29 November 2018

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Dear Hannah

WAIANIWA-OPORO RD CULVERT – RESPONSE TO REQUEST FOR FURTHER INFORMATION

This letter and the attached supporting information have been prepared to respond to questions you have raised in relation to the consent application for the above culvert APP-20171214-01-V2. As you are aware, the culvert has consent (AUTH-20171214-01-V1) to be placed at "natural bed level", but a further change to the consent is required because the culvert has since been confirmed to be approx. 240 mm above this level.

All parties involved acknowledge that the situation which has occurred is not ideal. The key question which needs to be addressed is whether any adverse effects are occurring which are sufficient in magnitude to warrant the re-installation of the culvert (which would involve significant disturbance to both the stream environment and the local community).

The concerns raised in your recent email (November 22nd), as well as earlier communications (formal Section 92 request on July 17th, and follow up email on September 21st) generally cover the following points:

- Fish passage,
- Flooding and other hydrological effects,
- Whether the placement of the culvert at this height constitutes "damming" under the relevant ES rules.

Specifically, these issues were raised in relation to an earlier email from us (November 14th), in which we proposed to:

- Provide an ecological assessment to identify the flow conditions through the culvert required to support fish passage.
- Complete visual and photographic monitoring over the 2018-19 summer to confirm whether these conditions are in place.
- Based on the above, make a decision as to whether the culvert provides adequate fish passage presently, or whether mitigation measures are required.

- Provide an engineer's assessment of whether flooding and related issues may occur in the catchment upstream of the raised culver.
- Provide further information in support of our initial view that the elevated placement of the culvert does not constitute "damming"

In addition to addressing those points, this letter also responds to your comments on our approach, and includes an update on consultation and notification issues with this application.

Fish passage

> ***Your comments: We are not satisfied that the approach set out in the email below will provide us with sufficient information to determine whether the actual or potential adverse effects on fish passage are less than minor or whether fish passage will be maintained. We are concerned that there could be an effect on fish passage occurring now, and over the summer when data collection is proposed to occur. Additionally, we consider the incorrect installation also has the potential to impact instream habitat upstream of the culvert which isn't addressed in the response.***

The attached *Assessment of Fish Passage* by Water Ways Consulting Ltd makes the following key points:

- The most sensitive species in the stream to any restriction in fish passage is the common bully, with the other species in the stream generally either non-migratory, strong climbers, or unlikely to be migrating during periods of low-flow.
- Even in the case of common bullies, restrictions in their ability to pass through the culvert are expected to be limited to periods of low flow, with any fish trapped temporarily below the culvert able to pass through once stream levels rise.
- There would be no benefit to carrying out a fish survey in the stream in the near future, as recent heavy rainfall will have ensured that adequate fish passage through the culvert is available (as evidenced by the attached photographic record to date). However, if there is an extended period of low flows over summer, and this causes a 'lip' to form at the down-stream end of the culvert, a fish survey in late summer after an extended period of low flows would be useful in confirming whether this has restricted the passage of common bullies.
- Upstream fish habitat is expected to be slightly improved (if there is any change) by the slight increase in depth immediately upstream of the culvert.

The following text from the report is of particular relevance:

If flow and visual culvert monitoring do not find a vertical drop has formed, then fish passage will not be prevented, even for common bully. It can also be expected that if the stream flow increases and the vertical drop is submerged upstream migrating bullies will continue upstream at this time, so impedance of fish passage will be temporary and fish surveys should be conducted only after extended periods of low flow. This will allow upstream migrating bullies to accumulate in sufficient numbers to indicate a fish passage barrier.

Returning to the concerns raised in your email:

- Based on the evidence available, there is no reason to expect that the culvert presents an immediate threat to fish populations in the stream.
- Further monitoring over the summer is needed to assess whether or not there is any significant barrier to fish passage at all.

We propose to continue our visual and photographic monitoring of levels in the stream over the coming summer (at least 3 times per week). If a period of low flows occurs which results in a visible lip being present at the downstream edge of the culvert for a period of greater than 1 week, a fish survey will also be carried out to assess whether common bully migration is being restricted. Based on the conclusions of the *Assessment of Fish Passage*, there would be no benefit to a fish survey if a lip does not form for an extended period of time.

If it is identified that there is a barrier to fish passage, the report on the fish survey will recommend appropriate mitigation measures, such as ramps at the downstream edge of the culvert, or grinding out a shallow channel in the base of the culvert to provide a pathway for fish migration even if a lip is present at the culvert edge.

In the event that the monitoring over this summer is inconclusive (e.g. if no periods of low flow occur due to a very wet summer), it may be necessary to repeat the above the following summer. Nonetheless, our professional opinion remains that the effects of the culvert on fish passage are likely to be less than minor, and that the above issues can be addressed by monitoring and adaptive management/mitigation conditions, rather than complete certainty being required before consent is granted. We envisage that the consent would include conditions requiring the above monitoring (and, if required, mitigation) be completed within a specified timeline.

Flood risk

Your comments: I have discussed the approach with the Catchment Division at ES. Based on their knowledge of the area, they are of the view that the incorrect installation of the culvert causes the upstream area to have a higher water level which has an effect on the drainage of local field tiles. The

Catchment Division have received complaints from upstream property owners regarding the effects of the incorrect installation and land drainage upstream. It has also been observed that rocks have been placed upstream and downstream of the new culvert which has further raised water levels. The placed rocks catch weeds in the stream which has an ongoing impact on ES's drainage works as the culvert will need to be cleaned more frequently due to the build up of sediment and weeds. It's also noted that approval under the Flood Control Management Bylaw for this culvert would also be required.

Firstly, to address your comments about land drainage, we have consulted with the owners and/or occupiers of the four closest properties to the culvert (two upstream, two downstream). Their comments are discussed in detail below, but it is important to note that only the owner of the property immediately upstream has raised significant concerns which are relevant to this consent application. The lessee of that property wasn't aware of any drains in the paddocks, although one tile drain was noted near the culvert by Andy Sinclair of Wilson Contractors while on site today. This was slightly above water level and appeared to be working correctly. The stream water level was measured this week at approx. 0.3 m deep 50 m upstream of the culvert, and approx. 2.3 m below the level of the surrounding banks.

We acknowledge that the elevated position of the culvert will have locally raised water levels in the area immediately upstream by up to approx. 240 mm, but this will only be the case during very low flows when adjacent land drainage is not an issue (at higher flows the effect of the 240 mm elevation is expected to be drowned out by downstream backwater effects). We consider that this is highly unlikely to have a noticeable effect on the drainage of paddocks which are approx. 2+ m above surface water level. This is consistent with the observations of the lessee of this land.

Regarding hydrological issues more generally, the attached *Flooding and Drainage Assessment* by Geosolve concluded that:

- Photographic evidence indicates that in relatively low flow conditions, and in the absence of rocks placed across the channel bed, upstream water levels are controlled by downstream backwater control (due to the low hydraulic gradient and heavy bank vegetation) rather than the culvert invert.
- The effect of the culvert invert level on upstream water levels is expected to decrease with increasing flows in the stream.
- The culvert's higher soffit (underside of top slab) is likely to "more than off-set any adverse effect of the raised invert", in a major flood event where the water level approaches the soffit level.
- Scour is not expected to be a significant issue, but if it occurs it can be readily identified visually and remediated by the addition of protection works as required.

- "[T]he as-built culvert invert is considered to have negligible effect on in channel water levels over the range of stream flows. Therefore, any increase in groundwater levels or loss of land drainage efficiency due to the culvert is expected to be insignificant."
- Vegetation becoming trapped on rocks placed upstream of the culvert may be influencing upstream water levels. If these rocks are not essential it may be beneficial to remove them.

