

**IN THE MATTER** of the Resource Management Act  
1991

**AND**

**IN THE MATTER** of applications by Meridian Energy Limited to Manawatū-Whanganui Regional Council, Greater Wellington Regional Council, Tararua District Council and Masterton District Council for resource consents to enable the construction, operation, and maintenance of a new wind farm on Mount Munro, located approximately 5km south of Eketāhuna

**SECTION 87F REPORT OF ADAM FORBES – FRESHWATER ECOLOGY**

**MANAWATŪ-WHANGANUI REGIONAL COUNCIL, GREATER WELLINGTON  
REGIONAL COUNCIL, TARARUA DISTRICT COUNCIL AND MASTERTON DISTRICT  
COUNCIL**

**15 March 2024**

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## **A. OUTLINE OF REPORT**

- 1 This report, required by section 87F of the Resource Management Act 1991 (**RMA**), addresses the issues set out in sections 104 to 112 of the RMA, to the extent that they are relevant to the applications lodged with the Manawatū-Whanganui Regional Council (**Horizons**), Greater Wellington Regional Council (**GWRC**), Tararua District Council (**TDC**) and Masterton District Council (**MDC**).
- 2 The resource consents applied for, by Meridian Energy Limited (**Meridian or the Applicant**), are required to authorise the construction, operation and maintenance and improvement of a new wind farm on Mount Munro, located approximately 5km south of Eketāhuna. The project is known as the Mt Munro windfarm project (the **Mt Munro Project or Project**).
- 3 In this report I address freshwater ecology matters relating to the resource consent applications lodged with Horizons and GWRC (the **Regional Councils**) and TDC and MDC (the **District Councils**) (the **Application**). Specifically, this report covers matters arising in respect of the applications to the Regional Councils.
- 4 While this report is pursuant to section 87F of the RMA, I have in accordance with section 42A(1A) and (1B) attempted to minimise the repetition of information included in the application and where I have considered it appropriate, adopt that information.

## **B. QUALIFICATIONS / EXPERIENCE**

- 5 My name is Adam Forbes. I am the Director and Principal Ecologist at Forbes Ecology Limited. I have been in that position since 2012.
- 6 Of most relevance to the Mt Munro Project, my role involves preparation and peer review of ecological assessments under the RMA.
- 7 I hold a bachelor's degree in applied science, a Master of Environmental Science and a PhD in Forestry.

8 I have 20 years' experience as an ecological consultant. The first 8 years I was employed as a project ecologist by MWH New Zealand Limited (now branded Stantec) and for the remaining 12 years I have been self-employed operating as an independent ecological practitioner working on RMA matters and also as an academic researcher. Much of my RMA work has been in the central and lower North Island in the regions of Hawke's Bay, Horizons, and Greater Wellington.

9 I am familiar with site and surrounding area. I visited the site along with other experts of the Regional Councils and District Councils on 23 June 2023.

**C. CODE OF CONDUCT**

10 I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023. This technical report has been prepared in accordance with that Code. In particular, unless I state otherwise, the opinions I express are within my area of expertise, and I have not omitted to consider material facts that might alter or detract from the opinions that I express.

11 I note that I have identified significant gaps in the freshwater assessment and as such this leaves me in a position where I am unable to assess the ecological values or effects, nor the adequacy of the proposed freshwater offset. The proposal for receiving environment effects monitoring is also inadequate. I have made a number of recommendations to address these concerns.

**D. EXECUTIVE SUMMARY**

12 The key conclusions of my report include:

(a) There are significant inadequacies in the methods followed for freshwater fish surveys and stream classifications. This creates uncertainty over the accuracy of the statutory significance assessment, freshwater values assessment, and corresponding effects assessment within the Application.

(b) The threatened status and level of natural diversity of aquatic species have been either omitted or diminished (respectively) in the

freshwater assessment which has had the effect of lowering the assessed ecological significance, values, and effects.

- (c) The statutory ecological significance assessment is incomplete and has not considered nor correctly portrayed the full breadth of information available.
- (d) Based on the freshwater assessment, and from further work through my assessment, I do not accept the Applicant's ecological values assessment as representative or complete. From the information available I am unable to determine what the actual freshwater ecology values are across the site.
- (e) Regarding the 210 m of culverting proposed for the Mangaroo tributary:
  - i. it is not clear how the effects management hierarchy has been applied, as is required by the National Policy Statement for Freshwater Management 2020 (**NPS-FM**); and
  - ii. the scale used for the magnitude of effect assessment is inappropriate and has the effect of diminishing the overall level of effect.
- (f) The magnitude of effects assessment does not include all structures required for culverting, meaning those effects are not included in the proposed offset.
- (g) A freshwater offset is proposed to address the direct effects of culverting; however this is not based on data collected from the site nor on an explicit calculation. The offsetting proposed contravenes the offsetting principles of ecological equivalence and transparency. Adequate information has not been provided to achieve an offset that I am confident meets key regulatory requirements (of the NPS-FM, and regional planning documents) and in particular a no-net-loss (or net gain) position for freshwater biodiversity.

- (h) The freshwater assessment has not adequately demonstrated how the effects management hierarchy has been applied. In particular, measures to avoid or reduce effects to river extent and instream habitat have not been adequately explored nor described.
- (i) As such I am unable to determine the adequacy of the assessed levels of effect or proposed offset/compensation package.
- (j) The proposed instream contaminant monitoring is not acceptable. In particular, there are inadequate measures proposed to identify and describe adverse effects in freshwater receiving environments (especially during the trout spawning season) from sediment discharges or to detect altered pH from concrete works.
- (k) Submitters raise concerns over adverse effects to stream and aquatic life from traffic, roading, construction and operational phases of the proposal. Concerns are raised over potential effects to trout along with concerns about the inadequate level of monitoring proposed. Four submitters consider the applicant's stream classification work to underrepresent the permanence of the stream network across the site. More robust instream monitoring is requested by submitters and those requests have my support.

**E. SCOPE OF REPORT**

13 My report focuses on issues related to the freshwater ecology assessment. It covers the following topics:

- (a) Receiving environments;
- (b) Issues with Freshwater Assessment Methods;
- (c) Accuracy of Statutory Ecological Significance Assessment;
- (d) Adequacy of Ecological Values Assessment;
- (e) Completeness and Accuracy of Freshwater Ecology Effects Assessment;

- (f) Adequacy of Proposed Freshwater Effects Management;
- (g) Issues Relating to Relevant National Policy Statements;
- (h) Submissions; and
- (i) Conditions.

