OPUHA WATER LTD
Enabling | Sustainable | Growth

Quarterly Water Quality Report

September 2022 to December 2022

Key Findings

- Rain events and associated increased inflows resulted in elevated **turbidity** in Lake Opuha with turbidity values above 500 NTU recorded.
- Low levels of **cyanobacteria** recorded in Lake Opuha over the September – December period.
- **Trophic Level Index (TLI)** scores for Lake Opuha since 2016 ranged from 3.8 – 4.2, indicating *FAIR* to *POOR* water quality.
- **Nitrate** levels decreased in the tributaries of Lake Opuha and the Te Ana Wai River after increased levels detected in June, July and August 2022.
- **Dissolved Reactive Phosphorus (DRP)** levels in the Upper Opihi River would achieve Band A or Band B status (the two best categories) of the National Policy Statement. Elevated DRP levels reported in Wellshot Stream and Hall Stream.
- **Heavy metals** and **DDT** sampling in 2022 showed mostly low levels with no public health or ecological concerns.
- Sediment sampling in the Kakahu River for **heavy metals** showed only low levels were present, indicating no ecological concern.

Introduction to Opuha Water's Quarterly Water Quality Report

Water quality is monitored on a quarterly to monthly basis at Lake Opuha and several waterways across the Opuha Scheme and wider Opihi catchment. Opuha Water Ltd (OWL) have 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. During the irrigation season, water quality monitoring also occurs within OWL's irrigation schemes.

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 undertaken to better understand river health and 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 on a monthly basis to identify any significant changes in water quality across the scheme and produce a quarterly report for shareholders and stakeholders.

The objective of this report is to highlight interesting data observed over the quarter for OWLs water quality monitoring programs and to track short-term changes. A more in-depth investigation of the water quality data such as trend analysis, statistical analysis and comparison to guidelines will be undertaken in 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 (5 m 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 undertaken 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 2022 September – December period are **turbidity**, **cyanobacteria** and the **TLI**.

Turbidity within the lake is typically below 10 NTU and is often less than 5 NTU. Figure 1 shows the turbidity in Lake Opuha from 1 September 2022 to 31 December 2022. During September and most of October, the turbidity in Lake Opuha was reasonably stable with the turbidity at depth varying between 2 – 15 NTU. During this time, there were rain events up to 12 mm/day (as measured at Dobson Ski Area and Fox Peak Ski Area) but the turbidity did not increase significantly. Between 31 October and 31 December there were four rain events which resulted in increased turbidity in Lake Opuha. Turbidity increased at both the surface (–) and at depth (–), but the greatest increase in turbidity occurs at depth due to the cooler inflows travelling along the bottom of the lake and not mixing with the warmer water at the top of the lake. The rainfall record for the four rain events and the maximum turbidity values are given in Table 1.

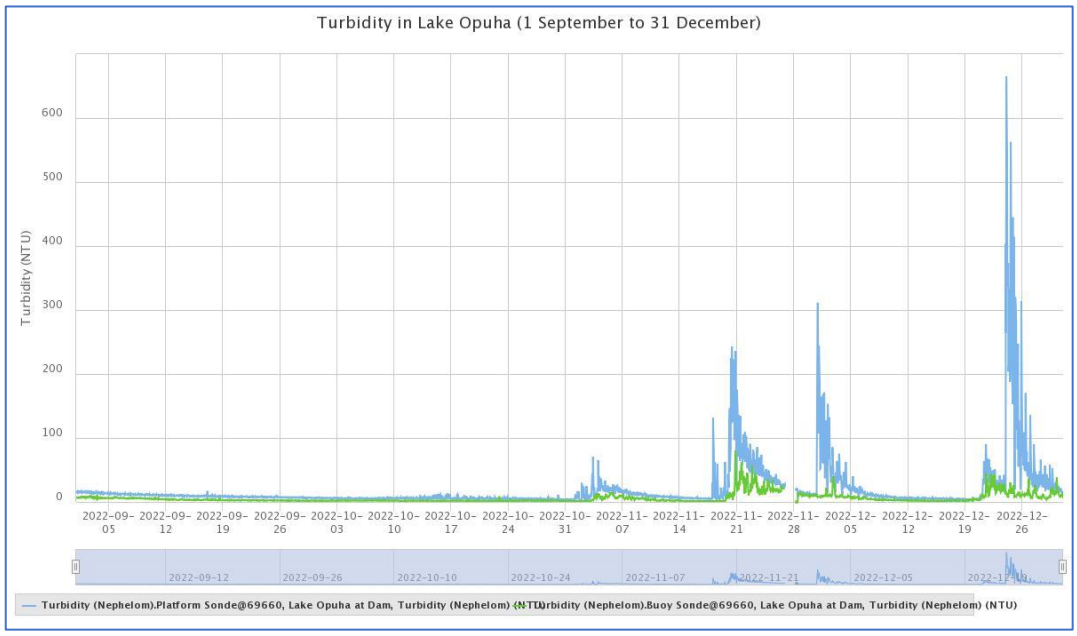


Figure 1: Turbidity in Lake Opuha at surface (–) and depth (–).

Table 1: Rain events showing rainfall at Fox Peak Ski Area and Dobson Ski Area and associated maximum turbidity values in Lake Opuha at depth.

Rain Event	Date	Fox Peak Rainfall (mm)	Dobson Rainfall (mm)	Maximum Turbidity (NTU)	Days for turbidity to return to ~10 NTU[1]
1	31 October	11	33	50 – 70	9
	2 November	70	42		
2	16 November	22	13	200 – 250	13
	17 November	10	45		
	18 November	8	11		
	19 November	60	63		
3	30 November	12	35	250 – 350	7
4	18 December	27	19	500 – 650	13
	19 December	17	15		
	20 December	41	40		

[1]The number of days since the start of the rain event that it took for the turbidity to return to ~10 NTU.

The increased turbidity in the lake has implications for the supply of water to the Kakahu Irrigation Scheme as the high turbidity water is passed down the Opuha River.

Cyanobacteria monitoring in Lake Opuha continued throughout the 2022 September – December period. Only low levels of cyanobacteria were detected. OWL undertake cyanobacteria monitoring and visual inspections to ensure that the lake is safe for recreational use and to identify if there is a risk of passing cyanobacteria downstream into the Opuha River. If high levels of cyanobacteria are detected, we notify ECan who determine if an alert should be issued for the lake.

