Aquatic Ecology

Phone: (03) 366-4070
Cell: 021 022-62517
Email: mark@ael.org.nz
Internet: www.ael.org.nz

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Alice Burnett
Davie Lovell-Smith
116 Wrights Road,
Addington, Christchurch

Dear Alice,

Introduction

Proposal

Bangor Village is a proposed new residential subdivision on a residentially zoned site adjoining the existing township of Darfield, Canterbury. Bangor Village was approved as a referred project under the Fast-track Approvals Act 2024, and the authorised applicant, Hughes Developments Limited (HDL), is intending to apply for substantive approvals for Bangor Village under that Act. If approved, the project would enable:

- the subdivision and development of the Site to create approximately 720 residential lots ranging between 650m^2 – 10,000 m^2 (1ha);
- the creation of one additional lot through subdivision which will provide the opportunity in future to establish a school;
- all necessary infrastructure to service that development, including roading and pedestrian/cycling connections, waters infrastructure, street lighting and communications infrastructure;
- the retention and enhancement of existing water races as key placemaking features within the site; and
- the creation of a network of open spaces distributed logically throughout the site which have varying functions.

AEL prepared a detailed report in support of the referral application for the Project on the aquatic ecology within the proposed development area. The report covered aquatic plants (macrophytes), fish, and aquatic macroinvertebrates (i.e. freshwater invertebrates visible with the naked eye). Much of the results are repeated in this updated summary. Recommendations were also made in that report in respect to ecologically appropriate waterway setbacks, which in the main have been accepted by HDL, although we understand that, while the culverts cannot comply with all of the NES-F fish passage criteria, they will have some invert bury into the natural substrate sufficient to allow fish passage.

As outlined in this memorandum, those recommendations have been incorporated into the Project design and/or as conditions of resource consent.

Scope

The brief for this memorandum is as follows:

- Address existing aquatic features within the proposed development area, including waterway physical habitat, existing instream ecology, and existing fish passage barriers
- Address key features of the Project, and identify opportunities for ecological enhancement within the Project.
- Confirm whether any further surveys are required on site and if not, the reasons for this.

This memorandum has been prepared in accordance with the Environment Court Code of Conduct for expert witnesses.

Summary of Qualifications and Experience

Mark James Taylor

- My full name is Mark James Taylor. I am an ecological consultant in respect to aquatic values. I hold the qualification of a Bachelor of Science (Zoology).
- I have 21 years' experience in aquatic habitat assessment, firstly nine years with MAF Fish (Ministry of Agriculture and Fisheries, Fisheries Research Division), followed by eight years with NIWA (the National Institute of Water and Atmospheric Research) and since 2001, within my own company, Aquatic Ecology Limited (AEL).
- I, and my colleagues at Aquatic Ecology Limited, have many years of experience in Plan Change Applications from either rural or in this case lifestyle residential (Residential D) to medium density Residential C, including green-field surveys, wetland assessments, and eco-hydraulic modelling, and experience in waterway naturalisations from their former aligned states. In addition, we have also worked with civil construction companies for the translocation of fauna away from civil works, and local governments on resource surveys. Riley Payne (skills and experience statement below) and I, have been involved in several Fast-Track Consent Applications since 2024.
- I am a member of the Limnological Society of New Zealand (now New Zealand Freshwater Sciences Society), and was member of the Styx River Living Laboratory Board of Management (2002-2014). I have sat on ECAN technical panels involved in providing advice on minimum flows for waterways in the Ashley, Halswell and Ellesmere catchments (2001-2005).

Riley Steven Payne

- My full name is Riley Steven Payne.
- I am a qualified Environmental Consultant, specialising in freshwater ecology.
- I have a Bachelor of Science from the University of Canterbury, with a double major in Environmental Science and Biology. I completed a summer internship as a Water Quality Officer with Environment Canterbury in 2019. Since then, I have held the position of Environmental Consultant with Aquatic Ecology Limited (AEL). I now have over six years of experience in the field of freshwater ecology.
- I have extensive experience in surveys of waterway ecology and physical habitat quantification. I also have signification experience in wetland delineation, including fish, macroinvertebrate, and plant identification.
- While with AEL, I have had experience with several fast-track applications.

