195 Rattray Street
PO Box 1023
Dunedin, 9054

T 03 477 2119
C 027 208 0588
d.olsen@ryderenv.nz

# Memorandum

**To:** Alexandra King, Consents Officer, **Otago Regional Council**

**From:** Dean Olsen, **Ryder Environmental Limited**

**Date:** 24 September 2019

**Subject:** **Resource Consent Application: RM18.345 – Luggate Irrigation Company and Lake Mackay Station - Technical Review**

Dear Alex,

As requested, please find below a technical review of the application by the Luggate Irrigation Company/Lake Mackay Station (hereafter the applicant or Luggate Partnership) to Otago Regional Council (ORC) to renew a number of existing water takes (97803.V1, 2008.519, WR7284, WR7285, WR7286, WR7298) to take up to 180 l/s as primary allocation, 80 l/s from the first supplementary block, and 86 l/s as second supplementary block for the purpose of irrigation, stock water and domestic supply.

**Background**

The Luggate Partnership applied for resource consent to take water from the North and South Branches of Luggate Creek (the South Branch is also referred to as Alice Burn) in February 2018. The application has been revised since the original application was lodged, and this assessment is based on the most recent revision (dated 19 September 2019).

Schedule 2A of the Regional Plan: Water (RPW, 2018)[1] lists the minimum flow and primary allocation limit for Luggate Creek. The assessments presented here are made within this context.

| Catchment See the B-series maps | Monitoring Site (with MS number) See the B-series maps | Minimum flow (litres per second – instantaneous flow) | Primary Allocation Limits in accord with Policy 6.4.2(a) (litres per second – instantaneous flow) |
|---|---|---|---|
| **Luggate catchment** | SH6 Bridge (MS 11) | 180 (1 November to 30 April)<br><br>500 (1 May to 30 October) | 500<br><br>*Luggate catchment from confluence with Clutha/Mata-Au to headwaters* |

[1] Otago Regional Council. 2018. Regional Plan: Water for Otago. Updated to 1 July 2018. Otago Regional Council, Dunedin.

**Hydrology**
The Management Flow Report (2006) for the Luggate Creek catchment[2] presents an estimate of flow statistics for the Luggate Creek catchment, with a naturalised 7-d MALF[3] at the SH6 bridge of 550 l/s and other low-flow statistics. However, these flow statistics are somewhat out of date and were calculated based on one-off flow gaugings in Luggate Creek, as the continuous flow monitoring site wasn't installed until early 2016. NIWA's NZ River Maps hydrological model[4] provides an estimated 7-d MALF for Luggate Creek at the SH6 bridge of 367 l/s (Table 1), although this estimate is based on a national model, which may be subject to substantial error.

Using NIWA's NZ River Maps hydrological model, Luggate Creek at the confluence with the Alice Burn is estimated to have a natural 7-d MALF of 209 l/s and a mean flow of 912 l/s (see Table 1). Meanwhile, the Alice Burn at the confluence is estimated to have a natural 7-d MALF of 124 l/s and a mean flow of 498 l/s (Table 1)

***Table 1 Flow statistics for the Luggate Creek catchment based on NZ River Maps.***

| Location | 1 in 5 y LF l/s | MALF l/s | Median l/s | Mean l/ |
|---|---|---|---|---|
| Criffel intake weir | 110 | 197 | 591 | 904 |
| Luggate Creek at confluence with Alice Burn | 122 | 209 | 601 | 912 |
| Alice Burn at confluence with Luggate Creek | 73 | 124 | 331 | 498 |
| Luggate Creek downstream of confluence with Alice Burn | 195 | 328 | 932 | 1,410 |
| Luggate Creek at SH6 bridge | 210 | 367 | 976 | 1,520 |
| Luggate Creek at Clutha confluence | 237 | 413 | 1,070 | 1,690 |

The estimated flow statistics for the Luggate Creek (North Branch) and Alice Burn suggest that at the 7-d MALF, approximately 63% of the flow at the confluence comes from the North Branch, while the Alice Burn contributes approximately 37%. This is in line with the relative catchment areas of these two sub-catchments.

[2] Otago Regional Council (2006). Management Flows for Aquatic Ecosystems in Luggate Creek. Otago Regional Council, Dunedin. August 2006. 21 p.
[3] 7-d Mean annual low flow – the average of the lowest 7-day low flow period for every year of record.
[4] Booker, D.J., Whitehead, A.L. (2017). NZ River Maps: An interactive online tool for mapping predicted freshwater variables across New Zealand. NIWA, Christchurch. https://shiny.niwa.co.nz/nzrivermaps/

**Values**
Schedule 1A of the RPW (2018) identifies the following ecosystem values for Luggate Creek: Weedfree, rare fish (kōaro), rare invertebrates upstream of F40: 040924[5], with significant habitat for kōaro.