The **Trophic Level Index (TLI)** is a metric that is used to give an overall picture of the health of a lake. The TLI score ranges from 0 to 9 with lower scores indicating better lake health. The TLI score is calculated using chlorophyll-a, total nitrogen (TN), total phosphorus (TP) and sometimes water clarity (secchi disk depth) data.

Both ECan and OWL collect data to calculate the TLI for Lake Opuha. From December to April/May each year, ECan undertake monthly sampling via helicopter to calculate an annual TLI score. Figure 2 shows the TLI scores from 2016 to 2021, calculated from ECan's data (OWL's data shows similar scores). The TLI scores have been reasonably consistent since 2016 with scores ranging from 3.8 to 4.2. From 2016 to 2020 the TLI score was classified as *FAIR* and in 2021 the TLI score was classified as *POOR*.

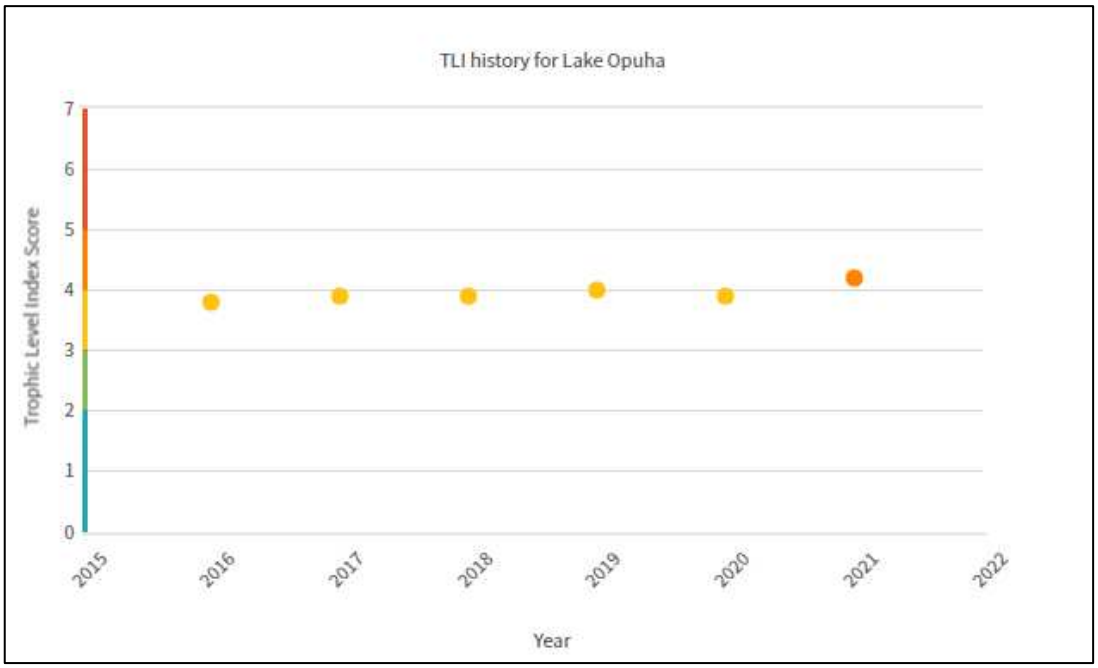


Figure 2: TLI scores for Lake Opuha based on ECan data (https://www.lawa.org.nz/explore-data/canterbury-region/lakes/lake-opuha/)

As mentioned above, the TLI score is currently calculated via monthly monitoring from December to April/May. OWL are currently undertaking work to understand how monthly monitoring over the entire year impacts the TLI score, rather than the current monitoring which only focuses on data from December to April/May. OWL have also commenced secchi disk measurements (water clarity) which will be used to determine how the inclusion of water clarity affects the TLI score. This work will define how the inclusion of year-round data and secchi depth measurements affect the TLI scores for Lake Opuha.

Tributaries of Lake Opuha

Water Quality monitoring is undertaken in the North Opuha River, South Opuha River, Ribbonwood Creek, Station Creek and Deep Creek. Monitoring in the North Opuha River and South Opuha River commenced in 2019, whereas monitoring in Ribbonwood Creek, Station Creek and Deep Creek started in February 2022. The water quality parameter of interest for the 2022 September – December period is **nitrate.**

Increased **nitrate** levels were observed in the Lake Opuha tributaries over the 2022 June – August period due to increased inflows. Monitoring over the 2022 September – December period has shown that nitrate levels have decreased and returned to expected levels, as shown for the North Opuha River and the South Opuha River in Figure 3. This behaviour was typical of all of tributaries of Lake Opuha during the 2022 September – December period.