- AEL was contracted to provide guidance on ecological values within the proposed development area, including but not limited to the existing irrigation raceways. I personally visited the site on the 12th of July 2024, to conduct an assessment of ecological values within the property boundaries. I also assisted in the writing of the high-level summary of ecology, dated 9th September 2025.

Wildlife approvals or permits

In addition to staff qualifications, AEL holds the necessary permits for ecological assessments, under the Conservation Act, in addition to a number of regional permits with Fish and Game Districts, including North Canterbury and Mid-Canterbury, for the handling of acclimatised fish (e.g. brown trout, rainbow trout, brook charr, and salmon). A Wildlife Act permit, specifically a Lizard Management Plan, is required for the translocation of lizards, and AEL understands this will be obtained for the Project. Other than the Wildlife Act permit in regard to lizard translocations, no further permits are required under the Wildlife Act or under the Freshwater Fisheries Regulations.

Existing Environment

Site

The Project development area is located at 160 Bangor Road, Darfield (shown in Figure 1 below).

Figure 1 – Site plan.

Physical Habitat

As illustrated on Figure 2 below, the development area incorporates two irrigation raceways, both part of Malvern irrigation network, and sourced from surface water intakes on the Kowhai River. The waterways meet the definition of an “artificial watercourse” in the Canterbury Land and Water Regional Plan.

A site visit was conducted to inspect and survey the waterways on 12 July 2024.

Figure 2 – Existing waterways.

Waterway 1 traverses the proposed development area, and contained continuous surface water at the time of the site visit. Hydraulic physical habitat fluctuated between fast run and slow run (i.e. uniform, non-turbulent flow of uniform depth), with wetted widths varying between 0.5 m and 1.5 m. Substrate consisted of soft sediment, with average sediment depths of c. 15 cm. Some embedded gravels were observed in the lower reaches of this waterway. The waterway was not fenced, and signs of sheep grazing and pugging were visible in riparian zones throughout the impacted reach. The waterway flowed through four short (length < 15 m) narrow (c. 0.3-0.2 m dia.) farm culverts within the proposed development area.

During the site visit in July 2024, a Clapcott Rapid Habitat Assessment (RHA) (Clapcott 2015) was conducted at the upstream and downstream fish sample locations of Waterway 1. The upstream location received a score of 26/100, and the downstream fish sample location received a score of 38/100. These are both considered low scores, indicative of poor-quality habitat for aquatic biota. The low scores were caused by a lack of fencing, with consequent stock-accelerated erosion, possible pollution, and sedimentation. There was also limited shade over the waterway.

Waterway 2 entered the property through a small (c. 15 cm diameter) road culvert under West Coast Road (SH73). The waterway flowed in a south-westerly direction along the proposed development area's eastern boundary. Waterway 2 consisted of slow run habitat, with a small, constructed weir in the eastern corner of the proposed development area. The waterway showed signs of historic fencing, but fencing was ineffective at the time of survey. An earth bund along the true right bank (i.e. the development side) of the waterway indicated historic weed and sediment removal. Waterway 2 received an RHA score of 25/100 in the vicinity of the downstream fish sample location, indicative of poor habitat quality for aquatic fauna. This low score was due to sedimentation in the waterway, along with active bank erosion and an overall lack of waterway shading. This too, was attributed to stock access.

Ecology

The ecological values of both waterways within the proposed development area were surveyed extensively during the site visit on 12th July 2024. Surveys were conducted under AEL's permits for backpack electric fishing (MPI permit 944, and under authority from NCFG).[1]

[1] Following AEL's complaint to the Ombudsman's Office in 2025, no Wildlife Act permits, administered by DOC, are required for fish investigations on non-DOC land, such as this example.

