Before Independent Hearings Commissioners
At Wellington

Under	the Resource Management Act 1991
In the matter of	Applications for resource consents, and a Notice of Requirement for Designation, by Wellington Water Limited on behalf of Upper Hutt City Council, for the construction, operation and maintenance of the structural flood mitigation works identified as the Pinehaven Stream Improvements Project.

Statement of evidence of Dr Alexander Bryan Wilfried James for Wellington Water Limited (Aquatic Ecology)

Dated 20 July 2020

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Statement of evidence of Alex James

1 Qualifications and experience

1.1 My full name is Alexander Bryan Wilfried James.

1.2 I am a Senior Freshwater Ecology Scientist at EOS Ecology, where I have worked for 10 years. My role entails undertaking freshwater ecology research and consultancy work for various clients including large multidisciplinary consultancies, local councils, regional councils, government departments and agencies, and private individuals.

1.3 Qualifications I hold include a PhD in freshwater ecology and BSc (Hons) in ecology, both from Massey University, and a BSc (majoring in Ecology, Geology, and Biology) from Victoria University of Wellington. I have extensive experience working on projects that involve disturbance of freshwater habitats, from the perspective of both the applicant and consenting authority. I have been a member of the New Zealand Freshwater Sciences Society (NZFSS) since 2002 and of the Engineering New Zealand/Water NZ Rivers Group since 2018.

1.4 I have worked on various projects that involve direct disturbance to riparian and freshwater habitats. I have produced freshwater ecology assessments of environmental effects for various infrastructure projects, including major roads such the West Belfast Bypass and Christchurch Northern Corridor, both of which involved bridging, stream piping, and diversion. I was involved in design and implementation of the in-river component of the Te Papa Ōtākaro/Avon River Precinct earthquake recovery Anchor Project. This project involved the designing and construction of channel modifications to improve physical habitat conditions. I have also reviewed numerous consent applications on behalf of regional councils that relate to disturbance of riparian and freshwater habitats.

1.5 My evidence relates to a Notice of Requirement ('**NOR**') for Designation and associated resource consent applications for the construction, operation and maintenance of the structural flood mitigation works identified as the Pinehaven Stream Improvements Project ('**the Project**'). Wellington Water Limited ('**WWL**') has lodged the resource consent applications and the NOR on behalf of Upper Hutt City Council ('**UHCC**').

1.6 I am familiar with the area that the Project covers, and have been involved with the Project initially in an advice and review role from September 2018, and then from 5 March 2019 in a technical expert role that included writing the freshwater ecology part of the Assessment of Environmental Effects ('**AEE**'). Freshwater ecology AEE fieldwork including macroinvertebrate sampling, a fish survey, and Stream Ecological Valuation ('**SEV**') was undertaken by Jacobs staff prior to my involvement in the Project. This information plus additional data from previous ecological surveys[1] was utilised in my technical report: "Pinehaven Stream Improvements Project – Assessment of Freshwater Ecological Effects: Main Works" included in Appendix S to the AEE. I have visited the Project area several times since September 2018. On 13 July 2020 I took part in expert witness conferencing in relation to aquatic ecology.

2 Code of conduct

2.1 While these applications are not before the Environment Court, I have read and am familiar with the Code of Conduct for Expert Witnesses in the current Environment Court Practice Note (2014). I have complied with the Code in the preparation of this evidence, and will follow it when presenting evidence at the hearing.

2.2 The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in my evidence to follow.

2.3 Unless I state otherwise, my evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

3 Scope of evidence

3.1 This evidence addresses the following matters:

a Existing environment;

b Aquatic ecology effects;

c Effects of alternative designs and methods;

d Recommended mitigation during construction;

e Recommended mitigation once construction is complete;

f Additional assessment of works at 50 Blue Mountains Road;

[1] i.e., Kingett Mitchell (2005), Warr (2007)) and the New Zealand Freshwater Fish Database (NZFFD; Crow, 2017).

g Responses to issues in submissions;

h Responses to section 42A report.

4 Executive summary

4.1 The Pinehaven Stream drains a catchment of approximately 450 ha, with the main channel flowing generally north until it joins Hulls Creek, which itself is a tributary of the Hutt River. The upper catchment (upstream of the urban area) has steep valleys clad primarily in pine trees. The middle catchment includes a piped section below Pinehaven Reserve and Pinehaven School. The lower catchment, starting at the downstream end of the Pinehaven Reserve, includes the Pinehaven Stream Improvements Project area, and flows through the residential areas of Pinehaven and part of Silverstream. The final approximately 500 m of the Pinehaven Stream flows through two pipes, one being a flood bypass that conveys water only during high flow events.

4.2 The aquatic ecological value of Pinehaven Stream has been assessed as being “moderate”. The macroinvertebrate fauna of the Project area is dominated by species that prefer or are tolerant of degraded habitat or water quality, although some more pollution-sensitive species persist. Four species of fish are known from the Project area, including two species that have an “At risk – Declining” conservation status (longfin eel and giant kokopu).

4.3 The construction phase of the Project has been assessed as potentially having a “moderate” level of adverse effect on the aquatic ecology of Pinehaven Stream as a result of unavoidable physical disturbance to the streambed and riparian zone. This can be reduced, in the context of the RMA, to a “minor adverse effects” level through the proposed avoidance, remedy, and mitigation actions including:

a Fish relocation;

b Reinstatement of pool habitat;

c Monitoring and remediation of stream bed compaction;

d Maintenance of fish passage for the majority of the construction phase;

e Using a ‘piped diversion’ construction method that physically separates active work sites from flowing water, such that earthworks and construction occurs in a dry site. This significantly reduces the risk of fine sediments and contaminants entering Pinehaven Stream during construction; and f Comprehensive project erosion and sediment control plan (‘**ESCP**’) and site-specific environmental management plans (‘**SEMPs’**) for each Project stage.