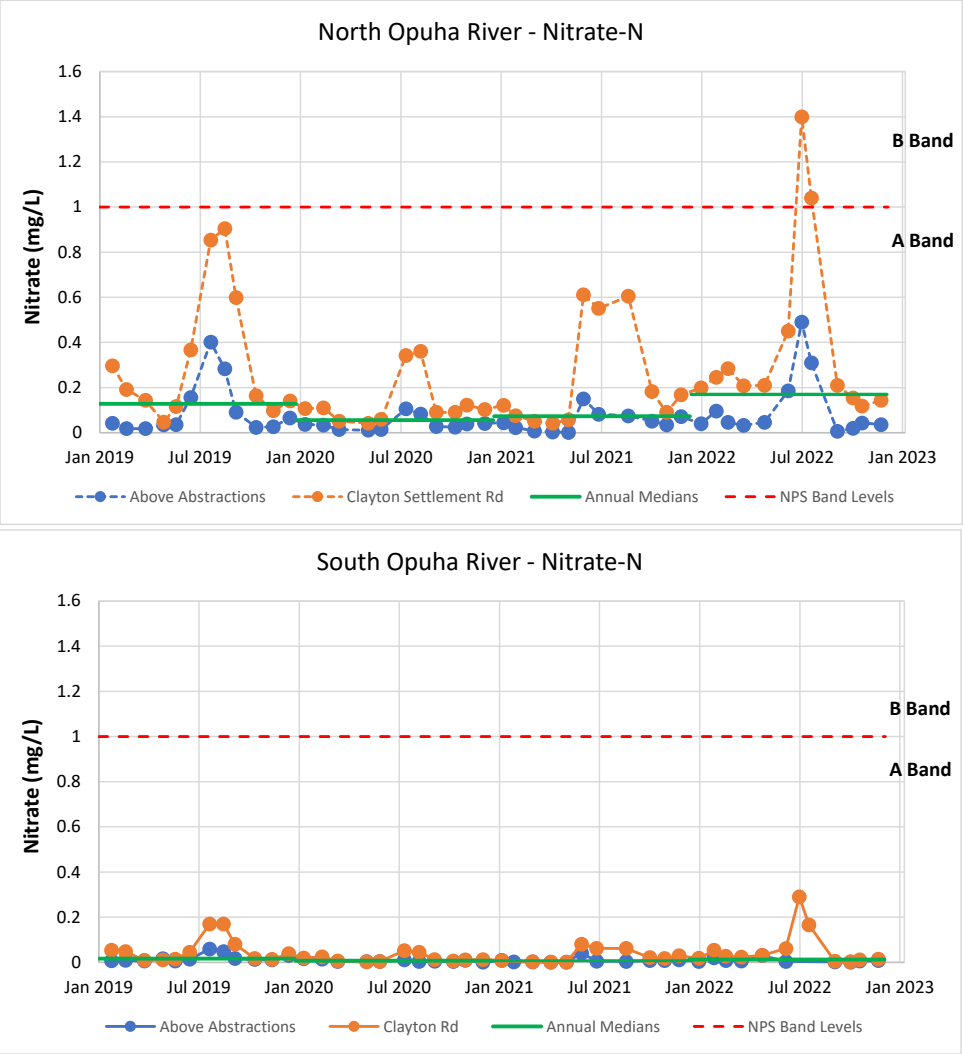


Figure 3: Nitrate levels in the North Opuha River and South Opuha River.

Upper Opihi River and Tributaries

Monthly water quality monitoring is undertaken in the Upper Opihi River and its tributaries. This sampling program started in January 2022 to better understand the water quality in the tributaries and their contribution to the Upper Opihi River. The major tributaries of the Upper Opihi River that are monitored include: Three Springs Culvert, Wellshot Stream, Hall Stream, Glenfield Stream, Allandale Stream, Strathconan Stream and Coal Stream.

Dissolved Reactive Phosphorus (DRP) is the water quality parameter of interest for the 2022 September – December period and data from all of 2022 will be shown.

Figure 4 shows the 2022 median DRP values for the tributaries of the Upper Opihi River and their comparison to the National Policy Statement (NPS) attribute bands, with A Band being the best and D band being the worst. Based on the 2022 data, Three Springs Culvert and Glenfield Stream would achieve Band A status whereas Allandale Stream, Strathconan Stream and Coal Stream would achieve Band B Status. Hall Stream would achieve Band C status and Wellshot Stream would achieve Band D status. Interestingly, Wellshot Stream and Hall Stream are in a similar geographic location. DRP monitoring will continue over the next 6 months for the Upper Opihi tributaries, after

which time it will be decided if any further investigations are required with regards to DRP in Wellshot Stream and Hall Stream.

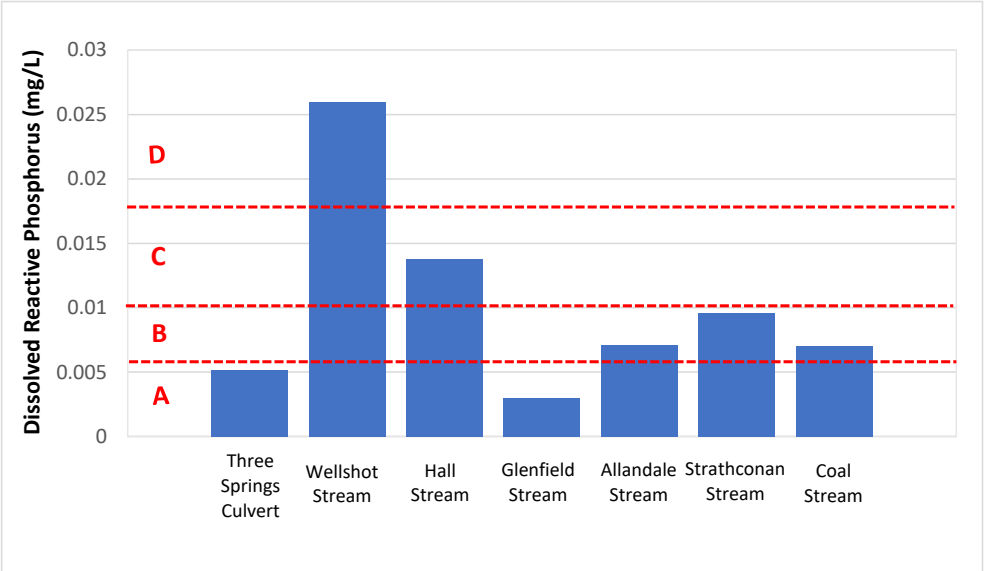


Figure 4: Median DRP levels for 2022 for tributaries of the Upper Opihi River and comparison to the NPS Band Levels (----).

Monitoring of DRP also occurs at four locations on the Upper Opihi River. Figure 5 shoes the median DRP levels at the four sampling locations from upstream to downstream – Stoneleigh Rd, Fairlie, Opihi Gorge Rd and Downstream of Strathconan and Coal Streams. Stoneleigh Rd and Downstream of Strathconan and Coal Streams achieve A Band status, whereas Fairle and Opihi Gorge Rd comfortably achieve B band status. Although there are some high DRP levels in the tributaries of the Upper Opihi River, the current DRP levels at the Upper Opihi River monitoring sites are reasonably low. These sites will continue to be monitored to observe if there is any increase over time.