Overall, the hydrological effects of the elevated culvert are considered to be less than minor. However, these effects could be further reduced by removing some of the rock upstream of the culvert to prevent vegetation becoming trapped.

We acknowledge the potential need for a bylaw approval in addition to the consent change, and have discussed this with Colin Young in the catchment team.

Damming

> ***Your comments: On the basis of the information I have regarding the proposal in addition to the relevant definitions in the pSWLP and RWP, I consider there is still a damming aspect of the proposal which is yet to be addressed.***

Dam construction is covered under Rule 60 of the pSWLP and Rule 29 of the RWP. The definition of "damming" in both plans is:

> *The impounding of all or part of the natural flow of any water that may involve an associated temporary or permanent structure.*

The key word is "impounding", which is not defined in either plan or the RMA. However, we have referred to these dictionary definitions for "impound":

- "to collect and confine (water) in or as if in a reservoir" (Merriam Webster);
- "(of a dam) hold back (water) - 'it will impound a reservoir 130 miles long'" (Oxford).

In our opinion, the slightly elevated culvert (and the associated slight increase in water levels for a short distance upstream of the culvert in low flow conditions) does not constitute "impounding" or "damming", according to these definitions, particularly given the presence of downstream backwater control.

Regardless, the effects of the raised culvert invert are not changed by whether or not it meets the definition of "dam". If ES considers the culvert to be a dam, it would be a

discretionary activity under Rule 60(b) of the pSWLP and Rule 29(b) of the RWP, primarily due to the upstream catchment area being greater than 500 ha. If ES consider that this is damming of water, then we suggest that it is *de minimis* and we cannot see any additional actual or potential effects arising that have not already been considered and addressed.

Consultation and notification

We have continued the ongoing consultation with Fish and Game, DOC and Te Ao Mārama Inc. (TAMI). The state of consultation with these parties is as follows:

- **Fish and Game** – no major concerns, and indicated that they are willing to sign an approval form, if required (pers. comm. Between Jacob Smyth and Andrew Sinclair, June 27th, confirmed in a phone conversation this week).
- **DOC** – requested monitoring of the stream to be carried out (pers. comm. Between Amy Evans and Andrew Sinclair, October 8th). The details of the monitoring programme suggested by DOC included consideration of seasonal variation and up-stream/downstream monitoring points, which may not be necessary in light of the information subsequently provided by Water Ways Consulting Ltd. We have contacted Amy this week for a preliminary discussion about this, and are open to working with DOC to confirm a monitoring approach that satisfies all parties.
- **TAMI** – the consent change application was provided to TAMI on May 17th. No formal feedback has been received, but we have arranged to speak with Stevie-Rae Blair of TAMI tomorrow to discuss any concerns they may have.

Regarding the neighbours, the culvert already has consent to be in place at stream level, and the only way that the elevated culvert position may affect neighbouring land is in relation to flooding and drainage issues. Given Geosolve's conclusions as summarised above, we consider any effects on the neighbours due to changes in the hydrology of the stream will be less than minor. Therefore, in our opinion the neighbours are not affected parties.

Nonetheless, we have made contact with the owners/occupiers of the four properties nearest the culvert to identify any concerns they have and how they may be addressed. The applicant is working with the two parties who have raised concerns in relation to fencing, road safety and similar issues. However, these are not relevant to this consent application. Brief notes on our conversations with the neighbours are below.

Property	Person contacted	Matters discussed
292 Argyle Otahuti Road	Allan Hamilton, owner	No concerns raised. Allan's daughter (who spoke to us briefly before referring us to her father) commented that they had noticed a difference in water depth in the stream from one end of their property to the other.
75 Waianiwa-Oporo Rd	David Craze, owner	David has a wide range of concerns, specifically: • Road safety issues, including visibility over the culvert, pot holes forming on the approaches, and that the rise in the road attracts "boy and girl racers", who also cause noise in the area. • Site reinstatement, including fences/railings and swales which he says were not properly reinstated, and a paddock area that he says has not been adequately re-grassed. • The potential for scour around the sides of the culvert in heavy rain. • Raised water levels upstream, which he says is exacerbated by weeds and branches catching on rocks upstream of the culvert. In a meeting today between Andrew Sinclair of Wilson Contractors Ltd. and Beverley Craze (David's wife), she clarified that the road safety issues were their primary concern. Fencing repairs were also discussed.
	Lindsay (a.k.a Jimmy) Shirley, lessee, and also the owner of 212 Argyle-Otahuti Rd, south-west of the culvert	Jimmy's primary concerns were around a gateway which was dug up for a temporary diversion during construction, and has not been reinstated to his satisfaction. He also had concerns about fencing around the culvert to prevent stock access to the stream or the road. He confirmed that there are no field tile drains or similar in the land leased from Mr Craze, and that he hadn't noticed any increase in soil moisture in those paddocks. He also commented on flooding that had occurred to the west recently, which he understood to be the result of a blocked swale/drain which is not related to the culvert works, but does drain into the culvert.

Property	Person contacted	Matters discussed
70 Waianiwa Oporo Road	Louise Tupoutoa, manager of Waitoru Farm	No concerns raised.

Conclusion

Considering all of the above information, we consider that:

- The raised position of the culvert will have a less than minor effect on the hydrology of the catchment and on neighbouring properties.
- Further information is needed in relation to fish passage. However, the information available to date does not suggest that the culvert forms a barrier to fish passage. Provided that consent conditions are in place requiring appropriate monitoring (and mitigation if necessary), we consider that conditions can be developed to ensure that effects on fish passage remain no more than minor in the long term.
- The raised level of the culvert does not constitute "damming".
- The adverse effects on both the stream environment and the local community of replacing the culvert at the depth originally intended are likely to far outweigh the effects of leaving the existing culvert in place.

We request that the application be processed either non-notified or with limited notification to Fish and Game, DOC and TAMI. We are also open to discussion around appropriate adaptive management consent conditions, assuming that you agree that this is an appropriate approach.

Yours sincerely

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21/3/2018

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29/11/2018

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Assessment of Fish Passage at Waianiwa Oporo Road Culvert, Southland

PREPARED FOR: WILSON CONTRACTORS LIMITED

DATE: NOVEMBER 2018

REPORT NUMBER: 70-2018

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1 INTRODUCTION

The newly install culvert at the Waianiwa Oporo Road crossing of an un-named stream, known locally as Hubbers Drain, was placed approximately 240 mm above the stream bed rather than at or below the stream bed level. A retrospective consent has been applied for with Environment Southland for the culvert. Environment Southland has queried the effect of the culvert on fish passage for upstream and downstream migrating fish species and effect of changes to water depth on fish habitat upstream of the culvert.

This report provides a desktop assessment of the potential for the culvert to form a fish passage barrier and determines which fish species are most vulnerable the culvert becoming a fish passage barrier. It also comments on the habit changes upstream of the culvert due to the raised level of the culvert base.

2 CULVERT LOCATION

The Waianiwa Opara Road crosses an un-named stream referred to as Hubbers Drain (Figure 1). The stream is a tributary of the lower Oreti River and the confluence with Oreti River is approximately 3 km downstream from the culvert.

