Evergreen Consulting
Environmental and Urban Planning

10 December 2025

Horizons Regional Council
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By Email:

Dear Ayesha

S92 response - APP-2025205512.00

Thank you for your letter dated 26 November 2025 requesting further information in respect of a number of matters. Below details responses from Mr Jon Bell, Principal Engineer, e2 Environmental Limited and Dr Mark Heath, Freshwater Scientist, Traverse Environmental. In addition, we have a further response from Ngati Rangi.

1. *The engineering report (Appendix 5) assesses water velocity through the bypass culvert at estimated typical low flow conditions (1-10% of MAF). The New Zealand Fish Passage Guidelines (NZFPGs) considers bankfull flow (QH) as well as low/base flow (QL) to be the relevant flow thresholds for fish passage design. Please provide an assessment of water velocity through the bypass culvert at these flow thresholds in accordance with Sections 4.5.3. and 4.5.4. of the NZFPGs.*

Mr Bell has reviewed the question and advised the following, with consideration of Sections 4.5.3. and 4.5.4. of the NZFPGs

"Due to the local topography, it is difficult to define 'bankfull' flow at the location of the crossing. This is due to the fact that while the channel is well defined in the reaches upstream and downstream of the ford, at the ford itself the channel of the Koukoupo Stream is much wider, with shallower less clearly defined banks. To account for this uncertainty, the bankfull flow could be considered to be equivalent to a mean annual flow, which one would typically expect to be around the flows contained in the main channel of a watercourse before it overtops its banks. Based on this assumption, the QL would be 0.49m/s (as per the 1% of MAF), and the QH would be 2.90 m/s (at MAF)". To provide some context, the QL and QH flow velocities in the upstream and downstream reaches, as well as those in the bypasss culvert, are shown in the table below.

Location	Flow	Velocity (m/s)
Upstream Reach	QL	0.47
	QH	2.60
Downstream Reach	QL	0.36
	QH	1.93
Bypass Culvert	QL	0.49
	QH	2.90

2. *In relation to question one (1) above, please provide further information regarding fish passage at the predicted water velocities, in accordance with Section 4.5.6. of the NZFPGs, using the sustained swimming speed of longfin tuna.*

Dr Heath has reviewed the data supplied by Mr Bell in respect of question 1 above and provided the following response, also noting the requirements of Section 4.5.6. of the NZFPGs:

"The mean sustained swimming speed of longfin elver is 0.22 m/s, which is lower than both the QH (2.90 m/s) and QL (0.49 m/s) estimated velocities in the bypass culvert. It is important to note, however, that the QH and QL velocities are also elevated in the upstream and downstream reaches of the Koukoupo Stream, and that the QL velocity within the bypass culvert is comparable to the velocity measured immediately upstream (0.47 m/s). This indicates that the bypass culvert will have velocities within the envelope of stream velocities in this reach of the Koukoupo Stream.

The steep gradient and naturally high velocities of the Koukoupo Stream mean that fish passage is difficult even under low flow conditions. Especially when considered alongside the presence of natural barriers (waterfalls) upstream and downstream of the culvert. The presence of tuna within the stream, including upstream of the culvert, suggests that individuals are accessing these areas during periods of low flow, supported by their strong swimming and climbing abilities.

Tuna have excellent climbing capacities that allow them to negotiate fast-flowing environments. Juvenile eels (elvers) are anguilliform (S – shape) swimmers, pressing and bracing their bodies against rough surfaces and progressing through low-velocity boundary layers along the stream margins. In a stream such as the Koukoupo, where high velocities occur even under low-flow conditions, elvers are likely relying on a combination of short burst movements between resting points and the use of low-velocity refugia to move upstream.

For this reason, it is critical that natural substrate is able to deposit inside the culvert, as it provides essential roughness, friction points, resting opportunities, and low-velocity pathways that facilitate elver passage in an otherwise hydraulically challenging environment. When natural substrate accumulates within a culvert, it creates surface heterogeneity, shallow margins, and micro-velocity refugia that elvers can use to crawl or swim upstream even when the bulk water velocity is high.

To facilitate substrate deposition, we also propose to install baffles within the bypass culvert to further disrupt the flow and generate surface and edge boundary layers where velocities can be substantially reduced. Baffles also provide additional climbing and movement pathways that elvers can exploit to incrementally work their way through the culvert, despite QL and QH velocities that exceed their sustained swimming speed."