**Fish distribution**
Brown trout have been recorded from the mainstem of Luggate Creek to the Alice Burn confluence, including the lower Alice Burn (Figures 1 & 2). Electric fishing records from the NZ Freshwater Fish Database (NZFFD) indicate that juvenile brown trout are abundant in the lower reaches of Luggate Creek (from the vicinity of SH6, downstream) (Figures 1 & 2). Kōaro and rainbow trout have been recorded from the mainstem of Luggate Creek from 2 km upstream of the Alice Burn confluence to the Criffel Station intake (Figures 1 & 2). Rainbow trout have also been recorded from the lower Alice Burn (Figures 1 & 2, and van Klink 2017[7]). Rainbow trout collected from the North Branch of Luggate Creek were of mixed size (length range 62-209 mm), indicating the presence of fry (length range 60-80 mm) and yearlings (length range 100-160 mm), with some larger individuals present (lengths 174 mm, 178 mm, 209 mm) indicating that other year-classes may also be present. If these larger individuals are 2+ or even 3+ individuals (in their second or third year of life), this suggests that this resident population may be stunted, and therefore likely to be of little interest to anglers.

The record from a survey of the Alice Burn in the vicinity of lower intake found brown trout ranging in length from 56-505 mm (NZFFDB record #114093, 24 April 2018). The presence of a large trout during this survey indicates that this may either be a resident fish, or that it had migrated into the Luggate Creek to spawn (this is especially likely given the survey was undertaken in mid-autumn, during the brown trout spawning season).

Spawning surveys undertaken by Fish and Game on 5 May 2017 observed spawning brown trout and redds[6] in the Alice Burn, Luggate Creek and irrigation races in the vicinity of where the Lake Mackay Station/Luggate Irrigation Company water takes occur (van Klink 2017[7]). No rainbow trout were observed during this survey, although this may reflect the timing of the survey; brown trout spawn in late April-July, while rainbow trout spawn later (June-August). The abundance of juvenile brown trout in the lower reaches of Luggate Creek and comparatively rarity of rainbow trout recorded in the lower reach of the Luggate Creek suggest that Luggate Creek is likely to be contributing to the recruitment of brown trout to the upper Clutha/Mata-Au fishery. However, there is no available evidence to indicate that Luggate Creek makes a substantial contribution to the recruitment of rainbow trout to in the broader upper Clutha/Mata-Au fishery.

No angler effort has been recorded from Luggate Creek in any of the National Angler Surveys to date (Unwin 2016[8]).

There are anecdotal reports of longfin eels being present in Luggate Creek. Historically, longfin eels would have been widely distributed in the upper Clutha/Mata-Au, although the abundance and distribution of longfin eels in the upper Clutha/Mata-Au are currently limited by passage for juvenile eels past Roxburgh and Clyde Dams. Any eels currently present are likely to either be large individuals that entered the upper Clutha/Mata-Au catchment prior to the dams, or individuals that have been translocated to areas above the dams.

[5] This location is well upstream of the reach affected by this application.
[6] Nests.
[7] van Klink, P. (2017). Luggate Creek Spawning Survey. Council Report, Otago Fish & Game Council Meeting, 15 June 2017. Otago Fish & Game Council, Dunedin.
[8] Unwin (2016). Angler usage of New Zealand lake and river fisheries: Results from the 2014/15 National Angling Survey. Prepared for Fish & Game New Zealand. *NIWA Report 2016021CH*. NIWA, Christchurch. July 2016.

Kōaro are native to the upper Clutha/Mata-Au catchment, forming land-locked populations in tributaries to Lakes Hāwea and Wanaka. As discussed by Water Ways Consulting[9], NZFFD records from prior to the formation of Lake Dunstan suggest that low numbers of kōaro juvenile entered Luggate Creek. Since the formation of Lake Dunstan, kōaro have been entering many of the tributaries of the lake and upper Clutha/Mata-Au, including Luggate Creek. The main driver of the kōaro population in Luggate Creek is expected to be predation by trout, as juvenile kōaro entering the Luggate Creek catchment would have to migrate through the lower reaches of Luggate Creek, and the high densities of juvenile trout present.