4.4 The operational phase of the Project has been assessed as having a “negligible” to potentially positive effect on the aquatic ecology of Pinehaven Stream. In a RMA context this equates to a “less than minor adverse effects”, “nil effects”, or potentially positive level of impact to aquatic ecology. This outcome results from:

a Permanent diversion though creation of new channel at 26 and 28 Blue Mountains Road with a ‘naturalised’ profile and riparian plantings, which will be an ecological improvement on the highly modified channel currently at these locations.

b The creation of bank habitat complexity, where possible, through the use of embedded pipes, installation of stable undercuts, and placement of marginal boulders to provide fish cover.

c Extensive revegetation of the riparian zone, with sedges, rush, and flax species proposed for the stream margins to provide some marginal cover and shading. Larger shrubs and trees will be planted further up the banks, which once mature will shade the channel.

d Improvement of fish passage through removal and/or remediation of several small grade control weirs in the Project area, and by the remediation of a partial fish barrier at the confluence of Pinehaven Stream and Hulls Creek downstream of the Project area.

4.5 Overall, the proposed works will result in an unavoidable disturbance to aquatic ecology, but the aquatic fauna will recover relatively quickly (i.e. in months for macroinvertebrates, and up to a few years for fish). After construction there will be some improvements in the ecological condition of Pinehaven Stream over time resulting from the stream having more physical space for natural processes to occur within, the establishment of a more natural riparian zone dominated by native plants, and potentially increased fish diversity and/or densities resulting from fish barrier remediation.

5 Existing environment

5.1 A full description of the existing freshwater environment is provided in my technical report “Pinehaven Stream Improvements Project – Assessment of Freshwater Ecological Effects: Main Works” included in Appendix S to the AEE. The key points are summarised here.

5.2 The Pinehaven Stream drains a catchment of approximately 450 ha with the main channel flowing generally north until it joins Hulls Creek, which itself is a tributary of the Hutt River. The upper catchment (upstream of the urban area) has steep valleys clad primarily in pine trees. The middle catchment includes a piped section below Pinehaven Reserve and Pinehaven School. The lower catchment, starting at the downstream end of the Pinehaven Reserve, includes the Project area, and flows through the residential areas of Pinehaven and part of Silverstream. The final approximate 500 m of the main channel flows through two pipes, one being a flood bypass that conveys water only during high flow events.

5.3 Pinehaven Stream is a small, stony bottomed watercourse with varied instream habitats including riffles, runs, and pools that has been adversely impacted by urban development. In the urbanised part of the catchment Pinehaven Stream has had its channel modified by urban development such that now the banks are concrete lined through much of the Project area. Survey data based on data from three representative survey reaches in the Project area showed that the bed substrate was predominantly small (2–8 mm) and small-medium (8–16 mm) gravels, although there was a significant silt/sand (<2 mm) component (16-27% cover among three representative survey sections). At the time of the habitat survey (which was undertaken in 2015) mean water depths were in the 0.12–0.18 m range and mean water velocities were low to moderate (0.24–0.35 m/s). (See **Table 1)**

Table 1: Physical habitat characteristics of the three representative sections of Pinehaven Stream in the Project area from survey data collected by Jacobs in 2015 (In relation to mean water depth, mean water velocities and bed substrate)

Parameter	Reach 1 – Pinehaven Lower	Reach 2 – Pinehaven Mid	Reach 3 – Pinehaven Upper
Water velocity (m/s)	Mean: 0.35±0.03 Median: 0.33 Range 0.03-1	Mean: 0.24±0.04 Median: 0.2 Range 0.11-0.5	Mean: 0.26±0.04 Median: 0.25 Range 0.13-0.5
Water depths (m)	Mean: 0.18±0.02 Median: 0.15 Range 0.02-0.9	Mean: 0.17±0.01 Median: 0.16 Range: 0.02-0.42	Mean: 0.12±0.01 Median: 0.12 Range 0.02-0.27
Bed substrate Silt/sand (<2mm) Small gravel (2-8mm) Small-med gravel (8-16mm) Med-large gravel (16-32mm) Large gravel (32-64mm) Small cobble (64-128mm) Boulder (>256mm) Small wood (<50mm) Med wood (50-100mm)	Silt/sand: 27% Small gravel: 37% Small-med gravel: 15% Med-large gravel: 6% Large gravel: 3% Small cobble: 2% Boulder:10%	Silt/sand: 17% Small gravel: 42% Small-med gravel: 18% Med-large gravel: 9% Large gravel: 9% Small cobble: 1% Small wood: 3% Med wood: 1%	Silt/sand: 16% Small gravel: 26% Small-med gravel: 28% Med-large gravel: 12% Large gravel: 13% Small cobble: 5%

5.4 Thirty one aquatic macroinvertebrate taxa have been recorded from within the Project area, based on kicknet samples collected from each of three representative survey reaches in the Project area in 2015.[2] The macroinvertebrate community was dominated by taxa that prefer or tolerate degraded habitat and/or water quality conditions (e.g., *Potamopyrgus* snails, *Paracalliope* amphipods, oligochaete worms), but still retained several Ephemeroptera-Plecoptera-Trichoptera ('**EPT**') taxa that require relatively good habitat and/or water quality conditions (e.g., *Deleatidium* mayflies, *Helicopsyche* caddisflies).

5.5 The macroinvertebrate community index ('**MCI**'), which is a score indicating habitat/water quality conditions based on the types of macroinvertebrates found at a location, showed the forested headwaters of Pinehaven Stream to be "excellent", the Project area to have "good" conditions, and Hull Creek

[2] Macroinvertebrate and habitat survey locations from the project area (Reach 1-3 collected by Jacobs (2017)) and greater catchment (PHU, SSU, and SSL) collected by Kingett Mitchell (2005)), AEE, Appendix S, pg 12.

downstream of its confluence with Pinehaven Stream to have “fair” conditions. This indicates an overall decline in habitat and water quality in a downstream direction; a situation typical of many watercourses traversing modified landscapes.

5.6 Seven species of fish are known from within the greater Hulls Creek-Pinehaven Stream catchment. These are longfin eel, shortfin eel, common bully, redfin bully, bluegill bully, inanga, giant kokopu. All are native or endemic and four (longfin eel, bluegill bully, inanga, giant kokopu) have a “declining” conservation status. according to the latest conservation status of Dunn *et al.* (2018)[3].

5.7 Four fish species are currently known from within the Project area (giant kokopu, shortfin eel, longfin eel, common bully).

5.8 Only two of these species (common bully and giant kokopu) would spawn locally, while eels migrate downstream to the sea to spawn in the Pacific Ocean around Tonga. Common bully spawn on hard surfaces (e.g., underside of rock or log) in spring and summer (approximately August to February) with the male guarding the eggs until they hatch.[4] It is probable much of the Project area includes common bully spawning habitat.