14 I have reviewed and relied on the information provided by:

- (a) Freshwater ecology sections of the Appendix C of the Application – Boffa Miskell (May 2023). Ecological Assessment Prepared for Meridian Energy Ltd (the **Freshwater Assessment**);
- (b) Application Section 92 Additional Information Request – Incite (7 September 2023) Response to the Mt Munro Proposed Wind Farm Resource Consent Application Section 92 Additional Information Request (**RFI#1 Response 1**); and
- (c) Response to Councils’ Section 92a Further Information Request – Response to Councils’ request for clarification on Section 92 Further Information Request Information – Incite (25 October 2023). Clarification of Meridian’s Response to the Mt Munro Proposed Wind Farm Resource Consent (**RFI#1 Clarification Response**).

15 In preparing this report, I have relied on the expert advice from the following technical advisors from the Council reporting team:

- (a) Sue Ira – Operational Water Quality/Stormwater;
- (b) Andres Roa – Operational Water Quantity Hydrology;
- (c) Kerry Pearce – Erosion and Sediment Control; and
- (d) Andrew Curtis – Air Quality.

16 I visited the site at the same time as James Lambie (Council’s terrestrial ecology reviewer) along with the Applicant’s ecologists and a representative from Meridian.

- 17 I also had input in the request for further information under section 92 of the RMA, dated 6 July 2023 (**RFI#1**), where I identified a range of matters which I considered necessary for the Applicant to address for the purposes of my review. RFI#1 led to the responses I describe at paragraph 14 above.
- 18 The requests I made in RFI#1 were the results of a detailed review of the Application and observations made during the site visit. My intention was to request all required information from the Applicant so that I could fully understand the effects of the proposal. However, the information I received has not been sufficient for me to reach that position.
- 19 Regarding the outstanding issues I raise below, taking my executive summary as a reference, I consider the values/significance/offset aspects still need to be addressed through further work prior to granting consent. The remaining issues such as protocols for instream works and instream health monitoring can be addressed through conditions and/or management plans.

#### **F. BACKGROUND**

- 20 The Mt Munro site is located in the Wairarapa approximately 3 km south of Eketahuna township. The site is located on the boundary between the Greater Wellington and Horizons Regions. To the east the site drains to the Kopaurunga catchment which is a subcatchment of the Ruamahunga river in the Wellington Region. Other parts of the site drain to the Mākākahi catchment (including the tributaries Bruce Stream and unnamed tributary of the Mangaroa subcatchment) which are all sub-catchments (i.e., Horizons One Plan (**One Plan**) subzone Mana\_8d) of the Mangatainoka river, and more broadly the Manawatū river, in the Horizons Region.
- 21 Of note, Schedule B of the One Plan lists Mana\_8d as a site of aquatic significance (SOS-A) due to records of the threatened freshwater fish shortjaw kokopu in areas of the subcatchment (i.e., a zone-wide not site specific value). Trout spawning (TS) is another recognised value (site specific) of Mana\_8d.
- 22 Schedule E of the One Plan gives the following relevant water quality targets:



- (a) pH = 7-8.5 and change of no more than 0.5.
  - (b) Deposited sediment cover = 20%.
  - (c) MCI = 120.
  - (d) Visual clarity = 3 m and change of no more than 20%.
- 23 Due to trout spawning values, the following additional water quality targets apply during the period 1 May – 30 September inclusive:
- (a) Deposited sediment or particulate organic matter = no observable change on the stream bed.
  - (b) Deposited sediment cover = <10%.
- 24 Based on data provided in the Freshwater Assessment, I draw the following comparisons between the above water quality targets and relevant survey results from the site:
- (a) Appendix 4 to the Freshwater Assessment gives 2011 estimates of pH for the Mākākahi tributaries as ranging pH 7.03-7.34. These results are within the Mana\_8d water quality targets.
  - (b) Appendix 4 to the Freshwater Assessment gives 2011 estimates of deposited sediment cover for the Mākākahi tributaries as ranging 13-32%. These are towards the upper end or exceeding the water quality targets, particularly for trout spawning values during the spawning season (May to September).
  - (c) Table 15 of the Freshwater Assessment gives MCI scores for 8 tributaries within the Mākākahi catchment. Mean MCI is 104 which is less than the water quality target.
- 25 Taking this information into account it is clear that the receiving environments are sensitive to sediment deposition. This is especially the case in relation to trout spawning values.

- 26 Regarding instream works, the proposal discusses the need to undertake culvert works offline (i.e., in dry conditions facilitated by a temporary flow diversion) and in my experience the water quality effects relate to sediment release upon livening of the constructed culvert. Also in my experience, this effect is short term and I consider it to be manageable with appropriate site management. I defer to the expert evidence of Mr Pearce as to the appropriateness of the site management proposed.
- 27 Regarding One Plan water quality targets, I am of the opinion that pH in receiving environments will be manageable within the pH water quality target range. Instream monitoring of pH should be a requirement of consent. Less easy to address are deposited sediment and macroinvertebrate community structure/health where the existing conditions do not meet water quality targets.

## **G. ASSESSMENT OF APPLICATION**

### **Issues with Freshwater Assessment Methods**

- 28 The freshwater fish survey was conducted over 50 m long stream reaches. However, best practice (Joy et al., 2013) states that 150 m long reaches are necessary, as an absolute minimum, in order to describe reach-scale fish diversity, population structure and relative abundance (or to provide a baseline for monitoring) in wadeable New Zealand Streams.<sup>1</sup> I am therefore concerned about the adequacy of the freshwater fish survey in terms of representing the fish values of the waterways surveyed. I consider it likely that the freshwater assessment has not adequately characterised the fish populations, nor communities, of the affected catchments.
- 29 The survey site “MAG2” was introduced in 2021 and only a spotlight survey (no electric fishing) was conducted. This is a weakness of the assessment as multiple fish survey methods are required to avoid underrepresenting species. For instance, species known to be underestimated by spotlight fishing include longfin and shortfin eel, torrent fish and lamprey (Joy et al., 2013; page. 8). This inadequacy in sampling is a particular concern for the

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<sup>1</sup> Joy et al., 2013; page 3.

integrity of the assessment of the Mangaroa Stream tributary/MAG2, where only spotlighting was conducted. This waterway is proposed to receive the greatest degree of direct adverse effects (through extensive culverting).