3. *Please provide an estimate of the depth of water within the bypass culvert at the fish passage design flows.*

Mr Bell has advised the following:

QL (depth) = 0.05m

QH (depth) = 0.78m

4. *It is noted that baffles are proposed within the bypass culvert at intervals of two metres. Please provide further information regarding type and configuration of proposed baffles.*

Following discussions with Mr Bell and Dr Heath, it is recommended that Flexi-baffles (FLEXIBAFFLE | INNOVATIVE CULVERT BAFFLE | ATS ENVIRONMENTAL), or bespoke baffled made from Stainless Steel (Final option is to be chosen in conjunction with iwi).

Flexi-baffles will be configured as follows:

- Spacing: 1,000 mm
- Length: 600 - 800 mm
- Height: 100 mm
- Positioning: centred within the culvert

This design is consistent with an installation guidance for Flexi-baffles through round culverts developed by the NZ Fish Passage Advisory Group (see: *Lessons Learnt 008 – Installation of Flexi-baffle*: https://www.doc.govt.nz/globalassets/documents/conservation/native-animals/fish/fish-passage/lessons-learnt-case-studies/lessons-learnt-008-installation-of-flexi-baffles.pdf)

5. *The water velocity and depth within the bypass culvert will be highly dependent on the amount of stream flow entering the bypass pipe. The engineering report assumes the pipe would take 50% of stream flow at 1%MAF and 40% at 10%MAF. Please provide further information on how these proportions of flow were determined. Given the dynamic nature of waterways, particularly steep streams such as this one, what degree of certainty is there regarding the proportion of flow entering the bypass culvert. Please provide information if there a risk that either too little or too much water will enter the bypass, potentially impacting fish passage.*

Mr Bell has responded as follows:

"The proportions of flow have come from the results of the HY-8 modelling. Whilst the stream overall is steep, it is noted that the short reach immediately upstream of the ford is relatively flat and significantly wider than the upstream and downstream reaches per figure 2 of my memo, attached as appendix 5 to the application. The presence of the ford leads to some heading up 'ponding' of the water in this area providing an element of control on the water levels at the inlet of the by-pass culvert.

Whilst this provides some confidence in the proportion of water that will flow via the bypass culvert, it is noted that the bed levels of the stream may fluctuate as gravels are moved by high flows events. In this regard the risk of the bed dropping is considered to be low due to the fact that the structure is close to the Papa bedrock. The more significant risk to the proportion of flows being altered by natural processes is therefore gravels being deposited that reduce flows in either the bypass culvert or the ford. This risk could be mitigated by the relocation of any gravels that are obstructing flows as part of maintenance activities."

The below image shows the ponding upstream of the structure (Taken 1 August 2025).



It is further noted that these maintenance activities would be allowed for by rule LF-AWBD R70 Other minor bed disturbances

6. *Migrating fish often aggregate at the upstream limit of migration (in this case, the outlet of the ford), which can reduce the effectiveness of bypass structures depending on the location of the bypass entrance (outlet). Please provide the distance between the bypass outlet and the upstream limit of migration and assess the likely effect of this distance on fish passage success.*

Dr Heath has provided the following response "The bypass entrance will be located within approximately 5m of the upstream limit of migration. Longfin eels typically explore their immediate environment intensively at

migration barriers and rely strongly on localised hydraulic cues to locate viable passage routes. Although the bypass entrance is offset laterally from the ford outlet, it remains very close to the point where eels may aggregate and will provide a strong attraction flow (approximately 50% of MAF). Based on this proximity and the strength of the attraction cue, it is unlikely that migrating eels will accumulate at the barrier and fail to locate the bypass."

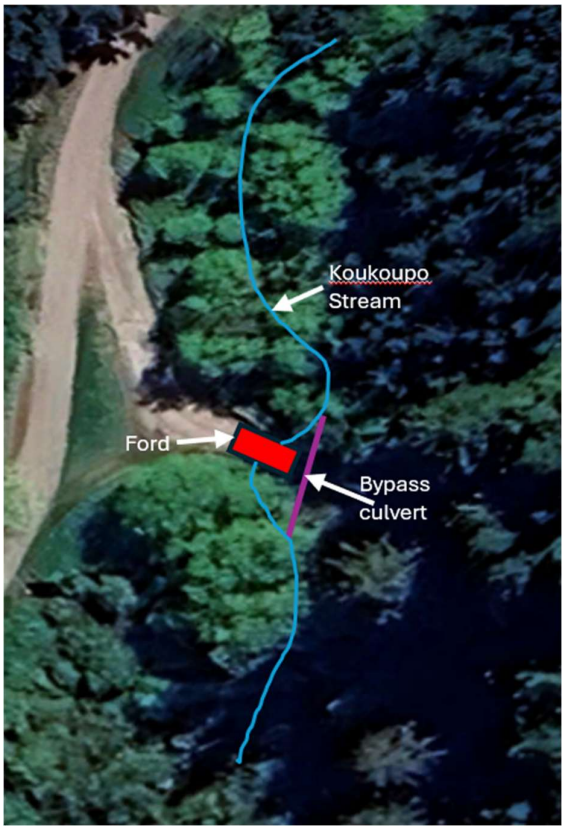
7. *Please provide further information indicating whether fish recovery will be undertaken in relation to the proposed stream diversion and provide an outline of the proposed methodology.*