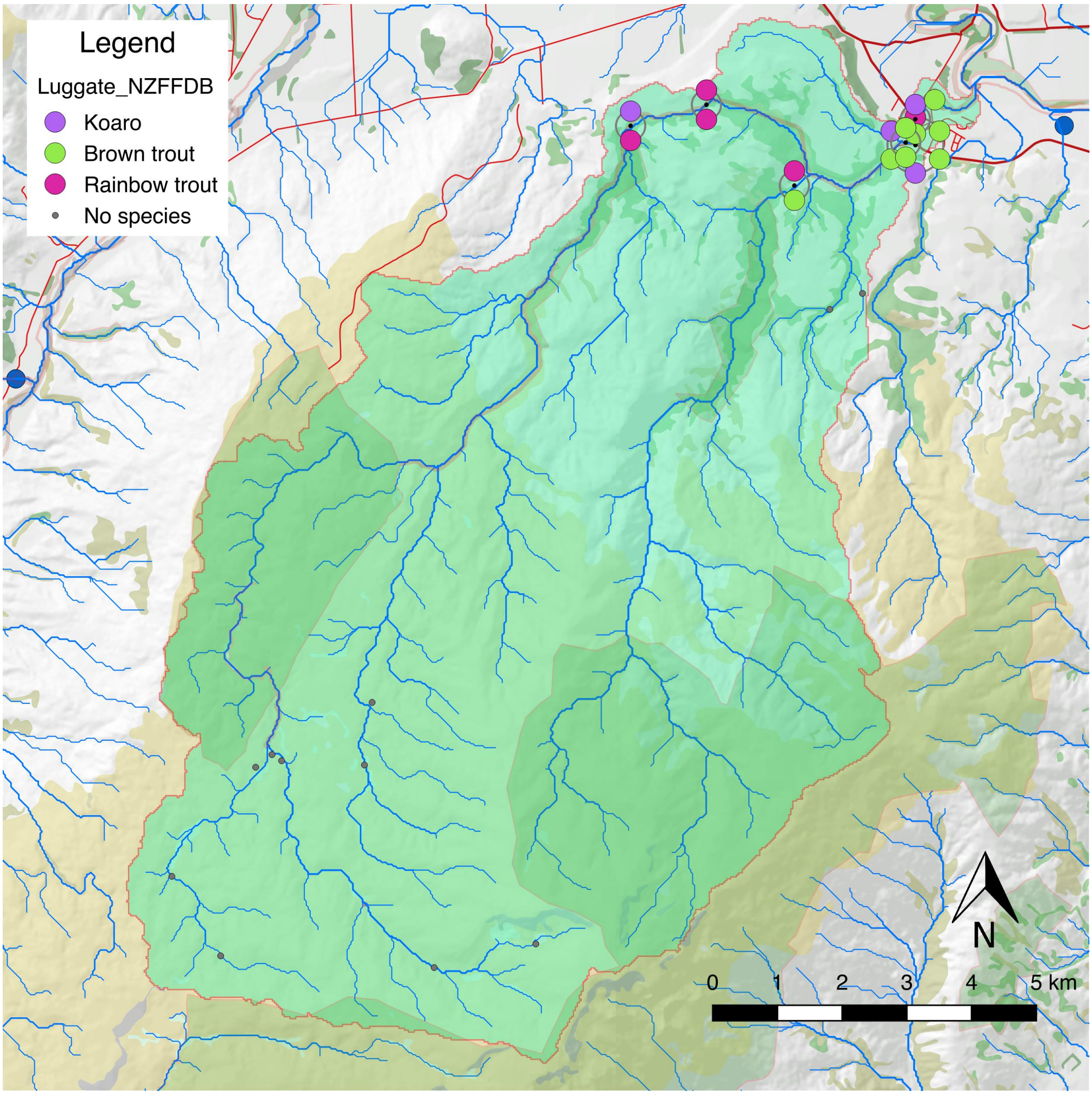


***Figure 1*** ***Distribution of fish species within the Luggate Creek catchment. Based on records in the NZ Freshwater Fish Database downloaded 5 September 2019.***

[9] Letter from Richard Allibone (Water Ways Consulting) to Mandy Bell (Criffel Water Limited), dated 13 June 2016.