During this survey, a macroinvertebrate sample was collected from each of the two waterways, using a standard 500-micron kicknet. The sampling techniques for both locations followed the protocols for sampling soft-bottomed waterways (Protocol C2 in Stark *et al.* 2001) Following collection, the macroinvertebrate samples were field-preserved in denatured ethanol and transported to the AEL Christchurch laboratory for processing. The samples were processed using the "first 100" method, in which the first 100 invertebrates are recorded, followed by a full sample scan for rare taxa. Invertebrates were identified using the standard identification keys (Chapman *et al.* 2011; Winterbourn 2021; Winterbourn *et al.* 2006). Following processing, a Macroinvertebrate Community Index (MCI) score was calculated for each sample, and index reflective of overall stream health (Stark & Maxted 2007).

The fish community in the catchment was sampled in three locations along Waterway 1, and two locations along Waterway 2, using a Kainga EFM300 backpack electric fishing machine. This machine temporarily (c. 3 seconds) incapacitates fish to facilitate their capture in nets. The machine was active for a combined total of 34 minutes during this survey, at an operating voltage of 200 V. D.C, the minimum voltage to effectively incapacitate fish for their capture. The locations of each fish sample were selected based on accessibility, fishability and habitat variety. Each location was spot-fished for 5-9 minutes, ensuring all habitat types were sampled.

- Waterway 1

The macroinvertebrate sample collected from Waterway 1 identified an abundance of the common New Zealand mud snail (*Potamopyrgus antipodarum*), introduced bladder snail (*Physa acuta*) and water mites (*Acari* sp.). The relatively high abundance of drying-reach micro-crustacea and water mites, and the absence of EPT taxa (i.e. Ephemeroptera, Trichoptera, and Plecoptera Orders), suggest the waterway may lack surface flow at times which inhibits macroinvertebrate breeding. Moreover, these species are all indicative of low stream health, with taxa tolerance values of 2.1, 0.1 and 5.2 respectively. The overall MCI score for Waterway 1 was 47.3, indicative of "Poor" stream health (MCI < 80). This was consistent with the available habitat for macroinvertebrates in this waterway. The sampled reach was slow flowing, with emergent macrophytes and a thick layer of duckweed. Substrate consisted of soft sediment.

Following significant fishing efforts, the only fish species identified in Waterway 1 was the upland bully (*Gobiomorphus breviceps*). This species is native to New Zealand, and has a conservation status of "At Risk – Naturally Uncommon" (Dunn *et al.* 2025), but is frequently observed in the surrounding area and wider Canterbury region. The upland bully is non-migratory, and can therefore form inland populations in waterways with compromised upstream or downstream fish passage. Fish in Waterway 1 were small, ranging from 32-44 mm in length, suggesting interrupted population recruitment. During the survey, upland bullies were only captured in the mid-reach location, with no fish caught or observed in the upstream or downstream survey locations.

- Waterway 2

The macroinvertebrate sample collected from Waterway 2 contained an abundance of the common N.Z. mud snail. A total of 17 macroinvertebrate taxa were identified in this waterway. These included the stonefly larvae *Zelandobius*, which is uncommon in Canterbury irrigation raceways. Some invertebrate species, sensitive to organic pollution, were present in the waterway, such as the aforementioned *Zelandobius* (taxon tolerance value = 7.4) and the free-living caddisfly larvae *Psilochorema* (taxon tolerance value = 7.8). The overall MCI score for Waterway 2 was 71.6. This was indicative of "Poor" stream health (MCI < 80). It is likely that some high-health invertebrates, such as *Zelandobius*, were carried downstream to this location from one or several irrigation intakes during high flow events. Fish screens, if present, cannot stop the dispersal of very small macroinvertebrate eggs and larvae.

