BEFORE THE HEARINGS PANEL

IN THE MATTER of the Resource Management Act 1991 ('the Act')

AND

IN THE MATTER of Proposed Plan Change 9 to the Hawke's Bay Regional Resource Management Plan

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STATEMENT OF REPLY EVIDENCE OF ALEXANDRA NATALIE HAIDEKKER FOR HAWKE'S BAY REGIONAL COUNCIL

CONTENTS

1. INTRODUCTION

1.1 My name is Alexandra Natalie Haidekker.

1.2 I am Senior Scientist in the Freshwater Quality and Ecology Team at the Hawke's Bay Regional Council (**HBRC**) and have been in this position for 11 years. I have 26 years of experience in the fields of freshwater ecology, and water quality effects on freshwater macroinvertebrates.

1.3 I hold the qualifications 'Diplom' in Biology (comparable to MSc: 4 years study and 1 year thesis) from the University Konstanz, Germany, and a PhD in ecology from the University Duisburg-Essen, Germany.

1.4 Until 2008, I worked at the University Duisburg-Essen and contributed to the programme AQEM/STAR for developing an assessment system using macroinvertebrates for the European Water Framework Directive. My focus of work was contributing to the development of type-specific reference conditions for rivers and research on the effect of water temperature regime on benthic macroinvertebrates.

1.5 Since being employed by HBRC, my area of work has been State of the Environment reporting, and studies on various components of water quality and aquatic ecology (e.g. instream nutrients, faecal source tracking, macroinvertebrates, environmental pressures in lowland streams). I was also involved in the development and trial of several monitoring protocols (e.g. for habitat, deposited sediment, macrophytes) and am involved in the Environmental Monitoring and Reporting (**EMaR**) rivers group for habitat and sedimentation.

1.6 I was the lead freshwater quality scientist throughout the Tūtaekurī, Ahuriri, Ngaruroro and Karamū (**TANK**) plan change process (ca. 8 years). This involved providing water quality and ecological information, information on attributes/indicators, guidelines and other information to support the TANK stakeholder group to understand the state of water quality and ecology in the TANK catchments, relate values with attributes, and assist in the setting of objectives. I authored /co-authored reports relevant to PPC9 on nutrient limitation in the Tūtaekurī and Ngaruroro catchments, ecosystem health in lowland streams with particular focus on the Karamū catchment, SOE reports for the TANK catchments for 2008-13 and 2013-18 reporting periods, and a report on the water quality information provided to support the development of limits and targets by the TANK group. I contributed to Schedule 26 and 27 in the PPC9, and to the following PPC9 section 42A reports: Appendix 1B Schedules, Appendix 2 Planning Maps, Appendix 9.

1.7 I have prepared this evidence in my capacity as an expert, and although this is not a court hearing I confirm that I have read and understand the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note dated 1 December 2014. I have complied with it when preparing my evidence, and I agree to comply with it when I give any oral evidence. Other than where I state that I am relying on the evidence of another person, my evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and scope of evidence

1.8 The purpose of this evidence in reply is to address matters raised in the statements of evidence filed by submitters.

1.9 I do not repeat matters that are addressed in my technical memo appended to the s 42A Hearing Report on Proposed Plan Change 9 (**Hearing Report**). However, to assist the Panel, where another witness has raised a significant matter that I have already addressed (and which I do not wish to discuss further), I provide a cross-reference to my technical memo.

1.10 I comment on matters raised by other witnesses only where I consider that what they are saying may be incorrect or that it should be qualified.

1.11 For the avoidance of doubt, any failure to cross reference or specifically discuss any matter raised by other witnesses does not mean I agree with that evidence of the other witnesses. My opinion remains as stated in my technical memorandum appended to the Hearing Report, except to the extent covered or identified now in this reply brief.

1.12 My evidence will address matters raised in the statements of evidence of Ms Catherine J Sturgeon for Horticulture New Zealand, and Dr Michael J C Greer on behalf of Beef & Lamb New Zealand.

