OPUHA WATER LTD
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Quarterly Water Quality Report

July 2023 to September 2023

Key Findings

- A rain event in July 2023 (30 – 90 mm rainfall) resulted in increased **turbidity** in **Lake Opuha** at depth (two weeks) and at the surface (a few days).
- **Cyanobacteria (blue-green algae)** health warning removed for **Lake Opuha** in July 2023 after 148 days.
- The **tributaries of Lake Opuha** experienced increased **suspended solids**, **nitrate-N** and **dissolved reactive phosphorus** due to increased flows from the July 2023 rain event.
- Increased **nitrate-N** and **dissolved reactive phosphorus** were observed in the **Opuha**, **Opihi** and **Te Ana Wai** rivers.
- **Macroinvertebrate Community Index (MCI)** and **Quantitative Macroinvertebrate Community Index (QMCI)** scores for the **Kakahu River** in August 2023 did not show any effects of the OWL discharge**.** Although the discharge was not occurring at the time of the survey, this is an important result as it indicates that there is no longer term *(i.e.* months after discharge ceases) effects of the discharge.
- **Longfin eel, upland bully** and **common bully** were caught in the **Kakahu River** as part of the August 2023 ecological survey. These fish were identified both upstream and downstream of the discharge point.

Introduction

Water quality is monitored monthly at Lake Opuha and several waterways throughout the Opuha Scheme and wider catchments. Opuha Water Ltd (OWL) has several water quality monitoring programs that focus on different areas of interest, such as Lake Opuha and its tributaries, the Upper Opihi River and its tributaries, the Opuha River and lower Opihi River, the Te Ana Wai River and the Kakahu River.

Water samples are collected and analysed for nitrogen, phosphorus, chlorophyll-a, iron, manganese, heavy metals, pesticides, *E. coli*, cyanobacteria, water clarity, dissolved oxygen, pH, and conductivity. River surveys for benthic periphyton (material attached to the surface of rocks in the water) are also carried out to better understand river health and to quantify the coverage of cyanobacteria and nuisance algae. The specific parameters analysed at each site depends on the objectives of the individual sampling programs.

OWL reviews the data monthly to identify any significant changes in water quality throughout the scheme and produces a quarterly report for shareholders and stakeholders.

The objective of this report is to highlight interesting data observed during the quarter for OWL's water quality monitoring programs, track short-term changes and update stakeholders and the community of additional investigations that OWL are undertaking. A more in-depth investigation of the water quality data – such as trend analysis, statistical analysis, and comparison to guidelines – will be undertaken for OWL's Annual Water Quality Report.

Additional information regarding sampling sites is given in *Appendix A – Sampling Locations.*

Lake Opuha

Continuous water quality monitoring occurs at Lake Opuha via sensors located on, or close to, the lake tower. Sensors measure dissolved oxygen, conductivity, turbidity, and temperature close to the lake surface (5m below the surface) and at depth (close to the bottom of the lake). Water quality samples are also collected at the lake and sent to a laboratory for analysis. This type of sampling is carried out for monitoring cyanobacteria, chlorophyll-a, total nitrogen, and total phosphorus. The chlorophyll-a, total nitrogen and total phosphorus data is combined to produce a lake health metric called the Trophic Level Index (TLI).

The water quality parameters of interest for the 2023 July – September period were **turbidity** and **cyanobacteria**.

Turbidity

Turbidity is a water quality parameter that is easily measured and gives insight into the amount of suspended sediment in a waterway and the visual clarity of the water. Increased turbidity generally corresponds to decreased visual water clarity. Turbidity within Lake Opuha is typically below 5 NTU, unless there is a rain event within the catchment. Figure 1 illustrates the turbidity in Lake Opuha from 1 July 2023 to 30 September 2023 along with the North Opuha and South Opuha river flows. The flow sensor in the South Opuha was not working correctly in early September (spike in data circled).

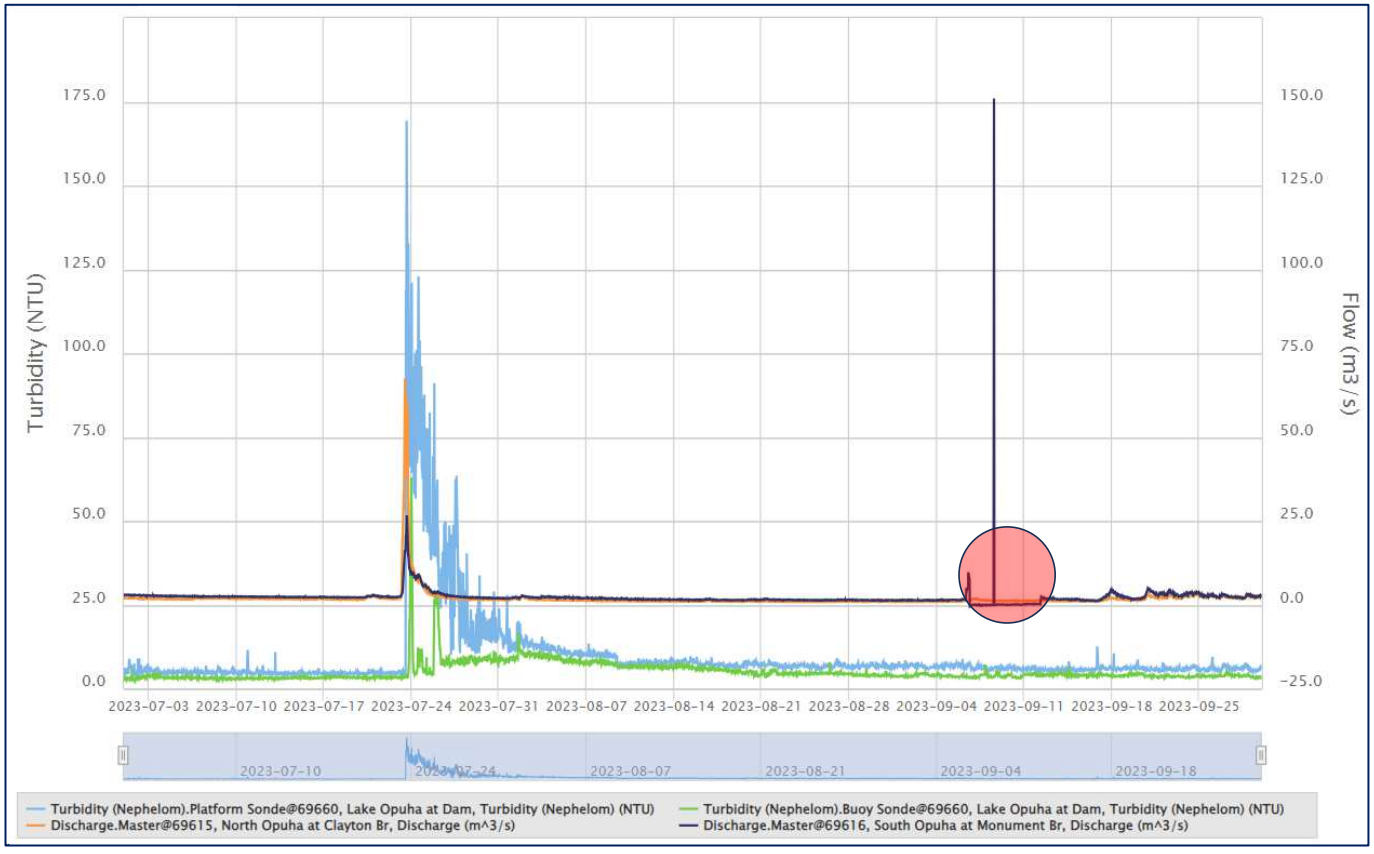


Figure 1: Turbidity in Lake Opuha (depth and surface) and flows from the North Opuha and South Opuha rivers from 1 July 2023 to 30 September 2023.