Following fish surveys in two locations along the impacted reach of Waterway 2, one fish species, the upland bully, was identified. Upland bullies were abundant in both the upstream and downstream survey locations, with a wide size range (46-82mm T.L.). Some individuals were gravid, and were likely breeding in the vicinity.

Overall, based on the RHA and the surveys undertaken by AEL, the ecological values of the waterways are considered to be low.

Fish passage barriers

Based on the site visits conducted in the winter of 2024 (12/7/24), the small culvert directing current irrigation inflow into the proposed development area is fully embedded into the substrate and passable by fish. The outflow, at Bangor Road, is piped with a fully embedded invert (field notes 12/7/24).

The existing farm culverts, as observed during the above site visit, were also passable by fish, despite non-compliance with the National Environmental Standards-Freshwater 2020 culvert regulations (NES-F). The culverts were buried, with continuous substrate throughout, and were short, with an approximated maximum length of 15 m. Observed flows through the culverts were low, well below the rule-of-thumb 0.3 m/s velocity associated with sustainable, aerobic swimming speeds, and regarded as easily passable for the small resident upland bullies.

Project

As part of the Project, specific activities are proposed in relation to the waterways in the proposed development area, including:

- The realignment of Waterway 1.
- Extensive riparian planting.
- The removal and installation of culverts.

Further detail regarding those activities, and their effects on the ecological values of the waterways, is set out below.

For the Project more broadly, the primary effects of subdivision on waterways arise from stormwater run-off from the increased impervious surface areas. In that regard, we understand that the stormwater system for the Project will be designed to prevent stormwater entering the water races, and the erosion and sediment control plan proposed to be implemented as a condition of resource consent will protect the water races from further sediment during the construction phase. Stormwater will be disposed to swales or soak pit. Those measures will ensure that the adverse effects of stormwater from the Project on the ecological health of the waterways are negligible.

Waterway 1 realignment

The latest available landscape plan (dated April 2026) is presented in Fig. 3 below.

As shown by that plan, it is proposed to realign Waterway 1 within proposed Reserve 801, to form a natural meandering flow path away from the mature *Eucalyptus* trees which are proposed to be retained. This will reduce the amount of *Eucalyptus* detritus leachate from falling into the channels which reduce the ecological values of the waterway.

Figure 3 –Landscape plan as of June 2026.

Downstream of proposed Reserve 801, there are options to retain the existing flow path, or divert the waterway approximately 45 m to the south, along the southern boundary of the proposed East West Linear Reserve (Figure 4 below).

