KAIPATIKI LOCAL BOARD WATER QUALITY & ECOLOGY 3 YEAR SUMMARY

ENVIRONMENTAL IMPACT ASSESSMENTS LTD
SUSTAINABLE WATER SOLUTIONS

KAIPATIKI LOCAL BOARD WATER QUALITY& ECOLOGY MONITORING PROGRAMME – 3 YEAR SUMMARY

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ENVIRONMENTAL IMPACT ASSESSMENTS CLIENT KAIPATIKI LOCAL BOARD REPORT **31 MAY 2023**

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Executive Summary

This report provides a comprehensive summary of water quality and ecology data generated from monthly water quality and annual ecology sampling of ten urban stream sites within the jurisdiction of the Kaipatiki Local Board.

The monthly sampling regime was recently reduced to quarterly sampling (December 2022) with the inclusion of a further three sites which have previously shown signs of ecological degradation. To date these three sites have only been sampled twice (December 2022, March 2023) however a comparison of these site's water chemistry is provided in this report. The limited data shows that these three sites have comparable water quality characteristics to the remaining sites with the exception of relatively high total copper concentration at Smith's Bush Stream. Further monitoring will confirm whether this is an artefact of small sample size or whether Smith's Bush Stream has significantly higher copper concentrations compared to other sites.

All sites fail to comply with relevant water quality guidelines for *E. coli*, dissolved oxygen, water clarity, total and acid soluble copper and total nitrogen. Most sites (except Soldiers Bay Stream which is compliant) also fail to comply with water quality guidelines pertaining to total and acid soluble zinc, nitrogen oxides and total phosphorus.

Some sites fail the dissolved reactive phosphorus guidelines (Chelsea Stream, Downstream Awataha, Eskdale and Onepoto) while the remaining sites comply. Dissolved reactive phosphorus concentrations are declining at Chelsea Stream, the reason for this is unclear. Flow monitoring of this site would enable us to determine whether this trend is due to flow dependence or increased catchment loads.

High spikes in *E. coli* concentrations recorded at Wairau Creek (130,000 cfu/100ml) and Onepoto stream (160,000 cfu/100ml) warrant a sanitary survey of each catchment as *E. coli* concentrations this high are not expected in environmental waterbodies Furthermore time series analysis of the Wairau Creek site reveals that *E. coli* loadings within this catchment are increasing. Kahika Creek recently experienced high concentrations of *E. coli*, total ammoniacal nitrogen and phosphorus (13,000 *E. coli*, 3.15 g/m^3 and 0.69 g/m^3 respectively). These results were submitted to Watercare who have since followed up with repairs to sewage cross connections, it is expected that the next sampling (June 2023) will display lower concentrations for these contaminants at this site.

There are four sites that consistently fail to meet the National Policy Statement for Freshwater Management (NPS-FM 2020) bottom line for aquatic life as assessed by the Macroinvertebrate Community Index (MCI<90). These sites are lower Eskdale Stream, Bayview Stream, Chelsea Stream and Awataha Stream. In the case of Eskdale Stream the reason for the poor ecosystem health is likely due to large sediment loadings entering the stream during storm events. The delivery of sediment from the incoming tributaries on the true right bank is evident downstream of the substation on Eskdale Rd. Upstream monitoring of the remaining sites during storm events could help determine whether the same sediment loading impact is occurring at these streams.

Other sites occasionally drop below the NPS-FM MCI threshold (Castleton Creek, Kahika Creek, Kaipatiki Stream) while other sites consistently remain above the NPS-FM bottom line threshold (Eskdale Stream upper, Little Shoal Bay Stream, Smiths Bush Stream, Soldiers Bay Stream, Onepoto Stream).

Fish monitoring reveals that most sites have good to excellent fish fauna (Fish Index of Biotic Integrity (IBI) $\geq$ 40) representative of good stream habitat for native fish. Three exceptions are Awataha Stream, Chelsea Stream and Kaipatiki Stream which show "fair condition. A fish passage barrier survey of these catchments would help determine if the poor fish communities in these stream catchments is related to fish passage issues.

The most compliant site of the KLB WQ monitoring programme is Soldiers Bay Stream. A study of catchment pressures will help to reveal possible catchment characteristics that contribute to its good water quality, for example, lower imperviousness, stormwater loadings or other features that are known to positively influence water quality and instream habitat provision. It is important that we study catchment pressures of our sites to gain a better understanding of what potential improvements could be made to our streams that are failing NPS-FM bottom line standards.

Chelsea stream was the least compliant site for total and soluble zinc. Catchment scale factors that may be contributing to the higher zinc concentrations in Chelsea stream could be roof and spouting of houses in the catchment and possible increased traffic volumes. Further research of the catchment pressures would be needed to understand why this site has higher zinc. Zinc concentrations at the site itself are not alarmingly higher than the others, so the differences in catchment characteristics could be quite subtle.

Total nitrogen concentrations are highest at the Wairau and downstream Awataha sites. This is not surprising as both of these sites are predominantly concrete. Wairau Creek is an open concrete lined channel while downstream Awataha is a stormwater pipe which is located down a manhole. Both of these sites would benefit from having a natural stream bed as opposed to being concrete or alternatively being converted into surface flowing wetlands. Natural stream channels and wetlands have some connection with groundwater and also have more colonizable surface areas on which stream biota can reside. The connection of biota with groundwater enables some denitrification processes that can convert dissolved nitrogen to nitrogen gas. The Wairau Creek site adjoins Marlborough Park and a constructed wetland on the park side would benefit this stream's water quality.

Dissolved reactive phosphorus concentrations are highest at Onepoto Stream, but without further investigation, it is difficult to identify the sources of phosphorus input to the stream. Sewage connection failures could be a potential source of phosphorus to the stream. Previous high *E. coli* concentrations at this site (160,000 cfu/100ml) signal potential cross connection sewage failures within this catchment, so a sanitary survey is warranted for this catchment.

Wairau Creek is the most non-compliant with respect to *E. coli* concentrations. There is evidence to suggest that sewage cross connection failures have occurred within this catchment. The 130,000 *E. coli* count which was recorded on 19th December 2022 is unexpectedly high. Furthermore, time series analysis indicates that *E. coli* loadings to this catchment are increasing so a sanitary survey of this catchment is also warranted.

Introduction

For the past three financial years the Kaipatiki Local Board has funded monthly water quality monitoring of ten sites in the local board area (see Figure 1). Monitoring of eight sites commenced on 29 August 2019. A further two sites were added to the programme on 1 November 2019. Separate to this programme there are 7 sites currently monitored by the local community which is also funded by the Kaipatiki Local Board (see Figure 2), however this programme is not reported on in depth other than to provide some comparisons of ecology where required.

This report provides a summary of the results for the past three years monitoring of water quality and ecology.

The sites monitored are:

- Wairau Creek (WAI – KLB Monitoring)
- Eskdale Stream (ESK – KLB Monitoring)
- Castleton Creek (Community Monitoring, Verran Primary School)
- Little Shoal Bay (LSB – KLB and Community Monitoring, Waimanawa)
- Kahika Creek (KAH – KLB and Community Monitoring, Birkdale Intermediate School)
- Bayview Stream (Community Monitoring Glendhu Reserve, Bayview Primary School)
- Kaipatiki Stream (KAI – KLB Monitoring)
- Smiths Bush (Community Monitoring, Ako Space)
- Soldiers Bay Stream (SOL – KLB Monitoring)
- Chelsea Stream (CHE – KLB and Community Monitoring, CHERPA)
- Onepoto Stream (ONE – KLB Monitoring)
- Upstream Awataha (UAWA – KLB and Community Monitoring)
- Downstream Awataha (DAWA – KLB Monitoring)

The following map show where these sites are located.

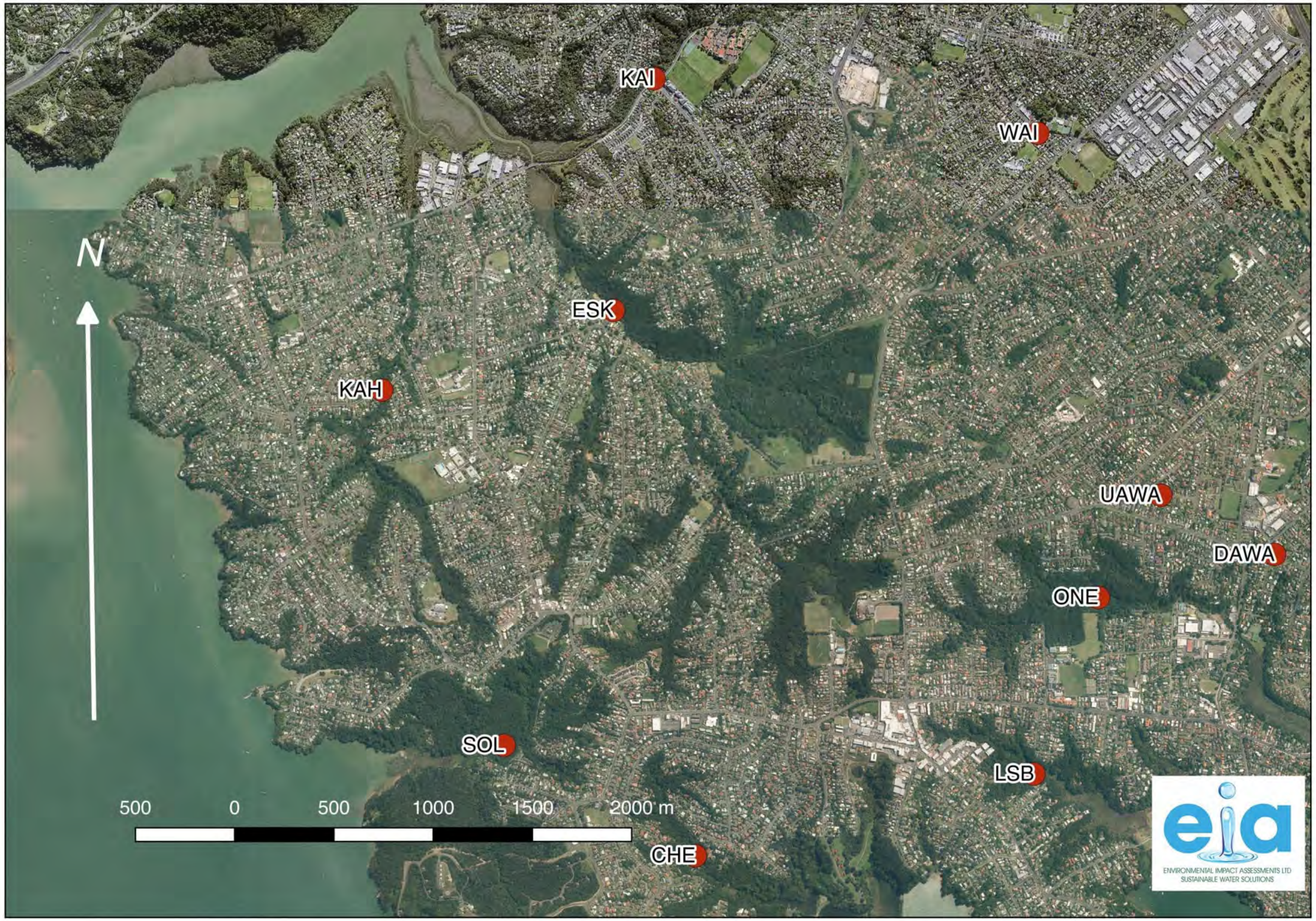


Figure 1: Monitoring Sites – Monthly Water Chemistry and Annual Ecology

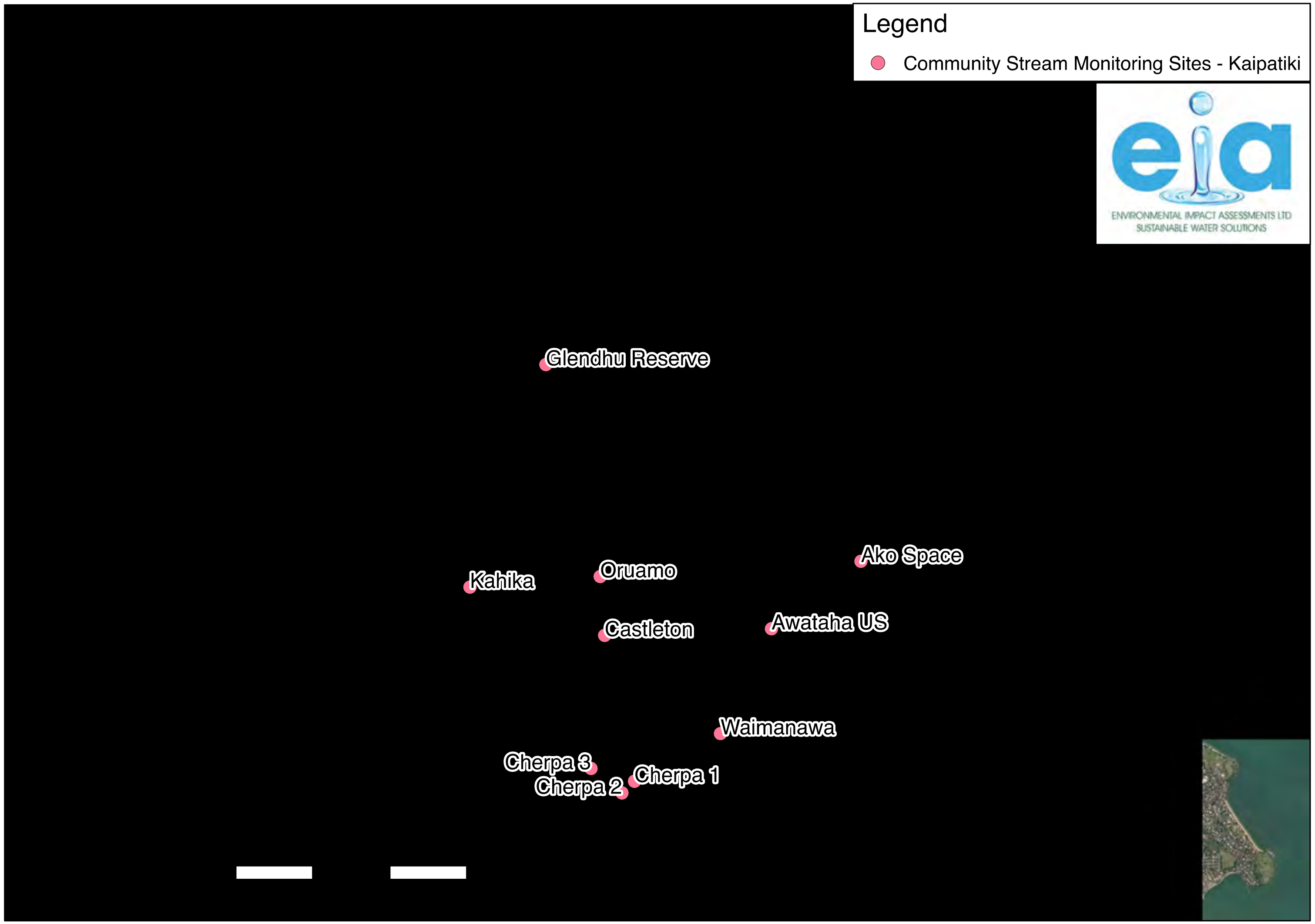


Figure 2: Community monitoring sites - Wai Care and ecology

A host of water quality analytes are monitored to determine the state of the environment for these stream and creek ecosystems, illustrated below.

Table 1: Physicochemical Water Quality Variables

Analyte	Onsite/ Laboratory	Reason
Temperature °C	Onsite	Warm temperatures impose stress to aquatic ecosystems
Dissolved Oxygen mg/l , %	Onsite	Low dissolved oxygen levels will not support life
Specific Conductivity (uS/cm @ 25°C)	Onsite	High electrical conductivity can indicate a high concentration of contaminants in the water
pH	Onsite/lab	Determines solubility of contaminants
Turbidity	Onsite/lab	Siltiness of water
Clarity	Onsite	Clarity of water
Total Hardness	Lab	Mineral (Mg and Ca) content of water, high hardness = naturally turbid water due to scale deposits forming.
Total Suspended Solids	Lab	Concentration of solids that are suspended in the water column. High TSS can clog gills and smother preferential habitat.
Zinc	Lab	Urban pollutant, total and acid soluble is measured to determine toxicity to aquatic organisms
Copper	Lab	Urban pollutant, total and acid soluble is measured to determine toxicity to aquatic organisms
Dissolved Inorganic Nitrogen	Lab	Readily available (dissolved) nutrient for plant uptake.
Dissolved Reactive Phosphorus	Lab	Readily available (dissolved) nutrient for plant uptake.
Total Ammoniacal Nitrogen	Lab	A dissolved form of nitrogen that is toxic to aquatic organisms in high concentrations
Nitrate Nitrogen	Lab	A dissolved nitrogen form of nitrogen that is toxic to aquatic organisms in high concentrations
Total Nitrogen	Lab	Dissolved + particulate forms of nitrogen in the aquatic environment.
Total Phosphorus	Lab	Dissolved + particulate forms of nitrogen in the aquatic environment.
Dissolved Organic Carbon	Lab	Determines the bioavailability of metals in solution
E. coli	Lab	Indicates the presence of bacteria from the gut of warm blooded animals. Can indicate a sewage failure if in high concentrations

The sites have also been monitored for stream ecology (Table 2).

Table 2: Ecology Variables

Variable	Method	Reason
Aquatic macroinvertebrates	Kick net	To assess stream ecosystem health
Fish	Trapping	To assess fish pass and ecosystem health

National Policy Statement For Freshwater Management 2020

A key purpose of the National Policy Statement for Freshwater Management 2020 is to set enforceable freshwater quality and quantity limits that reflect local and national values and freshwater objectives .Auckland Council's NPS-FM 2020 programme is being led by Plans and Places Department with the aim of notifying a plan change by December 2023. This required work forms part of the NPS-FM requirements as amended February 2023.

The council's state of the environment monitoring provides evidence of the degradation of freshwater arising from intensive land use activity. This includes elevated levels of *E. coli*, nitrate, sediment and heavy metals (Ingley & Groom, 2022). River ecology monitoring indicates that about half of the monitored sites are characterised as having poor ecology quality.

Collectively the results indicate that there are likely to be numerous failures of the NPS-FM national bottom lines in Auckland Streams.

The Auckland Unitary Plan contains a comprehensive set of provisions for freshwater management and ecosystem health across all levels of the plan (Regional Policy Statement, Regional and District Plan).

The plan contains numerous objectives and policies that have relevance to freshwater including;

- An overall improvement in water quality and ecosystem health with emphasis on degraded systems needing improvement and maintenance where good ecosystems currently exist.
- An emphasis on freshwater systems and strong provisions to manage/minimise stream loss/modification and hydrological change.
- Integrated land and water management.
- The efficient allocation and use of water within identified limits.

Environmental Guidelines

The water quality and ecology variables reported on in this document have been assessed against the most relevant guidelines taken from the National Policy Statement for Freshwater Management (2020) and the Australia and New Zealand Guidelines for Fresh & Marine Water Quality (ANZ, 2018). The following table provides the thresholds used to assess compliance of the stream ecosystems. Note for Total Nitrogen, Total Phosphorus, Dissolved Reactive Phosphorus, Dissolved Oxygen, Turbidity and Clarity the threshold is dependent on the national River Environment Classification (REC) class. For this reporting we have assessed sites against the more lenient warm wet REC criteria to provide consistent reporting across all sites (https://www.waterquality.gov.au/anz-guidelines/your-location/new-zealand/search-results?region=WW).

Table 3: Environmental Guidelines

Analyte	20 %ile Limit	Median Limit	80 %ile Limit	Guideline Source
Total Nitrogen (g/m^3)		N/A	0.292	ANZ 2018, WW REC
Total Phosphorus (g/m^3)		N/A	0.024	ANZ 2018, WW REC
Dissolved Reactive Phosphorus (g/m^3)		N/A	0.014	ANZ 2018, WW REC
DO%	92	N/A	103	ANZ 2018, WW REC
Turbidity (NTU)		N/A	5.2	ANZ 2018, WW REC
Clarity (m)	0.8	N/A		ANZ 2018, WW REC
		NBL Median	NBL 95 %ile	
pH adjusted TAN (toxicity, g/m^3)		0.24	0.4	NPS-FM 2020
Nitrate (toxicity, g/m^3)		2.4	3.5	NPS-FM 2020
E. coli (cfu/100ml)		130	1200	NPS-FM 2020
		20-30%>540	>34%>260	NPS-FM 2020
Nox (g/m^3)			Max 0.444	ANZ 2018, WW REC
		80% Protection	90% Protection	
Total Copper (toxicity, g/m^3)		0.0025	0.0018	ANZ 2018, WW REC
Total Zinc (toxicity, g/m^3)		0.031	0.015	ANZ 2018, WW REC

River Environment Classification

The River Environment Classification (REC) is a geographical river classification system developed in 2004 and updated in 2010. The REC enables rivers and streams to be grouped according to their natural, physical, and biological characteristics at a range of spatial scales. Characteristics that are important for management, such as hydrology, hydraulics, water quality and biological communities are similar within classes and significantly different between classes (Snelder et al 2010).

The REC represents rivers as networks of reaches including their upstream catchments. Sections have an average length of 700 metres. The class of each section is based on an evaluation of six factors. The first four factors are the climate, topography, geology and land cover of the upstream catchment of individual reaches of the river network. The last two factors are the Network-Position and the landform of the valley of each section of the network.

The REC groups rivers and parts of river networks that share similar ecological characteristics, including physical and biological. Rivers that share the same class can be treated as similar to one another and different to rivers in other classes. The REC classification groups rivers according to several environmental factors that strongly influence or cause the rivers physical and ecological characteristics (climate, topography, geology and landcover).

The six factors represent a hierarchy of natural influences on a streams water quality and biology in the absence of land use. This enables comparison of 'like for like' by using streams with same REC class or alternatively providing commentary on what type of water quality and biology is expected for a given REC class. Figure 3. shows the REC classes within the Kaipatiki Local Board Stream Water Quality Monitoring Programme.

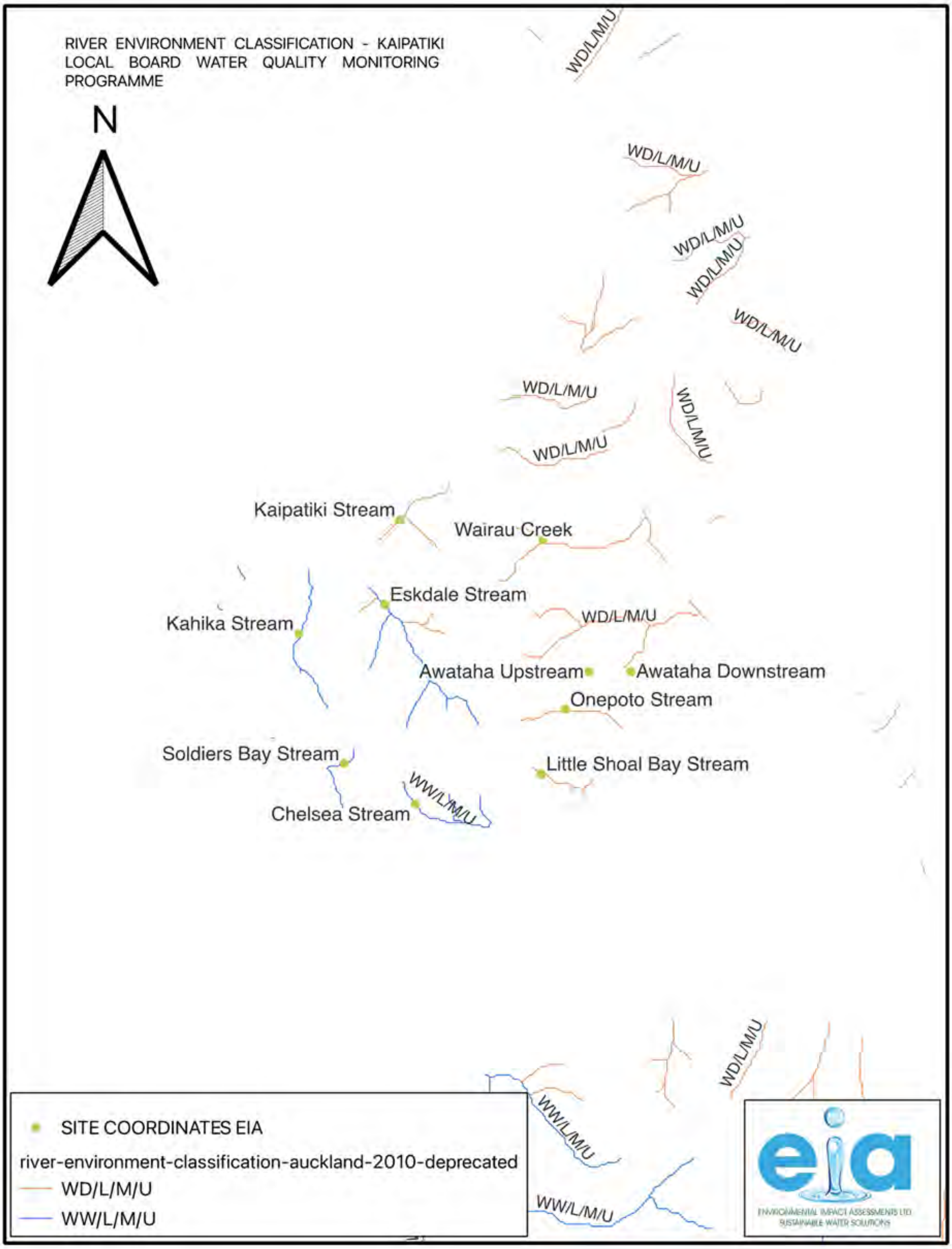


Figure 3: REC Classes

Figure 3 shows that the sites within the Kaipatiki Local Board Water Quality Network are either warm wet or warm dry, low elevation, miscellaneous geology, of urban catchment land use. Streams of this type tend to have poor water quality as they are surrounded by intensive urban land uses which have direct and indirect impacts on stream environments.

Methods

Field Sampling

Sites are visited in the same order each sampling occasion to reduce variability in readings of diurnally variable water quality variables such as dissolved oxygen, temperature and pH.

On each sampling occasion onsite measurements of water temperature (°C), dissolved oxygen (% saturation and mg/l), electrical conductivity (uS/cm), specific conductivity (uS/cm @ 25°C), and pH are undertaken using a calibrated YSI Pro Plus handheld meter. Turbidity is also measured using a calibrated Hach 2100Q Turbidity Meter and water clarity measured using a SHMAK water clarity tube.

Grab samples are taken at each site for analysis of nutrients and metals (Table 1), stored in an iced chill bin and dispatched to Hill Laboratories (Hamilton).

Data Preparation

Total ammoniacal nitrogen data is adjusted according to stream pH (Hickey, 2014) and water clarity measurements of > 0.5m are adjusted according to Biggs and Kilroy (2002). These adjustments are made to ensure the total ammoniacal nitrogen concentrations more accurately reflect their instream toxicity potential, while the water clarity adjustment ensures the clarity tube measurements more accurately reflect the black disc clarity measurements.

Prior to any data analysis, non numerical characters are removed from the data set as statistical software requires numerical entries only. Data is also examined for any data entry errors by viewing time series plots and looking for extreme outliers. Less than detect data are amended to half the detection value, while greater than detect data are amended to the detection value. This is standard practice for preparing water quality data to ensure consistency of reporting (Ward et al 2003).

Data Analysis

To analyse the November 2019 – March 2023 data, spatial trends of sites are conducted using box and whisker plots with relevant environmental guidelines set as limits using NIWA software Trend and Equivalence Testing version 10.

Many water quality variables display seasonality in their concentration values (e.g. lower water clarity in winter due to higher stream flows). The seasonal patterns are driven by the changes in climate that can give rise to higher influxes of stormwater and land runoff during wetter winter months. Alternatively, instream water temperatures rise in the warmer summer months due to greater solar influx to the stream channel. These seasonal changes can bias a time series analysis so it is important to test for seasonality of each variable first.

Prior to temporal trend testing, each water quality variable is tested for seasonality using the seasonality test using NIWA's freeware Time Trends.
Temporal trend testing is conducted using the Mann Kendall Trend test for non-seasonal water quality data and the Seasonal Kendall trend test for seasonal water quality data.

Flow is also an important variable that can bias a time series trend of a contaminant because higher flows can often give rise to higher concentrations of contaminants due to increased inputs of stormwater and land runoff entering a stream. If higher flows are experienced towards the end of a time series it may raise the contaminant concentration giving rise to an upward trend of the contaminant. It is therefore important to reexamine any time series plot of raw data to determine whether the trend observed in the raw data is due to changes in stream flow or whether the trend is due to an increased loading of the contaminant.

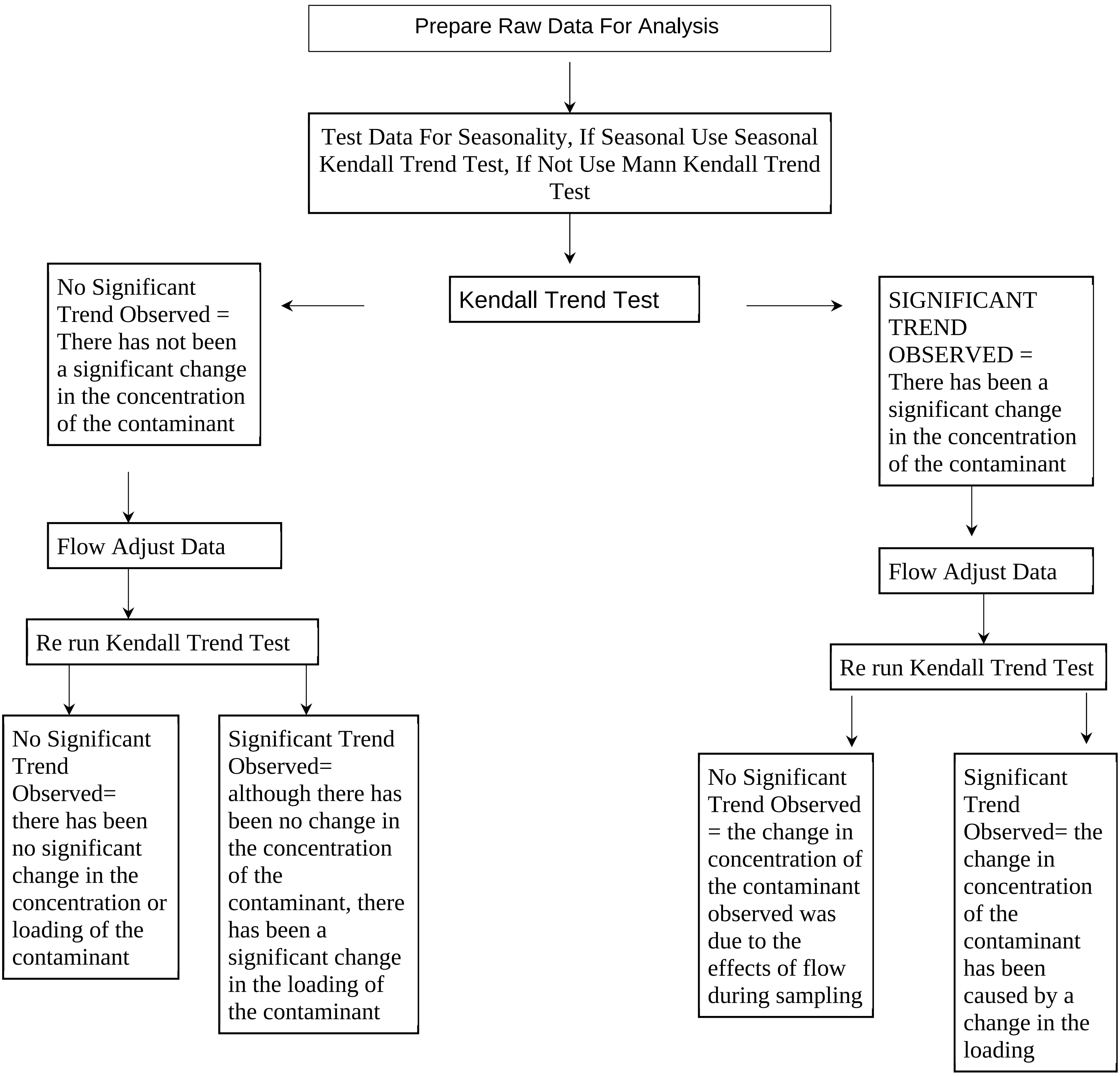
For some sites flow adjustment of data is conducted for which telemetered hydrology data is available from Auckland Council's Data Portal (Eskdale, Kaipatiki Creek, Wairau Creek). A further 2 sites are flow adjusted using flow correlations with the Eskdale Stream telemetered site (Kahika Creek, Waimanawa Creek). The remaining sites do not have flow data so could not be adjusted for flow. Flow adjustment is conducted using LOESS smoothing (tension =0.3) using NIWA's freeware Time Trends version 10.0.

Confirmation of a temporal trend required 3 criteria.

- The trend must be statistically significant ($p<0.05$)
- The trend must be environmentally significant (>1% change / year)
- The sum of the trend must be greater than current laboratory detection limits.

All temporal trend testing results are provided in Appendix 1 of which deterministic trends are discussed in this report (likely, highly likely, almost certain). Flow correlations are provided in Appendix 3. Summary statistics provided in Appendix 2 were created using R version 4.3.

The flow diagram overleaf provides the data analysis procedure and explanation of temporal trend testing results.


Prepare Raw Data For Analysis
Test Data For Seasonality, If Seasonal Use Seasonal Kendall Trend Test, If Not Use Mann Kendall Trend Test
Kendall Trend Test
No Significant Trend Observed = There has not been a significant change in the concentration of the contaminant
SIGNIFICANT TREND OBSERVED = There has been a significant change in the concentration of the contaminant
Flow Adjust Data
Re run Kendall Trend Test
No Significant Trend Observed= there has been no significant change in the concentration or loading of the contaminant
Significant Trend Observed= although there has been no change in the concentration of the contaminant, there has been a significant change in the loading of the contaminant
Flow Adjust Data
Re run Kendall Trend Test
No Significant Trend Observed = the change in concentration of the contaminant observed was due to the effects of flow during sampling
Significant Trend Observed= the change in concentration of the contaminant has been caused by a change in the loading

Results

Spatial Summary

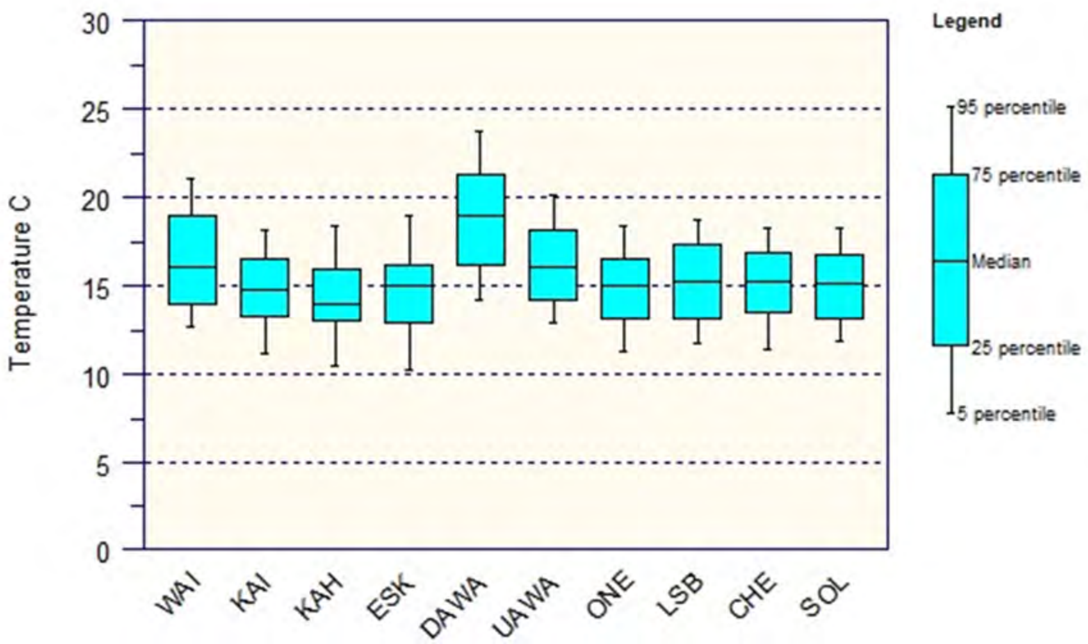


Figure 4: Water Temperature

Figure 4 shows that water temperatures are often warmer at the Awataha Downstream site (DAWA). This site drains a large carpark area of the Northcote shopping complex, which is likely to deliver warm water during rainfall events due to the tarseal areas warming any surface runoff prior to entering the stormwater network. The Wairau site (WAI) is also generally warmer than the remaining sites. This site is an open concrete lined channel which is also likely to warm up easier than a natural stream that has greater shading and water depth compared to the Wairau Stream.