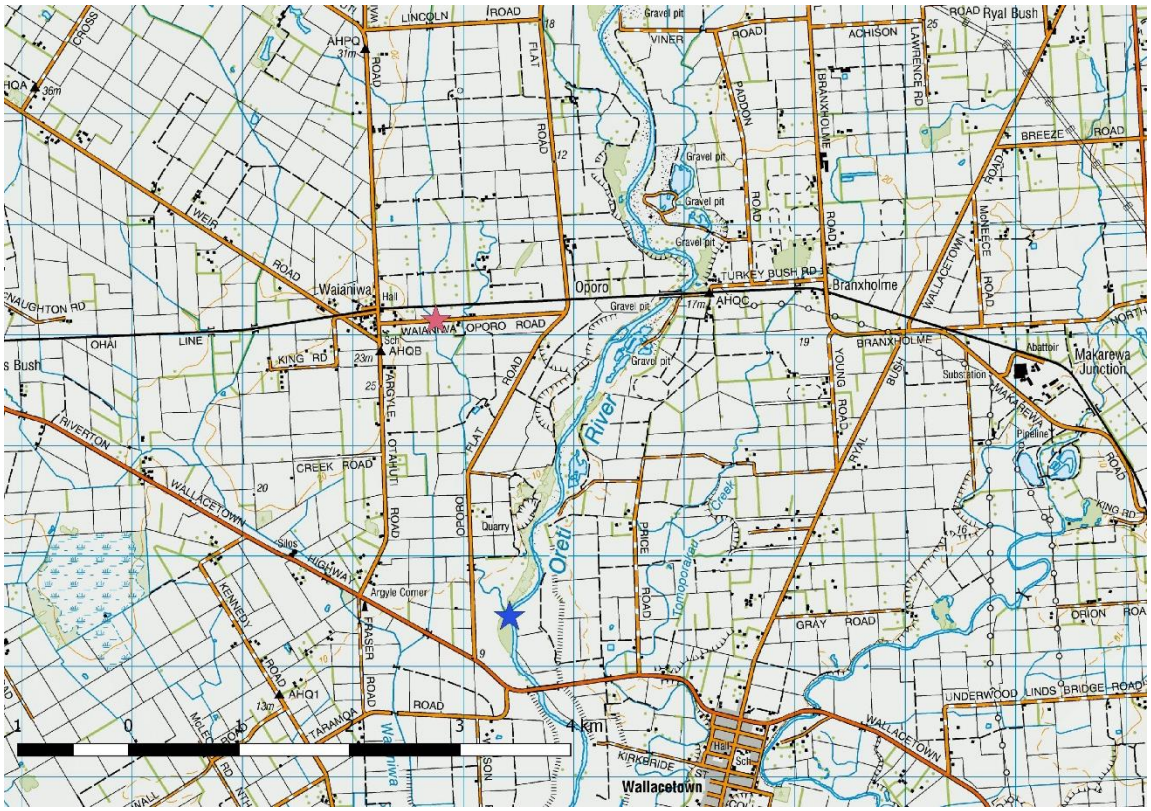

Figure 1: Location of culvert (red star) on Waianiwa Oporo Road, Southland and the confluence of Hubbers Stream with the Oreti River (blue star).

3 PRESENT CULVERT CONDITION

At present the culvert has rock placed downstream and upstream of the concrete culvert floor (Figure 2). The downstream boulders help raise the water level of the stream immediately downstream of the culvert and provide an upstream fish passage pathway

Figure 2: Waianiwa Oporo Road culvert downstream end.

Within the culvert the flat bed of the culvert provides for fish passage. Due to the gentle gradient of Hubbers Stream there is no high water velocity issue that can restrict fish passage in the culvert. For downstream migrating fish passage will be available through the culvert at all times unless the stream stops flowing. Therefore, the key issue is maintaining upstream fish passage especially when flows are low and the culvert lip maybe exposed despite the placement of boulders downstream of the culvert.

4 FISHERIES DATA

The New Zealand freshwater Fish Database (NZFFD) was searched for fish survey records for Hubbers Stream, and to provide further data the nearby Waianiwa Creek and sites in the Oreti neare the confluence of the river and Hubbers Stream. Eight data records, two from Hubbers Stream, two from the Oreti River and four from the Waianiwa Creek catchment (Figure 2) were used to provide information on the fish present or potentially present in Hubbers Stream. The survey dates range

from 1981 to 2012 with the Hubbers Stream records from fish surveys in 1981. Location maps for each species are provided in Appendix A.

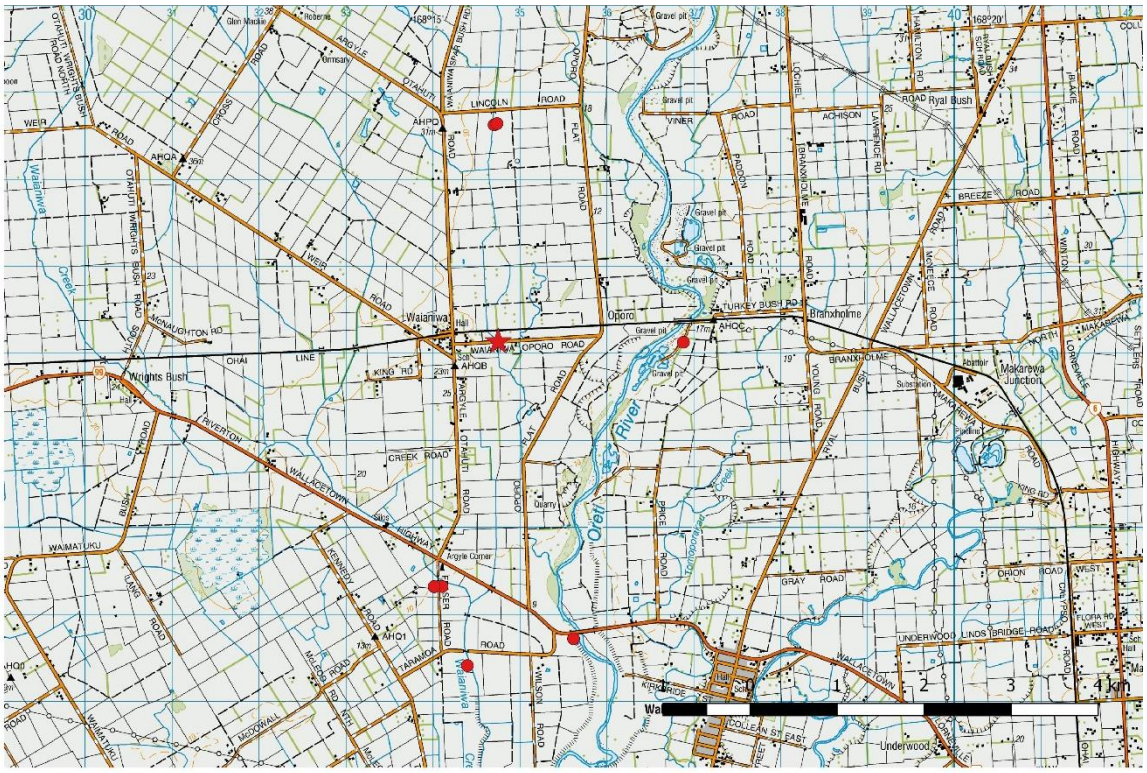

Figure 3: Fish survey locations from the NZFFB.

The fish surveys report nine species present; shortfin eel, longfin eel, Gollum galaxias, inanga, common bully, upland bully, black flounder, perch and brown trout in Hubbers Stream, Waianiwa Creek and nearby sites in the Oreti River (see Appendix A). Two of these species, longfin eel and inanga are classified as *At Risk Declining* fish species and Gollum galaxias as *Nationally Vulnerable* in the New Zealand freshwater fish threat rankings (Dunn et al 2018).

Longfin eel and common bully have been reported both upstream and downstream of the culvert and shortfin eel only upstream of the culvert on Hubbers Stream. Black flounder, inanga, upland bully, brown trout, and perch have only been reported at sites in Waianiwa Creek and Oreti River but not in Hubbers Stream.