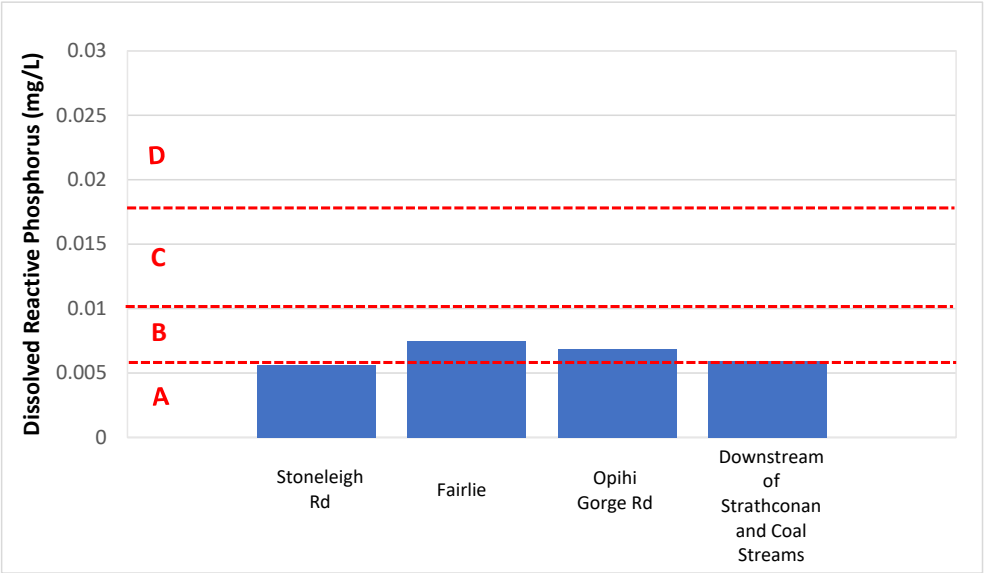


Figure 5: Median DRP levels for 2022 for sampling sites on the Upper Opihi River and comparison to NPS Band Levels (----).

Opuha River and Lower Opihi River

Monthly water quality monitoring is undertaken in the Opuha River (Downstream Weir, Gorge and Skipton Bridge) and the Lower Opihi River (Raincliff and Pleasant Point). The water quality parameters of interest for the 2022 September – December period are **nitrate**, **DDT** and **heavy metals.**

Overall water quality results for the Opuha and Opihi rivers were reasonably 'normal' during the 2022 September – December period. **Nitrate** levels returned to baseline levels after an increase in the 2022 June – August period due to rain events and high flows. **DDT** levels were measured below the Downstream Weir in 2022 on a

quarterly basis and have always been less than the laboratory detection limit, meaning that DDT has not been detected.

Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel and zinc) are monitored monthly in the Opuha River below the downstream weir, and **DDT** (pesticide) is monitored quarterly. For heavy metals, the total amount of metal is measured along with the dissolved fraction. The total metal measurement gives us an id ea of how much metal is present in total, whereas the dissolved fraction gives us an understanding of how much of the metal is actually 'free' to interact with aquatic species (*i.e.* biologically available) – this bioavailable or dissolved fraction is more closely related to the toxic fraction of metal than the total metal concentration.

To understand the ecological effects of the heavy metal concentrations measured below the Downstream Weir, values can be compared to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The Water Quality guidelines recognise three categories of current or desired ecosystem condition: high conservation or ecological value systems, slightly to moderately disturbed systems and highly disturbed systems. The water within Lake Opuha and immediately downstream of the lake most likely fits into the *slightly to moderately disturbed systems* category.

According to the Water Quality guidelines, a hierarchy of measurements should be used for comparison to the guideline values (GV). For example, if the total metal concentration is less than the GV, then we know that the bioavailable or toxic fraction must be less than the GV and the risk of ecological effects is considered low . If the total metal concentration is greater than the GV, then further investigation or measurement is required. The next step would be to look at the dissolved metal concentration, as this fraction is more closely related to the bioavailable or toxic fraction, and compare to the GV. If the dissolved fraction is less than the GV then the risk of ecological effects is considered low. It is not unusual for the total metal concentration to exceed a guideline value, but the dissolved metal fraction to be less than the guideline value.

This section will show all data collected in 2022 for total heavy metals and dissolved heavy metals.

Figure 6 and Figure 7 shows the total metal and dissolved metal results, respectively, for below the Downstream Weir. Green data is data that is less than the laboratory detection limit whereas blue data is data that is above the laboratory detection limit. For example, the total metal data for cadmium shows that all values were less than the laboratory detection limit whereas the total metal data for copper shows that all values were above the laboratory detection limit.

All Total metal data for arsenic, cadmium, lead and nickel were less than their respective guideline values for all measurements in 2022, whereas at times the total metal data for chromium, copper and zinc were above the guideline values for various months throughout 2022. The se exceedances coincide with increased rainfall and flows during July, August and September – this is not surprising given increased sediment loads coming into and out of the lake and the high affinity for heavy metals to bind to fine sediment.

As mentioned above, if any total metals exceed GV then the dissolved fraction should be compared to GV to understand any potential ecological effcts as the dissolved fraction is more aligned with the toxic fraction. All dissolved metal concentrations were less than the GV with the exception of copper in August which was at the same level as the GV. Collectively, these results indicate that the ecological risk from heavy metals in the Opuha River is considered low.