Increased flows recorded in the North Opuha River (>50 m^3/s) and South Opuha River (25 m^3/s) in July, resulted in increased lake turbidity at depth (>100 NTU) and at the surface (>50 NTU) – Figure 2. Turbidity levels at depth increased above 100 NTU on 23 July 2023 and remained above 10 NTU until 9 August 2023. The increased turbidity at the surface was short-lived compared to depth, with turbidity increasing above 50 NTU briefly on 23 July 2023 and above 25 NTU on 25 July 2023, however by 26 July 2023 the turbidity at the surface returned to <10 NTU.

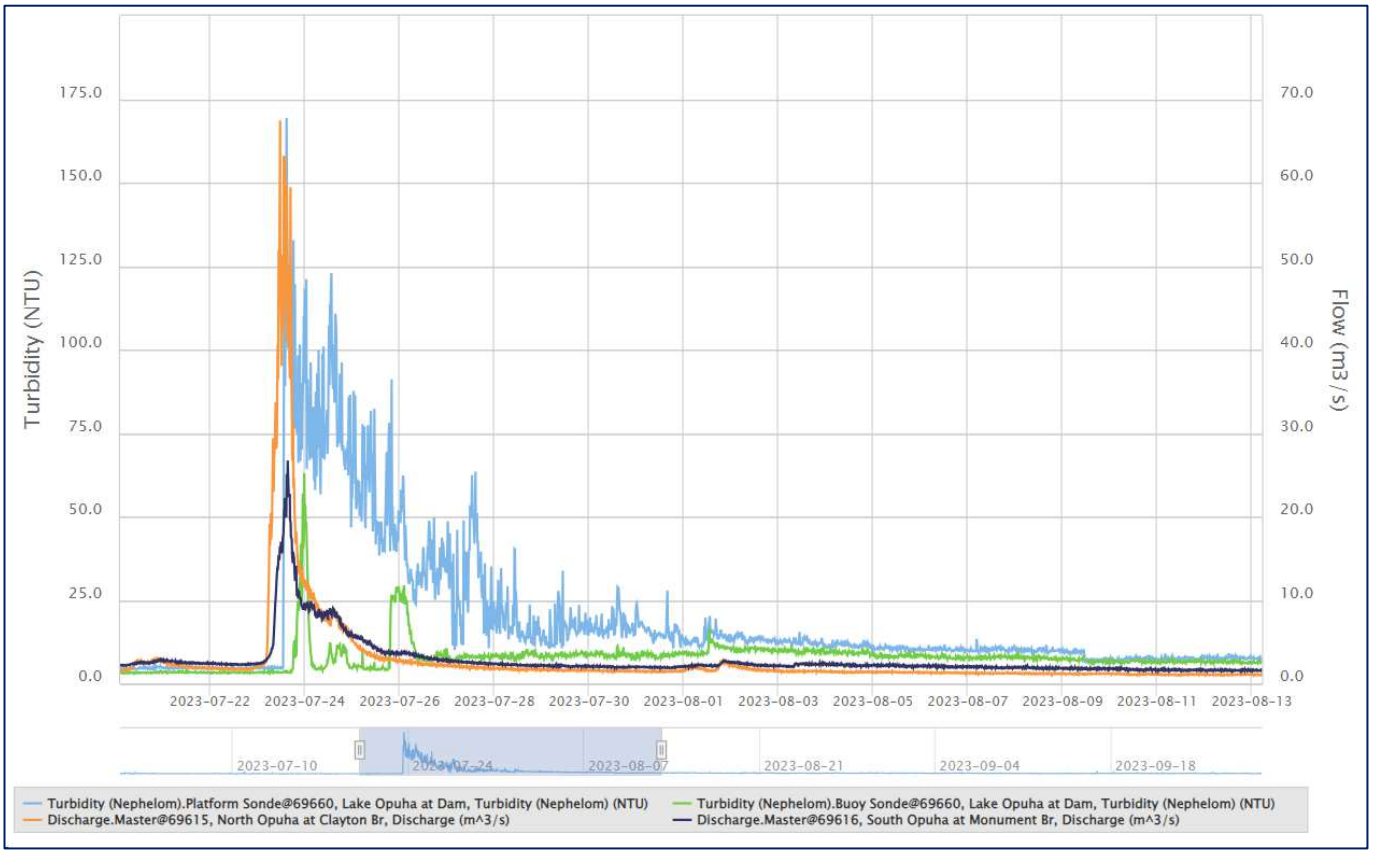


Figure 2: Turbidity in Lake Opuha (depth and surface) and flows from the North Opuha and South Opuha rivers from 20 July 2023 to 13 August 2023.

OWL continues to work with NIWA, research scientists from the University of Canterbury, and environmental consultants to better understand the sources of sediment coming into Lake Opuha. More intensive lake and tributary monitoring will be undertaken over the 2023/24 summer period which will start to give OWL an increased understanding of sediment dynamics within the lake and the factors that can be controlled to improve water clarity.

Cyanobacteria (blue-green algae)

As mentioned in previous quarterly water quality reports, a cyanobacteria health warning was issued for Lake Opuha on 1 March 2023 due to scums observed at various locations around the lake. The health warning was removed on 27 July 2023 after 148 days.

When a cyanobacteria bloom is detected in Lake Opuha, sampling downstream of the lake is enacted to check if cyanobacteria is being discharged downstream. Downstream sampling sites in the Opuha River include below the downstream weir and Skipton Bridge. Only low levels of cyanobacteria were detected in the Opuha River during the March – July bloom, indicating that cyanobacteria was not being discharged from the lake to any significant extent. This result is as expected as water is discharged from the lake at depth; cyanobacteria are more likely to reside closer to the surface of the lake.

Tributaries of Lake Opuha

Monthly water quality monitoring is undertaken in the North and South Opuha rivers and Ribbonwood, Station, and Deep creeks.

In July 2023, the catchment above Lake Opuha received substantial rainfall with rain gauges in the region recording 30 – 90 mm of rainfall. This resulted in flows in the North Opuha River of 56 m^3/s and the South Opuha River of 25 m^3/s, and elevated flows in Ribbonwood, Station and Deep creeks. The increased flows resulted in an increase

in **suspended solids** (decrease in **water clarity**) in the tributaries (Figure 3) as well as increases in **nitrate-N** and **dissolved reactive phosphorus (DRP)**, as illustrated in Figure 4 for the North and South Opuha Rivers. Sampling in September 2023 showed that levels of nitrate-N and DRP returned to normal.