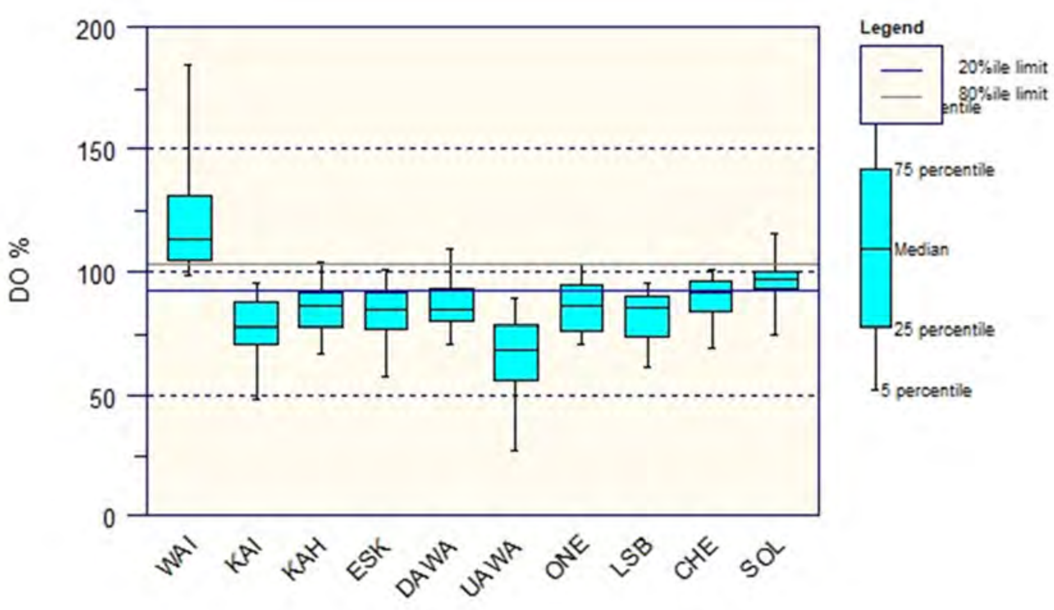


FIGURE 5: % DISSOLVED OXYGEN SATURATION

Figure 5 shows that percent dissolved oxygen saturation is generally higher at Wairau Creek (WAI). This is an open concrete channel that often gets extensive periphyton growths in the summer. This creek is less likely to self-clean as it does not have movement of cobbles or stones during storm events, instead the periphyton layer remains adhered to the concrete channel and will not slough off until very high or multiple high flows are experienced.

Figure 6: Wairau Creek Channel With Periphyton Growth

The only site to resemble close compliance with the dissolved oxygen limits of the ANZ 2018 guidelines is Soldiers Bay stream (SOL). The 20%ile value for this site is 89% while the 80%ile value is 100. This means the site breaches the lower limit (92%) but complies with the upper limit (103%).

Wairau Creek fails this guideline because it is supersaturated most of the time while the remaining sites (except SOL) fall below the optimal DO threshold required to meet aquatic health requirements.

The Awataha Upstream site (UAWA) has the lowest % saturation readings of all sites. This site is the smallest of all the sites and during summer flows stagnates to a series of pools. It is possible that the stagnation of the water during summer results in lower dissolved oxygen concentrations at this site owing to microbial respiration occurring within the pools.

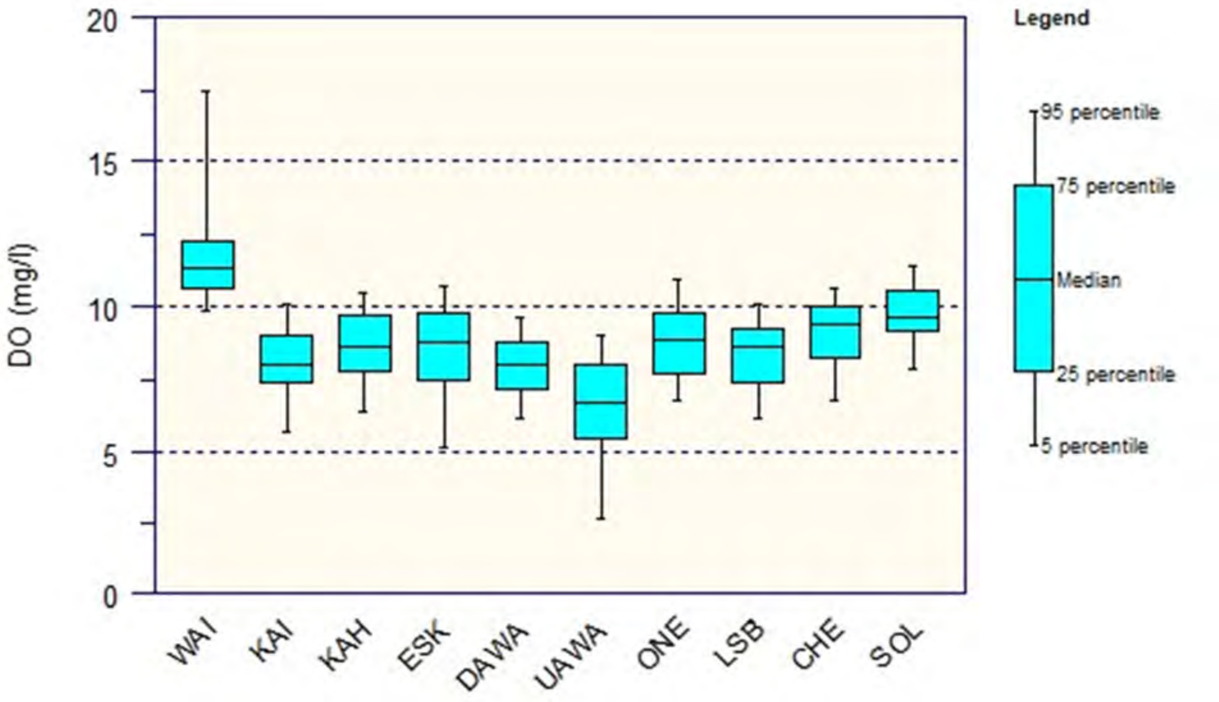


Figure 7: Dissolved Oxygen Concentrations

Figure 7 shows that dissolved oxygen concentrations are elevated at Wairau Creek (WAI) as previously discussed this is likely to be because this site often has extensive periphyton growths in summer. The lowest dissolved oxygen concentration is shown at the upstream Awataha site (UAWA), again likely to be due to exceptionally low flows during the summer resulting in stagnation of the water column.

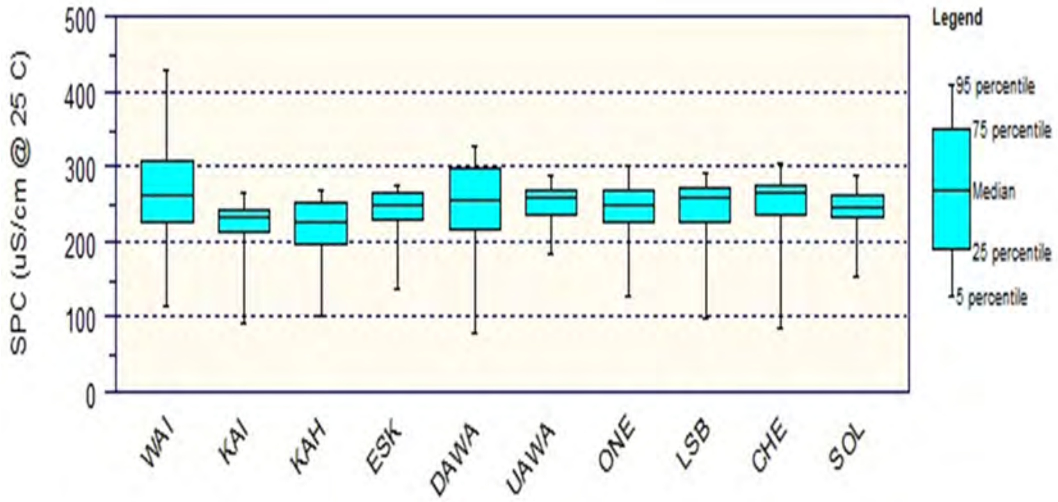


FIGURE 8: SPECIFIC CONDUCTIVITY

Specific conductivity measures how well the water conducts electricity and has a close correlation with total dissolved solids. All sites have fairly similar specific conductivity although the concrete channel (WAI) and stormwater pipe (DAWA) are slightly more variable. This may be due to the fact that concrete channels have less absorptive capacity than a natural stream which has an abundance of plant life or biota to process nutrients.

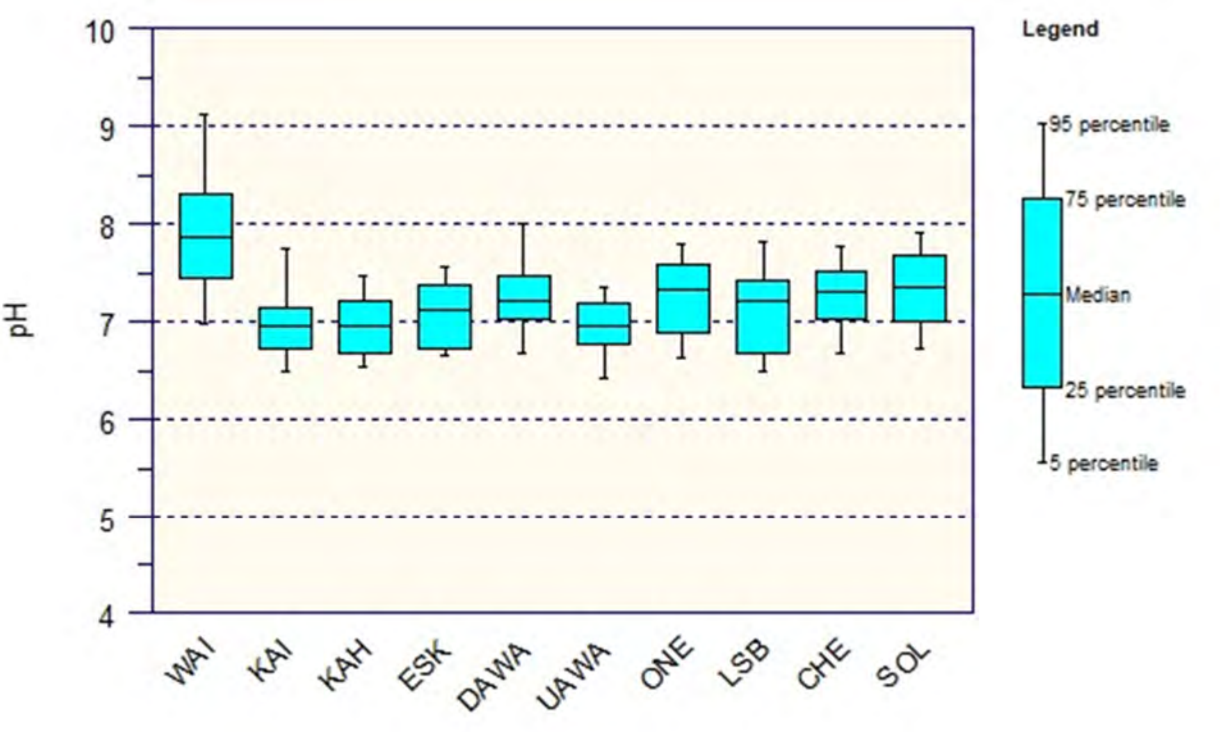


FIGURE 9: PH

Figure 9 shows that most sites are within the 6.5 to 8 pH range. The WAI site displays higher pH, possibly due to lime leaching from the concrete channel and a more prolonged prevalence of periphyton in summer periods which drives pH up during the day.

One thing that is unique about Wairau Creek is that it grows prolific amounts of periphyton (algae) during summer. The stable flows and open concrete channel provide ideal growing conditions for periphyton. Photosynthesis of the periphyton during the day releases bicarbonates that raise pH of the water particularly in summer when stable flows and high light intensities prevail. Having higher pH means contaminants like ammoniacal nitrogen are more toxic in this creek because more unioinised ammonia is released into the water column. The greater variability of pH of Wairau Creek could be because the stream has lower alkalinity. Alkalinity is a measure of how well a stream buffers pH changes. Unfortunately alkalinity is not measured in this water quality program to determine this.

There are no environmental guidelines for pH however it is generally accepted that pH values between 6 and 9 will support a healthy aquatic ecosystem.

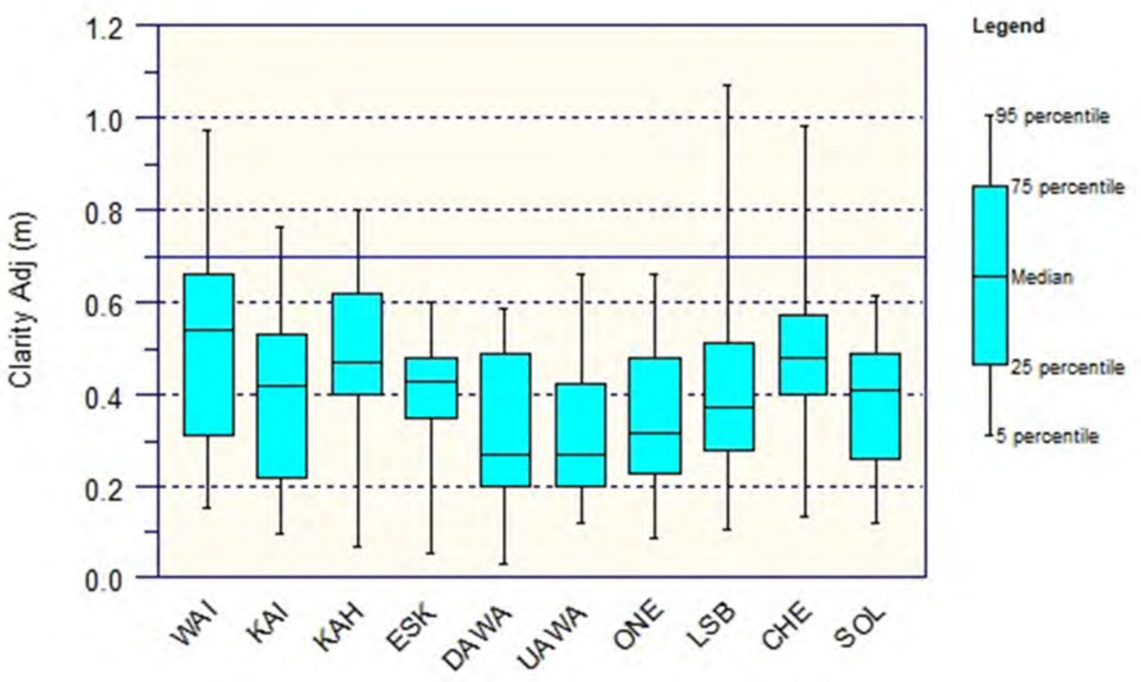


FIGURE 10: WATER CLARITY

Figure 10 shows that all sites fall below the 20th %ile limit of 0.7m for WW streams . Clarity tends to be lower at the upstream Awataha site (UAWA) which often accrues algal fragments in stagnant pools in summer. These algal fragments reduce the water clarity.

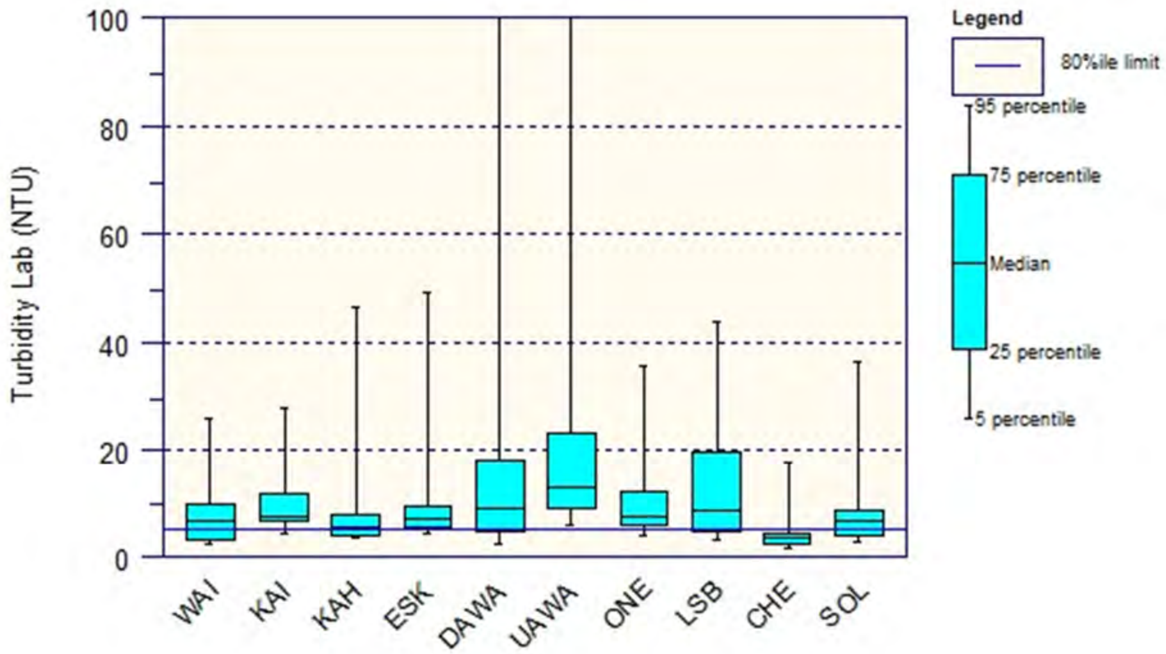


FIGURE 11: TURBIDITY MEASURED IN THE LAB

Figure 11 shows turbidity levels tend to be higher at the upstream Awataha site (UAWA), its possible that during stagnant periods, fragments of periphyton form a large part of light absorption in the water column. All sites except Chelsea Stream fail to meet the 80th %ile ANZ guideline of 5.2 NTU *(see Appendix 2).

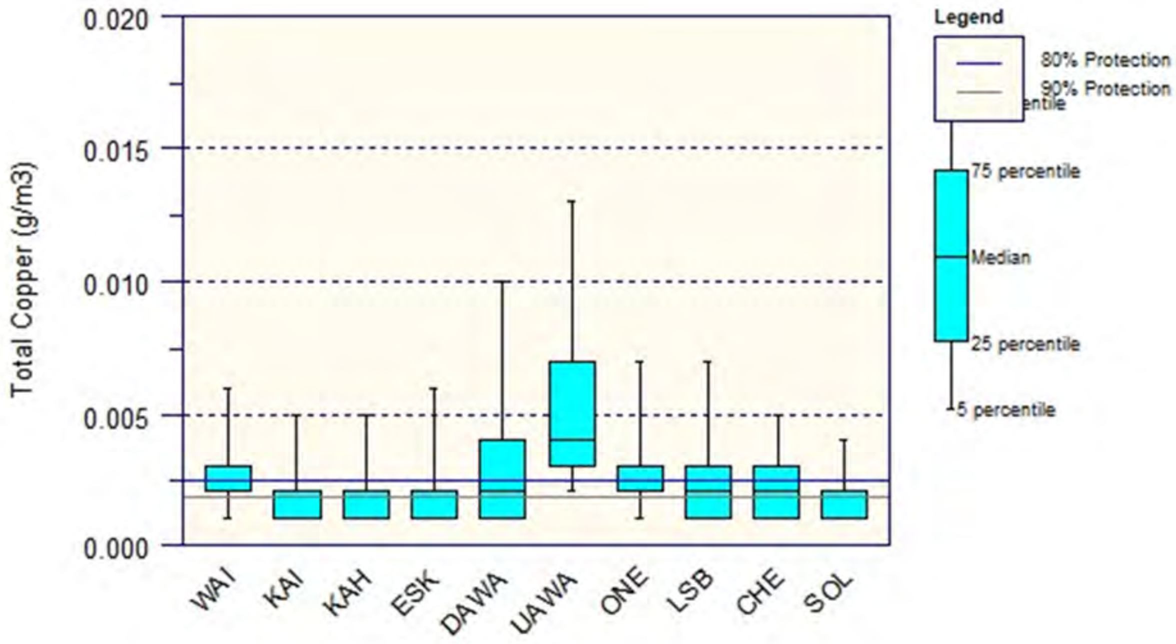


FIGURE 12: TOTAL COPPER CONCENTRATIONS

Figure 12 shows that none of the sites comply with the ANZ 80% species protection guideline for total copper. The upstream Awataha (UAWA) site has slightly elevated concentrations, the reason for this is unclear. It should be noted here that the DAWA site has higher hardness concentrations than the remaining sites. This means the compliance threshold values for this site are 2.5 times higher, however the site still fails to meet the respective concentration criteria on occasions.

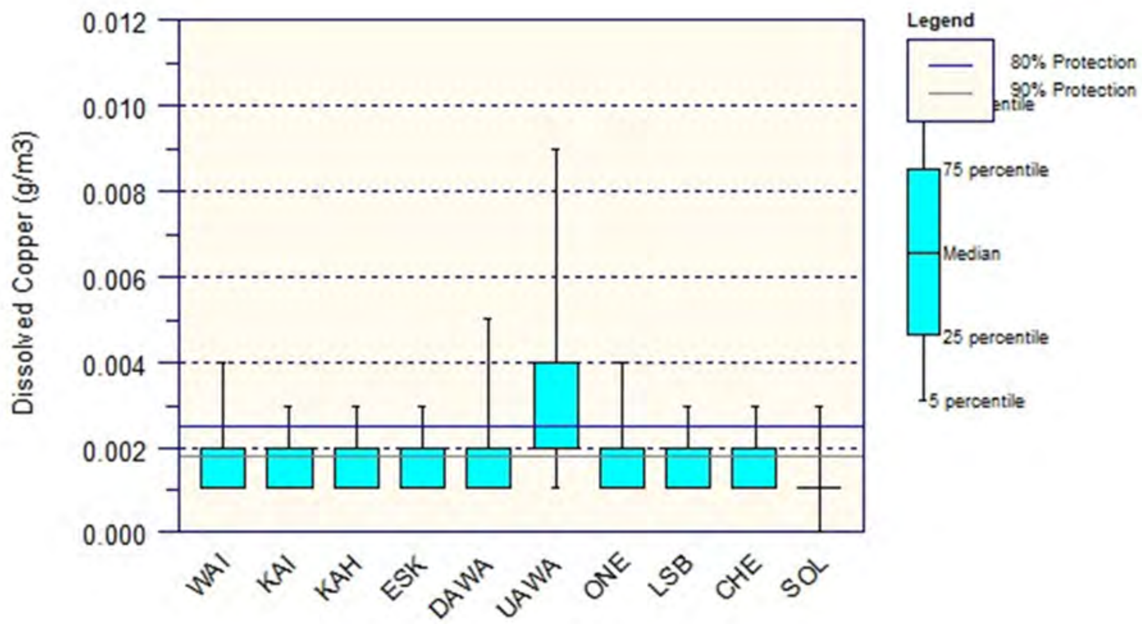


FIGURE 13: DISSOLVED COPPER CONCENTRATIONS

Dissolved metals represent the bioavailable fraction that is available for uptake by instream biota, it is for this reason we also examine dissolved metal concentrations. Figure 13 shows that when dissolved copper concentrations are considered the sites still exceed the ANZ 2018 guidelines for 80 or 90% species protection. It should be noted here that the DAWA site has higher hardness concentrations than the remaining sites. This means the threshold values for this site are 2.5 times higher, however even at these thresholds (0.0045 & 0.00625) this site exceeds the 90% protection threshold on occasions.

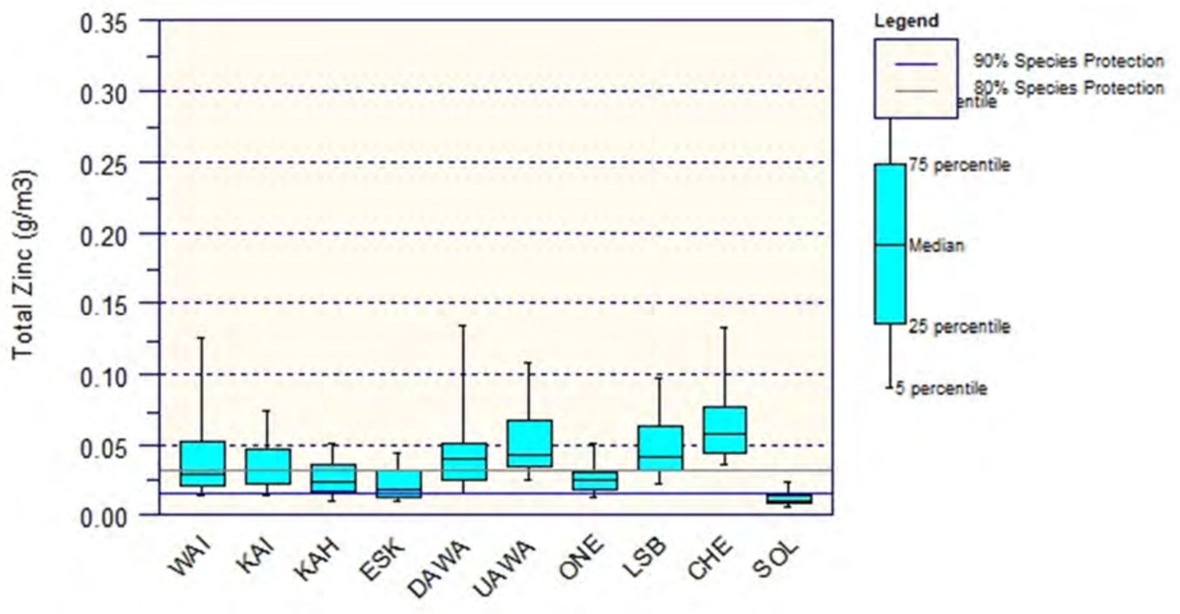


FIGURE 14: TOTAL ZINC

Figure 14 shows that all sites except Soldiers Bay Stream (SOL) exceed the 80% species protection threshold. This site also complies with the 90% species protection threshold most of the time (75%). The remaining sites breach the total zinc thresholds regularly. It should be noted here that the DAWA site has higher hardness than the remaining sites. This means the threshold values for this site is 2.5 times higher. This means the DAWA site complies with the higher ANZ thresholds for 80 and 90% species protection (0.0375, 0.0775).

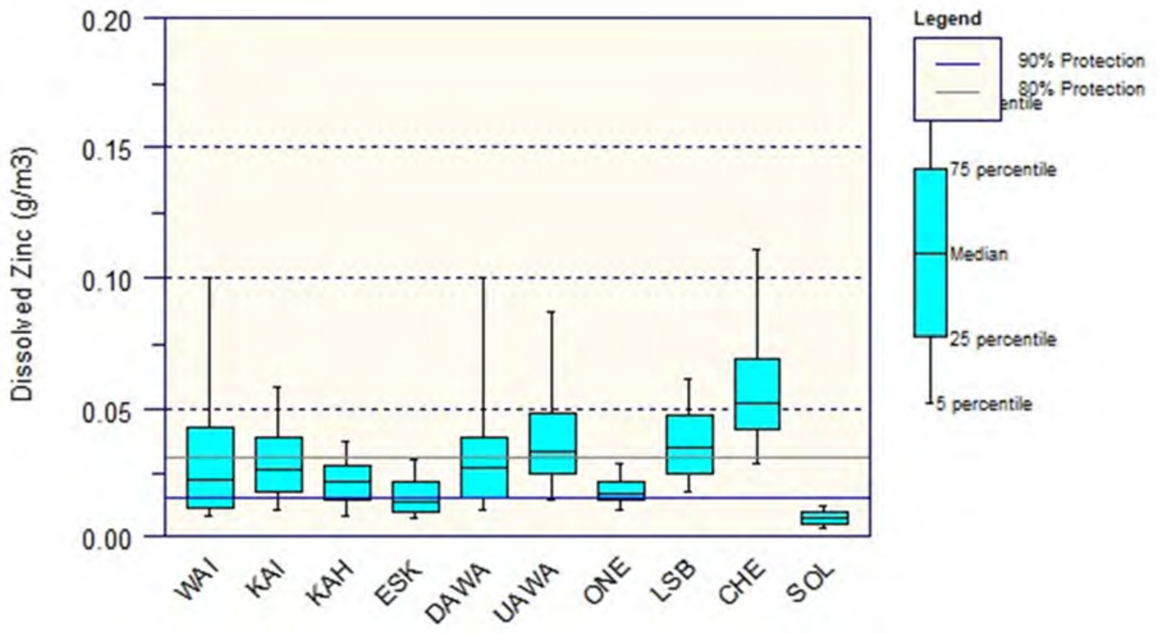


FIGURE 15: DISSOLVED ZINC CONCENTRATIONS

Figure 15 shows that all sites except Soldiers Bay Stream (SOL) exceed the 80% species protection threshold for dissolved zinc. This site also complies with the 90% species protection threshold all the time. The remaining sites breach the dissolved zinc thresholds regularly. It should be noted here that the DAWA site has higher hardness concentrations than the remaining sites. This means the hardness adjusted threshold values for this site are 2.5 times higher. This means the DAWA site also complies with the ANZ thresholds for 80 and 90% species protection (0.0375, 0.0775).

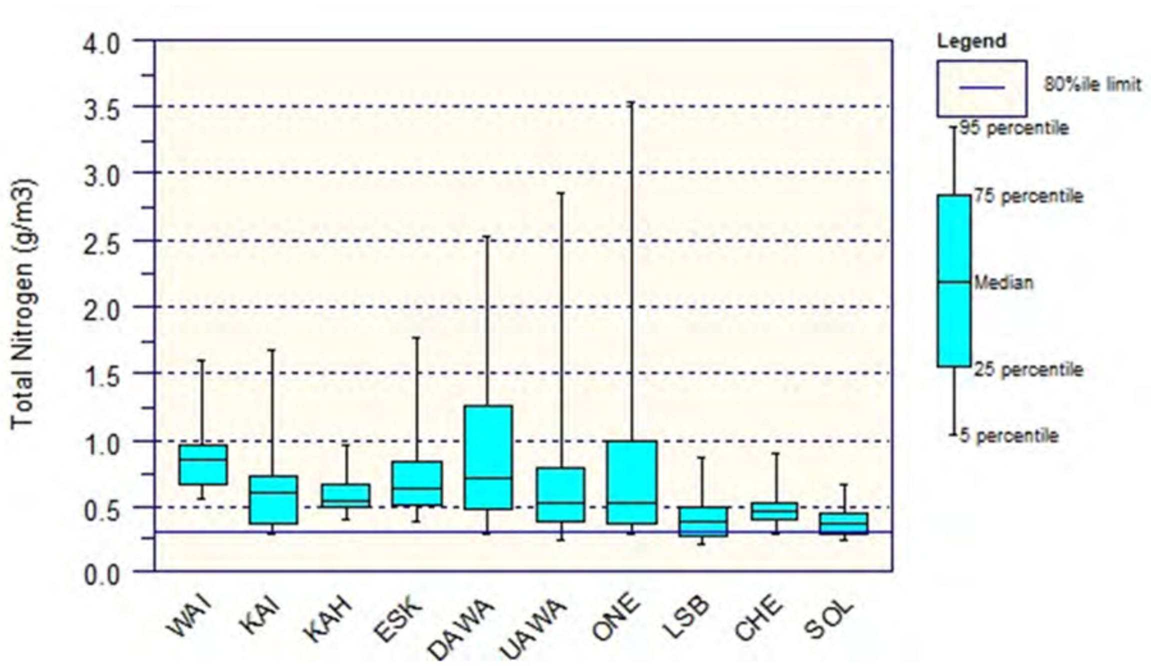


FIGURE 16: TOTAL NITROGEN

Figure 16 shows that all sites exceed the 0.444 g/m^3 ANZ 80th %ile threshold for lowland streams. Nitrogen concentrations are characteristically high owing to sewage connection failures and stormwater discharges.

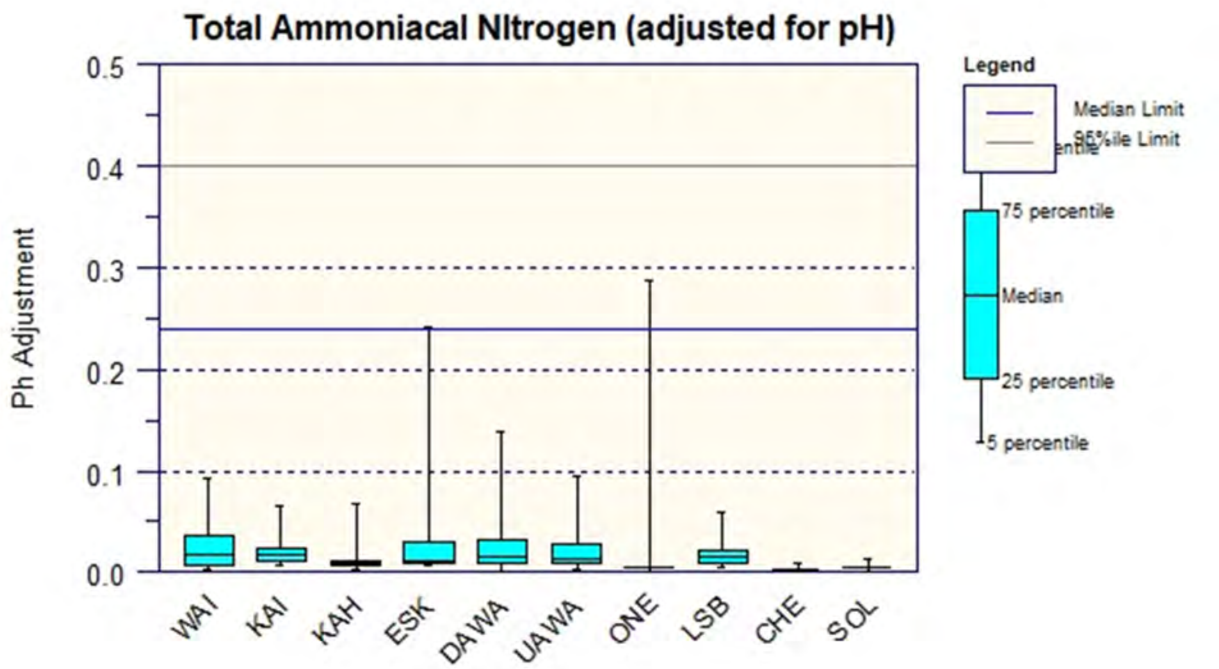


FIGURE 17: TOTAL AMMONIACAL NITROGEN

Figure 17 shows that all sites comply with the NPS-FM 2020 total ammoniacal nitrogen toxicity national bottom lines (for both the median and the 95th %ile metrics). The Eskdale Stream and

Onepoto Streams tend to have higher 95th %ile values, however they still comply with the environmental guidelines. Chelsea Stream, Kahika Creek, Little Shoal Bay and Soldiers Bay Streams are class A for total ammoniacal nitrogen while the remaining sites are class B (see Appendix 5)

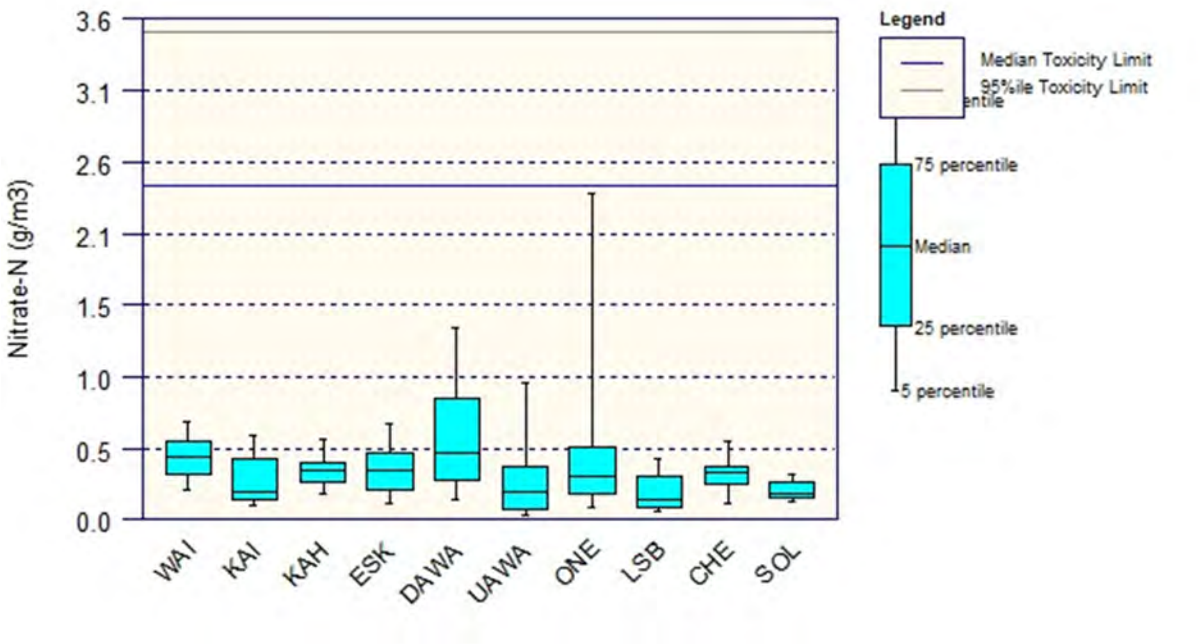


FIGURE 18: NITRATE NITROGEN

Figure 18 shows that all sites comply with the NPS-FM 2020 nitrate toxicity national bottom line thresholds (for both the median and the 95th %ile). All sites are in band A for nitrate nitrogen toxicity except for Onepoto Stream which is band B (See Appendix 5).