5.9 Giant kokopu spawn in suitable riparian vegetation (grasses and sedges) when water levels are elevated.

5.10 Assuming Pinehaven Stream has a breeding population of giant kokopu, the incised and concrete lined nature of the existing channel for much of the Project area provides minimal suitable spawning areas.

5.11 Fish passage in Pinehaven Stream is adversely impacted by the lower reach flowing through an approximately 500 m long pipe all the way to Hulls Creek, and by the outlet to Hulls Creek being perched (i.e., having a freefall to the water below). Hence it is highly likely the fish community of Pinehaven Stream is depauperate (i.e. reduced number of species) compared to the situation if these barriers were not present.

5.12 The Stream Ecological Valuation (‘**SEV**’) is a method of quantifying stream value based on the performance of key ecological functions, as described in Storey *et*

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[3] Nicholas R. Dunn, Richard M. Allibone, Gerard P. Closs, Shannan K. Crow, Bruno O. David, Jane M. Goodman, Marc Griffiths, Daniel C. Jack, Nicholas Ling, Jonathan M. Waters and Jeremy R. Rolfe *Conservation status of New Zealand freshwater fishes* (Department of Conservation, Wellington, 2017).

[4] McDowall, R.M *New Zealand Freshwater Fishes – A Natural History and Guide* (2nd ed, Heinemann Reed, Auckland, 1990).

al. (2011).[5] In short, it assesses the performance of each function relative to reference conditions and provides a scheme to compile data and then interpret and report the results as a numeric scoring system, which has a theoretical perfect score of 1. SEV scores from three representative sites within the Project area were in the 0.35–0.42 range. Compared to scores from the 19 trial sites from the Auckland region (shown in Storey *et al.* (2011)), these scores are in the range of the more degraded urban sites and well below native forest and exotic forest sites (which had SEV scores of 0.68–0.96)[6]. Those SEV functions that scored particularly poorly across all representative Pinehaven Stream sites included 'natural flow regime' (on account of highly modified channel form and stormwater inputs), 'floodplain connectivity' (due to flood flows being artificially contained in the channel), and 'riparian zone connection' (on account of highly modified channel form and stormwater inputs). Overall, Pinehaven Stream in the Project area would be considered to have relatively poor ecological function (if compared to a natural stream) based on the SEV.

5.13 The overall freshwater ecological value of the Project area was determined using the methodology outlined in Roper-Lindsey *et al.* (2018)[7], which evaluates ecological value or importance in terms of four matters: representativeness, rarity/distinctiveness, diversity and pattern, and ecological context. Ecological context was deemed to be "low", representativeness and diversity/pattern were both deemed to be "moderate", and rarity/distinctiveness was deemed to be "high" (due to the presence of two fish species with an "At risk – declining" threat classification). Based on the methodology of Roper-Lindsay *et al.* (2018), with one low, two moderates, and one high score, the overall freshwater ecological value of Pinehaven Stream in the Project area is considered to be "moderate".

6 Aquatic ecology effects during construction phase

Construction methodology change

6.1 Since submission of the original resource consent application there has been a change to the construction methodology, such that all construction will now involve a piped diversion approach which involves damming and diverting the flow of Pinehaven Stream through active work sites such to ensure that almost all

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[5] 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 functions of Auckland streams. Auckland Council, Auckland, New Zealand. Technical Report 2011/009.

[6] 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 functions of Auckland streams. Auckland Council, Auckland, New Zealand. Technical Report 2011/009.

[7] Judith Roper-Lindsay, Stephen Fuller, Scott Hooson, Mark Sanders and Graham Ussher *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (2nd ed, Environmental Institute of Australia and New Zealand Inc, Melbourne, 2018). Available at: https://www.eianz.org/document/item/4447.

earthworks and machinery movements will be physically separated from flowing water.[8] Machinery will only operate in flowing water during the initial construction of the diversion dams and it is at these times that short durations of high turbidity are likely.[9] Further it is expected there will be groundwater and seepage inputs into the dewatered work areas, with this being pumped to sediment treatment tanks before being discharged back to the stream downstream of the active work area.[10] These changes to methodology are fully described in the evidence of **Mr Tim Haylock**. My freshwater ecology technical report appended to the AEE (Appendix S) was written at a time when a large proportion of the Project area involved machinery tracking in the flowing water during construction, hence some text in that report is no longer accurate, and my evidence is based on the updated construction methodology.

Specific RMA matters

6.2 In relation to s5(b) (safeguarding life supporting capacity) of the RMA, the Project will safeguard the life supporting capacity of the Pinehaven Stream through avoiding, remedying, or mitigating the proposed works via the ESCPs, SEMPs, and construction management plans and the proposed avoidance, remedy, and mitigation methods proposed (see Section 9 and 10 of my evidence).

6.3 In relation to s6(a) (preservation of natural character) of the RMA, the Project area has limited existing natural character due to it being an urbanised environment. The stream has been subjected to various modifications such as concrete bank linings, piping, stormwater inputs, and installation of grade control weirs such that it has relatively low existing natural character. The landscape and visual assessment identified no outstanding natural features or landscape protected areas directly affected by the project[11]. Hence the proposed works are unlikely to diminish the natural character of Pinehaven Stream.

6.4 The Project area (and Pinehaven Stream as a whole) is not included in Schedule F1 (ecosystems and habitats with significant indigenous biodiversity values) of the Proposed Natural Resources Plan for the Wellington region (Decisions Version) as having “either high macroinvertebrate community health” or “threatened or at risk fish habitat”. Hence, from a planning perspective the Project area will not include any effects on any area designated as significant habitats of indigenous fauna in terms of s6(c) of the RMA with respect to freshwater

[8] Haylock EIC, para 11.6.
[9] Haylock EIC, para 11.4.
[10] Haylock EIC, para 9.2.
[11] Refer Appendix V: Landscape and Visual Assessment, Pinehaven Stream Improvements combined NOR and AEE, dated September 2019

environments. However, since giant kokopu and longfin eels are known from Pinehaven Stream in the Project area, it could technically considered to be "threatened or at risk fish habitat" as both those species have an "at risk – declining" conservation status (Dunn *et al.,* 2017).[12]

Freshwater habitat disturbance

6.5 The current construction methodology involves the installation of temporary dams and diversion of flow down pipes ('piped diversion') to create dry work areas in the stream bed. Dewatering of the streambed will cause mortality of fish and macroinvertebrates through asphyxiation and desiccation. Access to work locations will primarily be via driving along the dry streambed. This has the potential to compact bed substrates reducing the interstitial spaces used by invertebrates and smaller fish once flow resumes, harming any organisms that are still alive in the dewatered section, and will require the infilling of pools to allow a flat, safe surface for machinery operation. Many of these effects are unavoidable consequences of channel dewatering and machinery working in the streambed, although many adverse outcomes can be avoided, remedied, or mitigated (see Section 9 of my evidence).