30 I also note that the fish surveys in the Bruce stream did not deploy dual survey methods (e.g., electric fishing and spotlighting) and as such those results should be viewed as incomplete.

31 Stream classification is an important aspect of an RMA-based freshwater assessment as the results of a stream classification not only provide some insights into likely stream values but importantly the status of a given waterway in relation to the RMA and NPS-FM definitions of a River. The assessment has not adopted a formal method of stream classification. The assessors could have selected from either the GWRC (2021) or Auckland Council (AUP 2021) methods. Comments from submitters (long standing land occupiers who are apparently familiar with the waterways over long timeframes) claim there to be inaccuracies in the assessed stream classifications. The freshwater assessment lacks credibility as it has not followed a formal and accepted stream classification assessment method.

32 While proposed instream works relating to culverts are located within mapped permanent/intermittent reaches (therefore there is no uncertainty over hydroclass for these sites), I consider the practical implication of this uncertainty for the Project to relate to the extent of intermittently flowing receiving environments in relation to site activities. In particular, discharges planned to occur to ephemeral reaches which could actually be intermittently flowing and therefore hold a higher sensitivity than assessed.

### **Accuracy of Statutory Ecological Significance Assessment**

33 Section 7.3 the Freshwater Assessment assesses statutory significance (i.e., RMA s 6(c)) of waterways within the Project area. The assessment relies solely on Regional Councils' assessments through One Plan Schedule B and GWRC Natural Resources Plan (**NRP**) Schedule I (the latter relates only to trout).

- 34 While the site does not contain reaches listed in One Plan Schedule B, I am concerned over the lack of consideration given to At Risk – Declining longfin eel. More generally, I am concerned that the limited survey effort given to native fish may have missed aspects that would trigger representativeness, rarity and/or diversity criteria.
- 35 The Freshwater Assessment omitted to consider GWRC NRP Schedule F “Ecosystems and habitats with significant indigenous biodiversity values”<sup>2</sup> which defines significance as those ecosystems and habitats which meet one or more criteria of Policy 23 of the GWRC Regional Policy Statement (**RPS**). While the assessment has not undertaken an assessment of the Kopuaranga tributaries against GWRC RPS Policy 23, in my view, it is obvious from fish data that one or more At Risk – Declining species are present (i.e., longfin eel and possibly torrent fish) which triggers the Rarity criterion of Policy 23.
- 36 Also given the macroinvertebrate communities are typical of the structure and diversity of pastoral systems New Zealand wide (as I have established in paragraphs 47 & 48 below), the natural diversity of those macroinvertebrate communities would also trigger the Diversity criterion. These results support a conclusion that the assessed reaches of the Kopuaranga tributaries hold statutory significance in terms of Policy 23 criteria. However, this has not been identified in the Freshwater Assessment.

### **Adequacy of Ecological Values Assessment**

- 37 I have concerns that the Freshwater Assessment undervalues the freshwater ecosystems of the Mt Munro Project area. The assessment has omitted important aspects of freshwater biodiversity applicable to tributaries of the project area. Importantly, the assessment downplays the conservation concern of longfin eel (which is At Risk – Declining)<sup>3</sup> and is likely to have underrepresented fish values through inadequate sampling (as discussed above). The assessment has not considered the value of other threatened species located nearby in the same catchments which, given adequate survey effort, could reasonably be found within streams of the Mt Munro

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<sup>2</sup> GWRC Natural Resources Plan, from page 484 onwards.

<sup>3</sup> Dunn et al., 2018.

Project area. In combination, these aspects of the Freshwater Assessment diminish the described ecological values of the waterways. In my opinion this has implications for the Applicant's assessment of effects and proposed effects management measures. I outline the reasons for my concerns below.

38 Appendix 6 to the Freshwater Assessment contains the freshwater values assessment presented against EIANZ (2018) Table 7 assessment criteria. Here, for tributaries in each main catchment (Mākākahi, Kopuaranga and Bruce Streams), the Rarity and Distinctiveness assessments have not taken the threat status of longfin eel (At Risk – Declining) into account. This is acknowledged in Appendix 6 with the reason given as a review of the New Zealand Freshwater Fish Database (NZFFD) indicates to the assessor that longfin eel are Not Threatened. This opinion appears to be based on a count the assessors have undertaken of survey results for longfin eel in the Manawatū Catchment. However, I note at a regional scale this opinion does not address, and is inconsistent with, regional threat rankings undertaken in the Wellington Region which classes the regional longfin eel population as Declining.<sup>4</sup>

39 Regarding longfin eel at the national scale, the most recent advice from the Department of Conservation<sup>5</sup> states:

... the panel remains concerned about the continuing degradation of longfin eel habitat, especially in lowland areas, and ongoing issues with fish passage (both upstream and downstream). Decline in water quality in many areas has resulted in shortfin eel occupying habitat that formerly held the longfin eel. Therefore, the assessment remains At Risk – Declining.

40 Further, and of direct relevance, assessment criteria given in the NPS-IB at Appendix 1 C Rarity and Distinctiveness (3) states: <sup>6</sup>

The list of Threatened and At Risk species is regularly updated by the Department of Conservation. Rarity at a regional or ecological

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<sup>4</sup> GWRC 2022, page. 7.

<sup>5</sup> Dunn et al., 2018; page. 4.

<sup>6</sup> National Policy Statement for Indigenous Biodiversity 2023 at Appendix 1, page 35.

district scale is defined by regional district list or determined by expert ecological advice. **The significance of nationally listed Threatened and At Risk species should not be downgraded just because they are common within a region or ecological district.**

- 41 This further confirms my opinion that the longfin eel threat status must not be downgraded from At Risk – Declining, given its rating at the national scale by Dunn et al. (2018) and the regional scale by GWRC (2022).
- 42 If the assessment had taken the threat status of longfin eel into account the results for Rarity and Distinctiveness would have been High (rather than Low; based on EIANZ 2018 Table 5) which would raise the assessed ecological value to Moderate value for the Mākākahi and Kopuaranga tributaries and High (rather than Moderate) for the Bruce Streams.
- 43 In addition to the above concerns, for completeness I have reviewed the NZFFDB for the Mt Munro Project area.<sup>7</sup> Through this review I found several nearby observations recorded in that database that are potentially relevant to the freshwater ecosystems of the Mt Munro Project and should have been, but were not, considered by the Freshwater Assessment. These omitted records are of Nationally Vulnerable species or species that if present would add to the assessed diversity/biodiversity<sup>8</sup> of the Mt Munro Project area’s waterways (each of which is currently assessed as Low value).
- 44 Firstly, a record<sup>9</sup> in the upper Mākākahi River (c. 900 m NNW from the summit of Mt Munro) for the recently described<sup>10</sup> species - Kaharore Bully (*Gobiomorphus mataraerore*). Secondly, a record from an unnamed tributary of the Mākākahi River (c. 4 km NE of the project area) for Kākahe (*Echyridella aucklandica*) which is a threatened native freshwater mussel species, able to inhabit small fast flowing streams, holding the national threat classification of Threatened – Nationally Vulnerable.<sup>11</sup>

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<sup>7</sup> Searched NZFFD catchment ID 325.201 which is the same search as used in the Freshwater Assessment.