The non-migratory galaxiid, Gollum galaxias, has been reported in Waianiwa Creek and an unidentified galaxiid has been reported upstream of the culvert in Hubbers Stream. The unidentified galaxiid was reported in fish surveys conducted in 1981 before Gollum galaxias was described in 1999 (McDowall & Chadderton 1999) and southern flathead was identified in Southland. All records for non-migratory galaxiids in Southland in the NZFFD were changed to unidentified galaxiid in the 2000s unless the site was resurveyed and the non-migratory galaxiid species confirmed as either Gollum galaxias or southern flathead. Gollum galaxias is common in drains and small streams on the Southland Plains and it is likely this unidentified galaxiid in Hubbers Stream is Gollum galaxias.

To assess the fish passage requirements at the culvert an understanding of the timing of fish movements is required. Smith (2015) provide a migration calendar for fish migrations and timing of migrations are also reported from fish trap and transfers at hydroelectric dams.

Shortfin and longfin elvers (juvenile eels) migrate upstream between December and March when water temperatures are warmest. However, elvers are both well known for their climbing ability and readily climb vertical faces several metres high (e.g., Figure 4). Free fall water drops such as occurs at some barrel culverts (Figure 5) are fish passage barriers to elvers as there is no pathway to climb up into the culvert. The culvert at Waianiwa Oporo Road will only be a fish passage barrier to upstream moving elvers if a freefall drop forms at the culvert outflow. This is extremely unlikely when splash zones and water flowing down the concrete face will provide a wetted pathway for elvers.

Figure 4: Elver climbing a wetted concrete face at hydroelectric power station.

Figure 5: An example of a culvert fish passage barrier to all fish species.

Inanga have not been reported in Hubbers Stream but may enter this stream. They migrate upstream as part of the whitebait run. The majority of whitebait enter river mouths between August and October and will continue to migrate upstream in November. Whitebait migrations that have been tracked upstream and Bonnett & Crow (2011) found whitebait 5-10 km from the sea in October and November. Similarly, the fish trap and transfer at Patea Dam 42 km inland on the Patea River in Taranaki has peak whitebait catches (of banded kokopu and koaro) in October and early November (Ryder Environmental 2018). Neither of these reports include inanga as they are not found upstream at the study locations. However, this provides an indicative timing of inanga spawning runs and this is supported by the migration calendar in Smith (2015) that has a spring time upstream migration for inanga. If upstream migrating inanga do get to the Waianiwa Oporo Road culvert it can be expected that they arrive between October and November. Therefore, flow conditions at the culvert are important in spring. At other times of year, the presence of a water level drop at the culvert is not expected to impact on upstream inanga migrations.

Common bullies are reported from upstream of the culvert, in the 1981 fish surveys, and passage for juvenile common bullies will be required if they are to continue to maintain an upstream population. Juvenile bullies migrate upstream during summer and early autumn (Smith 2015). The juvenile bullies do not climb and have limited ability to jump obstacles with drops of 5 cm or more being fish passage barriers. Therefore, if the flow drops and a lip forms at the downstream end of the culvert juvenile common bullies are unlikely to gain upstream passage. However, if flow increases to a level that submerges any lip the bullies will gain passage again. The photographs show (Figure 2) flow conditions suitable for upstream passage for common bully so any fish passage barrier that could form is not expected to be a complete or continuous barrier (as the culvert in Figure 4 would be).

There is no information available on the timing of black flounder migrations, nor for this stream do fish surveys show if flounder penetrate upstream to culvert. However, black flounder can migrate upstream through riffle reaches and the culvert with the downstream boulders does provide flows conditions very similar to riffle habitat and black flounders are expected to gain passage through the culvert unless, during low flows, a lip forms at the downstream outflow.

Two species, Gollum galaxias and upland bully, are non-migratory species for which passage to and from the sea is not required and these species are not expected to make large distance movements around the stream. These species will be able to move through the culvert, although the upland bully maybe restricted, like the common bully, during low flow periods. Any effect would be localised to a small area around the culvert and temporary in duration.

5 ASSESSING FISH PASSAGE

5.1 General Assessment Considerations

The Waianiwa Oporo Road culvert is expected to provide fish passage for all fish species when flows are moderate to high. During low flow periods, if a vertical drop forms at the downstream end of the culvert, it may impede upstream movement for some fish species with this most likely to affect common bully.

For elvers and any climbing galaxiids (kokopu or koaro not reported in this stream) even the vertical faces will not prevent fish passage as they can climb the vertical surfaces. Therefore, it is not

expected that fish surveys at the culvert will detect accumulations of elvers as it is not a fish passage barrier to elvers.

The timing of the upstream migration of inanga is in spring and will, most likely be occurring during moderate to high flow periods, and fish passage will be available. Therefore, it is not expected that inanga will be restricted.

5.2 Fish Surveys to Assess Fish Passage

Fish surveys can attempt to detect fish passage barriers. For the culverts such as in Figure 5 this is simple as accumulations of fish will be present immediately downstream of the culvert as fish passage is never available. However, it can be expected that the Waianiwa Oporo Road will only limit fish passage for bully species and only during low flow periods. Therefore, assessment of fish passage should only occur after a period of low flow during the migration period for the fish of interest. However, accumulations of fish immediately downstream of the culvert can be expected even if fish passage is available through the culvert as the boulder pile has created habitat that will provide good cover for fish and will be readily occupied. Therefore, the occurrence of fish in a higher density immediately downstream of the culvert does not prove fish passage is prevented.

Fish surveys to determine if fish passage is being achieved should also first determine which fish species penetrate upstream to the culvert. Common bully, and the two eels species have been reported upstream of the culvert in 1981. Inanga, and black flounder have only been found in adjacent streams. The first requirement for determining fish passage requirements for these two species would be determine if they are present in Hubbers Stream and determine their present upstream limit. If this is well downstream of the culvert, then there is little need to provide fish passage for them.

5.3 Immediate Assessment of Fish Passage in 2018

Attempting to assess fish passage at the culvert during November or December 2018 is not recommended. At present, there appears to be sufficient water in the stream to provide fish passage for all fish species at the culvert so there will be no accumulations of fish downstream of the culvert due to fish passage issues. In addition, at this time of year the only fish migrating upstream will be inanga and it is unknown if this species even reaches Waianiwa Oporo Road. The upstream migrations of elvers and common bully occur in summer and if the culvert forms a barrier at anytime it is expected that this is to common bully. To determine if this occurs fish surveys should be conducted in late summer during low flows and only if a vertical drop has formed at the downstream culvert lip. If flow and visual culvert monitoring do not find a vertical drop has formed, then fish passage will not be prevented, even for common bully. It can also be expected that if the stream flow increases and the vertical drop is submerged upstream migrating bullies will continue upstream at this time, so impedance of fish passage will be temporary and fish surveys should be conducted only after extended periods of low flow. This will allow upstream migrating bullies to accumulate in sufficient numbers to indicate a fish passage barrier.

6 UPSTREAM HABITAT ALTERATION

Stocker (2018) has estimated that any effect of the raised culvert has on upstream water level extends for approximately 100 m upstream of the culvert. The maximum water level increase in this

reach can only be 240 mm if the culvert floor was built at the surface level of the stream and the depth increase will get progressive shallower moving upstream along the 100 m effected.

The potential effect can be assessed using the habitat preferences (Jowett 7 Richardson 2008) for the fish present. Longfin eel adults have a depth preference for water 0.3m or deeper with no maximum depth limit. The raising of the water level in areas less than 0.3 m deep may have been sufficient to create good adult lonfin eel habitat. For longfin eel elvers their depth preference range from 0.05 to 0.9 m all these depths are with the range of depths immediately upstream of the culvert and no loss of habitat is expected.

Adult shortfin eels have a depth preference for water between 0.2 and 0.8 m deep and this will be provided in the 100 m section upstream of the culvert. Shortfin elvers prefer shallow water between 0.0 and 0.6 m with ideal habitat between 0.15 and 0.4 m deep. Again this is expected to be provided in the 100 m reach.

Common bully prefer water depths between 0.05 and 0.5 m and this is expected to be provided in the 100 m reach. Jowett (2002) provides habitat prefers for feeding inanga (and no other habitat preference data is available) and shows that all water depths over 0.3 m is optimal feeding habitat. Therefore any increase in water depth will either improve shallow water habitat for inanga feeding or have no effect.

7 SUMMARY

The construction of the new Waianiwa Oporo Road culvert has place the culvert bottom 240 mm above the stream bed level creating potential fish passage issues. To mitigate this potential effect boulders have been placed in the stream bed downstream of the culvert to raise the water level to provide fish passage. Eight fish species are report in stream or near by stream reaches of which five are migratory. Fish passage for shortfin eel and longfin eel elvers is not expected to be impeded by the culvert. Juvenile common bully may be impeded during low flow periods, but this restriction is not expected to completely block upstream passage. Inanga and black flounder are expected to achieve upstream fish passage although it is unknown whether they penetrate upstream as far as the culvert.

To assess whether fish passage is impeded it is recommended that fish surveys wait until a period of low flow has occurred in the stream and a vertical drop has formed at the culvert outflow. This may prevent upstream passage for juvenile common bullies and accumulations immediately downstream of the culvert may reach detectable levels. Fish surveys in November and December 2018 are not recommended as no fish may be migrating upstream at this time and fish passage does appear to be available at the culvert at this time so there will be no detectable accumulations of fish.

Any changes to water depth upstream of the culvert are expected to extend only a short distance and have no effect on habitat for fish species reported in Hubbers Stream.

8 REFERENCES

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Stocker H. (2018). Flooding and Drainage Assessment Hubbers Tributary box culvert, Waianiwa. Report prepared for Wilson Contractors Ltd.

9 APPENDIX A FISH LOCATION MAPS

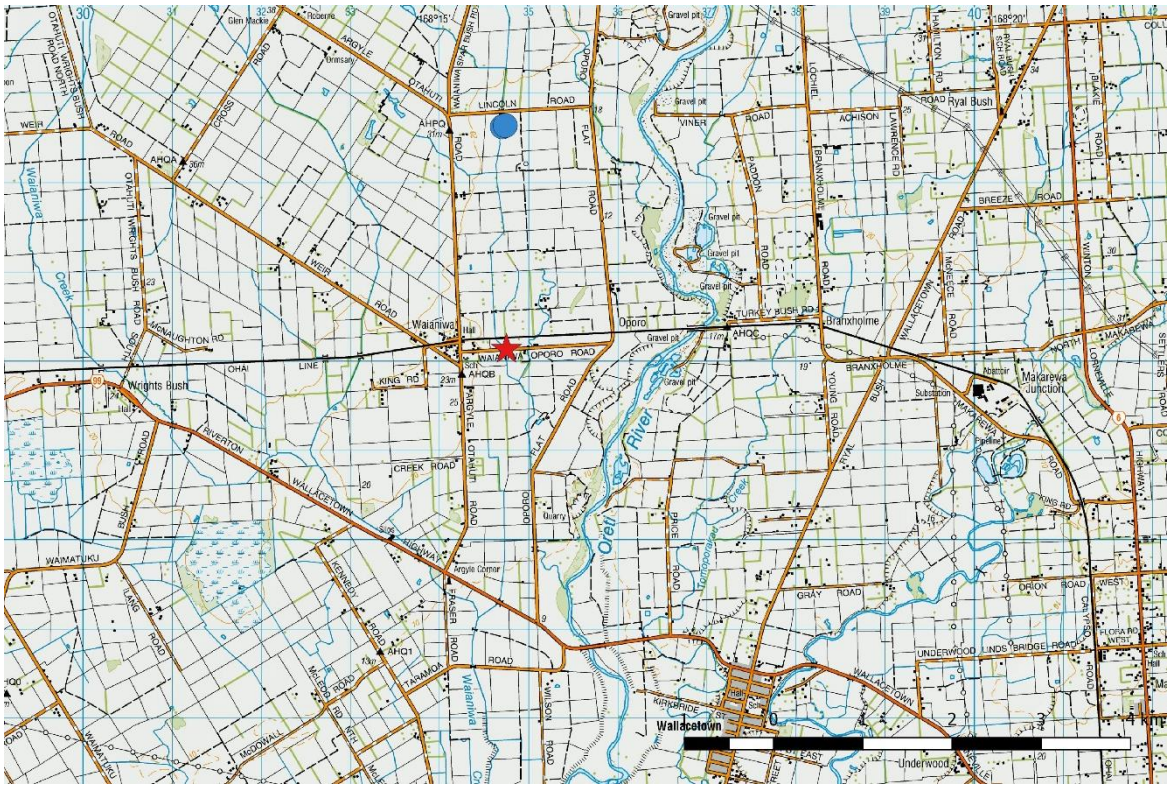

Figure A1 Shortfin eel locations.

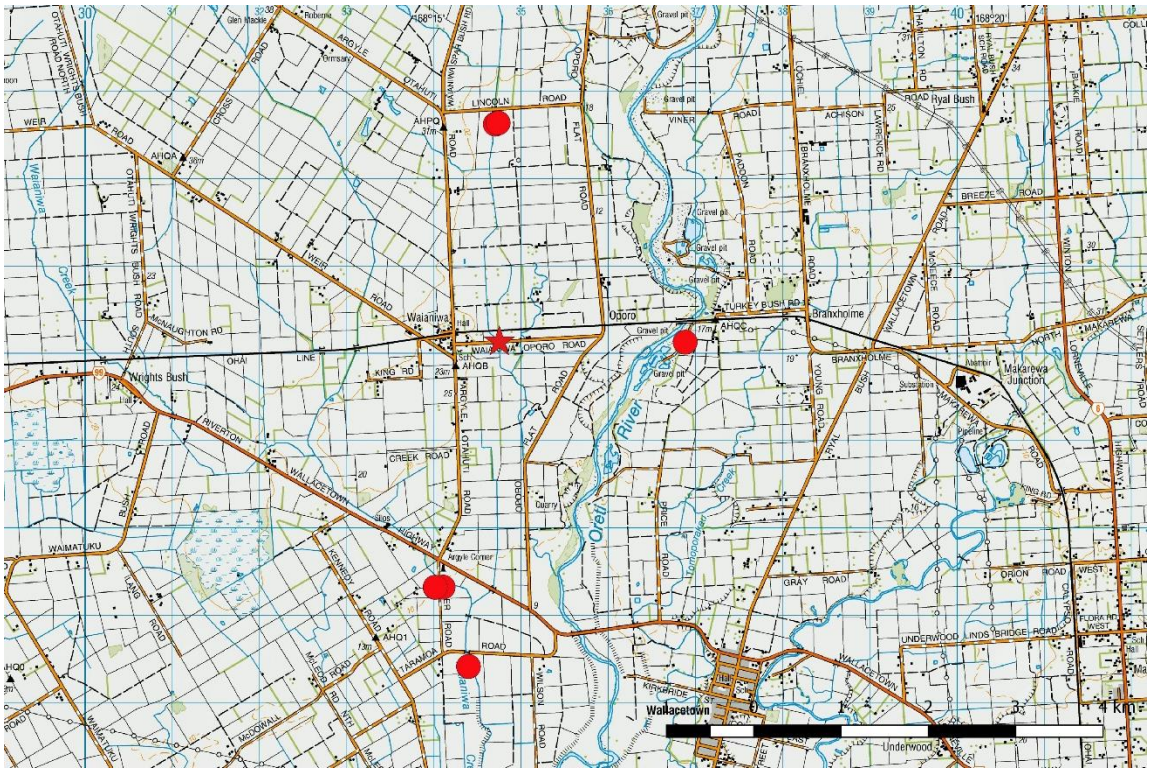

Figure A2 Longfin eel locations.

