BEFORE THE INDEPENDENT HEARINGS PANELS APPOINTED TO HEAR AND MAKE RECOMMENDATIONS ON SUBMISSIONS AND FURTHER SUBMISSIONS ON PROPOSED PLAN CHANGE 1 TO THE NATURAL RESOURCES PLAN FOR THE WELLINGTON REGION

UNDER	the Resource Management Act 1991 (the Act)
AND	
IN THE MATTER	of Hearing of Submissions and Further Submissions on Proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region under Schedule 1 of the Act

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STATEMENT OF EVIDENCE OF JAMES MITCHELL BLYTH

ON BEHALF OF GREATER WELLINGTON REGIONAL COUNCIL

TECHNICAL EVIDENCE – REVISION OF LOAD REDUCTIONS TO MEET VISUAL CLARITY TARGETS

HEARING STREAM 2 – ECOSYSTEM HEALTH AND WATER QUALTIY POLICIES

28 FEBRUARY 2025

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INTRODUCTION

1 My full name is James Mitchell Blyth. I am a Director and Water Scientist at Collaborations.

2 I have read the submissions provided by submitters relevant to the Section 42A report on Ecosystem Health and Water Quality policies.

3 I have prepared this statement of evidence on behalf of Greater Wellington Regional Council (**the Council**) in respect of technical matters arising from the submissions and further submissions Proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region (**PC1**).

4 This statement of evidence relates to the matters in the Section 42A Report – Ecosystem Health and Water Quality policies. Specifically, this Statement of Evidence relates to the suspended sediment load reductions required to achieve the visual clarity target attributes. These load reductions are included in PC1 in Table 8.5 of WH.P4 and Table 9.4 of P.P4. Further context for these matters can be found in paragraphs 55 to 57 and 209 in Dr Michael Greer's Statement of Evidence.

QUALIFICATIONS AND EXPERIENCE

5 I hold a Master of Science degree (**MSc**) with first class honours from the University of Waikato.

6 I am a Certified Environmental Practitioner (**CEnvP**) under the Environmental Institute of Australia and New Zealand (**EIANZ**).

7 I am a member of the New Zealand Freshwater Sciences Society.

8 I have 15 years' experience at roles within regional councils, industry (mining) and consulting, and have worked internationally. My experience covers a range of water sciences, including water quality, water resources, hydrology, hydraulics and wetlands. Throughout my career I have been involved in numerous water balance and catchment hydrological and water quality models. While working overseas, I was a technical consulting lead in hydrological and water balance modelling, and worked on models and trained staff in Africa, Canada, Laos, Thailand and Australia. Prior to joining Collaborations, I was the New Zealand lead for integrated catchment modelling at Jacobs New Zealand In addition, I have contributed and led many projects involving water quality sampling, investigation, analysis and reporting.

9 I have been involved in all four Whaitua processes the Council has run to date, and most recently was a technical advisor as part of the Council's project team for Whaitua Te Whanganui-a-Tara (**TWT**). I was involved in co-developing the catchment water quality models in Ruamāhanga Whaitua, and project managing Te Awarua-o-Porirua (**TAoP**) Whaitua catchment water quality modelling. These detailed models attempted to represent the current landuse, catchments, historical climate and streamflow in order to predict the movement of contaminants from source (i.e headwaters) to sink (rivers, lakes or the coast), and how effective landuse mitigations could be on these contaminants at scale.

10 My experience involves preparing evidence for the High Court, expert conferencing, and evidence at Council-level hearings and Environment Court cases.

CODE OF CONDUCT

11 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023 (Part 9). I have complied with the Code of Conduct in preparing this evidence. My experience and qualifications are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SCOPE OF EVIDENCE

12 My evidence covers the following topics:

12.1 An overview of fine suspended sediment and visual clarity relationships for monitoring sites within PC1.

12.2 Revision of the predicted sediment load reductions required to meet visual clarity targets.

12.3 A discussion on uncertainty in predicting the load reductions

OVERVIEW OF SEDIMENT AND VISUAL CLARITY RELATIONSHIP

13 The Council maintain a number of monitoring stations within the PC1 area that are suitable for assessing the relationship of sediment to visual clarity. I have considered a total of 23

monitoring sites, as described in Section 9 of Greer *et al.* 2023[1]. The primary difference in the work I have completed to inform this evidence from previous analysis in Greer *et al.* 2023 is that a longer data record was used, extending from July 2011 to December 2021.