<sup>8</sup> EIANZ 2018 Table 7.

<sup>9</sup> NZFFD Record ID 125775. Surveyed by Boffa Miskell on 1/11/21.

<sup>10</sup> Thacker et al., 2021.

<sup>11</sup> Grainger et al., 2014.

- 45 These are two aspects of the freshwater biodiversity of the upper Mākākahi River tributaries which the Freshwater Assessment has omitted to consider. Freshwater mussels were not included in the freshwater survey and given the Threatened – Nationally Vulnerable status of Kākahe, a conservative approach in the absence of survey results is both reasonable and responsible. Assessing the Kaharore Bully as potentially present would increase the assessed natural diversity from Low to Moderate. Including the freshwater mussel in the ecological assessments would increase the Rarity and Diversity assessments which would boost the assessment of overall ecological value (to a minimum of Moderate, and perhaps High value depending on the location and combination of other revisions made to the assessment).
- 46 In addition, lamprey were recorded historically in the Mākākahi River (c. 22 km to the NNE near the intersection of Rock Road and SH2). Lamprey have the threat classification of Threatened - Nationally Vulnerable.<sup>12</sup> Lamprey are more widespread than usually appreciated or as indicated by survey results. They are a nocturnal, burrowing, species and can easily be confused with eels during night spotlighting or overlooked during electric fishing as their habitats tend to be under sampled. James (2008) noted it probable that lampreys are present in all New Zealand river catchments excepting those that lack appropriate habitat. Further, lamprey are consistently underrepresented in spotlight survey results.<sup>13</sup> There is insufficient evidence to conclude absence of lamprey from the waterways of the Project area especially those where only spotlighting was applied. As with the potential presence of Kākahe, the Threatened – Nationally Vulnerable status of lamprey makes assuming its presence a reasonable and responsible assumption to make and would significantly increase the rarity assessments and the overall values assessments.
- 47 Regarding macroinvertebrate health and diversity, taking MCI as a broadly available and comparable index for comparison, Table 15 of the Freshwater Assessment presents 2021 MCI results from across the site. The mean MCI

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<sup>12</sup> Dunn et al., 2018.

<sup>13</sup> Joy et al., 2013.

score across the 10 sites is  $104.7 \pm 5.4SD$ . Nationally (from 863 long-term monitoring sites; source LAWA) the mean MCI is  $101.8 \pm 18.9SD$ . This comparison indicates the MCI data from 2021 shows the mean state of the macroinvertebrate community to be representative of typical conditions (actually a little greater than; MCI 104 vs MCI 101) across New Zealand. A national survey of pastoral streams showed mean MCI score of  $99.1 \pm 1.7CI$ <sup>14</sup> lending further support to my opinion over the representative state of macroinvertebrate communities in the surveyed streams. Further comparison can be drawn from a national survey of 66 sites which returned median MCI 103. The same study returned a measure of diversity (Shannon's Index ( $H'$ )) of 1.52  $H'$  (Scarsbrook et al., 1999) which I note is approximately central to the range calculated by Dr Keesing in Appendix 12 to the RFI#1 Response 1 where he stated  $H'$  values across the 10 surveyed sites ranged 1.35 to 1.7  $H'$ .

- 48 The macroinvertebrate data presented in the Freshwater Assessment are representative of typical conditions at national scales and have a moderate diversity. However, those data are not portrayed in that manner by the Freshwater Assessment. As such, Appendix 6 to the Freshwater Assessment ranks Diversity for all catchments and waterways as Low which has a further effect of diminishing the assessed ecological value of all assessed streams.
- 49 Regarding the freshwater values assessment, overall, I conclude that the values stated have been diminished by disregarding the threat classification of longfin eel (which has reduced the Rarity component of the values assessment) and through inadequate fish sampling in both extent and method to adequately characterise fish populations and communities. NZFFD Records from wider areas of the affected catchments indicate that the values could reasonably be greater than what the assessment suggests. The typical nature of the surveyed macroinvertebrate diversity has not been recognised. In combination these factors would lead to alternative outcomes for the assessed ecological value (sites would likely be Moderate or High) and also the ecological significance assessment, as discussed above.

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<sup>14</sup> Larned et al., 2016; Table 4.



50 The limitations I have identified with the Freshwater Assessment mean that I am unclear over the actual ecological values for the Mt Munro Project area. In my opinion, these issues need to be addressed by the Applicant.

### **Completeness and Accuracy of Freshwater Ecology Effects Assessment**

51 Regarding the proposed 210 m of culverting (i.e., two long culverts labelled Culvert 1 and 2) in the Mangaroo tributary, the effects are assessed by the freshwater assessment as being of a Low magnitude, to a Low value waterway, resulting in a Very Low overall effect.

52 As I have explained above, I would consider the ecological value of the Mangaroo tributary as Moderate rather than Low. This is based on corrections to the Freshwater Assessment I consider necessary, regarding:

- (a) rarity assessments in the context of the presence of At – Risk Declining fish species (longfin eel);
- (b) a level of fish survey effort inadequate to fully describe the fish community;
- (c) a representative and typical diversity of macroinvertebrates being present but not accounted for through the assessment;
- (d) and the presence of other Threatened species in nearby areas of the catchment which are unaccounted for by the Freshwater Assessment.

53 Regarding the magnitude of effect of the 210 m culvert being assessed as Low, I have below reproduced Table 8 of EIANZ (2018; on which the effects magnitude assessment is based) gives the descriptions of the classes, including for Low and Moderate.