1.13 My evidence focuses on the following matters:

(a) Review of Schedule 28 priority maps

(b) Derivation and applicability of attributes and targets in Schedule 26

2. KEY FACTS AND ASSUMPTIONS RELIED ON

2.1 In preparing my evidence I have reviewed the following documents and evidence.I also contributed to the reports listed below:

(a) Proposed Plan Change 9 Report

(b) TANK Evaluation Report

(c) TANK hearing report

3. EXECUTIVE SUMMARY

3.1 In partial agreement with Ms Sturgeon, I think the table and maps for priority catchments should be based on (1) sediment yield (updated), (2) total nitrogen (**TN**) yield (updated), (3) total phosphorus (**TP**) yield (added) and (4) dissolved oxygen (**DO**) levels (not changed). I recommend that the maps and table thresholds are all derived from modelled data to provide almost full spatial coverage and relative comparability of the TANK catchments for prioritisation. The recently modelled Ahuriri catchment should be added to the TN and TP yield maps. The TN concentration map should be deleted to avoid redundancy and confusion with the TN yield map and Schedule 26.

3.2 I disagree with Ms Sturgeon that the TN map should be replaced with a dissolved inorganic nitrogen (**DIN**) map. The biotic influences on nitrogen forms mean TN is a more reliable variable to use in modelling and for accounting purposes, and TN is more appropriate for estimating loads to downstream receiving environments. I recommend using TP rather than dissolved reactive phosphorus (**DRP**) for the same reasons.

3.3 I think the rationale applied by Dr Greer for changing DIN and DRP targets disregards the stipulated ki uta ki tai approach (NPSFM 2020, Policy 3), the downstream effects of contaminants along the river continuum, and their effects on receiving environments. The changes proposed by Dr Greer for DIN and DRP would increase the risk of failing to maintain and enhance ecosystem health in the TANK catchments.

3.4 I think the nutrient and macrophyte guidelines in Matheson *et al.* 2016 represent the best available science for the critical values of periphyton and macrophyte growth in the context of the specific characteristics of Hawke's Bay. The 'interim' thresholds

were the best fit for the TANK catchments and the TANK group objectives regarding the frequency and duration of algal blooms.

3.5 I agree with Dr Greer that there is a discrepancy between the narrative and numeric objectives for MCI in lowland streams. There appears to have been a transcription error from the PPC9 Schedule 26 to the s42a Schedule 26 in Appendix 2a for the numerical long-term MCI target. Updating the long-term target for lowland streams to a 'Good' state (MCI ≥ 110), would be consistent with the approach taken for the macroinvertebrate targets in the revised Schedule 26 in all other TANK areas.

4. RESPONSE TO MS STURGEON

Priority maps and Schedule 28: Priority catchments

4.1 Ms Sturgeon (paragraph 61, 62, 65) notes that the TN priority map does not correspond with the thresholds in the priority table from Schedule 28. I concur with Ms Sturgeon and confirm that the thresholds used to produce the maps were different from the table.

4.2 Ms Sturgeon (63, 64, 66) raised concerns that the SOURCE model overestimates TN concentrations compared to measured SOE data, and that modelled TN concentrations place areas in the Karamū catchment into the high priority category, whereas SOE data would classify these as medium to long-term priority.

4.3 Ms Sturgeon (66, 68) notes more discrepancies in modelled TN vs measured DIN data in relation to nutrient guidelines, and in relation to algal growth risk and suggests using a DIN risk map rather than a TN risk map to be comparable to measured SOE data. She raises concerns that there is little correlation between Schedule 26 and 28.

4.4 I agree that differences between measured (SOE) and modelled (SOURCE) datasets can create confusion. SOE and modelled data each bring limitations and advantages, and each should be used in the right context. Therefore, they are used to inform different parts in the plan and are not interchangeable. SOE data reflects the current state at a point in time and location and is influenced by site specific and variable attenuation factors, and by limited spatial representation. The accuracy of modelled data can be limited due to complex interactions that affect nutrient concentrations in-stream (e.g. biological processes including uptake) but provides relative comparability within the modelled dataset to estimate a relative risk for a system (before attenuation). The modelled dataset has almost full spatial coverage in the catchments.