Dr Heath has provided the following response "Fish recovery will be carried out on site by the local contractor, who will be trained by a freshwater ecologist. It is important to note that the works will primarily occur outside of the stream and within a dry working area. At the culvert inlet, where we propose to install a coffer dam constructed from sandbags, the dewatered area (approximately <10 m^2) will be inspected for fish. Inspections will include active searching, such as turning over rocks, both immediately after dewatering and again one hour later."

We agree to propose this as a condition of consent.

8. *The geometry of the bypass culvert appears from Figure 4. In the E2 Environmental Report to require at least one change of direction to get around the existing structure. Please confirm if manholes are proposed.*

Mr Bell has confirmed that no man holes are proposed. Mr Bell further notes the perspective of figure 4 in his memo provides a false impression of a curvature. Mr Bell confirms "The culvert will infact be straight, as the ford actually takes the stream around a bend (around the alignment of the original bridge). This is indicated on the sketch below.



Any small curvature that may be required in the bypass culvert will be created through small angular deflections at the joints (with in the manufacturer's tolerances)"

9. *In relation to question eight (8) above, a 1600 mm diameter culvert embedded 400 mm the top of the pipe will be approximately at the same level as the ford surface. Please confirm the finished geometry/material type of the approach road over the 1600 mm pipe so that sufficient cover is provided and it is resilient to overtopping during flood events.*

Mr Bell has responded as follows: "The road ramps up significantly from the ford to provide access to the Station. The geometry means that at least 600mm of compacted cover will be provided over the culvert. The material will be similar to that for the existing road. This surface has withstood previous flood events, and, while not expected to occur, the consent holder will repair any damage to maintain their access should it be required".

10. *Our technical advisor has assessed that information related to measures to mitigate the risk of the bypass pipe being outflanked/damaged and consideration of outlet protection to prevent the culvert becoming perched is not provided. Please provide further information to mitigate this risk. e.g. the need for inlet and outlet headwalls and erosion protection. This assessment/design is to be based on flood flows not low flows.*

Mr Bell advises the risk of perching is very low. He further explains "Firstly the culvert will be embedded by 400mm or 25% (as per the NES-FW requirements). Secondly the bed of the stream downstream of the ford is at the bed-rock level. As such significant degradation of this level is minimal.

The risk of outflanking of the culvert is considered to be low – the river bank in this area has been stable for some time and has withstood a number of high flow events. As part of the construction of the culvert, this bank will be well compacted and vegetated to minimise the risk of erosion. It is noted that if the culvert were to be outflanked, the only infrastructure that would be impacted is the applicant access road. As such if any erosion begins to develop it will be remediated as part of maintenance works."

11. *Please confirm the Mannings n roughness that has been assumed for the bypass pipe for calculating low flow velocities.*

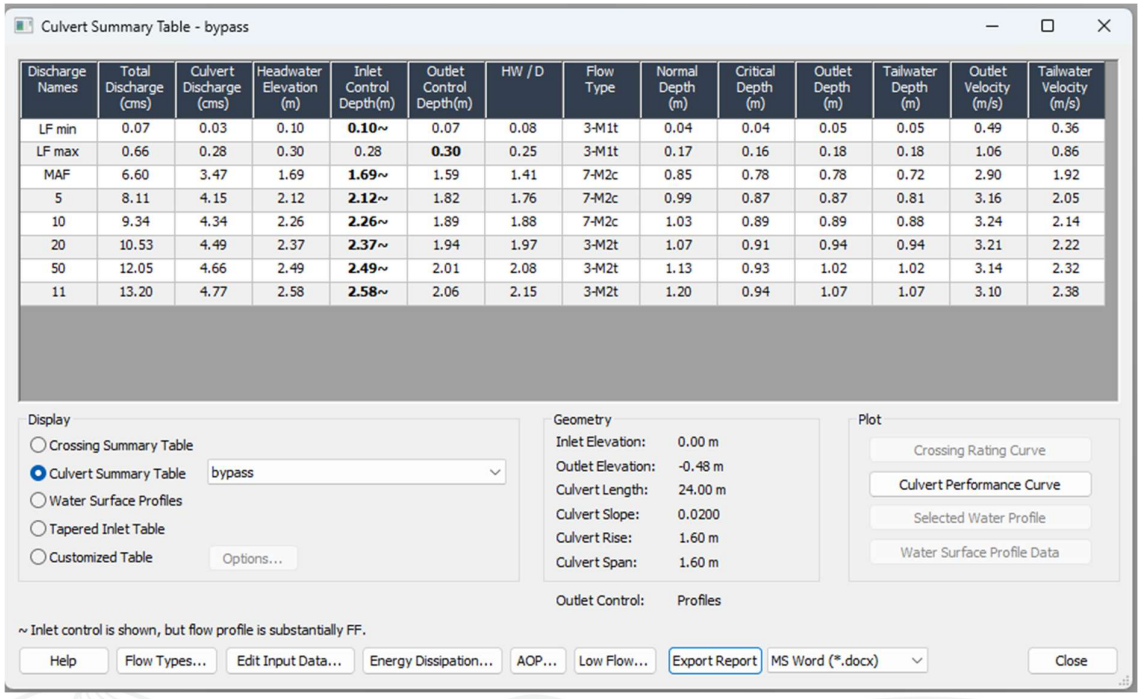
Mr Bell advises these are as follows:

0.011 for the culvert, and 0.035 for the bed

12. *Please confirm the invert level of the bypass pipe relative to the existing structure and provide HY-8 model results.*

Mr Bell has provided the following:

The bypass culvert inlet has been set 0.02m lower than the ford.





13. *Please confirm embedment depth and planform extent geometry of right bank rock work including a plan view.*

Mr Bell advises

"The toe of the rock will be embedded up to 1.5m. However, given my observations on site it is noted that bedrock will likely be encountered before this depths, if so this will be the founding depth of the rock.

As per the application the rock riprap lining will be placed along the road embankment for a length of approximately 10 metres downstream of the ford crossing, until the stream and the road diverge from each other. This has been indicated on the aerial image below.

N.b. this image is indicative as the aerial photography predates the flood that precipitated the bridge failure and later ford construction.

N.b. the exact placement of the rock will be directed on site to ensure that it extends far enough downstream, so that it will not be directly attacked by the Koukoupo Stream."



14. Please provide design velocity and calculations to verify 300 kg rip-rap is suitable in this location.

Mr Bell has provided the following assessment

"For conservatism the higher slope of the upstream reach has been assumed to be representative of the channel. This slope is 0.308m/m. To be able to quantify flow velocities in the stream the channel was assumed to be trapezoidal in cross-section, with a bed with of 4m, and side slopes of 1:1 (H:V). A conservative manning's n value of 0.05 has been assumed to represent the roughness of the channel.

NIWA's Flood Estimation Tool suggests that the 1% AEP flood in the Koukoupo Stream is 13.2m3/s. Using Mannings equation, the flow velocity in this event has been estimated to be 3.25 m/s. Allowing a factor of safety of 4/3 to account for increased velocities on the outside of a bend, the design velocity is therefore 4.33 m/s. If greywacke rock with a specific gravity of 2.65 is used, and the rock lining is placed on a 1:1.5 (V:H) slope.The mass of the critical rock is then estimated using the California Division of Highways (1960) Method.

This equation is:

$$W = \frac{0.01135V^6\gamma}{\sin^3(\rho - \alpha)(\gamma - 1)^3}$$

Where:

W = mass of critical stone (kg)

V = water velocity (m/s)

γ = specific gravity of rock

ρ = angle of repose of the riprap material (degrees)

α = embankment slope (degrees)

Using this method the critical rock has been estimated to be 213 kg. Upsizing this to 300 kg adds a level of conservatism to the design."

15. *The assessment of flood risk effects is not provided. Please provide further information and assessment related to changes to upstream flood levels associated with the structure and its impacts on other property;*

Mr Bell advises:

"As discussed in the application, the stream upstream of the site is steep and well incised. The dimensions of the ford mean that the stream channel now has a greater cross sectional conveyance area than it had under the 6m span bridge that predated it. As such it is concluded that flood levels are in fact likely to be lower than they would previously have been. Therefore, there will be no adverse effects on any other properties, including the adjacent road. The risk of flooding remains to the ford crossing, and this is something that only impacts the applicant, who is comfortable with the risk and the need for on-going maintenance."

16. *The assessment from Ngati Rangi provided with the application states that "Once a resource consent for the works has been submitted we will be in a better position to examine the details of the proposed works before making a final decision. In particular, we will need to evaluate the sediment management plan, planting plan and any other necessary steps to prevent scouring". Please provide confirmation from iwi regarding proposed works.*

Please see response attached.

Closing

We trust that this satisfies the further information request and look forward to hearing from you in respect of your decision.

Yours sincerely,



Natasha Adsett
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Cc by email

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Encl: Feedback from Ngati Rangi.