

16 August 2021

Crissie Drummond
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Dear Crissie,

Willowby Water Race Diversion

Proposal

The Ashburton District Council (ADC) has received an application for the closure of the Willowby Water Race (130 years old, pers. comm. Emma Montgomery, ADC). The Willowby Water Race is a narrow stockwater waterway which flows south through the small township of Willowby, south of Ashburton, central Canterbury (red line in Fig. 1). There is already an existing alternative water path with greater hydraulic capacity (blue line in Fig. 1), which bypasses the Willowby township, and re-joining the Willowby Water Race at Boundary Road (Fig. 1). The length of the Willowby Water Race proposed for decommissioning is 1,521.6 m.

ADC commissioned Aquatic Ecology Limited (AEL) to undertake an ecological assessment of the Willowby Water Race, detailing ecological values and recommendations on how to avoid, minimise or mitigate any negative effects (of Water Race decommissioning) (email Emma Montgomery, 29/4/21).

Physical Habitat

The relevant reach of Willowby Water Race traverses four properties (344, 378, & 273 Longbeach Road, 816 Boundary Road, Fig. 1). The substrate in this reach varies between hard clay and soft sediment. The upper section, at 344 Longbeach Road, flows through a potential stock paddock but is unfenced. Both banks have been sprayed with herbicide (App. I, Fig. a). Patches of macrophytic growth were present, however no native macrophytes were found. Downstream of this section, a short reach of the Water Race flows through 378 Longbeach Road. This approximately 50 m reach is not sprayed and displays an abundance of watercress and monkey musk (App. I, Fig. b). The Water Race then flows southwest alongside Longbeach Road for 380 m. At the time of survey, this section appeared to have been recently dredged of all macrophytes, resulting in a hard clay stream bed with no instream cover (App. I, Figs. c, d). After crossing Longbeach Road through a culvert, the stream flows south through the 273 Longbeach Road and 816 Boundary Road properties. Most of this downstream section consists of a deep channel and soft sediment, with an approximately 1 m wide fenced riparian section on the true left bank and a hedge on the true right bank (App. I, Fig. e). Part of this section, in the 816 Boundary Road property, has native instream and riparian planting (*Carex*, *Juncus* and harakeke) and a cobble bed (App. I, Fig. f). The planted section is approximately 40 m in length, however patches of native plants such as *Carex* and raupo continue for approximately 100 m (App. I, Fig. g) before returning to a deep channel with soft sediment. A slight backflow was present where the Willowby Water Race re-joins the alternative water race at the Boundary Road culvert.

Upon arrival, the water level of the relevant section of Willowby Water Race was low, with ponded sections. After a diversion board was removed by ADC staff from the upstream end at 344 Longbeach Road, the water level rose significantly overnight. Because water was still present despite the damming, and the channel was watered by inflows downstream of the diversion board, we consider that the obstruction did not affect our results materially.



Figure 1. Showing the current path of the Willowby Water Race (red line), and the alternative water race route (blue line). Areas surveyed using GM traps are marked in blue, electric fishing sites are marked in yellow, and the site of invertebrate sample is marked in green. Orange arrows mark the sites where upland bullies were identified.

The nearby Willowby wildlife reserve, a historic wetland, was dry during the AEL survey (App. I, Fig. h). Native plants such as *Carex* and harakeke were still present, however there are no signs the wetland had contained water recently. The ground is not waterlogged, and there is a thick layer of terrestrial grass covering the lowest points. There are also indications of recent grazing by sheep.

Field Survey

- Invertebrates

The macroinvertebrate sample for this ecological survey was taken from the most ideal habitat, specifically the unsprayed section of 378 Longbeach Road (Figs. 1, App. I, Fig. b). Very little flow was present at the time of sample, as the sample was collected before the diversion board was removed upstream.