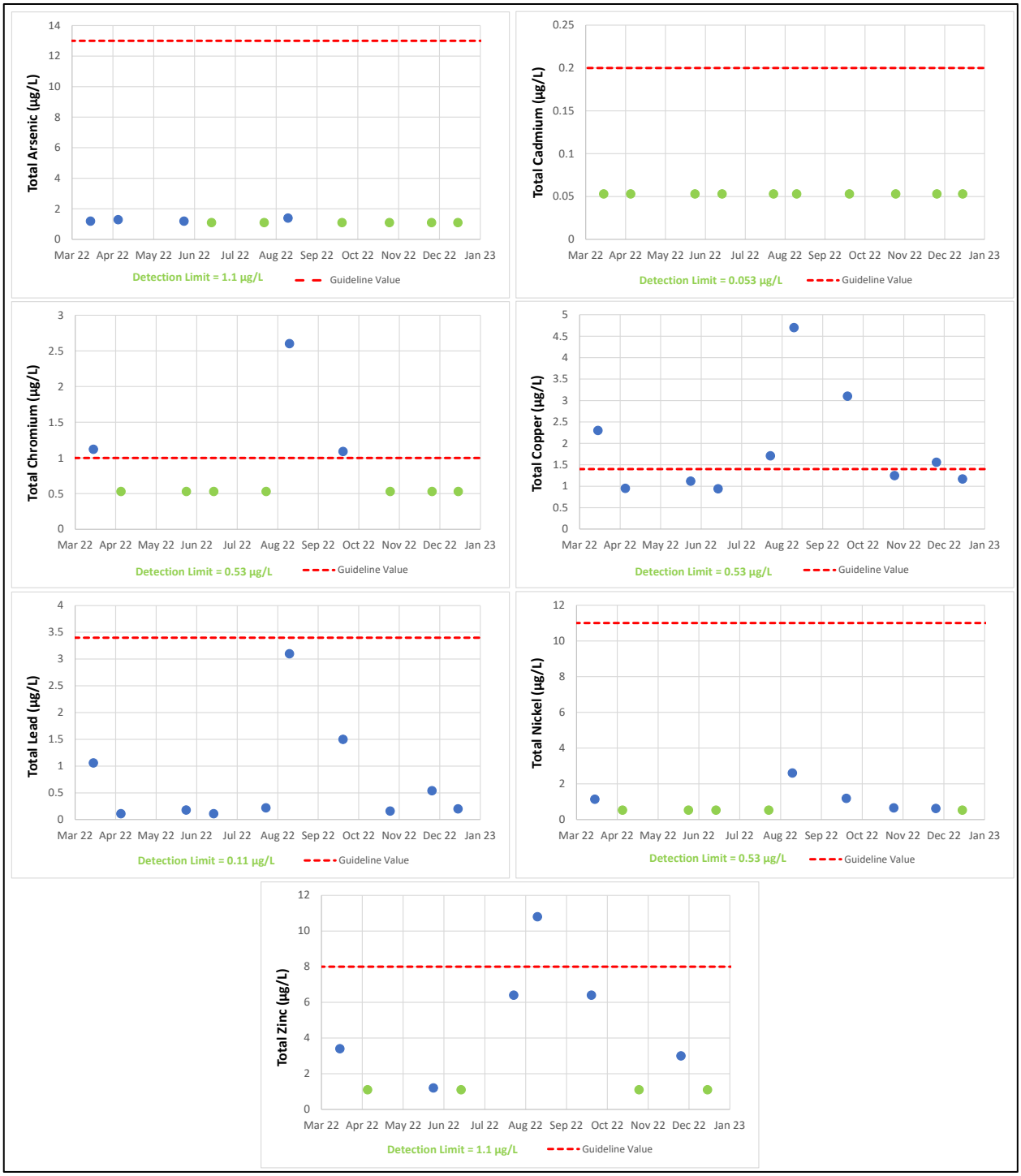


Figure 6: Total metal results for arsenic, cadmium, chromium, copper, lead, nickel and zinc for the Opuha River below the Downstream Weir and comparison to guideline value (-----). Green dots (■) indicate values less than the detection limit and blue dots (■) indicate values above the detection limit.

Figure 7: Dissolved metal results for arsenic, cadmium, chromium, copper, lead, nickel and zinc for the Opuha River below the Downstream Weir and comparison to guideline value (-----). Green dots (■) indicate values less than the detection limit and blue dots (■) indicate values above the detection limit.

Te Ana Wai River

Water Quality monitoring in the Te Ana Wai River started in 2019 and is undertaken at four locations: Albury, Cave, Chisholm Road and Te Ngawai Road Bridge. The water quality parameters of interest for the 2022 September – December period is nitrate.

Increased **nitrate** levels were observed in the Te Ana Wai River over the July – August period due to increased rainfall and flows. Nitrate levels have returned to baseline levels for the September – December period (Figure 8).

Figure 8 also compares the annual median values for all sampling sites (—) to the NPS band levels for nitrate toxicity (---) to determine which band the Te Ana Wai River sits in. Since sampling began, the Te Ana Wai River has comfortably achieved Band A status for nitrate toxicity.

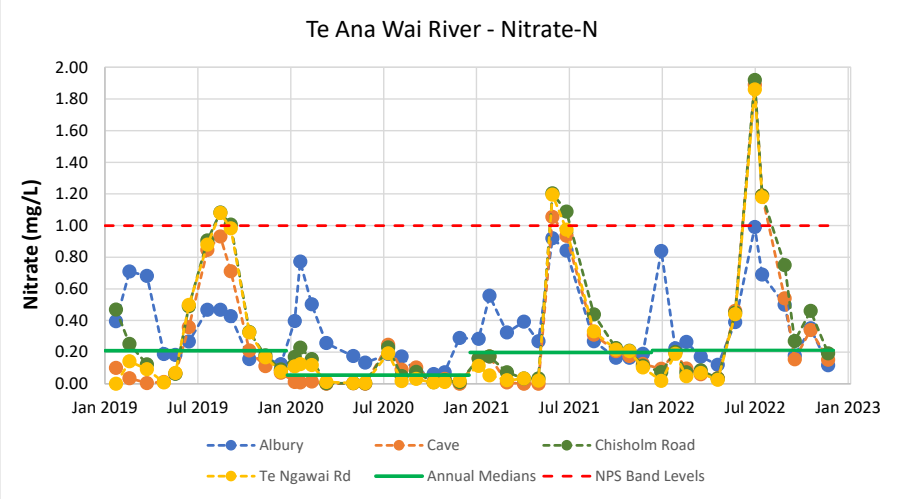


Figure 8: Nitrate levels in the Te Ana Wai River since 2019. Sample data (●); annual medians (—); NPS band levels (---).

Kakahu River

Water Quality monitoring in the Kakahu River is undertaken during the irrigation season and more recently, selective months outside of the irrigation season. Going forward, sampling in the Kakahu River will be undertaken monthly over the entire year. Sampling is undertaken at five locations on the Kakahu River – Mulvihills Flow Recorder, 30 m Upstream of the Pipeline Discharge, 100 m Downstream of the Pipeline Discharge, Morrison's Bridge and Winchester Hanging Rock Road Bridge.

In the 2022 September – December period, increased **water clarity** (**black disc**) monitoring occurred to ensure that the discharge was within the consent limits or that the discharge would be within the consent limits if started. At the end of the irrigation season, the water clarity data will be looked at in more detail to gain a better understanding about how rainfall patterns affect the water clarity in both the Opuha River and the Kakahu River.

In December 2022, sediment sampling was undertaken in the Kakahu River and the Kakahu Irrigation Scheme Intake due to an unsubstantiated claim of arsenic and cadmium contamination of Kakahu River sediment. Sampling occurred at Earl Rd, Goodwin Rd, Winchester Hanging Rock Rd, Downstream of Discharge, ECan Flow Recorder and the Kakahu Scheme Intake (Opuha River). OWL sediment sampling for arsenic, cadmium, chromium, copper, lead, nickel and zinc showed only low levels of metals at all sites and all concentrations were considerably less than sediment quality guidelines, indicating no ecological concern. Results are shown in Figure 9.