Although nitrate-N and DRP were elevated in both the North and South Opuha Rivers, the concentration of both parameters was significantly higher in the North Opuha River relative to the South Opuha River (Figure 4).

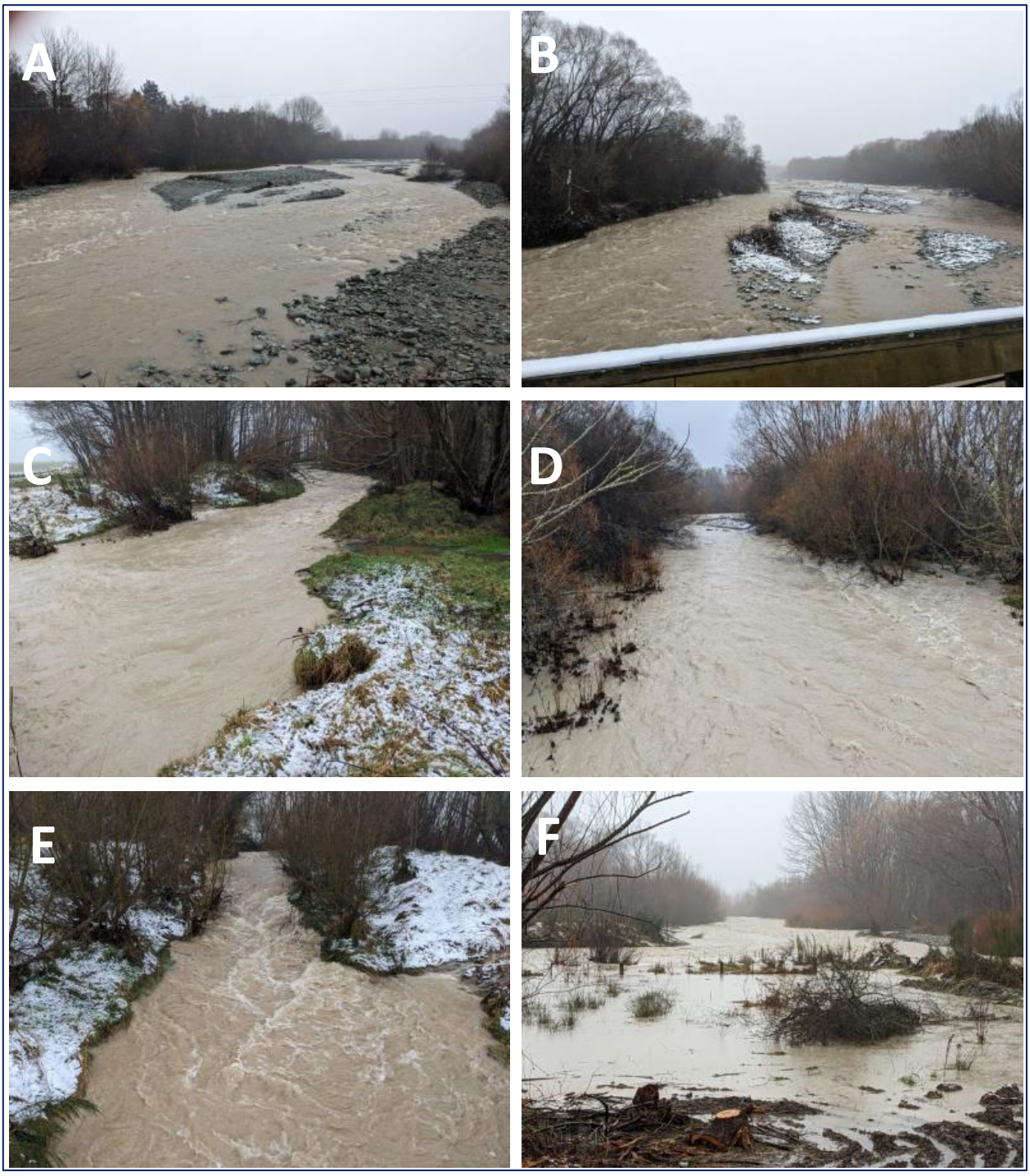


Figure 3: Photos of the Lake Opuha tributaries on 23 July 2023. A) South Opuha River Clayton Rd; B) North Opuha River Clayton Settlement Rd; C) Ribbonwood Creek Clayton Rd; D) Station Creek Clayton Rd; E) Deep Creek Clayton Rd; and F) area between Station Creek and Ribbonwood Creek.