14 A negative correlation exists in the riverine environment between visual clarity and suspended sediment, where increasing Total Suspended Solid (**TSS**) concentrations lead to declining visual clarity.

15 While there are many visual clarity measurements collected as part of state of the environment (**SOE**) monitoring, often paired suspended sediment concentration (**SSC**) or TSS concentrations collected at the same time are at or below detection level, as higher sediment concentrations primarily occur during wet weather events which are infrequent (compared to dry days) and can be a hazard to sample.

16 This evidence utilises relationships between TSS and visual clarity above detection levels as opposed to SSC and visual clarity, due to the greater number of paired samples available. This is discussed in detail in Greer *et al.* 2023[1].

17 Where a relationship exists at a monitoring site, a target visual clarity state (for example, set by a Whaitua Committee or required to achieve the national bottom line in the NPS-FM 2020[2]) can be compared against its median baseline visual clarity state, and be used to predict the suspended sediment load reduction that may be required.

18 The proportional (%) change in sediment load required to meet visual clarity targets was estimated using the approach in Hicks et al. (2019)[3] (also reported in Neverman et al. (2021)[4]). This empirical prediction model has been presented in Equation 1.

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[1] Greer, M.J.C., Blyth, J., Eason, S., Gadd, J., King, B., Nation, T., Oliver, M., Perrie, A. 2023. Technical assessments undertaken to inform the target attribute state framework of proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region. Torlesse Environmental Limited, Christchurch, New Zealand

[2] Ministry for the Environment. 2020. National Policy Statement for Freshwater Management 2020. Ministry for the Environment, New Zealand

[3] Hicks, D. M., Haddadchi, A., Whitehead, A., & Shankar, U. 2019. Sediment load reductions to meet suspended and deposited sediment thresholds. NIWA Client Report 2019100CH, prepared for Ministry for the Environment, Wellington

[4] Neverman AJ, Smith H, Herzig A, Basher L. 2021. Modelling baseline suspended sediment loads and load reductions required to achieve Draft Freshwater Objectives for Southland. Manaaki Whenua – Landcare Research Contract Report LC3749 prepared for Environment Southland

19 Equation 1:

$$PR_v = 1 - (V_o/V_b)^{1/\alpha}$$

PR_v = minimum proportional (%) reduction in load required to achieve the objective

V_o = target median visual clarity

V_b = baseline median visual clarity

α = co-efficient used in power law relationship between TSS and visual clarity

REASONS FOR UPDATES AND TECHNICAL APPROACH

20 PC1[5] identified a total of five sites in Table 8.5 (TWT Whaitua) and one site in Table 9.4 (TAoP Whaitua) that required load reductions to improve their median visual clarity states to meet targets. These load reductions were based on Table 40 in Section 9.6 of Greer *et al.* 2023[1]. For TWT Whaitua, clarity targets were set by the Whaitua Committee, while TAoP had targets set for the Pāuatahanui Stream at Elmwood Bridge by the Council (to meet the national bottom line), as no fine suspended sediment NPS-FM 2020 attribute existed at the time of the TAoP Whaitua Implementation Programme (**WIP**)[1].

21 Following consideration of submissions and a review of Tables 8.5 and 9.4 in PC1 and the length of monitoring data used to determine relationships of visual clarity and TSS at each monitoring site[1], it was determined that:

21.1 The Mangaroa River is colour affected due to peat tannins from the Mangaroa Peatland. A colour adjusted median visual clarity target is required to ensure sediment load reductions were not unrealistic.

21.2 There is potential to expand upon the previous assessments used to inform Table 8.5 and Table 9.4 in PC1 as they only utilised 5-years of paired monitoring data above detection level to develop correlations between visual clarity and TSS. This should be extended to account for the complete record (if data was available) from 2011 to 2021 to improve correlations, recognising some landuse change may have occurred over this time.