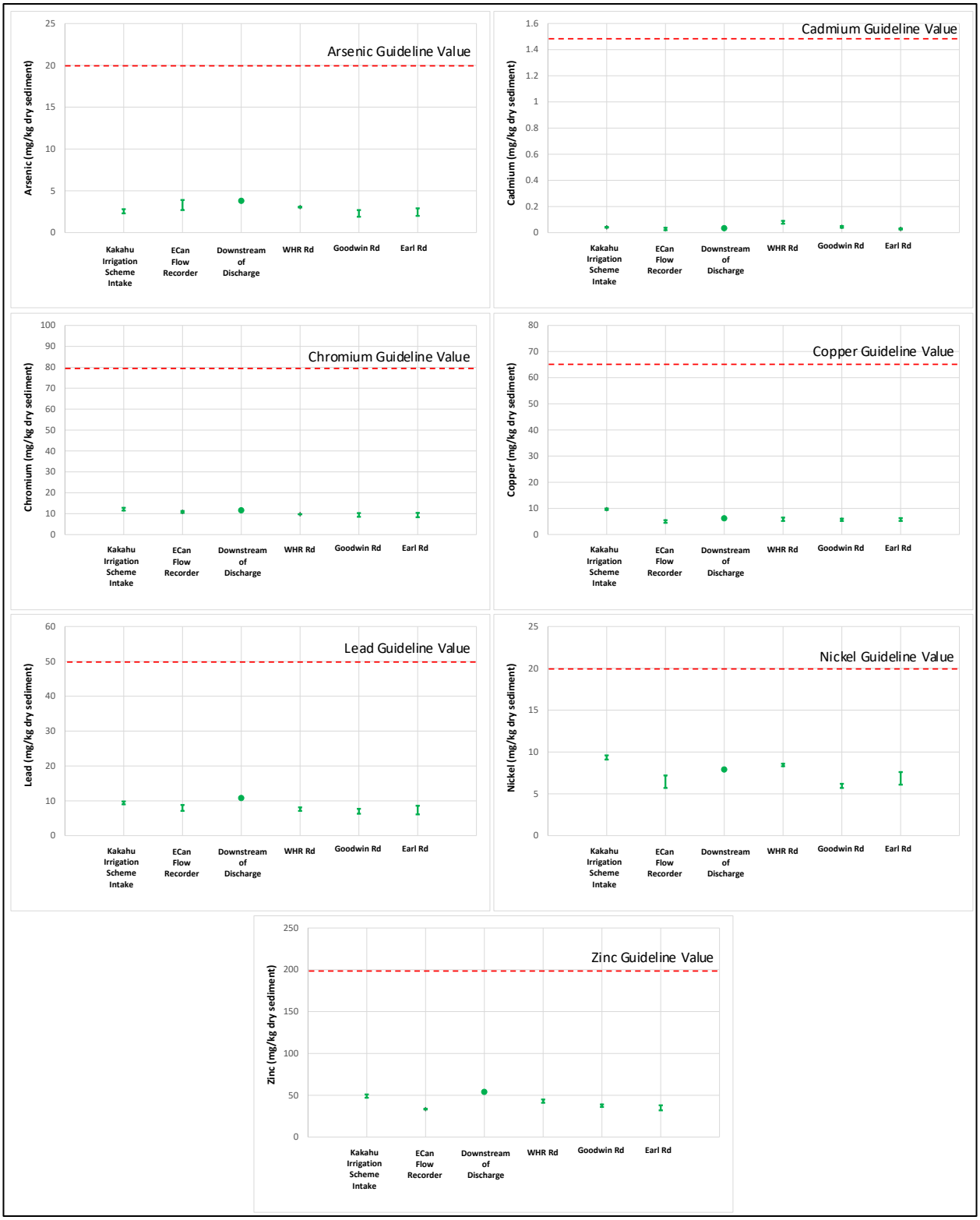
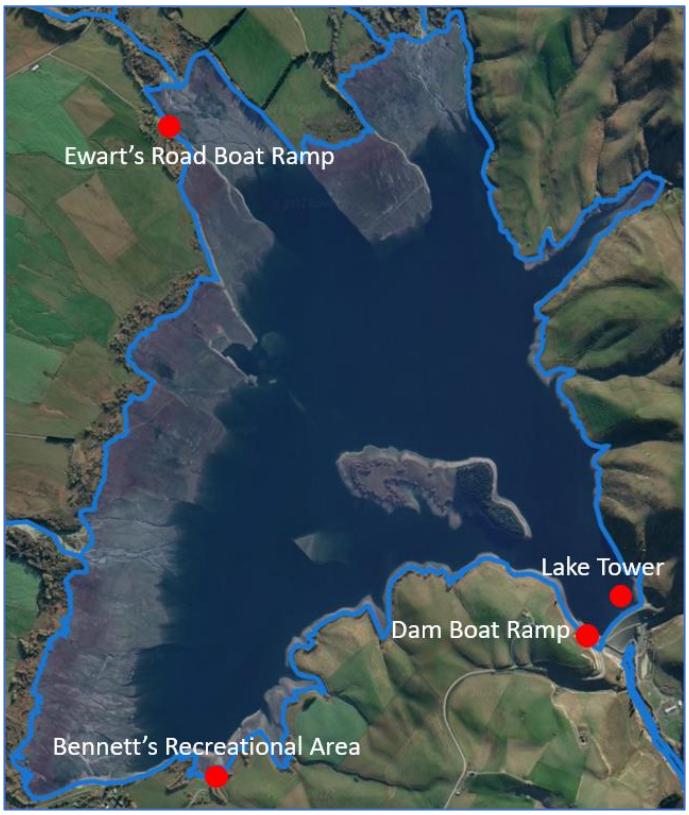


Figure 9: Sediment concentration results for the Kakahu River and Kakahu Irrigation Scheme Intake and comparison to Australian and New Zealand Guidelines for Fresh and Marine Water Quality sediment guidelines (default guideline values ----).