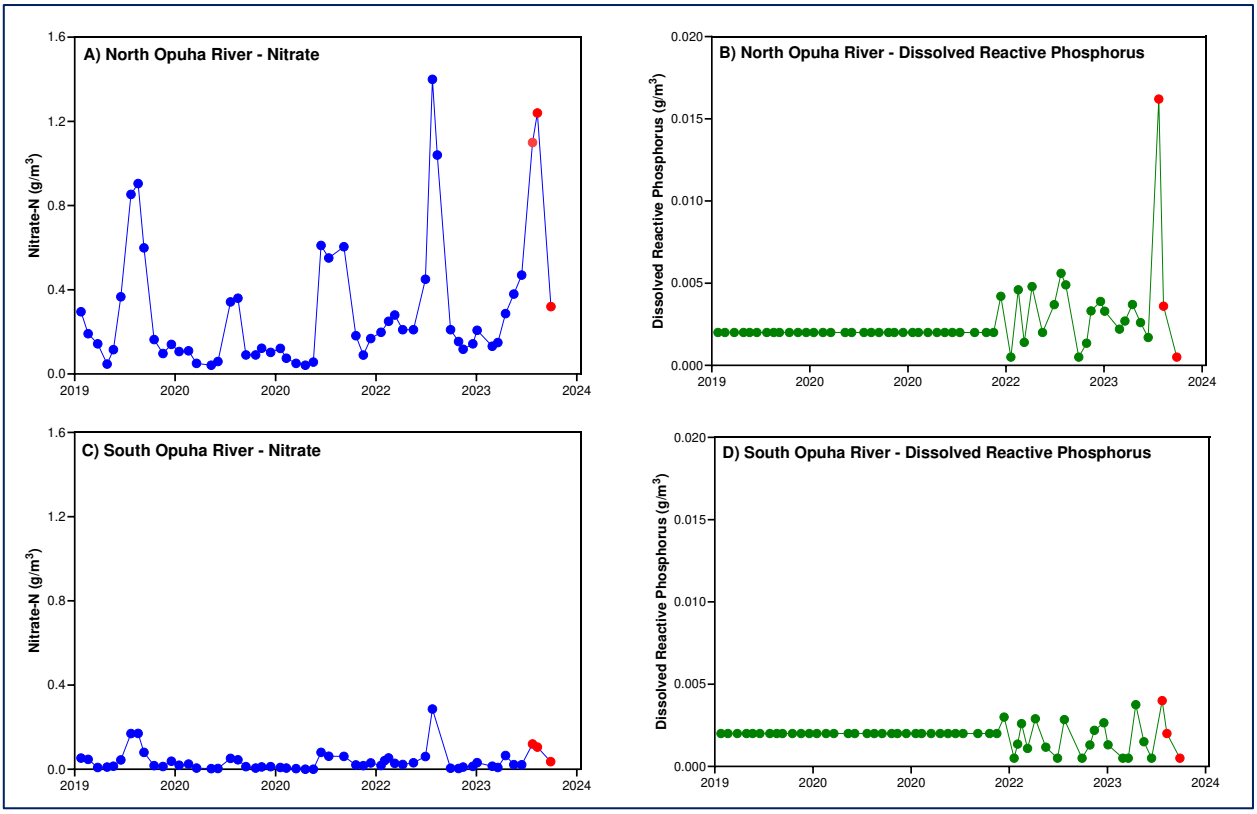


Figure 4: Nitrate-N concentration at A) North Opuha River and D) South Opuha River; and dissolved reactive phosphorus concentration at B) North Opuha River and D) South Opuha River. Red data points are those from sampling in July, August and September 2023.

Opuha River, Opihi River and Te Ana Wai River

Monthly sampling is undertaken in the Opuha River, Opihi River (and its tributaries) and the Te Ana Wai River. Generally, results from sampling in these rivers were unremarkable during the July to September 2023 period, however increased levels of **nitrate-N** and **DRP** were elevated after the July 2023 rain event for some of these rivers (Figure 5 and Figure 6). These elevated levels were similar to rain events in previous years.

Nitrate-N in the Opihi and Te Ana Wai rivers peaked in August 2023 whereas nitrate-N levels in the Opuha River peaked prior to the rain event (June 2023). DRP in the Opuha and Te Ana Wai rivers peaked in August 2023 whereas DRP in the Opihi River peaked prior to the rain event (June 2023).

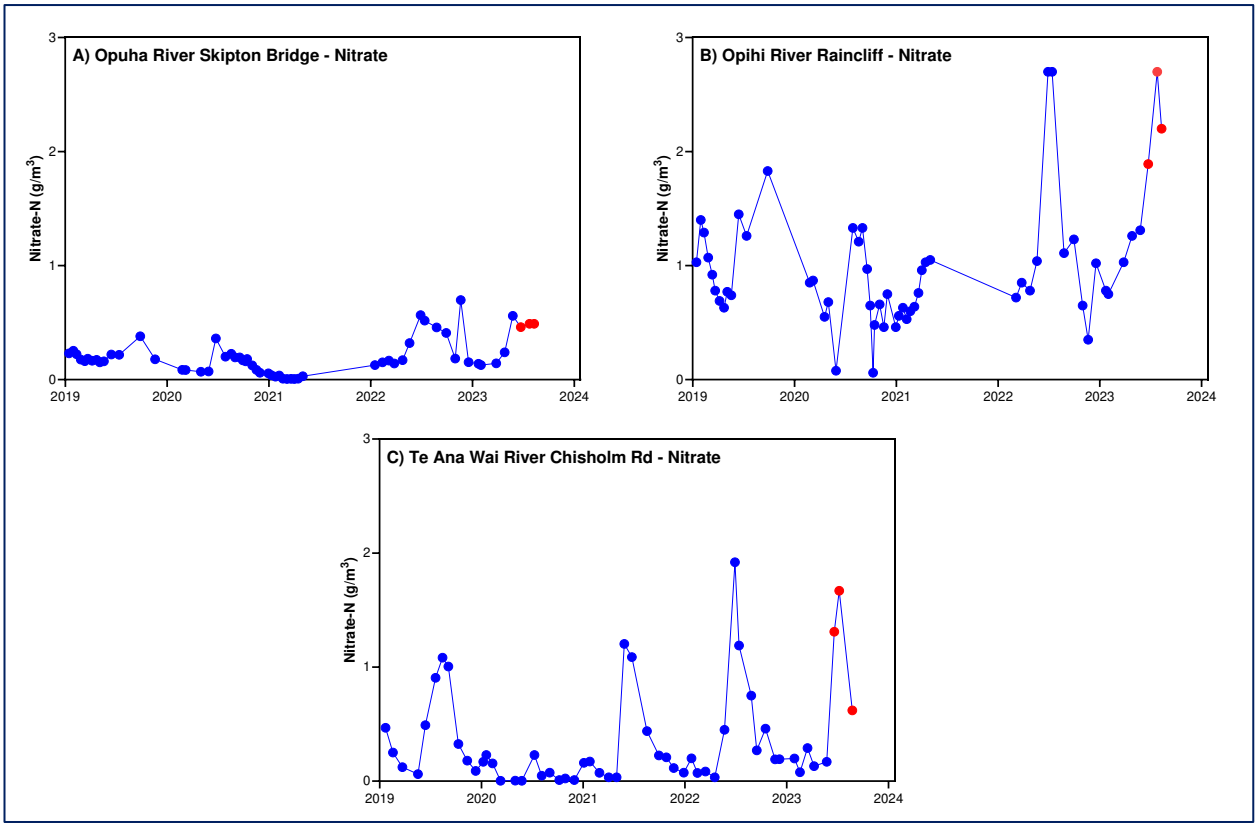


Figure 5: Nitrate-N concentration at A) Opuha River Skipton Bridge; B) Opihi River Raincliff; and C) Te Ana Wai River Chisholm Rd. Red data point are those from sampling in July, August and September 2023.