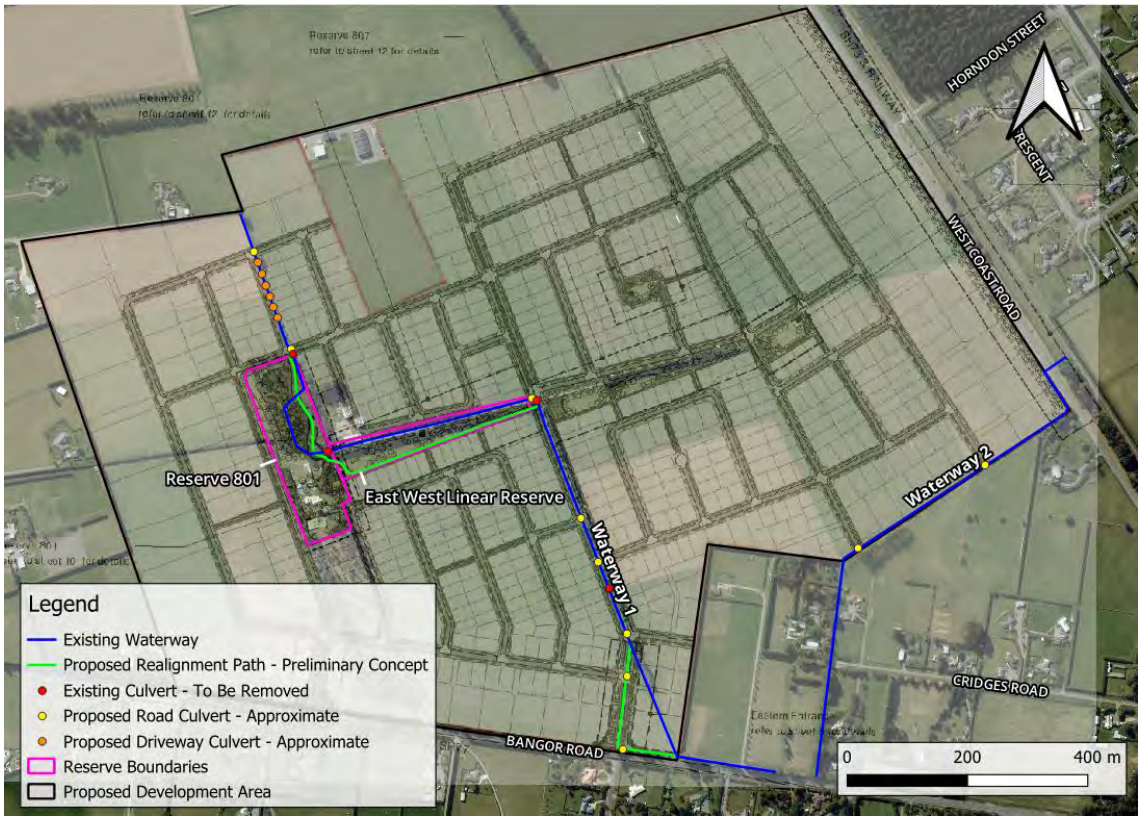

Figure 4 – The proposed realignment and culvert works.

Inclusive of the realignment in Reserve 801, both proposed options would result in an overall decrease in total habitat length of approximately 15 – 30 m.

The small loss in habitat is proposed to be mitigated by the significant improvements in habitat quality that could be achieved through appropriate native riparian planting and the inclusion of habitat heterogeneity, such as riffles and pools.

Additionally, a further realignment is proposed for Waterway 1, at the downstream limit of the proposed development area (Fig. 4). This realignment would increase total habitat length by approximately 80 m, partially offsetting the loss of habitat from proposed culvert installations (described below).

We have recommended that the re-aligned reaches of Waterway 1 should feature cobble substrate and because of low baseflow due to raceway management, a V shaped channel cross-section should be used. This will ensure water depth regardless of flow, and ensure that spawning habitat for resident upland bullies in always available.

All proposed waterway realignments would require fish translocation by a suitably qualified ecologist, prior to the diversion of baseflow. Fish translocations should follow the methods outlined in an approved fish management plan, also prepared by a suitably qualified ecologist.

Riparian planting

As observed in July 2024, the existing riparian management of the waterways consists of mature *Eucalyptus* canopies, shading from macrocarpa hedgerows, heavy grazing by sheep stock, and herbicide spraying in reaches that are not grazed.

As part of the Project, all open channel reaches of both Waterway 1 and Waterway 2 will have a minimum of one row of overhanging *Carex* sp. on each bank. In reaches where space allows, such as proposed Reserve 801, AEL recommends that a native-planted riparian setback of 10 m on each bank is included, measured from the wetted margin of the waterway under baseflow conditions.

Riparian planting in wider setbacks should be consistent with the CCC stream design guidelines (Christchurch City Council 2003), with low-growing overhanging species such as *Carex* sp. at the waterway margins, and larger tree and shrub species such as harakeke/NZ flax (*Phormium tenax*) or cabbage tree (*Cordyline australis*) further up the bank, to provide waterway shade and bank stability through deeper roots.

Our recommendations in that regard have been adopted in the landscape concept plan, dated June 2026. A full planting plan will be provided by the landscape architect, with inputs from AEL and the terrestrial ecologist.

Culverts – installation and removal

As part of the Project, a total of eight road culvert installations will be required along the length of Waterway 1, and approximately six driveway culverts. Within this same proposal, three road culverts may be required across Waterway 2. All other reaches of each waterway will remain as open channel.