6.6 Macroinvertebrates will quickly recolonise disturbed and dewatered sections of streambed once flow resumes, via colonists from the relatively good habitat upstream of the Project area, that would recolonise the site primarily via downstream drift. Dewatering the stream through the active worksite has major benefits for sediment control and control of contaminant spills (and thus protection of downstream habitats) by physically separating machinery and materials from the flowing water. Using piped diversions, while having a greater localised adverse effect (i.e., dewatering of streambed), are the best option in this instance to minimise downstream adverse effects. If a piped diversion methodology was not proposed and machinery was tracking along the flowing stream, the effects on aquatic ecology would be worse overall, as higher volumes of fine sediments and other contaminants would be transported to downstream environments, including the Hutt River.

Fish migration and spawning disruption

6.7 Migration and/or spawning of fish species known from the Project area encompasses the entire year and the construction is anticipated to occur over 70

[12] Nicholas R. Dunn, Richard M. Allibone, Gerard P. Closs, Shannan K. Crow, Bruno O. David, Jane M. Goodman, Marc Griffiths, Daniel C. Jack, Nicholas Ling, Jonathan M. Waters and Jeremy R. Rolfe *Conservation status of New Zealand freshwater fishes* (Department of Conservation, Wellington, 2017).

weeks but may take up to two years. Hence it is impossible to avoid fish migration and spawning periods during construction.

6.8 The dam and diversion construction methodology allows fish passage to be maintained to some extent as there will always be a continuity of flow through the work sites free of any temporary barriers.

6.9 Of the four species of fish known from Pinehaven Stream, only two species (common bully and giant kokopu) would spawn locally, while eels migrate downstream to the sea to spawn in the Pacific Ocean around Tonga. There is therefore the potential for spawning of common bully and giant kokopu to be disrupted if works are occurring at the same time of year as the spawning period, and in a stream section with suitable spawning habitat.

6.10 Common bully spawn on hard surfaces (e.g., underside of rock or log) in spring and summer (approximately August to February) with the male guarding the eggs until they hatch (McDowell, 1990). It is probable much of the Project area includes common bully spawning habitat. In my experience they are a common and widespread species that rapidly colonise disturbed environments, hence I do not consider any special procedures are required to avoid common bully spawning.

6.11 Giant kokopu spawn in suitable riparian vegetation (grasses and sedges) when water levels are elevated. Assuming Pinehaven Stream has a breeding population of giant kokopu, the incised and concrete lined nature of the channel for much of the Project provides minimal suitable spawning areas, hence I do not consider any special procedures are required to avoid giant kokopu spawning. Indeed the proposed works in those zones where a naturalised bank profile is to be constructed will likely create more areas of potential spawning habitat for giant kokopu.

Release and deposition of fine sediments

6.12 The Project involves significant earthworks in close proximity to and within Pinehaven Stream as well as demolition and/or removal of houses, bridges, and bank linings. The piped diversion construction methodology being used for the majority of works will mean most of the construction will be done in a dry stream bed and physically separated from the flowing water such that the likelihood of ongoing fine sediment mobilisation during the construction works is minimal. Only during the construction of diversion dams and at the resumption of flow through dewatered areas will there be a short period of unavoidable sediment release.

6.13 Suspended sediment can have a range of impacts on aquatic ecosystems including alteration of water chemistry, increasing turbidity, increasing invertebrate drift and altering community structure.[13] High turbidity can also affect the amenity value of naturally clear waterways leading to public perceptions that the water is “dirty”.

6.14 Many aquatic biota are relatively tolerant of at least short-term increases in suspended sediment, however, the deposition of this sediment on the streambed (at rates and with quantities of smaller particles greater than the natural state) is a major stressor on waterway ecosystems through altering physical habitat (clogging interstitial spaces in the stream bed used as refugia by fish and invertebrates), altering food resources (e.g., smothering algae), and degrading sites used for egg laying by many aquatic species. In other words deposited sediment is more likely to be of concern in ecological terms than suspended sediment (at least over the short term).

6.15 Sediment affects the diversity and composition of algae, macrophytes, fish, and aquatic invertebrates (Clapcott *et al*., 2011).[14] Pinehaven Stream and downstream receiving environments (Hulls Creek and Hutt River) have hard; stony streambeds hence are likely to have some sensitivity to increased rates of fine sediment deposition. If the Project was to result in fine sediments covering relatively clean stony substrates both within and downstream of the Project area, then significant adverse effects could result.

Water contamination

6.16 The machinery used for demolition and construction has the potential to release contaminants (e.g., fuel, oil, grease) into the environment where they may enter waterways. Demolition of existing instream and bank structures may create contaminants (e.g., concrete dusts, buried rubbish), while many substances used during construction can contaminate waterways if used carelessly.

6.17 The greatest potential risk of water contamination during the construction phase is related to cementitious products. The construction includes the installation of new pre-cast Redi-Rock concrete block bank linings, new pre-cast bridge

[13] Paddy A. Ryan “Environmental effects of sediment on New Zealand streams: a review” (1991) 25 NEW ZEAL J MAR FRESH 207.
[14] Joanne Clapcott, Roger Young, Jon Harding, Christoph Matthaei, John Quinn, Russell Death Sediment *Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values* (Cawthron Institute, Nelson, 2011).

structures, and some use of concrete in close proximity to flowing water.[15] Mortars and grouts may also be used at various locations.[16]

6.18 Concrete wash water and uncured cement-related products can harm aquatic life, primarily though causing rapid pH shifts and the discharge of ammonia. The piped diversion construction methodology being used for the majority of works will mean most of the construction will be done in the dry stream bed and physically separated from the flowing water such that the likelihood of water contamination is minimal.