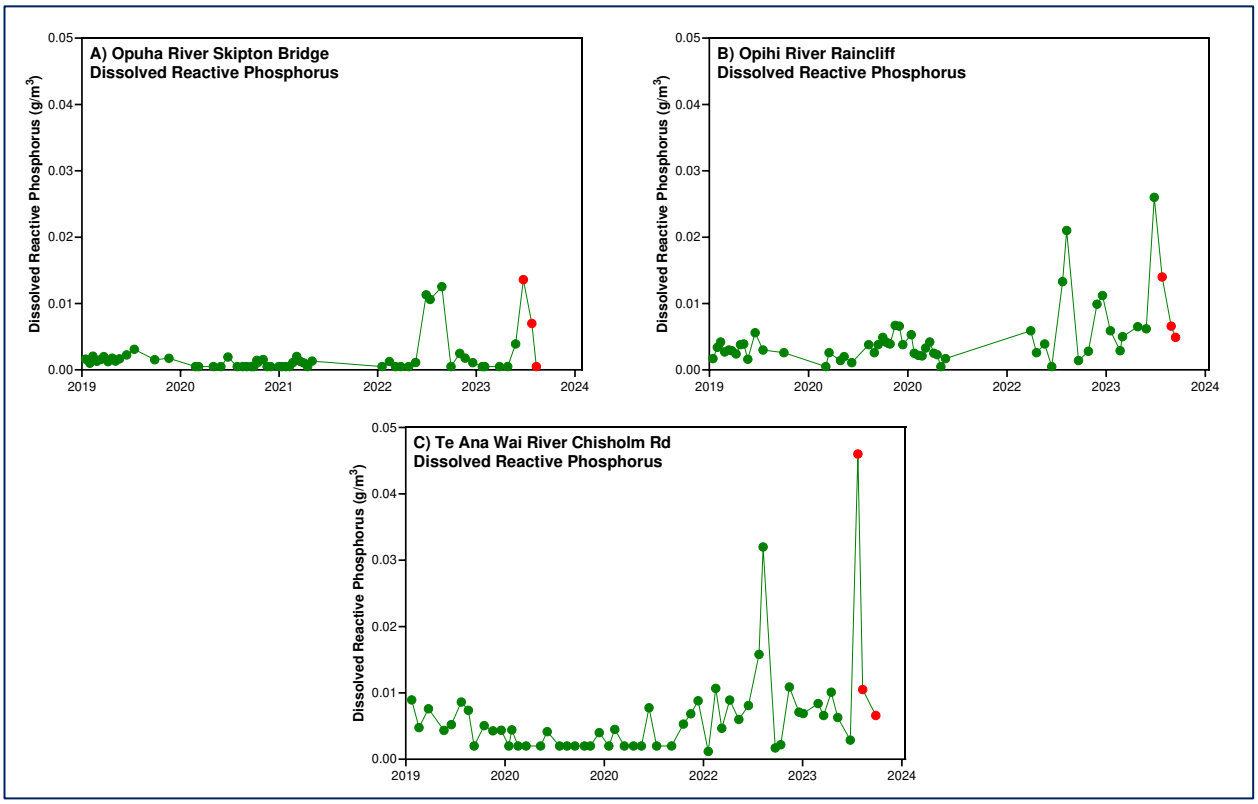


Figure 6: Dissolved reactive phosphorus concentration at A) Opuha River Skipton Bridge; B) Opihi River Raincliff; and C) Te Ana Wai River Chisholm Rd. Red data points are those from sampling in July, August and September 2023.

Kakahu River

An ecological survey was carried out at several locations in the Kakahu River in August 2023, by 4Sight Consulting. This survey included macroinvertebrate and fish monitoring. Ecological surveys are undertaken to investigate the impact that the OWL discharge has on the Kakahu River. Two sites upstream of the discharge point (Kakahu at Mulvihill Bridge Rd and Kakahu upstream discharge) and three sites downstream of the discharge point (Kakahu downstream discharge, Kakahu at Morrison's Bridge and Kakahu at WHR Rd Bridge), were surveyed.

Macroinvertebrates are small animals without backbones that live on or just below the stream bed. Macroinvertebrates include snails, worms, insects, larvae of insects and kōura (crayfish). Macroinvertebrates are an important food source for animals further up the food chain, such as wading birds and fish.

Two macroinvertebrate metrics widely adopted by regional councils in New Zealand to assess the health of waterways are the macroinvertebrate community index (MCI) and the quantitative macroinvertebrate community index (QMCI). Generally, the MCI looks at the presence and absence of species, whereas QMCI also considers the number or abundance of these species.

At the time of the August 2023 survey, there was no discharge into the Kakahu River – there had been no discharge since March 2023. The timing of the surveys is agreed upon between Environment Canterbury and OWL.

The **MCI** data from the 2023 ecological survey shows that the MCI score was similar upstream and downstream of the discharge point, except for Winchester Hanging Rock Road Bridge (Kakahu at WHR Road Bridge) which is the furthest downstream site studied (Figure 7) and often has poorer water quality than other sites in the Kakahu River– scores ranged from *Fair* to *Good* with sites immediately upstream and downstream of discharge point rated *Good*.

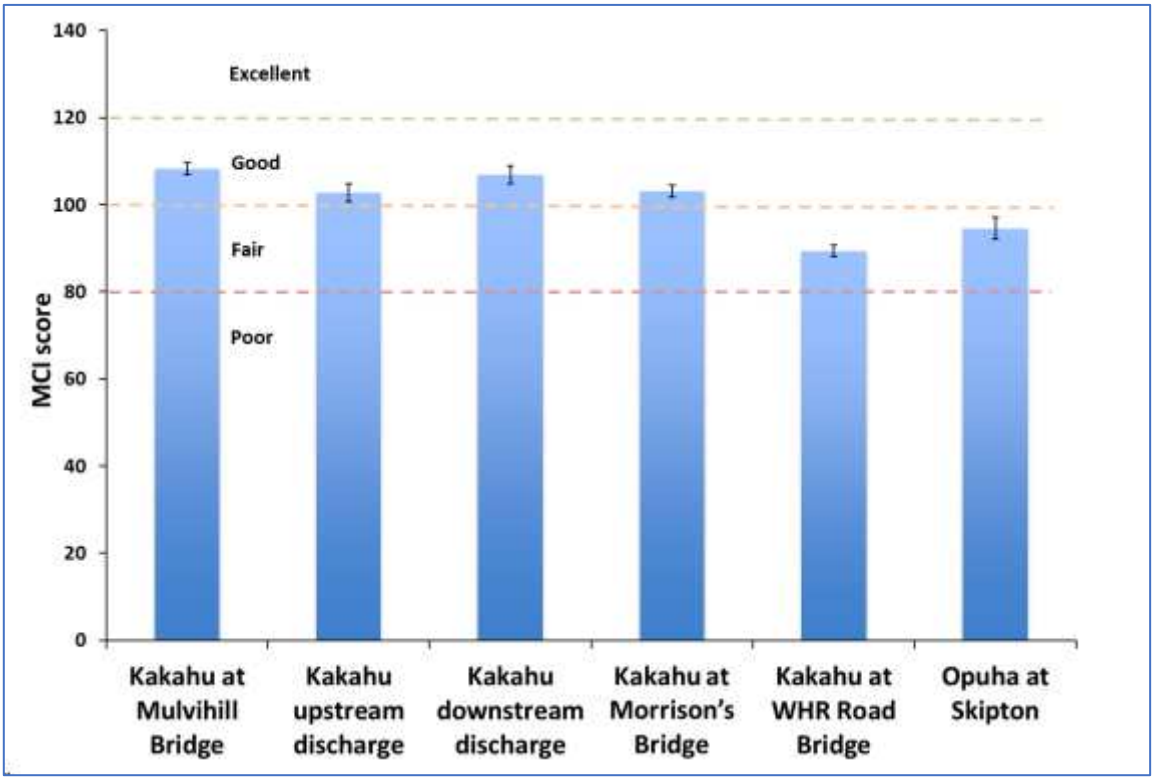


Figure 7: Average MCI scores at Kakahu and Opuha river sites, August 2023 (mean +/- one standard error).

