Introduction

Monitoring waterways is essential to identify and quantify the factors that affect ecological, cultural, and human health, so they can be improved in the future. The Waterways Monitoring Framework (WQMF) was established in 2018 to create a standardised monitoring program for Waiutuutu/Okeover and Ōtākaro/Avon streams (Figure 1). The UC Waterways Plan aims to increase base flow, reduce contamination, and improve habitat for aquatic species. To assess these goals, water quality and quantity measurements are collected quarterly, and ecological monitoring is conducted annually. This is compared to previous studies conducted on campus since 1979, to evaluate long-term change.

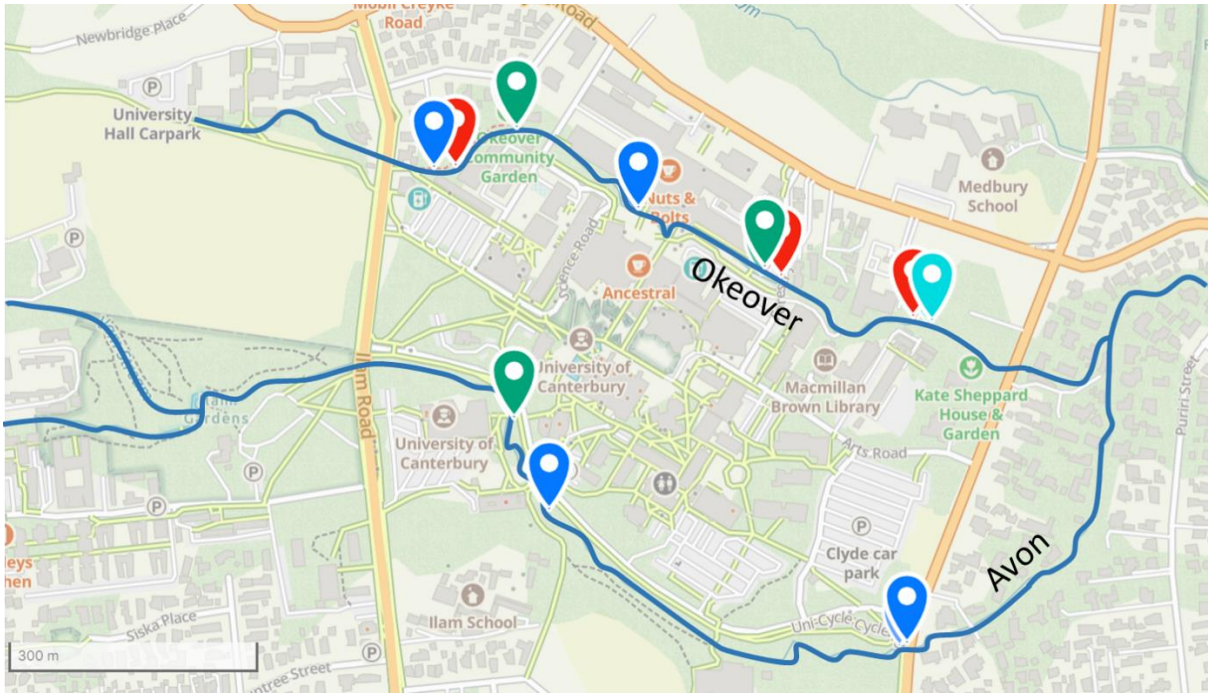

Figure 1: *Waterways monitoring sites along the Okeover and Avon streams. Blue pins show the location of water chemistry sampling sites, green indicates ecology (macroinvertebrates), and teal is both water chemistry and ecology. Red shows the locations of the stormwater samplers. Basemap Gaia GPS.*

Stream flow

Stream flow measures the volume of water moving through a waterway per second, it is an important component of water quality as it impacts turbidity, dissolved oxygen, and in-stream animals. In 2024, flow in the Okeover stream ranged between 0.04 m^3/s below Ilam Road to 0.16 m^3/s downstream near the greenhouses. Flow in the Okeover is strongly influenced by relatively consistent air conditioning discharges and stormwater inputs. Flow in the Avon is higher, ranging from 0.16 to 0.32 m^3/s. Flow is similar to previous years.

Temperature

Temperature affects water chemistry such as dissolved oxygen and is a key driver of biological activity. Average temperatures remained consistently low throughout the year (14.1 and 13.6 in summer and winter, respectively) creating suitable conditions for aquatic plants and animals. Historical records show that temperatures have decreased since 2000 as riparian plantings increased in-stream shade.