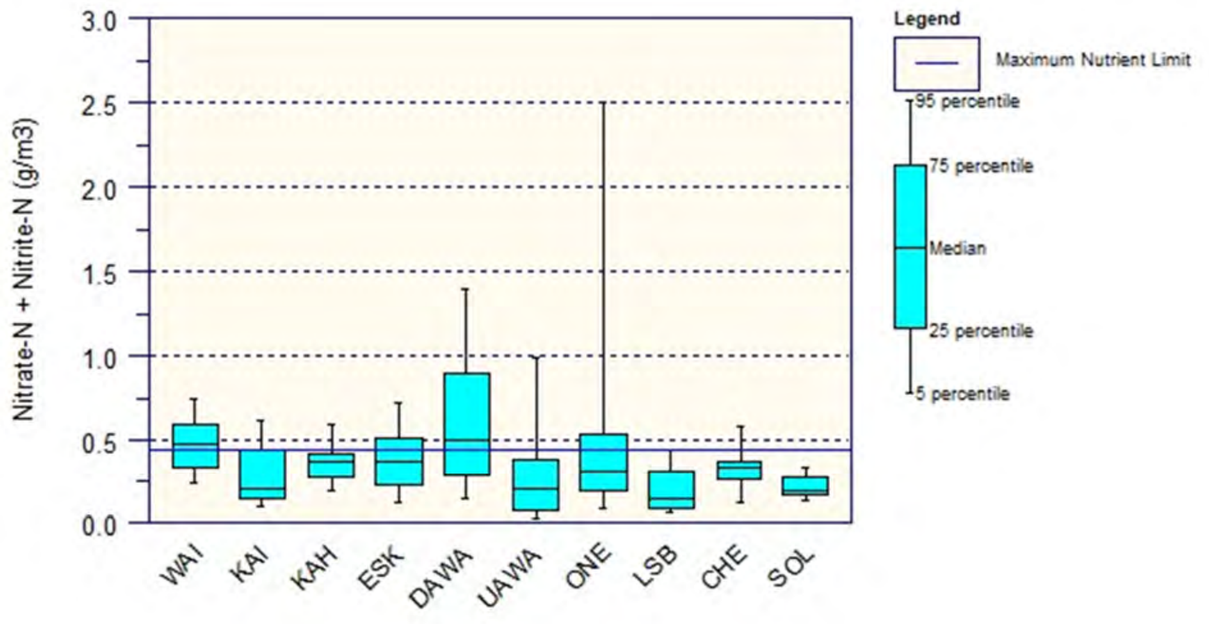


FIGURE 19: NITROGEN OXIDES

Figure 19 shows that most sites exceed the NOx maximum which is a maximum nutrient limit of the ANZ 2018 guidelines. Soldiers Bay Stream (SOL) is the only site to comply with these guidelines closely followed by Little Shoal Bay Stream (LSB).

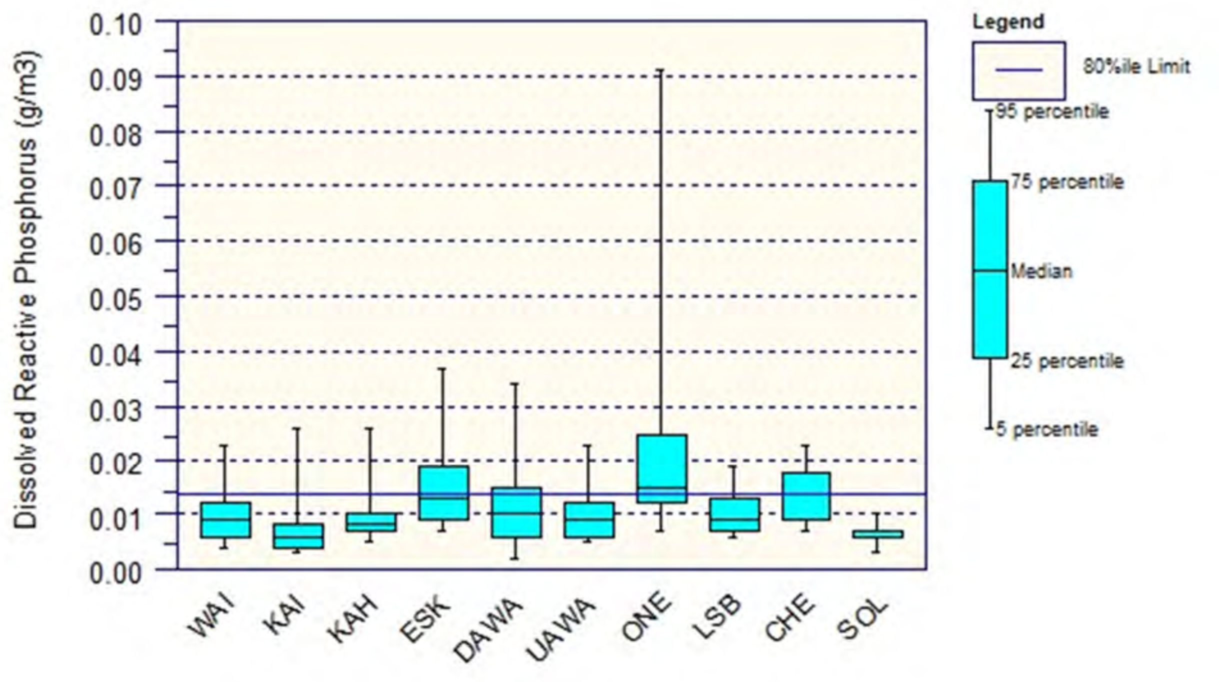


FIGURE 20: DISSOLVED REACTIVE PHOSPHORUS

Figure 20 shows that most sites comply with the Dissolved Reactive Phosphorus 80th %ile threshold of the ANZ 2018 guidelines except Eskdale (ESK) downstream, Awataha (DAWA), Onepoto (ONE) and Chelsea Stream (CHE). The reason for this is unclear. Soldiers Bay Stream has the lowest dissolved reactive phosphorus concentrations of any of the sites, demonstrating the best compliance with the guideline. The sites cover a spectrum of gradings of the NPS-FM attribute bands (see Appendix 5).

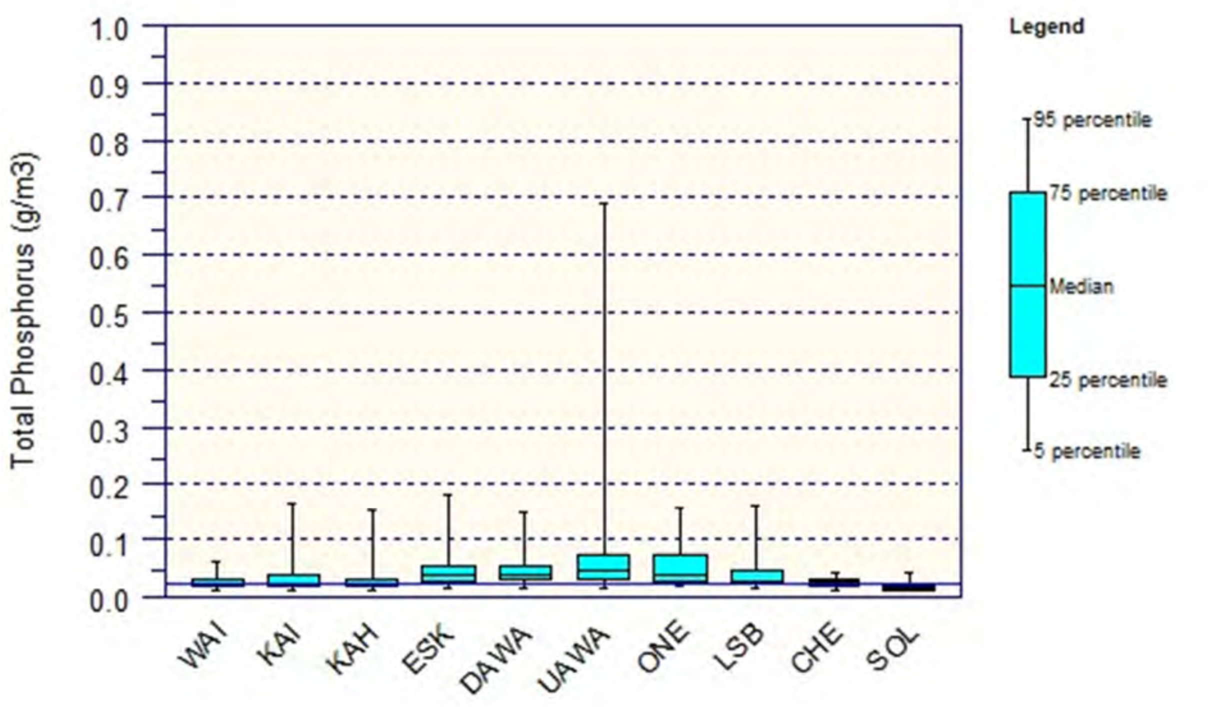


FIGURE 21: TOTAL PHOSPHORUS

Figure 21 shows that all sites except Soldiers Bay Stream exceed the ANZ 80th %ile limit for total phosphorus.

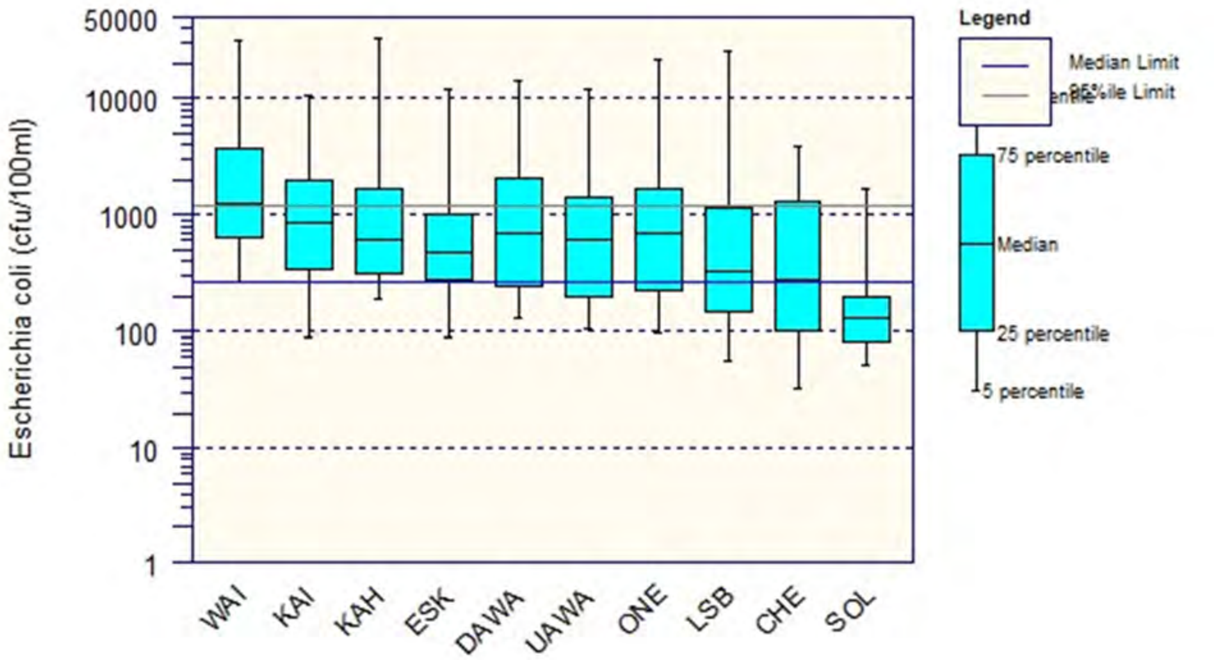


FIGURE 22: *E. COLI* CONCENTRATIONS

E. coli is an indicator bacteria found in the gut of warm blooded animals. The presence of *E. coli* in water can mean that there is faecal contamination in the water. Figure 22 shows that all sites exceed the NPS-FM 2020 median and 95th %ile limits except Soldiers Bay Stream which only exceeds the 95%ile limit. Soldiers Bay Stream demonstrates the lowest *E. coli* concentrations of the group while Wairau (WAI) demonstrates the highest *E. coli* concentrations of the group. All sites fall within band E of the NPSFM attribute grading (see Appendix 5).

Temporal Trends

This section describes temporal trends that have been identified for raw and flow adjusted data and have been identified as “very likely” or “almost certain”.

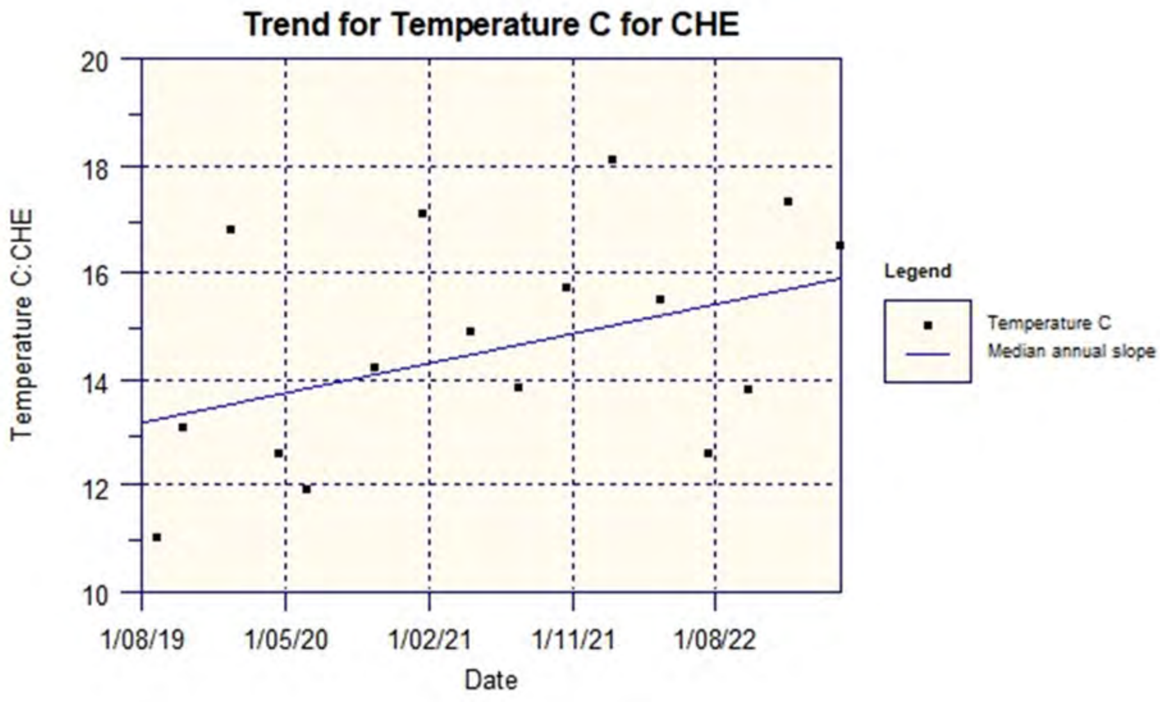
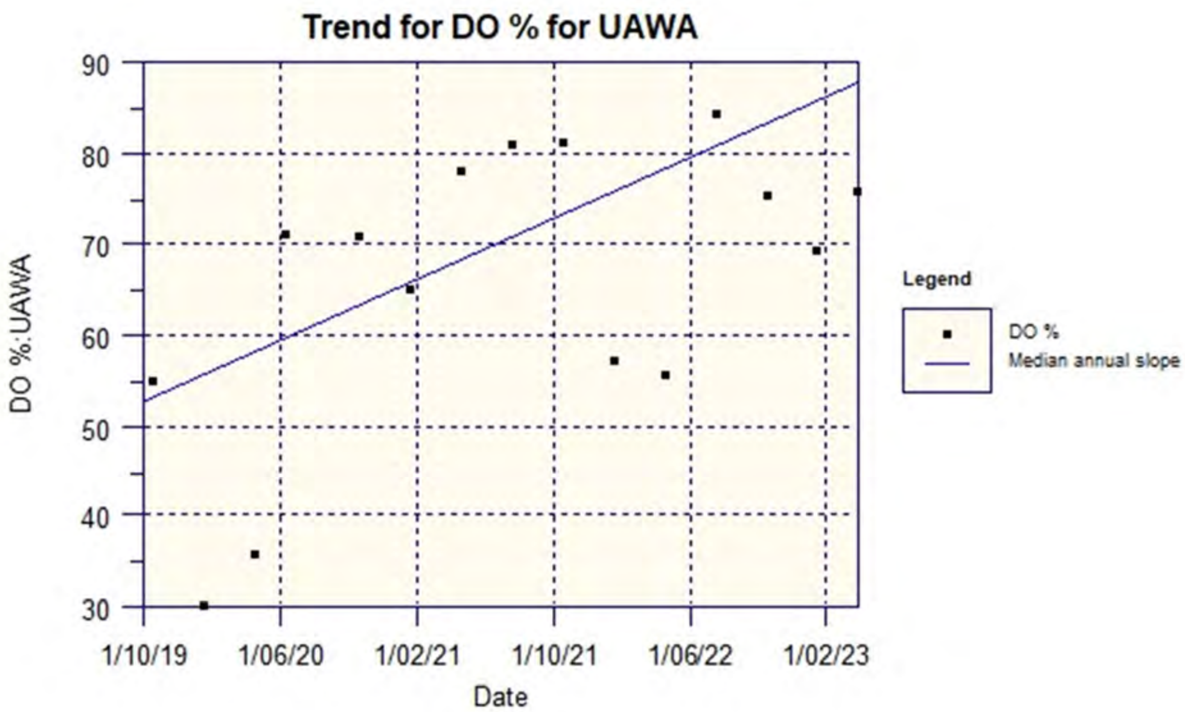


FIGURE 23: TIME SERIES TREND FOR WATER TEMPERATURE AT CHELSEA STREAM

The only site to show a “very likely trend” for declining water temperature was Chelsea Stream. As no flow data is available for this site it is difficult to determine the reason for this trend. It is possible that the observed trend is due to altered flow.



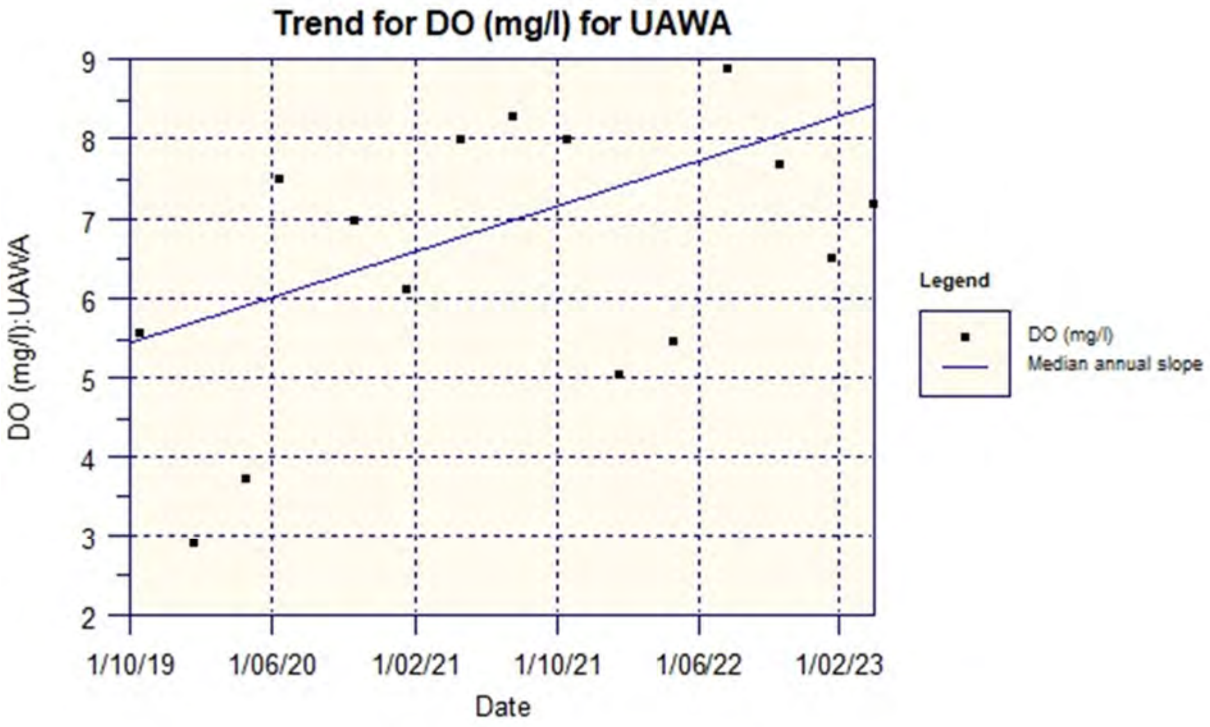
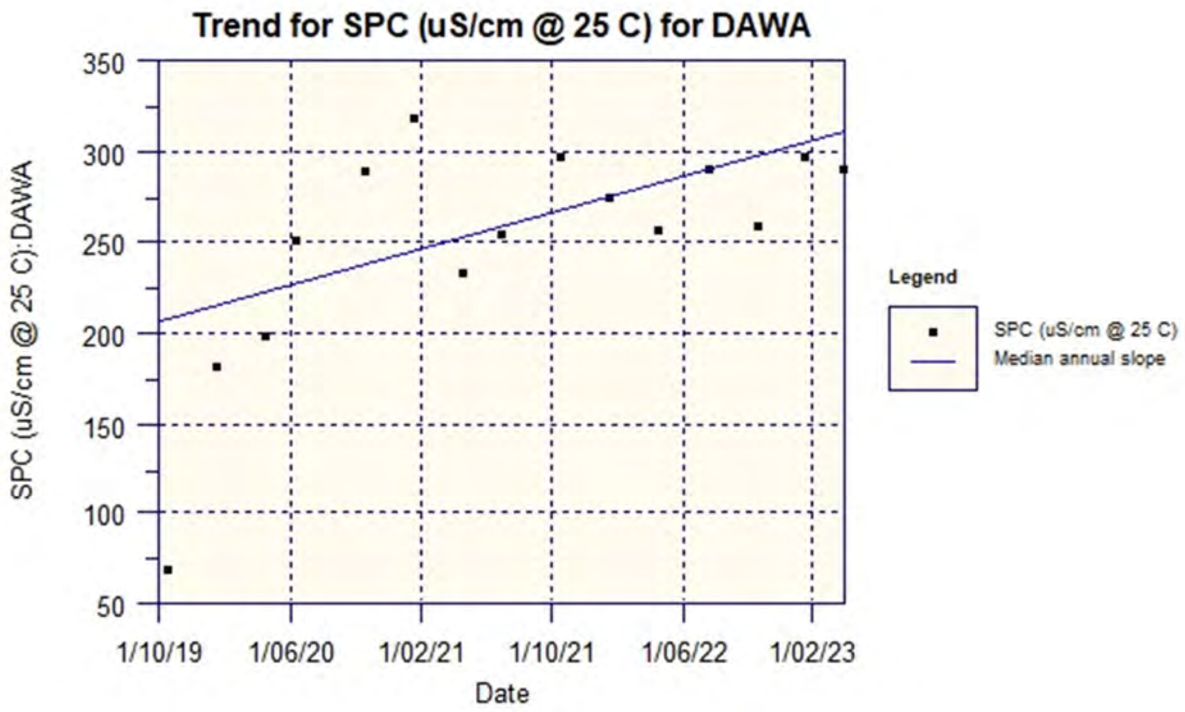


FIGURE 24: DISSOLVED OXYGEN TIME SERIES TREND AT UPSTREAM AWATAHA

The only site to demonstrate a 'very likely' trend with respect to improving oxygen levels was the upstream Awataha site. The reason for this trend is unclear as this site is not monitored for flow. It could be that the observed trend is due to flow or the collective efforts of stream riparian restoration within this reach of stream.



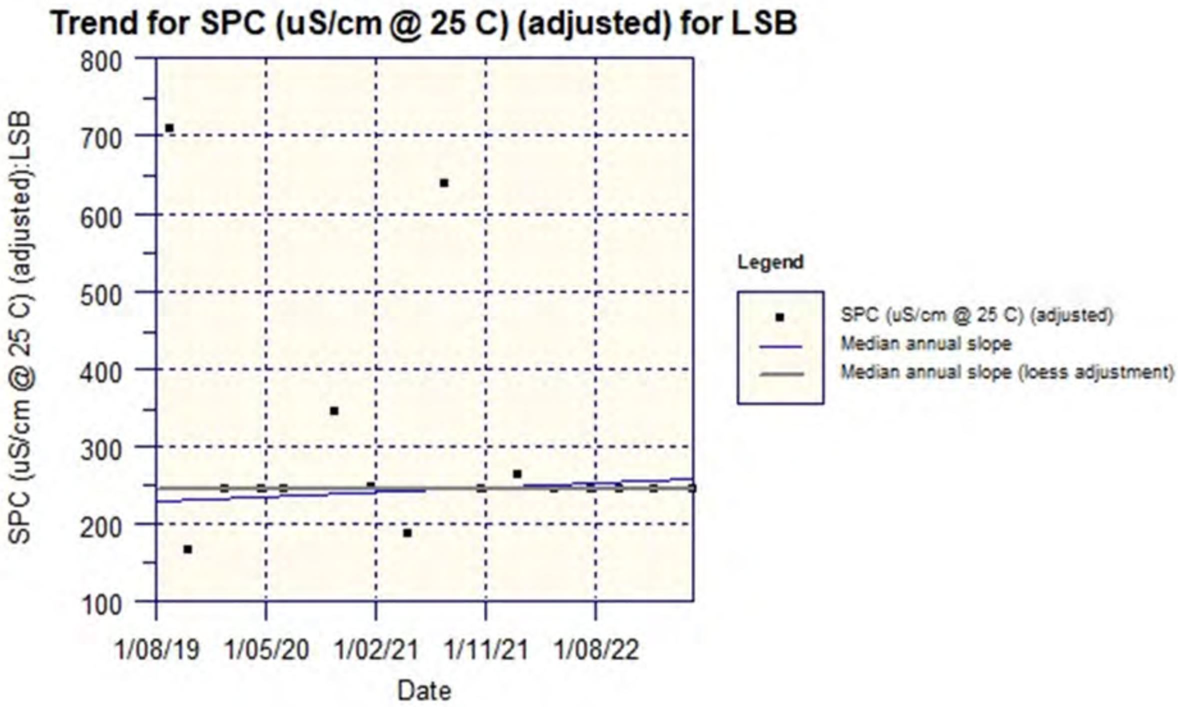
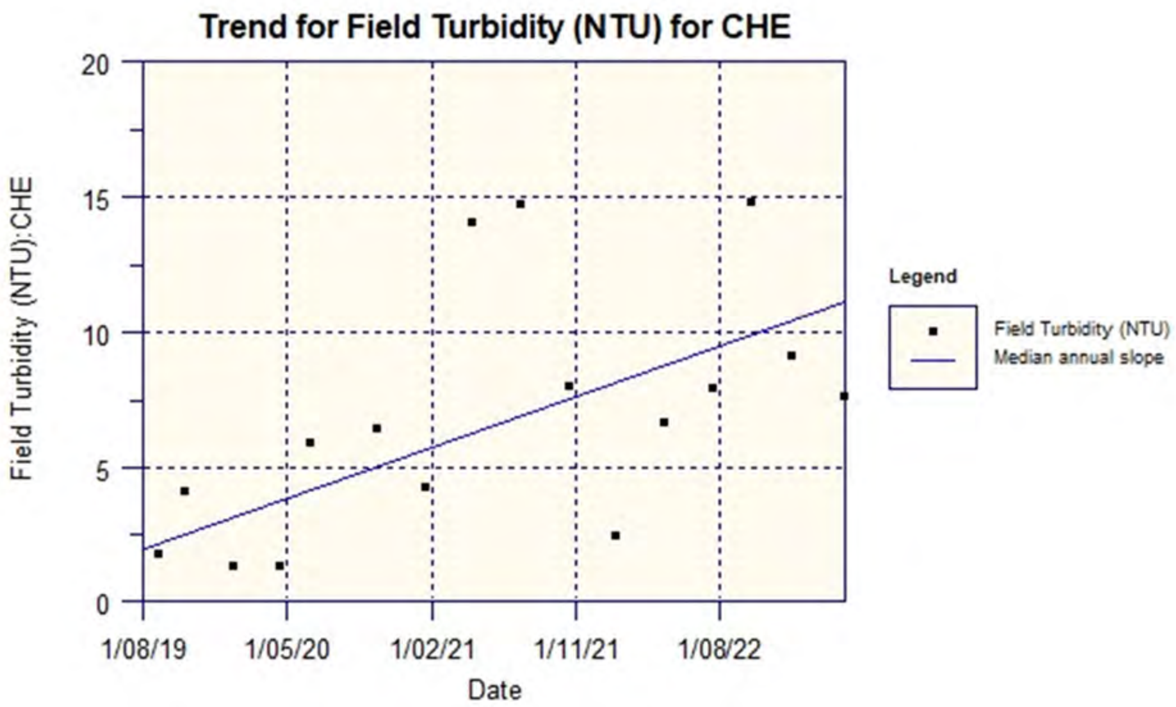
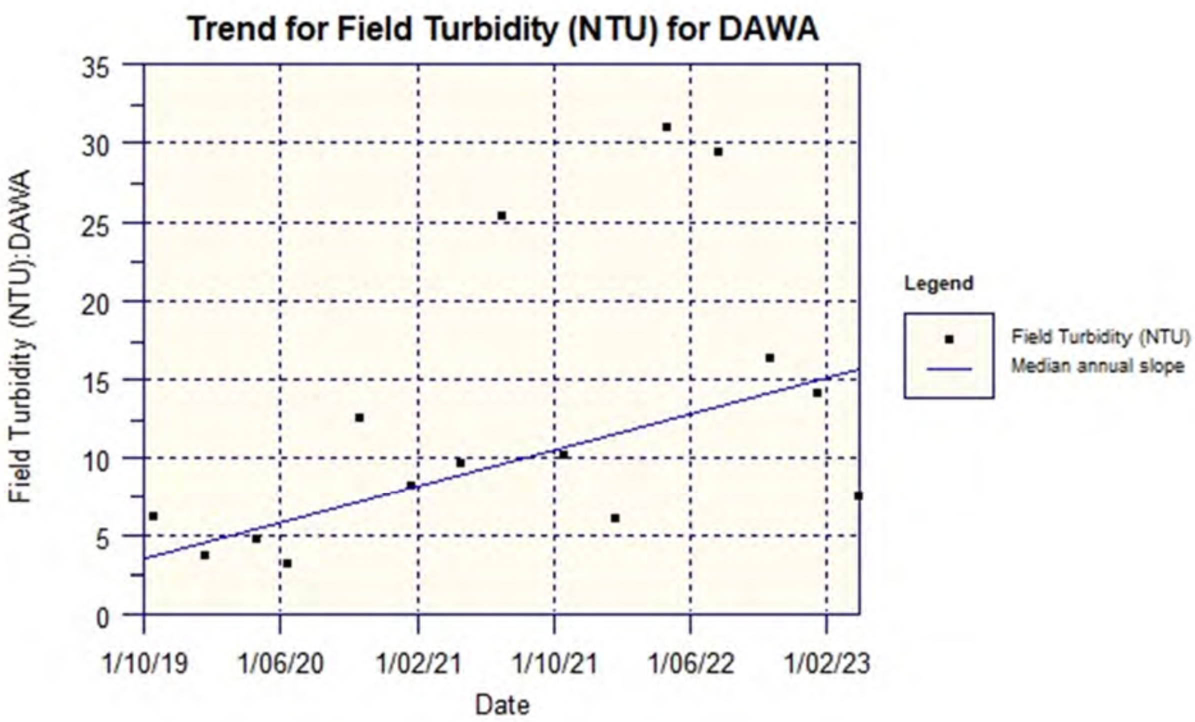


FIGURE 25: TIME SERIES TRENDS IN SPECIFIC CONDUCTIVITY

Two sites demonstrated ‘very likely trends’ with respect to specific conductivity, (downstream Awataha and Little Shoal Bay). The reason for the upward trend at downstream Awataha is unclear as no flow data is available. Conversely the increasing trend observed at little shoal bay stream was due to flow as the flow adjusted trend was not detectable.

No significant time series trends were observed with respect to pH or water clarity, however some trends were observed with respect to field measurements of turbidity.


Trend for Field Turbidity (NTU) for CHE
Field Turbidity (NTU):CHE
20
15
10
5
0
1/08/19
1/05/20
1/02/21
1/11/21
1/08/22
Date
Legend
Field Turbidity (NTU)
Median annual slope


Trend for Field Turbidity (NTU) for DAWA
Field Turbidity (NTU):DAWA
35
30
25
20
15
10
5
0
1/10/19
1/06/20
1/02/21
1/10/21
1/06/22
1/02/23
Date
Legend
Field Turbidity (NTU)
Median annual slope

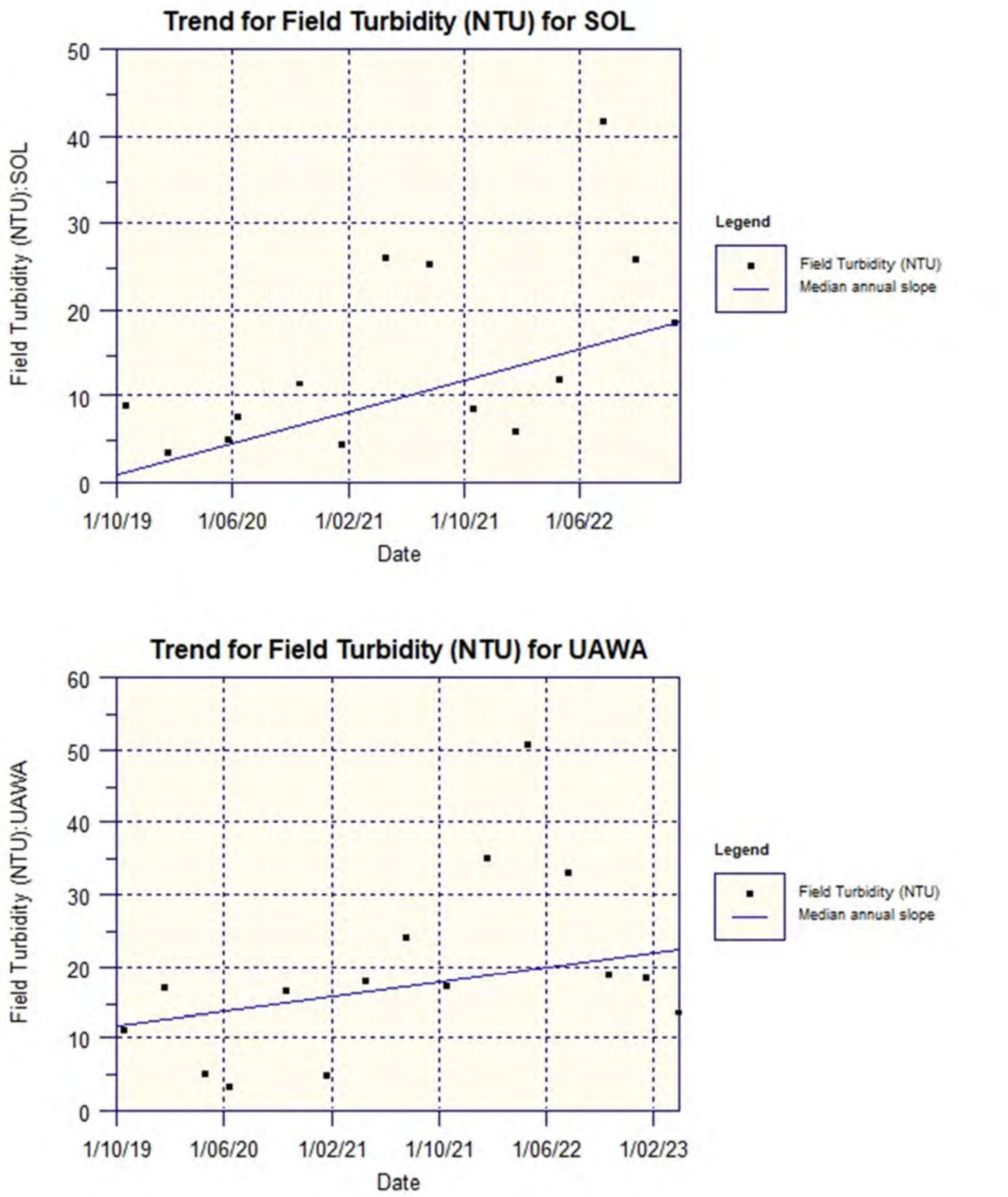


FIGURE 26:TIME SERIES TRENDS FOR FIELD TURBIDITY

Figure 26 shows that four sites demonstrated increases in field turbidity (Chelsea Bay Stream, downstream Awataha, upstream Awataha and Soldiers Bay Stream. Unfortunately none of these sites are monitored for flow. The reason for these trends is unclear.