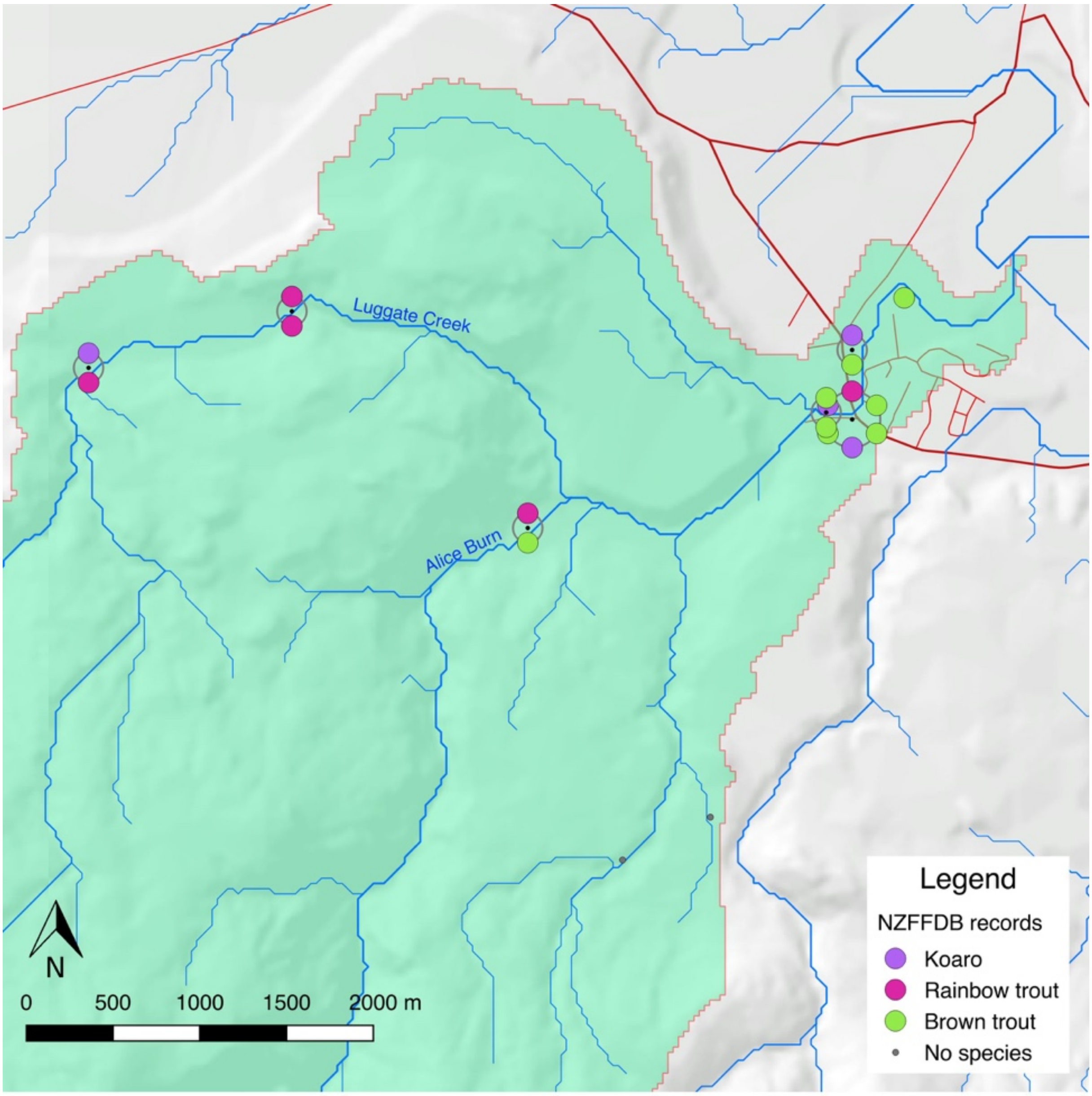


***Figure 2*** ***Distribution of fish species within the lower Luggate Creek catchment. Based on records in the NZ Freshwater Fish Database downloaded 5 September 2019.***

## Assessment of environmental effects

### Residual flows

The application did not propose any residual flow in the Alice Burn at the top take. No fish have been recorded in the vicinity of the take within the NZFFD, and an electric fishing survey undertaken by Ross Dungey Consulting did not catch any fish[10]. The fish distribution downstream of this take is unknown, although the stream gradient for most of this reach is very steep, with pools punctuated by cascades and waterfalls (Figure 3). The Fish & Game submission suggests a residual flow on this take of 46 l/s, which equates to approximately 50% of the MALF at the point of take. This suggestion has been accepted by the applicant. Given the steep, confined nature of this upper section of river, and the apparent lack of fish, this residual flow will appropriately provide for instream values.


***Figure 3 Upper Alice Burn, just downstream of the upper Alice Burn intake.***

The applicant proposes a residual flow "*for the maintenance of a connecting flow*" in the Alice Burn at the ford above the confluence with Luggate Creek. The applicant expresses a preference for a visual residual flow rather than a numerical value given the expense and practical difficulty to establish and maintain a flow site below the point of take. These arguments apply to most water take locations in Otago, including many that have numerical residual flows.

Brown and rainbow trout are present in the lower Alice Burn (Figures 1 & 2), and it is also likely that kōaro are also present. The North Branch of Luggate Creek in the vicinity of the LIC offtake supports

[10] This survey took place in 2018, although the record does not appear on the NZFFD. The survey was undertaken on behalf of ORC, and the lack of fish is recorded in a file note from Pete Ravenscroft to Alexandra King, dated 10/10/2018, Re: RSU assessment of Resource Consent No RMA 18.345 Lake McKay to take s surface water take from Luggate Creek [sic]. Otago Regional Council, 10 October 2019.

brown trout, rainbow trout and kōaro (Figures 1 & 2). Given the values present in the Alice Burn and lower North Branch of Luggate Creek, it is difficult to assess the appropriateness of the proposed *"maintenance of a connecting flow"* residual flow suggested for the both these takes. However, in practice, the summer minimum flow of 180 l/s downstream at the SH6 bridge will likely dictate the flows in the lower Alice Burn before the suggested residual flow condition would come into effect. Therefore, I conclude that the minimum flow will adequately provide for the instream values in this section of the lower Alice Burn and Luggate Creek. Therefore, the residual flows are to ensure that the exercise of either of the takes will not dewater either the section of the Alice Burn or Luggate Creek immediately downstream of the points of take.