**Table 8. Criteria for describing magnitude of effect** (Adapted from Regini (2000) and Boffa Miskell (2011))

Magnitude	Description
Very high	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

54 Choosing a correct and reasonable scale of assessment of magnitude is critical to achieving a correct and reasonable result. If the scale of assessment is too large, then the magnitude of effect is diminished through the assessment. On this, EIANZ (2018) recommend the scale of assessment to be at the 'site' or 'zone of influence'. This could reasonably be taken as the length of the unnamed tributary (i.e. the affected sub-catchment). However, the Freshwater Assessment has based the scale of assessment as the entire Mangaroa catchment, which I consider to be too larger area. In my view the Mangaroa catchment is removed from both the culverting sites and from the zone of influence of the proposed culvert activity. In my view the wider catchment is not relevant to an assessment of magnitude of effect.

55 An assessment at the sub-catchment scale, which according to the Freshwater Assessment would be 7% permanently modified by the total culvert length, would be Moderate - loss or alteration of one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed. This is appropriate as the stream ecosystem will be modified where is flows through the culvert length. In my view, the magnitude should not be assessed as low at the sub catchment scale because:

- (a) There would be more than a minor shift away from the existing baseline conditions; and
- (b) The existing baseline would be altered so it is no longer similar to the pre-development character (i.e., a culverted reach is of a dissimilar character to a non-culverted reach).

- 56 In addition to Culverts 1 and 2 on the unnamed Mangaroa tributary, two other areas of culvert works (i.e., one new culvert, Culvert 3; and one upgrade with extension, Culvert 7) are proposed in the Freshwater Assessment, along with one proposed bridge. All sites are proposed to be located in tributaries of the Mākākahi catchment. I understand that culverts 3 and 7 are within entrenched settings and will be temporally dammed and stream flows pumped around the respective works areas.
- 57 Bridge crossings of small tributaries tend to be the preferable method of crossing as direct effects can be avoided and their presence tends to have no ongoing adverse effect. This is assuming there are no instream bridge support structures required and that construction follows best practice by avoiding adverse effects from stream disturbance or sediment and any other contaminant runoff from the works area. If this is the case, then I have little concern over the proposed bridge crossing.
- 58 Proposed Culvert 3 in the Mākākahi tributary has a proposed length of 30 m. However, it is my understanding from Appendix 12<sup>15</sup> to RFI#1 Response 1 that the 30 m length does not include wingwalls at either end, and also that no riprap armouring of the stream bed is proposed. On this latter point, armouring (if proposed) would be a concern to me as in some situations it can be difficult to maintain surface water and other stream functions where heavy armouring of the stream bed occurs. The total length of stream works used for effects management (ideally freshwater offsetting) should include both the culvert length plus the length of wingwalls and any other activities that create direct effects to the stream. In my opinion, it should be made clearer that no stream armouring shall take place in on the project.
- 59 Regarding the proposed upgrade and extension to Culvert 7, my comments are the same as for Culvert 3 – that is the total effects length needs to account for the new culvert length plus any new wingwalls. No riprap armouring of the wetted stream bed should be allowed.

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<sup>15</sup> Boffa Miskell Memorandum, dated 29 August 2023.

## Adequacy of Proposed Freshwater Effects Management

- 60 The direct effects to waterways from instream works (i.e., Culverts 1, 2, 3 & 7) have not been quantified for the purposes of calculating a freshwater biodiversity offset. By this I mean field data has not been collected from the affected sites to adequately quantify the nature of affected areas or of areas where residual adverse effects are proposed to be offset.
- 61 A key principle of biodiversity offsetting is ecological equivalence<sup>16</sup> which describes the degree to which the biodiversity gain attributable to an offset is balanced with the biodiversity losses due to development, and whether a no-net-loss (or net gain) outcome is achieved. Assessing equivalence requires the biodiversity at both the impact and offset site to be described and measured to quantify losses and gains. Demonstrating ecological equivalence differentiates biodiversity offsetting from environmental compensation.<sup>17</sup>
- 62 A second offsetting principle is relevant here: transparency. The transparency principle requires any offset to be designed and implemented in a transparent and timely manner.<sup>18</sup> To conduct an offset in a manner that achieves both equivalence and transparency, in New Zealand the best practice method of quantifying and calculating the losses and gains is the Stream Ecological Valuation,<sup>19</sup> which entails a range of detailed field measurements at the impact, offset, and reference sites. A MS Excel calculator can then be used from those field derived data to calculate an Environmental Compensation Ratio (**ECR**) which is a multiplier used to determine the extent of positive effects required to achieve a no-net-loss (or net gain) position. Factored into the calculation of an ECR are provisions (additional positive effects) for risk and time lag. This is because the positive effects from the restoration treatment (riparian retirement, restoration and legal protection) will lag behind the time of culverting by about 5-10 years (+) and planting native trees is an uncertain exercise regarding weather,

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<sup>16</sup> Maseyk et al., 2018.

<sup>17</sup> Maseyk et al., 2018.

<sup>18</sup> NPS-FM Appendix 6, principle 11; NPS-IB Appendix 3, principle 11; Maseyk et al., 2018.

<sup>19</sup> Storey et al., 2011.

pests, and other factors that might arise at the restoration site which are beyond the consent holder's control.

63 The Freshwater Assessment has not demonstrated equivalence nor is the asserted offset transparent in terms of the accuracy of the values supporting their calculated ECR. Strictly speaking, as the offset is not based on data collected from relevant areas of the site (it is not clear where in New Zealand the data used relate to), the positive effects proposed in the form of stream restoration should be considered environmental compensation rather than a biodiversity offset.<sup>20</sup> An offset could be achieved if the Freshwater Assessment had collected SEV data from relevant parts of the site.

64 In an effort to progress and resolve this issue I raised this issue during the site visit with the Applicant's ecologist, Dr Keesing and then again in RFI#1.<sup>21</sup> However, the issue remains unaddressed by the Applicant and as a result I am unable to determine the adequacy of the positive effects proposed to address adverse effects to freshwater (termed offset in the assessment).

65 In my opinion the Applicant needed to collect relevant site data to support an SEV based freshwater offset calculation which is consistent with One Plan Policy 13-4 (d) (ii) and the GWRC NRP Schedule G2 principle 6 (f), which states:

Any proposals for biodiversity offset will demonstrate: (f) that an explicit calculation of loss and gain has been undertaken as the basis for the biodiversity offset design, and should demonstrate the manner in which no net loss, and preferably a net gain of biodiversity, can be achieved by the biodiversity offset, ...