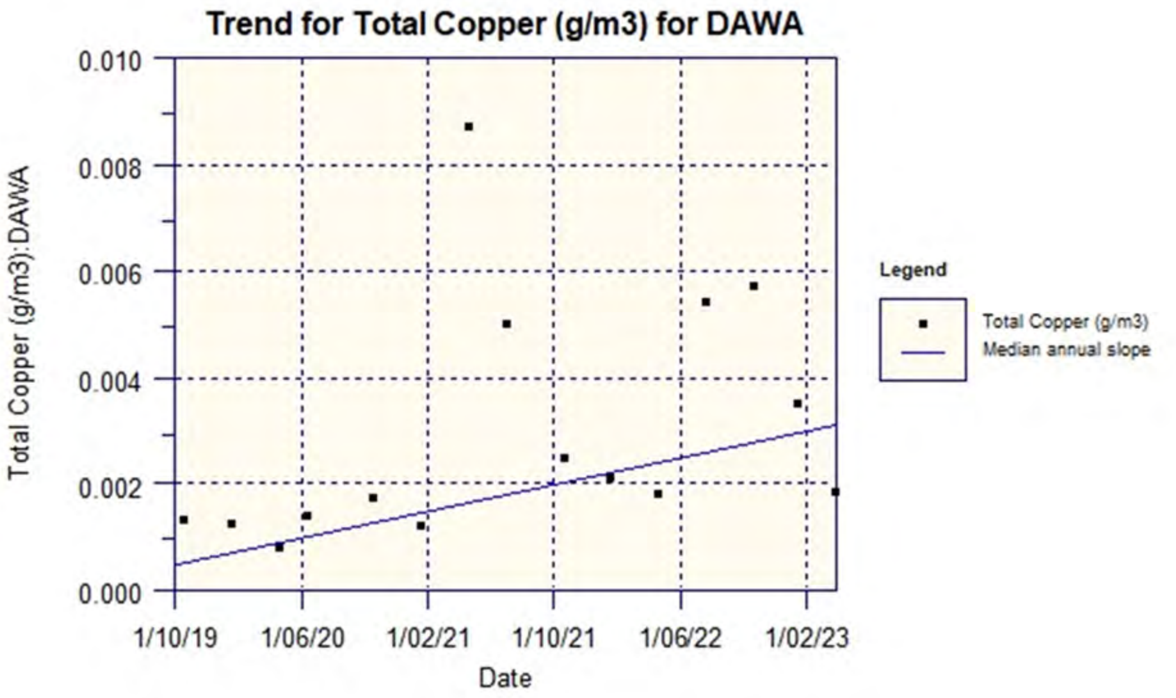
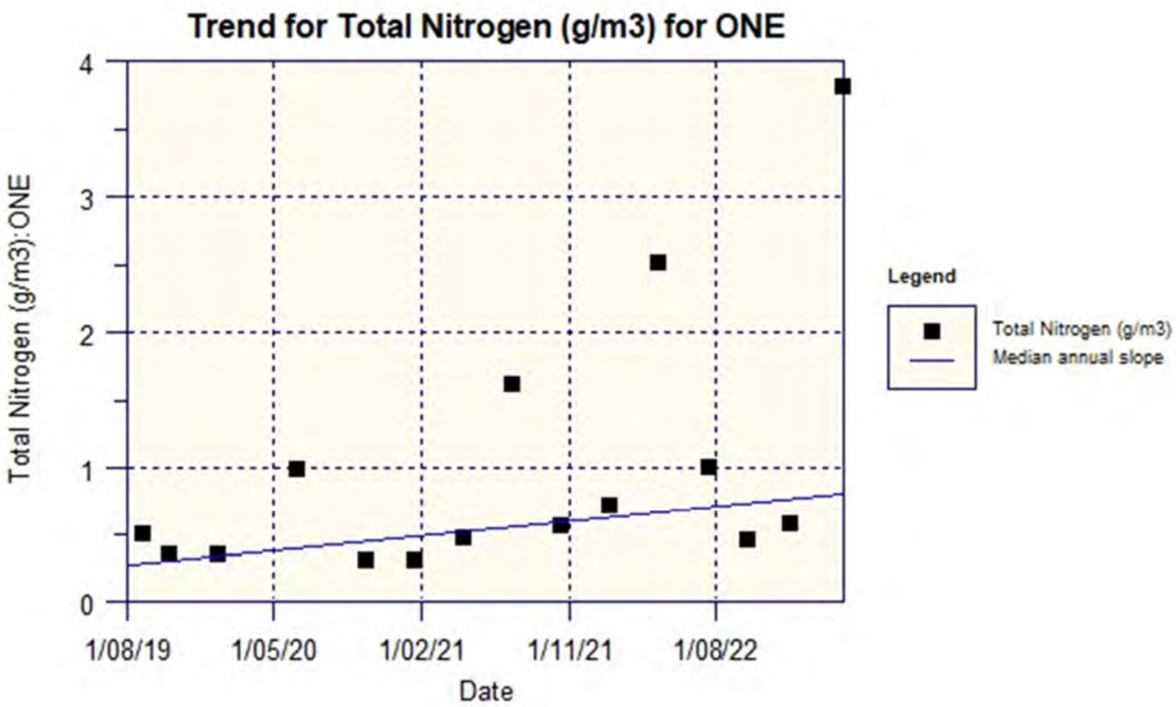
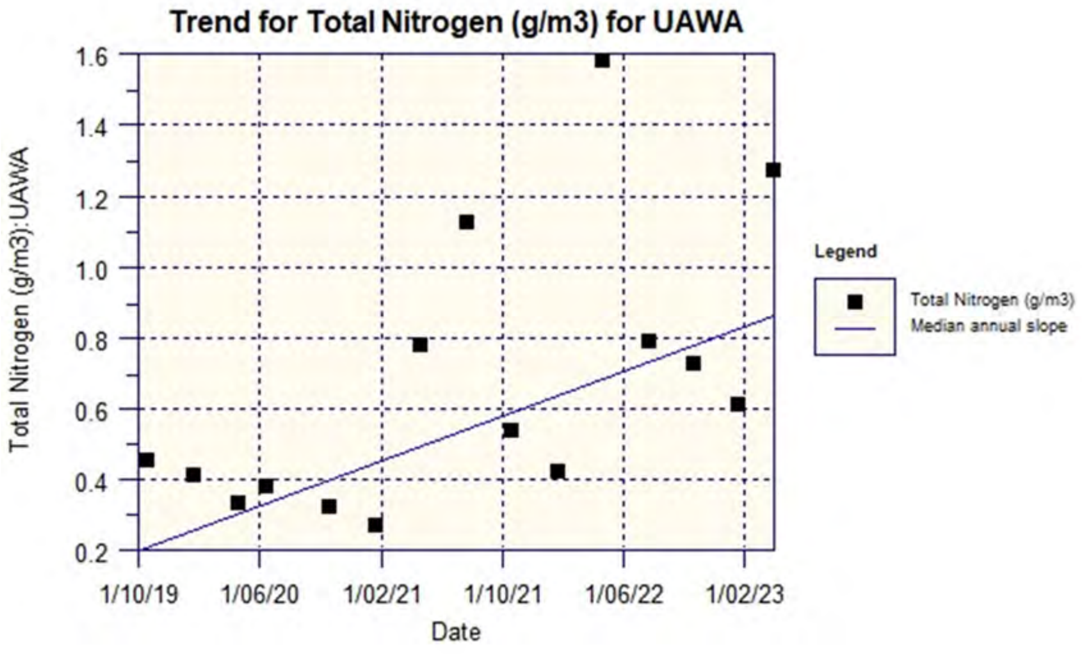
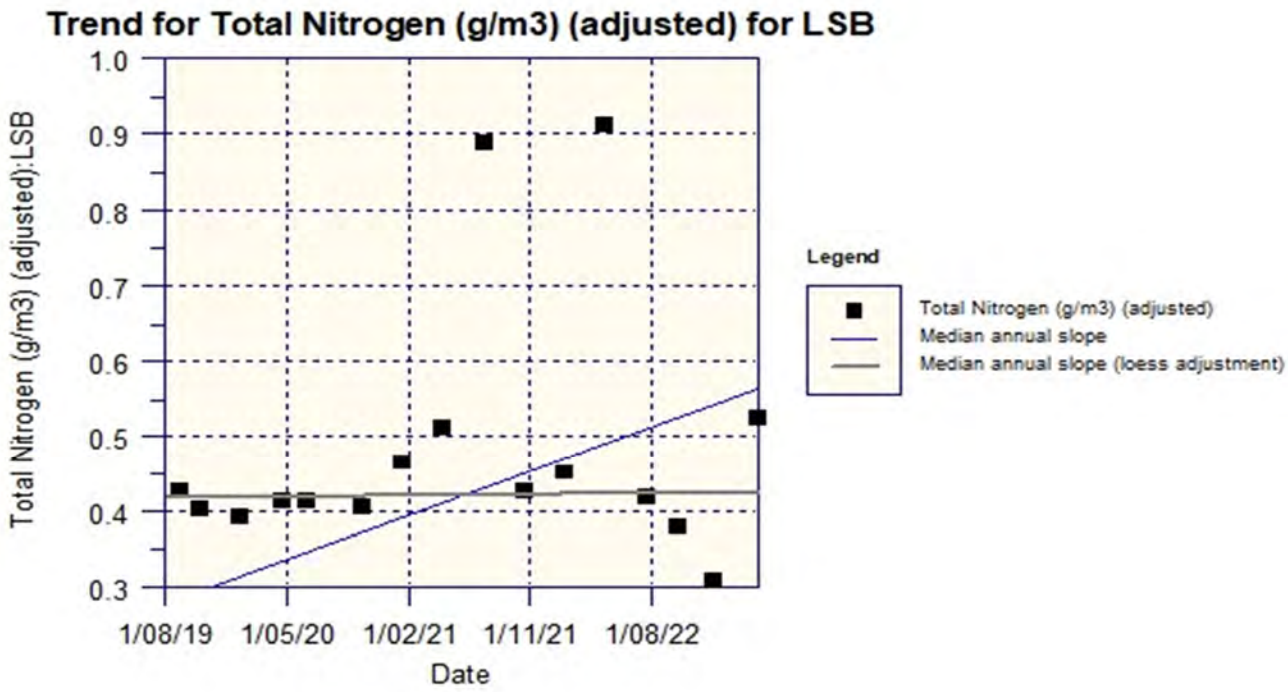


FIGURE 27: TEMORAL TRENDS FOR METALS

The only site to show a 'very likely' upward metals trend was total copper at the Downstream Awataha site. Kahika Creek and Kaipatiki Creek also showed an increase in total copper, however flow adjustment revealed that the trends were not significant. It is likely that the upward trend observed at the downstream Awataha site is also due to flow variability.




Trend for Total Nitrogen (g/m3) for UAWA
Total Nitrogen (g/m3):UAWA
Date
1/10/19
1/06/20
1/02/21
1/10/21
1/06/22
1/02/23
Legend
Total Nitrogen (g/m3)
Median annual slope


Trend for Total Nitrogen (g/m3) (adjusted) for LSB
Total Nitrogen (g/m3) (adjusted):LSB
Date
1/08/19
1/05/20
1/02/21
1/11/21
1/08/22
Legend
Total Nitrogen (g/m3) (adjusted)
Median annual slope
Median annual slope (loess adjustment)

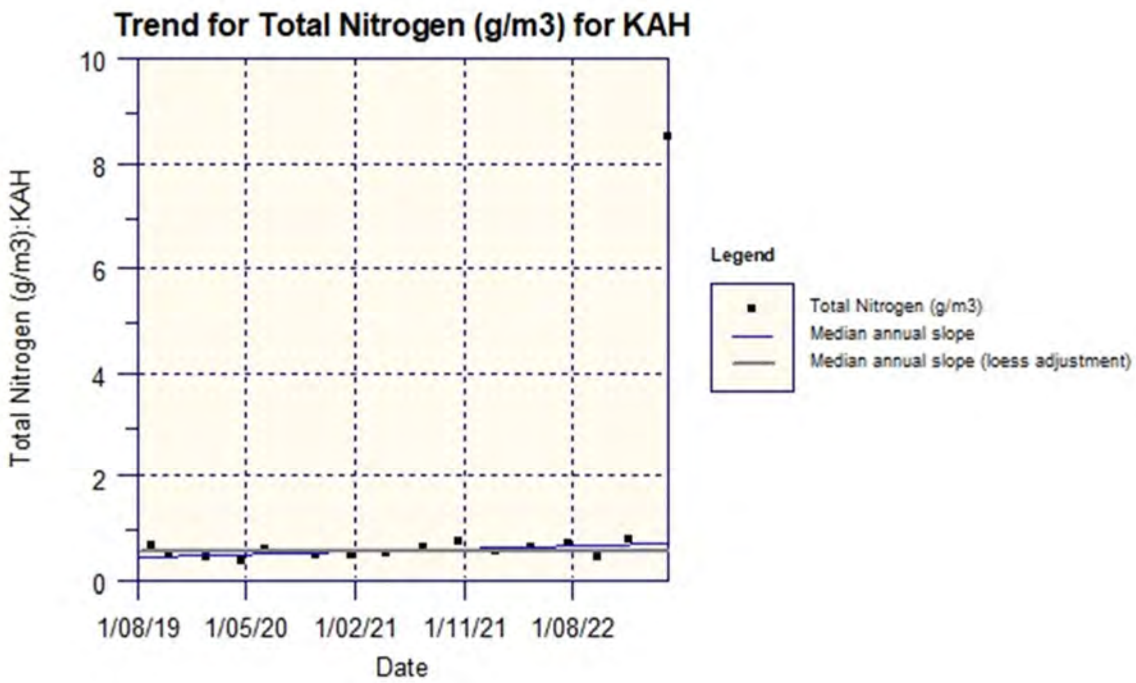
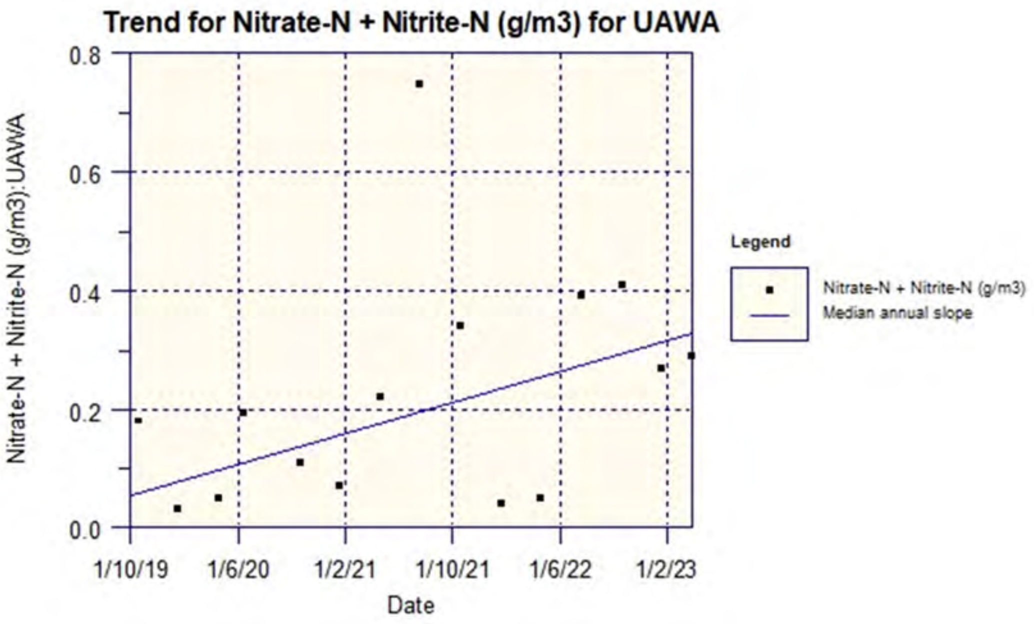


FIGURE 28: TRENDS IN TOTAL NITROGEN

Four sites demonstrated increases in total nitrogen (Kahika, downstream Awataha, Onepoto and Little Shoal Bay Stream). For both the Kahika and Little Shoal Bay streams, the analysis conducted on flow adjusted data revealed no significant trend. It is likely that the total nitrogen trends at all sites are simply due to flow variability.

No significant trends were observed for pH adjusted total ammoniacal nitrogen, however significant trends were observed for oxidised nitrogen.



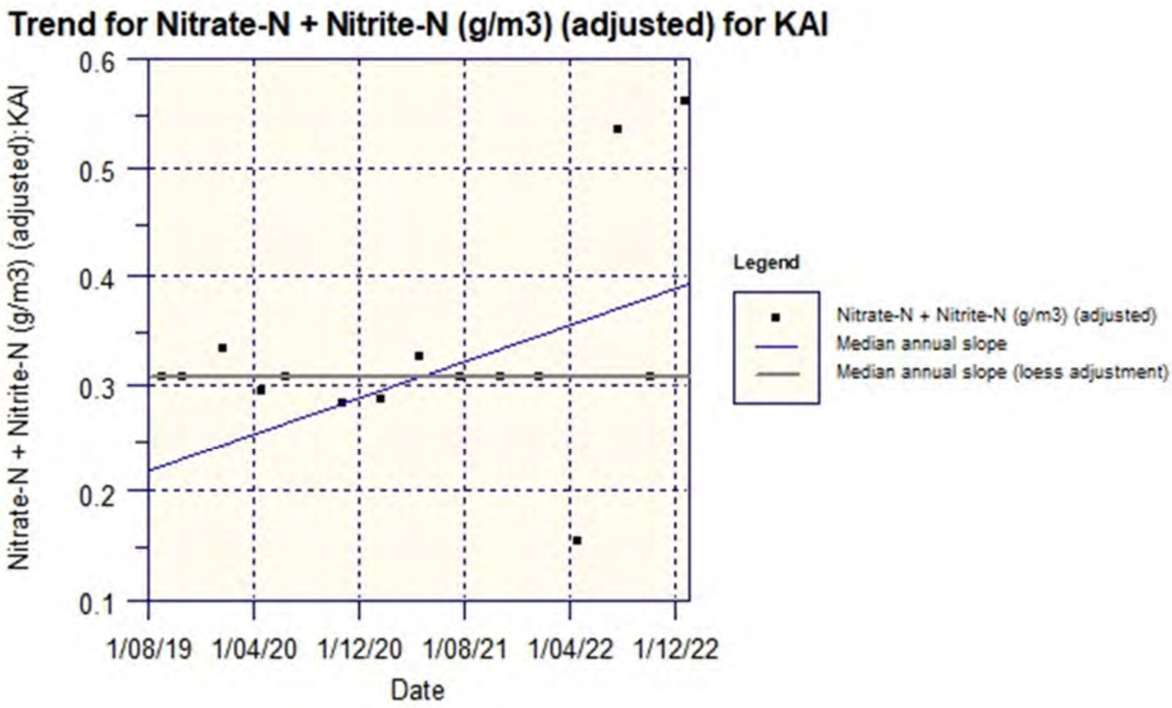


FIGURE 29: TIME SERIES TRENDS FOR OXIDISED NITROGEN

Two sites Kaipatiki and downstream Awataha revealed upward trends for nitrate+nitrite nitrogen, however flow adjustment for the Kaipatiki site revealed no significant trend after flow adjustment. It is likely the observed trend for upstream Awataha is also due to flow.

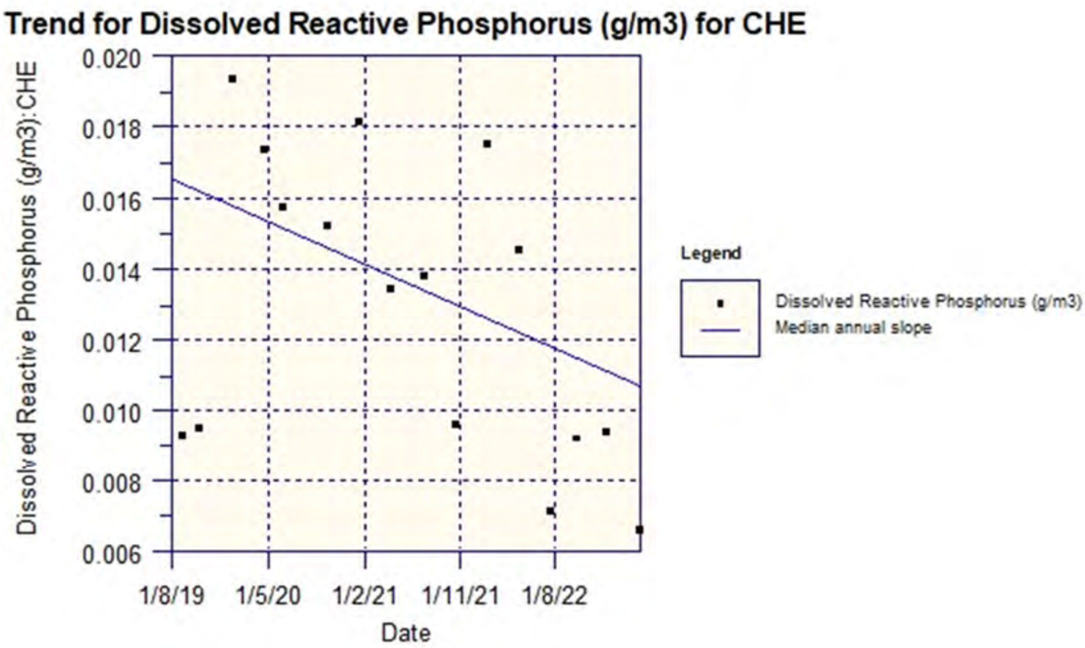
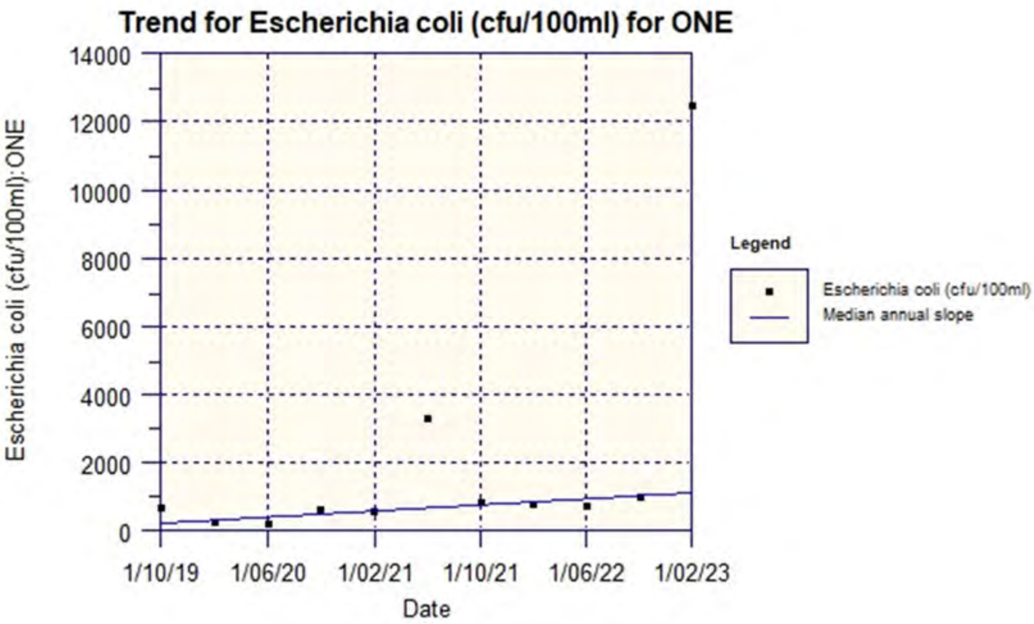


FIGURE 30: DISSOLVED REACTIVE PHOSPHORUS TIME SERIES TREND

Many sites did not reveal a significant trend for dissolved reactive phosphorus or total phosphorus, except Chelsea Stream which revealed a downward trend for dissolved reactive phosphorus. The reason for this trend is unclear as Chelsea Stream is not monitored for flow.



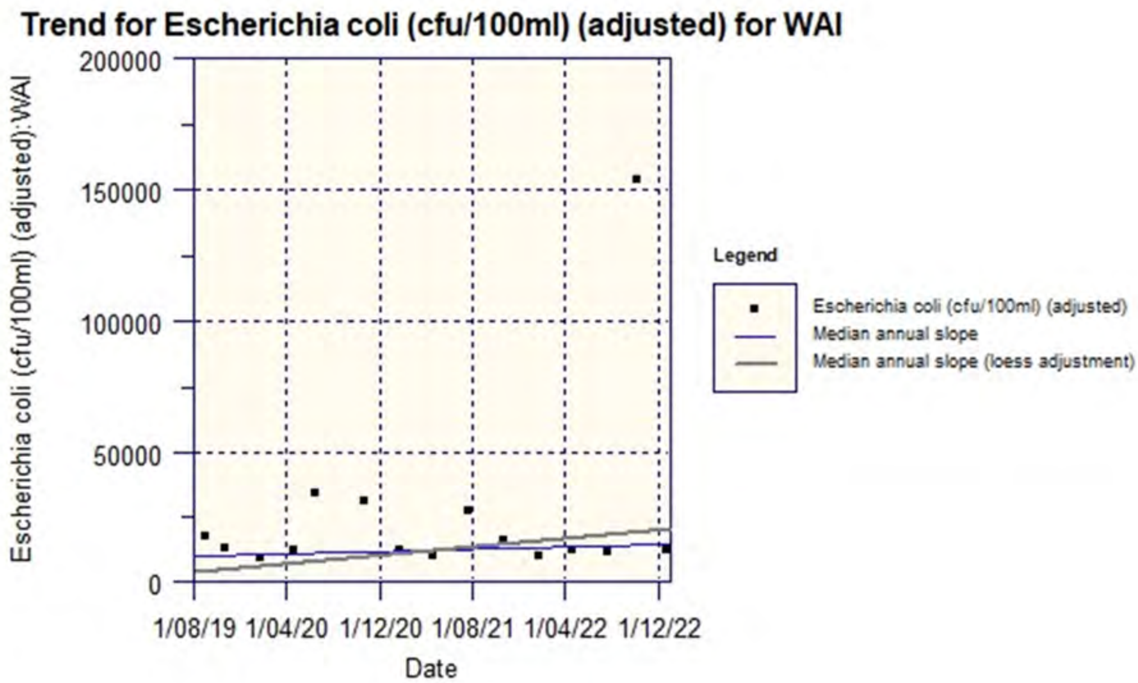


FIGURE 31: E.COLI TIME SERIES TRENDS

Figure 31 shows that *E. coli* concentrations have increased at two sites namely, Onepoto Stream and Wairau Creek. Flow is not measured at Onepoto Stream so it is difficult to determine what is causing the increase in concentrations over time however the Wairau Creek plot shows an increase for both raw and flow adjusted data. This suggests that the Wairau Creek is receiving an increased loading of *E. coli* over time resulting in increased *E. coli* concentrations. This could be the result of cross connection sewage failures. Interestingly Wairau Creek has recorded the highest concentration of *E. coli* at any of the sites (160,000 cfu/100ml). A concentration this high should warrant a sanitary survey of the catchment for sewage cross connection failures.

New Monitoring Sites

In December 2022, three additional sites were introduced to the monitoring programme as concern was expressed about the ecological health of these streams which had not previously been monitored for nutrient or metals water quality (Stansfield 2021). The new sites are Castleton Creek, Bayview Stream and Smith's Bush which have been monitored on a quarterly basis since December 2022. The plots that follow represent mean concentrations of contaminants for two sampling periods (December and March) to provide a comparison of how the water quality of these new sites compares to the remaining sites of the programme.

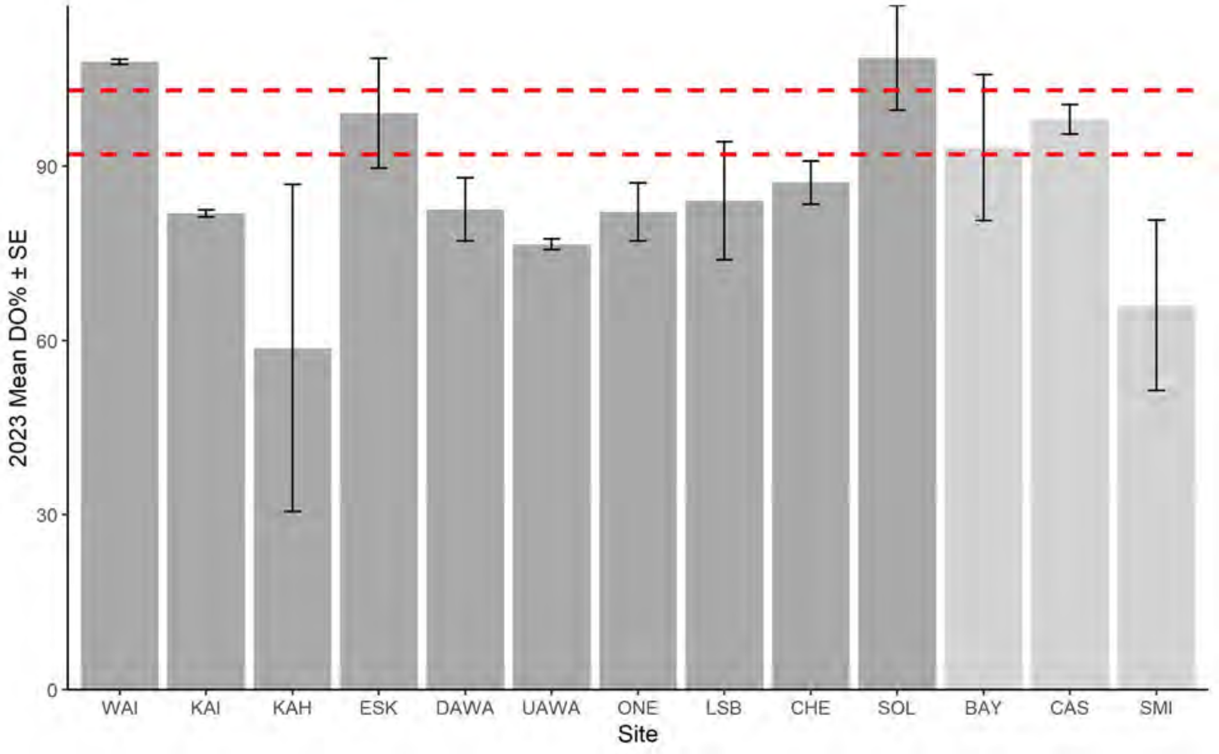


FIGURE 32: DISSOLVED OXYGEN COMPARISONS

Figure 32 shows that the new sites (BAY, CAS, SMI) have similar oxygen levels to the remaining sites. Smith's Bush (SMI) has comparatively lower dissolved oxygen saturation. Further sampling will have clarify whether this is simply a result of small sample size (n=2) or whether the site genuinely has low oxygen concentrations year round. Kahika Creek experienced very low oxygen saturation on 27 March 2023 (30%) during which a suspected sewage cross connection failure was occurring. Sewage fungus was growing on the sides of the stream as well as an abundance of detergent foam which is a sign of detergent presence. Laboratory results confirmed very high total ammonia, total nitrogen and *E. coli* concentrations at this site which also indicates sewage input to the Kahika Creek. Photos and laboratory data was sent to Watercare who have followed up on this. We expect pollution levels at this site to have reduced markedly as a result of the follow up. The next sampling will be undertaken on June 26th 2023.

FIGURE 33: DETERGENT FOAM (LEFT), SEWAGE FUNGUS (RIGHT) AT KAHIKA CREEK

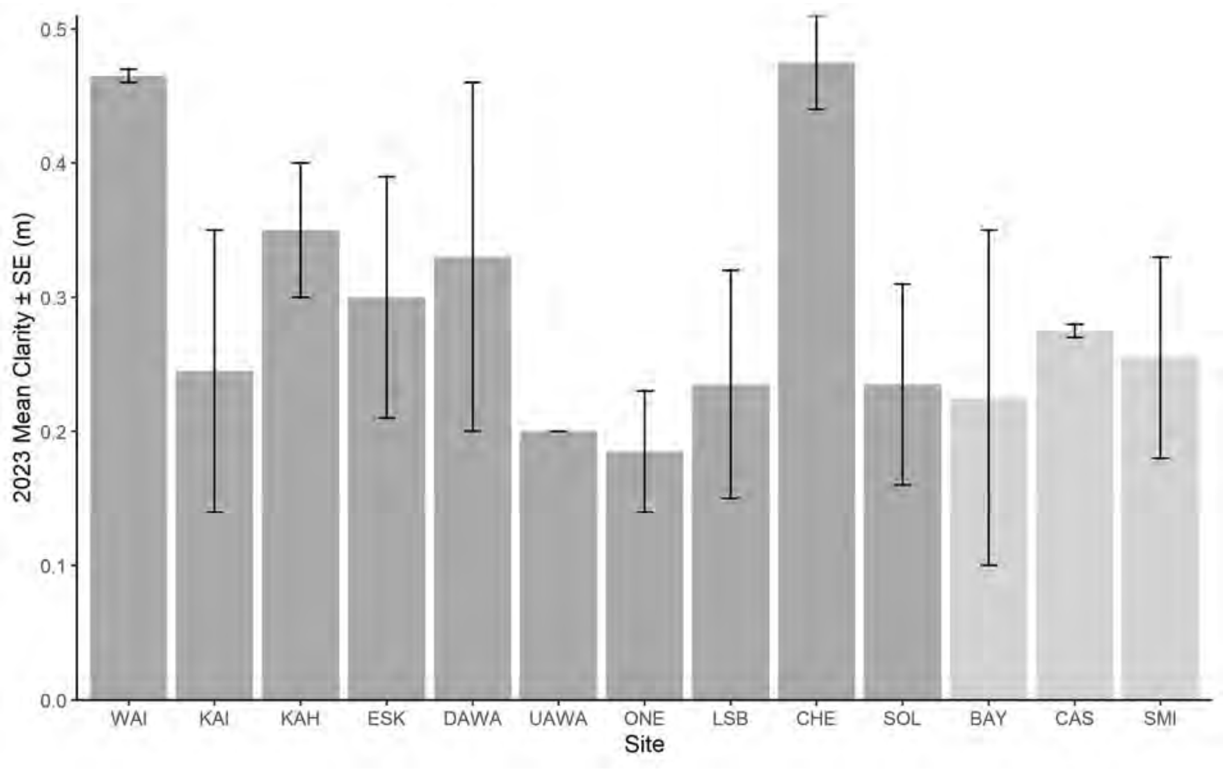


FIGURE 34: WATER CLARITY COMPARISONS

Figure 34 shows that the new sites (BAY, CAS, SMI) have similar water clarity to the remaining sites. As with the other sites compliance with ANZ clarity guidelines is poor (80%ile limit = 0.8m).