The **QMCI** data from the August 2023 ecological survey shows that the QMCI score was similar upstream and downstream of the discharge point, except for Winchester Hanging Rock Road Bridge (Kakahu at WHR Road Bridge) which is the furthest downstream site studied (Figure 8) – scores ranged from *Poor* to *Good* with sites immediately upstream and downstream of discharge point rated *Good.*

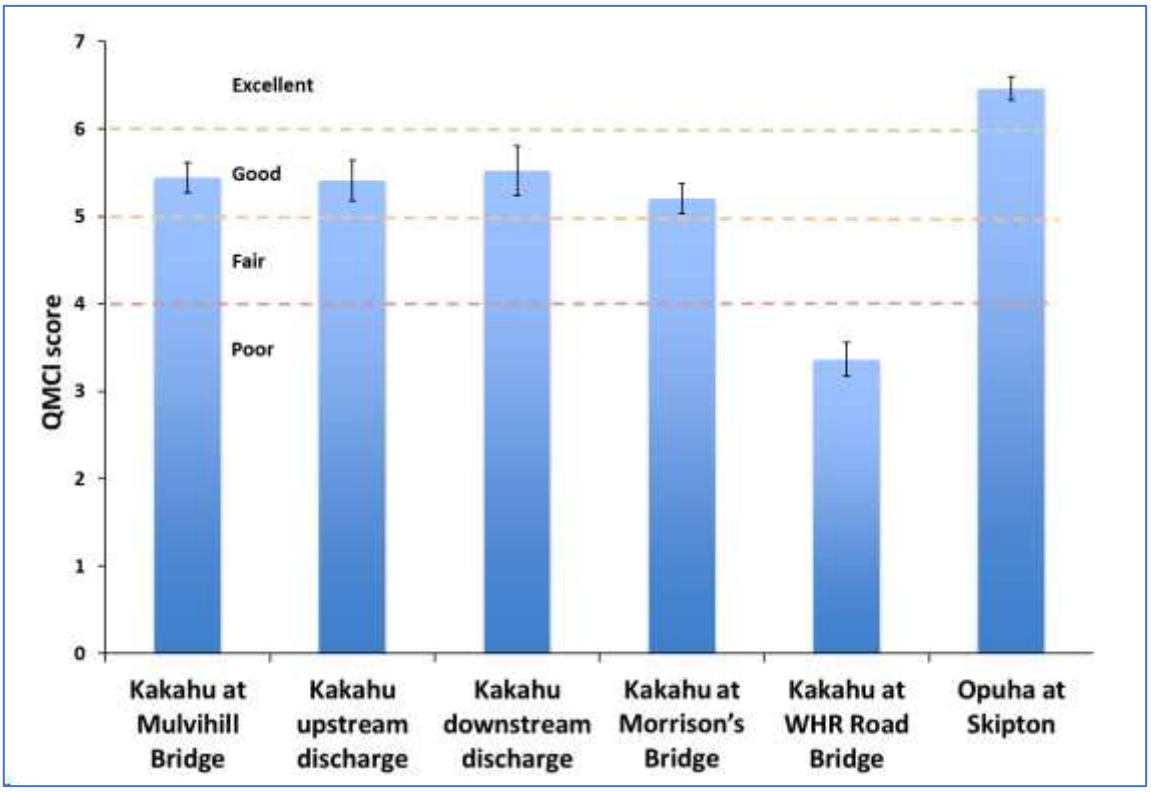


Figure 8: Average QMCI scores at Kakahu and Opuha river sites, August 2023 (mean +/- one standard error).

The August 2023 survey (like previous surveys) showed that Winchester Hanging Rock Road Bridge (WHR) had lower MCI and QMCI scores than the other sites; this is more a reflection of the sampling site rather than the discharge as WHR tends to have higher nitrogen, phosphorus and *E.coli* than other sampling sites, indicating other inputs from the catchment affecting WHR.

The fish monitoring component of the survey identified longfin eel, upland bully and common bully (Figure 9), upstream and downstream of the discharge location.

Overall, the ecological survey in August 2023 did not find any consistent patterns to indicate adverse effects of the discharge on the freshwater communities in the Kakahu River. Although the discharge was not occurring at the time of the survey, this is an important result as it indicates that there is no longer term (*i.e.* months after discharge ceases) effects of the discharge.

The next ecological survey will be undertaken when the discharge is occurring or shortly after cessation of the discharge.

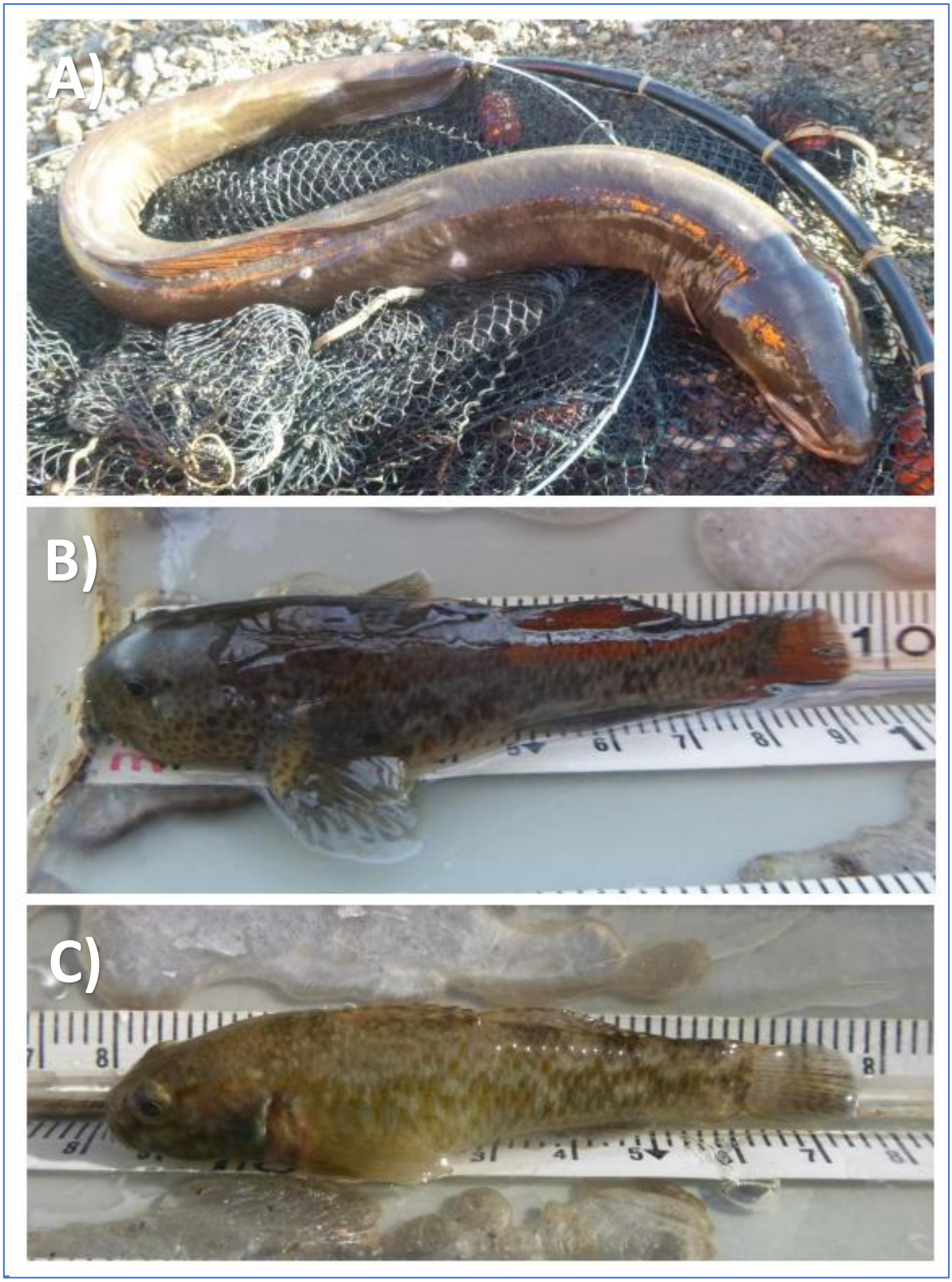
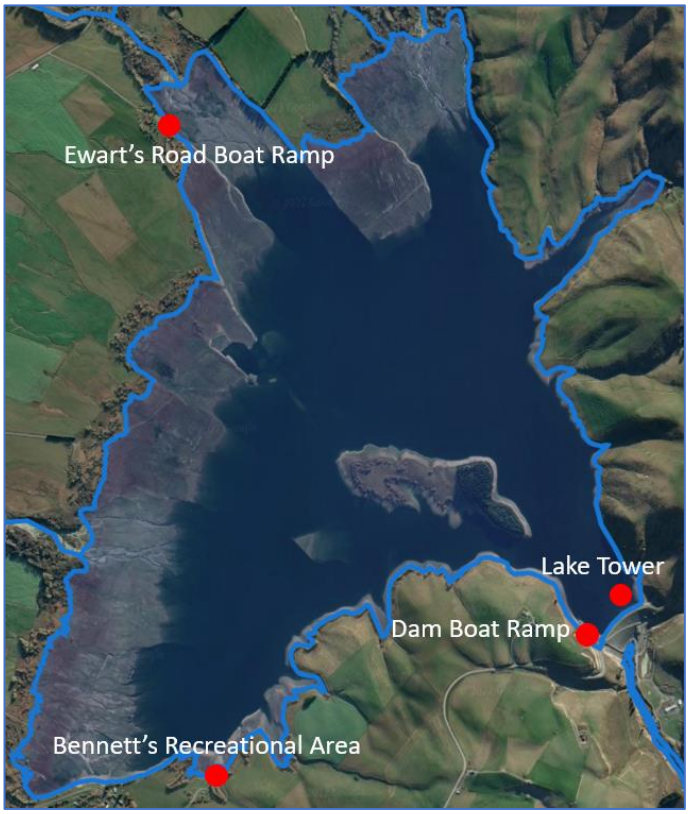