6.19 Only during the construction of diversion dams will there be a short period when machinery is operating in flowing water with a heightened risk of water contamination. Additional avoidance measures are covered in Section 9.4.

Overall construction phase effects

6.20 Based on the best practice criteria for describing magnitude of effect in Table 8 of Roper-Lindsay *et al.* (2018), the construction phase effects will be "moderate" before mitigation. The relevant table is reproduced as **Appendix B** to my evidence.

6.21 With the Project area being of "moderate" ecological value, the overall adverse effect of the construction phase will be "moderate" prior to mitigation based on the ecological value-magnitude of effect matrix (Table 10) of Roper-Lindsay *et al.* (2018).[17] This matrix is reproduced as **Appendix C** to my evidence.

6.22 Provided the recommended avoidance, remedy, and mitigation measures are adequately implemented in accordance with the proposed consent conditions, the overall adverse effect of the construction phase based on the ecological value-magnitude of effect matrix (Table 10) of Roper-Lindsay *et al.* (2018) can be reduced to a "low" level. In the context of the RMA, this would be considered a "minor adverse effects" level of impact to aquatic ecology.

7 Aquatic ecology effects during operational phase

Creation of new stream channel

7.1 The diversion of approximately 78 m of existing stream channel at 26 and 28 Blue Mountains Road will result in approximately 61 m of new channel being created,

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[15] Haylock EIC, para 5.3
[16] Haylock EIC, para 5.15
[17] Judith Roper-Lindsay, Stephen Fuller, Scott Hooson, Mark Sanders and Graham Ussher *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (2nd ed, Environmental Institute of Australia and New Zealand Inc, Melbourne, 2018). Available at: https://www.eianz.org/document/item/4447.

with a permanent loss of approximately 17 m of channel. This new channel will be designed with the input of a freshwater ecologist and will incorporate varied habitats (pool, run, riffle) and result in no net loss of ecological value. Construction of this new channel is likely to have permanent positive effects on Pinehaven Stream as it removes a highly modified confined reach with vertical concrete walls and grade control weirs that are likely partial fish barriers.

Loss of existing bank habitat complexity

7.2 The extensive bank works through the Project area may permanently remove existing bank features that provide cover for fish and macroinvertebrates such as undercuts, holes, and crevices. These may have formed beneath/between existing bank protection elements (e.g., concrete blocks, rubble, gabions) or in more natural areas of bank that will be removed during the works. Given the nature of the Project to widen the channel, this is unavoidable. No specific assessment of bank habitat complexity has been made through the project area, however given the Project will widen the channel I am of the opinion there will be a net decrease in bank habitat complexity. Some of this loss will be mitigated through installation of bank habitat features during the construction phase (see Section 10.2).

Loss of stream shading

7.3 All riparian vegetation between the new top of bank on each side of the channel will be removed, exposing the stream temporarily to more sunlight, while taller riparian vegetation re-establishes. This could result in increased growth of periphyton and higher water temperatures, both of which can have adverse effects on stream fauna depending on the magnitude of any increase and species-specific tolerances.

Fish passage

7.4 Existing grade control weirs will likely be damaged/removed to allow machinery access along streambed. If these are deemed to still be necessary, they will be reinstated. If new weirs are installed there is the potential they will be fish barriers. Debris arrestors are proposed at key locations to protect infrastructure and reduce the likelihood of channel/pipe blockages. There is the potential such arrestors could make the downstream passage of large eels difficult if the bars were too close together. For example, large migrant female longfin eels can be upwards of 165 mm in diameter. I support condition 59 recommended in the GWRC Section 42A Report, as this will ensure that debris arrestors are designed and constructed in consultation with an ecologist, so that fish passage can be protected.

Overall operational phase effects

7.5 Based on the best practice criteria for describing magnitude of effect ,[18] the operational phase effects are deemed to be "negligible" to potential positive. With the Project area being of "moderate" ecological value, the overall effect of the operational phase will be "high" based on the best practice ecological value-magnitude of effect matrix of Roper-Lindsay *et al.* (2018).[19]

7.6 Provided the proposed mitigation measures outlined in Section 10 of my evidence are adequately implemented, the adverse operational effects (i.e. the longer term effects after construction is complete) based on the ecological value-magnitude of effect matrix (Table 10) of Roper-Lindsay *et al.* (2018) can be reduced to a " very low" to "net gain" level. In the context of the RMA, this would be considered to be "less than minor adverse effects" to "nil effects" and potentially a positive level of impact to aquatic ecology.

8 Effects of alternative designs and methods

8.1 Alternative designs and construction methods are described in the evidence of **Mr Eric Skowron**. I comment on the ecological effects of those relative to what is now proposed below.

Alternative designs

8.2 Two stream bank types were originally proposed – naturalised banks and vertical retaining walls. These were further refined during the design phase to three naturalised channel types and two vertical retaining wall types, to take into account hydraulic, environmental, and amenity values, as well as private property and operational maintenance, while achieving the desired stream capacity. Where there was space the naturalised channel forms will be used, while the vertical retaining walls will be employed where space is limited, often to replace existing vertical walls.

8.3 From a freshwater ecology perspective the low flow channel morphology will not be altered by the Project, hence during normal flow conditions the instream

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[18] Judith Roper-Lindsay, Stephen Fuller, Scott Hooson, Mark Sanders and Graham Ussher *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (2nd ed, Environmental Institute of Australia and New Zealand Inc, Melbourne, 2018). Available at: https://www.eianz.org/document/item/4447.

[19] Judith Roper-Lindsay, Stephen Fuller, Scott Hooson, Mark Sanders and Graham Ussher *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (2nd ed, Environmental Institute of Australia and New Zealand Inc, Melbourne, 2018). Available at: https://www.eianz.org/document/item/4447.

habitat (i.e., wetted width, water depths, velocities, substrate size) will be the same as prior to the Project, although the widening of the channel will allow the low flow channel to meander somewhat within the confines of the new banks.