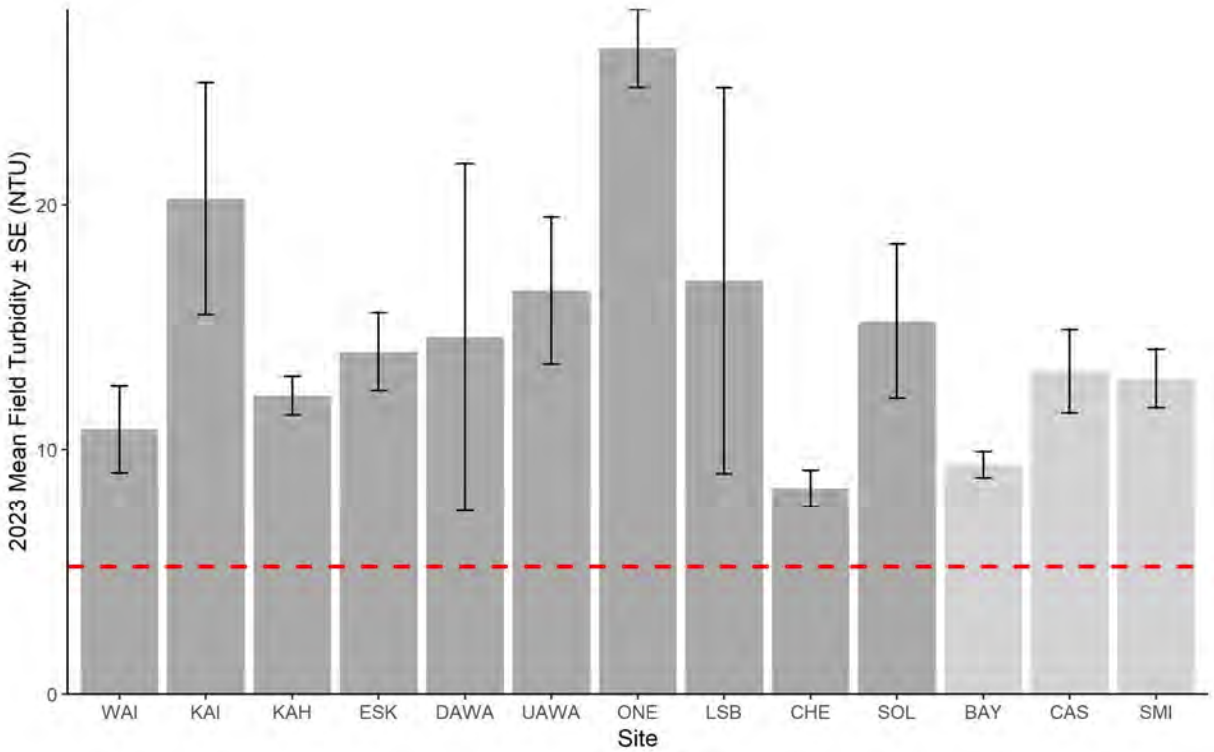


FIGURE 35: TURBIDITY LEVELS AT THE SITES

Figure 35 shows that the new sites (BAY, CAS, SMI) have similar turbidity levels to the remaining sites. Compliance of the 80%ile limit is poor at all sites.

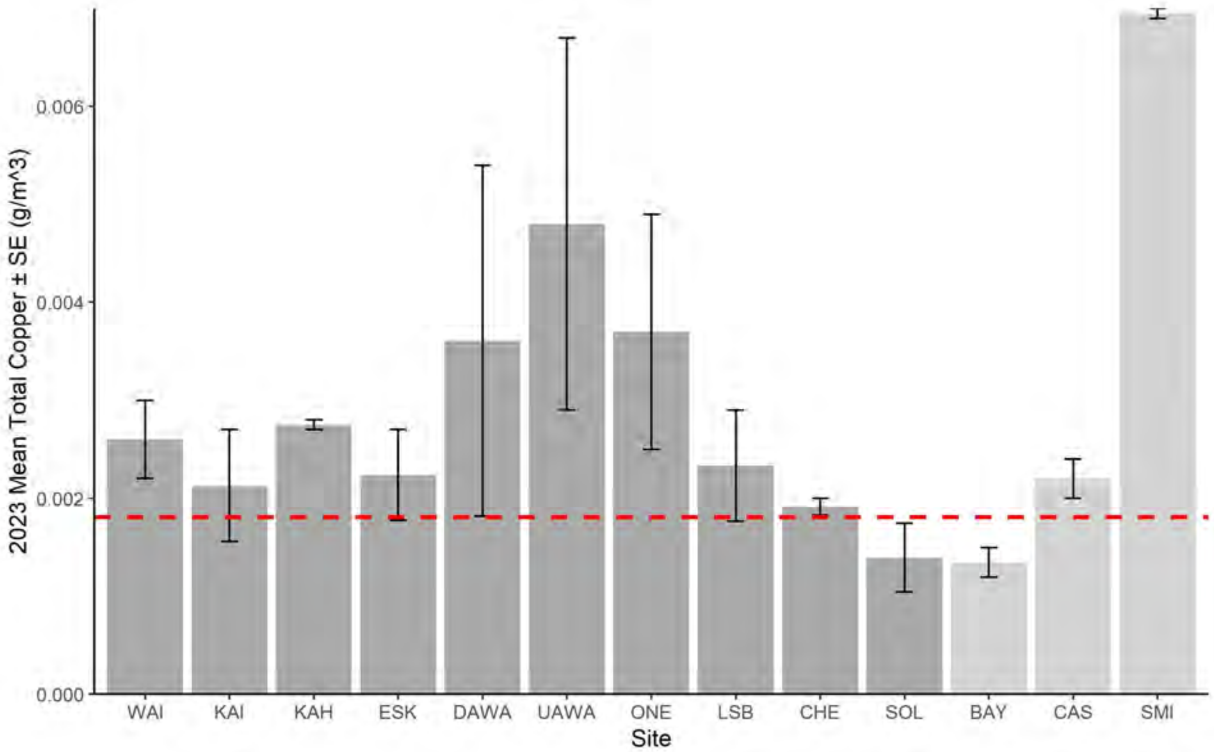


FIGURE 36: TOTAL COPPER CONCENTRATIONS

Figure 36 shows that total copper concentrations are significantly higher at Smiths Bush. The only sites to show compliance with the 0.0018 ANZ guideline are Soldiers Bay Stream and Bayview. The reason for these patterns is unclear.

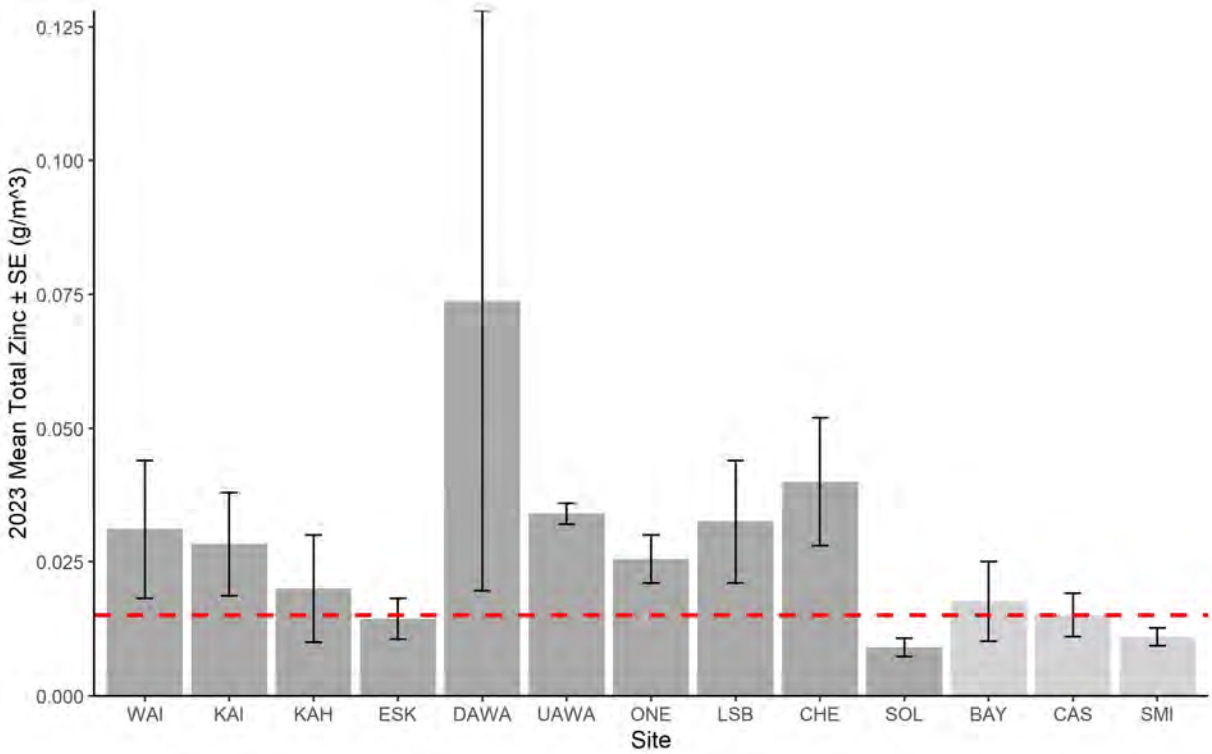


FIGURE 37: TOTAL ZINC CONCENTRATIONS

Figure 37 shows that total zinc concentrations tend to be higher at the downstream Awataha site. Total zinc concentrations at the new sites tend to be comparatively low. The only sites to show compliance with the ANZ limit are Soldiers Bay stream and Smith's Bush.

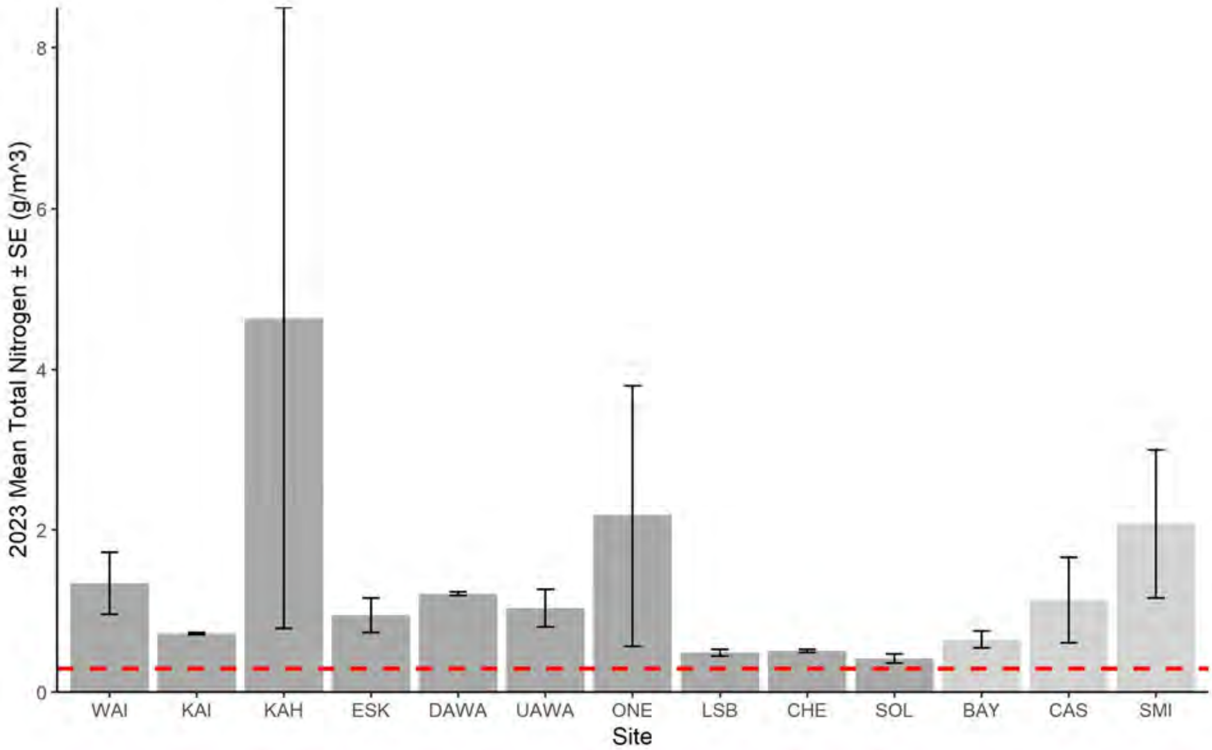


FIGURE 38: TOTAL ZINC CONCENTRATIONS

Figure 38 shows that all sites exceed the ANZ total zinc concentration threshold for 90% protection of species. The new sites have fairly similar concentrations to the remaining sites. Total nitrogen for Kahika is high with large variability owing to the cross connection sewage failure detected in March 2023.

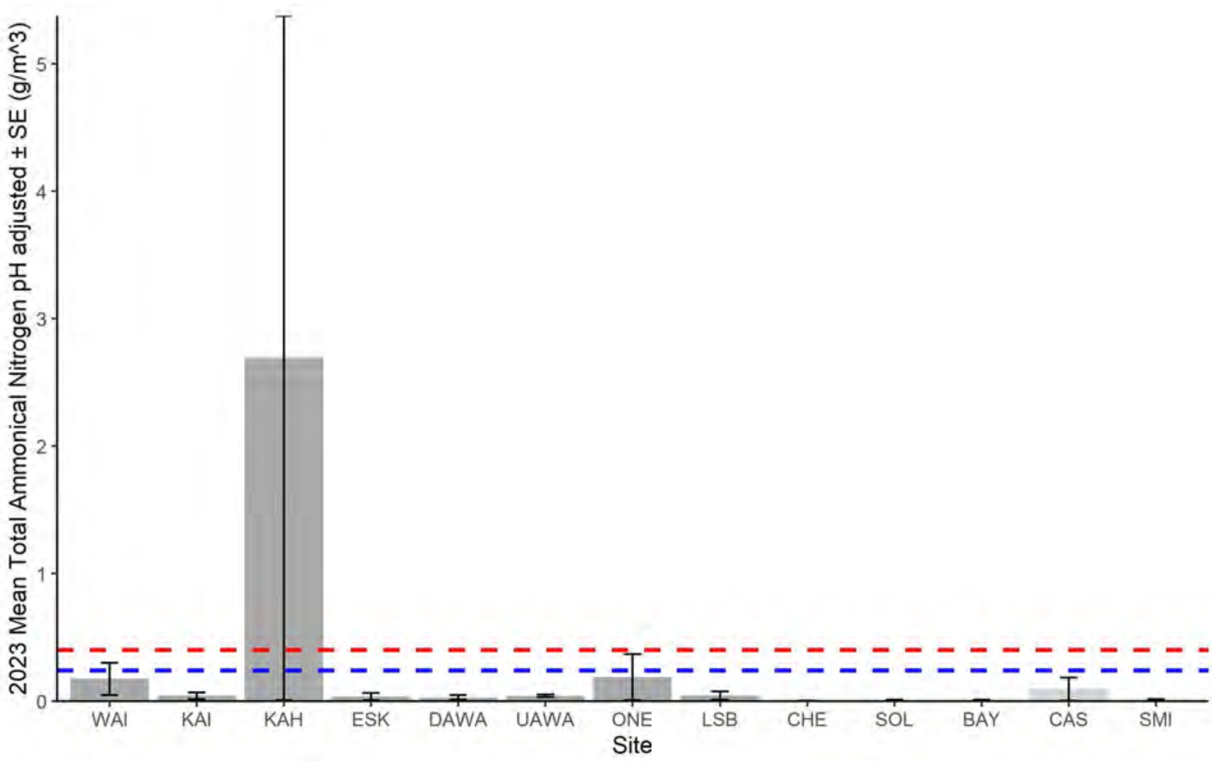


FIGURE 39: TOTAL AMMONIACAL NITROGEN CONCENTRATIONS (PH ADJUSTED)

Figure 39 shows that most sites comply with the Total Ammoniacal Nitrogen 95%ile NPSFM median and 95%ile limits. The exception is Kahika Creek which has had a previous sewage cross connection failure. Because this plot only focuses on the average of the last two sampling occasions, the Kahika Creek result is exaggerated compared to the 3 year statistics.

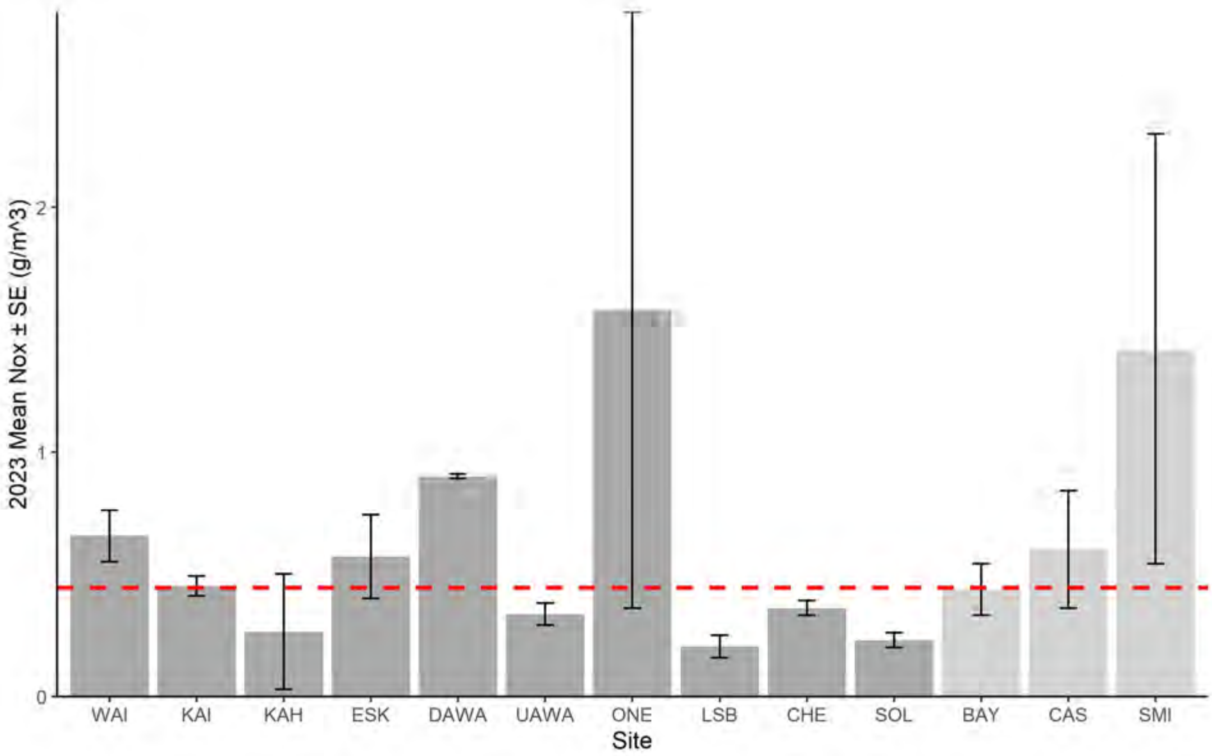


FIGURE 40: NOX CONCENTRATIONS

Figure 40 shows that the new sites have comparable oxidised nitrogen concentrations to the remaining sites.

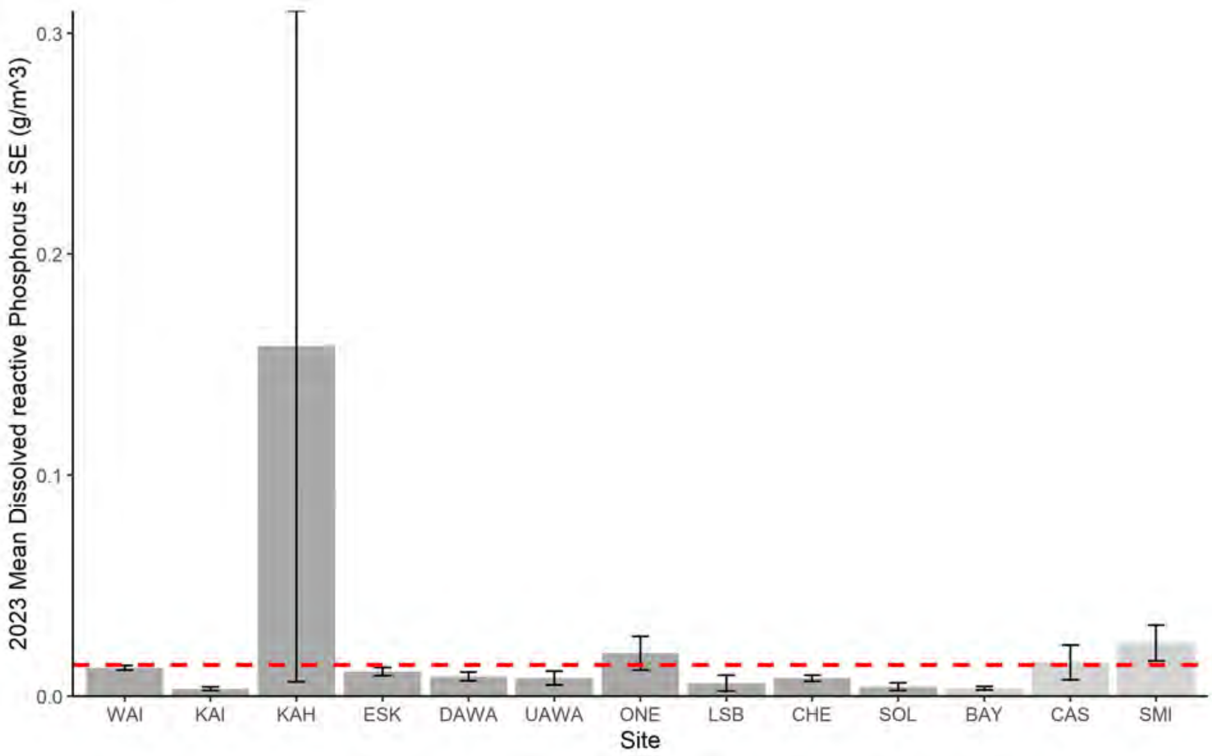


FIGURE 41: DISSOLVED REACTIVE PHOSPHORUS CONCENTRATIONS

Figure 41 shows that the new sites have comparable dissolved reactive phosphorus concentrations to the remaining sites. The Kahika Creek bar is biased due to the recent sewage cross connection failure resulting in abnormally high concentrations of this contaminant.

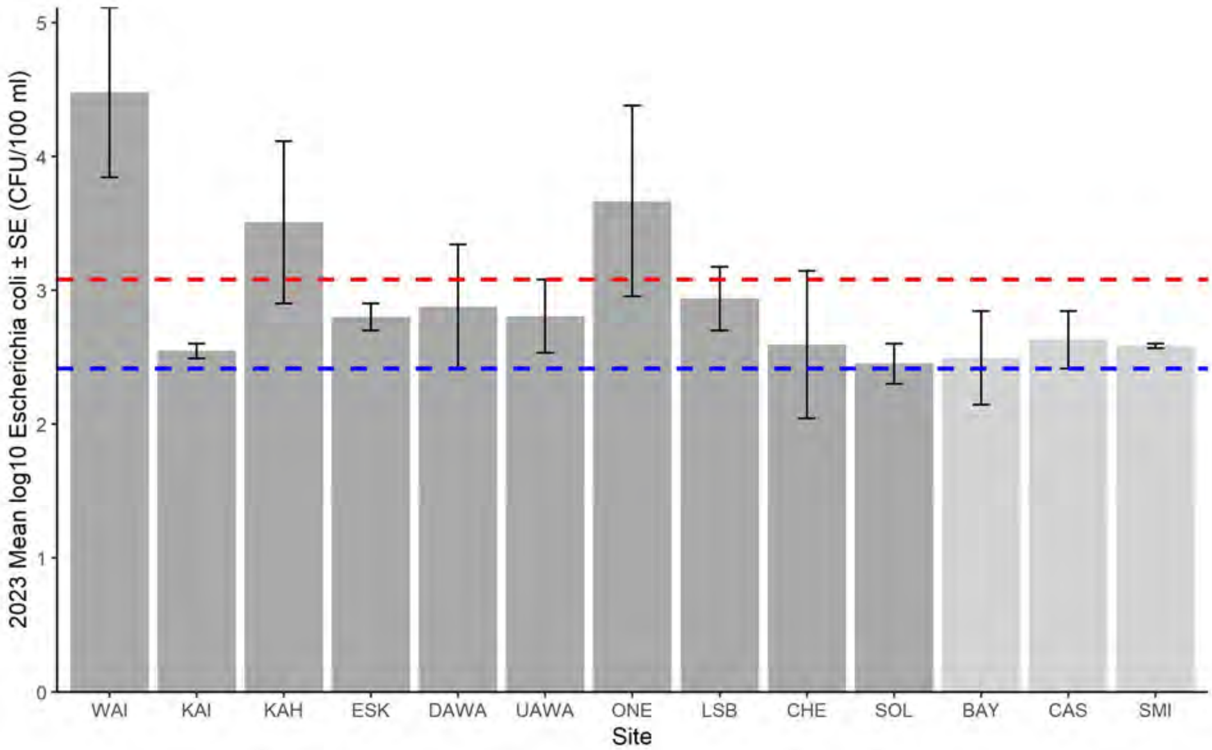


FIGURE 42: E.COLI CONCENTRATIONS

Figure 42 shows that the new sites have similar E.coli concentrations to the remaining sites.

Ecology

Since 2017 aquatic macroinvertebrates have also been sampled as part of the local schools stream care monitoring programme. This section provides combined results of data collated since this time. Data has been grouped according to 2 year blocks to provide adequate sampling replication for each time period/stream combination. Note the NPS-FM 2020 threshold assessments are based on a 5 year median score. The results presented here are therefore preliminary only.

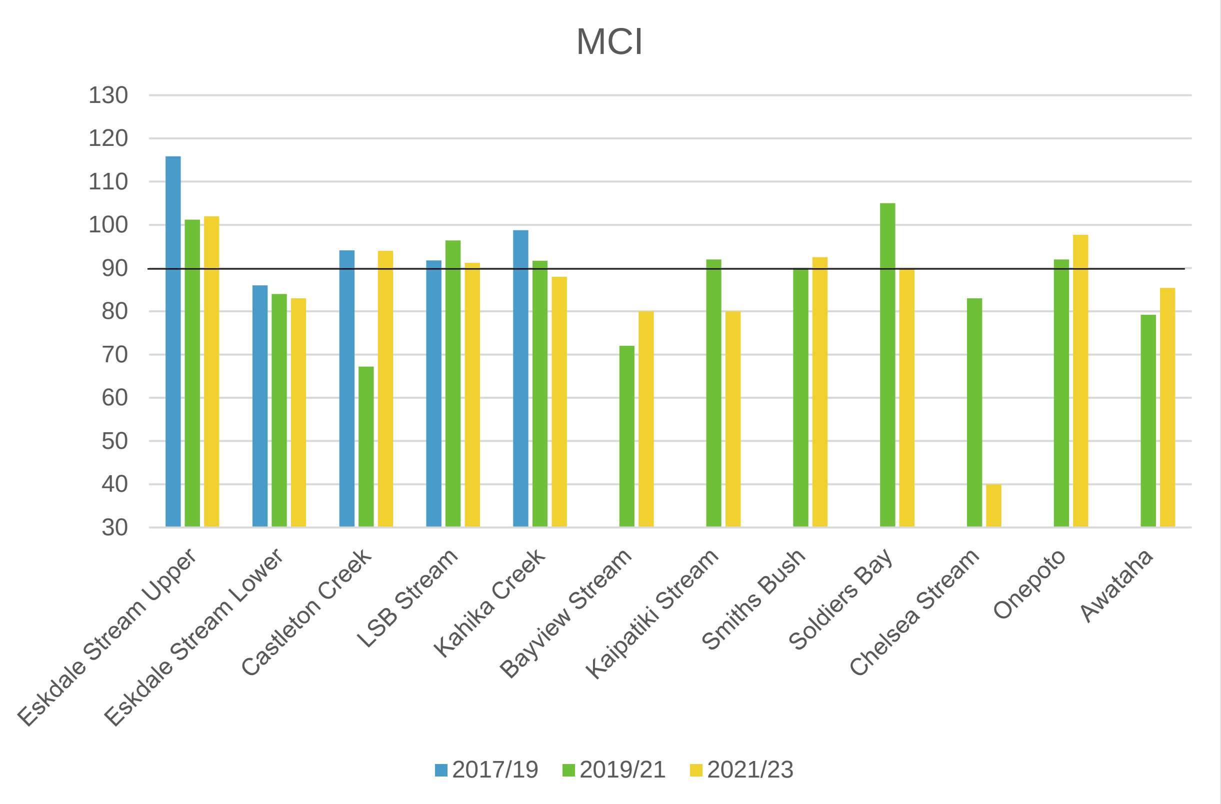


FIGURE 43: MACROINVERTEBRATE COMMUNITY INDEX RESULTS.

Figure 43 shows that some sites are always below the NPS-FM 2020 national bottom line standard for ecosystem health (<90). These sites are Eskdale Stream Lower, Bayview Stream, Chelsea Stream and Awataha Stream. Other sites occasionally drop below the NPS-FM national bottom line (Castleton Creek, Kahika Creek, Kaipatiki Stream) while other sites consistently remain above the NPS-FM national bottom line standard for ecosystem health (Eskdale Stream Upper, Little Shoal Bay Stream, Smiths Bush Stream, Soldiers Bay Stream, Onepoto Stream).

Three sites show a progressive decline in ecosystem health (Eskdale Lower, Kahika Creek, Soldiers Bay Stream) however these changes are not considered to be ecologically significant. The same can be said for the progressive increases in MCI for Bayview Stream, Onepoto Stream, and Awataha Stream).

One site does show a significant decline in ecosystem health (Chelsea Stream; from 83 to 40 MCI), the reason for this decline is unclear and will warrant further investigations.

The Eskdale Stream shows a notable decline between the upper and lower sites. The reason for this decline is likely to be due to the significant sediment inputs that are delivered to the stream from tributaries on the true right bank downstream of the substation. These sediments are most prevalent during high rainfall events. A video of these inputs has been recorded during a rainfall event.

FIGURE 44: INCOMING SEDIMENT LOAD TO THE ESKDALE STREAM

FISH

Fish trapping was undertaken using fine mesh fyke and g minnow trapping following the protocols outlined in Joy @ Death 2013, at all KLB sites with the exception of Wairau Creek and downstream Awataha as these sites do not have sufficient depth or a firm substrate to attach a fish trap to. For this analysis all data for the past three years is presented as one chart. The fish data is condensed into an index of stream condition for fish known as the Index of Biotic Integrity (IBI). The Fish-IBI compares the present fish community to what would be expected given altitude and distance to sea. The study sites were graded ranging from excellent, very good, good, and fair (Table 4). Sites that fall into the Fair category could have issues with fish passage or fish habitat provision.

TABLE 4: FISH IBI RESULTS

Index of Biological Integrity - Auckland Region : Fish

Centre for Freshwater Ecosystem Modelling and Management, Massey University

Site	IBI score	Rating
Eskdale	54	Excellent
Castleton	50	Excellent
LSB	46	Very Good
Kahika	50	Excellent
Bayview	48	Very Good
Kaipatiki	28	Fair
Smith's Bush	40	Good
Soldiers Bay	50	Excellent
Chelsea	30	Fair
Onepoto	46	Very Good
Awataha	30	Fair

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Table 4 shows that most sites fall within the good to excellent category, however three sites (Kaipatiki, Chelsea and Awataha) fall within the Fair category. These three sites could have fish passage or fish habitat provision issues as the fish fauna found at these sites is less than that expected for a stream of similar altitude and distance to sea.

Discussion

The Kaipatiki Local Board Water Quality Monitoring Programme has revealed a number of spatial and temporal trends that are worthy of note.

- Most sites fall below the required % Saturation Dissolved Oxygen threshold for aquatic ecosystem protection, except Wairau Creek which is usually super saturated (too high). Soldiers Bay Stream shows the closest resemblance to compliance with this guideline but falls just shy of the 20%ile limit (92%) with a value of 89%. Upstream Awataha is showing rising concentrations of dissolved oxygen over time, this is a good result and could be due to riparian enhancement works occurring at this site or could be due to flow.
- All sites except Chelsea Stream fail to meet the ANZ water clarity and turbidity requirement for protection of aquatic ecosystems. Chelsea Stream passes the Turbidity requirement but fails the clarity requirement. Four sites are demonstrating rises in field turbidity measurements (Awataha up and downstream, Chelsea Stream and Soldiers Bay Stream). The reason for the trends is unclear and warrants further investigation.
- All sites fail to meet the ANZ total and dissolved copper 80% species protection guideline. An upward trend of total copper has been observed at the downstream Awataha site; however this is suspected to be due to flow as three other sites have shown increases due to flow.

- All sites except Soldiers Bay Stream fail to meet the ANZ total and dissolved zinc 80% species protection guideline.
- Soldiers Bay Stream demonstrates the lowest metal concentrations of all the sites, conversely Chelsea Stream demonstrates the highest zinc concentrations while upstream Awataha demonstrates the highest copper concentrations.
- All sites exceed the 80%ile total nitrogen ANZ guideline, lower concentrations are displayed at little shoal bay and soldiers bay stream. Increases of total nitrogen at four sites have been observed however for two of these the increases are due to flow. It is possible that this is also the case for streams that are not monitored for flow.
- All sites are compliant with the NPSFM total ammoniacal nitrogen toxicity 95%ile limit
- All sites are compliant with the NPSFM national bottom line regarding nitrate toxicity limit.
- All sites except soldiers bay stream exceed the ANZ limits for oxidized nitrogen and total phosphorus.
- All sites except Downstream Awataha, Eskdale, Onepoto and Chelsea stream are compliant with the ANZ dissolved reactive phosphorus guidelines. Concentrations of dissolved reactive phosphorus are declining at Chelsea Stream, the reason for this is unclear as this site is not monitored for flow.
- All sites except soldiers bay stream exceed the median and 95%ile limits for *E. coli*. Soldiers Bay Stream exceeds the median limit but passes the 95% limit for *E.coli*.
- *E. coli* concentrations are increasing at Onepoto and Wairau Creek. In the case of Wairau Creek the increase is due to increase loadings occurring within the catchment. A sanitary survey of this catchment is warranted as this site has previously recorded 130,000 *E. coli*. Onepoto is not monitored for flow so it is difficult to determine the reason for *E. coli* increases at this site. A sanitary survey of this site is also warranted as previously *E. coli* has reached 160,000 *E. coli* / 100ml which exceeds expectations for freshwater environments. A recent high *E. coli* and nitrogen species result at Kahika Creek prompted a submission to Watercare. Our understanding is that sewage cross connection failures in this area has occurred. We expect *E. coli* concentrations to come down at this site as a result of these works.

In December 2022 three additional sites were added to the programme, results of the last two sampling occasions reveal that these sites (Bayview Stream, Castleton Creek and Smith's Bush Stream) have similar water quality characteristics to the other ten sites. An exception is Smiths Bush which so far has shown very high Total Copper concentrations compared to the remaining sites. This could be an artefact of small sampling size; however further monitoring will confirm whether this spatial trend remains.

There are four sites that consistently fail to meet the National Policy Statement for Freshwater Management bottom line for aquatic ecosystem health (MCI>90). These sites are lower Eskdale Stream, Bayview Stream, Chelsea Stream and Awataha Stream. In the case of Eskdale Stream the reason for the poor ecosystem health is likely to be due to large sediment loadings entering the stream during storm events. The delivery of sediment from the incoming tributaries on the true right bank is highly evident downstream of the substation on Eskdale Rd. Upstream monitoring of the remaining sites during storm events could help determine whether the same sediment loading impact is occurring at theses streams. Other sites periodically drop below the NPSFM threshold (Castleton Creek, Kahika Creek, Kaipatiki Stream) while other sites consistently remain above the NPS-FM bottom line threshold (Eskdale Stream upper, Little Shoal Bay Stream, Smiths Bush Stream, Soldiers Bay Stream, Onepoto Stream). Chelsea

Stream has shown a substantial decline in MCI value from 83 to 40. Further investigations of this catchment are warranted.

Fish monitoring reveals that most sites have good to excellent fish fauna representative of good stream habitat for native fish. Three exceptions are Awataha Stream, Chelsea Stream and Kaipatiki Stream which show fair condition possibly indicating fish passage or habitat provision issues. A fish passage survey and stream ecological valuation of these catchments would help determine whether this is the reason for poor fish communities in these sites.

The most compliant site of the KLB WQ monitoring programme is Soldiers Bay Stream. A study of catchment pressures and comparison of stream ecological valuations may reveal potential reasons for the better water quality at this site. It is important to study catchment pressures and conduct stream habitat assessments to gain a better understanding of what potential improvements could be made to our sites and catchments that are failing NPSFM bottom line standards.