Figure 9: Fish caught at the Kakahu River sites, August 2023: A) longfin eel; B) upland bully; and C) common bully.

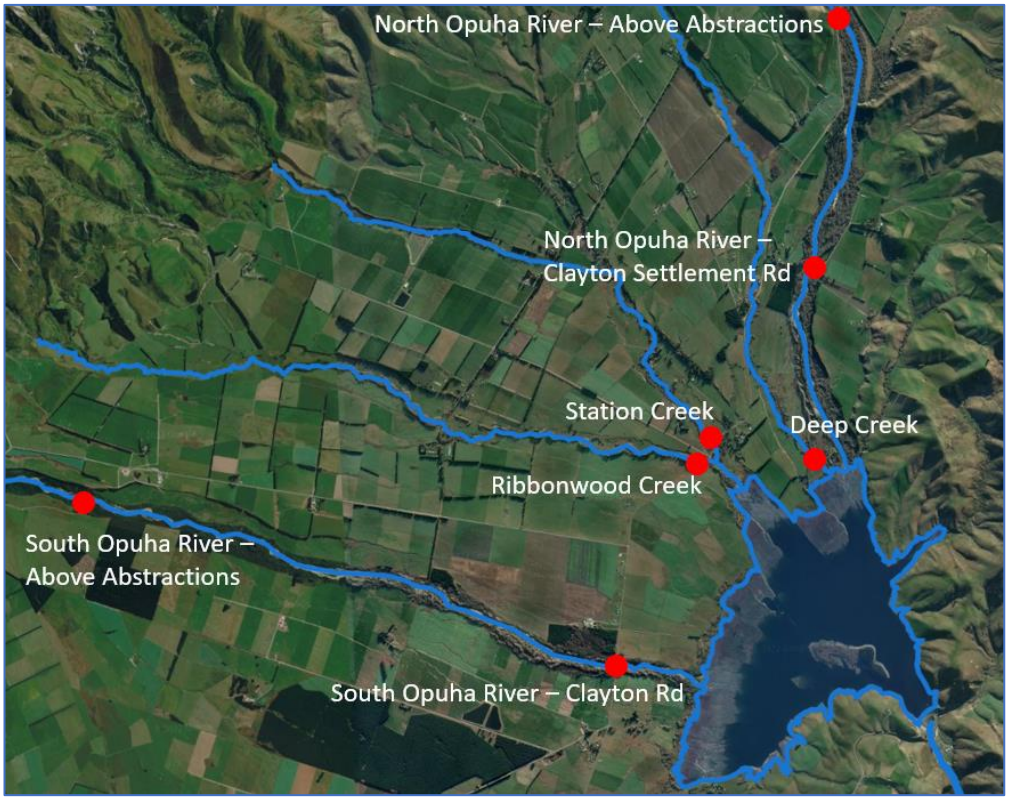
Any questions or feedback regarding the Quarterly Water Quality Report can be directed to Jared Panther (jared@opuha.co.nz; 021 223 7465) or Julia Crossman (julia@opuha.co.nz; 021 535 174).