8.4 However, naturalised bank profiles allow the stream to behave more “naturally” during flood events. Additionally, naturalised banks afford a greater ability to create a varied and self-sustaining riparian margin of native vegetation with zonation of plant assemblages. Hence, overall from a freshwater ecology perspective the naturalised bank design is preferable to vertical retaining walls. The current design makes use of naturalised bank profiles (referred to as “trapezoidal channel” in the General Arrangement Plans dated 11 June 2020) wherever space allows. Such a design will result in better long term ecological outcomes than if vertical walls were used throughout. The widened channel will provide more space for natural processes to occur within (including spawning of galaxiid fish species) and allow establishment of a more natural vegetated riparian zone.

Alternative construction methods

8.5 Alternative construction methodologies are described in the evidence of **Mr Tim Haylock**. The original construction methodology did not involve physically separating the flowing water from machinery, such that machinery would be tracking up and down the stream bed in flowing water.[20] This method would have resulted in the creation and downstream transport of suspended sediments through vehicle movements, and would have required installation and ongoing maintenance of temporary fish barriers so fish did not recolonise active work areas following fish relocation. The new proposed methodology involves creating dry work areas via damming and piped diversion of the stream, such that flowing water is always physically separated from zones of active earthworks and construction. From a freshwater ecology perspective this piped diversion methodology has numerous advantages over the previous method:

a The risk of fine sediment being transported downstream is much reduced;

b The risk of water contamination from fuel spills, hydraulic hose failures, oils and grease are much reduced;

c Fish passage can be maintained through active work areas (provided diversion pipes are passable);

[20] Haylock EIC, paras 6.4 – 6.5.

8.6 Overall, the effects associated with the piped diversion methodology will be minor, with the proposed mitigation, but if works involved machinery tracking in the flowing streambed water then the effects would have been moderate.

9 Recommended mitigation during construction phase

Habitat disturbance

9.1 Habitat disturbance will be minimised during the construction phase by:

a Fish relocation. Injury and mortality of fish and larger invertebrates (i.e., waikoura) will be minimised by undertaking fish removal prior to dewatering each section. The recommended conditions of consent provided in the GWRC Section 42A Report contain conditions outlining the fish relocation requirements of the project (Conditions 12, 56, and 57).

b Pool habitat reinstatement. Where pools have had to be infilled to facilitate machinery access, they will be reinstated to their original dimensions. Conditions 50 and 51 of the recommended conditions of consent provided in the GWRC Section 42A Report ensures this will occur.

c Streambed compaction. The compaction of the streambed will be monitored and where necessary, will be remediated. Conditions 52 and 53 of the recommended conditions of consent provided in the GWRC Section 42A Report ensures this will occur.

Fish passage

9.2 The piped diversion construction methodology will ensure there is a continuous flow of water free of temporary barriers, hence there is a greater chance of maintaining fish passage throughout the construction phase. The only possible exception is during work within 50 Blue Mountains Road, where flow may be over-pumped if there is insufficient space for a piped diversion (see Section 11 of my evidence).

Fine sediment

9.3 The new proposed construction methodology involves creating dry work areas via damming and piped diversion of the stream such that flowing water is always physically separated from zones of active earthworks and construction. From a freshwater ecology perspective this dam and divert methodology has numerous advantages to working in the flowing water including avoidance of fine sediment being transported downstream for the majority of the construction process. An

ESCP has been completed that details the procedures and equipment to be utilised to avoid suspended fine sediments from entering Pinehaven Stream.[21] Fine sediments will be monitored during construction to ensure any issues are identified and corrected quickly. The ESCP is more fully described in the evidence of **Mr Tim Haylock.** Further, SEMPs will be written, so any controls are tailored to the unique characteristics of each stage (currently 12 stages).

Water contamination

9.4 Contamination of water will be avoided through:

a Avoiding contact of flowing water with uncured construction materials (e.g., grouts, mortars, concrete) through physical separation of flowing water from work area via dam and diversion methodology;

b A higher than usual level of vehicle maintenance and cleanliness for those that will be operating within the stream channel[22];

c Using biodegradable hydraulic fluids where possible in vehicles working in the streambed;

d Ensuring a spill kit is in close proximity to all machinery and staff are trained how to use it properly.[23]

Overall level of effect after mitigation

9.5 The construction phase of the Project has been assessed as having a “moderate” level of adverse effect on the aquatic ecology of Pinehaven Stream, in the absence of mitigation.

9.6 However, with the proposed mitigation measures outlined above, the overall adverse effect of the construction phase based on the ecological value-magnitude of effect matrix (Table 10) of Roper-Lindsay *et al.* (2018) can be reduced to a “low” level. In the context of the RMA, this would be considered a “minor adverse effects” level.

10 Recommended mitigation during operational phase

[21] Section 92 response to UHCC dated 21 February, 2020, Appendix B.
[22] Recommended to be addressed in the Construction Management Plan, GWRC Section 42A Report dated 13 July 2020, Appendix 2, Condition 16g
[23] Recommended to be addressed in the Construction Management Plan, GWRC Section 42A Report dated 13 July 2020, Appendix 2, Condition 16h

New channel at 26 and 28 Blue Mountains Road.

10.1 This new section of channel is to have a ‘naturalised’ profile with riparian plantings, which will be a great ecological improvement on the current highly modified channel currently at this location. The morphology of the new section will predominantly be determined by its gradient, and where possible will include run, riffle, and pool habitats as well as meanders to negate or minimise the length of channel loss due to the diversion. Condition 63 of the recommended conditions of consent provided in the GWRC Section 42A Report dated 13 July 2020 ensures a freshwater ecologist is involved in channel design.

Bank habitat

10.2 Where possible, the level of existing bank habitat complexity will be recreated through the use of embedded pipes (for use by eels), installation of stable undercuts, and placement of marginal boulders to provide fish cover. The ability to install embedded pipes and stable undercuts on vertical walls depends on sufficient water depths against such structures during normal/low flows. Given the flood channel is being widened, and the small size of the stream, such features may only be viable in a few locations, such as at a proposed concrete step structure in Willow Park. Marginal boulders, however, can be placed throughout the Project area. Condition 49 of the recommended conditions of consent provided in the GWRC Section 42A Report will ensure this occurs.

Stream shading

10.3 Upon completion of bank works, extensive revegetation of the stream margins with sedges, rush, and flax species will provide some marginal cover and shading. Larger shrubs and trees will be planted in the wider riparian zone further up the banks, which once mature will shade the channel. The planting plan is described in more detail in the evidence of **Mr David Compton-Moen**. To ensure successful vegetation establishment a monitoring and maintenance plan will be required and implemented over many years, and preferably include successional planting (i.e., replacement of sedges/rushes with ferns as canopy cover develops over time). Conditions 64–69 of the recommended conditions of consent provided in the GWRC Section 42A Report cover revegetation of the riparian zone and new floodplain areas.

