved by GMP mitigations derived from the percentage reduction estimates for each land use type provided in Appendix 1(a). Those phosphorus reduction estimates were then weighted by the estimated area of each land use type in each biophysical class and are presented in Appendix 1(b).

Table 34 Panel Summary for Scenario assessment of dissolved reactive phosphorus (DRP). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	D (B-D)	0	0	2	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4-15% summer rainfall decrease, 5-10 day increase in annual hot days <1 degree summer temperature). SedNetNZ model showed reduced dilution and increased sediment, thus increasing DRP. Catchment geology and redox cycling in stream influence sediment reactivity for P and so are a major source of between-stream variability in DRP concentrations, and as both these are unlikely to change significantly little change is expected. There is already such a wide range in DRP, that it is unlikely that there would be a detectable change in state as a result of climate change. Potential direction is likely to be getting worse. **Effect** At a 2040 horizon changes are likely to be small, and effects on biota limited. **Confidence** Confidence in climate change model low but increased to moderate due to low likelihood of state change out of D.
Mitigation (GMP)	NV_IF	D (B-D)	0	0	3	NA	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) +	NV_IF	D (B-D)	0	0	2	NA	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment
Climate Change (RCP4.5)	NV_EF	D (B-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days, <1 degree summer temperature). Some added uncertainty around effects during harvest for the EF land cover class. High nutrient run-off is likely three to five years after harvest. If increased rainfall coincides with harvest it may lead to pockets of increased concentrations. However, there is likely reasonable canopy cover and shade with exception of smaller streams immediately after harvest. There would likely be associated increase in DRP if uptake is already saturated, which it appears to be because this class is already in D state. Although, as the class is already in D band it is unlikely to change. On balance, no detectable change is expected for this class. **Effect** As the degree of change is negligible, the effect also negligible. Also limited further negative effects on higher order attributes given already saturated. **Confidence** While relatively confident that EF would have similar effects to the IF class, there is uncertainty around harvesting effects. Acknowledgement of the general uncertainty around climate change direction (as detailed in section 2.6.2) resulted in the Group Assessment assessed as 1-low.
Mitigation (GMP)	NV_EF	D (B-D)	0	0	3	NA	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	D (B-D)	0	0	1	NA	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	NV_P	C (B-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 increase in annual hot days, <1 degree summer temperature). NV has greater erosion (compared to the V classes), which the P class could exacerbate. Literature suggests a small to moderate increase in DRP is likely under climate change. Increased frequency of high rainfall events likely to result in increased stormflow loading (difficult to measure). Any increase in uptake with increasing temperature and lower flows is offset by increased sediment, fertiliser and dung being flushed into streams as a result of increased antecedent conditions and intense events. Effects on dissolved phosphorus are also likely complex and in both directions, with the net effect difficult to predict. At a 2040 horizon changes are likely to be small and not detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence reflects uncertainty in Climate Change model.
Mitigation (GMP)	NV_P	C (B-D)	1	0	1	NA	**Degree of change** The majority of this class (65%) is subject to GMPs. The weighted load reduction for TP is estimated as 12%. There are some questions whether some of the GMPs would actually be applied/applicable in this class e.g., top-dressing P spread in this area so GMPs may not be as effective as the generic assumptions and the steepness of the land could mean the mitigation are not applied (or not applied as effectively) to this class. For these assessments, it has to be assumed that GMPs are applied and applied to the level assumed in section 2.3.4. As such, in this scenario, there would be a positive change. There is potential to change band in some areas, but overall considered to be stay in the C state.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect No detectable effect on higher order attributes. If P is limiting, there will be positive effects but unlikely to be detectable at this scale. **Confidence** Given uncertainties around potential for a band shift and application of GMPs, this assessment has 1-low confidence.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	C (B-D)	1	0	1	NA	**Degree of Change** The GMP scenario is considered to be dominant and largely driving results. The results therefore reflect the GMP scenarios. **Effect** As per GMP assessment. **Confidence** As per GMP assessment
Climate Change (RCP4.5)	NV_PI	D (C-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 increase in annual hot days, <1 degree summer temperature). Some possible increase in nutrient load associated with weather events. But already in D state so no band change. Literature suggests a small to moderate increase in DRP is likely under climate change. Increased frequency of high rainfall events likely to result in increased stormflow loading (difficult to measure). Any increase in uptake with increasing temperature and lower flows is offset by increased sediment, fertiliser and dung being flushed into streams as a result of increased antecedent conditions and intense events. Effects on dissolved phosphorus are also likely complex and in both directions, with the net effect difficult to predict. At a 2040 horizon changes are likely to be small and not detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence reflects uncertainty in Climate Change model., however, moderately confident that any direction of change would be worsening.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	NV_PI	D (C-D)	2	1	1	NA	**Degree of change** The majority of this class (80%) is subject to GMPs. The weighted load reduction for TP is estimated as 13%. There are some questions whether some of the GMPs would actually be applied/applicable in this class e.g., top-dressing P spread in this area so GMPs may not be as effective as the generic assumptions and the steepness of the land could mean the mitigation are not applied (or not applied as effectively) to this class. For these assessments, it has to be assumed that GMPs are applied and applied to the level assumed in section 2.3.4. The magnitude of change is expected to be small, but as this class is on the border of C/D band the degree of change is assessed as 2 to reflect that there could be a band change for overall state. **Effect** If P is limiting there will be positive effects on higher order attributes. **Confidence** Given uncertainties around potential for a band shift and application of GMPs, this assessment has 1-low confidence. High confidence that there would be a detectable change in the positive direction, low confidence that it would result in a band change.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	D (C-D)	1	0	1	NA	**Degree of Change** The GMP scenario is considered to be dominant and largely driving results. However, the lower degree of change reflects that Climate Change would dampen the benefits of GMPs somewhat, making a band change less likely. **Effect** If P is limiting there will be positive effects on higher order attributes, but as climate change would be dampening GMP effects, it is unlikely that these effects would be detectable. **Confidence** Low confidence reflects the reliance on climate change and SedNetNZ models.
Climate Change (RCP4.5)	V_HG_IF	A (A-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-10 day increase in annual hot days <1-degree summer temperature).

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							SedNetNZ model showed significantly greater sediment loads. Catchment geology and redox cycling in streams influence sediment reactivity for phosphorus and so are a major source of between-stream variability in DRP concentrations. As both of these are unlikely to change significantly little change is expected. There is already such a wide range in DRP, that it is unlikely we could detect a change in state as a result of climate change. Although unlikely to be a detectable change, any direction of change is likely to be getting worse. **Effect** At a 2040 horizon changes are likely to be small, and effects on biota limited. **Confidence** Confident that the direction of change is worsening, but low confidence in climate change models.
Mitigation (GMP)	V_HG_IF	A (A-D)	0	0	3	NA	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A-D)	0	0	1	NA	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment
Climate Change (RCP4.5)	V_HG_EF	D (B-D)	0	0	2	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-10 day increase in annual hot days, <1-degree summer temperature). Some added uncertainty around effects during harvest for the EF land cover class. High nutrient run-off is likely three to five years after harvest. If increased rainfall coincides with harvest it may lead to pockets of increased concentrations. However, there is likely reasonable canopy cover and shade with exception of smaller streams immediately after harvest. Reasonably confident than any change would be in a negative

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							direction for DRP. Rationale for worsening change in reduced dilution and increased sediment (thus DRP) based on SedNetNZ model. Although, as the class is already in D band it is unlikely to change. **Effect** As the degree of change is negligible, the effect also negligible. Also limited further negative effects on higher order attributes given already saturated. **Confidence** There is higher confidence in this class compared to the NV-IF class as SedNetNZ shows greater erosion on the East Coast (majority of NV-IF class), the pumice volcanic geology in this class tends to be more stable.
Mitigation (GMP)	V_HG_EF	D (B-D)	0	0	3	NA	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	D (B-D)	0	0	2	NA	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	C (A-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-10% summer rainfall decrease, 5-15 increase in annual hot days, <1 degree summer temperature). Literature suggests a small to moderate increase in DRP is likely under climate change. Increased frequency of high rainfall events likely to result in increased stormflow loading (difficult to measure). Any increase in uptake

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							with increasing temperature and lower flows is offset by increased sediment, fertiliser and dung being flushed into streams as a result of increased antecedent conditions and intense events. Effects on dissolved phosphorus are also likely complex and in both directions, with the net effect difficult to predict. At a 2040 horizon changes are likely to be small and not detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence reflects uncertainty in Climate Change model as per section 2.6.2. However, moderately confident that any direction of change would be worsening.
Mitigation (GMP)	V_HG_P	C (A-D)	2	0	1	NA	**Degree of change** Approximately 44% is subject to GMPs. The weighted load reduction for TP is estimated as 11%. State assessment was C but close to B band. Regional split with lower bands reflecting groundwater source, while other sites (in the Tauranga and Kaimai area) were in the A-C bands. The Tauranga and Kaimai areas may experience some reductions in DRP, whereas groundwater/pumice dominated areas may not. A detectable improvement and possible state change to B is predicted due to current state being close to the B/C border. **Effect** No detectable effect on higher order attributes. If P is limiting, there will be positive effects but unlikely to be detectable at this scale. **Confidence** Given uncertainties around potential for a band shift and application of GMPs, this assessment has 1-low confidence.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	C (A-D)	1	0	1	NA	**Degree of Change** The GMP scenario is considered to be dominant and largely driving results. However, climate change dampens the degree of change from GMPs. Hence the lower degree of change of 1-low compared to the GMP scenario. **Effect** As per GMP assessment.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence As per GMP assessment.
Climate Change (RCP4.5)	V_HG_PI	D (A-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-10% summer rainfall decrease, 10-15 increase in annual hot days, <1-degree summer temperature). Literature suggests a small to moderate increase in DRP is likely under climate change. Increased frequency of high rainfall events likely to result in increased stormflow loading (difficult to measure). Any increase in uptake with increasing temperature and lower flows is offset by increased sediment, fertiliser and dung being flushed into streams as a result of increased antecedent conditions and intense events. Effects on dissolved phosphorus are also likely complex and in both directions, with the net effect difficult to predict. At a 2040 horizon changes are likely to be small and not detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence reflects uncertainty in Climate Change model., however, moderately confident that any direction of change would be worsening.
Mitigation (GMP)	V_HG_PI	D (A-D)	1	0	1	NA	**Degree of change** Approximately 51% is subject to GMPs. The weighted load reduction for TP is estimated as 13%. Current state likely to be well into the D band. Therefore, small improvement unlikely to result in a band shift. **Effect** No detectable effect on higher order attributes. If P is limiting, there will be positive effects but unlikely to be detectable at this scale. **Confidence** Given uncertainties around potential for a band shift and application of GMPs, this assessment has 1-low confidence.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	D (A-D)	1	0	1	NA	**Degree of Change** Although Climate Change will dampen the effectiveness of GMPs. The GMP scenario is considered to be dominant and largely driving results. **Effect** As per GMP assessment. **Confidence** As per GMP assessment
Climate Change (RCP4.5)	V_LG_IF	A (A-D)	0	0	2	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-20 day increase in annual hot days <1-degree summer temperature). SedNetNZ model showed reduced dilution and increased sediment, thus increasing DRP. Catchment geology and redox cycling in streams influence sediment reactivity for P and so are a major source of between-stream variability in DRP concentrations. As both of these are unlikely to change significantly little change is expected. There is already such a wide range in DRP, that it is unlikely we could detect a change in state as a result of climate change. DRP also tends to be a relatively stable attribute across time. Although unlikely to be a detectable change, any direction of change is likely to be getting worse. **Effect** At a 2040 horizon changes are likely to be small, and effects on biota limited. **Confidence** Confident that the direction of change is worsening, but low confidence in climate change models.
Mitigation (GMP)	V_LG_IF	A (A-D)	0	0	3	NA	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A-D)	0	0	2	NA	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment
Climate Change (RCP4.5)	V_LG_EF	D (B-D)	0	0	2	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-20 day increase in annual hot days, <1-degree summer temperature). Some added uncertainty around effects during harvest for the EF land cover class. High nutrient run-off is likely three to five years after harvest. If increased rainfall coincides with harvest it may lead to pockets of increased concentrations. However, there is likely reasonable canopy cover and shade with exception of smaller streams immediately after harvest. Reasonably confident than any change would be in a negative direction for DRP. Rationale for worsening change in reduced dilution and increased sediment (thus DRP) based on SedNetNZ model. Although, as the class is already in D band it is unlikely to change. **Effect** As the degree of change is negligible, the effect also negligible. Also limited further negative effects on higher order attributes given already saturated. **Confidence** Low confidence is reflective of confidence in SedNetNZ model and the potential for a detectable change. There is higher confidence in this class compared to the NV-IF class as SedNetNZ shows greater erosion on the East Coast (majority of NV-IF class), the pumice volcanic geology in this class tends to be more stable.
Mitigation (GMP)	V_LG_EF	D (B-D)	0	0	3	NA	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As the degree of change is negligible, the effect also negligible. **<u>Confidence</u>** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	D (B-D)	0	0	2	NA	**<u>Degree of Change</u>** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **<u>Effect</u>** As per Climate Change assessment. **<u>Confidence</u>** As per Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	C (A-D)	0	0	1	NA	**<u>Degree of Change</u>** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~2%-10% summer rainfall decrease, 5-20 increase in annual hot days, <1-degree summer temperature). Literature suggests a small to moderate increase in DRP is likely under climate change. Increased frequency of high rainfall events likely to result in increased stormflow loading (difficult to measure). Any increase in uptake with increasing temperature and lower flows is offset by increased sediment, fertiliser and dung being flushed into streams as a result of increased antecedent conditions and intense events. Effects on dissolved phosphorus are also likely complex and in both directions, with the net effect difficult to predict. At a 2040 horizon changes are likely to be small and not detectable. **<u>Effect</u>** As the degree of change is negligible, the effect is also negligible. **<u>Confidence</u>** Low confidence reflects uncertainty in Climate Change model. However, moderately confident that any direction of change would be worsening.
Mitigation (GMP)	V_LG_P	C (A-D)	1	0	2	NA	**<u>Degree of change</u>** Approximately 38% (dry stock) is subject to GMPs. The weighted load reduction for TP is estimated as 8-11%. State assessment was a C band but any improvement is unlikely to shift to a B band as data shows a tendency towards a D band and there is high variability within this class. **<u>Effect</u>**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							No detectable effect on higher order attributes. If phosphorus is limiting there will be positive effects but unlikely to be detectable at this scale. **Confidence** Confidence is assessed as moderate due to the understanding of GMPs on nutrient improvements.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	C (A-D)	1	0	1	NA	**Degree of Change** The GMP scenario is considered to be dominant and largely driving results. Although, Climate Change will have some negating effect, reducing any chance of any level of effect. **Effect** As per GMP assessment. **Confidence** As per GMP assessment.
Climate Change (RCP4.5)	V_LG_PI	D (C-D)	0	0	2	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-20 increase in annual hot days, <1-degree summer temperature). Literature suggests a small to moderate increase in DRP is likely under climate change. Increased frequency of high rainfall events likely to result in increased stormflow loading (difficult to measure). Any increase in uptake with increasing temperature and lower flows is offset by increased sediment, fertiliser and dung being flushed into streams as a result of increased antecedent conditions and intense events. Effects on dissolved phosphorus are also likely complex and in both directions, with the net effect difficult to predict. At a 2040 horizon changes are likely to be small and not detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Moderate confidence reflects the confidence that the direction would be negative, and the current state is already in D band.
Mitigation (GMP)	V_LG_PI	D (C-D)	1	0	2	NA	**Degree of Change**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Majority of the class (63%) subject to GMPs. The weighted load reduction for TP is estimated as 13%. GMPs likely to have less effect in larger rivers, and in strongly groundwater fed systems (Pongakawa). As this class is a very high D at present, a state change is very unlikely. **Effect** No detectable effect on higher order attributes. If P is limiting, there will be positive effects but unlikely to be detectable at this scale. **Confidence** Given uncertainties around potential for a band shift and application of GMPs, this assessment has 1-low confidence.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	D (C-D)	1	0	2	NA	**Degree of Change** Although Climate Change will dampen the effectiveness of GMPs. The GMP scenario is considered to be dominant and largely driving results. **Effect** As per GMP assessment. **Confidence** As per GMP assessment.
Climate Change (RCP4.5)	Urban	C (B-D)	0	0	1	NA	**Degree of Change** Climate Change impacts on urban areas are difficult to predict and likely to be outweighed by degree of development over the 2040 period. Increases from agricultural component in the Urban class are likely. Although, at a 2040 horizon changes are likely to be small, and effect on biota limited. **Effect** As change is negligible, effect is also negligible. **Confidence** Low confidence reflective of the uncertainty in climate models.
Mitigation (GMP)	Urban	C (B-D)	0	0	2	NA	**Degree of Change**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							The Urban class incorporates approximately 16% of land subject to GMPs such as pasture. As such, the weighted load reduction for TP is only approximately 6% and negligible degree of change is expected. **Effect** As negligible change, also negligible effect. **Confidence** Added level of uncertainty compared to other areas of minimal GMP as there is still 16% of areas subject to GMP.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	C (B-D)	0	0	1	NA	**Degree of Change** Minimal GMP, therefore Climate Change dominates, and assessment is reflective of that. **Effect** As per the Climate Change assessment. **Confidence** As per the Climate Change assessment.

Suspended Fine Sediment (SFS)

Suspended solids are fine particles (clay or silt categories of 0.2 - 63µm diameter; Davies-Colley et al., 2015) that travel in suspension in water, and generally represent the fine sediment that is suspended in the water column. Suspended solids impact on ecosystem health by reducing visual clarity and light penetration, or clogging gills and smothering habitat. The amount of suspended fine sediment (SFS) in a water column depends on the size, shape and composition of the sediment, and the flow of the river. The faster a river/stream flows, the more suspended solids it can transport. Once stream flow slows down, some of these suspended solids settle to the bottom of the river/stream and become deposited fine sediment (DFS). Suspended solids are measured and reported as the Total Suspended Solids (TSS) in a known volume of water.

As outlined in section 2.4.2, the SFS attribute has its own bespoke sediment classes that are used for the assessments. The relationship between the biophysical/landcover classes and the bespoke suspended sediment classes is described in section 2.4.2 and the proportion of each SFS class occurring in each biophysical class is shown in Table 13.

The assessments in Table 35 should be read in conjunction with the methods described in section 2.4, the results from sediment analyses presented in Appendix 3, the discussions on uncertainty in section 2.6.2 and the comments above.

Table 35 Panel Summary for Scenario assessment of suspended fine sediment. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17..