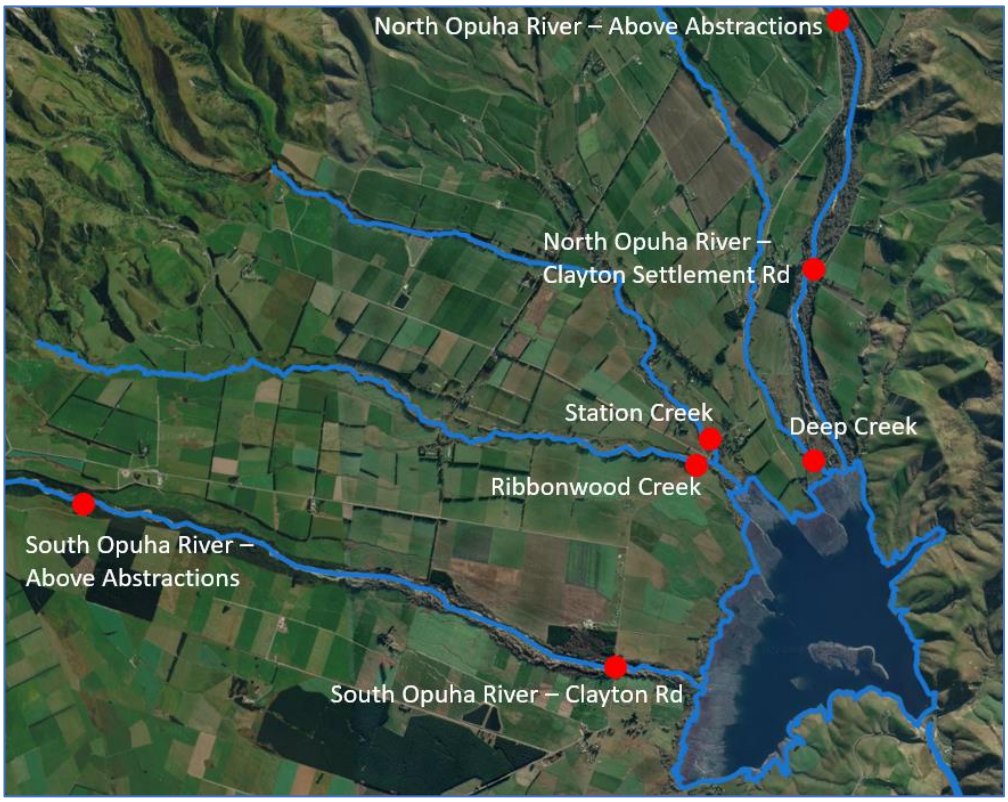
Any questions or feedback regarding the Quarterly Water Quality Report can be directed to Jared Panther (jared@opuha.co.nz; 021 223 7465) or Julia Crossman (julia@opuha.co.nz; 021 535 174).

Appendix A – Sampling Locations

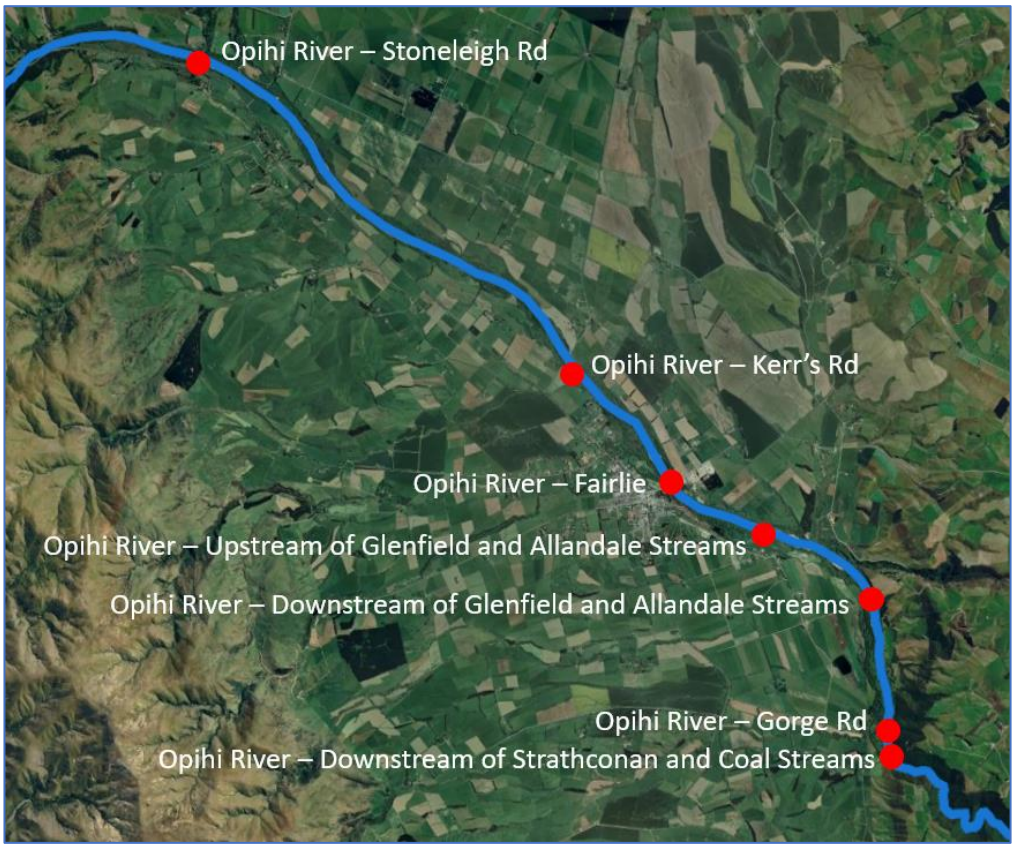
Lake Opuha Sampling Locations



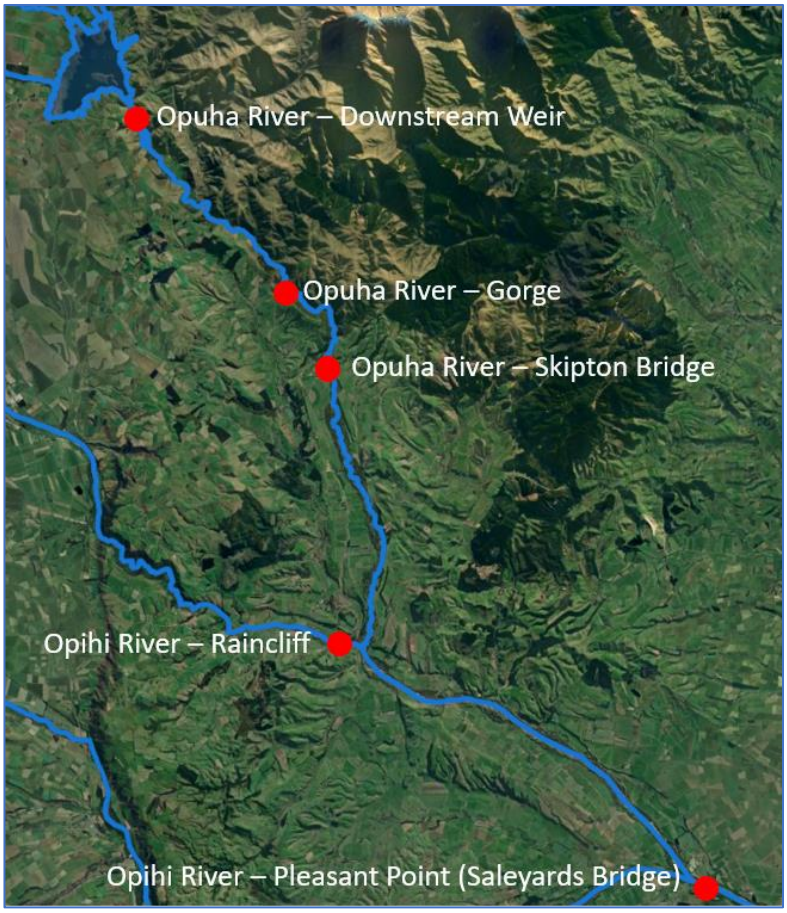
Tributaries of Lake Opuha Sampling Locations