66 Based on the information provided in the Freshwater Assessment and responses to further information requests, in my view, the following points (a)-(c) would need to be provided prior to granting consent to adequately meet offset principles. Point (d) could be required as a condition of consent:

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<sup>20</sup> Maseyk et al., 2018; page. 5.

<sup>21</sup> In particular, item 71 .

- (a) Confirmed effect types/activities and quantities, and SEV scores (SEVi-I);
- (b) SEV data from affected waterway lengths (SEVi-C & SEVi-P), the proposed offset site (SEVmC & SEVm P), and suitable reference data;
- (c) Clear calculations using the SEV formula<sup>22</sup> for calculating ECRs for the waterways at the locations of proposed culverts 1, 2, 3 and 7. Offset requirements should be itemised by proposed culvert location to ensure transparency; and
- (d) An offset management plan which meets regulatory requirements<sup>23</sup> and includes details such as:
  - i. The parameters (such as planted width etc assumed in the ECR calculations and) carried through into the offset management plan;
  - ii. Offset location, area, and timing;
  - iii. Proposed planted species composition and spacing;
  - iv. A description and quantification of what is described in the Freshwater Assessment as “*improvements to substrate and flow heterogeneity*” at the offset site;
  - v. A fencing plan describing the alignment and standard of fencing, including the location of any gates or other access features to support establishment and maintenance;
  - vi. A regime of maintenance to ensure success;
  - vii. A regime of monitoring and a method of determining when the offset has been successful; and

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<sup>22</sup> Using the formula in its entirety as presented on page 56 of Storey et al. (2011).

<sup>23</sup> I note that the NRP at Schedule G2 principle 6 (i) requires an intention to include and use a biodiversity offset management plan with specifics listed in (i) – (iii).

viii. A method of legal protection adequate to ensure the offset is permanently protected.

67 I note this is an initial list - other factors may also be required as determined through this consenting process.

68 I also consider that detailed methods for mitigating adverse effects on instream life and habitat need to be developed on a site-specific basis for culvert installation. Amongst other factors, this should include a fish salvage method and methods of conducting stream works offline.

69 A regime of assessing freshwater receiving environments for sediment discharges also needs to be developed and proposed by the Applicant. This monitoring needs to be coordinated with stormwater/erosion and sediment control site/device monitoring. I recommend the general approach to be:

- (a) Establish monitoring triggers – likely to be a rainfall and a stormwater clarity trigger used in tandem. The purpose of these triggers is to direct surveys of freshwater receiving environments to determine whether significant sedimentation has occurred and whether biotic life has been affected, and if so, to what extent.
- (b) Survey sites could be based at least partly on existing stream survey sites. The first step should be to estimate benthic deposited sediment using SAM 2 methodology (Clapcott et al., 2011). This would need to be replicated upstream and downstream of discharge points to isolate effects from the site from those of the surrounding land uses.
- (c) A significant change in deposited sediment when detected would trigger a quantitative assessment of macroinvertebrate community structure (Protocols C3 or C4; Stark et al., 2001). This would require a quantitative baseline of deposited sediment and macroinvertebrate community structure prior to works commencing, especially given the stringent water quality targets relating to the trout spawning season.

- (d) Where significant sediment deposition is detected through monitoring, a plan for stream remediation should be required to be submitted to Councils for review and approval and then implemented.
- (e) In addition, I recommend summer and winter monitoring of deposited sediment and macroinvertebrate community structure during the construction period. Then further monitoring of these aspects until the site has been demonstrated through receiving environment monitoring to be stabilised.

70 The above monitoring regime is my recommendation in the absence of a recommended approach from the Applicant. I have made corresponding recommendations for inclusion in proposed conditions of consent.

#### **Issues Relating to Relevant National Policy Statements**

71 Specific requirements of the NPS-FM are relevant to the proposal, as I described below.

72 The Applicant is required to adopt an approach to managing adverse effects structured according to the effects management hierarchy. This imperative also comes through in the NPS-FM where the loss of river extent must be avoided unless Council is satisfied that:<sup>24</sup>

- (a) there is a functional need for the activity in that location; and
- (b) the effects are managed by applying the effects management hierarchy.

73 I have not directly considered the question of functional need for the activity, which I understand others address. My focus has been whether the effects are managed by applying the effects management hierarchy.

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<sup>24</sup> NPS-FM, clause 3.24(1). Every regional council must include this policy (or words to the same effect) in its regional plan.



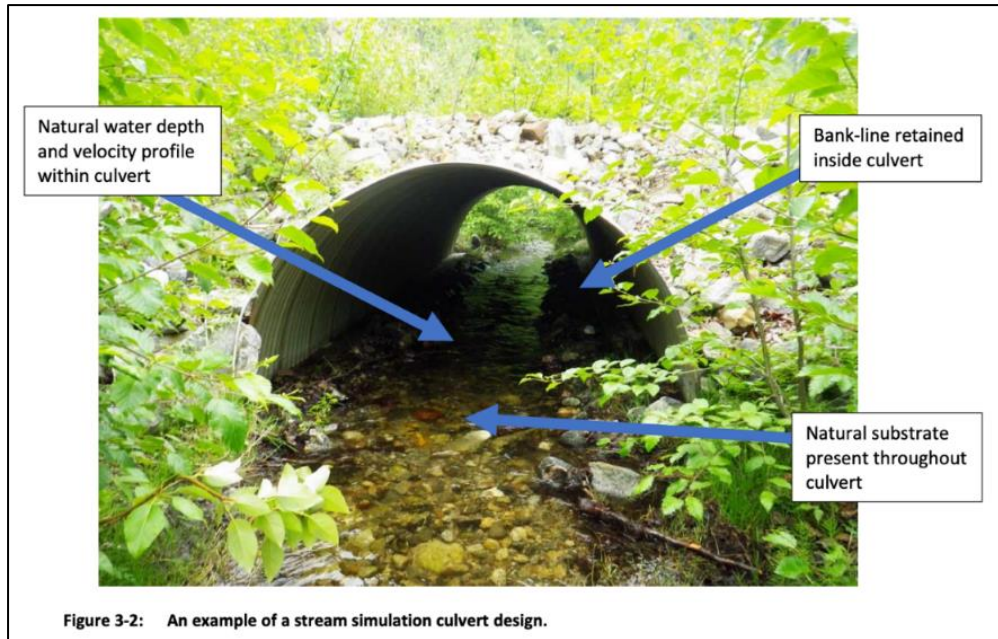
74 For the effects management hierarchy, the main concern from a freshwater effects perspective is the proposed culverting of the Mangaroa tributary. I see two main avenues for avoidance of loss of river extent or values:

- (a) Firstly, alternative routing of the proposed access track to avoid or minimise interaction with the tributary. The Freshwater Assessment does not contain or refer to such as assessment and I would require that assessment in order to understand how the effects management hierarchy has been applied.
- (b) Secondly, the method of culvert design. Proposed are standard barrel culverts which I consider to have a homogenising effect on the stream ecosystem. This presents risk for fish passage and inevitably reduces habitat diversity and more generally, ecosystem health and indigenous biodiversity values. Alternatives to barrel culverts exist in the form of Stream Simulation Culverts, which are defined by the New Zealand Fish Passage Guidelines (**NZFPG**)<sup>25</sup> (see also Figure 3-2 from the NZFPG included for illustrative purposes below):

The aim of the stream simulation design approach is to create within the structure a channel as similar as possible to the adjacent stream channel in both structure and function, resulting in a continuous streambed that simulates natural channel width, depth and slope (Figure 3-2). This provides the diverse water depths, velocities, resting areas and wetted edge habitats that different fish species use during their migrations. Furthermore, it maintains habitats that support macroinvertebrate communities and other biodiversity values.

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<sup>25</sup> NIWA, 2018; also Figure 3-2 from the NZFPG included for illustrative purposes below.



- 75 Fish passage is part of the reason from my recommendation for stream simulation culverts, but there are also additional reasons for their use, which are mainly driven by NPS-FM 3.24 (1)(b), (3)(a)(i), and (3)(b)(i).
- 76 In essence, use of the stream simulation culvert would achieve (in addition to securing fish passage) the following:
- (a) demonstrating application of the mitigation hierarchy,
  - (b) lowering the magnitude of effects on the stream, and
  - (c) mitigating the loss of stream extent, health, and hydrological diversity (which are a clear NPS-FM directives).
- 77 Appendix 4 to the NPS-FM specifies details for instream structures, with Part 1 specifying required information. I consider that each of these requirements should be addressed by the applicant through conditions of consent and/or management plan requirements.
- 78 For completeness, I note that Appendices 6 and 7 to the NPS-FM present principles for aquatic offsetting and environmental compensation which I have referred to in my review of the Freshwater Assessment.

## Natural Character and Management of Natural Character

- 79 The One Plan Policies 6.8 and 6.9 address natural character of rivers and their margins and management of natural character, respectively. Policy 6.8 directs that the natural character of rivers and their margins must be protected from inappropriate use and development, and must be restored and rehabilitated where this is appropriate.
- 80 Regarding natural character management in the Wellington Region, GWRC's NRP has Policy 23 (identification of outstanding/high natural character) and Policy 24 (preserving and protecting natural character from inappropriate use and development). Policy 24 provides that preserving and protecting natural character occurs through avoiding, remedying or mitigating other adverse effects on the natural character of wetlands, rivers, lakes and their margins that are not addressed under Policy 24. Again, this is consistent with my view over the importance of mitigating the effects of culverting through use of simulation culverts and also tightly managing sediment discharges to avoid effects to natural character of the waterways concerned.
- 81 On my review of Policy 6.8, attributes of natural character given which are relevant to the Mt Munro Project waterways are: natural and ecological elements and the natural movement of water. I note in particular that the proposed culverting has the potential to directly adversely impact these aspects of the affected rivers' natural character. So also would adverse levels of sediment discharged to rivers from Project site development.
- 82 Regarding Policy 6.9 f., the proposed culverting of the Mangaroa tributary is of a scale (7% of the tributary) where I would consider the activity to significantly disrupt the existing ecosystem. This disruption would come about if barrel culverts were to be installed causing the natural stream bed and associated habitats and complexities to be lost. Further, if adverse levels of sediment are discharged to rivers then I would regard this as having the potential to significantly disrupt natural ecosystems (river ecosystems).
- 83 In my opinion, Policies 6.8 and 6.9 provide support for my recommendations to:

- (a) retain natural stream beds by using stream simulation culverts; and
- (b) retain instream monitoring and appropriate response mechanisms around unauthorised discharges to receiving environments.

## H. SUBMISSIONS

### *Concerns over effects to streams and aquatic life.*

- 84 One submitter (S21) is concerned about effects of construction on streams and aquatic life, and also heavy traffic on trout, eels, koura, and freshwater mussels. It is my expectation that sediment and contaminant discharges will be adequately addressed through appropriate and best practice erosion and sediment control measures, and I defer to the expert evidence of the relevant experts on this matter (Sue Ira - Operational Water Quality/stormwater; Andres Roa – Operational Water Quantity Hydrology; Kerry Pearce - Erosion and Sediment Control; and Andrew Curtis - Air Quality).
- 85 A further submitter (S34; in addition to S21) mention that freshwater mussels are present on site. This is consistent with my observations from the NZFFD (of records near the site) outlined earlier in my report at paragraph 44. Freshwater mussels hold threat classifications<sup>26</sup> and where present would boost ecological significance and value as I have described above. The submitter (S34) is also concerned about a brown trout hatching area but I am unaware of the location and nature of this on site. They consider that the Freshwater Assessment has incorrectly identified streams which they consider has led to an underestimate of freshwater ecology effects. As I have detailed in my evidence, I too have identified numerous issues with the freshwater statutory significance assessment, and the values and effects assessments. In my opinion the Applicant needs to address these concerns.
- 86 Two submitters (S40 and S68) are concerned over effects to waterways. No specific details are provided. I have however thoroughly reviewed the Applicant's effects assessment and my opinion of it is presented in my report.

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<sup>26</sup> Grainger et al., 2018.