The least compliant sites of the KLB WQ monitoring programme depends on the contaminant being examined.

The least compliant site for oxygen concentrations, water clarity, total and soluble copper, concentrations, and total phosphorus concentrations is the upstream Awataha Stream site. This stream is the smallest of the entire group. Potential ways to ameliorate the contaminant impacts on this stream would be to:

- Augment the stream flow with groundwater recharge. This could be achieved using a solar powered groundwater pump that delivered water back to the stream. The upstream Awataha site turns into a series of stagnant pools in the summer. These pools contain bacteria that breakdown organic matter giving rise to a depletion of oxygen in the water column. A greater flow delivery to the stream would ensure organic matter would be exported from the pools to the downstream culvert that runs under kaka street.
- Create a wetland near the true right bank and divert all stormwater discharges to the wetland that would remove particulates from the water column which then would flow back to the stream. This would improve the water quality of the stream; however it would still need groundwater augmentation to make the stream larger in volume such that it did not stagnate in the summer.

Continued riparian plantings in the upper catchment is potentially helping the Awataha Stream stream as oxygen concentrations do appear to be rising over time, however the stream is too small to cope with the contaminant loading it receives at present and the two suggestions above would need to occur to see an improvement in stream health.

The least compliant site for total and soluble zinc is the Chelsea Stream. The high zinc concentrations could be due to roof and spouting of houses in the catchment or possibly traffic volumes providing a high zinc loading to the stream. Further research of the catchment pressures would be needed to understand why this site has higher zinc.

Total nitrogen concentrations are highest at the Wairau and downstream Awataha sites. This is not surprising as both of these sites are predominantly concrete. Wairau Creek is an open concrete lined channel while downstream Awataha is a stormwater pipe which is located down a manhole. Both of these sites would benefit from having a natural stream bed as opposed to being concrete or alternatively being converted into surface flowing wetlands. Natural stream channels and wetlands have connection with groundwater and also have higher colonizable surface area on which stream biota can reside. A natural stream or wetland channel has the advantage of having some denitrification processes that can convert dissolved nitrogen to nitrogen gas. The Wairau Creek site adjoins Marlborough Park and a constructed wetland to treat stormwater inputs would benefit this stream greatly.

Dissolved reactive phosphorus concentrations is highest at Onepoto Stream, it is difficult to know the reason for this. Sewage connection failures could be a potential source of phosphorus to the stream but without further investigations a remedy for this problem cannot be advised.

Wairau Creek is the most non-compliant with respect to *E. coli* concentrations. There is evidence to suggest that sewage cross connection failures have occurred within this catchment. The 130000 *E. coli* cfu/100ml count which was recorded on 19th December 2022 signals potential sewage overflows or cross connection failures.

Conclusions

The Kaipatiki Local Board Water Quality and Ecology Monitoring Programme has identified streams of concern where catchment improvements are required to ensure compliance with the National Policy Statement for Freshwater Management water quality standards and associated objectives.

The results of this programme can feed into Auckland Council's Plan Implementation Programme as well as RMA section 35 reporting to ensure that streams of the Kaipatiki Local Board area are acknowledged and receive appropriate mitigation measures to ensure streams are compliant with relevant standards and guidelines.

Recommendations

For some stream catchments mitigation methods have been suggested in this report (Awataha Stream, Wairau Creek), while for other stream catchments further investigations are required to formulate appropriate mitigation methods (Onepoto Stream, Eskdale lower, Chelsea Stream, Bayview). Sanitary surveys are warranted for Wairau Creek and Onepoto stream for which sewage cross connection repairs may be all that is required to improve water quality in these catchments. Fish pass surveys are recommended for the Kaipatiki Creek, Chelsea Stream and Awataha stream to identify any potential fish barriers.

Continued monitoring of the streams is recommended to ensure greater statistical power in our analysis of these streams. Concurrent stream gaugings are recommended for Chelsea Stream, Onepoto Stream and Soldiers Bay Stream. With flow information we are then able to determine whether any observed trends are due to flow or due to an increase in contaminant catchment loading. There is also now potential to undertake concurrent stream gaugings within the newly created Awataha Stream Greenway in Northcote. This flow information would be useful for determining the reason for trends in raw data observed in the Awataha Stream.

The use of rain tanks on all properties within the Kaipatiki Local Board Area is recommended to ensure that stormwater first flush effects on aquatic ecosystems are minimised.

A targeted storm event sampling regime for the upper and lower Chelsea Stream, Bayview Stream, Awataha Streams is recommended to determine whether suspended sediment inputs to these streams could be contributing to poor ecosystem health at these sites. This may not even require water sampling as Figure 44 of this report reveals sometimes sediment sources can be easily captured by camera.

A study of stream catchment pressures would help determine why some sites have particularly good or poor water quality. This component of “pressure – state – response” is often overlooked in monitoring programmes and without this information appropriate mitigation methods cannot be formulated.

Acknowledgements

The Kaipatiki Local Board’s commitment to monitoring and improvement of local streams within the area is acknowledged. Without funding from the local board we would have no understanding of the water quality or ecological state of our streams.

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Appendix 1: Temporal Trend Results - Mann Kendall

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median value	Kendall statistic	Variance	Z	P	N (slopes)	Median annual slope	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	pH	0	0	0	11	1/10/19-19/12/22	7.876	8.83	7.17	7.755	-17	165	-1.246	0.213	11	-0.135	-1.737	-0.530 to 0.179	0.914	Decreasing trend possible
WAI	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-19/12/22	13558.18	130000	270	1200	25	165	1.868	0.062	11	1197.541	99.795	-120.604 to 4056.785	0.966	Increasing trend likely
KAI	pH	0	0	0	11	1/10/19-19/12/22	6.944	7.49	6.58	6.95	-8	164	-0.547	0.585	11	-0.039	-0.557	-0.283 to 0.103	0.759	Decreasing trend about as likely as not
KAI	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-19/12/22	1339.091	4400	90	1000	-1	165	0	1	11	-120.123	-12.012	-1025.571 to 616.344	0.584	Trend exceptionally unlikely
KAH	pH	1	0	0	11	1/10/19-30/1/23	6.975	7.35	6.6	7.14	-14	165	-1.012	0.312	11	-0.06	-0.842	-0.286 to 0.103	0.879	Decreasing trend possible
KAH	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-30/1/23	2659.091	16850	200	550	15	165	1.09	0.276	11	281.25	51.136	-155.160 to 1902.818	0.854	Increasing trend possible
ESK	pH	0	0	0	11	1/10/19-30/1/23	7.12	7.44	6.655	7.195	-11	165	-0.778	0.436	11	-0.066	-0.917	-0.230 to 0.198	0.814	Decreasing trend about as likely as not
ESK	Escherichia coli (cfu/100ml)	1	0	0	11	1/10/19-30/1/23	1351.364	9500	110	510	9	165	0.623	0.533	11	127.5	25	-201.435 to 316.578	0.745	Increasing trend about as likely as not
DAWA	pH	1	0	0	11	1/10/19-30/1/23	7.277	7.99	6.67	7.305	-15	165	-1.09	0.276	11	-0.133	-1.822	-0.378 to 0.076	0.896	Decreasing trend possible
DAWA	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-30/1/23	2432.273	18000	200	1000	-18	164	-1.327	0.184	11	-317.422	-31.742	-771.309 to 94.614	0.931	Decreasing trend possible
UAWA	pH	0	0	0	11	1/10/19-30/1/23	6.965	7.24	6.51	7.04	-3	165	-0.156	0.876	11	-0.03	-0.426	-0.301 to 0.183	0.640	Trend unlikely
UAWA	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-30/1/23	955.909	4150	200	565	3	165	0.156	0.876	11	17.158	3.037	-513.523 to 392.166	0.538	Trend unlikely
ONE	pH	0	0	0	11	1/10/19-30/1/23	7.301	7.775	6.78	7.4	-16	164	-1.171	0.241	11	-0.096	-1.303	-0.437 to 0.151	0.908	Decreasing trend possible
ONE	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-30/1/23	1910.455	12450	150	655	29	165	2.18	0.029	11	270.111	41.238	31.617 to 1370.676	0.986	Increasing trend very likely
LSB	pH	0	0	0	11	1/10/19-30/1/23	7.162	7.725	6.51	7.29	-21	165	-1.557	0.119	11	-0.165	-2.259	-0.372 to 0.146	0.960	Decreasing trend possible
LSB	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-30/1/23	1622.273	9100	100	400	6	164	0.39	0.696	11	60	15	-130.680 to 660.735	0.652	Trend unlikely
CHE	pH	0	0	0	11	1/10/19-30/1/23	7.274	7.645	6.695	7.31	-3	165	-0.156	0.876	11	-0.036	-0.487	-0.341 to 0.169	0.620	Trend unlikely
CHE	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-30/1/23	733.182	2850	35	205	9	165	0.623	0.533	11	59.975	29.256	-149.144 to 633.635	0.733	Increasing trend about as likely as not
SOL	pH	1	0	0	11	1/10/19-19/12/22	7.351	7.82	6.71	7.455	-20	164	-1.484	0.138	11	-0.15	-2.011	-0.497 to 0.121	0.949	Decreasing trend possible
SOL	Escherichia coli (cfu/100ml)	0	0	0	11	1/10/19-19/12/22	250	1000	80	130	17	163	1.253	0.21	11	21.76	16.738	-22.674 to 142.583	0.895	Increasing trend possible

Seasonal kendall outputs

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	Temperature C	0	0	0	14	16/8/19-19/12/22	16.468	19.8	13.25	15.9	0	24.667	0	1	14	0.029	0.184	-0.293 to 0.548	0.500	No detectable trend
WAI	DO %	0	0	0	14	16/8/19-19/12/22	115.182	136.05	102.4	111.625	-10	24.667	-1.812	0.07	14	-4.351	-3.898	-8.075 to -0.603	0.986	Decreasing trend likely
WAI	DO (mg/l)	0	0	0	14	16/8/19-19/12/22	11.27	12.5	10.07	11.18	-10	24.667	-1.812	0.07	14	-0.601	-5.377	-0.836 to -0.095	0.992	Decreasing trend likely
WAI	SPC (uS/cm @ 25 C)	0	0	0	14	16/8/19-19/12/22	251.854	332.9	126.6	259.95	-2	24.667	-0.201	0.84	14	-9.681	-3.724	-43.127 to 42.357	0.663	Trend unlikely
WAI	EC (uS/cm)	10	0	0	10	28/9/20-19/12/22	202.96	289.7	103.6	210.85	2	9.333	0.327	0.743	10	17.377	8.241	-39.063 to 56.154	0.655	Trend unlikely
WAI	Clarity Adj (m)	10	0	0	10	28/9/20-19/12/22	0.491	0.798	0.21	0.496	0	9.333	0	1	10	-0.023	-4.684	-0.377 to 0.114	0.500	No detectable trend
KAI	Temperature C	0	0	0	14	16/8/19-19/12/22	14.814	17.3	11.6	14.8	8	24.667	1.409	0.159	14	0.475	3.21	-0.224 to 1.181	0.909	Increasing trend possible
KAI	DO %	0	0	0	14	16/8/19-19/12/22	76.439	92	53	76.05	0	24.667	0	1	14	0.988	1.299	-6.622 to 8.954	0.500	No detectable trend
KAI	DO (mg/l)	0	0	0	14	16/8/19-19/12/22	8	9.605	5.16	7.93	-2	24.667	-0.201	0.84	14	-0.158	-1.993	-0.627 to 0.341	0.710	Trend unlikely
KAI	SPC (uS/cm @ 25 C)	0	0	0	14	16/8/19-19/12/22	218.096	258.5	110.9	230.975	2	24.667	0.201	0.84	14	2.472	1.07	-13.721 to 12.913	0.574	Trend unlikely
KAI	EC (uS/cm)	10	0	0	10	28/9/20-19/12/22	172.055	204.7	86.7	192.35	4	9.333	0.982	0.326	10	33.747	17.545	-10.145 to 64.730	0.903	Increasing trend possible
KAI	Clarity Adj (m)	10	0	0	10	28/9/20-19/12/22	0.38	0.594	0.14	0.412	-2	9.333	-0.327	0.743	10	-0.11	-26.72	-0.266 to 0.383	0.855	Trend unlikely
KAH	Temperature C	1	0	0	15	16/8/19-27/3/23	14.507	17.9	10.8	14.7	7	29.667	1.102	0.271	15	0.65	4.421	-0.150 to 1.452	0.887	Increasing trend possible
KAH	DO %	1	0	0	15	16/8/19-27/3/23	82.237	93.85	30.5	86.8	-5	29.667	-0.734	0.463	15	-1.063	-1.225	-10.265 to 0.649	0.858	Decreasing trend about as likely as not
KAH	DO (mg/l)	1	0	0	15	16/8/19-27/3/23	8.456	10.135	2.94	8.48	-11	29.667	-1.836	0.066	15	-0.3	-3.54	-0.764 to -0.012	0.984	Decreasing trend likely
KAH	SPC (uS/cm @ 25 C)	1	0	0	15	16/8/19-27/3/23	224.937	327.5	140.6	227.6	7	29.667	1.102	0.271	15	9.265	4.071	-18.474 to 35.650	0.872	Increasing trend possible
KAH	EC (uS/cm)	10	0	0	11	28/9/20-27/3/23	186.245	278.2	110.6	186.4	4	12	0.866	0.386	11	16.489	8.846	-11.656 to 45.589	0.861	Increasing trend about as likely as not
KAH	Clarity Adj (m)	10	0	0	11	28/9/20-27/3/23	0.434	0.64	0.09	0.46	-4	12	-0.866	0.386	11	-0.089	-19.26	-0.154 to 0.199	0.909	Decreasing trend about as likely as not
ESK	Temperature C	0	0	0	15	16/8/19-27/3/23	14.763	18.2	10.7	15.3	5	29.667	0.734	0.463	15	0.35	2.289	-0.594 to 0.822	0.750	Increasing trend about as likely as not
ESK	DO %	0	0	0	15	16/8/19-27/3/23	84.437	108.5	56.35	85.8	7	29.667	1.102	0.271	15	3.302	3.849	-2.566 to 7.760	0.869	Increasing trend possible
ESK	DO (mg/l)	0	0	0	15	16/8/19-27/3/23	8.612	10.69	5.405	8.78	5	29.667	0.734	0.463	15	0.383	4.362	-0.569 to 0.679	0.743	Increasing trend about as likely as not
ESK	SPC (uS/cm @ 25 C)	0	0	0	15	16/8/19-27/3/23	235.533	267.5	150.6	239.1	1	29.667	0	1	15	0.194	0.081	-9.938 to 4.877	0.505	Trend exceptionally unlikely
ESK	EC (uS/cm)	10	0	0	11	28/9/20-27/3/23	187.518	234.1	113.4	194.6	2	12	0.289	0.773	11	1.842	0.946	-15.455 to 29.591	0.540	Trend unlikely

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
ESK	Clarity Adj (m)	10	0	0	11	28/9/20-27/3/23	0.386	0.532	0.1	0.43	-1	11	0	1	11	-0.009	-2.206	-0.177 to 0.073	0.727	Trend exceptionally unlikely
DAWA	Temperature C	1	0	0	14	16/11/19-15/2/23	18.436	23.35	11.2	18.85	-4	24.667	-0.604	0.546	14	-0.35	-1.857	-1.378 to 0.800	0.855	Decreasing trend about as likely as not
DAWA	DO %	1	0	0	14	16/11/19-15/2/23	84.929	103.65	70.5	83.3	-8	24.667	-1.409	0.159	14	-5.125	-6.152	-13.652 to 2.358	0.955	Decreasing trend possible
DAWA	DO (mg/l)	1	0	0	14	16/11/19-15/2/23	7.914	9.55	6.81	7.865	-8	24.667	-1.409	0.159	14	-0.581	-7.382	-1.030 to 0.268	0.962	Decreasing trend possible
DAWA	SPC (uS/cm @ 25 C)	1	0	0	14	16/11/19-15/2/23	256.9	317.2	115.5	281	8	24.667	1.409	0.159	14	18.162	6.463	-4.668 to 56.740	0.895	Increasing trend possible
DAWA	EC (uS/cm)	9	0	0	11	28/9/20-15/2/23	244.536	296.9	188.3	250	0	12	0	1	11	0.15	0.06	-18.390 to 31.899	0.500	No detectable trend
DAWA	Clarity Adj (m)	9	0	0	11	28/9/20-15/2/23	0.325	0.5	0.08	0.391	-4	12	-0.866	0.386	11	-0.064	-16.485	-0.281 to 0.028	0.934	Decreasing trend about as likely as not
UAWA	Temperature C	0	0	0	14	16/11/19-15/2/23	16.261	19.3	12.9	16.25	0	24.667	0	1	14	0.05	0.308	-0.739 to 0.988	0.500	No detectable trend
UAWA	DO %	0	0	0	14	16/11/19-15/2/23	65.168	84.2	22.75	67.6	12	24.667	2.215	0.027	14	7.064	10.449	0.947 to 13.611	0.986	Increasing trend very likely
UAWA	DO (mg/l)	0	0	0	14	16/11/19-15/2/23	6.485	8.87	2.185	6.543	12	24.667	2.215	0.027	14	0.61	9.325	0.183 to 1.380	0.983	Increasing trend very likely
UAWA	SPC (uS/cm @ 25 C)	0	0	0	14	16/11/19-15/2/23	249.611	269.1	181.7	258.1	-6	24.667	-1.007	0.314	14	-3.192	-1.237	-9.320 to 5.920	0.926	Decreasing trend possible
UAWA	EC (uS/cm)	8	0	0	11	28/9/20-15/2/23	205.141	238.5	144.2	212.3	-2	12	-0.289	0.773	11	-5.179	-2.439	-21.342 to 35.967	0.809	Trend unlikely
UAWA	Clarity Adj (m)	8	0	0	11	28/9/20-15/2/23	0.33	0.594	0.12	0.32	-4	12	-0.866	0.386	11	-0.11	-34.399	-0.295 to 0.094	0.924	Decreasing trend about as likely as not
ONE	Temperature C	0	0	0	15	16/8/19-27/3/23	14.873	18.1	11.3	15.1	5	29.667	0.734	0.463	15	0.453	2.999	-0.291 to 1.020	0.806	Increasing trend about as likely as not
ONE	DO %	0	0	0	15	16/8/19-27/3/23	84.743	99.4	73.7	82.8	-7	29.667	-1.102	0.271	15	-2.475	-2.989	-7.407 to 1.736	0.919	Decreasing trend possible
ONE	DO (mg/l)	0	0	0	15	16/8/19-27/3/23	8.626	10.875	6.96	8.45	-7	29.667	-1.102	0.271	15	-0.282	-3.342	-0.766 to 0.051	0.941	Decreasing trend possible
ONE	SPC (uS/cm @ 25 C)	0	0	0	15	16/8/19-27/3/23	242.617	304.1	182.4	245.5	1	29.667	0	1	15	3.602	1.467	-10.921 to 19.065	0.530	Trend exceptionally unlikely
ONE	EC (uS/cm)	10	0	0	11	28/9/20-27/3/23	193.264	252.3	143.3	197.3	6	12	1.443	0.149	11	16.141	8.181	-11.119 to 26.312	0.909	Increasing trend possible
ONE	Clarity Adj (m)	10	0	0	11	28/9/20-27/3/23	0.337	0.5	0.14	0.32	-4	12	-0.866	0.386	11	-0.085	-26.585	-0.218 to 0.060	0.928	Decreasing trend about as likely as not
LSB	Temperature C	0	0	0	15	16/8/19-27/3/23	15.267	18.4	11.85	15.4	7	29.667	1.102	0.271	15	0.356	2.311	-0.437 to 0.908	0.850	Increasing trend possible

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
LSB	DO %	0	0	0	15	16/8/19-27/3/23	81.78	95.4	60.8	83.9	-5	29.667	-0.734	0.463	15	-2.937	-3.5	-9.131 to 2.413	0.834	Decreasing trend about as likely as not
LSB	DO (mg/l)	0	0	0	15	16/8/19-27/3/23	8.228	10.17	6.03	8.73	-5	29.667	-0.734	0.463	15	-0.363	-4.161	-1.122 to 0.260	0.869	Decreasing trend about as likely as not
LSB	SPC (uS/cm @ 25 C)	0	0	0	15	16/8/19-27/3/23	242.177	309.1	96.9	259.2	14	28.667	2.428	0.015	15	11.142	4.299	2.858 to 20.547	0.992	Increasing trend very likely
LSB	EC (uS/cm)	10	0	0	11	28/9/20-27/3/23	192.527	260.9	76.5	218.8	10	12	2.598	0.009	11	17.131	7.829	4.035 to 42.881	0.99	Increasing trend virtually certain
LSB	Clarity Adj (m)	10	0	0	11	28/9/20-27/3/23	0.405	1.072	0.145	0.35	4	12	0.866	0.386	11	0.068	19.315	-0.218 to 0.267	0.744	Increasing trend about as likely as not
CHE	Temperature C	0	0	0	15	16/8/19-27/3/23	15.18	18.1	11.8	15.3	10	28.667	1.681	0.093	15	0.5	3.27	-0.144 to 1.040	0.954	Increasing trend likely
CHE	DO %	0	0	0	15	16/8/19-27/3/23	87.012	97.7	32.53	90.6	-1	29.667	0	1	15	-0.075	-0.083	-4.552 to 6.272	0.612	Trend exceptionally unlikely
CHE	DO (mg/l)	0	0	0	15	16/8/19-27/3/23	11.088	37.41	7.98	9.45	-9	29.667	-1.469	0.142	15	-0.207	-2.186	-0.757 to 0.002	0.974	Decreasing trend possible
CHE	SPC (uS/cm @ 25 C)	0	0	0	15	16/8/19-27/3/23	251.24	417.2	76.2	260.1	-3	29.667	-0.367	0.713	15	-6.332	-2.435	-40.800 to 11.944	0.728	Trend unlikely
CHE	EC (uS/cm)	10	0	0	11	28/9/20-27/3/23	191.927	235.5	59.3	216	0	12	0	1	11	-0.5	-0.232	-4.215 to 41.383	0.500	No detectable trend
CHE	Clarity Adj (m)	10	0	0	11	28/9/20-27/3/23	0.52	0.798	0.23	0.48	-2	12	-0.289	0.773	11	-0.008	-1.77	-0.097 to 0.071	0.747	Trend unlikely
SOL	Temperature C	1	0	0	14	27/9/19-19/12/22	14.882	17.45	12	14.95	10	24.667	1.812	0.07	14	0.314	2.099	-0.083 to 1.054	0.955	Increasing trend likely
SOL	DO %	1	0	0	14	27/9/19-19/12/22	94.189	100.4	83.45	96.525	2	24.667	0.201	0.84	14	0.098	0.102	-5.790 to 6.866	0.503	Trend unlikely
SOL	DO (mg/l)	1	0	0	14	27/9/19-19/12/22	9.619	10.76	8.015	9.59	1	23.667	0	1	14	0.019	0.199	-0.610 to 0.684	0.500	Trend exceptionally unlikely
SOL	SPC (uS/cm @ 25 C)	1	0	0	14	27/9/19-19/12/22	239.429	276.9	148.8	244.7	0	24.667	0	1	14	0.855	0.349	-10.722 to 18.775	0.500	No detectable trend
SOL	EC (uS/cm)	9	0	0	10	28/9/20-19/12/22	189.71	235.9	118.9	192.95	6	9.333	1.637	0.102	10	11.927	6.182	-2.247 to 19.982	0.964	Increasing trend possible
SOL	Clarity Adj (m)	9	0	0	10	28/9/20-19/12/22	0.38	0.552	0.16	0.418	-2	9.333	-0.327	0.743	10	-0.073	-17.473	-0.306 to 0.060	0.854	Trend unlikely

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	Field Turbidity (NTU)	1	0	0	14	16/8/19-19/12/22	10.799	20.5	3.26	9.565	4	24.667	0.604	0.546	14	2.451	25.622	-3.000 to 4.267	0.772	Increasing trend about as likely as not
WAI	Turbidity Lab (NTU)	1	0	0	14	16/8/19-19/12/22	8.186	17.65	2.4	7.775	8	24.667	1.409	0.159	14	1.886	24.252	-1.094 to 3.989	0.918	Increasing trend possible
WAI	pH Lab	0	0	0	14	16/8/19-19/12/22	7.764	8.6	7	7.725	-4	24.667	-0.604	0.546	14	-0.147	-1.9	-0.323 to 0.152	0.833	Decreasing trend about as likely as not
WAI	Total Hardness (g/m3)	0	0	0	14	16/8/19-19/12/22	56.536	66	31	59.5	-4	24.667	-0.604	0.546	14	-1.559	-2.62	-6.710 to 4.436	0.845	Decreasing trend about as likely as not
WAI	Total Suspended Solids (g/m3)	1	0	0	14	16/8/19-19/12/22	3.607	9	1.5	3	1	21.667	0	1	14	0	0	-1.498 to 1.445	0.500	Trend exceptionally unlikely
WAI	Dissolved Calcium (g/m3)	0	0	0	14	16/8/19-19/12/22	15.843	18.7	9.2	16.675	-2	24.667	-0.201	0.84	14	-0.625	-3.748	-2.285 to 0.955	0.773	Trend unlikely
KAI	Field Turbidity (NTU)	1	0	0	14	16/8/19-19/12/22	13.077	28.1	3.52	11.05	2	24.667	0.201	0.84	14	1.034	9.353	-4.477 to 5.298	0.631	Trend unlikely
KAI	Turbidity Lab (NTU)	0	0	0	14	16/8/19-19/12/22	10.371	21	5.2	8.35	1	23.667	0	1	14	0.25	2.996	-2.578 to 3.658	0.500	Trend exceptionally unlikely
KAI	pH Lab	0	0	0	14	16/8/19-19/12/22	7.039	7.25	6.7	7	1	21.667	0	1	14	0	0	-0.156 to 0.100	0.500	Trend exceptionally unlikely
KAI	Total Hardness (g/m3)	0	0	0	14	16/8/19-19/12/22	49.5	60	23	52	-5	23.667	-0.822	0.411	14	-1.25	-2.404	-4.645 to 5.594	0.891	Decreasing trend about as likely as not
KAI	Total Suspended Solids (g/m3)	0	0	0	14	16/8/19-19/12/22	6.732	19	1.5	4	-1	23.667	0	1	14	-0.751	-18.763	-6.057 to 3.313	0.660	Trend exceptionally unlikely
KAI	Dissolved Calcium (g/m3)	0	0	0	14	16/8/19-19/12/22	12.693	15.3	6	13.15	-8	24.667	-1.409	0.159	14	-0.192	-1.459	-1.307 to 1.722	0.948	Decreasing trend possible
KAH	Field Turbidity (NTU)	2	0	0	15	16/8/19-27/3/23	15.691	68.2	2.68	7.18	15	29.667	2.57	0.01	15	3.632	50.592	0.811 to 11.131	0.992	Increasing trend very likely
KAH	Turbidity Lab (NTU)	0	0	0	15	16/8/19-27/3/23	9.483	37	3.9	6.4	7	27.667	1.141	0.254	15	0.901	14.072	-0.289 to 2.051	0.873	Increasing trend possible
KAH	pH Lab	0	0	0	15	16/8/19-27/3/23	7.217	7.7	6.7	7.2	-4	24	-0.612	0.54	15	0	0	-0.200 to 0.029	0.846	Decreasing trend about as likely as not
KAH	Total Hardness (g/m3)	0	0	0	15	16/8/19-27/3/23	47.167	54	30	49	0	28.667	0	1	15	0	0	-3.200 to 2.583	0.500	No detectable trend
KAH	Total Suspended Solids (g/m3)	0	0	0	15	16/8/19-27/3/23	7.717	45	1.5	3	2	24	0.204	0.838	15	0	0	-0.900 to 2.605	0.581	Trend unlikely
KAH	Dissolved Calcium (g/m3)	0	0	0	15	16/8/19-27/3/23	11.497	12.9	7.6	12.1	-2	28.667	-0.187	0.852	15	-0.1	-0.826	-0.640 to 0.327	0.712	Trend unlikely
ESK	Field Turbidity (NTU)	1	0	0	15	16/8/19-27/3/23	14.29	59.15	3.58	7.97	12	28.667	2.054	0.04	15	2.515	31.554	0.018 to 5.310	0.98	Increasing trend very likely
ESK	Turbidity Lab (NTU)	0	0	0	15	16/8/19-27/3/23	9.72	27	4.1	7.3	5	29.667	0.734	0.463	15	1.401	19.191	-1.523 to 3.277	0.804	Increasing trend about as likely as not

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
ESK	pH Lab	0	0	0	15	16/8/19-27/3/23	7.283	7.5	6.8	7.3	1	25	0	1	15	0	0	-0.114 to 0.094	0.500	Trend exceptionally unlikely
ESK	Total Hardness (g/m3)	0	0	0	15	16/8/19-27/3/23	52.867	66	31	53	-7	29.667	-1.102	0.271	15	-2.912	-5.494	-5.922 to 0.639	0.944	Decreasing trend possible
ESK	Total Suspended Solids (g/m3)	0	0	0	15	16/8/19-27/3/23	6.883	25	1.5	4	3	27.667	0.38	0.704	15	1.166	29.16	-1.413 to 4.013	0.648	Trend unlikely
ESK	Dissolved Calcium (g/m3)	0	0	0	15	16/8/19-27/3/23	12.707	16.1	7.6	12.8	-9	29.667	-1.469	0.142	15	-0.759	-5.929	-1.551 to 0.013	0.971	Decreasing trend possible
DAWA	Field Turbidity (NTU)	1	0	0	14	16/11/19-15/2/23	15.963	41.8	3.15	12.05	8	24.667	1.409	0.159	14	4.983	41.349	-3.912 to 12.551	0.944	Increasing trend possible
DAWA	Turbidity Lab (NTU)	0	0	0	14	16/11/19-15/2/23	20.922	135	2.31	8.55	4	24.667	0.604	0.546	14	1.956	22.873	-1.461 to 7.623	0.755	Increasing trend about as likely as not
DAWA	pH Lab	0	0	0	14	16/11/19-15/2/23	7.479	7.8	7	7.5	6	22.667	1.05	0.294	14	0.1	1.332	-0.044 to 0.186	0.853	Increasing trend possible
DAWA	Total Hardness (g/m3)	0	0	0	14	16/11/19-15/2/23	76.714	103	45.5	77.5	6	24.667	1.007	0.314	14	5.835	7.529	-8.306 to 13.023	0.820	Increasing trend possible
DAWA	Total Suspended Solids (g/m3)	0	0	0	14	16/11/19-15/2/23	15.357	111	3	7	8	22.667	1.47	0.141	14	2.25	32.145	-0.222 to 3.668	0.929	Increasing trend possible
DAWA	Dissolved Calcium (g/m3)	0	0	0	14	16/11/19-15/2/23	17.957	25	10.5	19.4	12	24.667	2.215	0.027	14	2.836	14.621	0.433 to 5.616	0.982	Increasing trend very likely
UAWA	Field Turbidity (NTU)	1	0	0	14	16/11/19-15/2/23	19.632	56.3	3.14	16.35	8	24.667	1.409	0.159	14	4.693	28.702	-3.363 to 8.657	0.919	Increasing trend possible
UAWA	Turbidity Lab (NTU)	8	0	0	11	28/9/20-15/2/23	27.477	147	7.5	13.95	4	12	0.866	0.386	11	3.915	28.066	-53.770 to 15.781	0.835	Increasing trend about as likely as not
UAWA	pH Lab	0	0	0	14	16/11/19-15/2/23	7.1	7.3	6.9	7.1	4	22.667	0.63	0.529	14	0.052	0.727	-0.100 to 0.178	0.736	Increasing trend about as likely as not
UAWA	Total Hardness (g/m3)	0	0	0	14	16/11/19-15/2/23	61.179	69	48	62.5	-4	24.667	-0.604	0.546	14	-1.167	-1.867	-5.304 to 2.965	0.826	Decreasing trend about as likely as not
UAWA	Total Suspended Solids (g/m3)	8	0	0	11	28/9/20-15/2/23	35.136	240	5	12	4	10	0.949	0.343	11	3.831	31.924	-29.954 to 12.176	0.829	Increasing trend about as likely as not
UAWA	Dissolved Calcium (g/m3)	0	0	0	14	16/11/19-15/2/23	15.629	17.4	13.1	15.9	2	23.667	0.206	0.837	14	0.1	0.629	-0.674 to 0.717	0.663	Trend unlikely
ONE	Field Turbidity (NTU)	1	0	0	15	16/8/19-27/3/23	16.367	50.1	5.01	10.805	9	29.667	1.469	0.142	15	5.08	47.011	-0.386 to 10.662	0.946	Increasing trend possible
ONE	Turbidity Lab (NTU)	0	0	0	15	16/8/19-27/3/23	9.55	16.7	3.8	7.6	3	29.667	0.367	0.713	15	1.597	21.009	-1.255 to 3.259	0.707	Trend unlikely
ONE	pH Lab	0	0	0	15	16/8/19-27/3/23	7.447	7.75	6.9	7.5	-6	28.667	-0.934	0.35	15	-0.05	-0.667	-0.187 to 0.079	0.904	Decreasing trend about as likely as not
ONE	Total Hardness (g/m3)	0	0	0	15	16/8/19-27/3/23	53.8	70	37	54	-5	29.667	-0.734	0.463	15	-1.941	-3.595	-7.561 to 4.109	0.893	Decreasing trend about as likely as not
ONE	Total Suspended Solids (g/m3)	0	0	0	15	16/8/19-27/3/23	7.717	21	1.5	6	6	26	0.981	0.327	15	1	16.663	-0.640 to 2.781	0.837	Increasing trend possible

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
ONE	Dissolved Calcium (g/m3)	0	0	0	15	16/8/19-27/3/23	13.287	17.4	9.5	13.4	-9	29.667	-1.469	0.142	15	-0.3	-2.238	-1.979 to 0.792	0.954	Decreasing trend possible
LSB	Field Turbidity (NTU)	1	0	0	15	16/8/19-27/3/23	11.78	31.5	1.6	9.58	15	29.667	2.57	0.01	15	3.532	36.873	2.019 to 7.039	0.993	Increasing trend very likely
LSB	Turbidity Lab (NTU)	0	0	0	15	16/8/19-27/3/23	12.347	43	3.7	8.9	9	29.667	1.469	0.142	15	2.433	27.335	-0.450 to 6.828	0.936	Increasing trend possible
LSB	pH Lab	0	0	0	15	16/8/19-27/3/23	7.323	7.7	6.85	7.3	-11	27.667	-1.901	0.057	15	-0.1	-1.371	-0.200 to -0.016	0.989	Decreasing trend likely
LSB	Total Hardness (g/m3)	0	0	0	15	16/8/19-27/3/23	60.967	72	25	65	2	28.667	0.187	0.852	15	0.667	1.025	-4.305 to 2.733	0.574	Trend unlikely
LSB	Total Suspended Solids (g/m3)	0	0	0	15	16/8/19-27/3/23	13.5	75	1.5	7.5	7	29.667	1.102	0.271	15	2.127	28.355	-4.350 to 6.990	0.867	Increasing trend possible
LSB	Dissolved Calcium (g/m3)	0	0	0	15	16/8/19-27/3/23	15.19	17.9	6.9	16.5	-4	28.667	-0.56	0.575	15	-0.356	-2.157	-1.098 to 0.274	0.825	Decreasing trend about as likely as not
CHE	Field Turbidity (NTU)	1	0	0	15	16/8/19-27/3/23	6.482	14.8	0.96	5.78	15	29.667	2.57	0.01	15	2.324	40.213	0.455 to 4.344	0.994	Increasing trend very likely
CHE	Turbidity Lab (NTU)	0	0	0	15	16/8/19-27/3/23	4.205	11.2	2.2	3.3	9	29.667	1.469	0.142	15	0.275	8.343	-0.390 to 0.793	0.925	Increasing trend possible
CHE	pH Lab	0	0	0	15	16/8/19-27/3/23	7.427	7.6	6.95	7.5	0	24	0	1	15	0	0	-0.124 to 0.032	0.500	No detectable trend
CHE	Total Hardness (g/m3)	0	0	0	15	16/8/19-27/3/23	55.027	77.5	18.9	55	-9	29.667	-1.469	0.142	15	-5.218	-9.487	-10.845 to 1.483	0.963	Decreasing trend possible
CHE	Total Suspended Solids (g/m3)	0	0	0	15	16/8/19-27/3/23	4.65	23	1.5	3	3	27.667	0.38	0.704	15	0.324	10.784	-1.136 to 3.206	0.648	Trend unlikely
CHE	Dissolved Calcium (g/m3)	0	0	0	15	16/8/19-27/3/23	13.647	19.85	5.2	13.3	-12	28.667	-2.054	0.04	15	-1.56	-11.73	-2.939 to -0.231	0.992	Decreasing trend very likely
SOL	Field Turbidity (NTU)	2	0	0	14	27/9/19-19/12/22	11.941	41.6	3.74	8.977	16	24.667	3.02	0.003	14	4.665	51.968	1.402 to 10.773	0.998	Increasing trend virtually certain
SOL	Turbidity Lab (NTU)	0	0	0	14	27/9/19-19/12/22	8.364	25	3	6.55	6	24.667	1.007	0.314	14	0.921	14.061	-0.833 to 2.960	0.835	Increasing trend possible
SOL	pH Lab	0	0	0	14	27/9/19-19/12/22	7.411	7.65	6.85	7.45	1	23.667	0	1	14	0.016	0.217	-0.177 to 0.100	0.500	Trend exceptionally unlikely
SOL	Total Hardness (g/m3)	0	0	0	14	27/9/19-19/12/22	52.893	67	36	52	-7	23.667	-1.233	0.217	14	-2.132	-4.099	-4.766 to 0.766	0.950	Decreasing trend possible
SOL	Total Suspended Solids (g/m3)	0	0	0	14	27/9/19-19/12/22	7.661	22	1.5	5.25	1	23.667	0	1	14	0.162	3.081	-3.125 to 1.382	0.500	Trend exceptionally unlikely
SOL	Dissolved Calcium (g/m3)	0	0	0	14	27/9/19-19/12/22	11.264	14.65	8.4	11.05	-10	24.667	-1.812	0.07	14	-0.455	-4.115	-1.181 to -0.101	0.984	Decreasing trend likely