Fish & Game's submission seeks that a residual flow be imposed that maintains *"visual flow to the confluence with the Luggate".* It is not known whether such flows would maintain downstream passage for juvenile trout, although it is highly likely that the race currently provides downstream passage for juvenile trout from the Alice Burn and North Branch and will continue to do so if screened close to the water metering location (see Figure 3). Fish & Game's submission suggests that the minimum flow will be the main mechanism to protect instream values at the Luggate Partnership's lower takes and that the purpose of the residual flows is to prevent these takes from dewatering the sections of river below these two takes. I generally agree with this assessment.

**Effects of allocation regime**

The applicant proposes a take of 180 l/s of primary allocation, 80 l/s of first supplementary water and a second supplementary take of 86 l/s from the North Branch of Luggate Creek and the Alice Burn. To consider the effects of this on the hydrology of Luggate Creek beyond the North Branch, it is necessary to consider the combined primary allocation for the whole Luggate catchment. Criffel Water Ltd. have also applied for water from the Luggate Creek catchment: a primary take of 358 l/s, a first supplementary take of 170 l/s (with a supplementary minimum flow of 788 l/s) and a second supplementary take of 80 l/s (with a supplementary minimum flow of 1,038 l/s). To consider the effects of this on the hydrology of the whole Luggate catchment, I have considered a combined primary allocation of 538 l/s (180l/s + 358 l/s), a first supplementary block allocation of 250 l/s (with a supplementary minimum flow of 788 l/s) and a second supplementary allocation take of 166 l/s (with a supplementary minimum flow of 1,038 l/s). Therefore, the total primary allocation considered for the purposes of this assessment is 538 l/s, the full first supplementary block of 250 l/s (with a supplementary minimum flow of 788 l/s) and 166 l/s of the second supplementary block (with a second supplementary minimum flow of 1,038 l/s).

Hydrological modelling for the SH6 bridge flow site for the period February 2016 to February 2018 has been provided by the applicant, assuming total catchment primary allocation of 538 l/s, and first and supplementary blocks of 250 l/s. The hydrographs prepared by the applicant compare naturalised flows (i.e. flows in the absence of abstraction), observed flows (current abstraction) and the allocation regime proposed (538 l/s primary allocation, 250 l/s first supplementary allocation with 788 l/s first supplementary minimum flow, 166 l/s second supplementary allocation with 1,038 l/s second supplementary minimum flow) (attached as Appendix A). Based on these hydrographs, the proposal is not expected to result in prolonged periods of flat-lining, with flow variability largely mimicking that expected in the absence of abstraction, albeit with a lower baseflow than the natural flow regime (Appendix A). The main effect of the proposal is to reduce the amount of water taken at low flows (thereby resulting in higher flows than currently observed), but increasing the amount of water that is taken as flows recede from high flows (Appendix A). This represents an improvement in in-stream habitat availability and will significantly reduce the length of time that the river is held at low flows compared with the existing abstraction regime. The minimum flow (180 l/s) will be the primary determinant of habitat availability in Luggate Creek for juvenile trout. Factors other than flow are likely to be the key drivers of kōaro and longfin eel populations in Luggate Creek, as discussed in the

‘Fish Distribution’ section above.

**Fish Screening**
Kōaro, brown trout and rainbow trout have been recorded from the vicinity of the water takes from the North Branch of Luggate Creek and the Alice Burn, due to the presence of fish the LIC/Lake Mackay Station water takes should therefore be screened to prevent small fish from entering the water race. Spawning brown trout have been observed in close proximity to the takes (including spawning within the water race from the Alice Burn). Therefore, screening should be designed to be effective for newly emerged trout (30 mm), following the guidelines of Jamieson *et al.* (2007). This is likely to necessitate approach velocities of 0.12 m/s and a fine mesh/slot size (3 mm) (see below for more on the technical fish screening requirements).

The applicant states that *"Installing and maintaining 3 mm screens on these two intakes is not a very practical option as screens of this smaller mesh size will require frequent manual cleaning and there is no power supply near these intakes to install automated self-cleaning screens."*. While it is correct that such screening will require regular maintenance, this applies to many fish screens and is not particular to this application. Screens with larger mesh/slot size will not be effective at screening small fish, increasing the risk of damage to fish, fish mortality, or fish escaping through the screen, all of which are undesirable outcomes. Any fish that enter the race below the water meter have limited opportunity to re-enter the Luggate River.