Fish passage

10.4 Fish passage will be maintained and/or improved by the Project through:

a Any grade control weirs removed during construction will only be reinstated if this is ‘necessary’ for flood control purposes. Any that are reinstated must be fully passable by all fish species. Conditions 60 and 61 of the recommended conditions of consent provided in the GWRC Section 42A report dated 13 July 2020 ensure this will occur.

b Debris arrestors will be designed in such a way they do not impede fish passage. Condition 59 of the recommended conditions of consent provided in the GWRC Section 42A report dated 13 July 2020 ensures this will occur.

c To maximise the ecological benefits of the Project and compensate for the ecological disturbance of the Project, the partial fish barrier at the confluence of Pinehaven Stream and Hulls Creek downstream of the Project area will be remediated. Condition 62 of the recommended conditions of consent provided in the GWRC Section42A Report dated 13 July 2020 ensures this will occur.

Overall level of effect after mitigation

10.5 Provided the mitigation recommended measures outlined above are adequately implemented, the adverse operational effects can be reduced from a “high” level to a “less than minor adverse effects” or “nil effects” level of impact to aquatic ecology.

11 Additional freshwater assessment of bank erosion works at 50 Blue Mountains Road

11.1 Since the freshwater ecology AEE was prepared, the Project has been refined to include some relatively minor (relative to the overall Project) bank erosion protection works on private property at 50 Blue Mountains Road. I have been asked to assess the impacts of these works on freshwater ecology.

11.2 This section of stream is within the bounds of the overall Project area, hence the assessment of ecological value as being “moderate” described above in paragraph 5.13 applies.

11.3 I visited 50 Blue Mountains Road on 17 April 2019 and have been sent images of the proposed areas of bank erosion protection works from a site visit undertaken by others on 12 March 2020.

11.4 Within the 50 Blue Mountains Road property there are two distinct locations along Pinehaven Stream where bank erosion protection works are proposed (see the General Arrangement Plans dated 11 June 2020 Sheet 5 – DRG-3105):

a Site B

b Site E[24]

11.5 Site B involves the relocation of a small pedestrian bridge approximately 8 m upstream and installation of an approximately 13 m long section of vertical retaining wall on the true-right bank using the same vertical wall design as the rest of the Project (i.e., Redi-Rock concrete blocks).

11.6 Site E involves the installation of rock material (rip rap) over an approximately 15 m length of the channel bed with Macmat R installed on the true-right bank on the outside of an actively eroding sharp bend in the stream. The rip rap in the channel bed will be overlain by 300 mm of existing channel gravel material. The sizing of the rip rap material will be as per GWRC grading envelope 'B', which equates to an equivalent spherical rock diameter ranging from 400 to 1300 mm.

11.7 Originally there were five locations in the 50 Blue Mountains Rd property where channel and/or bank erosion control works were proposed. Through engineering and terrestrial ecological assessment these have been reduced to the two sites described above, such that I am confident that only the most necessary works are being undertaken in Pinehaven Stream at this property.

11.8 Construction of bank erosion protection structures at 50 Blue Mountains Road will involve the same piped diversion methodology used throughout the project or if space is limited, over pumping (Tim Haylock, Downer, pers. comm.). Either method will physically separate the sites from flowing water, allowing works to be done in the dry and avoid the suspension and downstream transport of fine sediments in Pinehaven Stream.

11.9 The adverse effects of construction fall under the same general effects described in Section 6 above and will be avoided/mitigated by the same actions described in Section 9 above and included in the proposed consent conditions. The proposed works at 50 Blue Mountains Road do not alter the overall conclusion that the construction phase of the Project will have "minor adverse effects" on the aquatic ecology of Pinehaven Stream as described above in paragraph 6.22.

11.10 The operational effects of the erosion control works at 50 Blue Mountains Road will be negligible because:

[24] This site is described as site C in the evidence of Dr Adam Forbes.

a The two sites are small in area and the original low flow channel will remain as is at Site B and natural stream gravels will be installed on top of rip rap at Site E;

b Both sites already have significant native riparian vegetation and this is largely being retained with revegetation proposed for any disturbed bank area;

c Any loss of pool habitat, compaction of the stream bed, or bank habitat complexity are mitigated by the proposed consent conditions for the overall project.

11.11 Overall, the addition of the erosion protection works at two discrete sites within 50 Blue Mountains Road to the Project scope does not materially change the overall impact of the Project on Pinehaven Stream from an aquatic ecology perspective nor change the conclusions outlined below in Section 14.

12 Responses to issues raised in submissions

12.1 I have reviewed the submissions lodged in relation to the resource consent applications for the Project. Where I am able to respond to the matters raised, I do this below.

12.2 Overall, freshwater ecology was not a major concern raised in submissions. Of the 15 submitters, only two make any comments of relevance to freshwater ecology.

Submitter 1 (Karyn Mills)

12.3 This submitter is concerned that the ecology of the stream is under threat, citing that the thin finned eels have been fished out, there is no concern for eels, native fish, spotted trout, and the removal of trees from the fenceline. As there is no “thin finned eel” in New Zealand, I assume the submitter is referring to longfin eel or shortfin eel. I have no data with regards to eels having been “fished out” in Pinehaven Stream, although this species is commercially harvested under the Quota Management System. The Project is unrelated to the commercial, recreational, or cultural harvest of eels.

12.4 I am also unsure what is meant by “spotted trout”; this could either be in reference to giant kokopu (which are spotted and were originally referred to by colonist Europeans as the ‘native trout’) or to brown trout (which are more spotted than rainbow trout).

12.5 In regards to the assertion that there is no concern for eels, native fish, or spotted trout, the existing fish ecology was described in the freshwater ecology technical report, and a number of measures put in place to ensure that harm to fish will be minimised during the construction and operational phase via the capture and relocation of fish from the work areas and having a piped diversion construction approach that will limit sediment release downstream during construction, maintaining and enhancing fish passage, and incorporating fish cover into the project (see Sections 9 and 10 above).