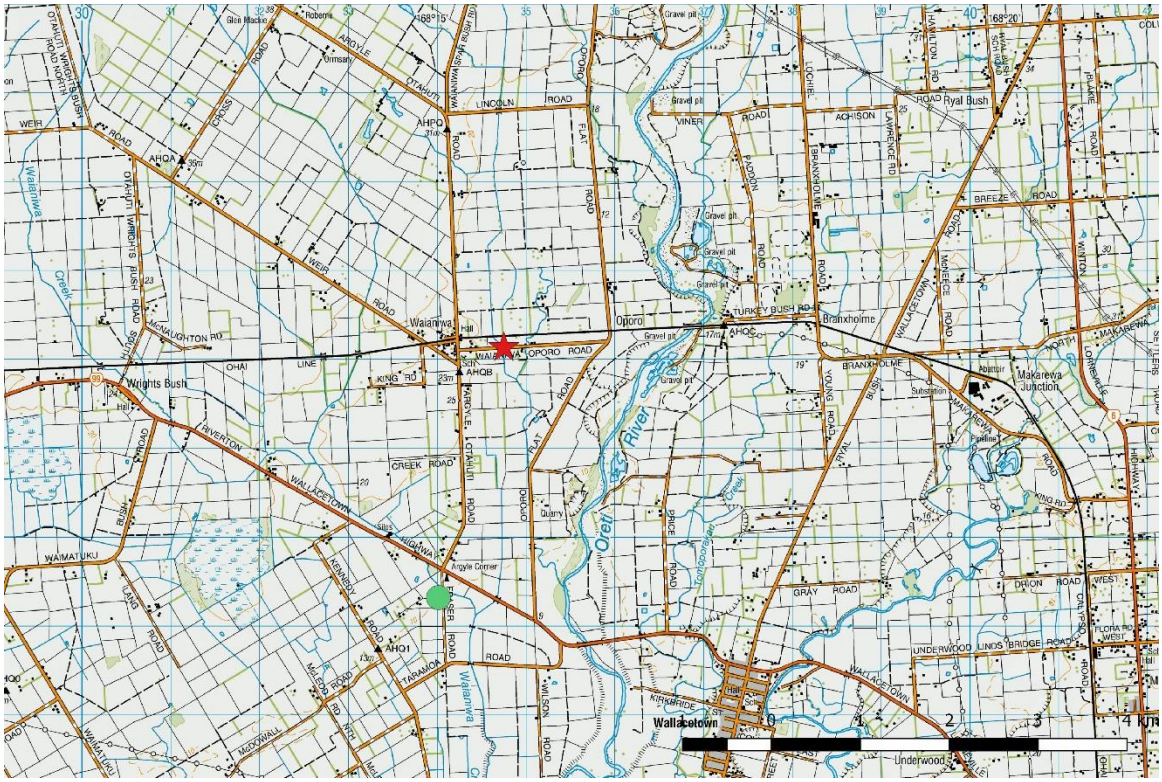

Figure A3 Black flounder locations.

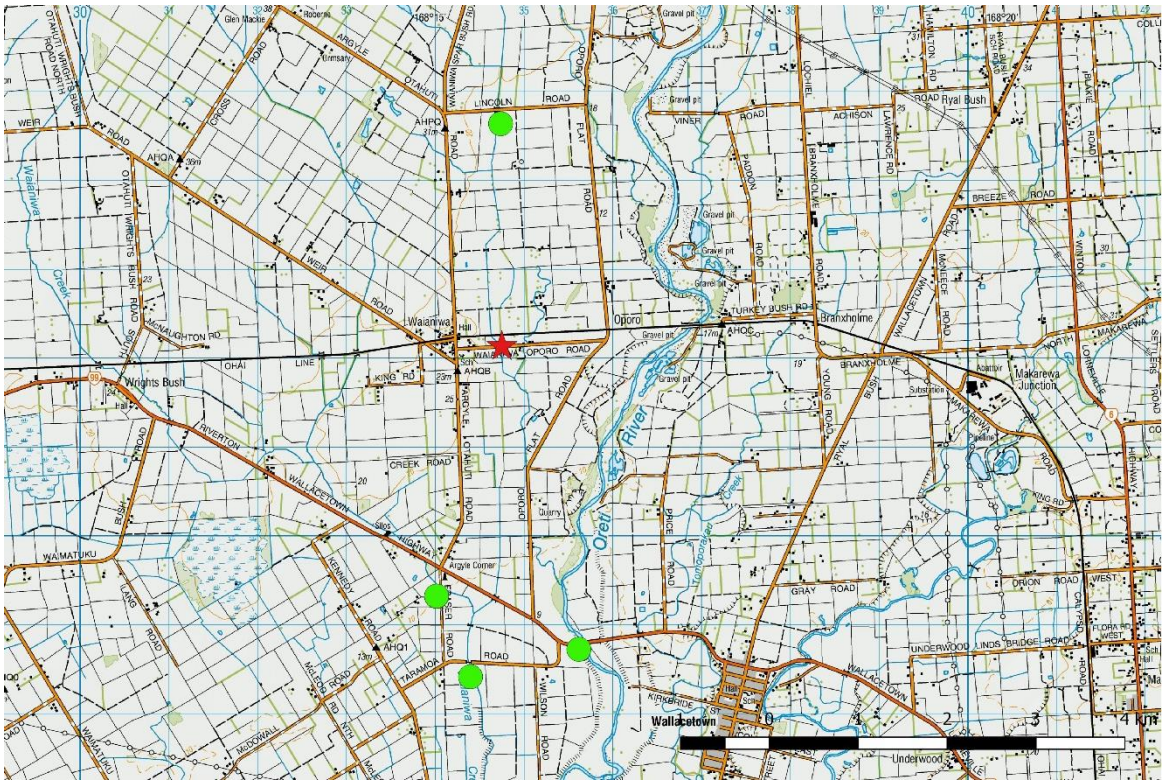

Figure A4 Common bully locations.