Macroinvertebrates were collected using a standard 0.3 m wide, 500-micron kicknet, using a subset of the standard sampling protocols outlined in Stark *et al.* (2001). Due to the lack of sampleable hard substrate, the conventional soft substrate sampling protocol (C2) was used. This involved jabbing along the overhanging vegetation on the bank margin, or macrophytes, with the kicknet for 1 m, then sweeping the kicknet through the disturbed section twice. This process was repeated 5 times, and supplemented with the washing of >3 m of instream woody debris through the sample net, to create a composite sample. This sample was field-preserved in iso-propyl alcohol, and transported to the Christchurch laboratory for identification using the standard identification keys (Chapman *et al.* 2011; Winterbourn 1973; Winterbourn *et al.* 2006).

A total of 5 invertebrate species were identified from this sample (Table 1). None of these species were from the so-called clean water group (i.e., EPT Ephemeroptera, Plecoptera, or Trichoptera orders), resulting in a low overall Macroinvertebrate Community Index (MCI-sb) score of 52.4. The most abundant species in this sample was the New Zealand mud snail, *Potamopyrgus antipodarum*. A total of 1,234 individuals were recorded in the sample. *Physa acuta* was also common, with 103 individuals recorded from the single sample.

Table 1. Macroinvertebrate taxa from Willowby Water Race.

		Willowby Water Race	
		No.	MCI-sb
ANNELIDA			
Oligochaeta		6	3.8
MOLLUSCA			
Gastropoda			
Hydrobiidae	<i>Potamopyrgus antipodarum</i>	1234	2.1
Physidae	<i>Physa acuta</i>	103	0.1
Bivalvia			
Sphaeriidae	<i>Sphaerium novaezelandiae</i>	2	2.9
INSECTA			
Diptera			
Stratiomyidae		6	4.2
No. Scoring taxa		5	
TOTAL No. of animals		1351	
Total indice score			13.1
MCI-sb			52.4
% EPT taxa			0.0

- Fish

Fishing was conducted by an electric fishing machine using a conventional Kainga EFM300 electric fishing machine at an operating voltage of 500 V. D.C. A higher-than-normal voltage was required because of the low electrical conductivity of the water (60 $\mu\text{S}/\text{cm}$), and the higher voltage was required to provide a sufficiently wide electrical field prevent escapement. Other than that, conditions were good for electric fishing with water clarity sufficient to the bottom and small fish.

Electric fishing serves to briefly (approx. 3 seconds) render fish unconscious to facilitate their capture in nets for identification. The machine incorporates a timer, allowing the effective fishing time to be recorded. The total effective fishing time (i.e., the total time that the machine was delivering current to the water) for these reaches was 35 minutes. Captured fish were then anaesthetised, identified, measured, and upon recovery from anaesthesia, released back into their resident habitats.

Fishing was undertaken using AEL's electric fishing permits (MPI Permit 749, DOC 70754-FAU and under authority from NCFGC).

Ten sites were electro-fished on 14th May 2021. In combination, these reaches encompassed all hydrological habitat types available in the reach being pool, riffle, fast-run, and slow-run habitats.

Electric fishing was also supplemented with overnight trapping. Trapping fishing techniques are more effective in deep and slow-flowing habitats, especially if there is overhanging vegetation which makes wading difficult. Trapping is also important in areas with difficult access, such as the lower section of Willowby Water Race at 273 Longbeach Road. On 13th May 2021, seven baited Gee Minnow™ (GM) lines were set overnight, spread evenly across the relevant reach (Fig. 1). Each GM line was composed of five baited GM traps. These lines were spread evenly across the relevant section of Willowby Water Race.

All captured fish were anaesthetised, identified, measured, and after recovery, released back into their resident habitat.

Together, electric fishing and GM traps were used to survey all different habitat types in the relevant reach. From this extensive fishing effort, only one fish species was found in Willowby Water Race. This was the upland bully (*Gobiomorphus breviceps*, App. I, Fig. i), of which 35 individuals were identified. Two upland bullies were identified in the 344 Longbeach Road reach, and the rest were identified at the downstream limit of the survey, near the Boundary Road culvert. Many individuals in the downstream population appeared gravid (App. I, Fig. j), therefore are likely spawning in this vicinity. Upland bullies are currently considered "Not Threatened" (Dunn *et al.* 2017).