The applicant proposes fish screening at the by-wash point near the water metering point (WM0671) (Figures 4 & 5). Both races join ~50 m upstream of this point and there is a strong by-wash flow to the Luggate River, some 50 m upstream of the Alice Burn confluence. The angle of the by-wash and race off-take (to water meter) seem to be appropriate to attain suitable approach and sweep velocities (Figure 4). This would maintain access to the race upstream of this point, where Fish & Game surveys have observed trout spawning occurring within the race (van Klink 2017[11]). However, it would mean that by-wash water and fish travel up to 420 m in the races from the point of take before being returned to the river.

Fish screens and by-washes are typically located within the race as close as possible to the point of take and with a suitable by-wash back to the stream. However, if this approach was taken in these cases, it would necessitate higher residual flows than those proposed, as any screened fish would be returned to the river downstream of the take and the residual flow would have to provide for suitable habitat and/or passage conditions for these (in addition to the by-pass flow being sufficient to create a sufficient sweep velocity at the screen. Therefore, I favour the approach proposed by the applicant: screening the combined flows from the Alice Burn and North Branch of Luggate Creek immediately above the water meter. This would maintain habitat availability for trout spawning and rearing within the Alice Burn race and allow juvenile out-migration from the North Branch race. However, it is possible that the by-wash will attract spawning adults, and the by-wash should be configured to prevent adult trout from entering the North Branch race (such as by creating a velocity barrier or physical barrier (e.g. a drop structure) where the by-wash enters the North Branch).

[11] van Klink, P. (2017). Luggate Creek Spawning Survey. Council Report, Otago Fish & Game Council Meeting, 15 June 2017. Otago Fish & Game Council, Dunedin.