- 87 A number of submitters (S24; S34; 36; S44; and S56) raise a common concern over contaminants (dust, mud and/or toxic runoff) to waterways being generated by the Mt Munro Project site and entering waterways. The likelihood of these discharges being generated is beyond my area of expertise and I defer to the expert evidence of Mr Pearce and Ms Ira. From my perspective, the Applicant needs to undertake an assessment of this matter and advise on the potential adverse effects and corresponding effects management measures.
- 88 Several submitters have concerns over effects to trout. Wellington Fish and Game (S18) is concerned about potential sediment discharges during the construction and operational phases. They also find the monitoring related conditions in Schedule F of the Application to be very general. They request that an appropriate environmental monitoring program be specified including macroinvertebrates, fish, deposited and suspended sediment.
- 89 I agree that macroinvertebrates and deposited sediment provide useful measures of sediment related effects. However, from my experience on other projects I am less confident in the utility of fish monitoring or suspended sediment monitoring due to natural variations, complexities in measurement (for suspended sediment) and difficulties in determining a cause and effect relationship.
- 90 Wellington Fish and Game request a program of monitoring for trout population impacts which appears to me to be very specific and is limited only to trout. It is not clear what this program would involve and how necessary it would be. I would suggest that appropriate erosion and sediment control and stormwater management coupled with appropriate monitoring would provide an ecosystem wide assessment which would be relevant to trout as well as other freshwater biota.
- 91 Wellington Fish and Game request that appropriate design and construction techniques be used for culverts to ensure fish passage at all times. Also, that sediment release is avoided or otherwise minimised to ensure impacts on the aquatic ecosystem are no more than minor, and that monitoring is

carried out to ensure this is achieved for the duration of the consent. I consider these suggestions to be reasonable and in line with best practice.

92 Lastly, Wellington Fish and Game request that they be given advanced notice of winter works.

93 I largely concur with the points raised by Wellington Fish and Game.

*Concerns over accuracy of stream classifications.*

94 A number of submitters raise concern over the accuracy of stream classifications (S34, S37; S47; and S5) consider the streams to have been incorrectly classified. In all cases the Freshwater Assessment has classified waterways to be less permanent than what the submitters claim them to be. If the submitters are correct, the effect of this misclassification is diminishing the described level freshwater values relative to actual values. This would be consistent with the types of gaps I have found from my assessment.

*Requests for stream monitoring*

95 Wellington Fish and Game (S18) and another submitter (S41) both seek a robust program of instream monitoring. I share their concerns over the current level of detail provided and I recommend the Applicant provide a plan for instream monitoring using, as a minimum, deposited sediment and macroinvertebrate variables as I have outlined earlier in my report at paragraph 69 and as per Council's proposed conditions.

**I. CONDITIONS**

96 I have reviewed and had input into the conditions proposed alongside the Regional Councils' s 87F planning report. I have also recommended specific conditions relating to the following aspects:

- (a) A freshwater ecology management plan to capture an adequate level of details regarding instream works (e.g., fish passage, stream simulation culverts, management of temporary diversions, and receiving environment monitoring including the adoption of One

Plan water quality targets for trout, which I note align with the winter works period).

- (b) A threatened species discovery protocol in the event that threatened species not already addressed by conditions of consent are discovered. The purpose should be to describe a course of action in the event this situation occurs.
- (c) A comprehensive offset management plan to ensure the freshwater offset is designed, implemented and concluded in a sound and principled manner, and over an acceptable duration.
- (d) Avoidance of adverse effects to freshwater ecology during construction of the proposed bridge crossing of the Mākākahi tributary.

**Adam Forbes**

**15 March 2024**

## J. REFERENCES

- AUP. (2021). Practice and guidance note. River/stream classification. Auckland: Auckland Council.
- Clapcott, J. E., Young, R. G., Harding, J. S., Matthaiei, C.D., Quinn, J.M., & Death, R.G. (2011). Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream value. Nelson: Cawthron Institute.
- Dunn, N. R., Allibone, R., Closs, G. P., Crow, S. K., David, B., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., & Rolfe, J. R. (2018). Conservation Status of New Zealand Freshwater Fishes, 2017. Wellington: Department of Conservation.
- EIANZ. (2018). Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.
- Grainger, N., Collier, K., Hitchmough, R., Harding, J., Smith, B., & Sutherland, D. (2014). Conservation Status of New Zealand Freshwater Invertebrates, 2013. Wellington: Department of Conservation.
- GWRC. (2021). Watercourse types: How to determine whether a watercourse is a river, ephemeral watercourse, highly modified river or stream, or artificial watercourse. Guidance note. Wellington: Greater Wellington Regional Council.
- GWRC. (2022). Conservation status of indigenous fish in the Wellington Region. Wellington: Greater Wellington Regional Council.
- Joy, M., David, B., & Lake, M. (2013). New Zealand Freshwater Fish Sampling Protocols. Wadeable Rivers and Streams. Palmerston North: Massey University.
- Larned, S. T., Snelder, T., Unwin, M. J., & McBride, G. B. (2016). Water quality in New Zealand rivers: current state and trends. *New Zealand Journal of Marine and Freshwater Research*, 50(3), 389-417.
- Maseyk, F., Ussher, G., Kessels G., Christensen, M., Brown, M. (2018). Biodiversity offsetting under the Resource Management Act: A guidance document. Biomangers Group.
- McArthur, K., Clark, M., & McGehan, J. (2007). Sites of Significance for Aquatic Biodiversity in the Manawatu-Wanganui Region: Technical Report to Support Policy Development. Palmerston North: Horizons Regional Council.
- NIWA. (2018). New Zealand Fish Passage Guidelines. Hamilton: NIWA.
- Scarsbrook, M. R., Boothroyd, I. K., & Quinn, J. M. (2000). New Zealand's National River Water Quality Network: Long-term trends in macroinvertebrate communities. *New Zealand Journal of Marine and Freshwater Research*, 34(2), 289-302.



- Stark, J. D., Boothroyd, I. K. G., Harding, J. S. Maxted, J. R., Scarsbrook, M. R. (2001). Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.
- Storey, R. G., Neale, M. W., Rowe, D. K., Collier, K. J., Hatton, C., Joy, M. K., Maxted, J. R., Moore, S., Parkyn, S. M., Phillips, N& Quinn, J. M. (2011). Stream ecological valuation (SEV): a method for assessing the ecological function of Auckland Streams. Auckland Council Technical Report 2011/009. Auckland: Auckland Council.
- Thacker, C. E., Geiger, D. L., & Shelley, J. J. (2023). Two new cryptic species of the freshwater fish genus *Gobiomorphus* (Gobiiformes: Gobioidae: Eleotridae) in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 57(1), 119-135.