[5] GWRC. 2023. Proposed Change 1 to the Natural Resources Plan for the Wellington Region. https://www.gw.govt.nz/assets/Documents/2023/10/Proposed-Plan-Change-1-document-as-notified-on-30-October-2023.pdf

21.3 The presentation of annual average sediment loads (tonnes/year) in Table 8.5 and Table 9.4 in PC1 should be modified to focus on the observed relationship of TSS to visual clarity, rather than a modelled sediment load. Further information is presented in paragraph 40 and the revised Table 4.

22 For each Target Attribute State (**TAS**) site with monitoring data, site specific TSS – visual clarity alpha coefficients were calculated using the full available record if available (dating back to 2011). This was undertaken by fitting a power trendline to data displayed on a logbase10 X and Y axis. An example is presented for Mākara Stream at Kennels in Figure 1.

23 Where the r^2 relationship of that site specific trendline fell below 0.5, the site was considered unsuitable for further analysis, either to determine the PC1 combined visual clarity: TSS relationship or to predict load reductions (if the monitoring site was required to improve visual clarity to meet the NPS-FM 2020). Whilst these relationships are based off observed monitoring data, the correlation is being used as an empirical model to predict a relative load reduction. Subsequently I considered an r^2 threshold of >0.5 to be 'satisfactory' while values greater than 0.65 would be 'good', aligning with watershed scale sediment model performance criteria in Moriasi *et al.* 2007[6].

24 A Pearson (r) correlation assessment was also undertaken for each site to determine the strength of relationships, which was then coupled with a paired T-Test on the Pearson correlation to determine if the directional relationship was statistically significant with a *p value* <0.05. Site correlations with a *p value* under 0.05 indicate the probability of this relationship being due to error or chance as <5%[7]. One site was removed due to a *p value* exceeding 0.05.

25 Following these assessments, 13 monitoring sites remained that were amalgamated to determine the 'regional' relationship (with regional representing sites within the PC1 area, across both Whaitua). This has been presented in Figure 2 and Table 1.

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[6] Moriasi, D. N., Arnold, J. G., Van Liew, M. W., Bingner, R. L., Harmel, R. D. and Veith, T. L. 2007. Model Evaluation Guideline for Systematic Quantification of Accuracy in Watershed Simulations. Transactions of the ASABE 50 (3), 885–900

[7] Kremelberg, D. 2011. Practical Statistics: A Quick and Easy Guide to IBM® SPSS® Statistics, STATA, and Other Statistical Software. SAGE Publications, Inc.

26 The regional relationship has an r^2 of 0.62 and an alpha of -0.704. The previous alpha presented in Greer *et al.* 2024[1] was -0.782. The national average alpha is -0.76, as reported in Hicks et al. (2019)[3].

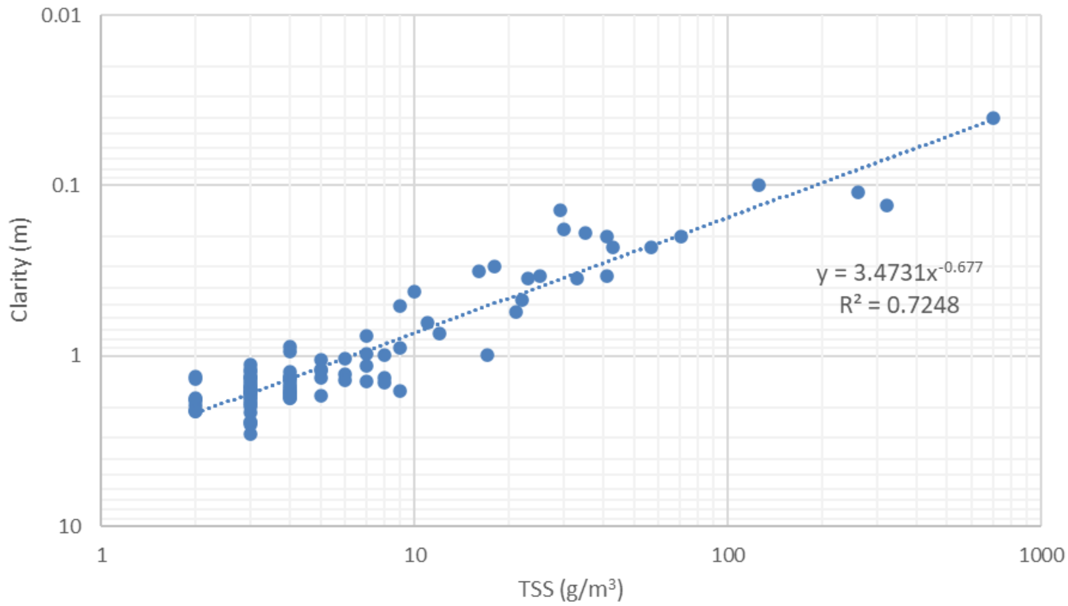

Figure 1. Site specific TSS: Visual clarity relationship for Mākara Stream at Kennels