During the 2024 site visit, four short (c. 5m) farm culverts (Figs. 5a, b) were installed along Waterway 1 within the proposed development area, and these will be removed within the proposal. The existing farm culverts were small in diameter, flow-constricting, and therefore non-compliant with current NES-F 2020 culvert requirements.

Figure 5a. Example of the small existing farm culverts, July 2024.

Figure 5b. Example of the small existing farm culverts, July 2024.

Due to the bed of the waterway being only a short distance below ground level, culverts of the size required by the NES-F conditions will not be possible within the proposed development area. Both waterways are artificial waterways, meaning they are excluded from the definition of a river under the RMA 1991 and therefore do not require regulatory compliance with the NES-F 2020. Notwithstanding, every effort will be made in the design and construction of the culverts to ensure resident fish passage. To that end, AEL recommends that:

1. The culvert inverts are buried at least a short distance under the waterway bed, with continuous natural substrate through each culvert.
2. The diameter of each culvert should be, at minimum, the same as the width of the adjacent open channel wetted width.
3. The slope of each culvert should also be similar to that of the surrounding open channel.
4. The measure of each culvert should ensure that the water velocity will approximately match that of the existing open channel.

As outlined above, the resident fish fauna was composed of a population of upland bully (*Gobiomorphus breviceps*), which has a recent elevation in conservation status from "not threatened" to "At Risk - Naturally Uncommon" (Dunn *et al.* 2025). No other fish species was identified despite high fishing effort (34 minutes electric- fishing current). The upland bully rears and spawns locally and does not require site access, although may be required to migrate locally to access spawning gravels to maintain population size. For that reason, we would recommend that any culverts are embedded into substrate gravels to facilitate fish passage. The swimming performance of upland bullies has not been extensively researched, but is likely similar to that of the related common bully (*Gobiomorphus cotidianus*). The common bully can use sustained swimming techniques to pass through a maximum surface water velocity of 0.3 $m.s^{-1}$over a c. 20 m distance (Mitchell 1989). To ensure passage for resident upland bullies, the water velocity within each culvert should not exceed c. 0.3 ms^{-1}.

We recommend that all proposed pedestrian waterway crossings that are not related to a roadway, such as those within the proposed East West Linear Reserve, should consist of footbridges, to ensure minimal impacts on fish passage and overall instream ecology. Foot bridges ensure the waterway remains the same as the adjacent open channel, and allow for the continuity of riparian dispersal paths for the flighted adult lifestages of aquatic macroinvertebrates.

No works should be conducted in flowing surface water. The removal of existing culverts and installation of proposed culverts will require temporary waterway diversions, and fish translocation by a suitably qualified ecologist. Fish translocations should follow the methods outlined in an approved fish management plan, prepared by a suitably qualified ecologist.

Summary

Conditional to the implementation of our recommendations outlined below, the adverse effects of the Project on the ecological values of the waterways and their physical habitat will be less than minor, and through the enhancement works proposed, we anticipate there will be a positive overall effect on the quality of the habitats within the waterways for fish and macroinvertebrates; specifically:

- Native riparian planting will result in higher levels of waterway shade, improving instream habitat by reducing peak surface water temperatures, decreasing oxygen demand for native fish.
- Additionally, shade produced by native riparian planting will minimise the instream growth of aquatic macrophytes and algae.
- Fish passage will be maintained through considered culvert design.

Consequently, the establishment of ecologically functional riparian strips has the potential to increase both abundance and diversity of macroinvertebrates in the development waterways, as there are ecological links between the aquatic and terrestrial habitats. For that reason, we recommend further meetings between the landscape architect and the consultant ecologist to finalise the planting plans, channel cross sections, and road crossing treatments.

Further Surveys

Due to the recent and still-relevant 2025 ecological survey, no further surveys of ecology are required prior to the proposed development. In addition, due to the stable nature of the raceways, the instream ecology of the waterways is likely unchanged since the extensive survey of fish and macroinvertebrates in 2024.