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	Dissolved Copper (g/m3)	0	0	0	14	16/8/19-19/12/22	0.002	0.003	0.001	0.002	6	24.667	1.007	0.314	14	0	10.811	-0.001 to 0.001	0.843	Increasing trend possible
WAI	Total Copper (g/m3)	0	0	0	14	16/8/19-19/12/22	0.003	0.005	0.001	0.002	8	24.667	1.409	0.159	14	0	12.421	-0.001 to 0.001	0.890	Increasing trend possible
WAI	Dissolved Magnesium (g/m3)	0	0	0	14	16/8/19-19/12/22	4.108	5.2	1.96	4.325	4	24.667	0.604	0.546	14	0.111	2.557	-0.459 to 0.725	0.693	Increasing trend about as likely as not
WAI	Dissolved Zinc (g/m3)	0	0	0	14	16/8/19-19/12/22	0.033	0.107	0.008	0.025	0	24.667	0	1	14	-0.003	-10.827	-0.026 to 0.004	0.500	No detectable trend
WAI	Total Zinc (g/m3)	0	0	0	14	16/8/19-19/12/22	0.043	0.111	0.015	0.037	0	24.667	0	1	14	0	-1.228	-0.023 to 0.009	0.500	No detectable trend
WAI	Total Nitrogen (g/m3)	0	0	0	14	16/8/19-19/12/22	0.861	1.295	0.57	0.878	2	24.667	0.201	0.84	14	0.011	1.308	-0.172 to 0.150	0.523	Trend unlikely
KAI	Dissolved Copper (g/m3)	0	0	0	14	16/8/19-19/12/22	0.001	0.002	0.001	0.001	12	24.667	2.215	0.027	14	0	28.303	0.000 to 0.000	0.983	Increasing trend very likely
KAI	Total Copper (g/m3)	0	0	0	14	16/8/19-19/12/22	0.002	0.003	0.001	0.002	10	24.667	1.812	0.07	14	0	24.6	0.000 to 0.001	0.967	Increasing trend likely
KAI	Dissolved Magnesium (g/m3)	0	0	0	14	16/8/19-19/12/22	4.303	5.2	1.81	4.725	-8	24.667	-1.409	0.159	14	-0.115	-2.428	-0.290 to 0.190	0.958	Decreasing trend possible
KAI	Dissolved Zinc (g/m3)	0	0	0	14	16/8/19-19/12/22	0.029	0.05	0.009	0.028	5	23.667	0.822	0.411	14	0.003	12.457	-0.005 to 0.006	0.795	Increasing trend about as likely as not
KAI	Total Zinc (g/m3)	0	0	0	14	16/8/19-19/12/22	0.036	0.059	0.012	0.035	8	24.667	1.409	0.159	14	0.004	12.669	-0.004 to 0.008	0.919	Increasing trend possible
KAI	Total Nitrogen (g/m3)	0	0	0	14	16/8/19-19/12/22	0.623	1.31	0.33	0.625	0	24.667	0	1	14	0.027	4.339	-0.212 to 0.218	0.500	No detectable trend
KAH	Dissolved Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.003	0.001	0.001	13	29.667	2.203	0.028	15	0	21.385	0.000 to 0.001	0.987	Increasing trend very likely
KAH	Total Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.004	0.001	0.002	11	29.667	1.836	0.066	15	0	25.017	0.000 to 0.001	0.975	Increasing trend likely
KAH	Dissolved Magnesium (g/m3)	0	0	0	15	16/8/19-27/3/23	4.495	5.4	2.6	4.6	0	28.667	0	1	15	0	0	-0.415 to 0.352	0.500	No detectable trend
KAH	Dissolved Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.021	0.035	0.008	0.021	8	28.667	1.307	0.191	15	0.001	5.357	-0.001 to 0.003	0.904	Increasing trend possible
KAH	Total Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.026	0.045	0.01	0.024	3	29.667	0.367	0.713	15	0.001	4.17	-0.002 to 0.003	0.651	Trend unlikely
KAH	Total Nitrogen (g/m3)	0	0	0	15	16/8/19-27/3/23	1.103	8.5	0.38	0.57	14	28.667	2.428	0.015	15	0.096	17.105	0.020 to 0.154	0.992	Increasing trend very likely
ESK	Dissolved Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.003	0.001	0.002	0	26	0	1	15	0	0	0.000 to 0.000	0.5	No detectable trend
ESK	Total Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.004	0.001	0.002	5	29.667	0.734	0.463	15	0	8.061	-0.001 to 0.001	0.813	Increasing trend about as likely as not

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
ESK	Dissolved Magnesium (g/m3)	0	0	0	15	16/8/19-27/3/23	5.123	6.4	2.9	5.3	-6	28.667	-0.934	0.35	15	-0.226	-4.273	-0.537 to 0.156	0.904	Decreasing trend about as likely as not
ESK	Dissolved Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.016	0.03	0.007	0.014	1	29.667	0	1	15	0	0.357	-0.003 to 0.002	0.544	Trend exceptionally unlikely
ESK	Total Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.02	0.038	0.01	0.018	1	29.667	0	1	15	0	0.521	-0.007 to 0.002	0.564	Trend exceptionally unlikely
ESK	Total Nitrogen (g/m3)	0	0	0	15	16/8/19-27/3/23	0.733	1.54	0.37	0.705	1	29.667	0	1	15	0.042	6.024	-0.145 to 0.173	0.553	Trend exceptionally unlikely
DAWA	Dissolved Copper (g/m3)	0	0	0	14	16/11/19-15/2/23	0.002	0.005	0.001	0.002	7	23.667	1.233	0.217	14	0	24.999	0.000 to 0.001	0.891	Increasing trend possible
DAWA	Total Copper (g/m3)	0	0	0	14	16/11/19-15/2/23	0.003	0.009	0.001	0.002	8	24.667	1.409	0.159	14	0	20.799	0.000 to 0.001	0.916	Increasing trend possible
DAWA	Dissolved Magnesium (g/m3)	0	0	0	14	16/11/19-15/2/23	7.686	13.5	4.65	6.9	2	24.667	0.201	0.84	14	0.259	3.761	-3.092 to 1.211	0.532	Trend unlikely
DAWA	Dissolved Zinc (g/m3)	0	0	0	14	16/11/19-15/2/23	0.033	0.09	0.011	0.026	2	24.667	0.201	0.84	14	0.006	23.234	-0.028 to 0.013	0.585	Trend unlikely
DAWA	Total Zinc (g/m3)	0	0	0	14	16/11/19-15/2/23	0.049	0.128	0.023	0.041	3	23.667	0.411	0.681	14	0.004	10.995	-0.017 to 0.017	0.660	Trend unlikely
DAWA	Total Nitrogen (g/m3)	0	0	0	14	16/11/19-15/2/23	0.902	1.51	0.38	0.825	10	24.667	1.812	0.07	14	0.3	36.419	-0.045 to 0.489	0.957	Increasing trend likely
UAWA	Dissolved Copper (g/m3)	0	0	0	14	16/11/19-15/2/23	0.003	0.006	0.001	0.003	12	24.667	2.215	0.027	14	0	17.988	0.000 to 0.001	0.981	Increasing trend very likely
UAWA	Total Copper (g/m3)	0	0	0	14	16/11/19-15/2/23	0.005	0.009	0.002	0.004	10	24.667	1.812	0.07	14	0.001	21.71	0.000 to 0.002	0.966	Increasing trend likely
UAWA	Dissolved Magnesium (g/m3)	0	0	0	14	16/11/19-15/2/23	5.382	6.6	3.6	5.5	-2	24.667	-0.201	0.84	14	-0.15	-2.727	-0.494 to 0.274	0.749	Trend unlikely
UAWA	Dissolved Zinc (g/m3)	0	0	0	14	16/11/19-15/2/23	0.038	0.082	0.01	0.035	4	24.667	0.604	0.546	14	0.004	10.955	-0.011 to 0.009	0.711	Increasing trend about as likely as not
UAWA	Total Zinc (g/m3)	0	0	0	14	16/11/19-15/2/23	0.051	0.088	0.023	0.048	2	24.667	0.201	0.84	14	0.003	7.039	-0.007 to 0.015	0.602	Trend unlikely
UAWA	Total Nitrogen (g/m3)	0	0	0	14	16/11/19-15/2/23	0.698	1.58	0.3	0.655	10	24.667	1.812	0.07	14	0.208	31.701	0.001 to 0.269	0.975	Increasing trend likely
ONE	Dissolved Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.003	0.001	0.002	9	29.667	1.469	0.142	15	0	16.655	0.000 to 0.001	0.93	Increasing trend possible
ONE	Total Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.003	0.005	0.002	0.003	3	29.667	0.367	0.713	15	0	7.913	0.000 to 0.001	0.682	Trend unlikely
ONE	Dissolved Magnesium (g/m3)	0	0	0	15	16/8/19-27/3/23	5.007	6.5	3.1	4.9	-4	28.667	-0.56	0.575	15	-0.175	-3.569	-0.667 to 0.457	0.825	Decreasing trend about as likely as not
ONE	Dissolved Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.017	0.028	0.01	0.016	5	27.667	0.76	0.447	15	0	1.865	-0.001 to 0.001	0.777	Increasing trend about as likely as not
ONE	Total Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.024	0.035	0.012	0.024	3	29.667	0.367	0.713	15	0.001	2.502	-0.004 to 0.002	0.612	Trend unlikely
ONE	Total Nitrogen (g/m3)	2	0	0	15	16/8/19-27/3/23	0.915	3.8	0.3	0.53	13	29.667	2.203	0.028	15	0.129	24.387	0.027 to 0.636	0.985	Increasing trend very likely

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
LSB	Dissolved Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.001	0.003	0.001	0.001	4	28.667	0.56	0.575	15	0	4.312	0.000 to 0.000	0.712	Increasing trend about as likely as not
LSB	Total Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.005	0.001	0.002	9	29.667	1.469	0.142	15	0	16.171	0.000 to 0.001	0.937	Increasing trend possible
LSB	Dissolved Magnesium (g/m3)	0	0	0	15	16/8/19-27/3/23	5.598	7.4	1.97	5.9	3	29.667	0.367	0.713	15	0.125	2.119	-0.221 to 0.749	0.645	Trend unlikely
LSB	Dissolved Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.036	0.063	0.017	0.036	-5	29.667	-0.734	0.463	15	-0.001	-2.549	-0.008 to 0.002	0.880	Decreasing trend about as likely as not
LSB	Total Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.046	0.097	0.021	0.041	4	28.667	0.56	0.575	15	0.001	3.156	-0.009 to 0.007	0.712	Increasing trend about as likely as not
LSB	Total Nitrogen (g/m3)	0	0	0	15	16/8/19-27/3/23	0.39	0.56	0.219	0.41	13	29.667	2.203	0.028	15	0.074	18.148	0.015 to 0.118	0.985	Increasing trend very likely
CHE	Dissolved Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.001	0.002	0.001	0.001	8	28.667	1.307	0.191	15	0	14.825	0.000 to 0.000	0.904	Increasing trend possible
CHE	Total Copper (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.004	0.001	0.002	12	28.667	2.054	0.04	15	0	9.347	0.000 to 0.000	0.98	Increasing trend very likely
CHE	Dissolved Magnesium (g/m3)	0	0	0	15	16/8/19-27/3/23	5.031	6.9	1.46	5.4	-6	28.667	-0.934	0.35	15	-0.225	-4.167	-0.891 to 0.096	0.904	Decreasing trend about as likely as not
CHE	Dissolved Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.055	0.111	0.028	0.048	-4	28.667	-0.56	0.575	15	-0.002	-3.351	-0.008 to 0.003	0.825	Decreasing trend about as likely as not
CHE	Total Zinc (g/m3)	0	0	0	15	16/8/19-27/3/23	0.061	0.108	0.028	0.052	-1	29.667	0	1	15	-0.003	-5.288	-0.011 to 0.007	0.665	Trend exceptionally unlikely
CHE	Total Nitrogen (g/m3)	0	0	0	15	16/8/19-27/3/23	0.455	0.66	0.31	0.45	-1	29.667	0	1	15	-0.005	-1.111	-0.084 to 0.064	0.613	Trend exceptionally unlikely
SOL	Dissolved Copper (g/m3)	0	0	0	14	27/9/19-19/12/22	0.001	0.002	0.001	0.001	8	22.667	1.47	0.141	14	0	11.111	0.000 to 0.000	0.929	Increasing trend possible
SOL	Total Copper (g/m3)	0	0	0	14	27/9/19-19/12/22	0.001	0.003	0.001	0.001	6	24.667	1.007	0.314	14	0	7.778	0.000 to 0.000	0.834	Increasing trend possible
SOL	Dissolved Magnesium (g/m3)	0	0	0	14	27/9/19-19/12/22	5.964	7.6	3.7	5.9	-4	24.667	-0.604	0.546	14	-0.172	-2.912	-0.486 to 0.279	0.856	Decreasing trend about as likely as not
SOL	Dissolved Zinc (g/m3)	0	0	0	14	27/9/19-19/12/22	0.007	0.01	0.004	0.007	0	24.667	0	1	14	0	-3.569	-0.001 to 0.001	0.500	No detectable trend
SOL	Total Zinc (g/m3)	0	0	0	14	27/9/19-19/12/22	0.012	0.024	0.007	0.01	0	24.667	0	1	14	0	-0.117	-0.005 to 0.001	0.500	No detectable trend
SOL	Total Nitrogen (g/m3)	0	0	0	14	27/9/19-19/12/22	0.362	0.505	0.24	0.353	8	24.667	1.409	0.159	14	0.045	12.769	-0.030 to 0.074	0.905	Increasing trend possible

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	Total Ammoniacal-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.025	0.063	0.003	0.018	6	24.667	1.007	0.314	14	0.008	45.847	-0.012 to 0.025	0.831	Increasing trend possible
WAI	Pb Adjustment	0	0	0	14	16/8/19-19/12/22	0.022	0.059	0.001	0.021	6	24.667	1.007	0.314	14	0.008	38.478	-0.011 to 0.017	0.859	Increasing trend possible
WAI	Nitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.014	0.029	0.005	0.013	0	24.667	0	1	14	0	-3.223	-0.004 to 0.003	0.500	No detectable trend
WAI	Nitrate-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.471	0.765	0.29	0.475	4	24.667	0.604	0.546	14	0.041	8.592	-0.082 to 0.077	0.773	Increasing trend about as likely as not
WAI	Nitrate-NNitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.486	0.79	0.3	0.495	6	24.667	1.007	0.314	14	0.036	7.235	-0.084 to 0.077	0.833	Increasing trend possible
WAI	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	16/8/19-19/12/22	0.01	0.016	0.006	0.009	0	24.667	0	1	14	0	1.098	-0.002 to 0.002	0.500	No detectable trend
KAI	Total Ammoniacal-N (g/m3)	2	0	0	14	29/8/19-19/12/22	0.049	0.164	0.011	0.04	-9	23.667	-1.644	0.1	14	-0.01	-25.967	-0.046 to -0.001	0.980	Decreasing trend possible
KAI	Pb Adjustment	2	0	0	14	29/8/19-19/12/22	0.025	0.124	0.004	0.015	-8	24.667	-1.409	0.159	14	-0.005	-35.247	-0.029 to 0.001	0.965	Decreasing trend possible
KAI	Nitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.006	0.02	0.002	0.003	-14	24.667	-2.618	0.009	14	-0.002	-73.542	-0.007 to 0.000	0.999	Decreasing trend virtually certain
KAI	Nitrate-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.282	0.51	0.106	0.194	10	24.667	1.812	0.07	14	0.037	18.996	-0.011 to 0.084	0.962	Increasing trend likely
KAI	Nitrate-NNitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.29	0.52	0.109	0.198	10	24.667	1.812	0.07	14	0.03	15.167	-0.009 to 0.086	0.961	Increasing trend likely
KAI	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	16/8/19-19/12/22	0.007	0.018	0.004	0.006	-12	24.667	-2.215	0.027	14	-0.001	-23.087	-0.004 to -0.001	0.995	Decreasing trend very likely
KAH	Total Ammoniacal-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.543	7.9	0.007	0.018	6	28.667	0.934	0.35	15	0.001	5.559	-0.002 to 0.005	0.825	Increasing trend about as likely as not
KAH	Pb Adjustment	0	0	0	15	16/8/19-27/3/23	0.219	3.147	0.003	0.007	7	29.667	1.102	0.271	15	0.002	24.12	-0.001 to 0.004	0.881	Increasing trend possible
KAH	Nitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.004	0.01	0.002	0.003	7	27.667	1.141	0.254	15	0	14.339	0.000 to 0.001	0.873	Increasing trend possible
KAH	Nitrate-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.342	0.5	0.018	0.37	5	29.667	0.734	0.463	15	0.04	10.818	-0.043 to 0.079	0.732	Increasing trend about as likely as not
KAH	Nitrate-NNitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.346	0.5	0.028	0.37	5	29.667	0.734	0.463	15	0.04	10.818	-0.038 to 0.079	0.730	Increasing trend about as likely as not
KAH	Dissolved Reactive Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.028	0.31	0.004	0.008	5	29.667	0.734	0.463	15	0.001	6.333	-0.001 to 0.002	0.790	Increasing trend about as likely as not
ESK	Total Ammoniacal-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.088	0.8	0.018	0.026	-4	28.667	-0.56	0.575	15	-0.004	-14.729	-0.034 to 0.009	0.825	Decreasing trend about as likely as not
ESK	Pb Adjustment	0	0	0	15	16/8/19-27/3/23	0.036	0.303	0.007	0.012	-3	29.667	-0.367	0.713	15	0	-4.075	-0.013 to 0.001	0.799	Trend unlikely
ESK	Nitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.009	0.041	0.002	0.004	0	28.667	0	1	15	0	0	-0.006 to 0.002	0.500	No detectable trend

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	Total Ammoniacal-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.025	0.063	0.003	0.018	6	24.667	1.007	0.314	14	0.008	45.847	-0.012 to 0.025	0.831	Increasing trend possible
WAI	Ph Adjustment	0	0	0	14	16/8/19-19/12/22	0.022	0.059	0.001	0.021	6	24.667	1.007	0.314	14	0.008	38.478	-0.011 to 0.017	0.859	Increasing trend possible
WAI	Nitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.014	0.029	0.005	0.013	0	24.667	0	1	14	0	-3.223	-0.004 to 0.003	0.500	No detectable trend
WAI	Nitrate-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.471	0.765	0.29	0.475	4	24.667	0.604	0.546	14	0.041	8.592	-0.082 to 0.077	0.773	Increasing trend about as likely as not
WAI	Nitrate-NNitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.486	0.79	0.3	0.495	6	24.667	1.007	0.314	14	0.036	7.235	-0.084 to 0.077	0.833	Increasing trend possible
WAI	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	16/8/19-19/12/22	0.01	0.016	0.006	0.009	0	24.667	0	1	14	0	1.098	-0.002 to 0.002	0.500	No detectable trend
KAI	Total Ammoniacal-N (g/m3)	2	0	0	14	29/8/19-19/12/22	0.049	0.164	0.011	0.04	-9	23.667	-1.644	0.1	14	-0.01	-25.967	-0.046 to -0.001	0.980	Decreasing trend possible
KAI	Ph Adjustment	2	0	0	14	29/8/19-19/12/22	0.025	0.124	0.004	0.015	-8	24.667	-1.409	0.159	14	-0.005	-35.247	-0.029 to 0.001	0.965	Decreasing trend possible
KAI	Nitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.006	0.02	0.002	0.003	-14	24.667	-2.618	0.009	14	-0.002	-73.542	-0.007 to 0.000	0.999	Decreasing trend virtually certain
KAI	Nitrate-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.282	0.51	0.106	0.194	10	24.667	1.812	0.07	14	0.037	18.996	-0.011 to 0.084	0.962	Increasing trend likely
KAI	Nitrate-NNitrite-N (g/m3)	0	0	0	14	16/8/19-19/12/22	0.29	0.52	0.109	0.198	10	24.667	1.812	0.07	14	0.03	15.167	-0.009 to 0.086	0.961	Increasing trend likely
KAI	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	16/8/19-19/12/22	0.007	0.018	0.004	0.006	-12	24.667	-2.215	0.027	14	-0.001	-23.087	-0.004 to -0.001	0.995	Decreasing trend very likely
KAH	Total Ammoniacal-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.543	7.9	0.007	0.018	6	28.667	0.934	0.35	15	0.001	5.559	-0.002 to 0.005	0.825	Increasing trend about as likely as not
KAH	Ph Adjustment	0	0	0	15	16/8/19-27/3/23	0.219	3.147	0.003	0.007	7	29.667	1.102	0.271	15	0.002	24.12	-0.001 to 0.004	0.881	Increasing trend possible
KAH	Nitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.004	0.01	0.002	0.003	7	27.667	1.141	0.254	15	0	14.339	0.000 to 0.001	0.873	Increasing trend possible
KAH	Nitrate-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.342	0.5	0.018	0.37	5	29.667	0.734	0.463	15	0.04	10.818	-0.043 to 0.079	0.732	Increasing trend about as likely as not
KAH	Nitrate-NNitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.346	0.5	0.028	0.37	5	29.667	0.734	0.463	15	0.04	10.818	-0.038 to 0.079	0.730	Increasing trend about as likely as not
KAH	Dissolved Reactive Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.028	0.31	0.004	0.008	5	29.667	0.734	0.463	15	0.001	6.333	-0.001 to 0.002	0.790	Increasing trend about as likely as not
ESK	Total Ammoniacal-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.088	0.8	0.018	0.026	-4	28.667	-0.56	0.575	15	-0.004	-14.729	-0.034 to 0.009	0.825	Decreasing trend about as likely as not
ESK	Ph Adjustment	0	0	0	15	16/8/19-27/3/23	0.036	0.303	0.007	0.012	-3	29.667	-0.367	0.713	15	0	-4.075	-0.013 to 0.001	0.799	Trend unlikely
ESK	Nitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.009	0.041	0.002	0.004	0	28.667	0	1	15	0	0	-0.006 to 0.002	0.500	No detectable trend
ESK	Nitrate-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.362	0.7	0.151	0.4	4	29.667	0.551	0.582	15	0.045	11.25	-0.016 to 0.157	0.712	Increasing trend about as likely as not

Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
ESK	Nitrate-NNitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.37	0.74	0.154	0.4	3	29.667	0.367	0.713	15	0.039	9.688	-0.025 to 0.171	0.685	Trend unlikely
ESK	Dissolved Reactive Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.014	0.034	0.006	0.013	-5	29.667	-0.734	0.463	15	-0.001	-6.25	-0.005 to 0.001	0.836	Decreasing trend about as likely as not
DAWA	Total Ammoniacal-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.036	0.082	0.009	0.028	-8	24.667	-1.409	0.159	14	-0.014	-48.247	-0.023 to 0.002	0.964	Decreasing trend possible
DAWA	Ph Adjustment	0	0	0	14	16/11/19-15/2/23	0.02	0.074	0.004	0.014	-8	24.667	-1.409	0.159	14	-0.004	-29.001	-0.018 to 0.002	0.960	Decreasing trend possible
DAWA	Nitrite-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.007	0.011	0.003	0.007	1	23.667	0	1	14	0.001	8.035	-0.002 to 0.002	0.500	Trend exceptionally unlikely
DAWA	Nitrate-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.571	1.22	0.145	0.51	2	24.667	0.201	0.84	14	0.149	29.249	-0.111 to 0.271	0.625	Trend unlikely
DAWA	Nitrate-NNitrite-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.58	1.23	0.149	0.515	2	24.667	0.201	0.84	14	0.149	28.965	-0.108 to 0.275	0.625	Trend unlikely
DAWA	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	16/11/19-15/2/23	0.011	0.02	0.001	0.009	2	24.667	0.201	0.84	14	0.001	6.154	-0.006 to 0.005	0.619	Trend unlikely
UAWA	Total Ammoniacal-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.035	0.075	0.007	0.03	-2	24.667	-0.201	0.84	14	-0.002	-5.003	-0.016 to 0.017	0.690	Trend unlikely
UAWA	Ph Adjustment	0	0	0	14	16/11/19-15/2/23	0.015	0.035	0.003	0.011	-2	24.667	-0.201	0.84	14	-0.002	-14.047	-0.008 to 0.007	0.675	Trend unlikely
UAWA	Nitrite-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.004	0.015	0.002	0.003	6	24.667	1.007	0.314	14	0.001	27.138	0.000 to 0.001	0.866	Increasing trend possible
UAWA	Nitrate-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.248	0.69	0.016	0.211	10	24.667	1.812	0.07	14	0.069	32.756	-0.030 to 0.157	0.953	Increasing trend likely
UAWA	Nitrate-NNitrite-N (g/m3)	0	0	0	14	16/11/19-15/2/23	0.254	0.7	0.018	0.216	10	24.667	1.812	0.07	14	0.07	32.556	-0.031 to 0.162	0.956	Increasing trend likely
UAWA	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	16/11/19-15/2/23	0.01	0.018	0.005	0.01	2	24.667	0.201	0.84	14	0	3.62	-0.004 to 0.003	0.532	Trend unlikely
ONE	Total Ammoniacal-N (g/m3)	2	0	0	15	16/8/19-27/3/23	0.05	0.6	0.005	0.012	13	28.667	2.241	0.025	15	0.002	12.943	0.000 to 0.003	0.982	Increasing trend very likely
ONE	Ph Adjustment	2	0	0	15	16/8/19-27/3/23	0.024	0.287	0.002	0.005	7	29.667	1.102	0.271	15	0.001	16.445	-0.001 to 0.003	0.824	Increasing trend possible
ONE	Nitrite-N (g/m3)	2	0	0	15	16/8/19-27/3/23	0.014	0.15	0.001	0.003	18	28.667	3.175	0.001	15	0.001	18.476	0.000 to 0.001	0.999	Increasing trend virtually certain
ONE	Nitrate-N (g/m3)	2	0	0	15	16/8/19-27/3/23	0.56	2.6	0.087	0.35	13	29.667	2.203	0.028	15	0.11	31.464	0.017 to 0.324	0.981	Increasing trend very likely
ONE	Nitrate-NNitrite-N (g/m3)	2	0	0	15	16/8/19-27/3/23	0.577	2.8	0.09	0.36	13	29.667	2.203	0.028	15	0.119	33.14	0.017 to 0.321	0.981	Increasing trend very likely
ONE	Dissolved Reactive Phosphorus (g/m3)	2	0	0	15	16/8/19-27/3/23	0.019	0.046	0.007	0.015	3	29.667	0.367	0.713	15	0	3.084	-0.001 to 0.002	0.613	Trend unlikely
Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence

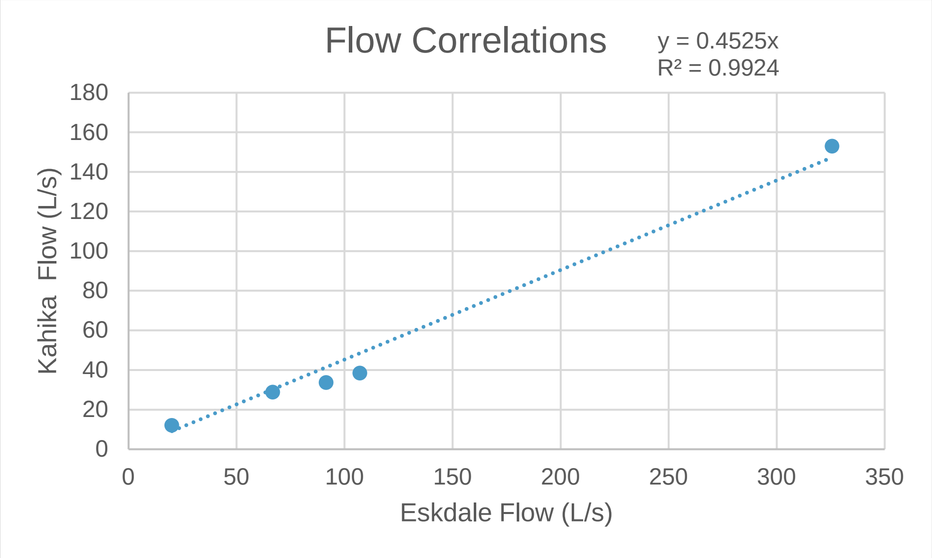
LSB	Total Ammoniacal-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.039	0.169	0.007	0.029	5	29.667	0.734	0.463	15	0.005	15.618	-0.009 to 0.018	0.757	Increasing trend about as likely as not
LSB	Ph Adjustment	0	0	0	15	16/8/19-27/3/23	0.017	0.067	0.006	0.011	7	29.667	1.102	0.271	15	0.001	8.295	-0.003 to 0.007	0.860	Increasing trend possible
LSB	Nitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.007	0.001	0.002	14	28.667	2.428	0.015	15	0	17.127	0.000 to 0.000	0.992	Increasing trend very likely
LSB	Nitrate-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.186	0.345	0.041	0.15	9	29.667	1.469	0.142	15	0.047	31.058	-0.013 to 0.077	0.943	Increasing trend possible
LSB	Nitrate-NNitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.188	0.35	0.042	0.157	9	29.667	1.469	0.142	15	0.04	25.495	-0.015 to 0.081	0.938	Increasing trend possible
LSB	Dissolved Reactive Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.01	0.018	0.002	0.009	-3	29.667	-0.367	0.713	15	0	-3.165	-0.003 to 0.001	0.735	Trend unlikely
CHE	Total Ammoniacal-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.005	0.008	0.003	0.005	0	26.667	0	1	15	0	0	-0.001 to 0.001	0.500	No detectable trend
CHE	Ph Adjustment	0	0	0	15	16/8/19-27/3/23	0.002	0.004	0.001	0.002	1	29.667	0	1	15	0	0.45	-0.001 to 0.001	0.565	Trend exceptionally unlikely
CHE	Nitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.002	0.004	0.001	0.002	-1	29.667	0	1	15	0	-5.108	-0.001 to 0.000	0.642	Trend exceptionally unlikely
CHE	Nitrate-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.307	0.49	0.127	0.33	1	29.667	0	1	15	0.006	1.961	-0.071 to 0.050	0.523	Trend exceptionally unlikely
CHE	Nitrate-NNitrite-N (g/m3)	0	0	0	15	16/8/19-27/3/23	0.309	0.49	0.131	0.33	1	29.667	0	1	15	0.006	1.961	-0.071 to 0.055	0.523	Trend exceptionally unlikely
CHE	Dissolved Reactive Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.013	0.021	0.007	0.012	-10	28.667	-1.681	0.093	15	-0.001	-6.727	-0.003 to 0.000	0.980	Decreasing trend likely
SOL	Total Ammoniacal-N (g/m3)	0	0	0	14	27/9/19-19/12/22	0.007	0.012	0.003	0.007	5	23.667	0.822	0.411	14	0.001	9.623	-0.001 to 0.003	0.795	Increasing trend about as likely as not
SOL	Ph Adjustment	0	0	0	14	27/9/19-19/12/22	0.004	0.007	0.001	0.003	-6	24.667	-1.007	0.314	14	0	-5.692	-0.002 to 0.001	0.901	Decreasing trend possible
SOL	Nitrite-N (g/m3)	0	0	0	14	27/9/19-19/12/22	0.001	0.002	0.001	0.001	8	24.667	1.409	0.159	14	0	14.825	0.000 to 0.001	0.93	Increasing trend possible
SOL	Nitrate-N (g/m3)	0	0	0	14	27/9/19-19/12/22	0.21	0.31	0.138	0.197	9	24.667	1.611	0.107	14	0.032	16.215	-0.011 to 0.053	0.950	Increasing trend possible
SOL	Nitrate-NNitrite-N (g/m3)	0	0	0	14	27/9/19-19/12/22	0.213	0.32	0.139	0.198	8	24.667	1.409	0.159	14	0.031	15.83	-0.017 to 0.053	0.945	Increasing trend possible
SOL	Dissolved Reactive Phosphorus (g/m3)	0	0	0	14	27/9/19-19/12/22	0.006	0.01	0.003	0.006	-2	24.667	-0.201	0.84	14	0	-3.434	-0.001 to 0.001	0.737	Trend unlikely