4.5 SOE data used in Schedule 26 informs baseline data, benchmarking against water quality guidelines and assessing trends over time. For this purpose, measured data is required. The SOE sites are representative for similar sites or catchments in the TANK area (i.e., upper catchments, main stems, hill country tributaries, lowland tributaries) but monitoring can't occur everywhere due to costs and logistics.

4.6 The SOURCE model output is used in Schedule 28 to identify a priority catchment order. For this, better spatial coverage than SOE sites is needed, which the model provides. Modelled data is used to enable prioritisation in a relative spatial context. Because in-stream attenuation factors are not explicitly modelled, this data is not used to benchmark against water quality guidelines in Schedule 26.

4.7 The TN priority map is based on modelled data (SOURCE), which was only run for TN and TP. The biotic influences on nitrogen forms mean TN is a more reliable variable to use in modelling and for accounting purposes, and TN is more appropriate for estimating loads to downstream receiving environments because nitrogen forms can be recycled such that more DIN could be mobilised from the TN pool.

4.8 I agree with Ms Sturgeon that the grouping of sediment, phosphorus and *E. coli* on the base of contaminant pathways is not applicable everywhere. While this concept usually applies to hill country areas, the contaminant pathways are different in lowland areas, particularly for tile drained land which provides pathways for DRP and *E. coli* into streams.

4.9 Phosphorus loss to waterways, along with nitrogen, can exert a major influence on ecosystem health. I agree with Ms Sturgeon that an additional phosphorus map for a farm plan prioritisation framework (i.e. priority maps) would benefit from identifying areas where phosphorus levels may be contributing to lower ecosystem outcomes. I recommend using TP rather than DRP for the same reasons as outlined in paragraph 4.7 for TN.

4.10 To summarise, for a wider range of information and to add clarity, the table in Schedule 28 and priority maps should be based on (1) sediment yield (updated), (2) TN yield (updated), (3) TP yield (added) and (4) DO levels (not changed). The proposed changed TN yield map and added TP yield map are in Appendix 1 and 2 respectively. The TN concentration map should be deleted to avoid redundancy and confusion with the TN yield map and Schedule 26.

5. RESPONSE TO DR GREER

5.1 In Table 6 of his evidence, Dr Greer summarises his recommended changes to the targets in Schedule 26. I disagree with Dr Greer's recommendations except regarding a partial amendment to the macroinvertebrate attribute.

5.2 Dr Greer recommends changes to attributes that are already reflected in the updated Schedule 26 in the S42a report Appendix 2B or are by default included in the National Policy Statement on Freshwater Management 2020 (**NPSFM 2020**) application. These recommendations are not discussed in my evidence. They are the following attributes: Temperature, turbidity, pH, *E. coli*, deposited sediment, periphyton biomass in the lower Tūtaekurī and lower Ngaruroro rivers, and sb-MCI.

Nutrient targets in Schedule 26

5.3 Dr Greer notes in paragraphs 56 and 59.4 that non-compliance with DIN and DRP targets in Schedule 26 does not appear to affect ecosystem health in any meaningful way and mentions that sites meeting nutrient targets do not meet periphyton targets and vice versa. 5.4

5.4 I disagree with the rationale being applied, which seems focused on linking DIN or DRP to conditions at that particular site. Algal growth depends also on other factors than nutrient concentration, e.g., light availability or substrate size. For example, at sites with high nutrient availability and small gravel or shade, algal growth is likely to be low (Tūtaekurī at Brookfields Bridge, Mangatutu Stream). By contrast, the nutrient concentration can be particularly low at sites with high algal cover in shallow, unshaded gravel beds, where nutrient uptake by long filamentous algae can be very high at summer low flows (Ngaruroro at Fernhill). Some sites tend to switch between periphyton and macrophyte dominated states, they are periodically highly productive, but the separate assessments may not make sense until all factors are put together (Ohiwia, Maraekakao streams). Importantly, the DIN and DRP being supplied from upstream areas including hill country tributaries is driving the growth of periphyton along the mainstem of the Ngaruroro, but the growth of periphyton in the mainstem means the measured DIN and DRP concentrations at Fernhill are low.