Following the proposed development and waterway naturalisation works, AEL recommends follow-up ecology surveys of the aquatic macroinvertebrate and fish communities, to monitor changes in macroinvertebrate biodiversity, and fish dispersal.

Recommendations

To ensure the Project minimises impacts on existing instream ecological values, and has an overall improvement on fish abundance and macroinvertebrate biodiversity, AEL recommends the following measures:

- Waterway 1 will be subject to a 10 m development setback within the reserve areas. This excludes the requirement of boundary fences where required. Setbacks elsewhere, in association with the landscape architect, should be as wide and naturalised as practicable.

- For Waterway 1, which may be subject to dewatering, the re-aligned reaches should feature cobble substrate and because of low baseflow due to raceway management, a V shaped channel cross-section should be used. This will ensure water depth regardless of flow, and ensure that spawning habitat for resident upland bullies is always available. For Waterway 2, no waterway profile adjustments are necessary. Improvement works should be confined to riparian planting, and bank regrading as required.

- Native riparian planting should be present in all reaches of open-channel waterway. In areas where space is limited, such as the proposed flush median reach, riparian planting can be limited to a single row of overhanging *Carex* sp. planted at the wetted margin. Where space permits, riparian planting should be consistent with the CCC stream design guide.

- In the interests of ecological function, further dialogue between the landscape architect and the consultant ecologist to finalise the planting plans, channel cross sections, and road crossing treatments.

- Ongoing maintenance of riparian areas will be required to ensure existing invasive species such as old man's beard (*Clematis vitalba*) do not regrow.

- All culverts, including road and driveway culverts, should allow the same level of fish passage as the adjacent open channel waterway. To achieve this, culvert diameters should be approximately equal to the adjacent waterway width, and the invert of each culvert should be buried, with continuous substrate throughout. Water velocity through culverts should not exceed 0.3 ms^{-1}.

- All pedestrian waterway crossings that are not related to a roadway, such as those within the proposed East West Linear Reserve, should consist of footbridges, to ensure minimal impacts on fish passage and overall instream ecology.

- Within the proposed realignments, such as that in Reserve 801, a variety of instream habitats should be included, such as pool, riffle and run habitats. We note that under baseflow conditions the waterway contains a small flow volume, and the potential for riffles will be limited by the existing waterway gradient.

- Follow-up surveys of macroinvertebrate biodiversity and fish abundance should be conducted upon completion of the proposed waterway enhancements, to monitor impacts of the development.

Conclusion

The waterways within the proposed development area are both raceways, which meet the definition of an artificial watercourse in the Canterbury Land and Water Regional Plan. Their aquatic values are heavily influenced by the raceway management regimes administered by the Selwyn District Council. Notwithstanding, we consider that the mitigation and habitat enhancement proposed as part of the Project will enhance the instream ecology within the context of a managed flow regime environment.

In particular, the management of riparian zones, including planting of native vegetation and ongoing control of invasive species, will result in a significant improvement over the existing riparian areas. The proposal ensures any retained mature eucalypts, which may have a negative impact on the waterway, will be situated at least 10 m from the wetted margins, with a native vegetated buffer in between.

The Project will include ecologically beneficial setbacks including a 10 m development setback of either waterway, excluding the reaches within a roadway flush median. Moreover, being artificial watercourses, the proposed raceway culverts are not required to meet the culvert requirements under the NES-F 2020. Nevertheless, the Project will provide fish passage for all resident species, with an adequate diameter to ensure fish passage and continuous raceway substrate through the culvert base. The loss of habitat to culverts will be sufficiently mitigated by the proposed habitat improvements in open-channel reaches.

Provided our recommendations are accepted, we conclude that the proposed waterway realignments, culvert enhancements and riparian planting will have a net beneficial effect on the habitat of both waterways within the development area.

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