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	SFS-1-IF	A (A)	-1	-1	2	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Distribution of this class is pumice and andesite in Kaimai's. Sediment country, big slips with episodic events would flush through quickly. There is the assumption that the Hicks equation accounts for episodic events. IF sites well into A band (~4 m), therefore the change estimated would unlikely result in a band change down to B. **Effect** -1 reflects the movement within A band having potential for effects on higher order attributes. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							If placing full trust into modelling methods, then we would have high confidence. The confidence level of 2-moderate reflects uncertainties around assumptions and band change potential.
Mitigation (GMP)	SFS-1-IF	A (A)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the bespoke sediment.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-1-IF	A (A)	-1	-1	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	SFS-1-EF	B (A-D)	-3	-2	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 80% increase in load (approximately a clarity of 1.7 m to 1.1 m), even a top band of B would result in a change to below bottom line. **Effect** This is quite a significant change and some effects would be expected on higher order attributes. Attributes such as Fish IBI are unlikely to be sensitive to these changes even when the community will likely change. However, would expect some significant habitat changes at this level of increased load and decreased water clarity. Deposited fine sediment (DFS) is also a higher order attribute that would be expected to change as a result of SFS increasing. Although DFS wouldn't be a main driver as this class is soft-bottomed pumice substrate. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							The low confidence reflects the uncertainty around the effect level between -1 or -2.
Mitigation (GMP)	SFS-1-EF	B (A-D)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-1-EF	B (A-D)	-3	-2	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	SFS-1-P	B (A-D)	-3	-2	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 73% increase in load (approximately a 25% reduction in clarity), even a top band of B would result in a change to below bottom line. **Effect** This is quite a significant change and some effects on higher order attributes would be expected. Attributes such as Fish IBI are unlikely to be sensitive to these changes even when the community will likely change. However, some significant habitat changes would be expected at this level of increased load and decreased water clarity. Deposited fine sediment is also a higher order attribute that would be expected to change as a result of SFS increasing, particularly as this class has a lot of hard-bottomed reaches.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence The low confidence reflects the uncertainty around the effect level between -1 or -2.
Mitigation (GMP)	SFS-1-P	B (A-D)	2	1	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 9% reduction in load (approximately a clarity of 1.7 m to 1.8 m), which would result in a noticeable improvement from B to A band. This class is highly variable, so there are a large range of processes having different levels of influence on change. **Effect** Would expect some small impacts on higher order attributes when shifting from a B to A band. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models. Low confidence also reflects the large range across this class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-1-P	B (A-D)	-3	-2	1	Yes	**Degree of Change** Climate change and GMP are in opposite directions. SedNetNZ still puts it in a D as improvement was ~10% and Climate Change was ~70% increase in loads. Judgement that Climate Change is therefore dominant and still a -3 of change. **Effect** Climate Change is considered dominant so an effect level of -2 reflects this. **Confidence** Confidence in line with separate scenario assessments.
Climate Change (RCP4.5)	SFS-1-PI	B (A-D)	-3	-1	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows a 79% increase in load (approximately a 35% reduction in clarity, 1.7 m to 1.1 m), current state of B would result in a change to below bottom line. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							This is quite a significant change and would expect some effects on higher order attributes. Attributes such as Fish IBI are unlikely to be sensitive to these changes even when the community will likely change. However, some significant habitat changes would be expected at this level of increased load and decreased water clarity. Deposited sediment is also a higher order attribute that would be expected to change as a result of SFS increasing, although these reaches are naturally soft-bottomed pumice substrate. The level of effect is given a -1 to reflect the lower impact on soft-bottomed reaches. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models. Low confidence also reflects the large range across this class.
Mitigation (GMP)	SFS-1-PI	B (A-D)	1	0	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 7% reduction in load (approximately a clarity of 1.67 m to 1.76 m), which would mean the class remains in the B band. This class is highly variable, so there are a large range of processes having different level of influence on change. **Effect** A less than 10% change here, which doesn't warrant a 1 for effect. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models. Low confidence also reflects the large range across this class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-1-PI	B (A-D)	-3	-1	1	Yes	**Degree of Change** Climate change and GMP are in opposite directions. Judgement that Climate Change is dominant and assessment reflective of the Climate Change assessment. **Effect** Climate Change is considered dominant so an effect level of -1 reflects this. **Confidence** Confidence in line with separate scenario assessments.
Climate Change (RCP4.5)	SFS-1-U	D (A-D)	-1	-1	1	Yes	**Degree of Change**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Assessment is based off results from the method outlined in section 2.3.1. Methodology shows a 66% increase in load (approximately a 30% reduction in clarity, 1.34 m to 0.91 m). However, current state is already in the D band. **Effect** While already in the D band, further clarity reductions could further impact biota. Although would be to a low level considering the class reaches are already very impacted urban streams. **Confidence** It is difficult to go beyond a confidence level of 1 with compounding assumptions with using multiple models.
Mitigation (GMP)	SFS-1-U	D (A-D)	0	0	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 3% reduction in load (approximately a clarity of 1.34 m to 1.37 m), which would mean the class remains in the D band and minimal change. **Effect** As change is negligible, effect is also negligible. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-1-U	D (A-D)	-1	-1	1	Yes	**Degree of Change** Climate change and GMP are in opposite directions. Judgement that Climate Change is dominant and assessment reflective of the Climate Change assessment. **Effect** Climate Change is considered dominant so an effect level of -1 reflects this. **Confidence** Confidence in line with separate scenario assessments.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	SFS-2-IF	A (A)	-1	-1	2	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 44% increase in load (approximately a clarity of 0.93 m to 0.70 m). However, IF sites well into A band (not on the border of A/B band as calculated), therefore the change estimated would unlikely result in a band change down to B. **Effect** -1 reflects the movement within A band having potential for effects on higher order attributes. **Confidence** If placing full trust into modelling methods, then we would have high confidence. The confidence level of 2-moderate reflects uncertainties around assumptions and band change potential.
Mitigation (GMP)	SFS-2-IF	A (A)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-2-IF	A (A)	-1	-1	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	SFS-2-EF	A (A-B)	-1	-1	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 51% increase in load (approximately a clarity of 0.93 m to 0.68 m). Given the distribution of this class being in the coastal eastern NV area and Matakana Island, and that this class comprises of EF with pockets of IF, we would expect similar results to the 2-IF class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect -1 reflects the movement within A band having potential for effects on higher order attributes. **Confidence** The low confidence reflects the uncertainty around the effect level between -1 or -2.
Mitigation (GMP)	SFS-2-EF	A (A-B)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-2-EF	A (A-B)	-1	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	SFS-2-P	A (A-B)	-3	-1	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 63% increase in load (approximately a 30% reduction in clarity, 0.93 m to 0.64 m). Current state is in the A band, the one site shows it to be close to the A/B boundary. Assuming that the average for this class is in the low A band, then this would result in a change to C band. **Effect** Would expect some small impacts on higher order attributes when shifting from A to C band. However, lower effect level reflective of that this sediment class is naturally more turbid.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Mitigation (GMP)	SFS-2-P	A (A-B)	1	0	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 12% reduction in load (approximately a clarity of 0.93 m to 1.03 m). This class is already in the A band. Some sites may shift from B to A, but overall, a degree of change of 1. **Effect** There may be some level of effect in areas that are in the B band, but overall, as already in the A band, minimal room for improvement on effects on higher order attributes. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-2-P	A (A-B)	-3	-1	1	No	**Degree of Change** Climate change and GMP are in opposite directions. Judgement that Climate Change is dominant and assessment reflective of the Climate Change assessment. **Effect** Climate Change is considered dominant so an effect level of -1 reflects this. **Confidence** Confidence in line with separate scenario assessments.
Climate Change (RCP4.5)	SFS-2-PI	A (A-B)	-2	-1	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows a 67% increase in load (approximately a 30% reduction in clarity, 0.93 m to 0.63 m). The level of change depends on where in the A band current state sits. This class is distributed across Waioeka-Otara and Rangitāiki Plains and foothills, Galatea, Kaituna/Pongakawa coastal plains, and small Tauranga pockets. Overall, expect an average of a single band change to B. **Effect** Some impacts on higher order attributes expected with a shift from A to B band. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Mitigation (GMP)	SFS-2-PI	A (A-B)	1	1	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 15% reduction in load (approximately a clarity of 0.93 m to 1.05 m). This class is already in the A band, so not possible for a band change. **Effect** Some benefits on higher order attributes with movement within the A band. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-2-PI	A (A-B)	-2	-1	1	No	**Degree of Change** Climate change and GMP are in opposite directions. Judgement that Climate Change is dominant and assessment reflective of the Climate Change assessment. **Effect** Climate Change is considered dominant so an effect level of -1 reflects this. **Confidence** Confidence in line with separate scenario assessments.
Climate Change (RCP4.5)	SFS-2-U	A (A-B)	-2	-1	1	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows a 18% increase in load (reduction in clarity from 0.93 m to 0.83 m based on A/B border as starting point). Again, as unsure of where current state lands in the A band, it is difficult to predict if a band change would occur. A band change is assumed as 18% is a reasonable amount of change. **Effect** Some effects on higher order attributes when shifting from an A to a B band. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							It is difficult to go beyond a confidence level of 1 with compounding assumptions with using multiple models.
Mitigation (GMP)	SFS-2-U	A (A-B)	0	0	2	No	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 5% reduction in load (approximately a clarity of 0.93 m to 0.97 m). Minor improvement that is most likely not detectable and this class is already in the A band. **Effect** As change is negligible, effect is also negligible. **Confidence** Minimal GMP applied in this class, so higher confidence of 2-moderate is warranted.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-2-U	A (A-B)	-2	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment
Climate Change (RCP4.5)	SFS-3-IF	D (A-D)	-1	-1	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 55% increase in load (approximately a clarity of 2.22 m to 1.59 m). Current state is in the D band already. There are likely sites that are in the A-C bands for this class, but the degree of change relates to overall state. As such, the degree of change can only be -1. **Effect** There may be effects in smaller streams where current state may be higher. It is also possible for the degree of effect to be higher in higher order attributes than the degree of change as higher order attributes might not be in D band. An effect level of -1 reflects some potential for change in those higher order attributes. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	SFS-3-IF	D (A-D)	0	0	3	Yes	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-3-IF	D (A-D)	-1	-1	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	SFS-3-EF	D (B-D)	-1	-1	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 51% increase in load (approximately a clarity of 2.22 m to 1.62 m). The current state is already in D band, so can only be a D band. This is a regionally small area with pockets distributed widely, dominantly in the east. **Effect** -1 reflects the movement within D band having potential for effects on higher order attributes and for those sites that are in B or C bands potentially degrading. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	SFS-3-EF	D (B-D)	0	0	3	Yes	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-3-EF	D (B-D)	-1	-1	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment
Climate Change (RCP4.5)	SFS-3-P	D (C-D)	-1	-1	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 57% increase in load (approximately a 30% reduction in clarity, 2.22 m to 1.58 m). The current state is already in D band, so can only be a D band. This class is dominant at the top of the Motu River and the Kaituna. **Effect** -1 reflects the movement within D band having potential for effects on higher order attributes and for those sites that are in B or C bands potentially degrading. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Mitigation (GMP)	SFS-3-P	D (C-D)	3	2	1	No	**Degree of Change** Assessment is based off results from the method outlined in section **2.3.4**. Methodology shows an approximately 30% reduction in load (approximately a clarity of 2.22 m to 2.86 m, which results in a substantial improvement from D band to a B band.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect Moderate level of effects on higher order attributes such as deposited fine sediment, macroinvertebrates and fish communities with this level of reduction. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-3-P	D (C-D)	-1	-1	1	Yes	**Degree of Change** Climate change and GMP are in opposite directions. While Climate change degree of change was small, this was because it was already in the D band, so a larger level on this scale was not possible. When balanced between Climate Change and GMP scenario, there is still a degradation (57% and 30% respectively). **Effect** Climate Change is considered dominant so an effect level of -1 reflects this. **Confidence** Confidence in line with separate scenario assessments.
Climate Change (RCP4.5)	SFS-3-PI	D (C-D)	-1	-1	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.1. Methodology shows an 76% increase in load (approximately a 35% reduction in clarity, 2.22 m to 1.44 m). Substantial degradation, but the current state is already in D band, so can only be a -1. **Effect** Level of effect depends on if being in the D band means that all the sensitive species have already been eliminated, leaving with nothing left to respond. The -1 reflects the movement within D band having potential for effects on higher order attributes and for those sites that are in B or C bands potentially degrading. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	SFS-3-PI	D (C-D)	1	1	1	Yes	**Degree of Change** Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an approximately 9% reduction in load (approximately a clarity of 2.22 m to 2.38 m, which is a relatively small change. No monitoring sites, so difficult to determine whether the current state is close to the C/D border or not. Assuming that it would on average, reaches wouldn't move from D to C band based on this level of improvement. **Effect** Small level of change results in a small level of effect on higher order attributes potentially getting some benefits. **Confidence** It is difficult to go beyond a confidence level of 1 when the assumptions are high with using multiple models.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-3-PI	D (C-D)	-1	-1	1	Yes	**Degree of Change** Climate change and GMP are in opposite directions. While Climate change degree of change was small, this was because it was already int eh D band, so a larger level on this scale was not possible. The GMP scenario resulted in minimal change, as such Climate Change dominates. **Effect** Climate Change is considered dominant so an effect level of -1 reflects this. **Confidence** Confidence in line with separate scenario assessments.
Climate Change (RCP4.5)	SFS-3-U	D (C-D)	-1	-1	1	Yes	**Degree of Change** Very small part of the region, with only a couple reaches in Rotorua, that it could be excluded. Assessment is based off results from the method outlined in section 2.3.1. Methodology shows a 63% increase in load (reduction in clarity from 2.22 m to 1.53 m). Already in the D band, so degree of change is -1. **Effect** Quite a substantial change in water clarity that there would be some effects on higher order attributes even though current state is already in D. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							It is difficult to go beyond a confidence level of 1 with compounding assumptions with using multiple models.
Mitigation (GMP)	SFS-3-U	D (C-D)	0	0	2	Yes	**Degree of Change** Very small part of the region with only a couple reaches in Rotorua. Assessment is based off results from the method outlined in section 2.3.4. Methodology shows an <7% reduction in load (approximately a clarity of 2.22 m to 2.33 m). Minor improvement that is most likely not detectable. **Effect** As change is negligible, effect is also negligible. **Confidence** Minimal GMP applied in this class, so higher confidence of 2-moderate is warranted.
Climate Change (RCP4.5) + Mitigation (GMP)	SFS-3-U	D (C-D)	-1	-1	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment

E. coli

If human or animal faecal matter finds its way into waters of recreational value, there is a risk that water users will be exposed to a diverse range of pathogenic (disease causing) micro-organisms. The impacts of pathogenic micro-organisms on human health are commonly manifested as gastro-enteritis, but other common illnesses include respiratory problems and skin rashes. Serious illness can also be attributed to infection from pathogens contained in waters, for example, hepatitis A, giardiasis, cryptosporidiosis, campylobacteriosis and salmonellosis (MfE/MoH, 2003).

Indicator micro-organisms are used to assess the suitability of recreational waters from a human health perspective. The bacteriological indicators chosen are associated with the gut of warm-blooded animals and are common in faecal matter. In fresh waters, the indicator bacteria recommended in the New Zealand Microbiological Water Quality Guidelines and established in the NPSFM is *E. coli*. Research that relates illness to indicator bacterial levels has been used to develop guideline levels which are based on the tolerable risk to healthy people.

Common themes that emerged for this attribute during the assessment included the difficulties of measuring *E. coli* accurately. *E. coli* results often have high variability, which mean detecting change can be difficult. The attribute partly attempts to address this with having multiple statistics. But this can also mean that a shift in band is difficult to achieve given that all the statistics are required to reach that band. For example, a hypothetical situation could be that the 95th percentile statistic may remain in the D band following GMP, while the remaining statistics are likely to improve to a C or B band. But overall, this attribute will remain in the D band because of the 95th percentile statistic. These nuances are considered in the assessments and commented on when deemed relevant.

The assessments in Table 36 should be read in conjunction with the discussions in section 2.6.2 and the comments above.

Table 36 Panel Summary for Scenario assessment of E. coli. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	B (A-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., 2% decrease in annual rainfall, <1 degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4%-15%) buffered by native forest land cover. Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Pest management and/or the likelihood of pest animals increasing have not been considered in these assessments but may well be a main driver of *E. coli* levels. On balance, negligible change is expected for *E. coli* under current modelled climate change predictions. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	NV_IF	B (A-D)	0	0	3	NA	**Degree of Change** No GMP in IF and <5% of area subject to GMP (38% GMP on 1% area. 24% GMP on 2% area). Unlikely to lead to a detectable change. Note GMPs around indigenous forest pests are unknown/uncertain (i.e., pest control) and not part of the assessment. **Effect** *E.coli* unlikely to affect higher order attributes. **Confidence** High confidence as no GMPs applied to IF and <5% of area subject to GMP.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	B (A-D)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	B (A-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., 2% decrease in annual rainfall, <1 degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4%-15%) buffered by native forest land cover. Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and; less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Pest management and/or the likelihood of pest animals increasing have not been considered in these assessments but may well be a main driver of *E. coli* levels. On balance, negligible change is expected for *E. coli* under current modelled climate change predictions. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	NV_EF	B (A-D)	0	0	3	NA	**Degree of Change** No GMP in EF and <5% of area subject to GMP (38% GMP on 1% area. 24% GMP on 2% area). Unlikely to lead to a detectable change. Note GMPs around exotic forest pests are unknown/uncertain (i.e., pest control) and not part of the assessment. **Effect** E.coli unlikely to affect higher order attributes. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							High confidence as no GMPs applied to IF and <5% of area subject to GMP.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	B (A-D)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	NV_P	D (A-E)	0	0	1	NA	**Degree of Change** While confident the climate will change; the key climate drivers show relatively little change to 2040 (eg., <1-degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4%-15%). Effects on E. coli could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Increased sediment and dung being flushed into streams as a result of antecedent conditions and intense events more likely in the pasture category (McBride *et al*., 2014). The temperature increase would also have more sustained *E. coli* in dung and river sediments. The panel were split here on a 0 or -1. As we are talking small change here, a 0 was decided on for this assessment. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	NV_P	D (A-E)	1	0	2	NA	**Degree of Change** The majority of this class (65%) is subject to GMP, with a weighted 15% improvement in *E. coli*. eSource modelling suggested 'drystock' land use contributed proportionally slightly less to *E. coli* load relative to area in both Kaituna and Rangitāiki. GMP effectiveness reduced due to low order

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							streams (not fenced) and dominance of drystock. Overall, a detectable improvement is probable, but a state change is unlikely given the 95th percentile statistic is well into the E band. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Moderate confidence based on understanding of GMP effectiveness, but not high confidence due to high variability in predicted state making it uncertain whether a state change will occur.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	D (A-E)	0	0	1	NA	**Degree of Change** Climate Change and GMP will offset each other. As a negative direction for Climate Change was predicted (although still a final assessment of 0), the net change here is 0. GMP might offset Climate Change, so any direction of change would likely be positive (improvement). **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Low confidence reflective of the lowest confidence in separate scenarios.
Climate Change (RCP4.5)	NV_PI	D (B-E)	-1	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., <1 degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4-15%). Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Increased sediment and dung being flushed into streams as a result of antecedent conditions and intense events more likely in the pasture category (McBride *et al*., 2014). The temperature increase would also have more sustained *E. coli* in dung and river sediments. More rainfall in this class compared to NV-P, although this may increase flushing, on balance we would expect climate change to result in a detectable negative change in this class. **Effect** *E. coli* unlikely to affect higher order attributes.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	NV_PI	D (B-E)	2	0	2	NA	**Degree of Change** The majority of this class (80%) is subject to GMP, with a weighted 26% improvement in *E. coli*. GMP effectiveness in dominant dairy areas likely to result in a detectable improvement in attribute bands in some areas. eSource model indicates improvement in some sub-catchments e.g., Kaituna, but not Galatea. While it is difficult to have a band change result due to the numerous attribute statistics and requiring the lowest one to improve, it is considered possible to shift band given the high proportion of the class subject to GMP. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Moderate confidence based on understanding of GMP effectiveness. A high confidence is not given due to the uncertainty around all the attribute statistics responding for a band change.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	D (B-E)	1	0	1	NA	**Degree of Change** Climate Change and GMP will offset each other. As a negative direction for Climate Change was predicted, the overall change is shifted to a 1. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Low confidence reflective of the lowest confidence in separate scenarios.
Climate Change (RCP4.5)	V_HG_IF	D (B-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., more heavy rain events, <1 degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4%-8%) buffered by native forest land cover. Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Pest management and/or the likelihood of pest animals increasing have not been considered in these assessments but may well be a main driver of *E. coli* levels. On balance, negligible change is expected for *E. coli* under current modelled climate change predictions. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	V_HG_IF	D (B-D)	0	0	3	NA	**Degree of Change** No GMP in IF and <5% of area subject to GMP. Note GMPs around indigenous forest pests are unknown/uncertain (i.e., pest control) and not part of the assessment. **Effect** *E.coli* unlikely to affect higher order attributes. **Confidence** High confidence as no GMPs applied to IF and <5% of area subject to GMP.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	D (B-D)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF Tier 1	A (A-C)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., less rainfall and more dry days, <1 degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4%-8%) buffered by native forest land cover. Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							predict. Pest management and/or the likelihood of pest animals increasing have not been considered in these assessments but may well be a main driver of *E. coli* levels. On balance, negligible change is expected for *E. coli* under current modelled climate change predictions. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	V_HG_EF Tier 1	A (A-C)	0	0	3	NA	**Degree of Change** No GMP in EF and <5% of area subject to GMP (38% GMP on 1% area. 24% GMP on 2% area). Unlikely to lead to a detectable change. Note GMPs around exotic forest pests are unknown/uncertain (i.e., pest control) and not part of the assessment. **Effect** *E.coli* unlikely to affect higher order attributes. **Confidence** High confidence as no GMPs applied to EF and <5% of area subject to GMP.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	A (A-C)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment
Climate Change (RCP4.5)	V_HG_P	D (B-E)	0	0	1	NA	**Degree of Change** While confident the climate will change; the key climate drivers show relatively little change to 2040 (eg., <1-degree summer temp increase, 5-15 increase in annual hot days, summer rainfall decrease of ~4%-10%). Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Increased sediment and dung being flushed into streams as a result of antecedent conditions and intense events more likely in the pasture category (McBride *et al*., 2014). The temperature increase would also have more sustained *E. coli* in dung and river sediments. On balance, a change of 0 is expected, but with any change likely being in the negative direction. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms.
Mitigation (GMP)	V_HG_P	D (B-E)	1	0	2	NA	**Degree of Change** The majority of this class (50%) is subject to GMP, with a weighted 25% improvement in E. coli. This would cause a detectable improvement, but unlikely to result in a band change due to the high variability in *E. coli* and the 95th percentile attribute statistic. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Moderate confidence based on understanding of GMP effectiveness.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	D (B-E)	1	0	2	NA	**Degree of Change** Climate Change and GMP will offset each other to a point. However, GMP is expected to dominate, and assessment therefore reflects that. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Moderate confidence reflects GMP scenario assessment, although it is unsure to what extent Climate Change may reduce the GMP benefit.
Climate Change (RCP4.5)	V_HG_PI	D (B-E)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., 2-4 increase in summer dry days, <1 degree summer temp increase, 0-15 increase in annual

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							hot days, summer rainfall decrease of ~4%-10%). Effects on E. coli could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, with the net effect difficult to predict. Increased sediment and dung being flushed into streams as a result of antecedent conditions and intense events more likely in the pasture category (McBride *et al*., 2014). The temperature increase would also have more sustained E. coli in dung and river sediments. On balance, a change of 0 is expected, but with any change likely being in the negative direction. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms.
Mitigation (GMP)	V_HG_PI	D (B-E)	1	0	1	NA	**Degree of Change** Although this class has relatively more forested reaches than other PI classes, the majority of this class (62%) is subject to GMP, with a weighted 21% improvement in *E. coli*. Some improvement likely with GMP effectiveness but gains small due to steeper nature of the land. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Confident that there will be improvement, but low confidence as could potentially move band and reaches are spatially disaggregated.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	D (B-E)	1	0	1	NA	**Degree of Change** Climate Change and GMP will offset each other to a point. However, GMPs were expected to dominate, and assessment therefore reflects that. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Low confidence reflective of GMP assessment.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	V_LG_IF	D (A-D)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., more heavy rain events, <1 degree summer temp increase, 5-20 increase in annual hot days, summer rainfall decrease of ~4%-8%) buffered by native forest land cover. Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Pest management and/or the likelihood of pest animals increasing have not been considered in these assessments but may well be a main driver of *E. coli* levels. On balance, negligible change is expected for *E. coli* under current modelled climate change predictions. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	V_LG_IF	D (A-D)	0	0	3	NA	**Degree of Change** No GMP in IF and <5% of area subject to GMP. Note GMPs around indigenous forest pests are unknown/uncertain (i.e., pest control) and not part of the assessment. **Effect** *E.coli* unlikely to affect higher order attributes. **Confidence** High confidence as no GMPs applied to IF and <5% of area subject to GMP.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	D (A-D)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	V_LG_EF	A (A-B)	0	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., less rainfall and more dry days, <1-degree summer temp increase, 5-20 increase in annual hot days, summer rainfall decrease of ~4%-8%) buffered by native forest land cover. This is porous pumice country which means there is little bypass flow and hence no increase in flushing. Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Pest management and/or the likelihood of pest animals increasing have not been considered in these assessments but may well be a main driver of *E. coli* levels. On balance, negligible change is expected for *E. coli* under current modelled climate change predictions. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms and direction.
Mitigation (GMP)	V_LG_EF	A (A-B)	0	0	3	NA	**Degree of Change** No GMP in EF and <5% of area subject to GMP (38% GMP on 1% area. 24% GMP on 2% area). Unlikely to lead to a detectable change. Note GMPs around exotic forest pests are unknown/uncertain (i.e., pest control) and not part of the assessment. **Effect** *E.coli* unlikely to affect higher order attributes. **Confidence** High confidence as no GMPs applied to EF and <5% of area subject to GMP.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	A (A-B)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence As per Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	D (A-E)	-1	0	1	NA	**Degree of Change** While confident the climate will change; the key climate drivers show relatively little change to 2040 (eg., <1-degree summer temp increase, 5-15 increase in annual hot days, summer rainfall decrease of ~4%-10%). Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off, although less in shaded streams), with the net effect difficult to predict. Increased sediment and dung being flushed into streams as a result of antecedent conditions and intense events more likely in the pasture category (McBride *et al*., 2014). The temperature increase would also have more sustained *E. coli* in dung and river sediments. There are a lot of sites currently in the D band, but there are some sites with pumice dominated substrate that are in the A band and could have a band change. LG streams have higher residence times and less flushing than the HG streams, increased heat and nutrients, longer longevity for *E. coli*. On balance, a small negative change is expected. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms.
Mitigation (GMP)	V_LG_P	D (A-E)	1	0	2	NA	**Degree of Change** This class is heavily pastoral with about 15% of area in dairy. There is a weighted 11% improvement in *E. coli*. This would cause a detectable improvement, but unlikely to result in a band change due to the high variability in *E. coli* and the 95th percentile attribute statistic. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Moderate confidence based on understanding of GMP effectiveness.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	D (A-E)	1	0	1	NA	**Degree of Change** GMP expected to dominate as the effects of GMP are likely to be pronounced in low gradient systems. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Low confidence reflects the uncertainty of to what extent Climate Change may reduce the GMP benefit.
Climate Change (RCP4.5)	V_LG_PI	D (A-E)	-1	0	1	NA	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., 2-4 increase in summer dry days, <1 degree summer temp increase, 5-20 increase in annual hot days, summer rainfall decrease of ~4%-8%). Effects on *E. coli* could conceivably be in both directions (e.g., increased runoff with extreme events could be balanced by overall rainfall decrease and less *E. coli* survival at hot/dry times with warmer temperatures accelerating die-off), with the net effect difficult to predict. Increased sediment and dung being flushed into streams as a result of antecedent conditions and intense events more likely in the pasture category (McBride *et al*., 2014). The temperature increase would also have more sustained *E. coli* in dung and river sediments. There are a lot of sites currently in the D band, but there are some sites with pumice dominated substrate that are in the band and could have a band change. Low gradient (LG) streams have higher residence times and less flushing than the high gradient (HG) streams, increased heat and nutrients, longer longevity for E. coli. On balance, a small negative change is expected. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms.
Mitigation (GMP)	V_LG_PI	D (A-E)	2	0	2	NA	**Degree of Change**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							38% GMP on 54% area. 24% GMP on 12% area resulting in a weighted 23% improvement in *E. coli*. This would cause a detectable improvement, and potential for band change depending on the 95th percentile attribute statistic. eSource modelling shows some band changes in Kaituna. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Moderate confidence based on understanding of GMP effectiveness.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	D (A-E)	1	0	2	NA	**Degree of Change** GMP expected to dominate as the effects of GMP are likely to be pronounced in low gradient systems. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** As per the GMP assessment.
Climate Change (RCP4.5)	Urban	D (B-E)	0	0	1	NA	**Degree of Change** While confident the climate will change; the key climate drivers show relatively little change to 2040 (e.g., <1-degree summer temp increase, 5-10 increase in annual hot days, summer rainfall decrease of ~4108%). Increase in *E. coli* possible if increase in rainfall, although only one more heavy rainfall (potential increase to sewer overflow) days modelled. This class also contains ~25% agricultural/lifestyle land use. Increased flushing into streams as a result of increased antecedent conditions and intense events (McBride *et al*., 2014), but offset by increased die-off in dry conditions and reduced summer rainfall. Current state is well into D state and a detectable change is unlikely. If any direction, it would be negative because more retention in these low gradient systems. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** Relatively confident in the change being small, but low confidence due to low confidence in the Climate change model and uncertainty in mechanisms.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	Urban	D (B-E)	0	0	2	NA	**Degree of Change** GMPs largely not relevant for this class. However, from areas that are subject to GMP, estimate that improvement to load is likely to be less <10%. As such expect that at least one of the four stats will remain in D band so state change is unlikely. **Effect** *E. coli* unlikely to affect higher order attributes. **Confidence** While the urban class generally finds the amount of area where GMP is applied negligible, confidence is reduced to a 2-moderate to reflect that there is some impact due to the pasture land use that occurs in the urban class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	D (B-E)	0	0	1	NA	**Degree of Change** GMP negligible, so consistent with Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.

Water temperature

Temperature not only influences water chemistry, such as solubility of DO and ammoniacal-nitrogen (NH4-N), but when elevated, can cause thermal stress in aquatic organisms. Lethal temperatures can be reached not much beyond optimum growth temperatures (Davies-Colley et al, 2013). Management of water temperature in fresh waters is not only a matter of avoiding lethal temperatures but should also be based on thermal requirements of all life stages.

Water temperature is affected by shading of the stream reach by riparian vegetation. Larger streams (>5 m wide) are generally not fully shaded by the planting of riparian vegetation under a GMP scenario. Furthermore, under the GMP scenario, reaches <1 m are not planted. To inform assessments of the effectiveness of GMP at managing water temperature the Expert Panel therefore estimated the proportion of stream length in each biophysical/landcover class that would be wider than 1m and would therefore be assumed to be subject to riparian planting under the GMP scenario (see Appendix 1(c) for method detail).

Table 37 Panel Summary for Scenario assessment of water temperature. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17..

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	A (A-B)	-1	0	2	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. This class is mostly indigenous forest with smaller faster flows and shaded waterways. Temperature is an attribute where we are more likely to be able to measure quite precisely, and therefore easier to be 'detectable'. There is also a close relationship between water and air temperature, meaning a more defined response. The degree of change for temperature is likely to be weak but detectable. **Effect** Ecosystem metabolism is the higher order attribute most likely to show an effect first, with a weak degree of change, a detectable effect on ecosystem metabolism is unlikely. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.
Mitigation (GMP)	NV_IF	A (A-B)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) +	NV_IF	A (A-B)	-1	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	A (A-B)	-1	0	1	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. Temperature is an attribute where we are more likely to be able to measure quite precisely, and therefore easier to be 'detectable'. There is also a close relationship between water and air temperature, meaning a more defined response, but will be buffered by forest cover for most of the harvest cycle. The degree of change for temperature is likely to be weak but detectable. **Effect** Ecosystem metabolism is the higher order attribute most likely to show an effect first, with a weak degree of change, a detectable effect on ecosystem metabolism is unlikely. **Confidence** Although generally a moderate confidence for temperature under IF and EF, this current state is close to the A/B boundary. The lower confidence reflects the uncertainty around the potential for a band change.
Mitigation (GMP)	NV_EF	A (A-C)	0	0	3	No	**Degree of Change** Only about 5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) +	NV_EF	A (A-C)	-1	0	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							**Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	B (A-C)	-1	-1	2	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature, but the change will likely be small. It is unlikely that climate change would push CRI above 21 degrees which is required for the C band. **Effect** While difficult to tease out just water temperature effects on higher order attributes, one would expect weak effects on e.g., DO, ecosystem metabolism and changing habitat for fish and invertebrates. Particularly as streams in the P class are not buffered in the same way that IF and EF classes are. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.
Mitigation (GMP)	NV_P	B (A-C)	1	0	1	No	**Degree of Change** The planting of riparian margins is the relevant GMP for this attribute. The distribution of stream order is needed to be considered as larger streams >3m will have less shading benefit and small streams <1 m are not planted as part of this GMP bundle. 65% land cover in this class are subject to GMP, but almost approximately 50% of the reaches are <1 m and therefore not planted in this scenario. The continuation of planting along stream reaches should also be considered as at least 100 m in first order streams is required before seeing a temperature change in the water. It would be expected that many plants would provide shade by 2040 and in some cases, there may be canopy closure. Overall, a small improvement is expected. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As the change is expected to be small, it is not expected to be large enough to have effects on higher order attributes. **Confidence** Low confidence reflects the reliance on assumptions that GMP is fully and promptly implemented and that there is therefore some shading provided by the 2040 timeline being assessed here.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	B (A-C)	0	0	1	No	**Degree of Change** Positive effect of GMP balances out negative effects of climate change leading to no detectable change. **Effect** Positive effect of GMP balances out negative effects of climate change leading to no detectable effect on higher order attributes. **Confidence** Low confidence based on climate model and unknowns regarding GMP effectiveness.
Climate Change (RCP4.5)	NV_PI	B (A-C)	-1	-1	1	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature, but the change will likely be small. **Effect** While difficult to tease out just water temperature effects on higher order attributes, one would expect weak effects on e.g., DO, ecosystem metabolism and changing habitat for fish and invertebrates. Particularly as streams in the P class are not buffered in the same way that IF and EF classes are. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	NV_PI	B (A-C)	1	0	1	No	**Degree of Change** The planting of riparian margins is the relevant GMP for this attribute. The distribution of stream order is needed to be considered as larger streams >3 m will have less shading benefit and small streams <1 m are not planted as part of this GMP bundle. The majority (~80%) of land cover in this class is subject to GMP, but only approximately 24% of the reaches are subject to riparian planting. The continuation of planting along stream reaches should also be considered as at least 100m in first order streams is required before seeing a temperature change in the water. It would be expected that many plants would provide shade by 2040 and in some cases, there may be canopy closure. Overall, a small improvement is expected. **Effect** As the change is expected to be small, it is not expected to be large enough to have effects on higher order attributes. **Confidence** Low confidence reflects the reliance on assumptions that GMP is fully and promptly implemented and that there is therefore some shading provided by the 2040 timeline being assessed here.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	B (A-C)	0	0	1	No	**Degree of Change** Positive effect of GMP balances out negative effects of climate change leading to no detectable change. **Effect** Positive effect of GMP balances out negative effects of climate change leading to no detectable effect on higher order attributes. **Confidence** Low confidence based on climate model and unknowns regarding GMP effectiveness.
Climate Change (RCP4.5)	V_HG_IF	A (A-B)	-1	0	2	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. This class is mostly indigenous forest with smaller faster flows and shaded waterways. Temperature is an attribute where we are

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							more likely to be able to measure quite precisely, and therefore easier to be 'detectable'. There is also a close relationship between water and air temperature, meaning a more defined response. The degree of change for temperature is likely to be weak but detectable. **Effect** Ecosystem metabolism is the higher order attribute most likely to show an effect first, with a weak degree of change, a detectable effect on ecosystem metabolism is unlikely. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.
Mitigation (GMP)	V_HG_IF	A (A-B)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A-B)	-1	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	B (A-C)	-1	0	2	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. Temperature is an attribute where we are more likely to be able to measure quite precisely, and therefore easier to be 'detectable'. There is also a close relationship between water and air temperature, meaning a more defined

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							response, but will be buffered by forest cover for most of the harvest cycle. Increases are also likely to be moderated by groundwater dominated pumice streams. It is also worth noting that this class is subject to greater climate change factors than other classes. The degree of change for temperature is likely to be weak but detectable. **Effect** Ecosystem metabolism is the higher order attribute most likely to show an effect first, with a weak degree of change, a detectable effect on ecosystem metabolism is unlikely. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.
Mitigation (GMP)	V_HG_EF	B (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	B (A-C)	-1	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	V_HG_P	C (B-C)	-1	-1	1	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature, but the change will likely be small. It is unlikely that climate change would push CRI above 24 degrees which is required for the D band, particularly as much of this class is relatively inland/high elevation and high gradient with smaller and faster flow that may buffer the effects from air temperature increases. **Effect** While only expecting a small change, the current state is already in the C band. Temperatures in this band start to get to ranges that can be quite negative for some species. As such, ecological effects likely to be more detectable when starting within the C band. However, the extent of this effect is uncertain and a band change into D band is not expected, therefore an effect level of 1-weak is predicted. **Confidence** Low confidence reflective of confidence in climate change model and uncertainty around level of effect.
Mitigation (GMP)	V_HG_P	C (B-C)	1	0	1	No	**Degree of Change** The planting of riparian margins is the relevant GMP for this attribute. The distribution of stream order is needed to be considered as larger streams >3 m will have less shading benefit and small streams <1 m are not planted as part of this GMP bundle. The majority of the reaches are <1 m and therefore not planted in this scenario. It is estimated about 22% of stream length in this class is planted. The continuation of planting along stream reaches should also be considered as at least 100 m in first order streams is required before seeing a temperature change in the water. It would be expected that many plants would provide shade by 2040 and in some cases, there may be canopy closure. Overall, a small improvement is expected. **Effect** As the change is expected to be small, it is not expected to be large enough to have effects on higher order attributes. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Low confidence reflects the reliance on assumptions that GMP is fully and promptly implemented and that there is therefore some shading provided by the 2040 timeline being assessed here.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	C (B-C)	0	0	1	No	**Degree of Change** Positive effect of GMP balances out negative effects of climate change leading to no detectable change. **Effect** Positive effect of GMP balances out negative effects of climate change leading to no detectable effect on higher order attributes. **Confidence** Low confidence based on climate model and unknowns regarding GMP effectiveness.
Climate Change (RCP4.5)	V_HG_PI	C (B-C)	-1	-1	1	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature, but the change will likely be small. It is unlikely that climate change would push CRI above 24 degrees which is required for the D band. **Effect** While only expecting a small change, the current state is already in the C band. Temperatures in this band start to get to ranges that can be quite negative for some species. As such, ecological effects likely to be more detectable when starting within the C band. However, the extent of this effect is uncertain and a band change into D band is not expected, therefore an effect level of 1-weak is predicted. **Confidence** Low confidence reflective of confidence in climate change model and uncertainty around level of effect.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	V_HG_PI	C (B-C)	1	0	1	No	**Degree of Change** The planting of riparian margins is the relevant GMP for this attribute. The distribution of stream order is needed to be considered as larger streams >3 m will have less shading benefit and small streams <1 m are not planted as part of this GMP bundle. The majority of the reaches are <1 m and therefore not planted in this scenario. It is estimated about 27% of stream length in this class is planted. The continuation of planting along stream reaches should also be considered as at least 100 m in first order streams is required before seeing a temperature change in the water. It would be expected that many plants would provide shade by 2040 and in some cases, there may be canopy closure. Overall, a small improvement is expected. **Effect** As the change is expected to be small, it is not expected to be large enough to have effects on higher order attributes. **Confidence** Low confidence reflects the reliance on assumptions that GMP is fully and promptly implemented and that there is therefore some shading provided by the 2040 timeline being assessed here.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	C (B-C)	0	0	1	No	**Degree of Change** Positive effect of GMP balances out negative effects of climate change leading to no detectable change. **Effect** Positive effect of GMP balances out negative effects of climate change leading to no detectable effect on higher order attributes. **Confidence** Low confidence based on climate model and unknowns regarding GMP effectiveness.
Climate Change (RCP4.5)	V_LG_IF	A (A-B)	-1	0	2	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. This class is mostly indigenous forest with smaller faster flows and shaded waterways. Temperature is an attribute where we are more likely to be able to measure quite precisely, and therefore easier to be 'detectable'. There is also

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							a close relationship between water and air temperature, meaning a more defined response. The degree of change for temperature is likely to be weak but detectable. **Effect** Ecosystem metabolism is the higher order attribute most likely to show an effect first, with a weak degree of change, a detectable effect on ecosystem metabolism is unlikely. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.
Mitigation (GMP)	V_LG_IF	A (A-B)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A-B)	-1	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	B (A-C)	-1	0	2	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. Temperature is an attribute where we are more likely to be able to measure quite precisely, and therefore easier to be 'detectable'. There is also a close relationship between water and air temperature, meaning a more defined response, but will be buffered by forest cover for most of the harvest cycle. Increases are also likely to

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							be moderated by groundwater dominated pumice streams. The degree of change for temperature is likely to be weak but detectable. **Effect** Ecosystem metabolism is the higher order attribute most likely to show an effect first, with a weak degree of change, a detectable effect on ecosystem metabolism is unlikely. **Confidence** A moderate confidence is warranted here due to the direct link between air and water temperature.
Mitigation (GMP)	V_LG_EF	B (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	B (A-C)	-1	0	2	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	A (A-C)	-2	-1	1	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature. There is potential for this class to shift to a B band due to the low riparian cover, shallow gradient and predicted Climate Change temperature rises. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Small effect on higher order attributes (DO, metabolism, changing habitat for inverts and fish) moving from <19 to >19 degrees. **Confidence** Confident that water temperature will increase and be detectable under Climate Change. The low confidence assessed here reflects the uncertainty around this change resulting in a band shift or not.
Mitigation (GMP)	V_LG_P	A (A-C)	1	0	1	No	**Degree of Change** The planting of riparian margins is the relevant GMP for this attribute. The distribution of stream order is needed to be considered as larger streams >3 m will have less shading benefit and small streams <1 m are not planted as part of this GMP bundle. 43% land cover in this class are subject to GMP, 2/3 of this have streams >1 m. It is estimated about 22% of stream length in this class is planted. The continuation of planting along stream reaches should also be considered as at least 100 m in first order streams is required before seeing a temperature change in the water. It would be expected that many plants would provide shade by 2040 and in some cases, there may be canopy closure. Overall, although the stream length subject to riparian planting is relatively small for this class, a small improvement is expected due to the continuation of planting and therefore good cumulative impact. **Effect** As the change is expected to be small, it is not expected to be large enough to have effects on higher order attributes. **Confidence** Low confidence reflects the wide variability in stream types i.e., stream size and what will have GMP applied.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	A (A-C)	-1	0	1	No	**Degree of Change** Positive effect of GMP dampens negative effects of climate change leading to a small negative change. **Effect** While still predicting a negative change, the changes will be within the A band and therefore not in the thermal stress zone. Hence no effect.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Low confidence based on climate model and unknowns regarding GMP effectiveness.
Climate Change (RCP4.5)	V_LG_PI	B (A-C)	-1	-1	1	No	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature. Individual sites might change band or range could shift A-D, but unlikely that overall band would shift from B to C as this requires >21 degrees for the CRI. **Effect** Small effect on higher order attributes (DO, metabolism, changing habitat for inverts and fish) moving from <19 to >19 degrees. **Confidence** Confident that water temperature will increase and be detectable under Climate Change. The low confidence assessed here reflects the uncertainty around this change resulting in a band shift or not.
Mitigation (GMP)	V_LG_PI	B (A-C)	1	0	1	No	**Degree of Change** The planting of riparian margins is the relevant GMP for this attribute. The distribution of stream order is needed to be considered as larger streams >3 m will have less shading benefit and small streams <1 m are not planted as part of this GMP bundle. 43% land cover in this class are subject to GMP, 2/3 of this have streams >1 m. Overall, it is estimated about 28% of stream length in this class is planted. The continuation of planting along stream reaches should also be considered as at least 100 m in first order streams is required before seeing a temperature change in the water. It would be expected that many plants would provide shade by 2040 and in some cases, there may be canopy closure. Overall, although the stream length subject to riparian planting is relatively small for this class, a small improvement is expected due to the continuation of planting and therefore good cumulative impact. **Effect** As the change is expected to be small, it is not expected to be large enough to have effects on higher order attributes. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Low confidence reflects the wide variability in stream types i.e., stream size and what will have GMP applied.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	B (A-C)	0	0	1	No	**Degree of Change** Positive effect of GMP balances out negative effects of climate change leading to no detectable change. **Effect** Positive effect of GMP balances out negative effects of climate change leading to no detectable effect on higher order attributes. **Confidence** Low confidence based on climate model and unknowns regarding GMP effectiveness.
Climate Change (RCP4.5)	Urban	D (A-D)	-1	-1	2	Yes	**Degree of Change** The key climate changes affecting water temperature (hot days, dry days, temperature) are likely to increase water temperatures, but to a relatively small extent to 2040. The change could well be detectable for a precisely measurable attribute like water temperature. Urban sites are largely low elevation and low riparian cover. Current state is already in the D band, it will likely get worse, but no change in state possible. **Effect** While already in the D band, it is predicted to only get worse, which increases the potential for lethal effects. **Confidence** Moderate confidence as already in the D band and the direct relationship between air and water temperature.
Mitigation (GMP)	Urban	D (A-D)	0	0	2	Yes	**Degree of Change**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							GMP is largely not applicable to the urban class. Most of the reaches are not subject to GMP as a very low proportion of reaches are >1 m. Overall it is estimated about 7% of stream length in this class is planted. **Effect** No degree of change, therefore no level of effect. **Confidence** Confidence is assessed as moderate rather than high due to there being some GMP compared to the EF and IF classes.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	D (A-D)	-1	-1	2	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Copper and Zinc

Toxicant is a term used for chemical contaminants that have potential to exert toxic effects at concentrations that might be found in the environment. There is a large range of toxicants that are potentially discharged into the environment, examples include: heavy metals such as copper, zinc, cadmium, arsenic; pesticides and herbicides; hydrocarbons; polychlorinated biphenyls (PCBs); and volatile organic compounds (VOC).

Some toxicants occur naturally in the environment, such as NO3-N and NH4-N already discussed above, and also heavy metals associated with geothermal discharges. Other toxicants might be associated with a range of activities where monitoring is targeted specifically to an activity and toxicant(s) of interest.

Copper (Cu) is an essential trace element required by most aquatic organisms, but toxic concentrations are not much higher than those that allow optimum growth of algae. Copper is readily accumulated by both plants and animals and Cu toxicity occurs when the rate of uptake exceeds the rates of physiological or biochemical detoxification and excretion.

Zinc (Zn) is also an essential trace element required by most organisms for their growth and development. It is found in most natural waters at low concentrations. Zinc toxicity occurs when the rate of uptake exceeds the rates of physiological or biochemical detoxification and excretion. Zinc toxicity can result in adverse chronic and acute effects on the reproduction, physicochemical and behaviour of aquatic organisms. For example, damaging gills in fish causing hypoxia (ANZECC, 2000).

Copper (Cu) and zinc (Zn) are common in urban environments (e.g., from vehicle brake pad and tyre wear and runoff from galvanised roofs) and can accumulate in the sediments of rivers, streams and downstream receiving waters. Concentrations in urban environments can often exceed concentrations found naturally in the environment, and at concentrations that can become toxic to aquatic life. Given the close association between urban development and stormwater, the assessments for Cu and Zn were only done for the urban land use class.

ANZECC (2000) guidelines have been developed to assist in protecting ambient waters from sustained exposure to toxicants, that is, chronic toxicity. Stormwater is the main source of input of heavy metals in streams. The intermittent nature of stormwater runoff means it can be difficult to collect stream water samples when discharges are occurring. Sediment can show the accumulated impact of potential pulses of discharges with high metal concentrations. As such, the regional attributes of copper and zinc are for sediment concentrations. The regional attribute tables showing the concentrations that define the thresholds between low, medium and high attribute states can be found in Appendix 2 and these thresholds were adapted from the ANZECC (2018) guidelines based on whole sediment sample analysis (see Crawshaw, 2021).

The assessments in Table 38 and Table 39 should be read in conjunction with the discussions in section 2.6.2.

Table 38 Panel Summary for Scenario assessment of copper (Cu). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimated of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	Urban	A / Low (Low-Medium)	0	-1	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., 0%-2% change in annual rainfall, +1 day more heavy rainfall <1 degree summer temp increase on majority at 19 degrees). Increase in Cu pollution (from roads mainly) associated with increased rainfall. But this is probably not enough for a noticeable change in state and low confidence in detectable change as well. It seems likely the RCP4.5 scenario will involve significant change to vehicle technology and potentially reduced sources of copper and zinc (possibly a degree of change of 1 or 2) but these have not been assumed in this climate change scenario. There is potential for an increase in pH with Climate Change which would result in greater Cu release from sediment, but change is estimated to be negligible. **Effect** A potential pH shift (increased acidification) would increase the bioavailability of Cu, and therefore a weak negative effect on higher order attributes predicted even if state didn't change. **Confidence** Low confidence is reflective of the low confidence in the climate change model.
Mitigation (GMP)	Urban	A / Low (Low-Medium)	0	0	3	No	**Degree of Change** No GMP applied to urban areas, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	A / Low (Low-Medium)	0	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence**

Scenario	Spatial Classification	EP Estimated of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Consistent with Climate Change assessment.

Table 39 Panel Summary for Scenario assessment of zinc (Zn). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	Urban	A / Low (Low - High)	0	-1	1	No	**Degree of Change** While confident the climate will change, the key climate drivers show relatively little change to 2040 (e.g., 0%-2% change in annual rainfall, +1day more heavy rainfall <1 degree summer temp increase on majority at 19 degrees). Increase in Zn pollution associated with increased rainfall. But this is probably not enough for a noticeable change in state and low confidence in detectable change as well. It seems likely the RCP4.5 scenario will involve significant change to vehicle technology and potentially reduced sources of copper and zinc (possibly a degree of change of 1 or 2) but these have not been assumed in this climate change scenario. The source and supply of Zn shouldn't change with climate change, but delivery and accumulation could increase. There is potential for an increase in pH with Climate Change which would result in greater Zn release from sediment, but change is estimated to be negligible. **Effect** A potential pH shift (increased acidification) would increase the bioavailability of Zn, and therefore a weak negative effect on higher order attributes predicted even if state didn't change. **Confidence** Low confidence is reflective of the low confidence in the climate change model.
Mitigation (GMP)	Urban	A / Low (Low - High)	0	0	3		**Degree of Change** No GMP applied to urban areas, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	A / Low (Low - High)	0	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Tier 2 attributes

Deposited Fine Sediment (DFS)

Deposited fine sediment refers to the fine sediment (< 2 mm diameter) that accumulates on the bed of a waterway (Clapcott et al., 2011). The composition of the streambed depends on slope, stream size, rainfall, catchment land use, vegetation, and geology. Streams are often classified as 'hard-bottomed' (HB, composed of gravel or larger substrate) or 'soft-bottomed' (SB, composed of sand, silt or clay) reflecting the bed composition. In the absence of human influence, classification systems (i.e., Freshwater Ecosystems of New Zealand (FENZ)) and GIS models estimate that most streams in New Zealand would be hard-bottomed (Clapcott et al., 2011). Deposited sediment can impact on ecosystem health by smothering organisms or changing the available habitat. Main drivers for change in deposited sediment included increased sediment loading from heavy rainfall and flooding events for climate change, while land use improvements and reduced erosion were the main drivers for changes under the GMP scenario.

As outlined in section 2.4.2, the DFS attribute has its own bespoke sediment classes that are used for the assessments. The relationship between the biophysical/landcover classes and the bespoke deposited fine sediment classes is described in section 2.4.2 and the proportion of each DFS class occurring in each biophysical class is shown in Table 14.

The assessments in Table 40 should be read in conjunction with the methods described in section 2.4, the results from sediment analyses presented in Appendix 3, and the discussions on uncertainty in section 2.6.2.

Table 40 Panel Summary for Scenario assessment of deposited sediment. Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	DFS-2-IF	A (A-D)	-1	-1	1	N	**Degree of Change** 43.8% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed only a 4% increase in DFS. The majority of IF is in the DFS class 4 (and SFS class 3). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. This class is scattered all around the region and has a mix of high and low gradient, resulting in a very mixed class with high variability. A 4% increase is unlikely to result in a band change. Some sites may be quite impacted e.g., east coast streams, but other sites e.g., pumice streams will have no detectable change. On average a small detectable change is expected in this class. **Effect** Possible negative impact on sensitive invertebrates. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-2-IF	A (A-D)	0	0	3	No	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the class.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-2-IF	A (A-D)	-1	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Consistent with Climate Change assessment.
Climate Change (RCP4.5)	DFS-2-EF	D (A-D)	-1	-2	1	Yes	**Degree of Change** 77.6% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a >50% increase in DFS cover. The majority of EF is in the DFS class 2 and 3 (and SFS classes 1 and 2). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. This class is already in the D band, so degree of change can't be more than -1. It is noted however, that some reaches may get a band shift as the current state range is from A-D. **Effect** There is a wide range of states in this class, so although the degree of change is 1-low, this is because the current state is already in the D band. Reaches in this class are largely already soft-bottomed, but current state for MCI and QMCI show there are still some sensitive species there and some that would be susceptible to DFS. The estimated increase in DFS would probably see these EPT taxa dropping out, hence a moderate effect on higher order attributes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-2-EF	D (A-D)	0	0	3	Yes	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the class.
Climate Change (RCP4.5) +	DFS-2-EF	D (A-D)	-1	-2	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							**Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	DFS-2-P	D (A-D)	-1	-2	1	Yes	**Degree of Change** 71.7% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a >20% increase in DFS. The majority of P is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in the eastern tops DFS class 4 (and SFS class 1). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Current state for this class is already in the D band, so degree of change can't be more than a -1. **Effect** DFS cover estimated to increase by >20% and likely over 50% cover in total. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-2-P	D (A-D)	0	0	1	Yes	**Degree of Change** 9% decrease in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.4 and assuming a 1:1 relationship showed a 2.5% decrease in DFS, which is also likely an overestimate. The streams in this class are a mix of hard-bottomed (streams flowing into Tauranga Harbour) and soft-bottomed (upper reaches flowing into the Kaituna Plains), so reducing the amount of SFS will only lead to meaningful reduction in DFS in the hard-bottomed streams. Overall, unlikely to detect any change at <5%, but the direction of any change would be positive. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Low confidence reflective of high uncertainty in method, low confidence in SedNet model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-2-P	D (A-D)	-1	-2	1	Yes	**Degree of Change** Climate change dominates as GMP results in negligible change. Assessment is therefore reflective of the Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	DFS-2-PI	D (B-D)	-1	-2	1	Yes	**Degree of Change** 77.8% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a >20% increase in DFS. The majority of PI is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in eastern tops DFS class 4 (and SFS class 1). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Current state for this class is already in the D band, so degree of change can't be more than a -1. Loads around the Eastern (NV) areas may increase a lot, and these are the areas less likely to be in D band at current state, so range may be compacted by Climate Change. **Effect** DFS cover estimated to increase by >20% and likely over 50% cover in total hence a moderate negative effect on higher order attributes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-2-PI	D (B-D)	0	0	1	Yes	**Degree of Change** 8% decrease in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.4 and assuming a 1:1

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							relationship showed a 2.5% decrease in DFS, which is also likely an overestimate. Overall, unlikely to detect any change at <5%, but the direction of any change would be positive. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-2-PI	D (B-D)	-1	-2	1	Yes	**Degree of Change** Climate change dominates as GMP results in negligible change. Assessment is therefore reflective of the Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	DFS-2-U	D (B-D)	-1	-1	1	Yes	**Degree of Change** 66.5% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a >20% increase in DFS. The majority of U is in the DFS class 2 and 3 (and SFS class 1 and 2). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Current state for this class is already in the D band, so degree of change can't be more than a -1. A significant increase, but only reflected as a -1 due to current state. **Effect** Invertebrate attributes are also already in the D band, so the level of effect is limited by the already degraded environment at current state. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	DFS-2-U	D (B-D)	0	0	2	Yes	**Degree of Change** While no GMP in urban areas, there is a reasonably significant proportion of the U class in P and PI. The overall load decrease for this class is predicted to be ~5%, which is unlikely to be detectable. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Moderate confidence here as there is some GMP outside of the urban areas in this class, so there cannot be high confidence as there is for IF and EF.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-2-U	D (B-D)	-1	-1	1	Yes	**Degree of Change** Climate change dominates as GMP results in negligible change. Assessment is therefore reflective of the Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	DFS-3-IF	C (A-D)	-1	-1	1	Yes	**Degree of Change** 42.3% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~11% increase in DFS cover. The majority of IF is in the DFS class 4 (and SFS class 3). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. No change in overall state, however some reaches may shift bands (deteriorate) as the current state range is from A-D. **Effect** Mainly hard bottomed streams near Matata, Whakatāne and Ōhope. Therefore, weak negative effect on higher order attributes likely, especially in B-C streams. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-3-IF	C (A-D)	0	0	3	Yes	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the class.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-3-IF	C (A-D)	-1	-1	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	DFS-3-EF	C (A-C)	-1	-1	1	Yes	**Degree of Change** 41.2% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~11% increase in DFS cover. The majority of IF is in the DFS class 4 (and SFS class 3). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. No change in overall state, however some reaches may shift bands (deteriorate) as the current state range is from A-C. Note that Matakana Island (which is dunes) is approximately 50% of the area of this class. **Effect** Many streams here are naturally soft-bottomed, so are not likely to be affected by slight increases in DFS. Overall though, a weak negative effect on higher order attributes likely, especially in streams with a current state in B-C.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Low confidence reflective of high uncertainty in method, low confidence in SedNet model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-3-EF	C (A-C)	0	0	3	Yes	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the class.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-3-EF	C (A-C)	-1	-1	1	Yes	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	DFS-3-P	D (A-D)	-1	-1	1	Yes	**Degree of Change** Very small area of mid-region coast (Ōhiwa Harbour and Waiotahe Plains). 71.8% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~19% increase in DFS. The majority of P is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in the eastern tops DFS class 4 (and SFS class 1). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Current state for this class is already in the D band, so degree of change can't be more than a -1, noting that reaches in the A-C bands (predicted range) are likely to see some degradation in state. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							DFS cover estimated to increase by <20%, but likely over 30% cover in total. The streams are dominated by pumice, sand and mud in this class, hence a -1-low detectable effect. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-3-P	D (A-D)	1	0	1	Yes	**Degree of Change** 14% decrease in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.4 and assuming a 1:1 relationship showed a 3.5% decrease in DFS, which is also likely an overestimate. The Panel were split here between a 0-negligible or 1-low degree of change but are unanimous that any direction of change would be positive. A small positive change is expected, but uncertainty around if that would be detectable. **Effect** Most of these streams are naturally soft-bottomed, so a small reduction of DFS is unlikely to have any effect on higher order attributes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-3-P	D (A-D)	-1	-1	1	Yes	**Degree of Change** Climate change dominates as GMP results much smaller change. Assessment is therefore reflective of the Climate Change assessment. **Effect** As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	DFS-3-PI	C (B-D)	-2	-1	1	Yes	**Degree of Change** 69% increase in sediment load predicted by SedNetNZ model. Assuming a correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							relationship showed a ~18% increase in DFS. The majority of PI is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in eastern tops DFS class 4 (and SFS class 1). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Estimate that a ~18% increase in DFS could deteriorate overall state from C to D band (hence –2 change). **Effect** DFS cover estimated to increase by <20%, but likely over 30% cover in total. The streams are dominated by pumice, sand and mud in this class, hence a -1-low detectable effect. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-3-PI	C (B-D)	1	0	1	Yes	**Degree of Change** ~17% decrease in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, a decrease in DFS is likely. The approach in section 2.3.4 and assuming a 1:1 relationship showed a 4.5% decrease in DFS, which is also likely an overestimate. The panel were split here between a 0-negligible or 1-low degree of change but are unanimous that any direction of change would be positive. A small positive change is expected, but uncertainty around if that would be detectable. **Effect** Most of these streams are naturally soft-bottomed, so a small reduction of DFS is unlikely to have any effect on higher order attributes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-3-PI	C (B-D)	-2	-1	1	Yes	**Degree of Change** Climate change dominates as GMP results much smaller change. Assessment is therefore reflective of the Climate Change assessment. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	DFS-3-U	D (C-D)	-1	-1	1	Yes	**Degree of Change** Very small area of coastal/urban use. A 56% increase in sediment load predicted by SedNet model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~15% increase in DFS. The majority of U is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in eastern tops DFS class 4 (and SFS class 1). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Current state for this class is already in the D band, so degree of change can't be more than a -1. **Effect** Sites most likely constrained by other stressors associated with stormwater discharge, higher order attributes are already in a poor state. As such, level of effect is limited to a -1. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-3-U	D (C-D)	0	0	2	Yes	**Degree of Change** While no GMP in urban areas, there is a reasonably significant proportion of the U class in P and PI. The overall load decrease for this class is negligible. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Moderate confidence here as there is some GMP outside of the urban areas in this class, so there cannot be high confidence as there is for IF and EF.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-3-U	D (C-D)	-1	-1	1	Yes	**Degree of Change** Climate change dominates as GMP results in negligible change. Assessment is therefore reflective of the Climate Change assessment. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As per Climate Change assessment. **Confidence** As per Climate Change assessment.
Climate Change (RCP4.5)	DFS-4-IF	A (A)	-1	-1	1	No	**Degree of Change** 53% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~7% increase in DFS cover. The majority of IF is in the DFS class 4 (and SFS class 3). DFS2 and DFS3 are lower power and DFS4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS2 and DFS3, higher in DFS4. Sites in this class have very low DFS and well into the A band, so even with a ~40% increase the sites should remain in the A band. The streams in this class (mostly the east coast) are more efficient at shifting sediment due to stream power and slope. As the sites are starting low, a change is likely to be detectable. **Effect** Some uncertainty around whether an effect could be detected from this small change. A low effect reflects that high quality sites may be quite sensitive to small changes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-4-IF	A (A-C)	0	0	3	No	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the class.
Climate Change (RCP4.5) +	DFS-4-IF	A (A-C)	-1	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							**Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	DFS-4-EF	A (A-C)	-1	-1	1	No	**Degree of Change** This is a very small (<1%) area in the NV class. 44.2% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~6% increase in DFS cover. The majority of EF is in the DFS classes 2 and 3 (and SFS classes 1 and 2). DFS-2 and DFS-3 are lower power and DFS-4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS-2 and DFS-3, higher in DFS-4. This is one of the smallest changes in SedNetNZ, so a low degree of change is predicted. **Effect** This class is mostly in the eastern part of the region, where streams are hard-bottomed. This slight increase in DFS may have a slight ecological effect. Also, DFS-4 is more likely to be less retentive, hence bias towards lower scores. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-4-EF	A (A-C)	0	0	3	Yes	**Degree of Change** <5% of this BPU subject to GMPs, as such, GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs area applied to <5% of the class.
Climate Change (RCP4.5) +	DFS-4-EF	A (A-C)	-1	-1	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this bespoke sediment class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							**Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	DFS-4-P	C (B-D)	-2	-1	1	No	**Degree of Change** 59% increase in sediment load predicted by SedNet model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~13% increase in DFS. The majority of P is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in eastern tops DFS class 4 (and SFS class 1). DFS-2 and DFS-3 are lower power and DFS-4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS-2 and DFS-3, higher in DFS-4. As the bands in this class are narrow, this level of change would likely result in a band change to D band. **Effect** Class is mostly in the upper motu, where it is likely hard bottomed streams. Weak negative effects on higher order attributes possible. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Mitigation (GMP)	DFS-4-P	C (B-D)	1	1	1	No	**Degree of Change** 31% decrease in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.4 and assuming a 1:1 relationship showed a 7% decrease in DFS, which is also likely an overestimate. State change is not out of the question, but more likely to stay within the current state band. Direction of change is definitely positive. **Effect** Improvement will have a positive weak effect on higher order attributes. Most reaches are in the upper Motu, which are assumed to be hard-bottomed streams. So, there will likely be some beneficial ecological effects.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-4-P	C (B-D)	-1	0	1	Yes	**Degree of Change** GMP mitigates some of the Climate Change impact and would likely prevent a state band shift, which is positive. **Effect** The scenarios oppose each other, and the resulting change is not expected to be large enough to show effect on higher order attributes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5)	DFS-4-PI	C (B-D)	-2	-1	1	Yes	**Degree of Change** This class is a very small area of the upper Motu and Mamaku's. 73.1% increase in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.1 and assuming a 1:1 relationship showed a ~17% increase in DFS. The majority of PI is in the DFS class 2 and 3 (and SFS class 1 and 2) with a little in eastern tops DFS class 4 (and SFS class 1). DFS-2 and DFS-3 are lower power and DFS-4 higher power for sediment transport (variance by stream order within each), therefore low moderation of SFS effects in DFS-2 and DFS-3, higher in DFS-4. The level of increase in sediment load would likely result in movement within the band and probably a band shift to below bottom line. **Effect** Class is mostly in the upper motu, where it is likely hard bottomed streams. The DFS-4 class is more likely to be less retentive, hence bias towards lower score for effect. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	DFS-4-PI	C (B-D)	0	0	1	No	**Degree of Change** Almost 10% decrease in sediment load predicted by SedNetNZ model. Assuming correlation between load and deposited sediment, an increase in DFS is likely. The approach in section 2.3.4 and assuming a 1:1 relationship showed a 2% decrease in DFS, which is also likely an overestimate. While the direction of change would be positive, the degree of change would not be detectable. **Effect** As negligible degree of change, there is also negligible effect on higher order attributes. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-4-PI	C (B-D)	-2	-1	1	Yes	**Degree of Change** GMP mitigates some of the Climate Change impact. However, the degree of change for Climate Change is much larger and will strongly dominate the combined scenario. **Effect** GMP benefits are relatively small relative to the size of Climate Change effects. Assessment reflects Climate change assessment. **Confidence** Low confidence reflective of high uncertainty in method, low confidence in SedNetNZ model and lack of quantitative relationship between load and DFS.
Climate Change (RCP4.5)	DFS-4-U	N/A	N/A	N/A	N/A	N/A	Not assessed as there is no current state assessment and a small part of the region.
Mitigation (GMP)	DFS-4-U	N/A	N/A	N/A	N/A	N/A	Not assessed as no Current State assessment and a small part of the region.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	DFS-4-U	N/A	N/A	N/A	N/A	N/A	Not assessed as no Current State assessment and a small part of the region.

Tier 3 attributes

Dissolved Oxygen (DO)

Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in the water. Oxygen is needed in aquatic ecosystems to support life. Stream ecosystems both produce and use oxygen, and this occurs on a diel (daily) cycle. Oxygen is provided to streams from the air, and from aquatic plants as a by-product of photosynthesis. Consequently, during the day oxygen levels reach their peak with peak photosynthetic activity. Conversely, oxygen is consumed within a stream by aquatic animals and plants as they respire, and as organic matter (e.g., leaves, twigs) decompose. Additionally, organic waste that is discharged into a river (e.g., from industry, urban or agricultural stormwater) can also contain contaminants that consume oxygen. Subsequently, during the night (when there is no photosynthesis to replenish oxygen levels), oxygen levels reach their minimum levels just before dawn. Water temperature is another factor that can affect the solubility of oxygen as water temperature increases, meaning that lower DO levels are observed at higher water temperatures.

Assessments for DO were largely based on changes to water temperature as the driving factor. While photosynthetic activity from periphyton and macrophytes would commonly be a driver also, this is not so much the case in the BOP due to the mobile pumice substrate that dominates the region. Where photosynthetic activity is considered relevant, this is noted in the justification. Sediment changes were also considered; however, water temperature was considered to dominate over sediment factors.

The assessments in Table 41 should be read in conjunction with the discussions in section 2.6.2.

Table 41 Panel Summary for Scenario assessment of dissolved oxygen (DO). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	A (A-B)	0	0	1	N	**Degree of Change** Lower order attributes had no effect (temperature), weak effect (SFS-3) and moderate negative effect (DFS-4) predicted. Higher temperatures result in lower max DO concentration, plus possible higher metabolism hence lower minima. Water temperature is expected to increase but no detectable effect on higher order attributes predicted. Probably buffered by cooler starting temperature in forested sites and likely higher reaeration rates due to stream type (smaller, higher gradient, unmodified). Change to DO considered negligible for EF and IF classes. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low confidence because sediment could deleterious effect DO through anaerobic pathways.
Mitigation (GMP)	NV_IF	A (A-B)	0	0	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	A (A-B)	0	0	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	A (A-B)	0	0	1	N	**Degree of Change** Lower order attributes had no detectable effect (temperature), weak effect (SFS-1, SFS-2, SFS-3) and moderate effect (DFS-2, DFS-4) predicted. Higher temperatures result in lower max DO concentration, plus possible higher metabolism hence lower minima. Water temperature is expected to increase leading to possible DO decrease with summer low flow conditions (i.e., lower velocity and increased warming leads to lower DO). Probably buffered by cooler starting temp in forested sites and likely higher reaeration rates due to stream type (smaller, higher gradient, unmodified). The only potential difference between EF and IF sites for DO is that there may be a bigger effect after logging cycle. However, long-term monitoring in the Coromandel (NIWA unpublished data) showed no effects on DO through the logging cycle. Slash can create oxygen demand, but also provides shading in logged areas. Change to DO considered negligible for EF and IF classes. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low confidence in climate model. Low confidence because sediment could deleterious effect DO through anaerobic pathways.
Mitigation (GMP)	NV_EF	A (A-B)	0	0	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) +	NV_EF	A (A-B)	0	0	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							As per Climate Change assessment. **<u>Confidence</u>** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	A (A-C)	-1	0	1	N	**<u>Degree of Change</u>** Small detectable degradation in temperature with detectable effect on higher order attributes predicted. Moderate negative effect predicted for DFS-4 and SFS-3. Water temperature increase likely coupled with summer lower flow, decreased velocity, increased productivity; likely to negatively impact DO levels, although band change unlikely. Extent of Climate Change by 2040 unlikely to cause dramatic shift in DO dynamics but may impact some reaches where there is more exposed topography. Low flow low order streams may be more affected. Climate Change could affect nutrient cycling but only slightly. Overall small detectable change possible due to effect of increased sediment on productivity and respiration. **<u>Effect</u>** Starting from an A baseline, so not likely to have substantial effect on other attributes (response variables). There may be some reaches where there would be negative consequences for other attributes, but on balance 0 effect. **<u>Confidence</u>** Low confidence because unsure of influence of the magnitude of sediment change.
Mitigation (GMP)	NV_P	A (A-C)	1	0	2	N	**<u>Degree of Change</u>** Primary drivers of productivity that effect DO include light, temperature, DIN (and coarse substrate and FRE2 specifically for periphyton). A small detectable improvement in DIN and temperature predicted, but no effect. Most of this class is DFS-4 sediment class which is predicted to have moderate improvement with weak effect. This class has regional distribution from high elevation streams to low gradient streams on the plains making the effect of substrate and flow difficult to factor in. Over 30% of reaches subject to GMP, and around 2/5 of these in riparian management. Overall, it is estimated about 16% of stream length in this class is planted. Increased shading likely to results in decrease in temperature and improvement in DO. Overall small detectable change possible making borderline A state a more definitive A state. **<u>Effect</u>** No effect as already in A state. **<u>Confidence</u>**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Moderate confidence in direction of change from GMP and because it is already in A.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	A (A-C)	0	0	1	N	**Degree of Change** Any detectable change due to climate effects mitigated by best management practice. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low confidence reflects the uncertainty and relative magnitude of each scenario and how much they cancel each other out. Not comfortable to say whether the net effect is positive or negative.
Climate Change (RCP4.5)	NV_PI	B (A-D)	-1	0	1	N	**Degree of Change** Small detectable degradation in temperature with weak detectable effect on higher order attributes predicted. Moderate negative effect predicted for DFS-4, DFS-3, DFS-2and SFS-3, weak negative effect for SFS-2. Water temperature increase likely coupled with summer lower flow, decreased velocity, increased productivity; likely to negatively impact DO levels, although band change unlikely. Extent of Climate Change by 2040 unlikely to cause a dramatic shift in DO dynamics but may impact some reaches where there is more exposed topography. Low flow low order streams may be more so affected. Climate Change could affect nutrient cycling but only slightly. Overall, small detectable change possible due to effect of increased sediment on productivity and respiration. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Low confidence because unsure of influence of the magnitude of sediment change.
Mitigation (GMP)	NV_PI	B (A-D)	1	0	1	N	**Degree of Change** Primary drivers of productivity that effect DO include light, temperature, DIN (and coarse substrate and FRE2 specifically for periphyton). A small detectable improvement in DIN and temperature predicted, but no effect. Regional split between streams in the plains of the Kaituna (low flow, high dairy, pumped drainage systems, and low DO) and spring-fed streams in Rotorua and Galatea Plains. A third of reaches are subject to GMP with around 40% of these with riparian management. Overall, it is estimated about 24% of stream length in this class is planted. Some thermal relief from riparian

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							management. This coupled with decreased productivity (due to temperature and solar radiation) and decreased sediment oxygen demand results improvement in DO, which could result in band change. Overall, more likely a small detectable change possible but unlikely to move to A state. **Effect** Already in good state (B). There could be localised impact, but overall, 0 effect. Noting that there could be a negative effect from GMP with decomposition of organic material in slow flowing drainage networks. Shading would get rid of some macrophytes in some of these low gradient streams. Many of these drainage canals are so degraded that they don't have much macrophytes. Regional diversity will be important for catchment cluster split. **Confidence** Low confidence because mixed class and regional influences, although moderate confidence in positive direction of change.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	B (A-D)	0	0	1	N	**Degree of Change** Any detectable change due to climate effects mitigated by best management practice. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low confidence reflects the uncertainty and relative magnitude of each scenario and how much they cancel each other out. Not comfortable to say whether the net effect is positive or negative,
Climate Change (RCP4.5)	V_HG_IF	A (A)	0	0	1	N	**Degree of Change** Lower order attributes had no effect (temperature), weak effect (SFS-3) and moderate negative effect (DFS-4) predicted. Higher temperatures result in lower max DO concentration, plus possible higher metabolism hence lower minima. Water temperature is expected to increase leading to possible DO decrease with summer low flow conditions (i.e., lower velocity and increased warming leads to lower DO). Probably buffered by cooler starting temperature in forested sites and likely higher reaeration rates due to stream type (smaller, higher gradient, unmodified). Change to DO considered negligible for EF and IF classes. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Low confidence because sediment could deleterious effect DO through anaerobic pathways.
Mitigation (GMP)	V_HG_IF	A (A)	0	0	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A)	0	0	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	A (A-B)	0	0	1	N	**Degree of Change** Lower order attributes had no detectable effect (temperature), weak effect (SFS-1) and moderate effect (DFS-2) predicted. Higher temperatures result in lower max DO concentration, plus possible higher metabolism hence lower minima. Water temperature is expected to increase leading to possible DO decrease with summer low flow conditions (i.e., lower velocity and increased warming leads to lower DO). Probably buffered by cooler starting temperatures in forested sites and likely higher reaeration rates due to stream type (smaller, higher gradient, unmodified). The only potential difference between EF and IF sites for DO is that there may be a bigger effect after logging cycle. however, long-term monitoring in the Coromandel (NIWA unpublished data) showed no effects on DO through the logging cycle. Slash can create oxygen demand, but also provides shading in logged areas. Change to DO considered negligible for EF and IF classes. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As the degree of change is negligible, the effect also negligible. **<u>Confidence</u>** Low confidence in climate model. Low confidence because sediment could deleterious effect DO through anaerobic pathways.
Mitigation (GMP)	V_HG_EF	A (A-B)	0	N/A	3	N	**<u>Degree of Change</u>** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **<u>Effect</u>** As the degree of change is negligible, the effect also negligible. **<u>Confidence</u>** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	A (A-B)	0	0	1	N	**<u>Degree of Change</u>** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **<u>Effect</u>** As per Climate Change assessment. **<u>Confidence</u>** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	A (A-B)	-1	0	1	N	**<u>Degree of Change</u>** Small detectable degradation in temperature with detectable effect on higher order attributes predicted. Moderate negative effect predicted for DFS-2 class, and weak effect for classes SFS-1 and SFS-2. Water temperature increase likely coupled with summer lower flow, decreased velocity, increased productivity; likely to negatively impact DO levels, although band change unlikely. Extent of Climate Change by 2040 unlikely to cause dramatic shift in DO dynamics but may impact some reaches where there is more exposed topography. Low flow low order streams may be more so affected. Could affect nutrient cycling but only slightly. Overall small detectable change possible due to effect of increased sediment on productivity and respiration. **<u>Effect</u>**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Starting from A baseline, so not likely to have substantial effect on other attributes (response variables). There may be sites there would be negative consequences for other attributes but on balance 0 effect. **Confidence** Low confidence because unsure of influence of the magnitude of sediment change.
Mitigation (GMP)	V_HG_P	A (A-B)	0	0	2	N	**Degree of Change** Primary drivers of productivity that effect DO include light, temperature, DIN (and coarse substrate and FRE2 specifically for periphyton). A small detectable improvement in DIN and temperature predicted but neither predicted to have a detectable effect on higher order attributes. Pasture streams subject to high macrophyte and algal biomass mitigated by high gradient reaeration. No change or effect predicted for DFS-2 class, and although class SFS-2 shows minor improvement, flow is difficult to factor in. Around 1/3 of reaches subject to GMP and over 60% of these would have riparian management. Overall, it is estimated about 22% of stream length in this class is planted. Increased shading could result in a decrease in temperature and improvement in DO, but unlikely to result in band change due to velocity and re-aeration. GMP may reduce stream productivity slightly but impacts on DO dynamics are likely to be very minor and may be difficult to detect. As current state is already in the A band, it is probably already close to saturation. Overall, expect GMP to move in a positive direction, but as already in the A band, this change is unlikely to be detectable. It may combat Climate Change impacts (see combined scenario). **Effect** No effect as already in A state. **Confidence** Moderate confidence as it is already in the A band.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	A (A-B)	0	0	1	N	**Degree of Change** Climate effects greater than GMP. Small detectable change possible, but more likely that GMP will provide buffering in A band to counter the effects of Climate Change. **Effect** As the degree of change is negligible, the effect is also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_PI	B (A-C)	-1	0	1	N	**Degree of Change** Small detectable degradation in temperature with detectable effect on higher order attributes predicted. Moderate negative effect predicted for DFS-2 class, and weak effect for classes SFS-1 and SFS-2. Water temperature increase likely coupled with summer lower flow, decreased velocity, increased productivity; likely to negatively impact DO levels, although band change unlikely. Extent of Climate Change by 2040 unlikely to cause dramatic shift in DO dynamics but may impact some reaches where there is more exposed topography. Low flow low order streams may be more so affected. Could affect nutrient cycling but only slightly. Overall small detectable change possible due to effect of increased sediment on productivity and respiration. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Low confidence because unsure of influence of the magnitude of sediment change.
Mitigation (GMP)	V_HG_PI	B (A-C)	1	0	1	N	**Degree of Change** Primary drivers of productivity that effect DO include light, temperature, DIN (and coarse substrate and frequency of floods (FRE2) specifically for periphyton). Moderate noticeable improvement in DIN (with weak effect) and small detectable improvement in temperature (no effect) predicted. Pasture streams subject to high macrophyte and algal biomass mitigated by high gradient reaeration. No change or effect predicted for DFS-2 class, small improvement and effect in SFS (visual clarity), and flow difficult to factor in. Increased shading likely to result in decrease in temperature. Overall, it is estimated about 27% of stream length in this class is planted. Coupled with decreased productivity (due to decreased temperature and solar radiation) and decreased sediment oxygen demand results improvement in DO. GMP may reduce stream productivity slightly. Impacts on DO dynamics are unlikely to be dramatic but could well be detectable. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Less confident of measurable improvement in HG due to likely higher reaeration potential with steeper streams and multiple different mechanisms and pathways.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	B (A-C)	0	0	1	N	**Degree of Change** Any detectable change due to climate effects mitigated by GMPs. Net improvement would be likely if DIN was the primary driver, GMP likely has net benefit. But overall degree of change is assessed as 0. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_IF	A (A-B)	0	0	1	N	**Degree of Change** Lower order attributes had no detectable effect (temperature), weak effect (SFS-1 and SFS-2) and moderate effect (DFS-2) predicted. Higher temperature results in lower max DO concentration, plus possible higher metabolism hence lower minima. Water temperature is expected to increase leading to possible DO decrease with summer low flow conditions (i.e., lower velocity and increased warming leads to lower DO). Probably buffered by cooler starting temperatures in forested sites. Reaeration rates likely lower in LG so possibly higher risk of detectable changes compared to where higher gradients are more prevalent. Overall, change to DO considered negligible for EF and IF classes. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence because sediment could deleterious effect DO through anaerobic pathways.
Mitigation (GMP)	V_LG_IF	A (A-B)	0	0	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A-B)	0	0	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	A (A-B)	0	0	1	N	**Degree of Change** Lower order attributes had no detectable effect (temperature), weak effect (SFS-1, SFS-2) and moderate effect (DFS-2) predicted. Higher temperature results in lower max DO concentration, plus possible higher metabolism hence lower minima. Water temperature is expected to increase leading to possible DO decrease with summer low flow conditions (i.e., lower velocity and increased warming leads to lower DO). Probably buffered by cooler starting temp in forested sites and likely higher reaeration rates due to stream type (smaller, higher gradient, unmodified). The only potential difference between EF and IF sites for DO is that there may be a bigger effect after logging cycle. however, long-term monitoring in the Coromandel (NIWA unpublished data) showed no effects on DO through the logging cycle. Slash can create oxygen demand, but also provides shading in logged areas. Change to DO considered negligible for EF and IF classes. **Effect** As the degree of change is negligible, the effect is also negligible. **Confidence** Low confidence in climate model. Low confidence because sediment could deleterious effect DO through anaerobic pathways.
Mitigation (GMP)	V_LG_EF	A (A-B)	0	0	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	A (A-B)	0	0	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	B (A-C)	-1	0	1	N	**Degree of Change** Moderate degradation in temperature and small detectable effect on higher order attributes predicted. Moderate negative effect predicted for DFS-2 class, and weak effect for classes SFS-1 and SFS-2. Water temperature increase likely coupled with summer lower flow, decreased velocity, increased productivity; likely to negatively impact DO levels, although band change possible due to lack of re-aeration. Extent of Climate Change by 2040 unlikely to cause dramatic shift in DO dynamics but may impact some reaches due to more exposed topography. Low flow low order streams may be more so affected. Could affect nutrient cycling but only slightly. Overall, small detectable change possible due to effect of increased sediment on productivity and respiration. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Low confidence because unsure of influence of the magnitude of sediment change.
Mitigation (GMP)	V_LG_P	B (A-C)	1	0	1	N	**Degree of Change** Primary drivers of productivity that effect DO include light, temperature, DIN (and coarse substrate and frequency of floods (FRE2) specifically for periphyton). No improvement or effects predicted for lower order attributes except for suspended sediment. Overall, it is estimated about 22% of stream length in this class is riparian planted under GMP. Increased shading likely to result in decrease in temperature, coupled with decreased productivity (due to temperature and solar radiation), and decreased sediment oxygen demand results improvement in DO. Unlikely to result in band change due to velocity and re-aeration. GMP may reduce stream productivity slightly but impacts on DO dynamics are likely to be very minor and may be difficult to detect. Positive changes to temperature predicted, while effects from lower order attributes were predicted to be 0, the collective impact of these improvements could have a

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							cumulative benefit. If there was to be any class that would improve from GMPs, it would be the lowland pasture streams that are captured in this class. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Relying on cumulative effects across multiple lower order attributes as none specifically had significant effect alone.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	B (A-C)	0	0	1	N	**Degree of Change** GMP helps moderate Climate Change effects and net benefits from GMPs would be expected. Some reaches would have stronger net benefit of GMP, but overall, unlikely to be detectable. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low because of cumulative effects of lower order attributes and uncertainty around Climate Change.
Climate Change (RCP4.5)	V_LG_PI	B (A-D)	-1	0	1	N	**Degree of Change** Moderate degradation in temperature and small detectable effect on higher order attributes predicted. Moderate negative effect predicted for deposited sediment DFS-2 class, and weak effect for SFS-1, SFS-2. Water temperature increase likely coupled with summer lower flow, decreased velocity, increased productivity; likely to negatively impact DO levels. Extent of Climate Change by 2040 unlikely to cause dramatic shift in DO dynamics but may impact some stream reaches where there is more exposed topography. Low flow low order streams may be more so affected. Could affect nutrient cycling but only slightly. Overall, small detectable change possible due to effect of increased sediment and water temperature on productivity and respiration. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Low confidence because unsure of influence of the magnitude of sediment change.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	V_LG_PI	B (A-D)	1	0	1	N	**Degree of Change** Primary drivers of productivity that effect DO include light, temperature, DIN (and coarse substrate and frequency of floods (FRE2) specifically for periphyton). Small detectable improvement in DIN and temperature predicted and a detectable effect for DIN. Small change and effect predicted for SFS (visual clarity); flow difficult to factor in. Overall, it is estimated about 28% of stream length in this class is riparian planted under GMP. Increased shading likely to result in decrease in water temperature. Coupled with decreased productivity (due to temperature and solar radiation) and decreased sediment oxygen demand results improvement in DO. GMP may reduce stream productivity slightly, impacts on DO dynamics are unlikely to be dramatic but could well be detectable. Greater change expected in this class compared to V-HG-P, but not expected to shift to the A band. Regional split noted in this class, pumice based and lowland drains. **Effect** A small detectable change unlikely to have effects on higher order attributes without a state change. **Confidence** Low confidence due to regional variation in class and uncertainty associated with detectable change.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	B (A-D)	0	0	1	N	**Degree of Change** Any detectable change due to climate effects mitigated by best management practice. Noting very different stream types, groundwater-dominated around Pongakawa and Rerewhakaitu, compared to rain dominated in the western bay. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Low confidence in climate change and GMP scenarios carries over.
Climate Change (RCP4.5)	Urban	C (A-D)	-1	-1	1	?	**Degree of Change** Small detectable degradation in temperature and detectable effect on higher order attributes predicted. Weak negative effect predicted for deposited and suspended sediment. Increased water temperature coupled with increased productivity and biological oxygen demand, so a detectable degradation is expected. Overall small detectable change possible if temperature and sediment drive DO in Urban class. Could be sufficient to move many sites below bottom line, but less confident in this than small

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							change without a band shift. Some urban streams are well shaded, some are not. Diverse spread within this class. **Effect** Current state is in the C band and further degradation will place additional stress on already stressed on organisms. Starting to shift more from long-term sublethal chronic effects to short-term acute effects. Temperature can increase 5°C -8°C with rainfall events in Hamilton streams and similar results in Auckland, resulting in rapid pulse effect. BOP urban streams are generally more shaded than Auckland and Hamilton urban streams, so small negative effect anticipated. **Confidence** Low confidence because unsure of influence of the multiple potential stressors and influencing mechanisms on DO.
Mitigation (GMP)	Urban	C (A-D)	0	0	2	N	**Degree of Change** Some positive offsetting benefits from GMP would be expected in P and PI classes, and in urban to the extent P and PI occur in the urban class. GMP estimates of ~10% or less for nutrients (due to other upstream land uses). It is estimated only about 7% of stream length in this class is riparian planted under GMP. Any effects are likely to be very minor and so unlikely to observe a strong in-stream response. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** Moderate confidence based on limited GMP in class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	C (A-D)	-1	-1	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Ecosystem Metabolism (EM)

Bay of Plenty Regional Council has no monitoring data available for ecosystem metabolism (EM). The Expert Panel did not feel they had sufficient information to be able to estimate Current State for EM and therefore could not undertake scenario assessments for this attribute. Instead, the Expert Panel recommended BOPRC commence data collection of EM data (which all Regional Councils and Unitary Authorities need to do as part of NPSFM implementation) to enable attribute state bands to be developed and allow assessment of current state in future.

Macroinvertebrate Community Index (MCI) and Quantitative MCI (QMCI)

Within New Zealand, the Macroinvertebrate Community Index (MCI) is widely used as a biotic index of water quality in streams (Stark, 1985, 1993; Stark and Maxted 2007). MCI scores can range from 20 to 200. Scores > 130 represent streams in “excellent” condition, while scores < 90 indicate highly degraded streams (NPSFM 2020). The MCI score relies on the presence or absence of invertebrate taxa in a stream and so provides only a relatively coarse indication of stream health. It is not sensitive to changes in the relative abundance of different taxa, which is arguably one of the first signs that a particular system is under stress. Because of this, the quantitative variant of the MCI (i.e., the QMCI) is also used to describe the health of a particular waterway. This score takes the relative abundance of each taxon into consideration. Calculated QMCI scores range from 1 to 10. Streams with scores > 6.5 represent streams in excellent condition, and streams with scores < 4.5 represent highly degraded streams (NPS-FM 2020). MCI and QMCI were assessed separately, however the Expert Panel noted that the overall state based on Table 14 in the NPSFM is assigned as the lower of the two metrics.

MCI values are driven by a combination of land use and environmental variability described in part by Tier 1, 2 and 3 attributes: nutrient toxicity (habitat/mortality), nutrients (food/growth), water temperature (growth/habitat/mortality), sediment (habitat), periphyton (habitat/food), DO (habitat/mortality), fish (mortality). These do not account for any hydrological effects. If changes were to be observed, it was commonly noted that the QMCI would respond first because the abundance of specific taxa are affected before presence/absence of a species (the latter being required for changes in MCI).

The Expert Panel also thought it important to highlight that any mitigation would be expected to have a positive effect. Some monitoring data where current riparian planting has occurred have shown negative trends (A. Suren pers comms.), but it is recognised that this has been ‘mosaic’ planting in a catchment with a mix of temporal and spatial scales which makes it hard to detect improvements. There are also expected to be lags in response from GMP efforts. Ultimately, as discussed in above, the communication of GMP outcomes is challenging and it is important to highlight that there are large benefits to undertaking GMP efforts on a large scale. If anything, GMPs would be required to happen on a larger scale for measurable improvements to be observed.

The assessments in Table 42 should be read in conjunction with the discussions above and in section 2.6.2.

Table 42 Panel Summary for Scenario assessment of macroinvertebrate community index (MCI). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	B (A-C)	-1	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase slightly, but with no effect on higher order attributes predicted. Sediment deposition (DFS) is predicted to increase with effects on higher order attributes in this area which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. Some research indicated potentially strong response (Piggott *et al.,* 2012) to sediment in various invertebrate metrics. This area to the east has high sediment loading and big increases under climate change. The invertebrate communities in some of these sites are in excellent condition, so there is potential for taxa sensitive to sediment to be impacted. Long term datasets in natural state sites from around the country are already seeing some degradation, which may reflect a Climate Change signal. Sediment changes drive the negative effect here, but cumulative effects from temperature and flow changes also contribute. This change could be a 0, as MCI requires a loss of species to cause a change. However, on balance a -1 is probably appropriate. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_IF	B (A-C)	0	N/A	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	B (A-C)	-1	NA	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover. class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	B (A-C)	-1	N/A	1		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase slightly, with a predicted small effect on higher order attributes. Sediment deposition is predicted to increase with effects on higher order attributes also predicted, which may place invertebrates under stress. Sediment stress is more likely than thermal stress. However, there is unlikely to be a loss of species from a stream, which is needed to cause a change in MCI. The relatively high diversity and condition of some of these streams may make them sensitive to relatively small changes. The distribution and modelled sediment response of this class is more variable than NV-IF. Overall, a negative direction that could be detectable in MCI due to sediment induced habitat changes is predicted. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_EF	B (A-C)	0	N/A	3		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	B (A-C)	-1	NA	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	C (B-D)	-1	N/A	1	N?	**Degree of Change** For P and PI classes negative effects on periphyton and subsequently MCI can come from negative effects of DIN, DO and water temperature. Negative effects on MCI directly from SFS and DFS. Temperature, SFS and DFS all have weak to moderate negative effects predicted on higher order attributes. One of the challenges of this class is the distribution across the region. Some sites are hard-bottomed and some are soft-bottomed, making it hard to land one single assessment. Some streams in the Rangitāiki FMU may not respond to climate change, as they are already fairly impacted. The median is very close to bottom line for monitored sites, so some sites could move to below the bottom line because of this. With four key drivers showing change and effect, the cumulative effect of all these drivers adds up. Overall, small detectable degradation in MCI predicted, noting the regional split and that some sites could shift band to below bottom line. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate and SedNetNZ models, complex response including unknown resilience on communities in an already erosion prone environment, high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_P	C (B-D)	0	N/A	1	No	**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS generally. So, temperature is generally the main driver, as well as the response

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							to riparian planting. It is estimated about 16% of stream length in this class is riparian planted under GMP. However, the effect of temperature is a less than that of sediment drivers. No effect of GMP predicted for lower order attributes except weak positive effect for DFS-4 in this class. Non-temperature effects of riparian vegetation (about 16% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to offer minimal improvement. Expect slight positive improvement, but probably not detectable. **Effect** N/A **Confidence** Low confidence reflects sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	C (B-D)	-1	NA	1	N?	**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	NV_PI	C (B-D)	-1	N/A	1	N	**Degree of Change** For P and PI classes negative effects on macroinvertebrates can come from negative effects of DIN, DO and water temperature, either directly or via excess plant growth. Negative effects on MCI directly from SFS and DFS. Temperature, SFS and DFS all have weak to moderate negative effects predicted on higher order attributes. In combination with possible reduced summer flows associated with Climate Change, there may be possible measurable declines in MCI scores due to cumulative effects. Although instream conditions may change (slightly) on the 2040 horizon, this class is already quite impacted

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							(mid-C). The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). There may be strong sediment drivers in this region which may worsen under climate change and could interact with temperature effects. Many of these streams are soft-bottomed, so a deterioration in SFS and DFS is unlikely to result in the loss of species from a stream. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes bottom line. **Effect** N/A **Confidence** Potential unknown resilience on communities in an already erosion prone environment. Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_PI	C (B-D)	1	N/A	1	N	**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was thus identified as the main driver, as well as the response to riparian planting. However, the effect of water temperature is less than that of sediment drivers. A third of reaches are subject to GMP, with around 40% of these under riparian management. Overall, it is estimated about 24% of stream length in this class is riparian planted under GMP. Some thermal relief is expected from riparian management, coupled with sediment and nutrient gains mean that it is likely there would be a small improvement in MCI scores. In particular, positive benefits (reductions) were predicted for DIN but in the BOP region these are not expected to reduce periphyton biomass to an extent that it would dominate the adverse effects of sediment on MCI. Invertebrates are generally not sensitive to nutrients, but more so to temperature and DFS. Reduced temperatures likely to be beneficial for EPT taxa, but habitat drivers and physical modification of PI streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. The current state for DFS is poor, with GMP expected to offer some improvement. Expect slight positive improvement, but not sufficient for state change. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	C (B-D)	-1	NA	1	N	**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects
Climate Change (RCP4.5)	V_HG_IF	B (A-D)	0	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase slightly, but with no predicted effect on higher order attributes. Sediment deposition is also predicted to increase in this area, with subsequent effects on higher order attributes, which will place organisms under stress. However, this is unlikely to result in the loss of species from a stream, which is needed to cause a change in MCI. The class is well sampled and sits mid-B band, so a change in state is unlikely due to climate alone. This class is a pumice-based system, so not as much sediment predicted as there was for NV-IF class. Overall, MCI scores could decline slightly, but this would not be detectable. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_IF	B (A-D)	0	N/A	3		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	B (A-D)	0	NA	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	B (A-D)	0	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition (DFS) is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress, rather than thermal stress, is likely to be the larger driver due to sediment induced habitat changes. However, these streams are mostly in D band for sediment attributes already, so there could potentially be no detectable change in MCI scores. Although there is a predicted increase in SFS and DFS, most of these sites are soft-bottomed due to pumice dominated landscape, so the invertebrate community is likely to be tolerant of soft-bottomed habitat. This class is also dominated by spring fed systems which will exhibit less temperature stress. Overall, a negative direction likely, but not detectable in the MCI. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_EF	B (A-D)	0	N/A	3		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	B (A-D)	0	N/A	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	B (B-D)	-1	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase slightly, with predicted weak effects on higher order attributes such as the MCI. Negative effects on macroinvertebrates directly from SFS and DFS in combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Sites in this class are a mix of hard-bottomed and soft-bottomed. Increased SFS may affect invertebrates slightly in terms of overall species composition, so a small change in macroinvertebrate community may arise. Potential for maximum temperatures to get into ranges that can induce stress, but unlikely to reach temperature bottom lines (as indicated by the CRI). Potential DO and metabolism negative effects. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	V_HG_P	B (B-D)	0	N/A	1	N	**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 22% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP is predicted for lower order attributes except for a weak positive effect for the DFS4 in this class. Non-temperature effects of riparian vegetation (about 22% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. The DFS current state is poor, with GMP expected to offer minimal improvement. Expect slight positive improvement, but probably not detectable. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	B (B-D)	-1	N/A	1	N	**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_HG_PI	B (B-D)	-1	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted weak effects on higher order attributes. Negative effects on macroinvertebrates directly from SFS and DFS in combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Sites in this class are a mix of hard-bottomed and soft-bottomed. Increased SFS may affect invertebrates slightly in terms of overall

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							species composition, so a small change in macroinvertebrate community may result. Potential for maximum temperatures to get into ranges that can induce stress but unlikely to reach temperature bottom lines (as indicated by the CRI). Potential DO and metabolism negative effects. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_PI	B (B-D)	1	N/A	1	N	**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 27% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. GMP estimates are substantial at around 10%-20% for nutrients, more for sediment. Non-temperature effects of riparian vegetation (about 27% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Most streams are soft-bottomed, so any benefits of GMPs in reducing DIN and sediment are unlikely to have any strong effects. Some thermal relief form riparian management, coupled with sediment and nutrient gains likely to see improvement but may not result in band change. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) +	V_HG_PI	B (B-D)	0	N/A	1	N	**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)							counter each other but need to determine the magnitude of effect in each case. In this class, expect that while climate change would dominate, they would more or less counter each other. Therefore, assessment of 0 change noting that the direction is likely negative. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_LG_IF	B (A-C)	0	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress, rather than thermal stress is likely to be the larger driver. However, this is unlikely to result in the loss of species from a stream, which is needed to cause a change in MCI. A very variable class, but with a few very high quality monitored sites which may be quite sensitive to Climate Change. So, any effect may be greatest on range/distribution rather than overall state, which will probably remain unchanged (at 2040). Overall, a negative direction likely, but not detectable. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_IF	B (A-C)	0	N/A	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	B (A-C)	0	N/A	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	B (A-C)	0	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is unlikely to result in the loss of species from a stream, which is needed to cause a change in MCI. Although, the relatively high diversity and condition of some of these streams may make them sensitive to relatively small changes. These streams are mostly all soft-bottomed and pumice based, so any increases in DFS would not be expected to shift MCI scores. Furthermore, most streams are in low gradient land, so direct runoff of sediments is not likely to be very high, especially given the porous nature of the soil. Overall, negative direction in MCI likely due to sediment induced habitat changes but as streams are mostly in D band already for sediment, no detectable change in MCI. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_EF	B (A-C)	0	N/A	3	N	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	B (A-C)	0	N/A	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	C (B-D)	-1	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted effects on higher order attributes. Negative effects on macroinvertebrates directly from temperature, SFS and DFS. This class sits high in the C band, so unlikely to have sufficient degradation to change state. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). These are a mix of hard-bottomed and soft-bottomed systems, as well as some strongly lake fed (Kaituna River) or groundwater fed systems. As such, temperature effects may not be as noticeable. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes, existing stressors being exacerbated and little buffering of impacts. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_P	C (B-D)	0	N/A	1	N	**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 22% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							lower order attributes except weak positive effect for SFS in this class. Non-temperature effects of riparian vegetation (about 22% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Streams in this class are approximately 50/50 hard-bottomed and soft-bottomed. GMPs will only have a beneficial effect on SFS and DFS in hard-bottomed streams. There is also less GMP in this class compared to others, so overall, no detectable change predicted in MCI. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	C (B-D)	-1	N/A	1	N	**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_LG_PI	C (B-D)	-1	N/A	1	N	**Degree of Change** Toxicity attributes are not expected to change. Negative effects on macroinvertebrates directly from predicted increases in temperature, SFS and DFS under climate change. This class sits high in C band, so unlikely to have sufficient degradation to change state. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). Most of these reaches are soft-bottomed systems, so unlikely that MCI scores will change significantly. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes, existing stressors being exacerbated and little buffering of impacts.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_PI	C (B-D)	1	N/A	1	N	**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 28% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. Weak positive effects from reductions in nitrate-N, ammonia-N, DIN, and SFS, resulting in more potential effects from lower order attributes than in other classes. Non-temperature effects of riparian vegetation (about 28% of class) will also have weak positive effect. Habitat drivers and physical modification of PI streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Streams in this class are soft-bottomed, pumiced based systems. GMP benefits will be constrained by this. Overall, the cumulative effects from multiple different pathways are likely to result in some detectable improvements. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	C (B-D)	0	N/A	1	N	**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect that the two scenarios will cancel each other out (although noting that Climate Change would likely be the slightly stronger driver and so although no detectable change predicted, the direction would likely be negative).

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	Urban	C (B-D)	-1	N/A	1	?	**Degree of Change** Toxicity attributes are not expected to change. Negative effects on macroinvertebrates directly from expected increases in water temperature, SFS and DFS. This class is already highly impacted and near the bottom line. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers), but there could still be a shift to below bottom line given it is currently in the C band. Some urban streams are unshaded, so temperature effects could be more pronounced. However, other urban streams are well shaded, so temperature increases are moderated in these areas. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes, existing stressors being exacerbated and little buffering of impacts. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	Urban	C (B-D)	0	N/A	2	N	**Degree of Change** Approximately 7% of reaches subject to riparian planting GMPs, mostly in upper catchment areas. Therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	C (B-D)	-1	N/A	1	N	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/land cover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Table 43 Panel Summary for Scenario assessment of Quantitative Macroinvertebrate Community Index (QMCI). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
Climate Change (RCP4.5)	NV_IF	B (A-D)	-1	N/A	1	N		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition (DFS) is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. Some research indicated potentially strong response (Piggott *et al.*, 2012) to sediment in various invert metrics. This area to the east has high sediment loading and big increases under climate change. Some of the sites are very high quality so potential for sensitive taxa to be impacted. Long term datasets in natural state from around the country are already seeing degradation, which can only be from Climate Change. Sediment changes drive the negative effect here, but cumulative effects from temperature and flow changes also contribute. More likely to detect change in QMCI compared to MCI and ASPM, but the level of change is unlikely to cause a band shift overall. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
Mitigation (GMP)	NV_IF	B (A-D)	0	N/A	3	N		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2 **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	B (A-D)	-1	N/A	1	N		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	C (A-D)	-1	N/A	1	N		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is unlikely to result in the loss of species from a stream but could affect abundance. The relatively high diversity and condition of some of these streams may make them sensitive to relatively small changes. The distribution and modelled sediment response of this class is more variable than NV-IF. QMCI metric is more sensitive than MCI, so overall, a negative direction that is more likely detectable (than for MCI) is expected. **Effect** N/A

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Confidence Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_EF	C (A-D)	0	N/A	3	N		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	C (A-D)	-1	N/A	1	N		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	D (B-D)	-1	N/A	1	Yes		**Degree of Change** For P and PI classes negative effects on periphyton and subsequently macroinvertebrates can come from small negative effects on DIN, DO and water temperature. Negative effects on QMCI directly from SFS and DFS. The distribution of this class across the region means that some sites are hard bottomed and some are soft bottomed, making it hard to land one single assessment. Rangitāiki streams may not respond as they are already fairly impacted. A negative direction of change is predicted, but as current state is already below bottom line, only a maximum of -1 is possible for this assessment. So, while QMCI may show more change in its metric compared to MCI (as it is more sensitive), the band cannot shift any further.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Effect N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_P	D (B-D)	1	N/A	1	Y		**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 16% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for lower tier attributes except weak positive effect for DFS-4 in this class. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to offer minimal improvement. As QMCI is more sensitive than MCI, a detectable small improvement is possible. **Effect** N/A **Confidence** Low confidence reflects sites not being necessarily representative, complex response, high variability in state and how cumulative effects might eventuate.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	D (B-D)	0	N/A	1	Y		**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to be more dominant, but GMP would somewhat counteract. **Effect**

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	NV_PI	D (B-D)	-1	N/A	1	Yes		**Degree of Change** For P and PI classes negative effects on periphyton and subsequently macroinvertebrates can come from negative effects of DIN, DO and water temperature. Negative effects on MCI directly from SFS and DFS. Temperature, SFS and DFS all have weak to moderate negative effects predicted on higher order attributes. In combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Although instream conditions may change (slightly) by 2040, this class is already quite impacted (mid-C). The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). There may be strong sediment drivers in this region which may worsen under climate change and could interact with temperature effects. Many of these streams are soft-bottomed, so a deterioration in SFS and DFS is unlikely to result in the loss of species from a stream. QMCI is already in the D band, so overall, while QMCI is more sensitive than MCI, a detectable change that can only be -1 **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_PI	D (B-D)	1	N/A	1	Y		**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main driver, as well as the response to riparian planting. It is estimated about 24% of stream length in this class is riparian planted under GMP. However, the effect of water temperature is less than that of sediment drivers. Some thermal relief from riparian management,

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								coupled with sediment and nutrient gains likely to see improvement. In particular, positive benefits (reductions) were predicted for DIN, but in the BOP region this is not expected to reduce periphyton biomass to an extent that it would dominate the adverse effects of sediment on QMCI. Invertebrates are generally not sensitive to nutrients, but more so to temperature and DFS. Reduced temperature is likely to be beneficial for EPT taxa, but habitat drivers and physical modification of PI streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to offer some improvement. Expect slight positive improvement, but not sufficient for state change. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	D (B-D)	-1	N/A	1	Y		**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects
Climate Change (RCP4.5)	V_HG_IF	C (A-D)	-1	N/A	1	N		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								the larger driver. Class is well sampled and sits mid-B band therefore a change in state is unlikely due to climate alone. This class is dominated by pumice based streams, so not as much sediment predicted as there was for NV-IF class. A small increase in DFS and SFS may have a slight effect on species relative abundance, therefore the QMCI may change sightly. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_IF	C (A-D)	0	N/A	3	N		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	C (A-D)	-1	N/A	1	N		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
Climate Change (RCP4.5)	V_HG_EF	D (A-D)	-1	N/A	1	Y		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but with no predicted effects on higher order attributes. Sediment deposition (DFS) is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver due to sediment induced habitat changes but streams mostly in D band for sediment attributes already. Although there is a predicted increase in SFS and DFS, most of these sites are soft-bottomed due to pumice dominated landscape, so the invertebrate community is likely to be tolerant of soft-bottomed habitat. This class is also dominated by spring fed systems which will exhibit less temperature stress from climate change. Overall, a negative direction likely, that may affect abundance of taxa and therefore a small detectable change in QMCI predicted. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_EF	D (A-D)	0	N/A	3			**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	D (A-D)	-1	N/A	1	?		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								<u>Confidence</u> Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	C (A-D)	-1	N/A	1	N		**<u>Degree of Change</u>** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted weak effects on higher order attributes. Negative effects on macroinvertebrate directly from SFS and DFS in combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Sites in this class are a mix of hard-bottomed and soft-bottomed. Increased SFS may affect invertebrates slightly in terms of overall species composition, so a small change in macroinvertebrate community may arise. Potential for maximum temperatures to get into ranges that can induce stress but unlikely to meet CRI bottom lines. Potential DO and metabolism negative effects. Overall, small detectable degradation in QMCI likely due to sediment induced changes to abundance of taxa. **<u>Effect</u>** N/A **<u>Confidence</u>** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_P	C (A-D)	1	N/A	1	N		**<u>Degree of Change</u>** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have as much impact on DFS. Temperature was thus regarded as the main driver, as well as responding to riparian planting. It is estimated about 22% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for lower tier attributes except weak positive effect for DFS-4 in this class. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								offer minimal improvement. Expect slight positive improvement, due to potential changes in abundance leading to a change in QMCI. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	C (A-D)	-1	N/A	1	N		**Degree of Change** Some mitigation of sediment and temp/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e. increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_HG_PI	C (A-D)	-1	N/A	1	N		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted weak effects on higher order attributes. Negative effects on macroinvertebrate directly from SFS and DFS in combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Sites in this class are a mix of hard-bottomed and soft-bottomed. Increased SFS may affect invertebrates slightly in terms of overall species composition, so may get a small change in macroinvertebrate community. Potential for maximum temperatures to get into ranges that can induce stress but unlikely to meet CRI bottom lines. Potential DO and metabolism negative effects. Overall, small detectable degradation in QMCI likely due to sediment induced changes to abundance of taxa.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Effect N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_PI	C (A-D)	1	N/A	1	N		**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main driver, as well as the response to riparian planting. It is estimated about 27% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. GMP estimates are substantial at around 10-20% for nutrients, more for sediment. Non-temperature effects of riparian vegetation (about 27% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Most streams are soft-bottomed, so any benefits of GMPs in reducing DIN and sediment are unlikely to have any strong effects. Some thermal relief form riparian management, coupled with sediment and nutrient gains likely to see improvement but may not result in band change. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	C (A-D)	0	N/A	1	N		**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								magnitude of effect in each case. In this class, expect that while climate change would dominate, they would more or less counter each other. Therefore, assessment of 0 change noting that the direction is likely negative. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects
Climate Change (RCP4.5)	V_LG_IF	C (A-D)	-1	N/A	1	N		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is a very variable class, but with a few very high quality monitored sites which may be quite sensitive to climate change. So, effect may be greatest on range/distribution rather than overall state. QMCI is a more sensitive metric than MCI and there is potential for effects on abundance. Overall, a small negative change likely for QMCI. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_IF	C (A-D)	0	N/A	3	N		**Degree of Change** <5% land cover subject to GMPs, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Confidence As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	C (A-D)	-1	N/A	1	N		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	C (B-D)	-1	N/A	1	N		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is unlikely to result in the loss of species from a stream but could affect abundance and the relatively high diversity and condition of some of these streams may make them sensitive to relatively small changes. Although, these streams are mostly all soft-bottomed and pumice based, so any increases in DFS would not be expected to cause dramatic shifts. Furthermore, most streams are in low gradient land, so direct runoff of sediments is not likely to be very high, especially given the porous nature of the soil. QMCI is a more sensitive metric than MCI. Overall, negative direction in QMCI likely due to sediment induced habitat changes that could be detectable in QMCI due to effects on abundance. **Effect** N/A

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Confidence Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_EF	C (B-D)	0	N/A	3	N		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	C (B-D)	-1	N/A	1	N		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	C (B-D)	-1	N/A	1	?		**Degree of Change** Negative effects on macroinvertebrates directly from temperature, SFS and DFS. This class sits high in C band, so unlikely to have sufficient degradation to change state. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). These are a mix of hard-bottomed and soft-bottomed systems, as well as some strongly lake fed (Kaituna River) or groundwater fed systems. As such, temperature effects may not be as noticeable. While QMCI is more sensitive than MCI, it is unlikely that a band change would occur due to the class sitting high in the C band. **Effect** N/A

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Confidence Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_P	C (B-D)	0	N/A	1	N		**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main driver, as well as the response to riparian planting. It is estimated about 22% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for lower tier attributes except weak positive effect for SFS in this class. Non-temperature effects of riparian vegetation (about 22% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Streams in this class are approximately 50/50 hard-bottomed and soft-bottomed. GMPs will only have a beneficial effect on SFS and DFS in hard-bottomed streams. There is also less GMP in this class compared to others, so overall, no detectable change predicted in QMCI. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	C (B-D)	-1	N/A	1	N		**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment.

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								Effect N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_LG_PI	D (B-D)	-1	N/A	1	?		**Degree of Change** Negative effects on macroinvertebrates directly from predicted increases in temperature, SFS and DFS. This class is already a D band, so can only have a -1 for degree of change. Species that are present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). Most of these reaches are soft-bottomed systems, so unlikely that QMCI scores will change significantly. Overall, detectable degradation in QMCI possible due to sediment induced habitat changes and existing stressors being exacerbated and little buffering of impacts. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_PI	D (B-D)	1	N/A	1	N		**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 28% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. Weak positive effects from reductions in nitrate-N, ammonia-N, DIN, and SFS, resulting in more potential effects from lower order attributes than in other classes. Non-temperature effects of riparian vegetation (about 28% of class) will also have weak positive effect. Habitat drivers and physical modification of PI streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Streams in this class are soft-bottomed, pumiced based

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								systems. GMP benefits will be constrained by this. Overall, the cumulative effects from multiple different pathways are likely to result in some detectable improvements. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	D (B-D)	0	N/A	1	?		**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect that the two scenarios will cancel each other out. However, noting that climate change would likely be the slightly stronger driver and so although no detectable change predicted, the direction would likely be negative. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	Urban	D (C-D)	-1	N/A	1	Y		**Degree of Change** Negative effects on macroinvertebrates directly from expected increases in water temperature, SFS and DFS. This class is already highly impacted and near the bottom line. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers), but there could still be a shift to below bottom line given it is currently in the C band. Many urban streams are quite exposed, so temperature effects could be more pronounced. But in Tauranga and Rotorua, many urban streams are well covered, so temperature increases are moderated in these

Scenario	Spatial Classification	Current State (EP Estimate)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main drivers	Justification
								areas. Change in QMCI would be greater than for MCI, but current state is already in the D band so change can only be a -1. Overall, detectable degradation in QMCI due to sediment induced habitat changes and existing stressors being exacerbated and little buffering of impacts. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	Urban	D (C-D)	0	N/A	2	Y		**Degree of Change** Approximately 7% of reaches subject to riparian planting GMPs, mostly in upper catchment areas. Therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	D (C-D)	-1	N/A	1	Y		**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Macroinvertebrates Average Score Per Metric (ASPM)

The Average Score Per Metric (ASPM, Collier 2008), which is a combination of the MCI, the richness of ‘pollution sensitive’ Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, and the percentage of EPT individuals present (%EPT abundance). Hydroptilidae caddisflies are excluded from the EPT counts, as these taxa are often very common in degraded streams and consume filamentous green algae which is often associated with high nutrient waters. Once these three metrics are calculated at each site, they are normalised with the following maxima: MCI (200), %EPT abundance (100), EPT richness (29). The normalised scores are then summed to derive the overall ASPM score.

Assessments for ASPM were more often similar to that of the QMCI rather than the MCI due to the incorporation of species abundance. As for MCI and QMCI, the benefits of GMPs requires careful communication. The assessments in Table 44 should be read in conjunction with the discussions here and in section 2.6.2.

Table 44 Panel Summary for Scenario assessment of macroinvertebrate Average Score Per Metric (ASPM). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
Climate Change (RCP4.5)	NV_IF	B (A-D)	-1	N/A	1	No		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected but without predicted effects on higher order attributes. Sediment deposition (DFS) is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. Some research indicated potentially strong response (Piggott *et al.,* 2012) to sediment in various invertebrate metrics. This area to the east has high sediment loading and big increases under climate change. Some of the sites are very high quality so potential for sensitive taxa to be impacted. Long term datasets in natural state from around the country are already seeing degradation, which can only be from Climate Change. Sediment changes drive the negative effect here, but cumulative effects from temperature and flow changes also contribute. ASPM is more sensitive to EPT taxa effects compared to MCI, but the level of change is unlikely to cause a band shift. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_IF	B (A-D)	0		3			**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	B (A-D)	-1		1			**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	B (A-D)	-1		1	No		**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is unlikely to result in the loss of species from a stream but could affect abundance. The relatively high diversity and condition of some of these streams may make them sensitive to relatively small changes. The distribution and modelled sediment response of this class is more variable than NV-IF. ASPM metric is slightly more sensitive than MCI, so overall, a negative direction that is more likely detectable (than for MCI) is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_EF	B (A-D)	0		3	No		**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								Confidence As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF Tier 3	B (A-D)	-1		1			**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	D (B-D)	-1		1			**Degree of Change** For P and PI classes negative effects on periphyton and subsequently MCI can come from negative effects of DIN, DO and water temperature. Negative effects on MCI directly from SFS and DFS. Temperature, SFS and DFS all have weak to moderate negative effects predicted on higher order attributes. The distribution of this class across the region means that some sites are hard bottomed and some soft bottomed, making it hard to land one single assessment. Rangitāiki streams may not respond as they are already fairly impacted. A negative direction of change is predicted, but as current state is already below bottom line, only a maximum of -1 is possible for this assessment. So, while ASPM may show more change in its metric compared to MCI (as it is more sensitive), the band cannot shift any further. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_P	D (B-D)	1	N/A	1			**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								driver, as well as the response to riparian planting. It is estimated about 16% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for lower tier attributes except weak positive effect for DFS-4 in this class. Non-temperature effects of riparian vegetation GMP (applied to about 16%of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to offer minimal improvement. As ASPM is slightly more sensitive than MCI, a detectable small improvement is possible. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	D (B-D)	-1	N/A	1			**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
Climate Change (RCP4.5)	NV_PI	C (B-D)	-1		1			**Degree of Change** For P and PI classes negative effects on periphyton and subsequently macroinvertebrates can come from negative effects of DIN, DO and water temperature. Negative effects on MCI directly from SFS and DFS. Temperature, SFS and DFS all have weak to moderate negative effects predicted on higher order attributes. In combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Although instream conditions may change (slightly) on the 2040 horizon, this class is already quite impacted (mid-C). The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). There may be strong sediment drivers in this region which may worsen under climate change and could interact with temperature effects. Many of these streams are soft-bottomed, so a deterioration in SFS and DFS is unlikely to result in the loss of species from a stream. ASPM is close to the C/D border at the assessed current state. So, there is the potential for a band shift. Assessed as a -1, recognising that there is the potential for a band shift given the proximity to the C/D threshold. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	NV_PI	C (B-D)	1		1			**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main driver, as well as the response to riparian planting. It is estimated about 24% of stream length in this class is riparian planted under GMP. However, the effect of water temperature is less than that of sediment drivers. Some thermal relief from riparian management, coupled with sediment and nutrient gains means that it is likely to see improvement. In particular, positive benefits (reductions) were predicted for DIN, but in BOP these are not expected to reduce periphyton biomass to an extent that it would dominate the adverse effects of sediment on ASPM. Invertebrates are generally not that sensitive to nutrients, more so to temperature and DFS. Reduced

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								temperatures likely to be beneficial for EPT taxa, but habitat drivers and physical modification of PI streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to offer some improvement. Expect slight positive improvement, but not sufficient for state change. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	C (B-D)	-1		1			**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_HG_IF	B (A-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is unlikely to result in the loss of species from a stream, which is needed to cause a change in MCI. Class is well sampled and

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								sits mid-B band therefore a change in state is unlikely due to climate alone. This class is a pumice-based system, so not as much sediment predicted as there was for NV-IF class. A small increase in DFS and SFS may have a slight effect on species relative abundance, therefore the ASPM may change sightly. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_IF	B (A-D)	0		3			**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	B (A-D)	-1		1			**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	B (A-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition (DFS) is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								thermal likely to be the larger driver due to sediment induced habitat changes but streams mostly in D band for sediment attributes already. Although there is a predicted increase in SFS and DFS, most of these sites are soft-bottomed due to pumice dominated landscape, so the invertebrate community is likely to be tolerant of soft-bottomed habitat. This class is also dominated by spring fed systems which will exhibit less temperature stress from climate change. Overall, a negative direction likely, that may affect abundance of taxa and therefore a small detectable change in ASPM predicted. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_EF	B (A-D)	0		3			**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	B (A-D)	-1		1			**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
Climate Change (RCP4.5)	V_HG_P	B (A-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted weak effects on higher order attributes. Negative effects on macroinvertebrates directly from SFS and DFS in combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Sites in this class are a mix of hard-bottomed and soft-bottomed. Increased SFS may affect invertebrates slightly in terms of overall species composition, so a small change in macroinvertebrate community may arise. Potential for maximum temperatures to get into ranges that can induce stress but unlikely to meet CRI bottom lines. Potential DO and metabolism negative effects. Overall, small detectable degradation in ASPM likely due to sediment induced changes to abundance of taxa. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_P	B (A-D)	1	N/A	1			**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main driver, as well as the response to riparian planting. It is estimated about 22% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for lower tier attributes except weak positive effect for DFS-4 in this class. Non-temperature effects of riparian vegetation GMP (about 22% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. DFS current state is poor, with GMP expected to offer minimal improvement. Expect slight positive improvement, due to potential changes in abundance leading to a change in ASPM.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								Effect N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	B (A-D)	-1	N/A	1			**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_HG_PI	B (B-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted weak effects on higher order attributes. Negative effects on macroinvertebrates directly from SFS and DFS in combination with possible reduced summer flows associated with Climate Change, suspect possible measurable decline due to cumulative effects. Sites in this class are a mix of hard-bottomed and Soft-bottomed. Increased SFS may affect invertebrates slightly in terms of overall species composition, so a small change in macroinvertebrate community may result. Potential for maximum temperatures to get into ranges that can induce stress but unlikely to meet CRI bottom lines. Potential DO and metabolism negative effects. Overall, small detectable degradation in ASPM likely due to sediment induced changes to abundance of taxa.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								Effect N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_HG_PI	B (B-D)	1		1			**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't predicted to have much impact on DFS. Temperature was regarded as the main driver, as well as the response to riparian planting. It is estimated about 27% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. GMP estimates are substantial at around 10%-20% for nutrients, more for sediment. Non-temperature effects of riparian vegetation (about 27% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Most streams are soft-bottomed, so any benefits of GMPs in reducing DIN and sediment are unlikely to have any strong effects. Some thermal relief form riparian management, coupled with sediment and nutrient gains likely to see improvement but may not result in band change. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	B (B-D)	0		1			**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect that