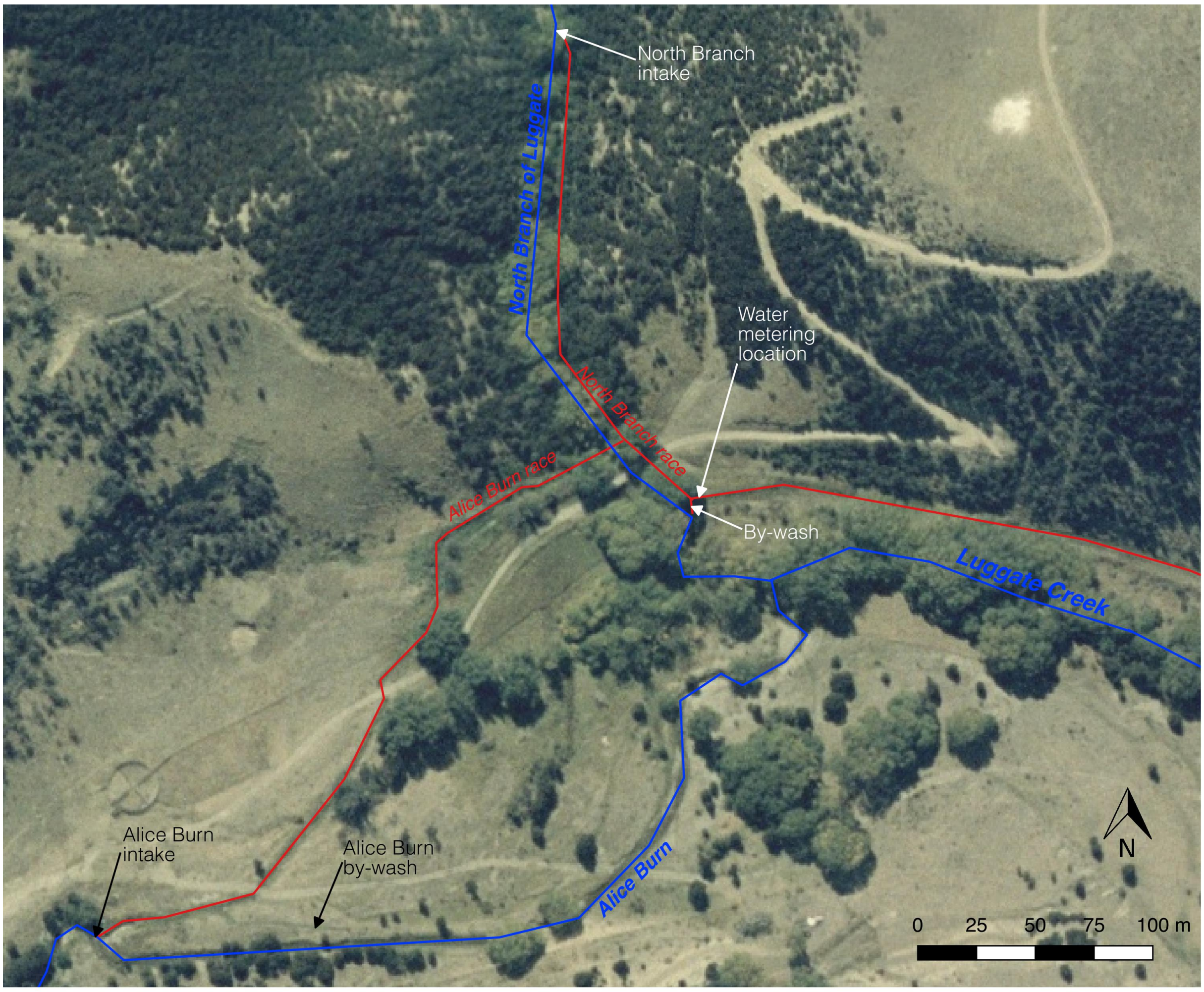


*Figure 4* ***Map of the confluence of Luggate Creek and Alice Burn showing irrigation races and by-washes.***

*Figure 5* ***Proposed fish screening location at the by-wash point near the water metering point (WM0671). The race at this point carries the combined flows from the Alice Burn and Luggate Creek.***

Any screens should be designed and installed in a way that is consistent with Canterbury good practice guidelines[12], including:

- (a) Water shall only be taken when a fish screen with a mesh size or maximum slot width of 3 mm is operated and maintained across the full width of the intake to ensure that fish and fish fry are prevented from passing through the intake screen; and
- (b) As far as possible, the screen area shall be designed to ensure the calculated average through-screen velocity does not exceed 0.12 m/s if a self-cleaning mechanism is in place, or 0.06 m/s if no self-cleaning mechanism is in place.
- (c) The sweep velocity parallel to the face of the screen shall exceed the design approach velocity.

Prior to installation of any fish screen, a report containing final design plans and illustrating how the screen will meet the required design criteria and an operation and maintenance plan should be provided to Council for consideration.

It is important that the fish screen is maintained in good working order, to ensure that the screen is performing as designed. Records should be kept of all inspections and maintenance and these should be made available to Council, on request.

Please do not hesitate to contact me should you require any further information or clarification of the above.

Yours sincerely,

Dean Olsen
*Environmental Scientist & Associate Director*
**Ryder Environmental Limited**

[12] Jamieson et al. (2007). Fish Screening: good practice guidelines for Canterbury. NIWA Client Report CHC2007.092. NIWA, Christchurch. October 2007.

**APPENDIX A**

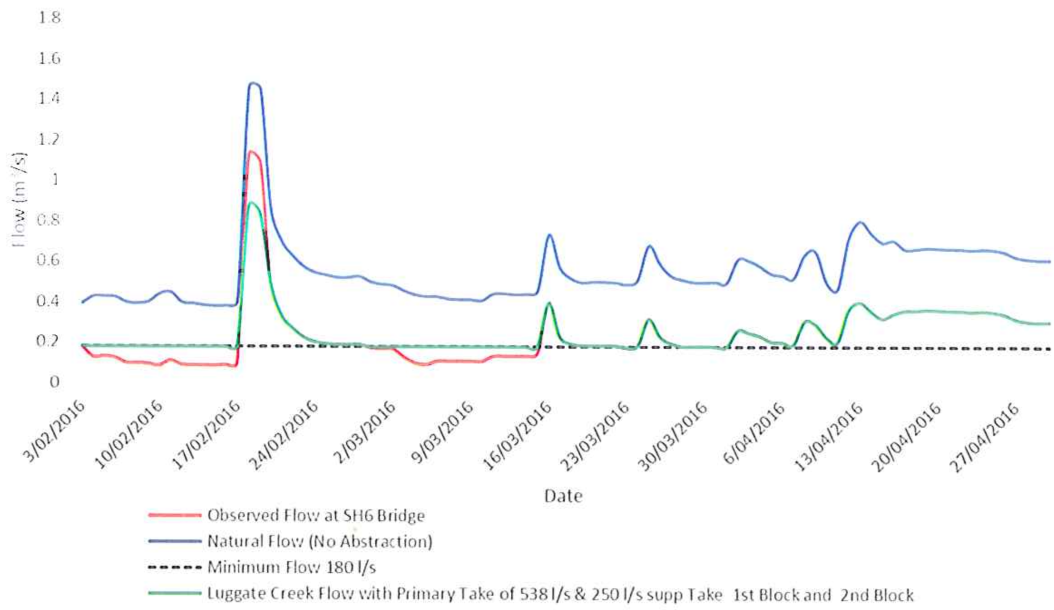


*Figure 1. Observed, natural and expected flows based on the Criffel and LIC allocation proposal at ORC's SH 6 flow site from 03/2/2016 to 30/4/2016.*