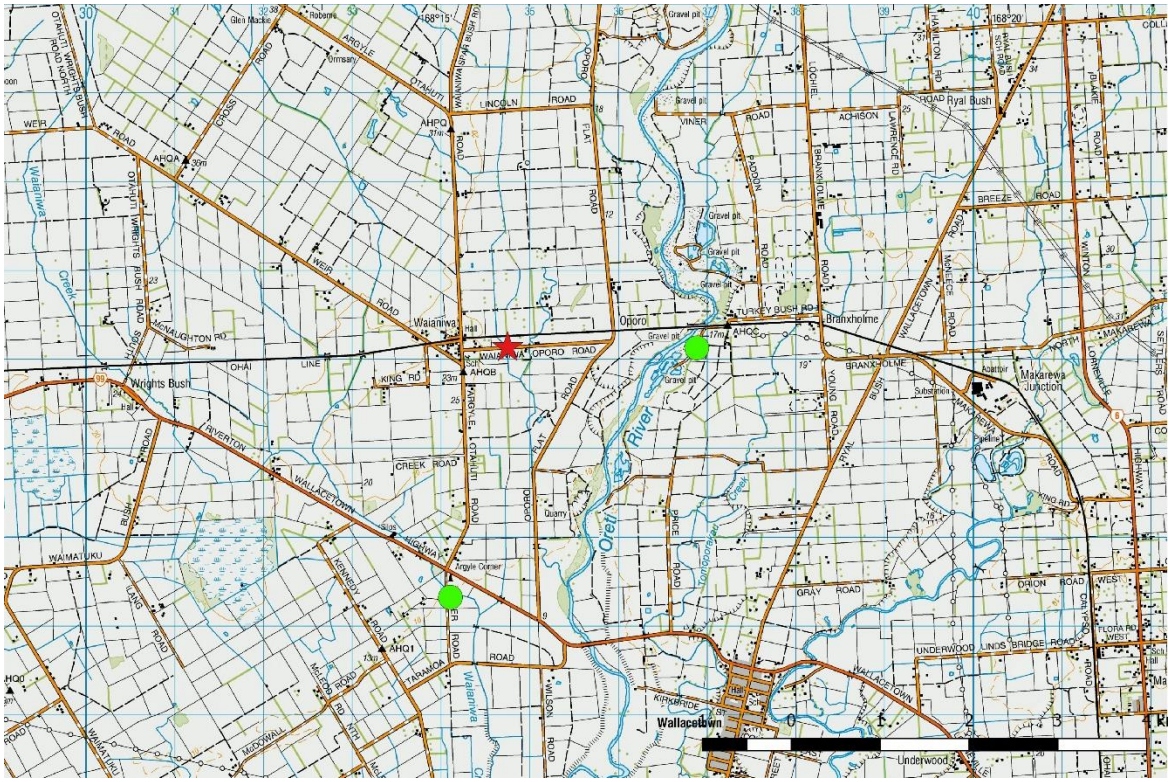

Figure A5 Upland bully locations.

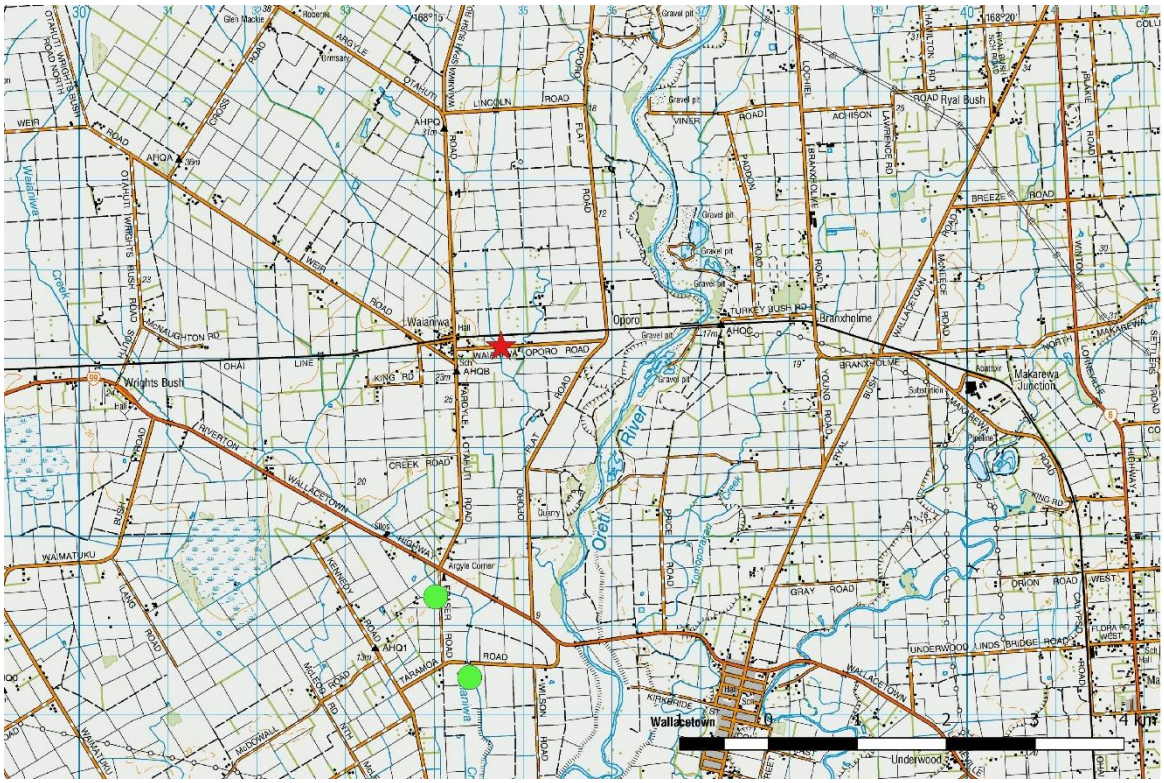

Figure A6 Inanga locations.

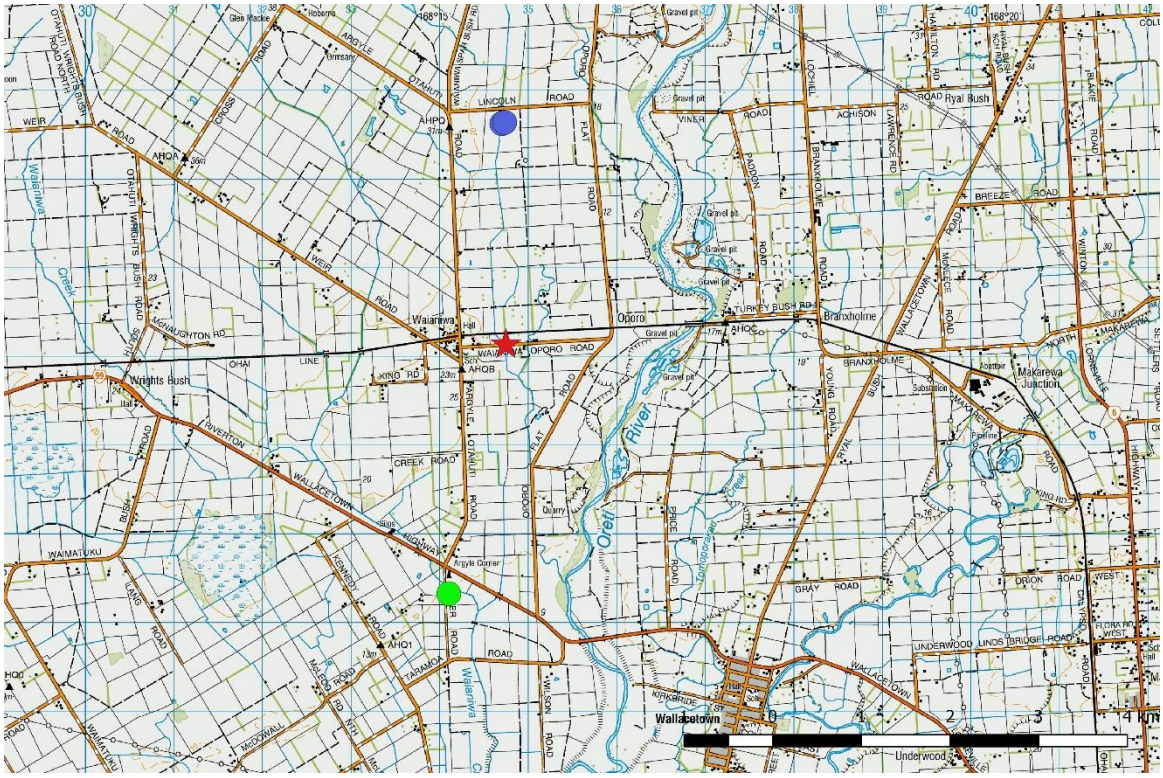

Figure A7 Gollum galaxias locations (green) and unidentified galaxias locations (blue).