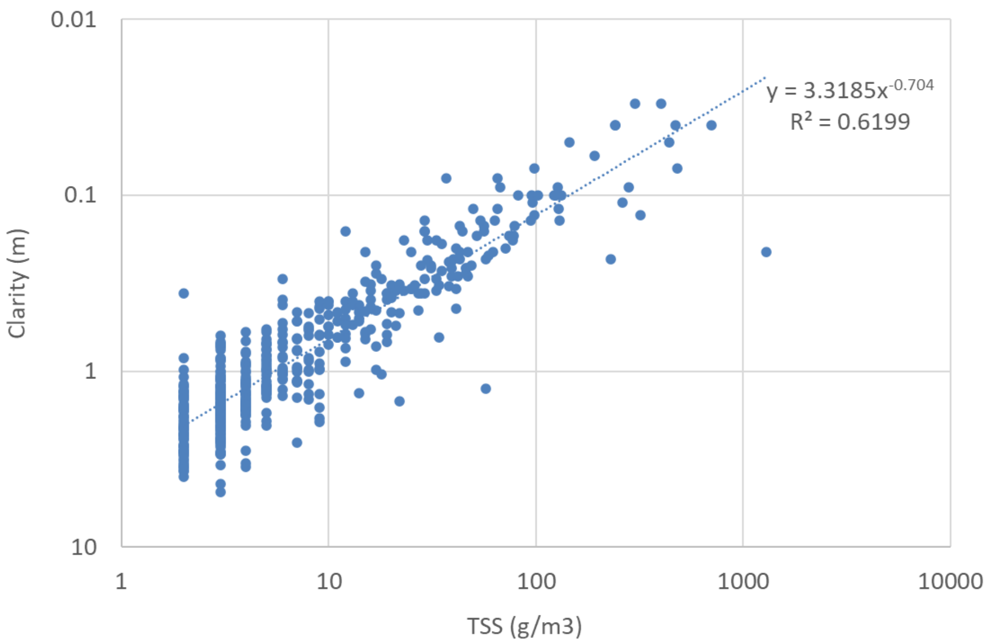

Figure 2. Revised PC1 'regional' relationship of visual clarity to TSS for acceptable monitoring sites

Table 1. Monitoring sites used in the regional relationship (Figure 2), and to derive the standard deviation of the alpha for sensitivity analysis.

Monitoring Site	Paired TSS:Visual clarity samples (above detection)	No. samples above 10 mg/L	No. samples above 50 mg/L	alpha	r^2
Horokiri Stream at Snodgrass	57	15	5	-0.727	0.66
Porirua Stream at Milk Depot	65	16	6	-0.692	0.72
Mangaroa River at Te Marua	43	13	0	-0.561	0.65
Hutt River at Boulcott	58	22	5	-0.709	0.74
Black Creek at Rowe Parade end	16	4	0	-0.766	0.78
Kaiwharawhara Stream at Ngaio Gorge	20	9	4	-0.718	0.74
Karori Stream at Makara Peak Mountain Bike Park	18	6	1	-0.762	0.54
Mākara Stream at Kennels	92	23	6	-0.677	0.72
Pākuratahi River 50m Below Farm Creek	23	8	1	-0.775	0.64
Porirua Stream at Glenside Overhead Cables	43	16	9	-0.745	0.61
Hulls Creek adjacent Reynolds Bach Drive	14	5	1	-0.819	0.9
Stokes Valley Stream at Eastern Hutt Road	12	4	1	-0.499	0.70
Ōrongorongo River at Ōrongorongo Station	26	11	7	-0.697	0.56

27 The variation in visual clarity: TSS relationships and alpha values as presented in Table 1 across the 13 monitoring sites was used to determine the mean 'regional' alpha and one standard deviation (**SD**), in order for a sensitivity assessment to be conducted. The range of alpha values runs from -0.499 to -0.819, with a mean of -0.704. The SD of the regional alpha was ±0.09 (-0.62 to -0.79), proportionately equivalent to ±12.4%. The national standard deviation of alpha reported by Neverman *et al.* 2021[4] was ±0.13 (proportionately equivalent to ±17.2%).