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								while climate change would dominate, they would more or less counter each other. Therefore, assessment of 0 change noting that the direction is likely negative. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_LG_IF	B (A-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. A very variable class, but with a few very high quality monitored sites which may be quite sensitive to Climate change. So, effect may be greatest on range/distribution rather than overall state. ASPM is a more sensitive metric than MCI and there is potential for effects on abundance. Overall, a small negative change likely for ASPM. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_IF	B (A-D)	0		3			**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								<u>Confidence</u> As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	B (A-D)	-1		1			**<u>Degree of Change</u>** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **<u>Effect</u>** As per Climate Change assessment. **<u>Confidence</u>** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	B (A-D)	-1		1			**<u>Degree of Change</u>** Toxicity attributes are not expected to change but water temperature is expected to increase but without predicted effects on higher order attributes. Sediment deposition (DFS) is also predicted to increase in this area with effects on higher order attributes predicted, which will place organisms under stress. Sediment stress rather than thermal likely to be the larger driver. This is unlikely to result in the loss of species from a stream but could affect abundance and the relatively high diversity and condition of some of these streams may make them sensitive to relatively small changes. Although, these streams are mostly all soft-bottomed and pumice based, so any increases in DFS would not be expected to cause dramatic shifts. Furthermore, most streams are in low gradient land, so direct runoff of sediments is not likely to be very high, especially given the porous nature of the soil. ASPM is a slightly more sensitive metric than MCI. Overall, negative direction in ASPM likely due to sediment induced habitat changes that could be detectable in ASPM due to effects on abundance. **<u>Effect</u>** N/A **<u>Confidence</u>** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
Mitigation (GMP)	V_LG_EF	B (A-D)	0		3			**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the biophysical/landcover class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	B (A-D)	-1		1			**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	C (A-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change but water temperature is expected to increase with predicted effects on higher order attributes. Negative effects on macroinvertebrates directly from temperature, SFS and DFS. This class sits high in C band, so unlikely to have sufficient degradation to change state. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). These are a mix of hard-bottomed and soft-bottomed systems, as well as some strongly lake fed (Kaituna River) or groundwater fed systems. As such, temperature effects may not be as noticeable. While ASPM is more sensitive than MCI, it is unlikely that a band change would occur due to the class sitting high in the C band. **Effect** N/A

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								Confidence Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_P	C (A-D)	0		1			**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 22% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. No effect of GMP predicted for lower tier attributes except weak positive effect for SFS in this class. Non-temperature effects of riparian vegetation (about 22% of class) will also have weak positive effect. Habitat drivers and physical modification of P streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Streams in this class are approximately 50/50 hard-bottomed and soft-bottomed. GMPs will only have a beneficial effect on SFS and DFS in hard-bottomed streams. There is also less GMP in this class compared to others, so overall, no detectable change predicted in ASPM. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	C (A-D)	-1		1			**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will also arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect climate change to dominate. Therefore, assessment reflective of climate change assessment. **Effect** N/A

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								Confidence Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	V_LG_PI	C (B-D)	-1		1			**Degree of Change** Toxicity attributes are not expected to change. Negative effects on macroinvertebrates directly from predicted increases in temperature, SFS and DFS. This class sits high in C band, so unlikely to have sufficient degradation to change state. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers). Most of these reaches are soft-bottomed systems, so unlikely that ASPM scores will change significantly. Overall, small detectable degradation in MCI possible due to sediment induced habitat changes and existing stressors being exacerbated and little buffering of impacts. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	V_LG_PI	C (B-D)	1		1			**Degree of Change** While climate change effects were driven by DFS and temperature, GMP wasn't generally predicted to have much impact on DFS. So, temperature is generally the main driver, as well as the response to riparian planting. It is estimated about 28% of stream length in this class is riparian planted under GMP. However, the effect of temperature is less than that of sediment drivers. Weak positive effects from reductions in nitrate-N, ammonia-N, DIN, and SFS, resulting in more potential effects from lower order attributes than in other classes. Non-temperature effects of riparian vegetation (about 28% of class) will also have weak positive effect. Habitat drivers and physical modification of PI streams (e.g., 'cleaning', straightening, widening, deepening etc) may reduce capacity for recovery. Streams in this class are soft-

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								bottomed, pumiced based systems. GMP benefits will be constrained by this. Overall, the cumulative effects from multiple different pathways are likely to result in some detectable improvements. **Effect** N/A **Confidence** Low confidence because sites not necessarily representative, complex response and high variability in state.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	C (B-D)	0		1			**Degree of Change** Some mitigation of sediment and temperature/DO and allochthonous input from riparian will help with climate change effects. Riparian management will arrest the modest impacts of climate change (i.e., increased sediment loading, and some summer thermal stress). Climate Change and GMP should counter each other but need to determine the magnitude of effect in each case. In this class, expect that the two scenarios will cancel each other out. However, it is noted that climate change would likely be the slightly stronger driver and so although no detectable change predicted, the direction would likely be negative. **Effect** N/A **Confidence** Low confidence because complex response and unsure if GMP will offset climate effects.
Climate Change (RCP4.5)	Urban	D (C-D)	-1		1			**Degree of Change** Negative effects on macroinvertebrates directly from expected increases in water temperature, SFS and DFS. This class is already highly impacted and near the bottom line. The species present are likely to be more tolerant and less prone to changes due to minor shifts in stream conditions (see drivers), but there could still be a shift to below bottom line given it is currently in the C band. Many urban streams are quite exposed, so temperature effects could be more pronounced. But in Tauranga and Rotorua, many urban streams are well covered, so temperature increases are moderated in these areas. Change in ASPM would be greater than for

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Main Drivers	Justification
								MCI, but current state is already in the D band so change can only be a -1. Overall, detectable degradation in ASPM due to sediment induced habitat changes and existing stressors being exacerbated and little buffering of impacts. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model, sites not being necessarily representative, complex response and high variability in state and how cumulative effects might eventuate.
Mitigation (GMP)	Urban	D (C-D)	0		2			**Degree of Change** Approximately 7% of reaches subject to riparian planting GMPs, mostly in upper catchment areas. Therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	D (C-D)	-1		1			**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Fish Index of Biotic Integrity (FishIBI)

Monitoring fish communities in streams is one way of determining the overall health of a waterway. Because of the prevalence of diadromous fishes (i.e. fish that migrate between marine and fresh waters) in New Zealand's freshwater fish communities, there is a strong influence of distance to sea and altitude on fish distributions in New Zealand, with more fish species at lowland sites close to the coast, and fewer species in higher elevation sites inland. However, other factors such as habitat quantity and quality, or water quality may also affect fish distributions at a site, as does the presence of any downstream barriers to migration.

Whilst the Expert Panel provided an assessment of Fish IBI as it is a named NPSFM attribute, they noted little faith in the value of this metric for supporting decision-making. The validity of Fish IBI in the context of New Zealand's freshwater fish communities, which are characterised by low species richness and prevalence of diadromous fishes, has long been questioned (McDowall & Taylor 2000). However, the biggest concern regarding the metric in the context of implementing the NPSFM is its lack of sensitivity to changes in fish communities over time. The current New Zealand Fish IBI is based simply on fish presence/absence, thus a species has to either appear or disappear completely at a site for the metric to change. Consequently, the abundance of different species at a site can change substantially in response to different stressors, yet the Fish IBI score remain largely (or completely) unchanged.

Table 45 Panel Summary for Scenario assessment of Fish Index of Biotic Integrity (F-IBI). Degree of Change: 0-Negligible, 1-Small, 2-Moderate, 3-Large. Effects: 0-Negligible, 1-Weak, 2-Moderate, 3-Strong. Confidence: 0-Not assessed, 1-Low, 2-Moderate, 3-High. Criteria for Degree of Change, Effect and Confidence are in Table 16 and Table 17.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_IF	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days <1-degree summer temperature). Small increase in water temperature and sediment predicted (no change in any other attribute) and lower summer flows. Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. Trout may be less happy with warmer water temps. Water temperatures are naturally quite cool in this class. Overall, no effect on F-IBI because no change in fish presence/absence is expected.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect N/A **Confidence** Low confidence reflects uncertainty in the climate model.
Mitigation (GMP)	NV_IF	A (A-C)	0	N/A	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_IF	A (A-C)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_EF	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days <1-degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Weak to moderate negative climate effect for DFSS and SFS, otherwise limited change to other drivers or invertebrate metrics. Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. Overall, no effect on F-IBI because no change in fish presence/absence is expected.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Effect N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	NV_EF	A (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_EF	A (A-C)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	NV_P	B (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days <1 degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Weak negative effects for DFS and SFS, water temperature, DO and invertebrate metrics (fish food). Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. More sensitive species more likely to be impacted like banded kokopu. Although uncommon, redfins could display a sediment response. Eels won't respond to this level of change and inanga unlikely to. Torrentfish like gravelly areas and fast flowing areas, which is

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							uncommon here. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	NV_P	B (A-C)	0	N/A	2	No	**Degree of Change** It is estimated about 16% of stream length in this class is riparian planted under GMP. Weak positive effects predicted for DFS. Some species may change relative abundance, but species composition is unlikely to change. A lot of this area is the upper Motu, which is a long distance from the sea. Potential to see few more banded kokopu in coastal areas, but there are not large populations around this class. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Moderate confidence due to the lack of sensitivity of the metric to detect changes in the fish community.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_P	B (A-C)	0	N/A	1	No	**Degree of Change** Some mitigation through riparian planting which will help mitigate climate change effects. But overall, climate change scenario will dominate, and no detectable change is expected for the Fish IBI. **Effect** N/A **Confidence** Low confidence reflective of the climate change assessment as climate change dominates.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5)	NV_PI	B (A-D)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-15% summer rainfall decrease, 5-10 day increase in annual hot days <1-degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Moderate negative effects for DFS and SFS. Weak negative effect of temperature/DO and invertebrate metrics (fish food). Shortfin eels and bullies dominate species list in this class. Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. Eels and bullies are the most resilient species to most stressors. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	NV_PI	B (A-D)	0	N/A	2	No	**Degree of Change** It is estimated about 24% of stream length in this class is riparian planted under GMP. Weak positive effects predicted for DFS. The species that are there now but are in low abundance may increase in numbers as a result of GMP, which would provide some resilience for climate change. A positive impact overall, just no change to F-IBI. Different actions will have a bigger effect on fish communities than GMP (e.g., barrier removal, physical habitat restoration). Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Moderate confidence due to the lack of sensitivity of the metric to detect changes in the fish community.
Climate Change (RCP4.5) + Mitigation (GMP)	NV_PI	B (A-D)	0	N/A	1	No	**Degree of Change**

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Some mitigation through riparian planting which will help mitigate climate change effects. But overall, climate change scenario will dominate, and no detectable change is expected for the Fish IBI. **Effect** N/A **Confidence** Low confidence reflective of the climate change assessment as climate change dominates.
Climate Change (RCP4.5)	V_HG_IF	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-10 day increase in annual hot days <1 degree summer temperature). Unlikely to be much increase in water temperature in these spring fed systems. Weak and moderate negative climate effect for SFS and DFS. Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. Longfin eels and redfin bullies most susceptible. Overall, no effect on F-IBI because no change in fish presence/absence. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model.
Mitigation (GMP)	V_HG_IF	A (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_IF	A (A-C)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_EF	B (A-D)	0	N/A	1	No	**Degree of Change** Hot and extreme hot days increase slightly, and increased PET could result in shallower water depth in summer, lower flows. Temperature rise by 2040 is projected to be minor to moderate (0.5-1°C). Weak negative climate effect for DFS and SFS, otherwise limited change to other drivers or invertebrate metrics. Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. Trout sensitive to temperature changes, but these streams are groundwater dominated and therefore buffered against this. Trout and redfin bullies susceptible to sediment impacts on spawning. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	V_HG_EF	B (A-D)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_EF	B (A-D)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_HG_P	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-10% summer rainfall decrease, 5-15 day increase in annual hot days <1 degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Moderate negative effect for DFS (habitat) and weak negative effects predicted for water temperature and DO (growth/mortality), SFS (habitat/visibility/mortality) and invertebrate metrics (fish food). Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. Smelt and lampreys more susceptible to temperature, but these have been rarely observed in BOP, so no influence on F-IBI in this class. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	V_HG_P	A (A-C)	0	N/A	2	No	**Degree of Change** It is estimated about 22% of stream length in this class is riparian planted under GMP. Weak positive effects predicted for SFS and possible weak positive effects from riparian vegetation (habitat/food). Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							response to temperature and sediment. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Moderate confidence due to the lack of sensitivity of the metric to detect changes in the fish community.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_P	A (A-C)	0	N/A	1	No	**Degree of Change** Some mitigation through riparian planting which will help mitigate climate change effects. But overall, climate change scenario will dominate, and no detectable change is expected for the Fish IBI. **Effect** N/A **Confidence** Low confidence reflective of the climate change assessment as climate change dominates.
Climate Change (RCP4.5)	V_HG_PI	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-10% summer rainfall decrease, 10-15 day increase in annual hot days <1 degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Moderate negative effect for DFS (habitat) and weak negative effects predicted for temperature (growth/mortality), SFS (habitat/visibility/mortality) and invertebrate metrics (fish food). Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. Smelt and lampreys more susceptible to temperature, but these are rarely observed in BOP, so no influence on F-IBI in this class. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	V_HG_PI	A (A-C)	0	N/A	2	No	**Degree of Change** It is estimated about 27% of stream length in this class is riparian planted under GMP. Weak positive effects predicted for SFS, DO and DIN and possible weak positive effects from riparian vegetation (habitat/food). Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Moderate confidence due to the lack of sensitivity of the metric to detect changes in the fish community.
Climate Change (RCP4.5) + Mitigation (GMP)	V_HG_PI	A (A-C)	0	N/A	1	No	**Degree of Change** Some mitigation through riparian planting which will help mitigate climate change effects. Overall, climate change scenario will dominate, and no detectable change is expected for the Fish IBI. **Effect** N/A **Confidence** Low confidence reflective of the climate change assessment as climate change dominates.
Climate Change (RCP4.5)	V_LG_IF	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-10 day increase in annual hot days <1-degree summer temperature). Unlikely to be much increase in water temperature in these spring fed systems. Weak and moderate negative climate effect for SFS and DFS. Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							response to water temperature and sediment. Trout are abundant in this class, which are susceptible to elevated DFS due to impacts on spawning and to temperature change. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model.
Mitigation (GMP)	V_LG_IF	A (A-C)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_IF	A (A-C)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this spatial class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_EF	A (A-D)	0	N/A	1	No	**Degree of Change** Change in summer dry days small, 5-20 increase in annual hot days, summer rainfall decrease (~4%-8%). Weak and moderate negative climate effect for SFS and DFSS, otherwise limited change to other drivers or invert metrics. Pumice dominated landscape and spring fed will reduce temperature stress, toxicity effects not anticipated. Impoundment impacts greater. Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. Land locked population of giant kokopu in this class, but barriers to migration is the

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							biggest issue here, not directly a climate change issue. A likely negative effect on the fish community, but no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	V_LG_EF	A (A-D)	0	0	3	No	**Degree of Change** <5% land cover subject to GMPS, therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_EF	A (A-D)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.
Climate Change (RCP4.5)	V_LG_P	A (A-C)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~2%-10% summer rainfall decrease, 5-20 day increase in annual hot days <1 degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Moderate negative effect for DFS (habitat) and weak negative effects predicted for water temperature and DO (growth/mortality), SFS (habitat/visibility/mortality) and invertebrate metrics

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							(fish food). Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. Regional split where groundwater, spring-fed, soft-bottomed streams in one area and hard bottomed streams in the other. This has resulted in diverse spread within this class. Western Bay area will respond more to climate change than other parts of the region. A general negative shift in abundance would be expected. But overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model but moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	V_LG_P	A (A-C)	0	N/A	2	No	**Degree of Change** It is estimated about 22% of stream length in this class is riparian planted under GMP. Weak positive effects predicted for SFS and possible weak positive effects from riparian vegetation (habitat/food). Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Moderate confidence due to the lack of sensitivity of the metric to detect changes in the fish community.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_P	A (A-C)	0	N/A	1	No	**Degree of Change** Some mitigation through riparian planting which will help mitigate climate change effects. But overall, climate change scenario will dominate, and no detectable change is expected for the Fish IBI. **Effect** N/A

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Low confidence reflective of the climate change assessment as climate change dominates.
Climate Change (RCP4.5)	V_LG_PI	A (A-D)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-8% summer rainfall decrease, 5-20 day increase in annual hot days <1 degree summer temperature). Increase in temperature is under 1degC, but potential for water temperature rise with lower flow and increased hot days. Moderate negative effect for DFS (habitat) and weak negative effects predicted for water temperature and DO (growth/mortality), SFS (habitat/visibility/mortality) and invertebrate metrics (food). Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. A general negative shift in abundance would be expected. But overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model – but moderate to high confidence that IBI will not detect climate effects on fish.
Mitigation (GMP)	V_LG_PI	A (A-D)	0	N/A	2	No	**Degree of Change** It is estimated about 28% of stream length in this class is riparian planted under GMP. Weak positive effects predicted for DIN, SFS, invertebrates and possible weak positive effects from riparian vegetation (habitat/food). Responses might be seen in the abundance, growth rates, survival, disease rates etc of individual or multiple species (and so measurable impacts on fish may be detectable) in response to temperature and sediment. General direction would be positive. But overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
							Confidence Moderate confidence due to the lack of sensitivity of the metric to detect changes in the fish community.
Climate Change (RCP4.5) + Mitigation (GMP)	V_LG_PI	A (A-D)	0	N/A	1	No	**Degree of Change** Some mitigation through riparian planting which will help mitigate climate change effects. But overall, climate change scenario will dominate, and no detectable change is expected for the Fish IBI. **Effect** N/A **Confidence** Low confidence reflective of the climate change assessment as climate change dominates.
Climate Change (RCP4.5)	Urban	C (B-D)	0	N/A	1	No	**Degree of Change** Key climate drivers show relatively little change (e.g., ~4%-10% summer rainfall decrease, 5-10 day increase in annual hot days <1-degree summer temperature). Increase in temperature is under 1°C, but potential for water temperature rise with lower flow and increased hot days. Negative effects for water temperature, DO, DFS, SFS, Cu, Zn, and invertebrates. Responses might be seen in the abundance, growth rates, survival, disease rates etc. of individual or multiple species (and so measurable impacts on fish may be detectable) in response to water temperature and sediment. May expect to see more invasive species with increase in temperature. Changes to relative abundance of species, but none of the dominant species are likely to disappear under climate change alone. Overall, no effect on F-IBI because no change in fish presence/absence is expected. **Effect** N/A **Confidence** Low confidence reflects uncertainty in the climate model. But moderate to high confidence that IBI will not detect climate effects on fish.

Scenario	Spatial Classification	EP Estimate of Current State (Variability)	Degree of Change	Effect	Confidence	Is state below Bottom Line?	Justification
Mitigation (GMP)	Urban	C (B-D)	0	N/A	2	No	**Degree of Change** Approximately 7% of reaches subject to GMPS, mostly in upper catchment areas. Therefore GMP = current state as per section 2.6.2. **Effect** As the degree of change is negligible, the effect also negligible. **Confidence** As per section 2.6.2, confidence is assessed as high when GMPs are applied to <5% to the spatial class.
Climate Change (RCP4.5) + Mitigation (GMP)	Urban	C (B-D)	0	N/A	1	No	**Degree of Change** Consistent with Climate Change assessment as negligible GMP applied in this biophysical/landcover class. **Effect** As per Climate Change assessment. **Confidence** Consistent with Climate Change assessment.

Appendix 5
Scenario end-point state results for biophysical classes

The following tables show compiled estimates of current attribute state using monitoring data and Expert Panel predictions of end-point state for all scenarios for each biophysical/land cover class.

Note that:

- Estimates of current and natural landcover state have been taken from the "State Report" (Carter *et al.,* 2023a).
- Predictions of end-point attribute state have been derived by applying the Expert Panel predictions of change under each GMP, CC and GMP + CC scenario (see Tables 1 to 4) to the current, natural landcover and hypothetical future landcover states reported in Carter *et al.,* (2023a).
- Attribute state bands (A-D or E for *E. coli*) are as per the NPS-FM 2020 or the regional attribute tables (Tables 24 to 26).
- Confidence is shown by superscript (1 = low, 2 = moderate, 3 = high). * indicates getting worse, but remaining within the same attribute band. + indicates getting better but remaining within the same band.
- For ease of viewing, any change from current (either within a band or to a different band) is in bold.
- Fish IBI attribute end-point results are not included in the following tables, simply because there was no change predicted to Fish IBI state compared to the current, natural landcover and hypothetical future landcover states presented in Carter *et al*., (2023a), under any scenario and for any biophysical class.

Attribute	Nitrate (toxicity)	Measured Data		Expert Panel Estimates					
Biophysical Class	**State/Variability**	**# Monitoring sites**	**Default Class State/ Observed Variability**	**Natural**	**Natural + CC**	**Current/ Future**	**Current + GMP Future + GMP**	**Current + CC Future + CC**	**Current + GMP + CC Future + GMP + CC**
NV-IF	State	12	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[3]	-	-	-
NV-EF	State	0	-	-	-	A[2]	A[3]	A[1]	A[2]
	Variability	-	-	-	-	A[2]	-	-	-
NV-P	State	1	A	-	-	A[2]	A[2]	A[1]	A[1]
	Variability	-	A	-	-	A-B[1]	-	-	-
NV-PI	State	1	A	-	-	A[2]	**+A[2]**	A[1]	**+A[1]**
	Variability	-	A	-	-	A-B[2]	-	-	-
V-HG-IF	State	3	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[3]	-	-	-
V-HG-EF	State	2	A	-	-	A[2]	A[3]	A[1]	A[2]
	Variability	-	A	-	-	A[2]	-	-	-
V-HG-P	State	4	A	-	-	A[2]	A[2]	A[1]	A[1]
	Variability	-	A	-	-	A-B[2]	-	-	-
V-HG-PI	State	0	-	-	-	A[1]	**+A[1]**	A[1]	**+A[1]**
	Variability	-	-	-	-	A-B[2]	-	-	-
V-LG-IF	State	2	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[2]	-	-	-
V-LG-EF	State	4	A	-	-	A[3]	A[3]	A[1]	A[2]
	Variability	-	A	-	-	A-B[2]	-	-	-
V-LG-P	State	18	A	-	-	A[3]	A[2]	A[1]	A[1]
	Variability	-	A-B	-	-	A-B[3]	-	-	-
V-LG-PI	State	3	B	-	-	B[2]	**A[2]**	B[1]	**A[1]**
	Variability	-	B	-	-	A-C[2]	-	-	-
U	State	2	A	-	-	A[2]	A[2]	A[1]	A[1]
	Variability	-	A	-	-	A-B[2]	-	-	-

Attribute	Ammonia (toxicity)	Measured Data		Expert Panel Estimates					
Biophysical Class	**State/Variability**	**# Monitoring sites**	**Default Class State/ Observed Variability**	**Natural**	**Natural + CC**	**Current/ Future**	**Current + GMP Future + GMP**	**Current + CC Future + CC**	**Current + GMP + CC Future + GMP + CC**
NV-IF	State	12	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[3]	-	-	-
NV-EF	State	0	-	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	-	-	-	A[2]	-	-	-
NV-P	State	1	A	-	-	A[2]	A[2]	A[1]	A[2]
	Variability	-	A	-	-	A-B[1]	-	-	-
NV-PI	State	1	A	-	-	A[1]	**+A[2]**	A[1]	**+A[1]**
	Variability	-	A	-	-	A-C[1]	-	-	-
V-HG-IF	State	3	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[3]	-	-	-
V-HG-EF	State	2	A	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	A	-	-	A[2]	-	-	-
V-HG-P	State	4	A	-	-	A[3]	A[2]	A[1]	A[2]
	Variability	-	A	-	-	A[2]	-	-	-
V-HG-PI	State	0	-	-	-	A[2]	**+A[2]**	A[1]	A[1]
	Variability	-	-	-	-	A[1]	-	-	-
V-LG-IF	State	2	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[2]	-	-	-
V-LG-EF	State	4	A	-	-	A[3]	A[3]	A[1]	A[1]
	Variability	-	A	-	-	A[2]	-	-	-
V-LG-P	State	18	A	-	-	A[3]	A[2]	A[1]	A[2]
	Variability	-	A-B	-	-	A[3]	-	-	-
V-LG-PI	State	3	A	-	-	A[2]	**+A[2]**	A[1]	**+A[2]**
	Variability	-	A	-	-	A-B[2]	-	-	-
U	State	2	B	-	-	B[2]	**+B[2]**	B[1]	**+B[1]**
	Variability	-	A-B	-	-	A-B[1]	-	-	-