5.5 It is my understanding that objectives should not be considered on a site-by-site basis, but rather a ki uta ki tai approach should be taken, as stipulated by policy 3 of the NPSFM 2020. Given the downstream effects from dissolved nutrients, I therefore think Dr Greer's conclusion that "non-compliance with the dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) Schedule 26 objectives does not appear to affect ecosystem health in any meaningful way" is misleading

and I don't think his recommendation to change the DIN and DRP objectives in Schedule 26 should be accepted.

5.6 Dr Greer raised concerns regarding the process by which both DIN and DRP attribute objectives (targets) were selected (paragraphs 59.4, 85 to 93) with regard to periphyton growth.

5.7 Dr Greer proposes the use of DIN targets from (Matheson *et al.*, 2016) Table 4-6, but selects the nutrient criteria related to periphyton abundance / biomass (chlorophyll *a*), not periphyton cover (%PeriWCC). The nutrient criteria in this table are derived from summer periphyton data.

5.8 HBRC assesses periphyton cover monthly at all hard-bottomed SOE sites year-round, while periphyton biomass is only monitored (additionally) at a representative site in each FMU. Therefore, the nutrient criteria proposed by Dr Greer are not related to the periphyton cover attribute that we report on at all suitable SOE sites. For further information on why periphyton cover, not biomass, is monitored at the majority of SOE sites refer to paragraph 5.22.

5.9 HBRC assesses periphyton cover year-round because long periphyton growing seasons are typical for Hawke's Bay due to the warm climate and prolonged periods of low flows. Summer-only monitoring may miss additional times of high periphyton cover. The nutrient criteria developed with summer-only data in Table 4-6 in (Matheson *et al.*, 2016) may therefore not be suitable. Furthermore, no DRP criteria were derived with this method, which would have made the nutrient approach related to periphyton cover inconsistent.

5.10 I concur there are currently no robust nutrient criteria relating to periphyton cover. For PPC9, I suggested using nutrient criteria that were used for modelling (Matheson *et al*., 2012), which are based on the analysis of the National River Water Quality Network (**NRWQN**) dataset and literature review. The thresholds represent 4 algal growth categories from very low risk to high risk of exceeding a filamentous algal cover threshold of 30%. Concern about excessive periphyton growth was clearly expressed during the community consultation process, and the approach taken represented the best available science at the time of the PPC9 process. I am of the opinion that these are the most suitable guidelines for nutrients for the specific characteristics of Hawke's Bay. The 'interim' thresholds were the best fit in the context of the TANK catchments, reflecting the level of algal cover observed in the different areas, and the objectives supported by the TANK group to reduce frequency and duration of algal blooms.

5.11 DIN concentrations at SOE sites in the upper Tūtaekurī and Ngaruroro catchments are well below 0.05 mg/L, and any change to the target in this area would not be cognisant of the objective to 'maintain' or 'improve'.

5.12 The 0.15 mg/L DIN target that applies to the mid to lower main stems of the Tūtaekurī and Ngaruroro reflects the current situation of increased nutrient concentrations and occasional algal blooms where periphyton growth is supported (gravel size, light availability). A more lenient target of 0.63 mg/L as suggested by Dr Greer would decrease the likelihood of maintaining or achieving ecosystem health objectives.

5.13 Similarly, the targets for the mid to lower main stems of the Tūtaekurī and Ngaruroro reflect the objectives set by the TANK stakeholder group and are within the ranges already observed within SOE data. Again, a more lenient target would appear inconsistent with the objectives in the plan.

5.14 Dr Greer notes, in paragraph 88, that the nutrient thresholds were based on the relationship with long green filamentous cover, not the periphyton cover measured as periphyton weighted composite cover (**PeriWCC**) index. I still consider this as the better fit than with periphyton biomass (chlorophyll *a*), particularly because mats are weighted only 0.5 in the PeriWCC periphyton cover index.