Water Clarity and Turbidity

Water clarity reduces when sediment or other particles are suspended in the water column. Lower clarity decreases the growth of aquatic plants, the feeding of aquatic animals, and the waterway's visual aesthetic. As part of this monitoring, both total suspended solids and turbidity are measured. Turbidity in the Okeover was lowest in March and December (mean 0.06 NTU), and slightly elevated during winter and spring (mean 0.80 NTU) when rainfall was higher. The Avon has higher turbidity, ranging from 0.23 - 1.54. Although higher than the Okeover, these show a notable decrease from 2002 when turbidity values were between 1.5 - 2.4 NTU. Total suspended solids have remained low, not exceeding 1.3 gl/L. This reflects the clear spring-fed water feeding Okeover and Avon streams.

Dissolved oxygen

Oxygen is essential for fish, eels, and aquatic insects to breathe and survive. Dissolved oxygen is commonly measured by the saturation of oxygen in the water. The Okeover and Avon had dissolved oxygen levels between 88 - 91.4 % and 81.8 - 86.2 %, respectively, across the course of the year. All measurements were above 8 mg/L. These values are within the bounds of healthy streams which typically have around 80% saturation. Oxygen levels are consistent with previous years. Note oxygen levels are lower during the day, when the stream was sampled, as oxygen is taken up by photosynthesising plants and algae.

Heavy metals

Urban streams are often polluted with heavy metals that runoff from surrounding soils, roofs, roads, and other impermeable surfaces. In high concentrations, heavy metals can become toxic to aquatic species and pose human health risks. We test directly for heavy metals and use proxies for chemical pollution including conductivity and pH. Conductivity, a measure of dissolved ions in the water ranged between 114.8-193.2 and 137-192.7 in the Avon and Okeover streams, respectively. Both streams have similar pH values are are classified as slightly alkaline (6.7-8.9). Direct heavy metal sampling indicates that some heavy metals are elevated, particularly during spring, however, they do not seem to exceed guideline values required to protect freshwater biodiversity (Table 1; Point sample). It is worth noting that while dissolved heavy metals in the water column may be at acceptable levels sediments on the stream bed, which are frequently disturbed, are a significant source of contamination.

***Table 1**: Mean heavy metal concentrations for 2024 (ug/l). Point samples were taken during regular sampling in both Avon and Okeover streams. Stormwater only collected in Okeover stream. Guideline values indicate heavy metal concentration to protect 90% of species*[1].

	Point sample - dissolved	**Stormwater - filtered**	**Guideline** (90% protection)
Copper	0.796	0.966	1.8
Lead	0.019	0.085	5.6
Zinc	4.661	5.111	15

Stormwater sampling

Stormwater samplers automatically collect water when the stream rises to a certain level, capturing water during the start of rain events. Surface runoff predominates these samples, however, re-suspended sediments likely also contribute. Stormwater samples are installed in the Okeover stream and collected quarterly. All heavy metal concentrations for 2024 were within the guideline values, which is a significant improvement from last year, where zinc (in particular) was ~16x the guideline value of 15.

[1] Australian and New Zealand guidelines for fresh and marine water quality. https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/search

Ecology

A diverse range of invertebrates live in freshwater. Identifying which ones are present can indicate longer-term water quality trends as some species are more sensitive to poor water quality than others. The sensitivity of invertebrate communities is summarised by the Macroinvertebrate Community Index (MCI). Scores range from <80 (Severe pollution), 80–99 (Moderate), 100-120 (Mild) to >120 (Excellent). MCI scores in the Okeover stream continue to slowly increase. This year, MCI scores indicate moderate pollution. Since 1979, MCI scores have fluctuated between severe and moderate pollution (Figure 2), and are yet to meet the biodiversity target set in the 2019-2024 UC Biodiversity Plan, of mild pollution or above. The average Okeover MCI score for 2024 is 92.012, while the Avon is slightly more polluted with a score of 80.