Appendix A – Sampling Locations

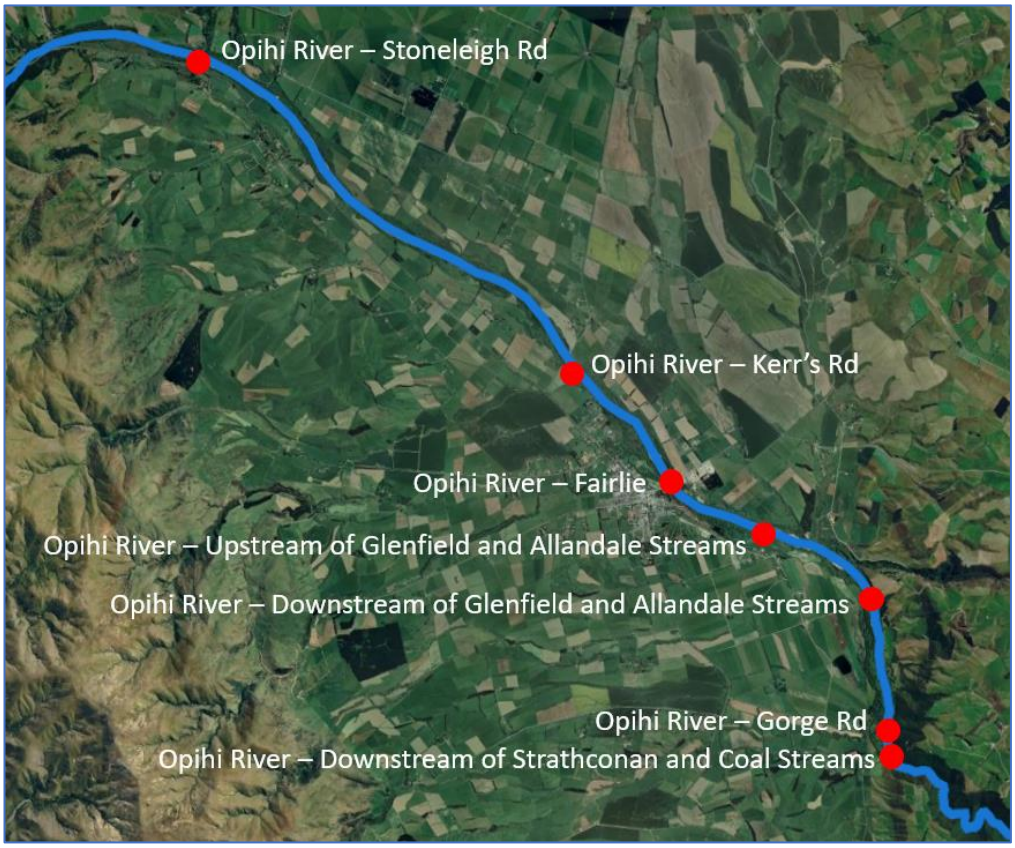
Lake Opuha Sampling Locations



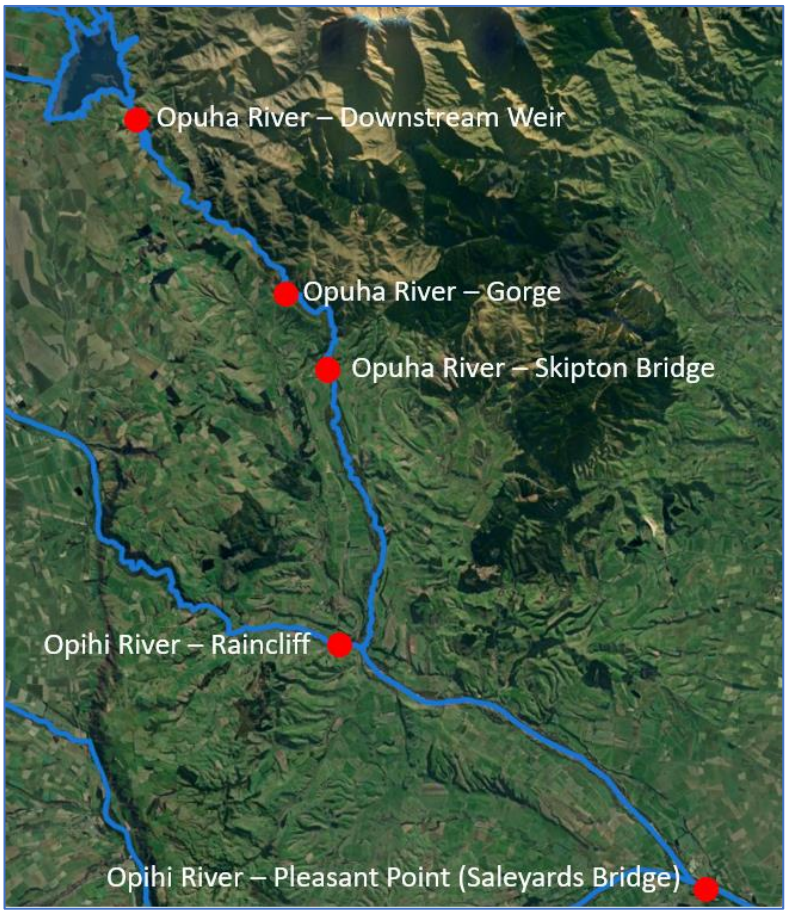
Tributaries of Lake Opuha Sampling Locations



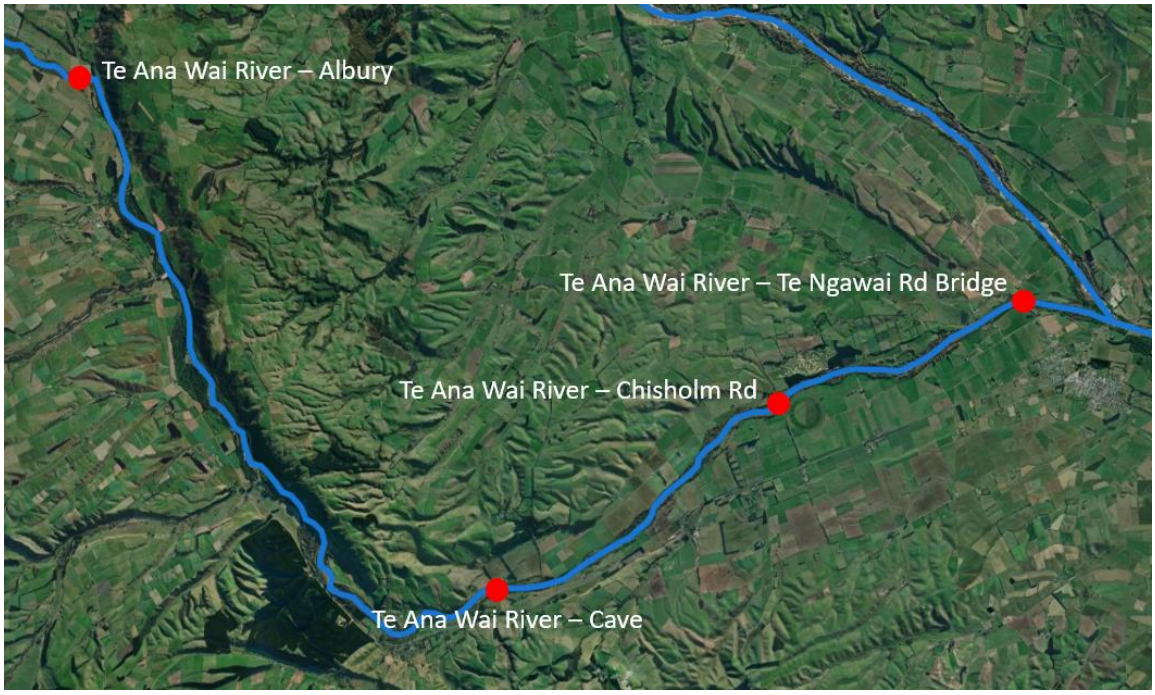
Upper Opihi River Sampling Locations



Opuha River and Lower Opihi River Sampling Locations



Te Ana Wai River Sampling Locations



Kakahu River Sampling Locations