5.15 As noted by Dr Greer in paragraph 91, lowland tributaries are not managed for periphyton growth, as they generally don't support benthic algae and are instead macrophyte dominated. However, the contribution of dissolved nutrients to estuarine health was considered here and is covered in the evidence of Ms Madarasz-Smith.

5.16 In paragraphs 92 and 93, Dr Greer raises concerns that the DRP criteria were updated to reflect the NPSFM 2020 nutrient criteria, and while the NPSFM 2020 includes DRP attribute states, it also requires exceedance criteria to be set for periphyton growth.

5.17 DRP targets have been updated to the NPSFM 2020 attributes as a response to submitter requests to update the attributes to NPSFM 2020. Unlike for DRP, I did not defer to the corresponding proposed DIN NOF thresholds, because these were not adopted by the NPSFM 2020. The nutrient criteria that were used for Schedule 26 before revision were based on algal growth risk categories as laid out in paragraph 5.10. for DIN. I consider the update of the revised Schedule 26 DRP target to the NPSFM 2020 DRP attribute as suitable because:

(a) it applies to all TANK areas, including lowland tributaries; and

(b) the NOF attribute includes outcomes related to algal and plant growth, which I consider suitable to relate to the corresponding objectives of the TANK group.

Periphyton attribute

5.18 Dr Greer suggests that periphyton targets should have been set using periphyton biomass (chlorophyll *a*) (paragraphs 100 to 106), as it is a compulsory attribute in the NPSFM 2020.

5.19 The periphyton biomass attribute is one of the compulsory ecosystem variables that needs to be managed according to the NPSFM 2020 framework. But this applies to a representative monitoring site for each FMU, not for all sites the council may undertake monitoring at. I have recommended a representative monitoring site for each of the four major catchments in TANK, which I think would make logical FMUs from a biophysical perspective. Periphyton biomass would be monitored at each of these four sites, as per NPSFM 2020. However, FMUs have not officially been proposed through PPC9 process, and rather FMUs will be consulted upon and confirmed during the Kotahi (i.e. region wide) plan change process.

5.20 The PPC9 process involved discussions around a diverse range of values that are affected by periphyton cover, and the diverse range of values are not well represented by the periphyton biomass attribute as stipulated in the NPSFM 2020. HBRC developed a periphyton monitoring network with this broader range of values in mind.

5.21 Specifically, HBRC started monitoring periphyton biomass in 2001. Visual algal cover assessments started in 2008. After a phase of assessing both attributes over 5 years at a subset of SOE sites until 2017, periphyton cover monitoring continued for all hard-bottomed SOE sites, while all FMU and some other representative SOE sites continued to have both periphyton cover and biomass assessments.

5.22 The decision to monitor periphyton biomass at FMU sites, and periphyton cover at all hard-bottomed SOE sites was based on the following reasons:

(a) The periphyton cover assessment captures more information in one assessment than periphyton biomass: eight periphyton categories are assessed that have different levels of impact on values (e.g., filamentous algae vs mats, cyanobacteria), additionally % fine sediment cover can be assessed at the same time.

(b) Periphyton cover is easier to communicate and discuss with stakeholders in relation to identified values, because % algal cover is easier to visualise on a stream bed than mg/m^2 chlorophyll *a*.

(c) Periphyton cover assessment is more economical because it is rapid and no lab sample analysis is required, which allows for all hard-bottomed SOE sites to be monitored monthly, all year round, providing more information but requiring less resources.

5.23 It is my opinion that the TANK collaborative process has reinforced the benefits of periphyton cover assessments for the reasons mentioned above.

5.24 An estimate of chlorophyll *a* could be derived from the visual assessments (Kilroy *et al.* 2013) if necessary, as we have concurrent data for key SOE sites to develop a relationship. This approach is also provided for in the NPSFM 2020, when biomass is clearly below the numeric objective. It is my opinion, however, that the periphyton cover assessment is not inferior to the biomass assessment (as shown in Kilroy *et al*. 2013) and is often better suited to linking objectives with community values, for the reasons mentioned above.