Attribute	DIN	Measured Data		Expert Panel Estimates					
Biophysical Class	**State/Variability**	**# Monitoring sites**	**Default Class State/ Observed Variability**	**Natural**	**Natural + CC**	**Current/ Future**	**Current + GMP Future + GMP**	**Current + CC Future + CC**	**Current + GMP + CC Future + GMP + CC**
NV-IF	State	12	A	A[3]	A[2]	A[3]	A[3]	A[2]	A[2]
	Variability	-	A	A[3]	-	A[3]	-	-	-
NV-EF	State	0	-	-	-	B[1]	B[3]	B[1]	B[1]
	Variability	-	-	-	-	A-C[1]	-	-	-
NV-P	State	1	A	-	-	B[1]	B[1]	B[1]	B[1]
	Variability	-	A	-	-	A-C[2]	-	-	-
NV-PI	State	1	C	-	-	C[1]	**B[1]**	C[1]	**+C[1]**
	Variability	-	C			A-D[1]	-	-	-
V-HG-IF	State	3	A	A[3]	A[2]	A[2]	A[3]	A[2]	A[2]
	Variability	-	A-B	A[3]	-	A-B[2]	-	-	-
V-HG-EF	State	2	B	-	-	B[1]	B[3]	B[1]	B[1]
	Variability	-	B	-	-	A-C[1]	-	-	-
V-HG-P	State	4	B	-	-	C[1]	C[1]	C[1]	C[1]
	Variability	-	B-C	-	-	A-D[2]	-	-	-
V-HG-PI	State	0	-	-	-	C[1]	**B[1]**	C[1]	**+C[1]**
	Variability	-	-	-	-	A-D[1]	-	-	-
V-LG-IF	State	2	A	A[3]	A[1]	A[2]	A[3]	A[1]	A[1]
	Variability	-	A	A[3]	-	A-B[2]	-	-	-
V-LG-EF	State	4	C	-	-	B[2]	B[3]	B[1]	B[1]
	Variability	-	B-C	-	-	A-C[2]	-	-	-
V-LG-P	State	18	C	-	-	C[2]	C[2]	C[1]	C[1]
	Variability	-	A-D	-	-	A-D[3]	-	-	-
V-LG-PI	State	3	D	-	-	D[2]	**+D[2]**	D[1]	**+D[1]**
	Variability	-	D	-	-	B-D[2]	-	-	-
U	State	2	C	-	-	C[2]	**+C[2]**	C[1]	C[1]
	Variability	-	C	-	-	B-D[2]	-	-	-

Attribute	DRP	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/Observed Variability	Natural	Natural + CC	Current/Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
NV-IF	State	12	D	D[3]	D[2]	D[3]	D[3]	D[2]	D[2]
	Variability	-	C-D	B-D[2]	-	B-D[2]	-	-	-
NV-EF	State	0	-	-	-	D[2]	D[3]	D[1]	D[1]
	Variability	-	-	-	-	B-D[1]	-	-	-
NV-P	State	1	B	-	-	C[1]	**+C[1]**	C[1]	**+C[1]**
	Variability	-	B	-	-	B-D[1]	-	-	-
NV-PI	State	1	D	-	-	D[2]	**C[1]**	D[1]	**+D[1]**
	Variability	-	D	-	-	C-D[1]	-	-	-
V-HG-IF	State	3	A	A[2]	A[1]	A[1]	A[3]	A[1]	A[2]
	Variability	-	A	A-D[1]	-	A-D[2]	-	-	-
V-HG-EF	State	2	D	-	-	D[2]	D[3]	D[2]	D[2]
	Variability	-	D	-	-	B-D[1]	-	-	-
V-HG-P	State	4	B	-	-	C[2]	**B[1]**	C[1]	**+C[1]**
	Variability	-	A-D	-	-	A-D[2]	-	-	-
V-HG-PI	State	0	-	-	-	D[1]	**+D[1]**	D[1]	**+D[1]**
	Variability	-	-	-	-	A-D[1]	-	-	-
V-LG-IF	State	2	A	A[2]	A[1]	A[1]	A[3]	A[2]	A[2]
	Variability	-	A	A-D[1]	-	A-D[2]	-	-	-
V-LG-EF	State	4	D	-	-	D[2]	D[3]	D[2]	D[2]
	Variability	-	C-D	-	-	B-D[2]	-	-	-
V-LG-P	State	18	C	-	-	C[2]	**+C[2]**	C[1]	**+C[1]**
	Variability	-	A-D	-	-	A-D[3]	-	-	-
V-LG-PI	State	3	D	-	-	D[3]	**+D[2]**	D[2]	**+D[2]**
	Variability	-	D	-	-	C-D[2]	-	-	-
U	State	2	C	-	-	C[2]	C[2]	C[1]	C[1]
	Variability	-	C	-	-	B-D[1]	-	-	-

Attribute	SFS	Measured Data		Expert Panel Estimates					
Sediment Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
SFS-1-IF	State	4	A	A[2]	***A[2]**	A[2]	A[3]	***A[2]**	***A[2]**
	Variability	-	A	A[2]	-	A[2]	-	-	-
SFS-1-EF	State	4	B	-	-	B[1]	B[3]	**D[1]**	**D[1]**
	Variability	-	A-D	-	-	A-D[2]	-	-	-
SFS-1-P	State	17	A	-	-	B[1]	A[1]	**D[1]**	**D[1]**
	Variability	-	A-D	-	-	A-D[3]	-	-	-
SFS-1-PI	State	3	A	-	-	B[1]	**+B[1]**	**D[1]**	**D[1]**
	Variability	-	A-B	-	-	A-D[2]	-	-	-
SFS-1-U	State	1	D	-	-	D[1]	D[1]	***D[1]**	***D[1]**
	Variability	-	D	-	-	A-D[1]	-	-	-
SFS-2-IF	State	3	A	A[2]	***A[2]**	A[2]	A[3]	***A[2]**	***A[2]**
	Variability	-	A	A[2]	-	A[2]	-	-	-
SFS-2-EF	State	0	-	-	-	A[1]	A[3]	***A[1]**	***A[1]**
	Variability	-	-	-	-	A-B[1]	-	-	-
SFS-2-P	State	0	-	-	-	A[1]	**+A[1]**	**C[1]**	**C[1]**
	Variability	-	-	-	-	A-B[1]	-	-	-
SFS-2-PI	State	1	A	-	-	A[1]	**+A[1]**	**B[1]**	**B[1]**
	Variability	-	A	-	-	A-B[1]	-	-	-
SFS-2-U	State	1	A	-	-	A[1]	A[2]	**B[1]**	**B[1]**
	Variability	-	A	-	-	A-B[1]	-	-	-
SFS-3-IF	State	10	C	D[1]	***D[1]**	D[1]	D[3]	***D[1]**	***D[1]**
	Variability	-	A-D	A-D[2]	-	A-D[3]	-	-	-
SFS-3-EF	State	2	B	-	-	D[1]	D[3]	***D[1]**	***D[1]**
	Variability	-	B-D	-	-	B-D[1]	-	-	-
SFS-3-P	State	6	D	-	-	D[1]	**B[1]**	***D[1]**	***D[1]**
	Variability	-	C-D	-	-	C-D[3]	-	-	-
SFS-3-PI	State	0	-	-	-	D[1]	**+D[1]**	***D[1]**	***D[1]**
	Variability	-	-	-	-	C-D[1]	-	-	-
SFS-3-U	State	0	-	-	-	D[1]	D[2]	***D[1]**	***D[1]**
	Variability	-	-	-	-	C-D[1]	-	-	-

Attribute	*E. coli*	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
NV-IF	State	12	B	A[2]	A[1]	B[2]	B[3]	B[1]	B[1]
	Variability	-	A-D	A-B[1]	-	A-D[3]	-	-	-
NV-EF	State	0	-	-	-	B[1]	B[3]	B[1]	B[1]
	Variability	-	-	-	-	A-D[1]	-	-	-
NV-P	State	1	D	-	-	D[1]	**+D[2]**	D[1]	D[1]
	Variability	-	D	-	-	A-E[2]	-	-	-
NV-PI	State	1	E	-	-	D[1]	**C[2]**	***D[1]**	**+D[1]**
	Variability	-	E	-	-	B-E[1]	-	-	-
V-HG-IF	State	3	D	A[2]	A[1]	D[1]	D[3]	D[1]	D[1]
	Variability	-	D	A-B[1]	-	B-D[1]	-	-	-
V-HG-EF	State	2	A	-	-	A[1]	A[3]	A[1]	A[1]
	Variability	-	A	-	-	A-C[1]	-	-	-
V-HG-P	State	4	D	-	-	D[1]	**+D[2]**	D[1]	**+D[2]**
	Variability	-	B-E	-	-	B-E[1]	-	-	-
V-HG-PI	State	0	-	-	-	D[1]	**+D[1]**	D[1]	**+D[1]**
	Variability	-	-	-	-	B-E[1]	-	-	-
V-LG-IF	State	2	D	A[1]	A[1]	D[1]	D[3]	D[1]	D[1]
	Variability	-	A-D	A-B[1]	-	A-D[1]	-	-	-
V-LG-EF	State	4	A	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	A-B	-	-	A-B[1]	-	-	-
V-LG-P	State	18	D	-	-	D[2]	**+D[2]**	***D[1]**	**+D[1]**
	Variability	-	A-E	-	-	A-E[3]	-	-	-
V-LG-PI	State	3	D	-	-	D[2]	**C[2]**	***D[1]**	**+D[2]**
	Variability	-	A-D	-	-	A-E[2]	-	-	-
U	State	2	D	-	-	D[2]	D[2]	D[1]	D[1]
	Variability	-	D	-	-	B-E[1]	-	-	-

Attribute	Water Temperature	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
NV-IF	State	1	B	A[2]	*A[2]	A[1]	A[3]	*A[2]	*A[2]
	Variability	-	B	A-B[2]	-	A-B[2]	-	-	-
NV-EF	State	0	-	-	-	A[1]	A[3]	*A[1]	*A[1]
	Variability	-	-	-	-	A-C[1]	-	-	-
NV-P	State	0	-	-	-	B[1]	+B[1]	*B[2]	B[1]
	Variability	-	-	-	-	A-C[1]	-	-	-
NV-PI	State	0	-	-	-	B[1]	+B[1]	*B[1]	B[1]
	Variability	-	-	-	-	A-C[1]	-	-	-
V-HG-IF	State	0	-	A[2]	*A[2]	A[1]	A[3]	*A[2]	*A[2]
	Variability	-	-	A-B[2]	-	A-B[1]	-	-	-
V-HG-EF	State	2	B	-	-	B[1]	B[3]	*B[2]	*B[2]
	Variability	-	B	-	-	A-C[1]	-	-	-
V-HG-P	State	1	C	-	-	C[1]	+C[1]	*C[1]	C[1]
	Variability	-	C	-	-	B-C[1]	-	-	-
V-HG-PI	State	0	-	-	-	C[1]	+C[1]	*C[1]	C[1]
	Variability	-	-	-	-	B-C[1]	-	-	-
V-LG-IF	State	0	-	A[2]	*A[2]	A[1]	A[3]	*A[2]	*A[2]
	Variability	-	-	A-B[2]	-	A-B[1]	-	-	-
V-LG-EF	State	2	B	-	-	B[1]	B[3]	*B[2]	*B[2]
	Variability	-	B-C	-	-	A-C[1]	-	-	-
V-LG-P	State	5	A	-	-	A[1]	+A[1]	B[1]	*A[1]
	Variability	-	A-C	-	-	A-C[1]	-	-	-
V-LG-PI	State	0	-	-	-	B[1]	+B[1]	*B[1]	B[1]
	Variability	-	-	-	-	A-C[1]	-	-	-
U	State	1	D	-	-	D[1]	D[2]	*D[2]	*D[2]
	Variability	-	D	-	-	A-D[1]	-	-	-

Attribute	Cu	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
U	State	0	-	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	-	-	-	A-B[2]	-	-	-

Attribute	Zn	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
U	State	0	-	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	-	-	-	A-C[2]	-	-	-

Attribute	DFS	Measured Data		Expert Panel Estimates					
Sediment Class	**State/Variability**	**# Monitoring sites**	**Default Class State/ Observed Variability**	**Natural**	**Natural + CC**	**Current/ Future**	**Current + GMP Future + GMP**	**Current + CC Future + CC**	**Current + GMP + CC Future + GMP + CC**
DFS-2-IF	State	25	A	A[1]	***A[1]**	A[1]	A[3]	***A[1]**	***A[1]**
	Variability	-	A-D	A-D[1]	-	A-D[3]	-	-	-
DFS-2-EF	State	19	C	-	-	D[1]	D[3]	***D[1]**	***D[1]**
	Variability	-	A-D	-	-	A-D[3]	-	-	-
DFS-2-P	State	31	D	-	-	D[3]	D[1]	***D[1]**	***D[1]**
	Variability	-	A-D	-	-	A-D[3]	-	-	-
DFS-2-PI	State	13	D	-	-	D[3]	D[1]	***D[1]**	***D[1]**
	Variability	-	B-D	-	-	B-D[2]	-	-	-
DFS-2-U	State	5	D	-	-	D[3]	D[2]	***D[1]**	***D[1]**
	Variability	-	C-D	-	-	B-D[2]	-	-	-
DFS-3-IF	State	7	C	B[1]	***B[1]**	C[1]	C[3]	***C[1]**	***C[1]**
	Variability	-	A-D	A-D[1]	-	A-D[2]	-	-	-
DFS-3-EF	State	1	B-D	-	-	C[1]	C[3]	***C[1]**	***C[1]**
	Variability	-	B	-	-	A-C[1]	-	-	-
DFS-3-P	State	1	D	-	-	D[1]	**+D[1]**	***D[1]**	***D[1]**
	Variability	-	D	-	-	A-D[1]	-	-	-
DFS-3-PI	State	2	C	-	-	C[1]	**+D[1]**	**D[1]**	***D[1]**
	Variability	-	C	-	-	B-D[1]	-	-	-
DFS-3-U	State	0	-	-	-	D[1]	D[2]	***D[1]**	***D[1]**
	Variability	-	-	-	-	C-D[1]	-	-	-
DFS-4-IF	State	12	A	A[2]	***A[1]**	A[2]	A[3]	***A[1]**	***A[1]**
	Variability	-	A	A[2]	-	A[2]	-	-	-
DFS-4-EF	State	1	A	-	-	A[1]	A[3]	***A[1]**	***A[1]**
	Variability	-	A	-	-	A-C[1]	-	-	-
DFS-4-P	State	0	-	-	-	C[1]	**+C[1]**	**D[1]**	***C[1]**
	Variability	-	-	-	-	B-D[1]	-	-	-
DFS-4-PI	State	1	B	-	-	C[1]	C[1]	**D[1]**	**D[1]**
	Variability	-	B	-	-	B-D[1]	-	-	-
DFS-4-U	State	0	-	-	-	-	-	-	-
	Variability	-	-	-	-	-	-	-	-

Attribute	Dissolved Oxygen	Measured Data		Expert Panel Estimates						
Biophysical Class	**State/Variability**	**# Monitoring sites**	**Default Class State/ Observed Variability**	**Natural**	**Natural + CC**	**Current/ Future**	**Current + GMP Future + GMP**	**Current + CC Future + CC**	**Current + GMP + CC Future + GMP + CC**
NV-IF	State	14	A	A[3]	A[1]	A[2]	A[3]	A[1]	A[1]
	Variability	-	A-B	A-B[2]	-	A-B[2]	-	-	-
NV-EF	State	0	-	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	-	-	-	A-B[1]	-	-	-
NV-P	State	1	A	-	-	A[1]	**+A[2]**	***A[1]**	A[1]
	Variability	-	A	-	-	A-C[1]	-	-	-
NV-PI	State	1	B	-	-	B[1]	**+B[1]**	***B[1]**	B[1]
	Variability	-	B	-	-	A-D[2]	-	-	-
V-HG-IF	State	3	A	A[3]	A[1]	A[2]	A[3]	A[1]	A[1]
	Variability	-	A	A[2]	-	A[1]	-	-	-
V-HG-EF	State	6	A	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	A-C	-	-	A-B[1]	-	-	-
V-HG-P	State	4	A	-	-	A[1]	A[2]	***A[1]**	A[1]
	Variability	-	A	-	-	A-B[1]	-	-	-
V-HG-PI	State	0	-	-	-	B[1]	**+B[1]**	***B[1]**	B[1]
	Variability	-	-	-	-	A-C[1]	-	-	-
V-LG-IF	State	2	A	A[3]	A[1]	A[1]	A[3]	A[1]	A[1]
	Variability	-	A	A-B[2]	-	A-B[1]	-	-	-
V-LG-EF	State	4	A	-	-	A[2]	A[3]	A[1]	A[1]
	Variability	-	A	-	-	A-B[1]	-	-	-
V-LG-P	State	20	A	-	-	B[1]	**+B[1]**	***B[1]**	B[1]
	Variability	-	A-B	-	-	A-C[2]	-	-	-
V-LG-PI	State	4	A	-	-	B[1]	**+B[1]**	***B[1]**	B[1]
	Variability	-	A-B	-	-	A-D[2]	-	-	-
U	State	2	D	-	-	C[1]	C[2]	***C[1]**	***C[1]**
	Variability	-	C-D	-	-	A-D[2]	-	-	-

Attribute	MCI	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
NV-IF	State	24	B	A[1]	*A[1]	B[3]	B[3]	*B[1]	*B[1]
	Variability	-	A-D	A-C[2]	-	A-C[3]	-	-	-
NV-EF	State	10	B	-	-	B[3]	B[3]	*B[1]	*B[1]
	Variability	-	B-C	-	-	A-C[2]	-	-	-
NV-P	State	5	D	-	-	C[1]	C[1]	*C[1]	*C[1]
	Variability	-	B-D	-	-	B-D[3]	-	-	-
NV-PI	State	4	C	-	-	C[2]	C[1]	*C[1]	*C[1]
	Variability	-	B-C	-	-	B-D[3]	-	-	-
V-HG-IF	State	16	B	A[1]	A[1]	B[2]	B[3]	B[1]	B[1]
	Variability	-	A-D	A-C[2]	-	A-D[2]	-	-	-
V-HG-EF	State	5	B	-	-	B[2]	B[3]	B[1]	B[1]
	Variability	-	A-D	-	-	A-D[2]	-	-	-
V-HG-P	State	11	B	-	-	B[3]	B[1]	*B[1]	*B[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-
V-HG-PI	State	3	B	-	-	B[1]	+B[1]	*B[1]	B[1]
	Variability	-	B-C	-	-	B-D[1]	-	-	-
V-LG-IF	State	5	B	A[1]	A[1]	B[2]	B[3]	B[1]	B[1]
	Variability	-	A-D	A-C[2]	-	A-C[2]	-	-	-
V-LG-EF	State	6	B	-	-	B[2]	B[3]	B[1]	B[1]
	Variability	-	A-C	-	-	A-C[2]	-	-	-
V-LG-P	State	17	C	-	-	C[3]	C[1]	*C[1]	*C[1]
	Variability	-	B-D	-	-	B-D[3]	-	-	-
V-LG-PI	State	9	C	-	-	C[2]	+C[1]	*C[1]	C[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-
U	State	7	C	-	-	C[3]	C[2]	*C[1]	*C[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-

Attribute	QMCI	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
NV-IF	State	24	B	A[1]	*A[1]	B[2]	B[3]	*B[1]	*B[1]
	Variability	-	A-D	A-C[2]	-	A-D[3]	-	-	-
NV-EF	State	10	C	-	-	C[2]	C[3]	*C[1]	*C[1]
	Variability	-	B-D	-	-	A-D[2]	-	-	-
NV-P	State	5	D	-	-	D[2]	+D[1]	*D[1]	D[1]
	Variability	-	C-D	-	-	B-D[2]	-	-	-
NV-PI	State	4	D	-	-	D[1]	+D[1]	*D[1]	*D[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-
V-HG-IF	State	16	C	A[1]	*A[1]	C[2]	C[3]	*C[1]	*C[1]
	Variability	-	A-D	A-C[2]	-	A-D[3]	-	-	-
V-HG-EF	State	5	D	-	-	D[1]	D[3]	*D[1]	*D[1]
	Variability	-	A-D	-	-	A-D[1]	-	-	-
V-HG-P	State	11	C	-	-	C[2]	+C[1]	*C[1]	*C[1]
	Variability	-	A-D	-	-	A-D[3]	-	-	-
V-HG-PI	State	3	B	-	-	C[1]	+C[1]	*C[1]	C[1]
	Variability	-	A-C	-	-	A-D[1]	-	-	-
V-LG-IF	State	5	C	A[1]	*A[1]	C[2]	C[3]	*C[1]	*C[1]
	Variability	-	A-D	A-C[2]	-	A-D[3]	-	-	-
V-LG-EF	State	6	C	-	-	C[2]	C[3]	*C[1]	*C[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-
V-LG-P	State	17	C	-	-	C[2]	C[1]	*C[1]	*C[1]
	Variability	-	B-D	-	-	B-D[3]	-	-	-
V-LG-PI	State	9	C	-	-	D[1]	+D[1]	*D[1]	D[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-
U	State	7	D	-	-	D[3]	D[2]	*D[1]	D[1]
	Variability	-	C-D	-	-	C-D[2]	-	-	-

Attribute	ASPM	Measured Data		Expert Panel Estimates					
Biophysical Class	State/Variability	# Monitoring sites	Default Class State/ Observed Variability	Natural	Natural + CC	Current/ Future	Current + GMP Future + GMP	Current + CC Future + CC	Current + GMP + CC Future + GMP + CC
NV-IF	State	24	B	A[1]	***A[1]**	B[3]	B[3]	***B[1]**	***B[1]**
	Variability	-	A-D	A-C[2]	-	A-D[3]	-	-	-
NV-EF	State	10	B	-	-	B[2]	B[3]	***B[1]**	***B[1]**
	Variability	-	A-C	-	-	A-D[2]	-	-	-
NV-P	State	5	D	-	-	D[2]	**+D[1]**	***D[1]**	***D[1]**
	Variability	-	B-D	-	-	B-D[2]	-	-	-
NV-PI	State	4	C	-	-	C[1]	**+C[1]**	***C[1]**	***C[1]**
	Variability	-	B-D	-	-	B-D[2]	-	-	-
V-HG-IF	State	16	B	A[1]	***A[1]**	B[3]	B[3]	***B[1]**	***B[1]**
	Variability	-	A-D	A-C[2]	-	A-D[3]	-	-	-
V-HG-EF	State	5	C	-	-	B[1]	B[3]	***B[1]**	***B[1]**
	Variability	-	A-D	-	-	A-D[2]	-	-	-
V-HG-P	State	11	B	-	-	B[3]	**+B[1]**	***B[1]**	***B[1]**
	Variability	-	A-D	-	-	A-D[3]	-	-	-
V-HG-PI	State	3	B	-	-	B[2]	**+B[1]**	***B[1]**	B[1]
	Variability	-	B	-	-	B-D[2]	-	-	-
V-LG-IF	State	5	B	A[1]	***A[1]**	B[2]	B[3]	***B[1]**	***B[1]**
	Variability	-	A-D	A-C[2]	-	A-D[2]	-	-	-
V-LG-EF	State	6	B	-	-	B[1]	B[3]	***B[1]**	***B[1]**
	Variability	-	B-C	-	-	A-D[1]	-	-	-
V-LG-P	State	17	C	-	-	C[3]	C[1]	***C[1]**	***C[1]**
	Variability	-	A-D	-	-	A-D[3]	-	-	-
V-LG-PI	State	9	C	-	-	C[2]	**+C[1]**	***C[1]**	C[1]
	Variability	-	B-D	-	-	B-D[2]	-	-	-
U	State	7	D	-	-	D[3]	D[2]	***D[1]**	***D[2]**
	Variability	-	B-D	-	-	C-D[2]	-	-	-