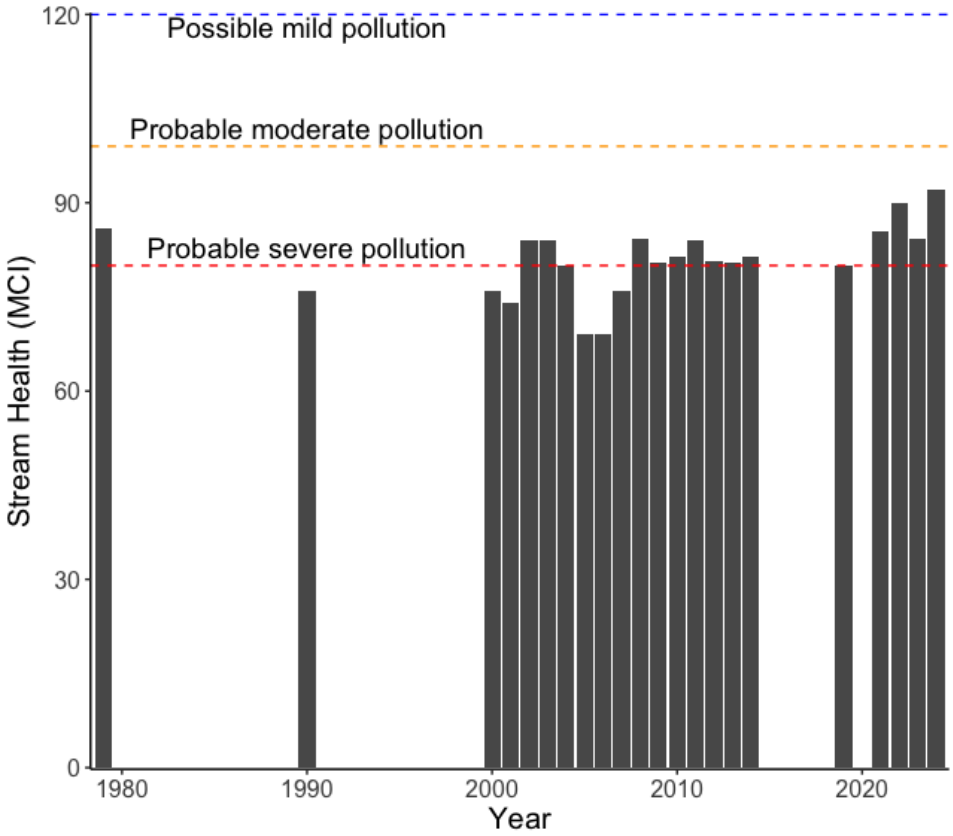

Figure 2: *Average MCI scores taken across three sites in Okeover Stream, University of Canterbury, from 1979 to 2024. The red, orange and blue dashed lines represent threshold values for pollution categories (<90 = severe pollution, ≥90 and <110 = moderate pollution, ≥110 and <130 = mild pollution, pristine conditions are ≥130) as outlined in the National Policy Statement for Freshwater Management (2020). Gaps between bars represent years where data was not available.*

Environmental DNA

Environmental DNA (eDNA) is an effective means of detecting valued native fish, even when few individuals are present. eDNA samples taken in the Okeover identified the presence of kaharore (upland bully), long- and short-finned tuna (eels), and in the lower section of the stream, brown trout. The macroinvertebrates identified were consistent with those collected and identified during annual sampling (Ecology section).

Engagement

The streams flowing through campus provide various teaching and engagement opportunities for the university and local communities. Members from the Royal Society of New Zealand participated in a tour showcasing the restoration efforts and ongoing monitoring of the waterways on campus. Members of staff and UC students also had an interactive session identifying invertebrates from the Okeover stream in celebration of World Biodiversity Week. Additionally, the He Puna Putaiao program, which acts to engage local high school students with science, used the campus streams as part of their case study this year. Two undergraduate courses, BIOL112 (biology) and GEOG201 (geography), also use the collection of annual macroinvertebrate and stream flow data to provide practical field opportunities. Additionally, this data provides a valuable addition to the monitoring provided as part of this project.

Recommendations for campus waterways management

One of the key persistent stressors experienced by the waterways on the UC campus is deposited fine sediment. As alluded to above, this sediment smothers the stream bed affecting aquatic animals by reducing the quality of habitats and hindering feeding. Additionally, any activity in the stream or high rain events causes the sediment to become suspended in the water column. We recommend a regular regime of sediment removal. A project installing large wood into the Okeover stream is due to take place in early 2025, and will also seek to address this concern. Results pre and post installation will be able to give some insight into the efficacy of instream wood as a sediment mobiliser.

Summary and next steps for the waterways monitoring program

While physical conditions such as temperature, dissolved oxygen, and water clarity indicate a healthy urban stream, aquatic life within the Okeover and Avon streams continues to be poor. Continual monitoring will provide a better indication of trends in water quality and indicate areas where improvements can be made. While current monitoring provides a good indication of physical and some ecological (macroinvertebrates) parameters we provide the following suggestions to further improve this program:

- Extending the stormwater monitoring to include the Avon.
- Testing for *E. coli*, nitrogen, and phosphorus.