5.25 I think the nutrient criteria in PPC9 are based on the best available science and are able to guide the TANK group's objective to reduce periods of algal blooms in areas of concern. The NPSFM 2020 DRP attribute band narratives include general algal growth categories that correspond to the categories discussed by the TANK group (A: similar to natural condition, B: additional algal and plant growth, C: increased algal and plant growth, D: excessive primary production). Intuitively, the bands appear to be a suitable fit. The DIN criteria used for modelling in Matheson *et al.* (2012) represent low, moderate, high risk for algal blooms. The thresholds for each of the categories fit in the TANK context.

5.26 In summary, I think the nested approach for setting numeric objectives and monitoring periphyton in the TANK goes over and above the requirements laid out in the NPSFM 2020. Periphyton biomass targets are set for representative monitoring sites in each proposed FMU, and periphyton cover is monitored at a much larger number of sites throughout the TANK catchment to ensure performance against a range of relevant values the TANK group identified as assessable. I think adding biomass targets for each monitoring site listed in Schedule 26 would be superfluous.

Macrophytes

5.27 Dr Greer argues that macrophytes should not be included in PPC9 as an attribute because guidelines in relation to macrophyte abundance are provisional (paragraph 110).

5.28 Macrophytes are a critical element of ecosystem health in lowland streams, as Dr Greer highlights (paragraph 41) and were identified as a key element to manage the poor ecosystem health in lowland streams. I concur the macrophyte abundance guidelines in Matheson *et al.* (2012 and 2016) are provisional, but they are the best science available, and I consider them to be robust for setting numeric objectives. Improving ecosystem health in lowland streams is one of the priority objectives of PPC9 and removing macrophyte guidelines could mean an unnecessary delay in guiding progress towards ecosystem health objectives.

Macroinvertebrates

5.29 Dr Greer notes that the target set for MCI in lowland areas does not match OBJ TANK 11-13, as MCI target is set at a 'Fair' state.

5.30 I concur with Dr Greer. There has been a transcription error from the proposed Schedule 26 and 27 to the updated S42a Schedule 26 that sets the long-term target for lowland areas erroneously to an MCI of ≥ 90 which is representative of a fair state. The TANK group's long-term objective was an MCI indicative of a good state and set at a long-term target of MCI ≥100 in Schedule 27.

5.31 For the macroinvertebrate attribute in the NPSFM 2020, the MCI thresholds were raised by 10 points across all bands compared to the original MCI framework by (Stark and Maxted, 2007). This means that an MCI of 100 is now indicative of a 'Fair' state only, and the threshold for a 'Good' state is at MCI 110. I recommend updating to an MCI ≥ 110 to be consistent with the approach taken for the macroinvertebrate targets in the revised Schedule 26 in all other TANK areas.

6. CONCLUSION

6.1 Phosphorus loss to waterways, along with nitrogen, can exert a major influence on ecosystem health. I agree with Ms Sturgeon that a farm plan prioritisation framework (i.e. priority maps) would benefit from identifying areas where phosphorus levels may be contributing to lower ecosystem outcomes.

6.2 In my opinion, assessing DIN/DRP concentrations with periphyton growth only on a site-by-site basis fails to acknowledge the principle of Ki uta ki tai/ river continuum concept. Periphyton abundance, at sites suitable to growth, reflects the cumulative nutrient contribution from upstream in the catchment.

6.3 I consider that the nutrient and macrophyte guidelines in Matheson *et al.* 2016 represent best available science for the critical values of periphyton and macrophyte growth in the context of the specific characteristics of Hawke's Bay. The 'interim' thresholds were the best fit in the context of the TANK catchments and the TANK group objectives to guide discussions around the frequency and duration of algal blooms.

Alexandra Haidekker
19 May 2021

REFERENCES

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MATHESON, F., QUINN, J. M. & UNWIN, M. 2016. Instream plant and nutrient guidelines. Review and development of an extended decision-making framework Phase 3. *Hamilton, New Zealand: National Institute of Water and Atmospheric Research. No. CHC2013-122*.