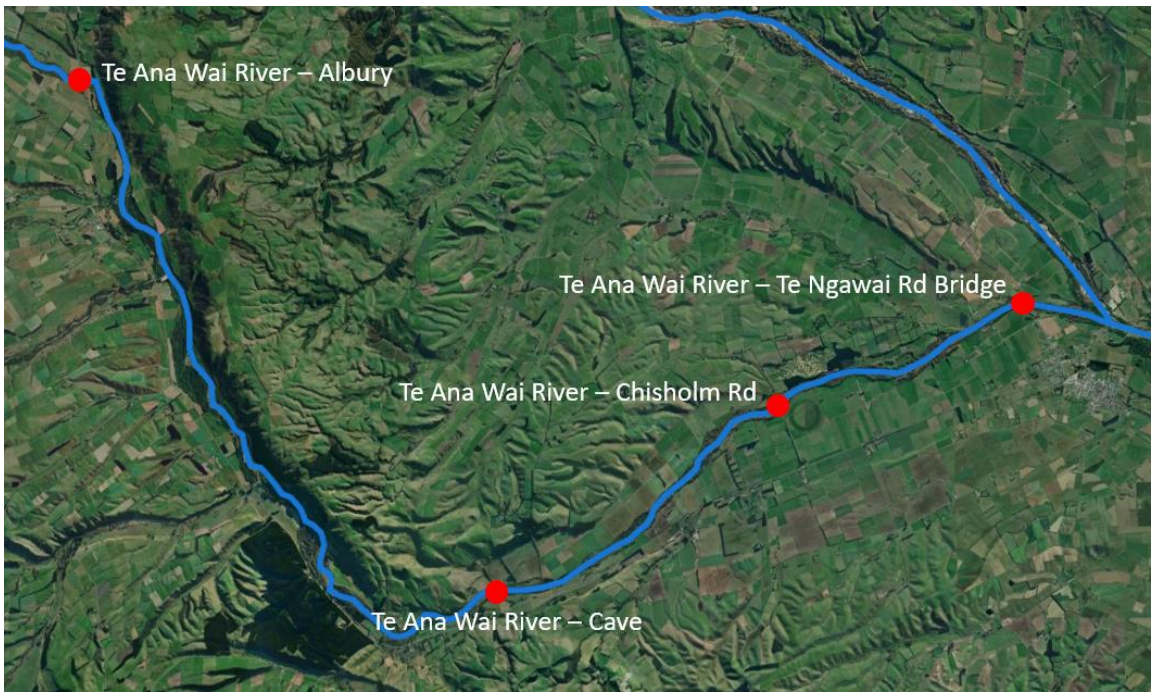
Upper Opihi River Sampling Locations



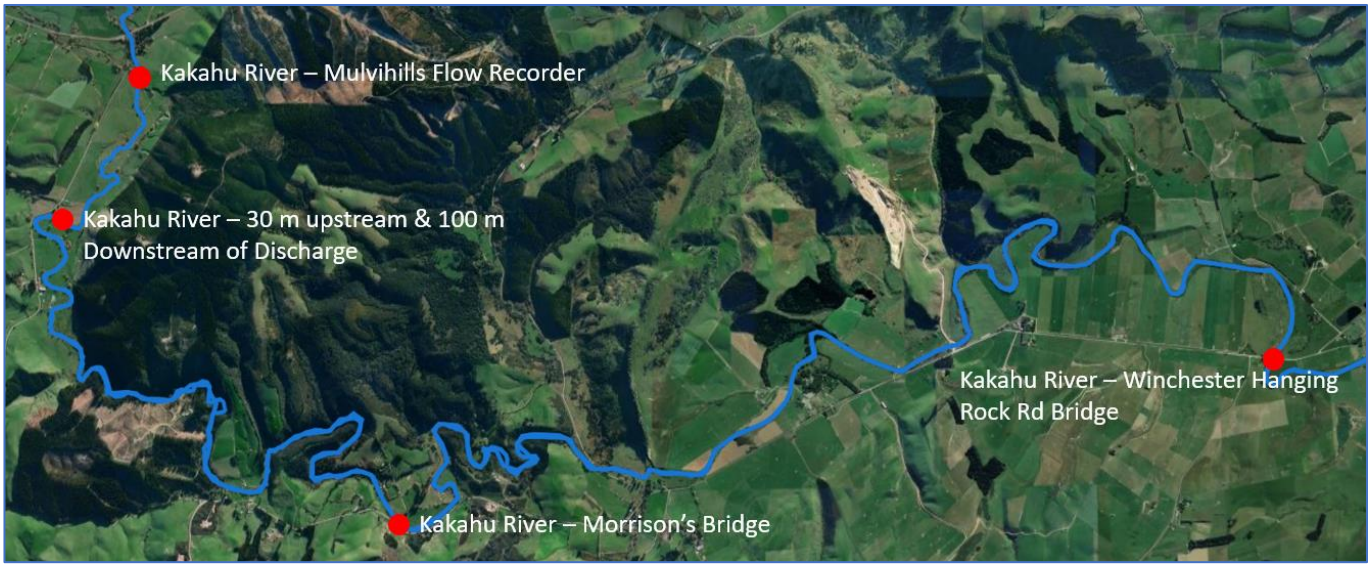
Opuha River and Lower Opihi River Sampling Locations



Te Ana Wai River Sampling Locations



Kakahu River Sampling Locations


Kakahu River – Mulvihills Flow Recorder
Kakahu River – 30 m upstream & 100 m Downstream of Discharge
Kakahu River – Winchester Hanging Rock Rd Bridge
Kakahu River – Morrison's Bridge