28 The maximum (-0.819) and minimum alphas (-0.499) are from two sites with limited amounts of data, Hulls Creek and Stokes Valley Stream. It could be assumed that greater paired samples above detection may lead to an alpha closer to the mean as exhibited in other monitoring sites. This would reduce the SD from the regional mean alpha.

29 Assuming one SD (±12.4%) as calculated off the regional mean alpha, this has been applied to relevant sites requiring load reductions (see paragraph 0).

MANGAROA RIVER AND COLOUR ADJUSTED VISUAL CLARITY

30 As identified in paragraph 21.1, submissions detailed concerns about the effect of colour on visual clarity in Mangaroa River.

31 Coloured dissolved organic matter (**CDOM**) can affect visual clarity in Mangaroa River, and colour measurements have been conducted alongside visual clarity over the last 12 months for this river and has been described in detail in the Statement of Evidence of Dr Amanda Valois[8].

32 That evidence shows that CDOM contributions in Mangaroa River are consistent across all flows, and that when adjusting for the average concentration of CDOM in visual clarity measurements, this would result in a revised NPS-FM 2020[2] site specific bottom line target of 1.67 m (from 2.22 m).

33 The revised visual clarity target for Mangaroa River, colour adjusted, of 1.67m has been incorporated into the load reduction predictions in Table 2 and Table 3 below.

REVISED CLARITY TARGETS AND LOAD REDUCTIONS

34 Table 2 details the revised predicted suspended sediment load reductions using Equation 1 (see paragraph 0) for six sites that were identified by the Council as requiring improvements to meet the TASs in PC1. For all sites presented in this evidence except for Hutt River at Boulcott, the visual clarity TAS was set at the national bottom line as detailed in section 2.2 of Greer *et al.* 2023[1].

[8] Valois, A. 2025. Statement of Evidence – Revision of baseline state and attribute bands for suspended fine sediment in light of naturally occurring processes. Prepared for GWRC PC1.

35 These sites are:

35.1 Pāuatahanui Stream at Elmwood Bridge

35.2 Mangaroa River at Te Marua

35.3 Hutt River at Boulcott

35.4 Black Creek at Rowe Parade end

35.5 Wainuiomata River Downstream of White Bridge

35.6 Mākara Stream at Kennels

36 Table 2 is based off visual clarity median 'baseline' state for the period 2012–2017.

37 Table 3 presents the same results as Table 2, however, utilised the current median visual clarity state as measured from 2019–2024.

38 Two sites (Pāuatahanui Stream and Wainuiomata River) utilised the regional alpha value (see paragraph 26) as their site-based monitoring relationships had an r^2 below 0.5.

Table 2. Predicted suspended sediment load reductions to achieve visual clarity targets by 2040 as proposed in PC1. Derived off the 'baseline' median visual clarity between 2012-2017 (as presented in Table 40 in Greer et al. 2023[1]).

Part-FMU	Site	Visual clarity Target (m) - using within generation target for TWT and NBL for TAoP	Visual clarity Target (band) - Using PC1 target for TWT and TAoP	Visual clarity baseline median 2012-2017 (m)	Site r2 relationship (if not regional)	alpha	PRv - sediment reduction to meet visual clarity target. Range in brackets is ±1SD
Takapū	Pāuatahanui Stream at Elmwood Bridge	2.22	C	1.80	Regional (0.62)	-0.704	26% (23-29%)
Te Awa Kairangi rural streams and rural mainstems	Mangaroa River at Te Marua	1.67*	C	1.50	0.65	-0.561	17% (15-20%)
Te Awa Kairangi lower mainstem	Hutt River at Boulcott	2.95	A	2.40	0.74	-0.709	25% (22-28%)
Wainuiomata urban streams	Black Creek at Rowe Parade end	2.22	C	1.30	0.78	-0.766	50% (44-57%)
Wainuiomata rural streams	Wainuiomata River Dnstr of White Bridge	2.22	C	2.10	Regional (0.62)	-0.704	8% (7-9%)
Parangārehu catchment streams and South-west coast rural streams	Mākara Stream at Kennels	2.22	C	1.60	0.72	-0.677	38% (34-43%)