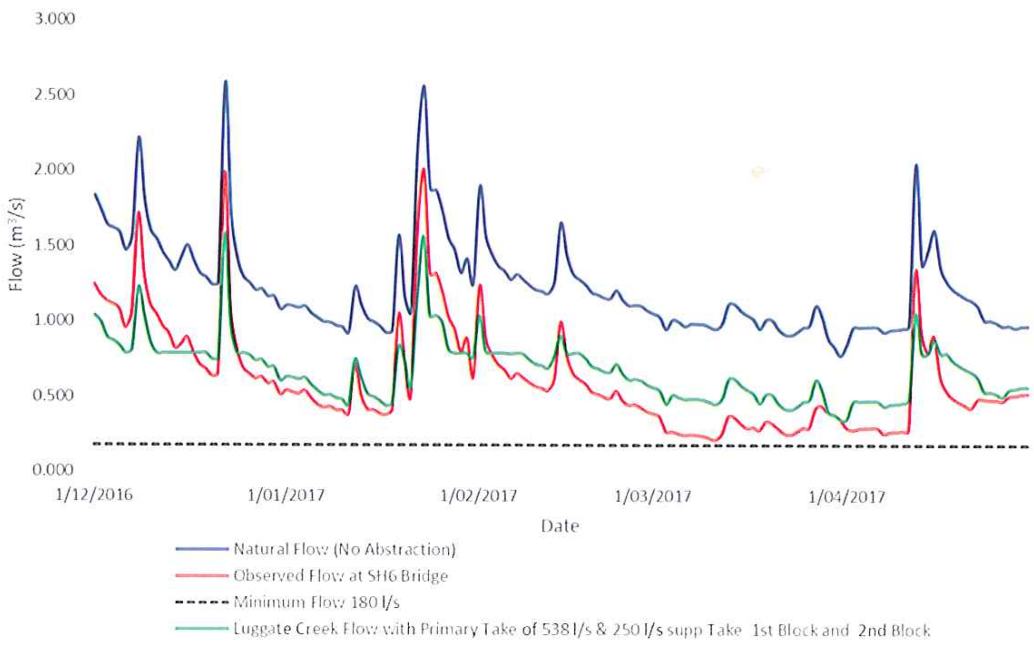


*Figure 2. Observed, natural and expected flows based on the Criffel and LIC allocation proposal at ORC's SH 6 flow site from 01/12/2016 to 30/4/2017.*

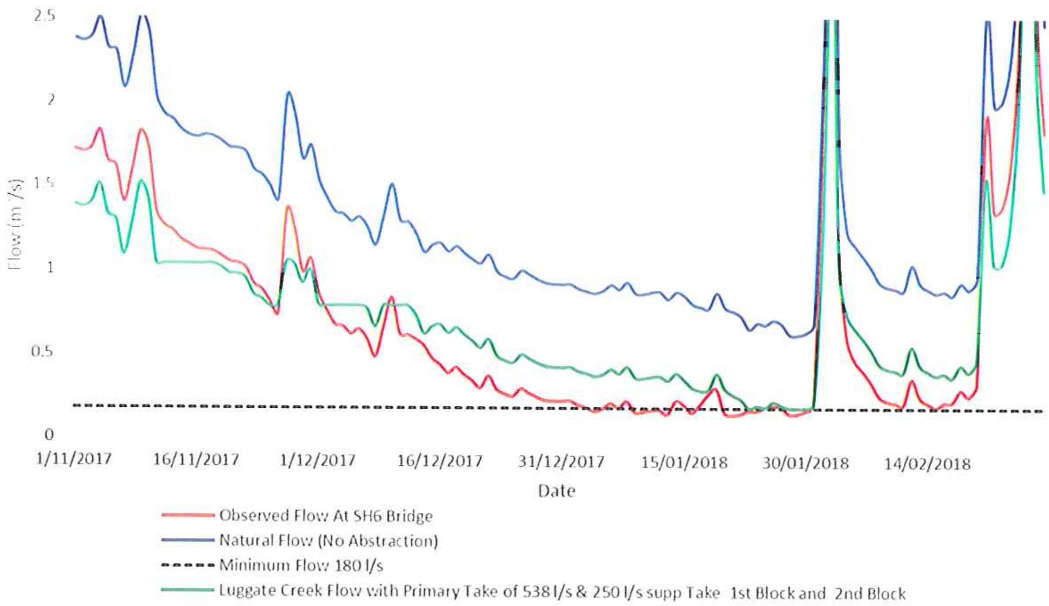


Figure 3. Observed, natural and expected flows based on the Criffel and LIC allocation proposal at ORC's SH 6 flow site from 01/11/2017 to 28/2/18