Discussion

Based on a lack of aquatic macrophytes, discussions with landowners, and our water level observations, it was determined that this Water Race is ephemeral. Technically, this is when the groundwater level is always below the thalweg (the mid-line of the channel). Based on discussions with a landowner the Water Race appears to dry out completely many times a year (pers. comm. Sheryl Stevens/816 Boundary Rd). While a reach of the Water Race, at 816 Boundary Road, was planted with a variety of native shrubs and rushes, such as *Carex*, *Juncus* and harakeke (i.e., flax). Riparian vegetation in all other reaches were entirely introduced.

The ephemeral nature of Willowby Water Race is likely to be limiting the number of fish and invertebrate taxa present. Only 5 invertebrate taxa were identified in the sample, none of which were sensitive to high levels of pollutants. The most abundant invertebrate identified was the New Zealand mud snail (*Potamopyrgus antipodarum*). This is a native species, but very common in soft-substrate waterways throughout New Zealand. The presence of *Physa acuta*, commonly known as the acute bladder snail, reflects an exceedingly low water quality. This species has an MCI-sb score of 0.1, meaning it can withstand high concentrations of contaminants. The species with the highest sensitivity to pollutants in this sample was soldier fly (*Stratiomyidae*) larvae, with still a fairly pollution-tolerant score of 4.2 from a maximum of 10. The overall MCI-sb score of 52.4 is indicative of (very) poor water quality (i.e., MCI < 80 (Stark & Maxted 2007).

The ephemeral nature of this waterway could also contribute to this low MCI score and skew the fauna towards one which can tolerate stagnant hypoxic conditions. Long-term bank spraying, both on private and road reserve land, is likely to be detrimental to aquatic invertebrates. There is little experimental information of toxicity of herbicides to NZ aquatic invertebrates. However field observations indicate some toxic effects at least for earlier herbicides (Burnet 1972). Moreover, because riparian vegetation has ecological links to the waterway, the loss of riparian plants is almost always detrimental to aquatic invertebrates.

We also consider it unlikely that freshwater mussels are present in the waterway. Freshwater mussels are unlikely to tolerate bed drying for extended periods and are considered to be sensitive to poor water quality but also low oxygen levels at the bed level (James 1985), which are likely to occur where water pools at night in the absence of macrophytes.

The artificially constructed wetland bed in the local-purpose reserve ("Willowby wildlife reserve", vicinity of 448 Longbeach Rd) was totally dry and hard at the time of survey (Fig. 9), and had deteriorated to a point that it cannot be further ecologically affected by the decommissioning of Willowby Water Race.

In 2002, Department of Conservation staff translocated a population of mudfish into this wetland, when water was still present (O'Brien & Dunn 2007). Although records on the New Zealand freshwater fish database (NZFFD) indicate a presence of Canterbury mudfish (*Neochanna burrowsius*) in the wetland in 2000, subsequent visits from DOC between 2009 and 2015, unfortunately, found no aquatic life (NZFFDB). Its likely that wetland naturally drained between 2002 and 2009, or may be related to potential low flows in the Willowby Water Race. Canterbury mudfish can tolerate some loss of surface water, but extended period of water loss reduces survival and reproductive success, after water returns (Eldon 1979; O'Brien 2005).

After significant fishing effort, only one species of fish was identified in Willowby Water Race, the upland bully, a species that does not require sea access. This species has high reproductive material, and a number of gravid fish were identified at the downstream limit of Willowby Water Race. The presence of this one non-migratory fish is probably an artifact of frequent waterway drying, combined with the perched culvert at Boundary Road at the downstream end of the survey reach (App. I, Fig. k). This is because, while some juvenile fish like eels and some whitebait species can climb damp surfaces, they cannot negotiate overhangs. While the perched culvert invert may be submerged at high flows, it is likely the opposing current in the Boundary Road culvert would be too fast for fish to negotiate. Potentially the fish diversity is already restricted by other or similar fish passage impediments further downstream.