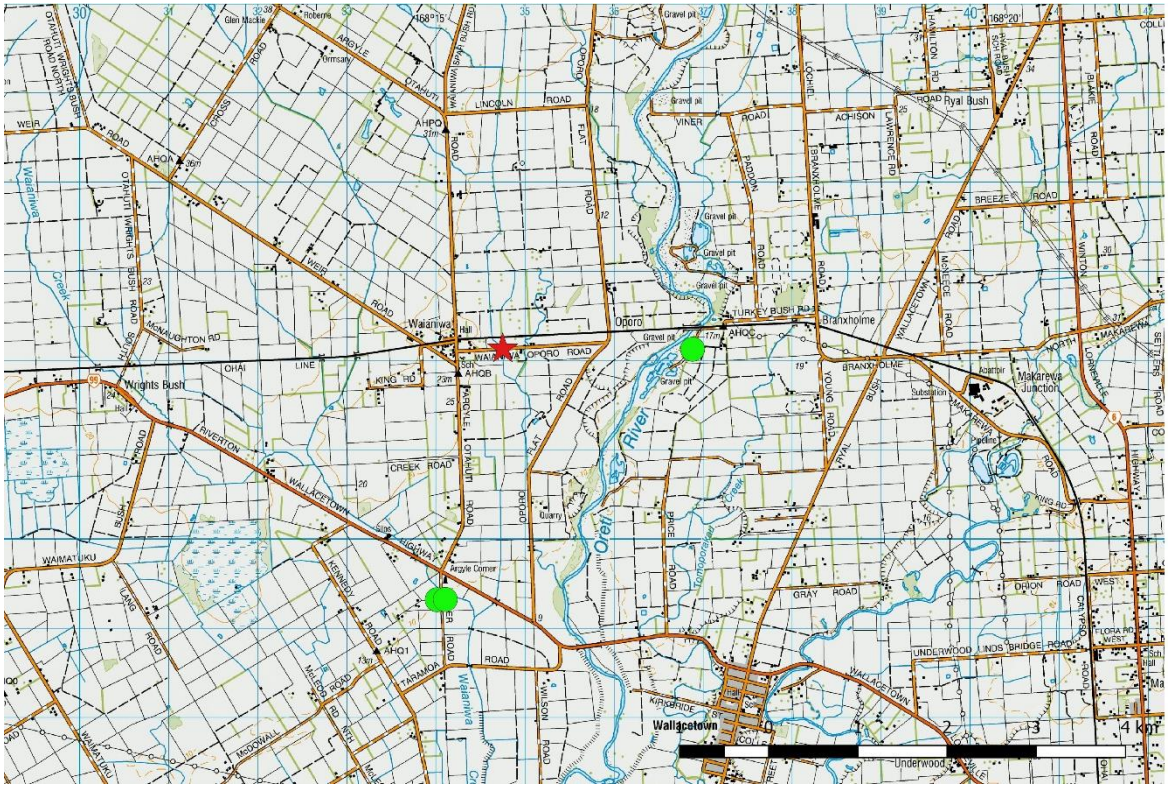

Figure A8 Brown trout locations.

GeoSolve Ref: 180737
29 November 2018

Wilson Contractors Ltd,
22 Onslow Street,
Invercargill 9812

Attention: Andrew Sinclair

Flooding and Drainage Assessment
Hubbers Tributary box culvert, Waianiwa

In accordance with our Agreement we have undertaken a qualitative assessment of flooding and drainage issues potentially associated with the installation of the culvert invert 240 mm higher than the consented level (pre-existing bed level).

We understand that application for a retrospective resource consent amendment has been submitted for the as-built culvert installation. The applicant is Wilson Contractors Ltd on behalf of Southland District Council.

We have examined site photographs, aerial photography, survey information, correspondence between the applicant and Environment Southland (ES), stream flow and groundwater level data from ES, and consultation notes and field notes & measurements supplied by LandPro.

Flooding

Even at relatively low flows, it is apparent that upstream water levels are governed by downstream backwater control rather than by the slightly elevated culvert invert. Photo 1 shows no water surface discontinuity that would be expected at the outlet if culvert the culvert was controlling the upstream water level.

This is not unexpected, given the flat bed gradient (less than 0.2% over 100 m downstream) and relatively high hydraulic roughness due to heavy vegetation on the stream banks (see Photo 2). These effects will be combining to control upstream water levels to the extent that any effect of the raised culvert invert is insignificant even at moderate flows, and under flood conditions any effect will be even less.

Even if the upstream water levels were not controlled by downstream channel backwater, any backwater effect of the 240 mm elevated culvert would rapidly taper out upstream, and thus affect water levels only immediately upstream of the culvert. The surveyed bed profile indicates that by 100 m upstream of the culvert the stream bed is already higher than the culvert invert; a residual backwater effect could theoretically persist beyond this point but would most likely be imperceptible.

The configuration of the as-built culvert means that its soffit (underside of top slab) is also 240 mm higher than the consented configuration. The higher soffit is likely to offer significant flood capacity benefit which is likely to more than off-set any adverse effect of the raised invert.

Erosion

Outlet scour can occur when a culvert is significantly smaller than the open channel resulting in locally increased velocities under high flow conditions. Standard engineering solutions are available to mitigate this situation, typically involving a rock or concrete apron which can be configured to facilitate fish passage. However, in this case the culvert has a large box cross section with dimensions similar to the adjacent open channel, therefore the velocity increase and consequent scour potential will not be great, and a protective apron may not be necessary.

Scour can also be potentially caused by runoff from heavy rain on the steep slopes at the culvert road approaches. Again, this can be mitigated by standard protective works such as the rockwork visible in Photo 1. The additional 240 mm height above consented invert level will not affect the potential for scour around the sides of the culvert in heavy rain. This rockwork should be monitored and repaired or extended if necessary.

There also appears to be some concern that local bed scour may leave the culvert outlet perched above the downstream channel bed, thus potentially impeding fish passage at low flows. This situation can be monitored, and if observed to develop, it can be simply remediated with rock or concrete works which can be engineered to facilitate fish passage while protecting the bed against scour. Any such measures will need minimal maintenance owing to the relatively low ambient velocities and minor local velocity increase.

Photo 1: Looking downstream through culvert following installation

Photo 2: Heavy vegetation on adjacent stream banks.

Drainage

As explained above, the as-built culvert invert is considered to have negligible effect on in-channel water levels over the range of stream flows. The adjacent farmland is generally some 2.5 m above the channel bed, and data from ES indicates groundwater levels at 3 m or greater depth. A 240 mm difference in stream bed level is unlikely to be significant in terms of surface drainage.

Therefore, any increase in groundwater levels or loss of land drainage efficiency due to the culvert is expected to be insignificant.

Subsequent to construction, rocks appear to have been placed across the channel bed at both sides of the culvert (Photo 3). These appear to be trapping vegetative debris and may be having a significant influence on local upstream water levels, particularly at lower flows. Any such influence is likely to be confined to a small upstream area in the near vicinity of the rocks. Consideration should be given to removing these rocks.

Photo 3: Showing rocks placed at each end of culvert.

Conclusions

It is our opinion that any adverse effects of the raised culvert on flooding, drainage and erosion will be less than minor. The culvert itself is not acting as a dam in any real engineering sense.

The rocks placed across the channel at each end of the culvert, and the debris they are trapping, may be having minor effects and their placement should be reviewed.

This has been a high-level assessment of the issues addressed; we have not visited the site nor undertaken numerical analysis. We are comfortable that the available information supports our findings. To more definitively verify and quantify these conclusions would require substantial further analysis including extensive surveying and hydraulic modelling.

This report has been prepared for the benefit of Wilson Contractors Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Yours faithfully,

Hank Stocker
Senior Engineer - Water