***Reflects a revised site specific bottom line target CDOM adjusted[8]**

Table 3. Predicted suspended sediment load reductions to achieve visual clarity targets by 2040 as proposed in PC1. Derived off the current state median visual clarity data from 2019-2024.

Part-FMU	Site	Visual clarity Target (m) - using within generation target for TWT and NBL for TAoP	Visual clarity Target (band) - Using within generation target for TWT and NBL for TAoP	Visual clarity current state median 2019-2024 (m)	Site r2 relationship (if not regional)	alpha	PRv - sediment reduction to meet visual clarity target. Range in brackets is ±1SD
Takapū	Pāuatahanui Stream at Elmwood Bridge	2.22	C	2.19	Regional (0.62)	-0.704	2% (1.7-2.2%)
Te Awa Kairangi rural streams and rural mainstems	Mangaroa River at Te Marua	1.67*	C	1.45	0.65	-0.561	22% (19-25%)
Te Awa Kairangi lower mainstem	Hutt River at Boulcott	2.95	A	2.83	0.74	-0.709	6% (5-6.4%)
Wainuiomata urban streams	Black Creek at Rowe Parade end	2. Wainuiomata rural stream 22	C	1.24	0.78	-0.766	53% (47-60%)
Wainuiomata rural streams	Wainuiomata River Dnstr of White Bridge	2.22	C	2.55	Regional (0.62)	-0.704	0%
Parangārehu catchment streams and South-west coast rural streams	Mākara Stream at Kennels	2.22	C	1.42	0.72	-0.677	48% (42-54%)

***Reflects revised site specific bottom line target CDOM adjusted[8]**

39 Table 3 shows that using recent visual clarity current state estimates from the last 5-years of monitoring data (rather than 2012-2017 data) results in:

39.1 Two sites (Pāuatahanui Stream and Hutt River) having a significant reduction in the suspended sediment load required to meet their targets of 24% (from 26% to 2%) and 19% (from 25% to 6%), respectively.

39.2 One site (Wainuiomata River) now meets visual clarity targets.

39.3 Three sites have an increase in the suspended sediment load reductions required to meet visual clarity targets. These are Black Creek (~3% increase), Mangaroa River (~4% increase) and Mākara Stream (~10% increase).

40 Table 8.5 and Table 9.4 in PC1[5] detail the 'baseline' sediment mean annual loads (in tonnes/year) for each of the monitoring sites. In my opinion, sediment loads should not be included in the plan, as they are based off long term modelling (i.e. 1992-2018 for TWT Whaitua), may be derived off calibrated parameters from another site and would change in the future as more data of higher resolution is collected, and with advances in science or model improvements. I recommend the utilisation of relative (%) reductions tied to site-based monitoring data (i.e. TSS, SSC and visual clarity) to track long term improvements in visual clarity, and subsequently suspended sediment load, for PC1. Hence, my Table 2 and Table 3 do not present an estimate of suspended sediment loads.

41 I recommend updating Table 8.5 and Table 9.4 in PC1 with Table 4 and Table 5 below, which utilises the mid-range sediment load reductions predicted from Table 2.

42 Ongoing SOE monitoring can be used to track changes in median visual clarity state and TSS concentrations over time to then compare against the visual clarity targets, in a similar manner that has been presented in Table 3 using current state monitoring data. Changes in suspended sediment load due to landuse changes and implementing mitigations (for example, land retirement or pole planting) can take many years, if not decades to be expressed as water quality improvements, particularly when accounting for inter-annual variations in climate.

Table 4. Recommended suspended sediment load reduction table for Whaitua TWT to meet visual clarity targets; to update Table 8.5 in PC1.

Part FMU	Monitoring Site	Median Visual Clarity 'Baseline' 2012-2017 (m)	Visual clarity Target (m) - using within generation target for TWT and NBL for TAoP	Suspended sediment load reduction to meet visual clarity target
Te Awa Kairangi Rural streams and rural mainstem	Mangaroa River at Te Marua	1.5	1.67*	-17%
Te Awa Kairangi lower mainstem	Hutt River at Boulcott	2.4	2.95	-25%
Wainuiomata urban streams	Black Creek at Rowe Parade end	1.3	2.22	-50%
Wainuiomata rural streams	Wainuiomata River Dnstr of White Bridge	2.1	2.22	-8%
Parangarehu catchment streams and south-west coast rural streams	Mākara Stream at Kennels	1.6	2.22	-38%

*** Reflects revised site specific bottom line target CDOM adjusted**

Table 5. Recommended suspended sediment load reduction table for Whaitua TAoP to meet visual clarity targets; to update Table 9.4 in PC1

Part FMU	Monitoring Site	Median Visual Clarity 'Baseline' 2012-2017 (m)	Visual clarity Target (m) - using within generation target for TWT and NBL for TAoP	Suspended sediment load reduction to meet visual clarity target
Takapu	Pāuatahanui Stream at Elmwood Bridge	1.8	2.22	-26%

CONSIDERATION OF UNCERTAINTY IN LOAD REDUCTIONS

43 In their submission Wairarapa Federated Farmers (**WFF**)[9] note they are "*very concerned about the dSedNet modelling to estimate the sediment load reductions required from catchments to meet the TASs for visual clarity* [and] *believe there is too much model uncertainty and error for the model outputs to be used as a basis for policy decisions*". I only partly agree with this submission.

44 I do agree that the dSedNet modelled mean annual load (tonnes/year) as presented in Tables 8.5 and 9.4 of PC1, should be considered with caution. However, the method to predict the load reduction required to meet the visual clarity TAS (i.e. -8% reduction for Wainuiomata River Downstream of White Bridge, as presented in Table 4 above) is based off empirical relationships of observed SOE data at monitoring sites, as detailed in this evidence. Subsequently, I recommend the removal of references to modelled loads as detailed in paragraph 40.

45 The sources of uncertainty in the empirical method used to predict the relative (%) sediment load reductions, and the actions that have or could be taken to reduce this uncertainty are set out below in paragraph 46 to 51.

46 Sediment is highly variable and tied strongly to storm events and landuse practices. As visual clarity and TSS data is collected through SOE monitoring (~12 per year, per site), it is possible that event-based sediment loads may have been missed, or rainfall intensity may have been lower than normal. No climatic analysis has been completed due to time constraints to compare the last 5-years of rainfall against the 'baseline' (2012-2017) period.

47 When considering the visual clarity: TSS relationship, some uncertainties may affect prediction of the load reduction (**PRv**) required to achieve TAS. This includes:

47.1 A greater variance in visual clarity measurements at low TSS concentrations (<10 mg/L), where NPS-FM (2020) targets typically fall.

47.2 Fewer paired clarity and TSS SOE monitoring samples during high flow and load events, where poorer visual clarity is likely.

[9] Hayes, D. 2023. Submission on Plan Change 1 to the Natural Resources Plan. Submission Number S193, retrieved from https://www.gw.govt.nz/assets/Documents/2024/01/S193-Wairarapa-Federated-Farmers.pdf

47.3 Monthly sampling through SOE monitoring may miss event based paired TSS:visual clarity measurements.

48 I have attempted to reduce this uncertainty through the refinement of the monitoring sites from 23 to 13, using data from sites with an r^2 greater than 0.5, including a filter requiring the site to have a minimum of four samples above 10 mg/L. The data from these sites has been fed into the regional relationship. The SD of the mean alpha from these 13 sites also helps to provide a sensitivity analysis of the load reductions required, accounting for site variability. The regional alpha compares well to national studies.

49 There is an increasing amount of visual clarity variance evident in monitoring data at lower TSS concentrations (<10 mg/L), which is likely due to site based natural variability and potentially, measurement and laboratory sampling errors (see Figure 2). Visual clarity targets (typically greater than 2.22 m) are set at these lower (<10 mg/L) TSS concentrations, based on existing relationships. Reliance on the power equation and alpha value is therefore dependent on ensuring event based flows are adequately captured at lower visual clarity: higher TSS concentrations to ensure the direction of the trendline is appropriate to predict the target visual clarity state.

50 As discussed in paragraph 47 and presented in Table 1, it is evident in some PC1 streams (across both Whaitua) that greater event based paired sampling in the short term, or consideration of current visual clarity state over a longer time period (to account for variabilities in climate and landuse that may be missed in monthly SOE) would be helpful to reduce this uncertainty in visual clarity current state and comparison to the PC1 TASs.

51 Sediment models may be utilised by the Council (such as dSedNet[10])) to help identify areas where erosion prone land could be mitigated to reduce loads, particularly at catchments that are identified in Table 4. Sediment models can be improved over time as data is collected (such as event based suspended sediment sampling) and new science is developed to better account for natural sediment processes and climate influences. Subsequently, the modelled load estimates may change over time and for this reason, I have recommended the removal of loads in the revised Table 4 and Table 5.

[10] Blyth, J.M. 2025. Statement of Evidence – Technical Evidence Modelling Overview. Prepared for GWRC PC1.

52 Despite the uncertainties discussed in paragraph 46 to 51, I consider that there is no scientific reason to adopt WFFs suggestion to delete rather than amend (as per my Table 4 and Table 5) Tables 8.5 and 9.4 of PC1, as:

52.1 The approach used to develop Table 2 and Table 3 currently represents the best available and practical method for quantifying the scale of the sediment load reductions required to achieve the visual clarity TASs in PC1, through an established relationship utilising monitoring data.

52.2 I understand that the load reductions cited in Tables 8.5 and 9.4 of PC1 are not performance targets that are required to be met by any on farm activity. Rather they provide a general indication of the magnitude of the improvement required by the visual clarity TASs in PC1. I also understand that the rural land-use provisions of PC1 (Rule WH.R27, Rule WH.R28 Rule P.R26 and Schedule 36) do not reference Tables 8.5 or 9.4 directly. Instead, they promote/require specific practices that have been assessed (by Greer 2023a and 2023b)[11,1] as being generally consistent with the achievement of the visual clarity TASs rather than Tables 8.5 and 9.4 load reductions.

CONCLUSION

53 Tables 8.5 and 9.4 in PC1 were based off sediment load reductions equations derived off paired site based TSS: visual clarity measurements from 2016 to 2021. This evidence utilised a longer dataset (2011 to 2021) to expand the paired sample count to improve empirical relationships.

54 Following a review process, a total of 13 sites (out of 23) were used to derive a regional relationship between TSS: visual clarity, and site based relationships where correlations were acceptable. The regional alpha (derived off an empirical power relationship) of -0.704 is comparable to national alpha of -0.76.

55 Visual clarity was identified as being affected by CDOM in Mangaroa River, and the Statement of Evidence from Dr Amanda Valois confirms that an adjustment was necessary to the NPS-FM 2020 site specific bottom line for the attribute fine suspended sediment (as

[11] Greer, M.J.C. 2023. Assessment of alignment between the regulatory provisions and target attribute states in proposed Plan Change 1 to the Natural Resources Plan – Whaitua Te Whanganui-a-Tara (Torlesse Environmental Report No. 2023–008). Torlesse Environmental Ltd, Christchurch, New Zealand

measured by visual clarity) from 2.22 to 1.67 m. This would reduce the suspended sediment load reductions required for Mangaroa River to reach the TAS set by the Whaitua Committee for fine suspended sediment.

56 It is recommended that Table 8.5 and Table 9.4 in PC1 be updated by Table 4 and Table 5 as presented in this evidence, to remove sediment loads (tonnes/year) from PC1, focussing instead on a relative (%) reduction in suspended sediment load as determined by established relationships of paired suspended sediment and visual clarity tracked through long term SOE monitoring.

57 While there are a number of sources of uncertainty in the load reduction values in Tables 8.5 and 9.4 of PC1, I do not consider that this is justification for accepting submissions requiring the deletion of Tables 8.5 and 9.4 of PC1.

DATE: 28 FEBRUARY 2025

JAMES MITCHELL BLYTH

DIRECTOR AND WATER SCIENTIST AT COLLABORATIONS