As an aside, native riparian planting will enhance the visual appeal of the New Willowby Water Race, and enhance the instream ecology, especially in respect to aquatic macroinvertebrates. The Boundary Road culvert will minimise any ecological enhancement of New Willowby Water Race Based, and based on the Google StreetView photo (vicinity of 779 Boundary Road) New Willowby Water Race may have its own perched outlet at the confluence with Boundary Road Water Race.

Concluding remarks

Ecological values in the Willowby Water Race are low, with particularly low stream health scores. The ephemeral nature of the flow, the presence of perched culverts, and bank spraying are probably major reasons for the low health score. The fishing effort was of an intensity that we are confident that the fish fauna is composed of only one species, the upland bully, a common species throughout New Zealand. We are also confident that freshwater mussels are not present given the ephemeral nature of the flow, and the poor water quality.

New Willowby Water Race was not fished, but it may have higher ecological values than Willowby Water Race, as it may have permanent (i.e., perennial) flow. However, fish diversity will always be constrained by perched culverts mentioned above, and potentially others between Boundary Road and the sea.

Decommissioning Willowby Water Race would result in the loss of limited upland bully habitat in the upper section of the Water Race, and no rare or important invertebrates. The upland bully population

in the downstream reach is close to the Boundary Road culvert, so their habitat is likely to be retained by backflow at the confluence of New Willowby Water Race. It would be possible to translocate the majority of the upland bullies to the new channel prior to the decommissioning. Following the removal of fish, as much flow as possible should be diverted into New Willowby Water Race at 344 Longbeach Road. With the water flow stopped, as the water level recedes in the Willowby Water Race, the channel should be electric fished in a downstream direction to either capture fish stragglers, or chase fish downstream out of the bottom of Willowby Water Race. Then, Willowby Water Race should be bunded at the bottom end, filled and compacted in an upstream direction. Any ponded groundwater should be trash-pumped on nearby pasture to filter the fines. If deemed necessary by ADC, the contractor is to consider means of mitigating the risk of erosion by groundwater along the filled path of Willowby Water Race. We have summarised the decommissioning fish handling aspects of any decommissioning below as Recommendations.

Recommendations:

If Council proceeded with closure of Willowby Water Race, we recommend, in order of operation:

- Translocation of fish, and any other significant aquatic life, from Willowby Water Race into New Willowby Water Race.
- Diversion of all remaining flow into New Willowby Water Race at 344 Longbeach Road, possibly by bunding the old channel.
- As Willowby Water Race dewater, the receding habitat should be electric-fished downstream to push any remaining fish out of the bottom of the Willowby Water Race.
- Bund the Willowby Water Race at its downstream confluence with the New Willowby Water Race vicinity of 779 Boundary Road.
- Fill Willowby Water Race in an upstream direction, pumping any residual dirty groundwater onto adjacent pasture.
- Contractor to consider the means of mitigating the residual flow of groundwater along the decommissioned course of Willowby Water Race.

Yours sincerely,



Mark Taylor,



Riley Payne

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Appendix I. Photographs mentioned in the text.



Figure a. Looking downstream along Willowby Water Race, at 344 Longbeach Road. Two upland bullies were identified in this reach.



Figure b. Looking downstream at an unsprayed section of the Water Race, at 378 Longbeach Road. The invertebrate sample was taken at this location.



Figure c. Looking upstream at a dredged section of Willowby Water Race, flowing alongside Longbeach Road.



Figure d. Looking downstream at the dredged section of Willowby Water Race, flowing south along Longbeach Road.(photo 30th April 2021).



Figure e. Willowby Water Race looking downstream through the fenced reach from 273 Longbeach Rd.



Figure f. Willowby Water Race looking upstream through the fenced reach at 816 Boundary Rd.



Figure g. Willowby Water Race, looking downstream at patches of native planting in the vicinity of 816 Boundary Rd.



Figure h. Willowby local purpose reserve. The wetland was dry.



Figure i. Upland bully identified at the downstream limit of the ecological survey.



Figure j. This upland bully, part of the downstream population, appears gravid.



Figure k. Perched culvert across Boundary Road, at the downstream limit of ecological survey.