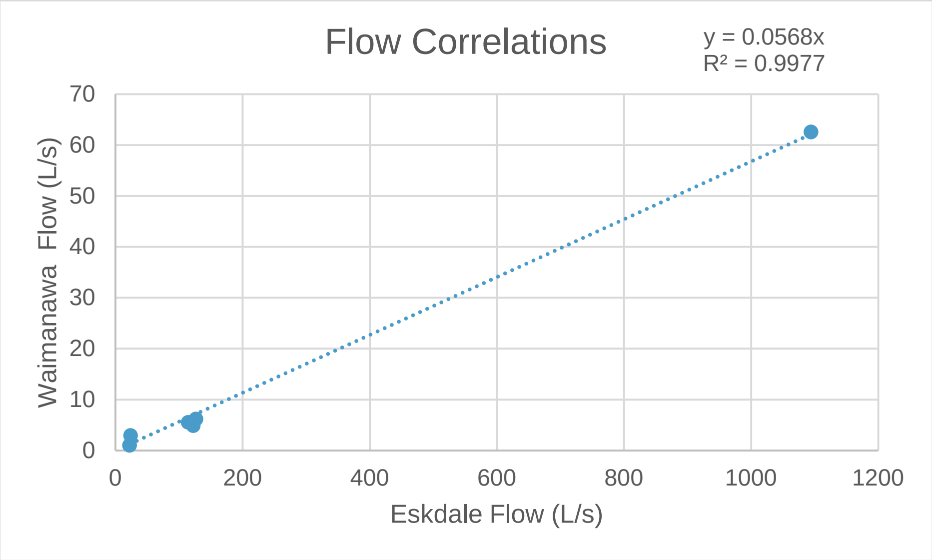
Site	Variable	Missing	Excluded	Non-detects	Samples used	Sampling period	Mean	Maximum	Minimum	Median	Kendall statistic	Variance	Z	P	N (slopes)	Sen slope (annual)	Percent annual change	95% confidence limits on slope	Likelihood	Trend direction and confidence
WAI	Total Phosphorus (g/m3)	0	0	0	14	16/8/19-19/12/22	0.026	0.045	0.014	0.025	0	24.667	0	1	14	0	1.531	-0.008 to 0.007	0.500	No detectable trend
WAI	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	4.411	5.9	3	4.625	12	24.667	2.215	0.027	14	0.623	13.477	0.100 to 0.792	0.981	Increasing trend very likely
KAI	Total Phosphorus (g/m3)	0	0	0	14	16/8/19-19/12/22	0.031	0.076	0.013	0.025	-7	23.667	-1.233	0.217	14	-0.011	-44.997	-0.025 to 0.001	0.950	Decreasing trend possible
KAI	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	3.886	5.4	2.6	4.05	4	24.667	0.604	0.546	14	0.225	5.559	-0.373 to 0.573	0.740	Increasing trend about as likely as not
KAH	Total Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.069	0.69	0.011	0.022	0	28.667	0	1	15	0	0	-0.003 to 0.009	0.500	No detectable trend
KAH	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	3.882	5.4	2.6	3.875	14	24.667	2.618	0.009	14	0.378	9.757	0.107 to 0.500	0.993	Increasing trend virtually certain
ESK	Total Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.044	0.089	0.02	0.04	-3	29.667	-0.367	0.713	15	-0.001	-3.235	-0.014 to 0.005	0.727	Trend unlikely
ESK	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	4.789	8.4	3.6	4.2	11	21.667	2.148	0.032	14	0.176	4.188	0.000 to 0.574	0.984	Increasing trend very likely
DAWA	Total Phosphorus (g/m3)	0	0	0	14	16/11/19-15/2/23	0.047	0.115	0.02	0.038	6	24.667	1.007	0.314	14	0.004	10.534	-0.004 to 0.010	0.858	Increasing trend possible
DAWA	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/11/19-23/1/23	2.575	3.8	0.9	2.9	11	23.667	2.056	0.04	14	0.739	25.494	0.006 to 1.115	0.98	Increasing trend very likely
UAWA	Total Phosphorus (g/m3)	0	0	0	14	16/11/19-15/2/23	0.115	0.81	0.018	0.044	6	24.667	1.007	0.314	14	0.003	7.336	-0.008 to 0.029	0.812	Increasing trend possible
UAWA	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/11/19-23/1/23	3.982	5.5	2.3	4	12	24.667	2.215	0.027	14	0.6	15.002	0.035 to 1.391	0.98	Increasing trend very likely
ONE	Total Phosphorus (g/m3)	2	0	0	15	16/8/19-27/3/23	0.058	0.161	0.022	0.038	7	29.667	1.102	0.271	15	0.005	11.94	-0.004 to 0.028	0.865	Increasing trend possible
ONE	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	3.954	5.5	2	3.925	9	23.667	1.644	0.1	14	0.325	8.275	-0.038 to 0.854	0.950	Increasing trend possible
LSB	Total Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.037	0.165	0.015	0.029	-2	28.667	-0.187	0.852	15	0	-1.116	-0.002 to 0.004	0.712	Trend unlikely
LSB	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	3.075	4.1	1.9	3.1	12	24.667	2.215	0.027	14	0.475	15.317	0.070 to 0.765	0.982	Increasing trend very likely
CHE	Total Phosphorus (g/m3)	0	0	0	15	16/8/19-27/3/23	0.024	0.04	0.012	0.025	-11	29.667	-1.836	0.066	15	-0.002	-9.487	-0.006 to -0.001	0.981	Decreasing trend likely
CHE	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	16/8/19-19/12/22	2.625	3.8	1.8	2.6	12	23.667	2.261	0.024	14	0.45	17.299	0.025 to 0.690	0.982	Increasing trend very likely
SOL	Total Phosphorus (g/m3)	0	0	0	14	27/9/19-19/12/22	0.017	0.035	0.011	0.015	5	23.667	0.822	0.411	14	0.002	12.027	-0.001 to 0.005	0.795	Increasing trend about as likely as not
SOL	Dissolved Non-Purgeable Organic Carbon (DNPOC) (g/m3)	1	0	0	14	27/9/19-19/12/22	3.232	5.2	2.1	3.25	10	24.667	1.812	0.07	14	0.647	19.918	-0.074 to 1.168	0.965	Increasing trend likely

Appendix 2: Summary Statistics

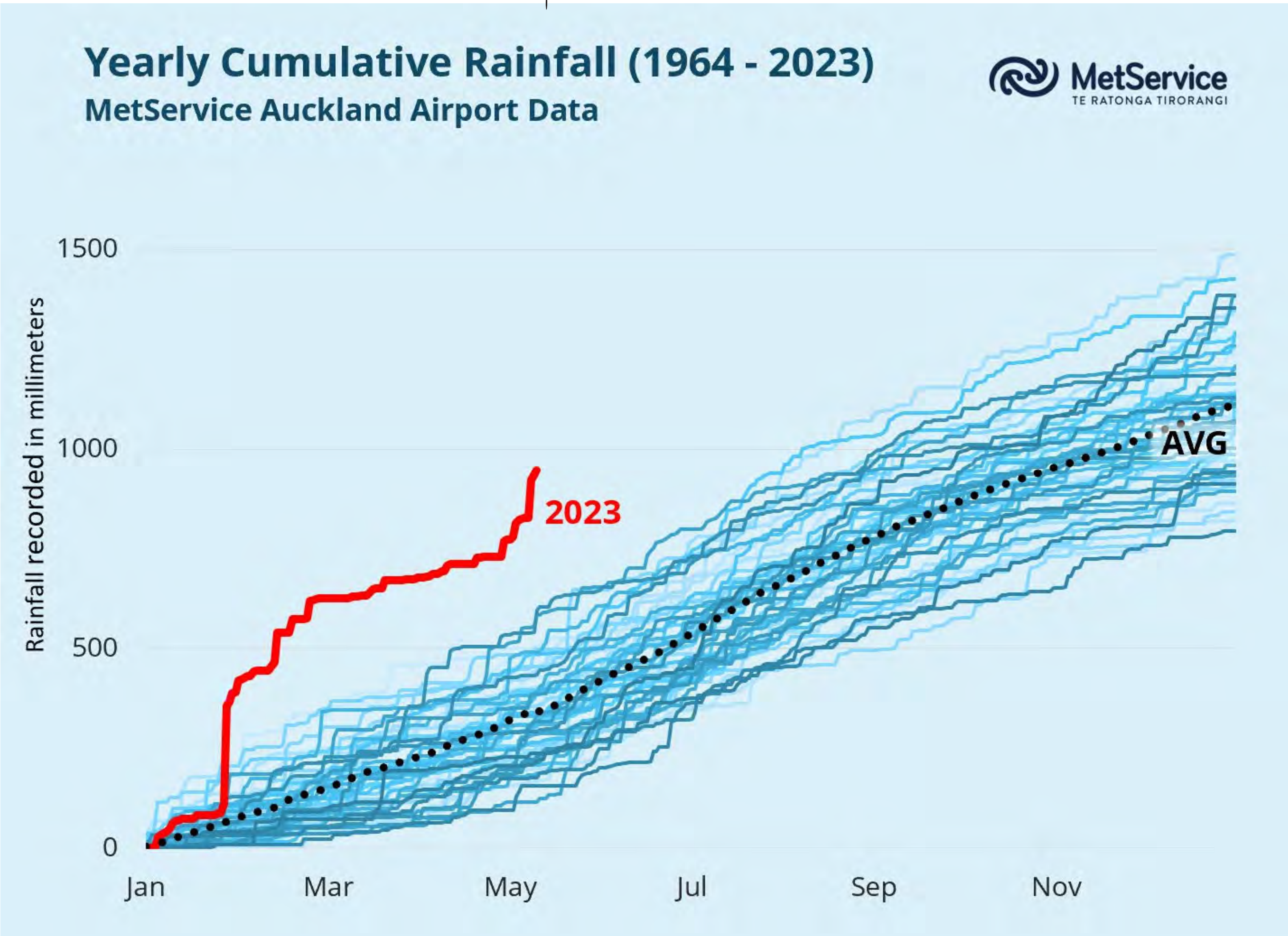
Site	Percentile	Temperature	DO%	DO (mg/l)	SPC (uS/cm	EC (uS/cm)	pH	Clarity (m)	Clarity Adj (n	Field Turbidi	Turbidity Lab	pH Lab	Total Hardne	Total Suspen	Dissolved Ca	Dissolved Co	Total Copper	Dissolved Ma	Dissolved Zir	Total Zinc (g	Total Nitroge	Total Ammo	Ph Adjustme	Nitrite-N (g/	Nitrate-N (g	Nitrate-N + N	Dissolved Re	Total Phosph	Dissolved No	Escherichia c	Flow (m3/s)
CHE	0.00%	11.00	58.50	5.72	68.80	55.50	6.55	0.13	0.13	0.67	1.42	6.70	15.40	1.50	4.20	8.00E-04	0.0011	1.180	0.026	0.028	0.220	0.003	0.001	0.001	0.071	0.073	0.007	0.008	1.200	30	NA
CHE	20.00%	13.10	82.40	8.01	219.00	133.40	6.98	0.38	0.38	2.35	2.10	7.30	46.00	1.50	11.50	0.001	0.00142	3.900	0.041	0.043	0.360	0.003	0.001	0.001	0.210	0.210	0.009	0.017	1.980	100	NA
CHE	25.00%	13.48	84.23	8.32	238.20	169.25	7.03	0.41	0.41	2.64	2.18	7.38	47.00	1.50	11.58	0.001	0.0014975	4.400	0.042	0.045	0.400	0.003	0.002	0.001	0.255	0.258	0.009	0.020	2.050	100	NA
CHE	50.00%	15.20	91.30	9.37	263.70	214.70	7.30	0.51	0.48	5.78	3.30	7.50	57.00	3.00	14.25	0.0013	0.00186	5.400	0.052	0.058	0.455	0.005	0.003	0.002	0.330	0.330	0.014	0.026	2.400	280	NA
CHE	Mean	14.99	90.87	9.19	248.83	191.47	7.26	0.47	0.50	7.43	4.91	7.42	55.37	4.96	13.93	0.0017	0.0024	5.006	0.058	0.066	0.490	0.008	0.004	0.002	0.322	0.324	0.014	0.026	2.751	1251	NA
CHE	75.00%	16.83	96.13	9.97	274.50	231.40	7.50	0.56	0.56	8.38	4.43	7.53	66.00	7.00	16.70	0.00205	0.0026	5.875	0.068	0.077	0.530	0.007	0.004	0.003	0.370	0.373	0.018	0.030	3.100	1250	NA
CHE	80.00%	16.90	96.20	10.01	279.40	234.60	7.59	0.57	0.59	8.98	5.00	7.60	66.00	8.00	17.00	0.0023	0.0026	6.300	0.070	0.083	0.530	0.008	0.004	0.004	0.380	0.390	0.018	0.032	3.140	1500	NA
CHE	95.00%	18.15	100.45	10.59	302.65	250.00	7.75	0.69	0.92	22.37	17.33	7.70	77.25	16.00	19.78	0.003325	0.0047	6.900	0.110	0.130	0.763	0.017	0.008	0.005	0.570	0.580	0.021	0.041	4.580	3750	NA
CHE	100.00%	19.00	173.00	16.66	531.00	258.80	7.81	0.73	1.07	26.80	19.10	7.80	84.00	23.00	21.00	0.0048	0.0091	7.400	0.122	0.165	1.200	0.072	0.031	0.007	0.590	0.590	0.027	0.049	8.300	16000	NA
DAWA	0.00%	11.20	66.30	6.00	5.90	53.30	6.54	0.01	0.01	2.75	1.42	6.90	16.10	1.50	4.60	5.00E-04	0.00061	1.120	0.009	0.014	0.240	0.003	0.001	0.001	0.001	0.001	0.001	0.016	0.300	90	NA
DAWA	20.00%	15.88	76.06	7.07	193.34	203.32	6.95	0.14	0.14	5.84	3.90	7.20	57.00	4.00	13.90	8.00E-04	0.00122	5.000	0.015	0.023	0.450	0.013	0.006	0.003	0.230	0.230	0.005	0.024	1.680	230	NA
DAWA	25.00%	16.15	79.85	7.19	219.85	219.60	7.03	0.20	0.20	6.51	4.70	7.30	61.75	4.75	14.35	8.00E-04	0.001295	5.100	0.016	0.025	0.475	0.013	0.008	0.004	0.283	0.283	0.006	0.030	1.700	253	NA
DAWA	50.00%	18.90	84.80	7.99	256.40	244.00	7.20	0.27	0.27	10.20	9.10	7.55	77.50	6.50	16.75	0.00145	0.001885	6.800	0.027	0.039	0.715	0.032	0.014	0.007	0.485	0.495	0.010	0.040	2.800	700	NA
DAWA	Mean	18.75	86.34	8.05	243.74	237.44	7.25	0.32	0.32	48.99	22.16	7.50	73.81	15.85	17.48	0.0019	0.0033	7.317	0.035	0.054	0.961	0.060	0.031	0.008	0.607	0.615	0.012	0.051	2.777	3816	NA
DAWA	75.00%	21.30	93.05	8.72	296.25	275.90	7.46	0.49	0.49	27.00	17.25	7.70	87.25	13.25	21.00	0.0023	0.003675	8.375	0.038	0.051	1.250	0.065	0.031	0.009	0.883	0.893	0.015	0.054	3.450	2050	NA
DAWA	80.00%	21.40	96.00	9.05	297.82	276.32	7.50	0.50	0.49	30.28	23.00	7.70	89.00	16.00	21.00	0.0026	0.005	8.900	0.043	0.070	1.360	0.071	0.034	0.010	0.900	0.910	0.018	0.070	3.800	2200	NA
DAWA	95.00%	23.41	105.28	9.59	321.22	294.53	7.94	0.55	0.56	133.41	81.75	7.83	102.25	88.50	25.50	0.0045	0.00925	13.050	0.094	0.130	2.250	0.118	0.097	0.022	1.280	1.290	0.030	0.128	4.730	9000	NA
DAWA	100.00%	24.30	117.20	10.37	382.70	356.10	8.08	0.60	0.66	894.00	200.00	8.00	122.00	113.00	28.00	0.0057	0.0143	14.700	0.160	0.340	2.900	0.740	0.280	0.031	2.600	2.600	0.049	0.173	9.300	80000	NA
ESK	0.00%	10.00	53.90	0.23	136.70	105.20	6.30	0.01	0.01	3.22	3.80	6.60	27.00	1.50	7.20	8.00E-04	0.00094	2.200	0.007	0.007	0.350	0.005	0.002	0.002	0.083	0.086	0.006	0.016	3.000	60	0.005
ESK	20.00%	12.20	76.30	7.32	216.60	149.70	6.71	0.21	0.21	5.68	5.30	7.00	49.00	1.50	11.40	0.0012	0.0014	4.500	0.009	0.011	0.470	0.018	0.007	0.003	0.190	0.194	0.009	0.025	3.900	276	0.009
ESK	25.00%	12.90	76.40	7.46	227.48	169.80	6.73	0.36	0.36	5.84	5.48	7.20	49.00	1.50	11.68	0.001275	0.001445	4.800	0.009	0.012	0.523	0.018	0.008	0.003	0.218	0.228	0.009	0.028	3.950	280	0.009
ESK	50.00%	14.95	84.80	8.76	246.80	196.40	7.12	0.43	0.43	7.73	6.80	7.30	54.50	4.00	13.25	0.0015	0.00178	5.450	0.013	0.017	0.635	0.026	0.011	0.004	0.350	0.365	0.013	0.038	4.500	480	0.018
ESK	Mean	14.53	82.67	8.23	234.42	185.64	7.06	0.39	0.39	21.18	16.72	7.27	53.58	16.65	12.99	0.0017	0.0025	5.139	0.015	0.024	0.777	0.094	0.039	0.008	0.365	0.374	0.016	0.055	4.706	3575	0.035
ESK	75.00%	16.20	91.08	9.71	263.25	215.00	7.34	0.51	0.48	13.90	9.13	7.40	60.00	8.50	14.70	0.0019	0.00225	5.800	0.021	0.030	0.830	0.058	0.028	0.007	0.493	0.505	0.019	0.055	5.100	950	0.040
ESK	80.00%	16.30	92.70	9.79	265.20	219.00	7.44	0.51	0.49	16.66	11.40	7.50	61.00	11.00	15.10	0.0024	0.0027	5.800	0.023	0.033	0.900	0.095	0.036	0.014	0.500	0.520	0.021	0.059	5.400	1400	0.050
ESK	95.00%	18.48	99.93	10.68	270.68	231.93	7.55	0.56	0.56	73.09	39.50	7.53	69.50	37.25	17.10	0.00315	0.0057	6.525	0.029	0.041	1.620	0.320	0.149	0.029	0.678	0.688	0.035	0.140	5.820	10200	0.121
ESK	100.00%	19.30	108.50	10.80	305.50	239.50	7.61	0.62	0.71	241.00	240.00	7.70	79.00	320.00	19.10	0.0045	0.0158	7.500	0.030	0.145	2.300	1.190	0.451	0.041	1.070	1.080	0.050	0.320	11.800	80000	0.158
KAH	0.00%	10.10	30.50	2.94	76.20	64.00	6.28	0.01	0.01	2.09	3.00	6.50	14.40	1.50	3.70	6.00E-04	0.00093	1.220	0.007	0.010	0.380	0.005	0.003	0.002	0.018	0.028	0.004	0.011	2.100	140	0.002
KAH	20.00%	12.46	75.64	7.70	192.58	140.80	6.66	0.30	0.30	4.63	3.90	7.00	43.00	1.50	11.10	0.001	0.00118	3.800	0.013	0.015	0.450	0.015	0.006	0.002	0.260	0.260	0.006	0.017	3.260	300	0.004
KAH	25.00%	13.05	77.80	7.80	197.15	154.78	6.70	0.40	0.40	4.97	4.05	7.10	46.50	1.50	11.48	0.001	0.001215	3.950	0.014	0.016	0.488	0.016	0.006	0.002	0.268	0.270	0.007	0.018	3.350	318	0.004
KAH	50.00%	14.00	86.00	8.57	226.70	186.25	6.95	0.47	0.47	6.30	5.40	7.20	50.00	3.00	12.20	0.0014	0.001755	4.700	0.021	0.023	0.550	0.018	0.008	0.003	0.345	0.355	0.008	0.022	3.800	600	0.008
KAH	Mean	14.33	84.19	8.64	215.92	177.05	6.99	0.43	0.45	22.54	13.66	7.19	46.37	13.63	11.32	0.0015	0.0022	4.382	0.021	0.028	0.796	0.239	0.098	0.004	0.348	0.353	0.017	0.048	3.817	3985	0.016
KAH	75.00%	15.90	91.25	9.71	249.75	210.03	7.20	0.58	0.61	12.60	7.78	7.33	52.25	6.00	12.53	0.0019	0.002425	5.200	0.027	0.035	0.658	0.023	0.010	0.004	0.405	0.413	0.010	0.029	4.300	1650	0.018
KAH	80.00%	16.10	92.24	9.81	253.04	213.20	7.26	0.59	0.64	28.24	8.60	7.40	53.00	11.00	12.70	0.0019	0.0027	5.200	0.029	0.036	0.700	0.025	0.010	0.004	0.420	0.430	0.010	0.034	4.420	2000	0.023
KAH	95.00%	18.11	100.52	10.44	266.15	222.40	7.43	0.64	0.77	69.04	44.25	7.60	55.25	46.00	13.10	0.002625	0.0046	5.425	0.035	0.052	0.888	0.044	0.043	0.007	0.570	0.578	0.019	0.101	5.030	30250	0.055
KAH	100.00%	18.80	107.50	10.81	327.50	278.20	8.66	0.65	0.80	234.00	152.00	7.70	57.00	210.00	13.60	0.0029	0.011	5.900	0.039	0.112	8.500	7.900	3.147	0.016	0.610	0.610	0.310	0.690	5.400	39000	0.071
KAI	0.00%	10.30	7.87	4.39	67.50	56.80	6.27	0.03	0.03	3.19	3.70	6.50	14.20	1.50	3.90	5.00E-04	0.00082	1.060	0.008	0.011	0.280	0.011	0.004	0.002	0.079	0.087	0.002	0.011	1.700	70	0.001
KAI	20.00%	12.80	69.40	7.32	185.40	139.10	6.70	0.20	0.20	6.52	6.30	6.90	48.00	1.50	12.20	8.00E-04	0.0011	3.900	0.016	0.019	0.350	0.027	0.010	0.003	0.131	0.134	0.004	0.019	2.960	230	0.003
KAI	25.00%	13.25	70.65	7.37	217.80	154.18	6.72	0.24	0.24	7.48	6.60	6.90	48.00	1.50	12.48	8.00E-04	0.001125	4.150	0.017	0.022	0.358	0.028	0.011	0.003	0.139	0.141	0.004	0.020	3.100	348	0.004
KAI	50.00%	14.80	77.75	8.01	231.25	191.10	6.95	0.42	0.42	9.47	7.25	7.05	52.50	3.50	13.40	0.0011	0.0015	4.750	0.026	0.031	0.600	0.041	0.017	0.003	0.195	0.198	0.006	0.024	3.800	870	0.007
KAI	Mean	14.74	77.42	8.08	215.72	171.00	6.98	0.39	0.40	15.25	12.84	7.06	49.70	9.72	12.82	0.0013	0.0020	4.312	0.029	0.037	0.634	0.053	0.027	0.006	0.286	0.292	0.008	0.042	3.826	2018	0.013
KAI	75.00%	16.40	87.43	8.95	242.65	199.43	7.13	0.54	0.53	15.45	11.35	7.20	58.00	8.00	14.90	0.001625	0.001965	5.000	0.038	0.047	0.730	0.053	0.023	0.006	0.440	0.443	0.008	0.035	4.300	2000	0.015
KAI	80.00%	16.70	88.20	9.29	246.30	200.80	7.16	0.54	0.53	16.98	13.10	7.20	58.00	11.00	15.10	0.0018	0.0022	5.100	0.039	0.055	0.790	0.066	0.033	0.008	0.470	0.490	0.008	0.044	4.420	2500	0.018
KAI	95.00%	17.98	94.23	9.77	261.93	209.13	7.58	0.63	0.73	30.20	24.75	7.35	61.25	25.00	15.73	0.003	0.004625	5.500	0.057	0.075	1.188	0.135	0.061	0.024	0.610	0.613	0.017	0.119	5.020	7150	0.047
KAI	100.00%	18.70	136.10	13.17	268.20	225.50	8.32	0.67	0.86	125.00	120.00	7.60	62.00	133.00	16.60	0.0033	0.0109	5.500	0.065	0.126	2.100	0.240	0.211	0.036	0.630	0.630	0.045	0.290	6.400	17000	0.052
LSB	0.00%	11.60	60.60	5.55	88.40	67.40	6.47	0.08	0.08	0.95	2.20	6.70	22.00	1.50	5.90	7.00E-04	0.00092	1.780	0.017	0.019	0.177	0.005	0.003	0.001	0.029	0.031	0.002	0.013	1.700	10	0.000
LSB	20.00%	12.70	72.70	7.09	197.90	135.40	6.66	0.24	0.24	4.56	4.30	7.20	56.00	3.00	14.30	9.00E-04	0.00122	4.600	0.022	0.028	0.260	0.015	0.007	0.001	0.070	0.071	0.007	0.021	2.480	120	0.000
LSB	25.00%	13.10	73.90	7.34	231.23	158.20	6.68	0.29	0.29	5.18	4.60	7.20	59.25	3.00	15.18	0.000975	0.0014325	5.000	0.026	0.032	0.268	0.017	0.008	0.001	0.082	0.083	0.008	0.024	2.500	153	0.001
LSB	50.00%	15.20	85.10	8.62	257.35	215.40	7.20	0.37	0.37	9.58	8.70	7.30	65.00	8.50	15.85	0.0011	0.001765	5.950	0.035	0.041	0.375	0.028	0.014	0.002	0.133	0.134	0.009	0.029	2.800	325	0.001
LSB	Mean	15.12	82.04	8.28	235.97	190.77	7.11	0.39	0.43	15.99	14.31	7.32	59.50	15.25	14.91	0.0015	0.0025	5.415	0.036	0.049	0.413	0.048	0.020	0.002	0.185	0.188	0.010	0.048	3.000	3152	0.002
LSB	75.00%	17.33	89.70	9.25	269.70	226.33	7.42	0.53	0.51	14.75	19.35	7.50	68.00	17.75	16.95	0.00165	0.0029	6.325	0.046	0.062	0.493	0.049	0.021	0.002	0.300	0.300	0.013	0.044	3.450	1025	0.002
LSB	80.00%	17.50	91.00	9.35	272.10	228.20	7.43	0.53	0.51	16.38	22.00	7.50	69.00	21.00	17.10	0.0023	0.0029	6.400	0.050	0.068	0.530	0.055	0.022	0.002	0.310	0.320	0.013	0.047	3.520	1500	0.003
LSB	95.00%	18.53	95.43	10.01	290.30	250.90	7.78	0.70	0.98	43.21	43.25	7.70	72.25	60.75	17.80	0.002875	0.006675	6.950	0.060	0.094	0.820	0.093	0.043	0.004	0.400	0.403	0.018	0.163	4.250	20750	0.007
LSB	100.00%	19.50	96.50	10.28	309.10	260.90	7.85	0.73	1.07	144.00	71.00	7.70	74.00	81.00	18.10	0.0038	0.007	7.400	0.068	0.117	1.180	0.480	0.176	0.007	0.520	0.530	0.023	0.300	5.000	41000	0.009
ONE	0.00%	10.80	63.70	5.94	73.30	55.50	6.39	0.06	0.06	3.29	3.40	6.70	15.70	1.50	4.00	0.0011	0.0014	1.360	0.010	0.011	0.260	0.003	0.001	0.001	0.079	0.081	0.007	0.018	2.000	90	NA
ONE	20.00%	12.70	74.70	7.56	221.40	143.40	6.88	0.23	0.23	5.45	5.30	7.30	48.00	3.00	11.70	0.0014	0.0017	4.100	0.013	0.017	0.346	0.006	0.004	0.002	0.164	0.165	0.011	0.026	3.160	220	NA
ONE	25.00%	13.10	76.63	7.67	225.53	167.73	6.89	0.23	0.23	6.27	5.68	7.30	49.00	3.00	11.88	0.0014	0.0017775	4.350	0.014	0.017	0.358	0.007	0.004	0.002	0.187	0.191	0.012	0.027	3.200	228	NA
ONE	50.00%	14.95	86.10	8.81	247.50	200.25	7.34	0.32	0.32	8.39	7.45	7.50	53.50	5.00	13.40	0.00175	0.0023	4.900	0.016	0.024	0.525	0.011	0.005	0.002	0.305	0.305	0.015	0.038	3.900	700	NA
ONE	Mean	14.72	86.69	8.83	241.68	188.71	7.24	0.35	0.36	17.06	12.02	7.43	52.69	10.46	13.05	0.0020	0.0030	4.889	0.018	0.025	0.908	0.099	0.042	0.011	0.556	0.571	0.024	0.058	4.271	6368	NA
ONE	75.00%	16.45	94.45	9.80	268.43	216.73	7.57	0.49	0.48	20.85	12.38	7.60	59.00	10.50	14.35	0.002325	0.0031	5.700	0.021	0.030	0.995	0.014	0.007	0.005	0.513	0.528	0.025	0.069	4.750	1700	NA
ONE	80.00%	16.80	96.60	10.01	272.10	221.90	7.60	0.51	0.48	24.98	13.70	7.60	61.00	12.00	15.30	0.0025	0.0034	6.000	0.023	0.030	1.244	0.018	0.010	0.005	0.802	0.806	0.028	0.077	4.940	1700	NA
ONE	95.00%	18.20	100.93	10.80	297.65	247.70	7.78	0.60	0.65	47.02	34.00	7.80	67.75	42.25	16.50	0.0037	0.006575	6.425	0.029	0.047	2.955	0.660	0.286	0.043	1.755	1.832	0.071	0.154	7.070	18750	NA
ONE	100.00%	18.70	126.40	12.23	409.20	256.70	7.82	0.60	0.66	113.00	81.00	7.80	92.00	69.00	22.00	0.0042	0.0118	9.000	0.032	0.055	4.000	1.420	0.566	0.150	3.600	3.700	0.105	0.270	10.900	160000	NA
SOL	0.00%	11.80	68.90	6.47	146.40	111.90	6.68	0.07	0.07	2.86	2.70	6.60	34.00	1.50	7.70	0.00025	0.00026	3.600	0.002	0.004	0.169	0.003	0.001	0.001	0.070	0.071	0.002	0.009	1.000	40	NA
SOL	20.00%	12.90	88.96	9.06	223.72	164.50	6.93	0.25	0.25	4.83	3.58	7.20	46.60	3.00	9.68	0.00068	0.000888	5.320	0.005	0.007	0.270	0.005	0.002	0.001	0.158	0.159	0.005	0.012	2.400	80	NA
SOL	25.00%	13.10	92.80	9.19	231.75	178.00	7.02	0.26	0.26	5.03	4.05	7.30	49.00	3.00	10.00	7.00E-04	0.00091	5.650	0.005	0.008	0.280	0.005	0.002	0.001	0.160	0.164	0.006	0.012	2.400	85	NA
SOL	50.00%	15.10	97.20	9.64	246.55	200.65	7.35	0.41	0.41	8.78	6.40	7.50	53.00	5.00	11.40	9.00E-04	0.00109	6.100	0.007	0.010	0.360	0.007	0.004	0.001	0.184	0.186	0.007	0.014	3.200	130	NA
SOL	Mean	14.92	96.04	9.71	239.04	190.92	7.34	0.39	0.39	14.94	10.25	7.41	53.29	9.69	11.49	0.0011	0.0015	5.969	0.007	0.011	0.378	0.008	0.005	0.002	0.208	0.209	0.007	0.018	3.332	321	NA
SOL	75.00%	16.68	99.80	10.54	260.53	211.15	7.65	0.52	0.49	13.70	8.45	7.60	58.00	8.00	13.00	0.0012	0.00172	6.700	0.009	0.013	0.440	0.009	0.005	0.002	0.270	0.270	0.007	0.018	3.475	200	NA
SOL	80.00%	16.78	99.94	10.67	262.40	215.90	7.77	0.53	0.51	17.40	9.36	7.60	61.00	11.60	13.22	0.00132	0.001848	6.800	0.009	0.014	0.454	0.010	0.006	0.002	0.280	0.280	0.008	0.020	4.140	220	NA
SOL	95.00%	18.01	111.82	11.31	276.94	240.10	7.91	0.56	0.57	45.04	35.60	7.63	68.30	33.70	15.12	0.00246	0.00366	7.600	0.011	0.021	0.645	0.019	0.011	0.003	0.313	0.320	0.010	0.040	6.015	1520	NA
SOL	100.00%	18.60	132.10	12.79	310.00	254.10	7.95	0.65	0.80	85.50	57.00	7.70	70.00	64.00	15.50	0.0027	0.0039	7.900	0.013	0.027	0.710	0.025	0.016	0.005	0.320	0.320	0.011	0.055	7.200	2400	NA
UAWA	0.00%	11.90	15.50	1.49	66.70	54.80	6.35	0.03	0.03	3.11	4.30	6.70	16.20	3.00	4.70	0.001	0.00147	1.070	0.008	0.020	0.200	0.006	0.002	0.001	0.003	0.006	0.004	0.011	1.500	60	NA
UAWA	20.00%	14.10	55.02	5.39	224.70	176.96	6.73	0.20	0.20	5.60	8.16	7.00	58.00	7.00	14.72	0.0016	0.00272	4.700	0.023	0.033	0.326	0.017	0.007	0.002	0.049	0.051	0.006	0.030	2.800	200	NA
UAWA	25.00%	14.20	55.60	5.44	237.00	188.50	6.78	0.20	0.20	7.81	9.10	7.00	58.00	8.00	14.90	0.0017	0.0029	5.000	0.024	0.034	0.370	0.021	0.009	0.002	0.067	0.069	0.007	0.031	2.975	200	NA
UAWA	50.00%	16.10	68.10	6.67	259.30	210.00	6.96	0.27	0.27	16.85	13.30	7.10	63.00	12.00	15.70	0.0023	0.0037	5.700	0.033	0.044	0.520	0.030	0.012	0.003	0.193	0.194	0.009	0.045	3.650	600	NA
UAWA	Mean	16.36	65.49	6.46	244.77	202.67	6.96	0.31	0.32	20.45	31.97	7.11	60.60	49.03	15.56	0.0034	0.0052	5.283	0.039	0.053	0.799	0.052	0.023	0.005	0.274	0.279	0.010	0.187	3.919	2013	NA
UAWA	75.00%	18.10	77.90	7.97	266.40	230.60	7.18	0.42	0.42	29.08	23.00	7.20	64.00	26.00	16.40	0.0041	0.0073	6.000	0.045	0.067	0.790	0.059	0.025	0.004	0.380	0.380	0.012	0.068	5.000	1400	NA
UAWA	80.00%	18.28	80.58	7.99	268.96	232.76	7.20	0.44	0.44	33.00	24.40	7.20	64.80	32.60	16.56	0.00528	0.00772	6.100	0.055	0.070	0.984	0.072	0.034	0.005	0.396	0.406	0.013	0.094	5.100	1400	NA
UAWA	95.00%	20.02	88.72	8.91	284.12	244.12	7.33	0.59	0.63	51.95	103.00	7.40	71.20	169.20	18.36	0.00846	0.01176	6.600	0.083	0.104	2.540	0.150	0.086	0.012	0.898	0.908	0.022	0.538	6.125	10600	NA
UAWA	100.00%	21.60	91.30	9.28	296.40	246.50	8.22	0.60	0.66	74.50	370.00	7.50	74.00	690.00	19.60	0.0099	0.0139	6.900	0.091	0.132	3.600	0.380	0.147	0.026	1.600	1.610	0.034	3.700	8.800	19000	NA
WAI	0.00%	11.90	83.40	8.56	40.70	34.50	4.70	0.12	0.12	1.29	2.00	6.70	8.40	1.50	2.60	0.001	0.00122	0.460	0.005	0.012	0.430	0.003	0.001	0.002	0.106	0.108	0.004	0.010	3.000	200	0.002
WAI	20.00%	13.80	103.70	10.38	209.80	164.60	7.37	0.29	0.29	4.31	2.68	7.40	53.00	1.50	14.40	0.0014	0.00158	3.800	0.010	0.018	0.650	0.008	0.005	0.008	0.290	0.310	0.006	0.016	3.480	430	0.003
WAI	25.00%	14.00	104.75	10.66	227.98	174.85	7.45	0.33	0.33	4.91	3.50	7.40	53.75	1.50	14.80	0.0014	0.0016375	3.900	0.011	0.020	0.660	0.010	0.007	0.008	0.318	0.328	0.006	0.018	3.550	675	0.003
WAI	50.00%	16.10	113.35	11.29	261.65	217.05	7.85	0.55	0.54	8.63	6.60	7.80	58.50	3.00	16.25	0.0017	0.0022	4.250	0.022	0.029	0.850	0.018	0.017	0.013	0.460	0.480	0.009	0.022	4.200	1250	0.006
WAI	Mean	16.39	121.94	11.87	261.86	218.16	7.87	0.47	0.52	12.92	9.21	7.86	56.68	6.47	15.81	0.0019	0.0028	4.168	0.032	0.046	0.876	0.034	0.033	0.017	0.466	0.483	0.010	0.029	4.371	7511	0.014
WAI	75.00%	18.93	129.73	12.21	301.38	253.25	8.26	0.60	0.66	13.25	9.60	8.30	65.25	5.50	18.15	0.00225	0.003025	4.700	0.041	0.053	0.963	0.041	0.035	0.023	0.568	0.593	0.012	0.031	5.150	3475	0.011
WAI	80.00%	19.00	133.30	12.29	321.70	276.90	8.62	0.61	0.69	15.50	10.62	8.40	66.00	6.00	18.60	0.0024	0.0034	4.800	0.046	0.070	0.980	0.046	0.044	0.024	0.600	0.600	0.013	0.032	5.200	4800	0.023
WAI	95.00%	20.55	163.35	15.52	395.80	377.25	9.08	0.69	0.94	38.04	24.20	8.60	69.00	15.00	19.70	0.00325	0.0054	5.200	0.099	0.119	1.415	0.069	0.081	0.045	0.703	0.730	0.023	0.057	5.730	28750	0.048
WAI	100.00%	22.20	274.70	25.50	449.00	396.80	9.20	0.72	1.03	68.60	52.00	9.40	82.00	89.00	21.00	0.0045	0.0127	8.100	0.107	0.188	1.730	0.340	0.340	0.067	1.220	1.260	0.027	0.165	6.600	130000	0.083

Appendix 3: Flow Correlations With Telemetered Sites





Appendix 4: Cumulative rainfall



Appendix 5: NPS-FM GRADING

SITE	TOTAL AMMONIA TOXICITY	NITRATE TOXICITY	E.COLI	DRP	MCI
Chelsea Stream	A	A	E	C	D
Downstream Awataha	B	A	E	B	n/a
Esk	B	A	E	C	C
Kahika	A	A	E	B	C
Kaipatiki	B	A	E	A	D
Little Shoal Bay	A	A	E	B	C
Onepoto	B	B	E	D	C
Soldiers Bay Stream	A	A	E	B	C
Upstream Awataha	B	A	E	B	D
Wairau Creek	B	A	E	B	n/a