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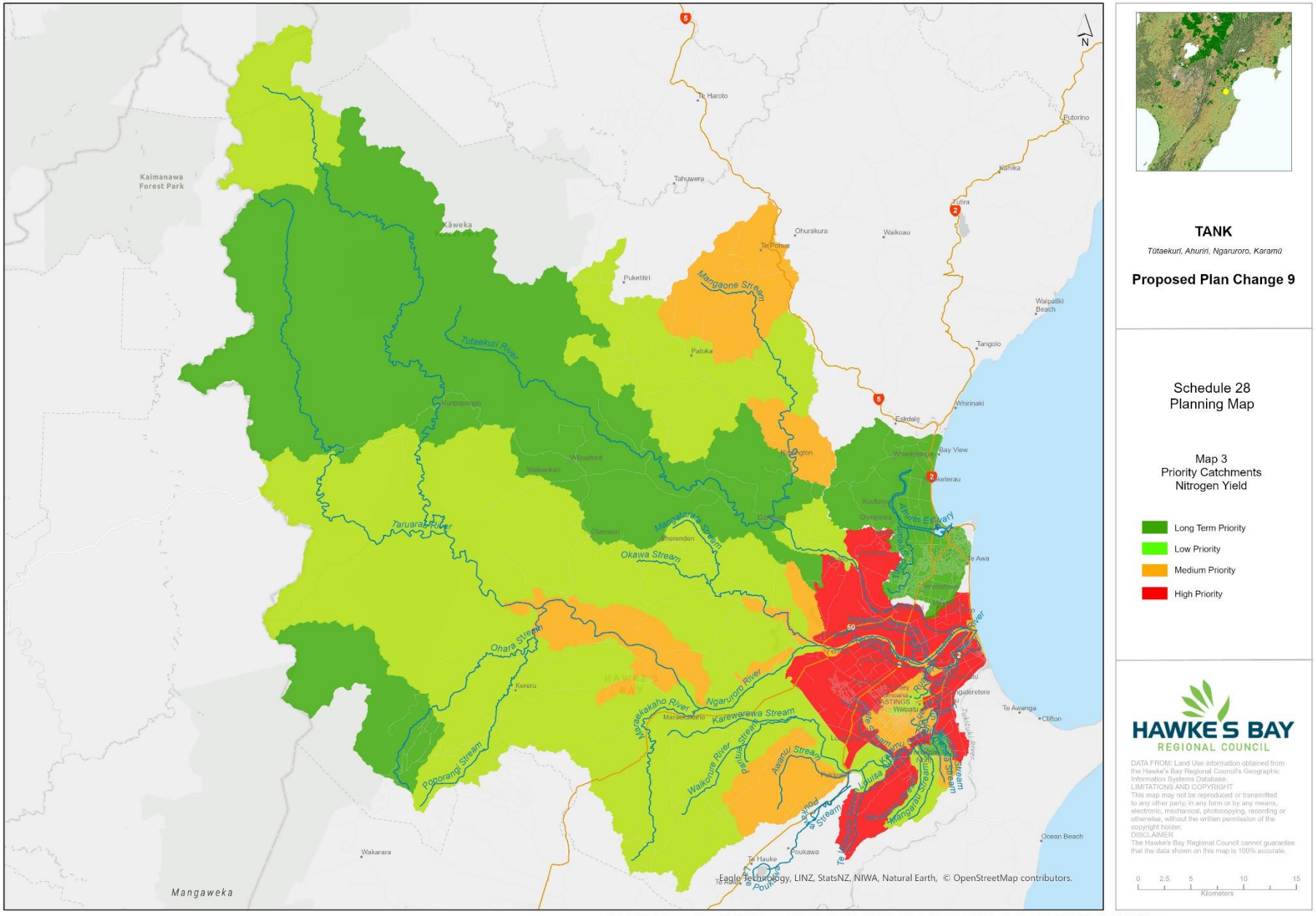
APPENDIX 1. Updated TN yield priority catchment map.



APPENDIX 2. New TP yield priority catchment map.