Submitter 4 (Deborah Griffiths)

12.6 This submitter is concerned the removal of old trees will have serious effect on bird and fish life along the stream. It is unlikely the removal of old trees will have any serious adverse effect on fish life, above those that will be experienced by the complete removal of existing riparian vegetation in the project area. In fact, it will actually be beneficial to the stream in the long run for large exotic trees that contribute large volumes of leaf fall to the stream once a year to be replaced by native, evergreen tree and shrub species (as is proposed)[25].

13 Response to section 42A report

13.1 Apart from those points outlined below, I am in general agreeance with the conclusions and proposed consent conditions outlined the GWRC Section 42A Report. I agree with the slight change to the criteria of what is considered “undue compaction” suggested by Dr Evan Harrison as described in Section 10.4.3 of the GWRC S42A Report. I also agree with Dr Harrison’s recommendation that the bed compaction be remediated back to its initial compaction rating.[26]

13.2 The first line of Section 10.4.6 paragraph 1 of the GWRC S42A Report states that “The proposed construction methodology of piped diversions will result in fish passage being blocked during the construction works”. This statement is incorrect given the piped diversion method, now to be used throughout the Project area, conveys low flows through pipes. Therefore some level of fish passage will be maintained for the duration of the project.

13.3 Some slight changes to the wording of the proposed GWRC consent conditions are suggested, and have been agreed to via expert conferencing with Dr Evan Harrison (GWRC):[27]

[25] Compton-Moen EIC, para 8.4.
[26] GWRC Section 42A Report, section 10.4.3.
[27] Anderson EIC, Appendix 2, page 45.

i Condition 12 b) – Remove the text reference to the electric fishing machine model, "(EFM400)" as it is overly restrictive to require a particular machine to be used for fish relocation work.

ii Condition 12 e) – Replace "immediately downstream" with "upstream or downstream" to give the ecologist(s) doing the fish relocation work more discretion as to the best location for releasing fish in the context of the overall Project area and stage of the Project at the time.

iii Condition 12 f) – Change wording to "Fish transfer in closed, cool containers that are kept in the shade at all times, and consider aeration during particularly warm weather"

iv Condition 56, para 2 – Replace "a fish movement barrier" with "the stages' piped diversion dam" as no fish movement barriers will be installed with the piped diversion method. This terminology is a remnant from the now abandoned construction method that involved tracking in the flowing stream bed.

14 Conclusions

14.1 Pinehaven Stream in the Project area is assessed as being of "moderate" ecological value.

14.2 The magnitude of construction phase effects is deemed to be potentially "moderate", in the absence of mitigation. Based on the best practice ecological value-magnitude of effect matrix of Roper-Lindsay *et al.* (2018)[28], the overall adverse effect of the construction phase will be "moderate". However, provided the recommended avoidance, remedy, and mitigation measures (as proposed in the draft consent conditions) are adequately implemented, the overall adverse effect of the construction phase based on the ecological value-magnitude of effect matrix (Table 10) of Roper-Lindsay *et al.* (2018) can be reduced to a "low" level. In the context of the RMA, this would be considered a "minor adverse effects" level of impact to aquatic ecology.

14.3 The magnitude of operational phase effects was deemed to be "negligible" to potential positive. Based on the best practice ecological value-magnitude of effect matrix of Roper-Lindsay *et al.* (2018),[29] will be "very low" to "net gain". Provided

[28] Judith Roper-Lindsay, Stephen Fuller, Scott Hooson, Mark Sanders and Graham Ussher *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (2nd ed, Environmental Institute of Australia and New Zealand Inc, Melbourne, 2018). Available at: https://www.eianz.org/document/item/4447.
[29] Judith Roper-Lindsay, Stephen Fuller, Scott Hooson, Mark Sanders and Graham Ussher *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (2nd ed, Environmental Institute of Australia and New Zealand Inc, Melbourne, 2018). Available at: https://www.eianz.org/document/item/4447.

the recommended mitigation measures are adequately implemented, the adverse operational effects can be reduced to a “less than minor adverse effects” or “nil effects” level of impact to aquatic ecology, in the context of the RMA. The Project may potentially have positive effects on aquatic ecology.

14.4 The proposed works will result in an unavoidable disturbance to aquatic ecology, however the aquatic fauna will recover relatively quickly (months for macroinvertebrates, up to a few years for fish). After construction there will potentially be some improvements in the ecological condition of Pinehaven Stream over time resulting from:

a The stream having more physical space for natural processes to occur within;

b The establishment of a more natural riparian zone dominated by native plants;

c A potentially increased fish diversity and/or densities resulting from remediation of the fish barrier at the confluence with Hulls Creek.

Dr Alexander Bryan Wilfried James

20 July 2020

Appendix A References

Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, 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 values. Cawthron Institute, Nelson, New Zealand.

Crow, S. 2017. New Zealand Freshwater Fish Database. Version 1.2. The National Institute of Water and Atmospheric Research (NIWA).

Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., 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. *New Zealand Threat Classification Series 24*. Department of Conservation, Wellington. 11 p.

Kingett Mitchell. 2005. Aquatic ecology and stream management groups for urban streams in the Wellington region. Kingett Mitchell, Auckland. 66 p + appendices.

McDowall, R.M. 1990. New Zealand Freshwater Fishes – A Natural History and Guide. Heinemann Reed, Auckland.

Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., & Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

Ryan, P.A. 1991. Environmental effects of sediment on New Zealand streams: a review. *New Zealand Journal of Marine and Freshwater Research* 25: 207-221.

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 functions of Auckland streams. Auckland Council, Auckland, New Zealand. Technical Report 2011/009. 72 p.

Warr, S. 2007. Hulls Creek – water quality and ecology. Greater Wellington Regional Council. 30 p.

Appendix B Table 8 of Roper-Lindsay *et al.* (2018) "Criteria for describing magnitude of effect"

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 change 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

Appendix C Table 10 of Roper-Lindsay *et al.* (2018) “Criteria for describing level of effects”

		Ecological Value				
		Very high	High	Moderate	Low	Negligible
Magnitude	Very high	Very high	Very high	High	Moderate	Low
	High	Very high	Very high	Moderate	Low	Very low
	Moderate	High	High	Moderate	Low	Very low
	Low	Moderate	Low	Low	Very low	Very low
	Negligible	Low	Very low	Very low	Very low	Very low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain