

Waikato River water quality monitoring programme: Data report 2018

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1 Introduction

1.1 Background

This report covers the calendar year of 2018 and follows the format of the previous data report (Tulagi, 2017).

To effectively manage water quality, the Waikato River monitoring programme addresses the following questions:

1. What is the quality of the water now?
2. Why is the water of the observed level of quality?
3. Is water quality getting better or worse? If so - what makes it change?
4. How can we improve the quality, ecological health and integrity of the Waikato River?

The monitoring information allows the Council to:

- determine compliance with classification standards
- define the suitability of the resource for various beneficial uses and values of the water
- monitor the impact of major discrete point source discharges on water quality
- monitor the impacts of diffuse discharges on water quality
- provide a basis for evaluating the effectiveness of resource management measures.

This dataset is invaluable for the evaluation of the Waikato River: its state, the pressures on it and its response to these pressures. We need to continue to gather comprehensive, reliable, and good quality data on the Waikato River to protect and enhance its values into the future.

This report is the 28th since the re-design of the Waikato River Monitoring Programme (WaRiMP) implemented in 1989. Copies of reports can be obtained via the Waikato Regional Council Internet site <http://www.waikatoregion.govt.nz/Publications/> or by contacting Waikato Regional Council (the Library) on 0800 800 401 and filling out the request for service form at: www.waikatoregion.govt.nz/request.

1.2 Report content

The report provides information on:

1. Routine monthly monitoring of water quality at 10 sites:
 - Year 2018 summary data tabulated by parameter for each location and reported with the median of the previous 5 years.
 - Key parameter graphs showing the average water quality for 2018 at each location, compared to results of the previous 5 years.
 - Summary tables identifying the number of samples meeting 'satisfactory' and 'excellent' water quality standards and guidelines.
 - Raw data for 2018.
 - Five-yearly pesticide survey at six sites.
2. Additional information is provided in the appendices on:
 - Flow (*Appendix I*): The effect of flow is important to assessing water quality and making comparisons between years. Appendix I provides information on annual median flow at some locations for the previous 10 years.
 - Continuous monitoring data via Datasonde (*Appendix II*): Plots of the Hamilton deployment undertaken during 2018 showing the level of diurnal and seasonal variation of selected parameters.
 - Water quality criteria (*Appendix III*): Identifying the water quality parameters, guidelines, standards, and analytical methods used in the Waikato River water quality monitoring programme.

1.3 Water quality guidelines and standards

Table 1 lists the physical and chemical water quality standards and guidelines used to assess the condition of the Waikato River in 2018. The standards mainly relate to either the protection of ecological health of rivers and streams or to whether they are suitable for water-based recreation, especially swimming.

Some water quality guidelines and standards are relevant to the use of the Waikato River for both general water supply (industrial/cooling water, irrigation, stock water etc.) and as a source of municipal drinking water. In most cases two criteria are shown. The less stringent criteria define water that is “satisfactory” for the desired use; these are mostly based on existing national and other guidelines and standards (Appendix III). The more stringent criteria identify “excellent” water, and reflect expert opinion. Samples gathered in 2018 whose results do not comply with the “satisfactory” criteria (Table 1) are underlined in raw data summaries.

Adoption of updated water guidelines within council is currently under review. Including the National Policy Statement for Freshwater Management 2017 (NPSFM) and updated ANZECC (2018) guidelines.

Table 1: Guidelines and standards for physiochemical water quality for ecological health and for human uses of water

Water quality measure	Relevance ¹	Satisfactory	Excellent
Ecological health			
Dissolved Oxygen (% sat.)	aquatic life (breathing)	>80	>90
pH	aquatic life (acidity)	6.5-9	7-8
Turbidity (NTU)	plant life (clarity)	<5	<2
Ammoniacal Nitrogen (g/m ³)	aquatic life (toxicity)	<0.88	<0.1
Water Temperature (°C)(May-Sep)	fish (spawning)	<12	<10
(Oct-Apr)	fish health	<20	<16
Total Phosphorus (g/m ³)	nuisance plant growth	<0.04	<0.01
Total Nitrogen (g/m ³)	nuisance plant growth	<0.5	<0.1
Human uses - recreation			
Black Disk (m)	visibility	>1.6	>4
<i>Escherichia coli</i> (✓100ml)	human health	<550	<55
Median <i>Escherichia coli</i> (✓100ml)	human health	<126	<23
Human uses - water supply			
Chlorophyll <i>a</i> (g/m ³)	filter blockage	<0.02	<0.005
Human uses - drinking water			
Arsenic (g/m ³)	human health (toxicity)	<0.01	-
Boron (g/m ³)	human health (toxicity)	<1.4	-

¹Refer to Appendix III for description of guideline and standards values used. These guidelines and standards are also defined on the Waikato Regional Council Internet site; www.waikatoregion.govt.nz/guidelines

2 The Waikato River monitoring programme design

2.1 Sampling collection

Sample collection occurs monthly, as two sampling runs. Locations in the upper catchment from Taupo to Waipapa are visited as part of the first run, and locations in the middle and lower catchments from Hamilton (at the Narrows) to Tuakau are visited on the next. Each location is sampled at a similar time on each occasion (coefficient of variation $\approx 2\text{--}6\%$) to minimise the effect of diurnal variation on the measurement of water quality parameters. Sample times are recorded in New Zealand Standard Time (NZST). Because of the controlled nature of the river, our daytime samples are generally collected at higher than median flows.

2.2 Sample locations

Routine water quality monitoring locations of the Waikato River Monitoring Programme and additional locations used during the summer microbiological surveys are illustrated in *Figure 1* and summarised in *Table 2*.

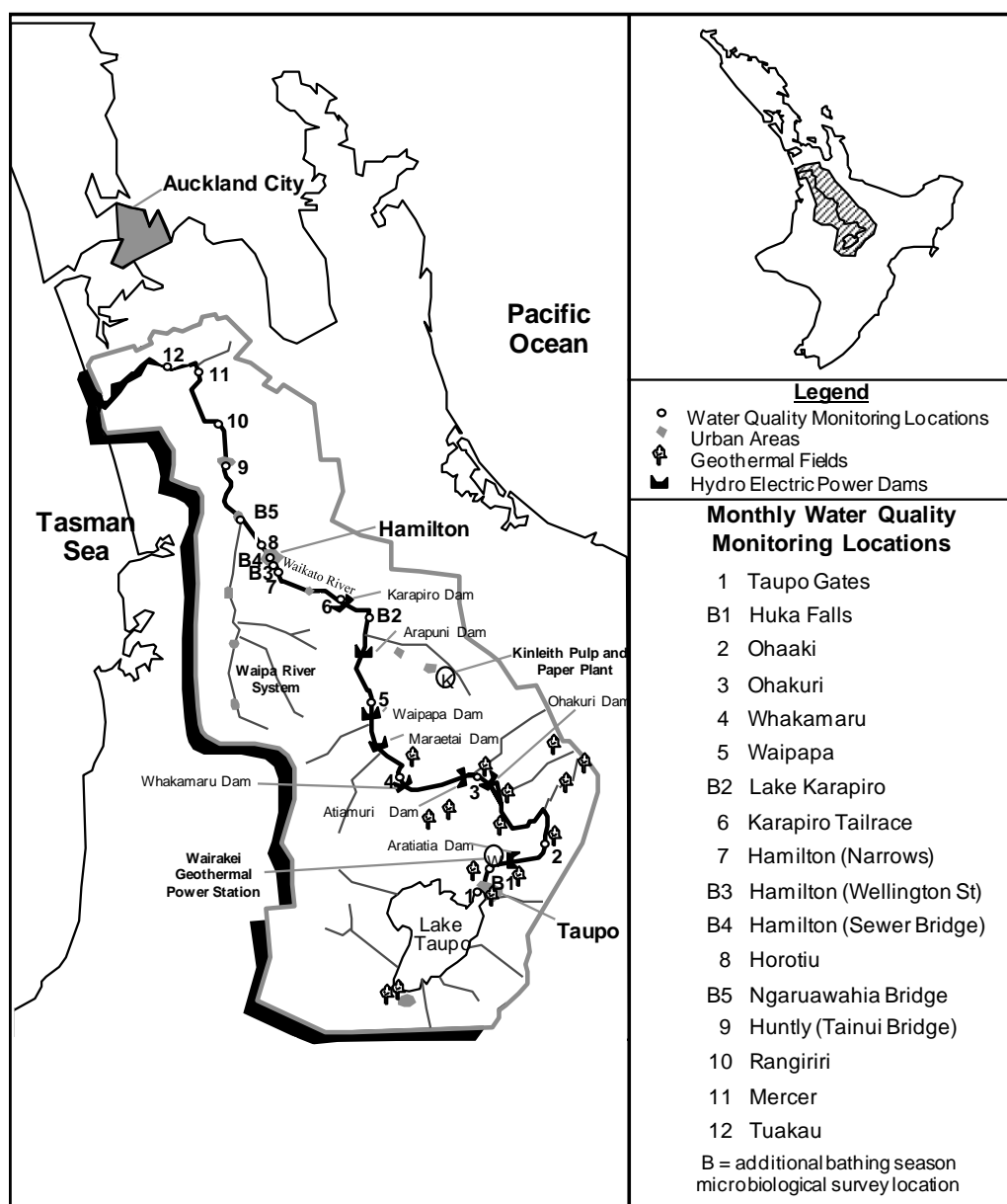


Figure 1: Waikato River water quality monitoring locations

Ten locations along the river are visited monthly (Taupo, Ohaaki, Ohakuri, Whakamaru, Waipapa, Hamilton-Narrows, Hamilton-Horotiu, Huntly, Mercer and Tuakau). Starting in September 2018 two more locations were added to the programme: Karapiro Tailrace and Rangiriri Bridge. Due to the incomplete annual data sets, data from the two added locations are not included in this year's. An additional four locations are included for the summer intensive microbiological survey (see Figure 1 and Table 2), the results of which are reported to LAWA for public access. The major tributaries that enter the Waikato River are also monitored monthly as part of the Regional River Monitoring Programme (ReRiMP) initiated in 1993 (Huser and Wilson, 1996b).

Table 2: Routine sampling and bathing beach water quality monitoring sites

Location number	Distance ¹ (km)	Location name	Location coordinate (NZTM)
1131-127	0.1	Taupo Gates	1867049, 5714142
1131-649 ^{*d}	2	Taupo Bungy at jetty, true right bank	1868453, 5714281
1131-219 ^d	8.4	Downstream Huka Falls at river boat jetty ²	1870167, 5719750
1131-105 ^d	36.5	Ohaaki Bridge at bridge, true right bank	1887985, 5729892
1131-107	75.8	Ohakuri Tailrace Bridge ³	1869480, 5744515
1131-147	105	Whakamaru Tailrace at boat ramp ⁴	1845004, 5743996
1131-143	126.1	Waipapa Tailrace at boat ramp ⁵	1834859, 5759095
1131-81 ^b	166.7	Lake Karapiro Boat Ramp at Horahora domain	1833397, 5795413
1131-79	179.3	Karapiro Tailrace, true right bank	1823187, 5799700
1131-328	202.2	Hamilton – Narrows at boat ramp ⁶	1806588, 5809381
1131-145 ^{*b}	210.8	Hamilton – Wellington St Bch at jetty, true right bank	1801658, 5814272
1131-64 ^d	211.5	Hamilton – Traffic Bridge true right bank	1801620, 5814821
1131-69	225.6	Horotiu Bridge d/s of bridge	1794554, 5825430
1131-102 ^b	232.3	Ngaruawahia Bridge u/s of confluence ⁷	1789439, 5829455
1131-77	246.5	Huntly – Tainui Bridge true left bank	1790260, 5840128
1131-117 ^{*d}	262.3	Rangiriri Bridge true right bank	1788389, 5855059
1131-91	286.3	Mercer Bridge	1781445, 5871961
1131-133	296.8	Tuakau Bridge at boat ramp ⁸	1772410, 5870516
1131-131 ^d	306.5	Tuakau – Elbows Landing at NZ Steel Ltd pumping station	1764150, 5873515

¹ approximate distance (in kilometres) from Lake Taupo's outlet.

² river boat jetty and boat ramp, true left bank, about 1.8 km downstream of Huka Falls

³ boat ramp in recreation reserve immediately upstream from dam (true left bank).

⁴ boat ramp at Whakamaru Power Station.

⁵ river access d/s of Lake Waipapa, about 500 m off S.H. 32 along a gravel road (true left bank).

⁶ boat ramp accessed via Narrows Lane (true right bank)

⁷ road bridge upstream of Waipa River confluence.

⁸ immediately d/s of bridge, at Reserve (true right bank).

^b bathing season intensive microbiological survey locations only – survey conducted over the 2017/18 summer.

^d datasonde deployment sites.

^{*} locations at Taupo (Taupo Bungy, 2 km d/s from Taupo Gates), at Hamilton (Wellington Street jetty) and at Rangiriri (Rangiriri Bridge) are sampled and reported as part of the National River Water Quality Network undertaken by NIWA. Contact person: Mike Crump, NIWA, Hamilton.

[†] logistic considerations mean field measurements are often made at slightly different locations from sample collection (e.g. sampling from bridges).

2.3 Water quality parameters

Water quality of the Waikato River is assessed by measuring up to 40 parameters (27 routinely). Some parameters are measured in the field, but the majority of parameters are analysed in a laboratory using standard analytical methods. Details of field measurements and analytical methods used are appended (*Appendix III*).

2.4 Quality control, data storage and analysis

Quality control measures are undertaken in accordance with Waikato Regional Council's standards including procedures for the collection, transport, storage of samples, and methods for data verification and quality assurance to ensure the consistency of data across the programme. Samples are sent to IANZ registered laboratories for analysis. Back-up samples are held for two months until results have been verified by routine quality assurance procedures. All data from field measurements and laboratory analyses are stored in Waikato Regional Council's database called WISKI.

Data analysis was performed using WQStats program. For the purpose of data analysis, non-detect results (i.e. results with "less than" values) were assumed to be equal to half the corresponding limit of detection (i.e. $<x = x/2$), and results greater than the value reported were taken as equal to the value reported (i.e. $>x = x$).

2.5 Reports

Waikato Regional Council Technical Report 2018/30, Trends in River Water Quality in the Waikato Region, 1993–2017 (Vant, 2018) outlines the trends in the Waikato River and other rivers in the region. Copies are available in electronic format from the publications page of the Waikato Regional Council website:

<http://www.waikatoregion.govt.nz/Publications/Technical-Reports>

The data contained in these Waikato River reports is updated to the Waikato Regional Council "Waikato River" Internet page:

<http://www.waikatoregion.govt.nz/Fresh-water-quality>

The "How healthy are our rivers?" link provides details of the guidelines and standards used to assess the condition of the Waikato River and other rivers in the region. A link to water quality at other regional river monitoring sites is also available from this page. This data is also supplied to the LAWA website:

<https://www.lawa.org.nz/explore-data/waikato-region>.

3 Results

3.1 Waikato River monitoring programme

Routine water quality monitoring

Summary statistics

Key parameter graphs

Comparison with water quality standards

Raw data

Summary statistics

Table 3: Sample statistics for 2018

Absorbance (340nm) (/cm)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.002	0.001	0.001	0.005	0.001	1.93	0.001
Ohaaki Br	12	0.004	0.003	0.001	0.007	0.001	0.96	0.003
Ohakuri Tailrace Br	12	0.006	0.006	0.004	0.009	0.002	0.54	0.006
Whakamaru Tailrace	12	0.010	0.007	0.005	0.039	0.001	3.40	0.007
Waipapa Tailrace	12	0.010	0.009	0.006	0.013	0.003	0.04	0.010
Narrows Boat Ramp	12	0.013	0.013	0.008	0.022	0.004	0.86	0.013
Horotiu Br	12	0.015	0.014	0.009	0.025	0.006	0.94	0.012
Huntly-Tainui Br	12	0.026	0.025	0.013	0.045	0.017	0.65	0.020
Mercer Bridge	12	0.033	0.033	0.014	0.074	0.018	1.29	0.023
Tuakau Br	12	0.035	0.033	0.014	0.072	0.025	0.92	0.027

Absorbance (440nm) (/cm)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.001	0.001	0.001	0.002	0.000	3.46	0.001
Ohaaki Br	12	0.001	0.001	0.001	0.001	0.000	0.00	0.001
Ohakuri Tailrace Br	12	0.002	0.001	0.001	0.007	0.000	3.46	0.001
Whakamaru Tailrace	12	0.002	0.001	0.001	0.007	0.000	3.31	0.001
Waipapa Tailrace	12	0.002	0.001	0.001	0.003	0.001	1.29	0.002
Narrows Boat Ramp	12	0.003	0.003	0.001	0.005	0.001	0.36	0.002
Horotiu Br	12	0.003	0.003	0.001	0.006	0.001	1.33	0.002
Huntly-Tainui Br	12	0.005	0.005	0.003	0.010	0.004	1.05	0.004
Mercer Bridge	12	0.006	0.007	0.003	0.012	0.003	0.83	0.004
Tuakau Br	12	0.006	0.007	0.003	0.012	0.004	0.67	0.005

Arsenic (g/m ³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.011	0.011	0.011	0.012	0.001	0.57	0.012
Ohaaki Br	12	0.021	0.019	0.017	0.032	0.007	1.16	0.022
Ohakuri Tailrace Br	12	0.026	0.026	0.019	0.036	0.006	0.80	0.028
Whakamaru Tailrace	12	0.025	0.023	0.019	0.036	0.007	0.97	0.028
Waipapa Tailrace	12	0.022	0.021	0.018	0.028	0.004	0.94	0.023
Narrows Boat Ramp	12	0.020	0.019	0.015	0.026	0.007	0.29	0.021
Horotiu Br	12	0.019	0.018	0.012	0.025	0.006	0.12	0.020
Huntly-Tainui Br	12	0.015	0.014	0.008	0.021	0.008	0.14	0.015
Mercer Bridge	12	0.014	0.014	0.007	0.019	0.007	-0.21	0.015
Tuakau Br	12	0.013	0.014	0.006	0.020	0.007	-0.06	0.014

Black Disk (m)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	0	-	-	-	-	-	-	-
Ohaaki Br	12	4.6	4.5	3.3	7.0	1.6	0.82	4.8
Ohakuri Tailrace Br	12	2.6	2.5	1.1	4.6	1.4	0.46	2.5
Whakamaru Tailrace	12	2.6	2.5	0.5	3.9	1.5	-0.64	2.4
Waipapa Tailrace	12	2.1	2.2	1.1	2.6	0.6	-0.93	2.2
Narrows Boat Ramp	12	1.6	1.6	0.8	2.2	0.6	-0.18	1.8
Horotiu Br	12	1.3	1.4	0.6	1.8	0.4	-0.60	1.5
Huntly-Tainui Br	11	0.6	0.5	0.3	1.3	0.3	1.06	0.9
Mercer Bridge	7	0.4	0.4	0.2	0.6	0.2	0.53	0.4
Tuakau Br	12	0.5	0.5	0.2	1.0	0.3	0.74	0.7

Skew = skewness (> 1 is lightly skewed, >2 is highly skewed; IQR = inter-quartile range)

Conductivity at 25 DegC (mS/m)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	11.9	11.8	11.7	12.7	0.2	2.58	12.0
Ohaaki Br	12	14.7	14.2	13.0	17.8	1.4	1.33	14.5
Ohakuri Tailrace Br	12	15.5	15.2	14.4	17.5	0.6	1.34	16.2
Whakamaru Tailrace	12	15.3	15.4	13.9	16.8	0.9	0.10	16.1
Waipapa Tailrace	12	15.1	15.1	14.2	15.7	0.8	-0.42	15.6
Narrows Boat Ramp	12	14.8	14.8	14.0	15.4	0.8	-0.22	15.3
Horotiu Br	12	15.0	15.0	14.1	15.8	0.9	-0.15	15.5
Huntly-Tainui Br	12	14.2	14.2	12.8	15.3	1.2	-0.11	14.4
Mercer Bridge	12	14.6	14.5	13.5	15.7	0.8	0.51	15.3
Tuakau Br	12	14.6	14.6	13.4	15.8	0.9	0.16	15.3

Dissolved Oxygen (g/m ³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	9.8	9.9	8.9	10.8	0.9	0.07	10.0
Ohaaki Br	12	10.3	10.3	8.4	12.5	2.4	0.13	10.1
Ohakuri Tailrace Br	12	9.9	10.1	7.8	11.4	1.9	-0.31	9.9
Whakamaru Tailrace	12	9.9	10.1	8.5	11.3	2.1	-0.19	9.9
Waipapa Tailrace	12	10.1	9.8	8.8	11.7	2.2	0.34	10.1
Narrows Boat Ramp	12	9.8	10.1	8.0	11.9	2.4	-0.03	10.0
Horotiu Br	12	9.9	10.1	8.2	11.7	2.4	-0.05	9.7
Huntly-Tainui Br	12	9.4	9.2	7.9	11.2	2.2	0.16	9.5
Mercer Bridge	12	9.1	8.5	7.8	10.8	1.8	0.42	9.3
Tuakau Br	12	9.0	8.5	7.9	10.9	2.0	0.57	9.4

Dissolved Oxygen (% sat.)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	101	101	96	106	4	0.00	102
Ohaaki Br	12	106	106	97	114	6	-0.50	104
Ohakuri Tailrace Br	12	103	103	88	114	7	-0.39	102
Whakamaru Tailrace	12	103	100	94	121	8	1.37	103
Waipapa Tailrace	12	104	102	96	113	12	0.24	102
Narrows Boat Ramp	12	99	98	89	114	13	0.45	98
Horotiu Br	12	99	98	88	111	8	0.06	97
Huntly-Tainui Br	12	95	94	85	108	8	0.60	95
Mercer Bridge	12	92	92	79	107	7	0.46	95
Tuakau Br	12	93	92	77	115	11	0.76	96

Enterococci (/100ml)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	22	3	1	200	12	3.33	2
Ohaaki Br	12	37	18	3	180	33	2.24	9
Ohakuri Tailrace Br	12	6	4	1	33	6	2.76	3
Whakamaru Tailrace	12	14	9	1	45	11	1.63	8
Waipapa Tailrace	12	19	5	1	120	10	2.74	5
Narrows Boat Ramp	12	151	50	13	900	135	2.71	47
Horotiu Br	12	279	110	10	1300	337	2.16	58
Huntly-Tainui Br	12	277	125	30	1100	250	1.76	58
Mercer Bridge	12	356	58	5	2100	253	2.24	32
Tuakau Br	12	242	86	6	1500	293	2.89	28

Skew = skewness (> 1 is lightly skewed, >2 is highly skewed; IQR = inter-quartile range)

Escherichia coli (/100ml)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	7	6	2	21	8	1.26	3
Ohaaki Br	12	50	29	5	170	46	1.62	15
Ohakuri Tailrace Br	12	6	5	2	14	4	1.25	4
Whakamaru Tailrace	12	20	15	3	49	28	0.80	9
Waipapa Tailrace	12	179	10	2	1800	20	3.36	7
Narrows Boat Ramp	12	290	33	18	1700	369	2.43	50
Horotiu Br	12	470	140	44	1800	600	1.55	100
Huntly-Tainui Br	12	839	200	50	3400	940	1.69	150
Mercer Bridge	12	770	190	37	5000	410	2.68	90
Tuakau Br	12	593	175	60	3300	690	2.67	85

Faecal Coliforms (/100ml)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	9	6	2	24	7	1.33	4
Ohaaki Br	12	64	42	5	230	45	1.73	17
Ohakuri Tailrace Br	12	7	5	2	18	5	1.51	4
Whakamaru Tailrace	12	26	20	3	60	35	0.61	11
Waipapa Tailrace	12	297	10	2	3100	22	3.39	8
Narrows Boat Ramp	12	371	41	28	1900	567	1.99	65
Horotiu Br	12	559	150	58	2100	775	1.46	125
Huntly-Tainui Br	12	995	245	60	4100	1370	1.58	190
Mercer Bridge	12	923	230	50	5000	895	2.24	115
Tuakau Br	12	785	245	80	4200	1025	2.47	110

Nitrate/Nitrite Nitrogen (g/m³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.002	0.001	0.001	0.003	0.002	0.913	0.001
Ohaaki Br	12	0.07	0.05	0.03	0.19	0.03	2.31	0.04
Ohakuri Tailrace Br	12	0.12	0.14	0.00	0.18	0.07	-1.00	0.10
Whakamaru Tailrace	12	0.19	0.19	0.01	0.26	0.05	-1.92	0.13
Waipapa Tailrace	12	0.27	0.25	0.17	0.37	0.12	0.35	0.22
Narrows Boat Ramp	12	0.40	0.34	0.17	0.66	0.28	0.43	0.30
Horotiu Br	12	0.42	0.37	0.21	0.66	0.27	0.48	0.32
Huntly-Tainui Br	12	0.61	0.44	0.32	1.15	0.50	0.66	0.43
Mercer Bridge	12	0.67	0.43	0.32	1.59	0.53	1.23	0.43
Tuakau Br	12	0.64	0.45	0.26	1.39	0.56	0.87	0.42

Ammoniacal Nitrogen (g/m³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.005	0.005	0.005	0.005	0.000	0.00	0.005
Ohaaki Br	12	0.012	0.005	0.005	0.033	0.012	1.39	0.005
Ohakuri Tailrace Br	12	0.010	0.009	0.005	0.018	0.011	0.14	0.005
Whakamaru Tailrace	12	0.007	0.005	0.005	0.018	0.003	1.83	0.005
Waipapa Tailrace	12	0.017	0.015	0.005	0.039	0.024	0.38	0.012
Narrows Boat Ramp	12	0.015	0.013	0.005	0.039	0.017	0.97	0.016
Horotiu Br	12	0.013	0.009	0.005	0.036	0.013	1.37	0.008
Huntly-Tainui Br	12	0.019	0.016	0.005	0.060	0.019	1.44	0.011
Mercer Bridge	12	0.016	0.008	0.005	0.080	0.010	2.94	0.005
Tuakau Br	12	0.015	0.005	0.005	0.061	0.016	2.30	0.005

Skew = skewness (> 1 is lightly skewed, >2 is highly skewed; IQR = inter-quartile range)

Total Kjeldahl Nitrogen (g/m ³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.06	0.06	0.03	0.11	0.02	0.33	0.07
Ohaaki Br	12	0.10	0.10	0.03	0.19	0.05	0.18	0.10
Ohakuri Tailrace Br	12	0.13	0.13	0.07	0.20	0.07	0.29	0.12
Whakamaru Tailrace	12	0.18	0.18	0.07	0.40	0.08	1.47	0.14
Waipapa Tailrace	12	0.13	0.14	0.06	0.20	0.04	-0.20	0.14
Narrows Boat Ramp	12	0.21	0.20	0.14	0.28	0.05	0.20	0.19
Horotiu Br	12	0.21	0.22	0.16	0.27	0.08	0.01	0.19
Huntly-Tainui Br	12	0.33	0.34	0.18	0.50	0.18	0.13	0.25
Mercer Bridge	12	0.39	0.34	0.17	0.93	0.21	1.92	0.31
Tuakau Br	12	0.41	0.36	0.22	0.84	0.15	1.84	0.33

Total Nitrogen (g/m ³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.06	0.06	0.03	0.11	0.02	0.27	0.07
Ohaaki Br	12	0.16	0.15	0.06	0.38	0.06	1.61	0.13
Ohakuri Tailrace Br	12	0.25	0.25	0.20	0.31	0.06	0.29	0.22
Whakamaru Tailrace	12	0.37	0.37	0.31	0.42	0.07	-0.05	0.27
Waipapa Tailrace	12	0.40	0.40	0.32	0.49	0.08	0.12	0.35
Narrows Boat Ramp	12	0.61	0.55	0.35	0.89	0.22	0.27	0.52
Horotiu Br	12	0.63	0.59	0.39	0.91	0.20	0.41	0.54
Huntly-Tainui Br	12	0.94	0.81	0.55	1.65	0.68	0.59	0.72
Mercer Bridge	12	1.06	0.76	0.56	2.52	0.72	1.52	0.74
Tuakau Br	12	1.05	0.80	0.57	2.23	0.72	1.18	0.72

pH								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	7.6	7.6	7.4	8.0	0.4	0.74	7.6
Ohaaki Br	12	7.2	7.2	6.9	7.5	0.3	0.19	7.3
Ohakuri Tailrace Br	12	7.3	7.3	7.1	7.7	0.2	0.80	7.4
Whakamaru Tailrace	12	7.5	7.5	7.1	8.0	0.3	1.04	7.4
Waipapa Tailrace	12	7.4	7.4	7.0	7.5	0.2	-1.25	7.4
Narrows Boat Ramp	12	7.5	7.4	7.1	7.8	0.4	0.13	7.4
Horotiu Br	12	7.5	7.5	7.2	7.8	0.3	-0.12	7.5
Huntly-Tainui Br	12	7.4	7.3	7.0	7.7	0.4	0.23	7.4
Mercer Bridge	12	7.4	7.5	6.8	7.9	0.5	-0.43	7.5
Tuakau Br	12	7.4	7.4	7.0	7.8	0.3	-0.26	7.4

Dissolved Reactive Phosphorus (g/m ³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.002	0.002	0.002	0.002	0.000	0.00	0.002
Ohaaki Br	12	0.005	0.005	0.002	0.010	0.003	0.57	0.006
Ohakuri Tailrace Br	12	0.008	0.008	0.002	0.018	0.007	0.62	0.009
Whakamaru Tailrace	12	0.009	0.010	0.002	0.013	0.004	-1.01	0.009
Waipapa Tailrace	12	0.014	0.015	0.004	0.021	0.005	-0.98	0.016
Narrows Boat Ramp	12	0.015	0.016	0.002	0.031	0.011	0.24	0.018
Horotiu Br	12	0.018	0.019	0.006	0.037	0.010	0.64	0.020
Huntly-Tainui Br	12	0.020	0.022	0.005	0.036	0.013	-0.07	0.022
Mercer Bridge	12	0.019	0.021	0.005	0.034	0.011	-0.01	0.018
Tuakau Br	12	0.017	0.018	0.002	0.025	0.008	-1.05	0.017

Skew = skewness (> 1 is lightly skewed, >2 is highly skewed; IQR = inter-quartile range)

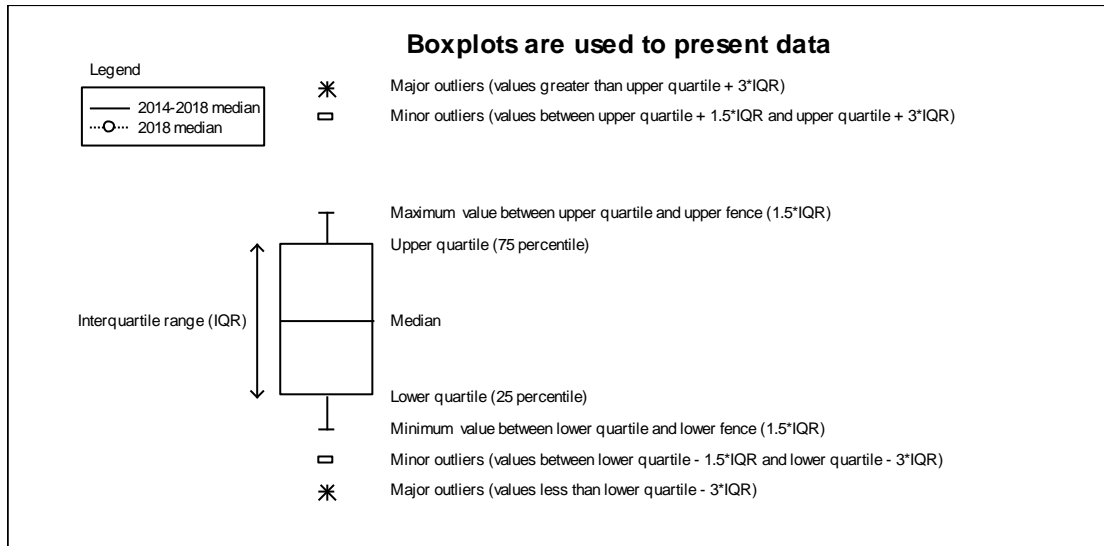
Total Phosphorus (g/m ³)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.006	0.003	0.002	0.025	0.005	2.73	0.004
Ohaaki Br	12	0.012	0.011	0.005	0.018	0.005	-0.22	0.010
Ohakuri Tailrace Br	12	0.020	0.020	0.008	0.033	0.003	0.34	0.019
Whakamaru Tailrace	12	0.024	0.022	0.014	0.045	0.004	2.05	0.022
Waipapa Tailrace	12	0.028	0.027	0.021	0.050	0.004	2.39	0.026
Narrows Boat Ramp	12	0.032	0.031	0.018	0.048	0.013	0.28	0.029
Horotiu Br	12	0.039	0.038	0.020	0.062	0.012	0.56	0.035
Huntly-Tainui Br	12	0.060	0.057	0.030	0.106	0.038	0.64	0.043
Mercer Bridge	12	0.077	0.071	0.045	0.186	0.040	2.20	0.048
Tuakau Br	12	0.070	0.057	0.044	0.152	0.041	1.71	0.050

Water Temperature (°C)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	15.0	15.1	9.9	20.7	6.3	0.12	14.6
Ohaaki Br	12	15.8	15.8	9.3	21.9	7.5	0.05	15.7
Ohakuri Tailrace Br	12	16.2	16.2	10.8	21.8	7.4	0.13	16.1
Whakamaru Tailrace	12	16.6	16.8	11.0	22.2	7.7	0.04	16.7
Waipapa Tailrace	12	16.5	16.8	11.0	21.7	7.8	0.02	16.3
Narrows Boat Ramp	12	16.4	16.1	10.7	22.2	8.3	0.13	16.1
Horotiu Br	12	16.3	16.3	10.5	21.8	8.1	0.04	16.3
Huntly-Tainui Br	12	16.4	16.4	9.5	21.7	8.4	-0.11	16.4
Mercer Bridge	12	16.7	17.1	9.7	22.7	8.3	-0.15	16.9
Tuakau Br	12	17.1	17.8	10.3	23.3	8.4	-0.15	17.4

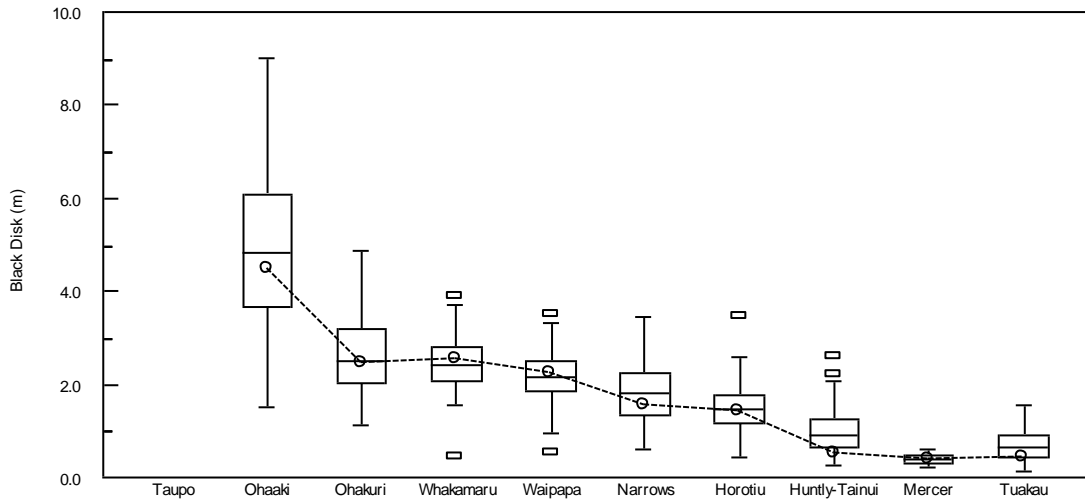
Turbidity (NTU)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 year median
Taupo Gates	12	0.4	0.3	0.3	1.4	0.1	3.05	0.4
Ohaaki Br	12	0.8	0.8	0.5	1.1	0.5	0.08	0.8
Ohakuri Tailrace Br	12	1.2	1.2	0.7	1.7	0.3	0.29	1.1
Whakamaru Tailrace	12	1.2	1.1	0.5	2.7	0.5	1.53	1.2
Waipapa Tailrace	12	1.4	1.3	0.9	1.9	0.2	0.60	1.3
Narrows Boat Ramp	12	2.7	2.2	1.9	6.6	1.0	2.62	1.9
Horotiu Br	12	3.5	3.1	2.0	8.2	1.5	2.10	2.6
Huntly-Tainui Br	12	10.7	9.1	3.3	23.0	11.8	0.63	6.0
Mercer Bridge	12	16.7	13.6	4.3	51.0	12.0	2.10	9.3
Tuakau Br	12	17.7	12.6	5.1	48.0	10.9	1.55	9.5

Skew = skewness (> 1 is lightly skewed, >2 is highly skewed; IQR = inter-quartile range)

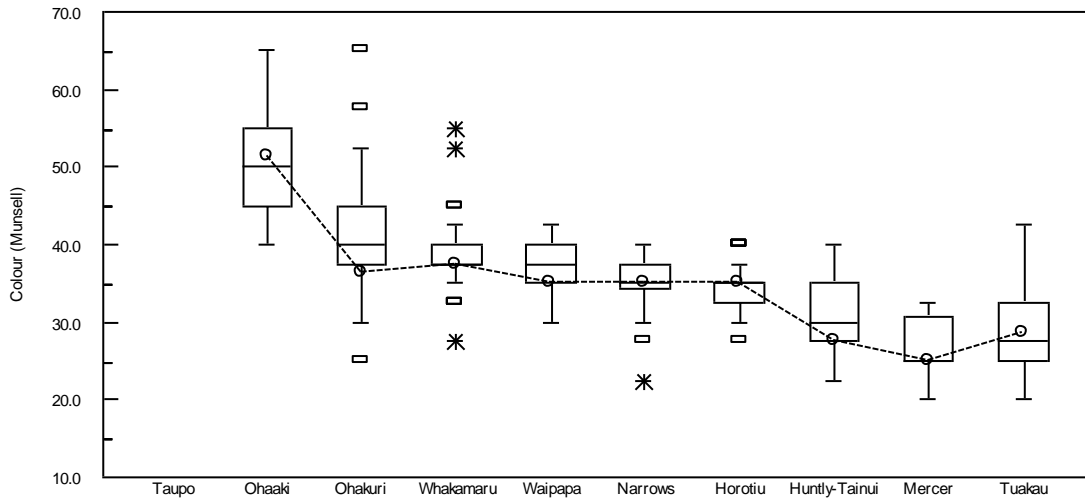
Key parameter graphs



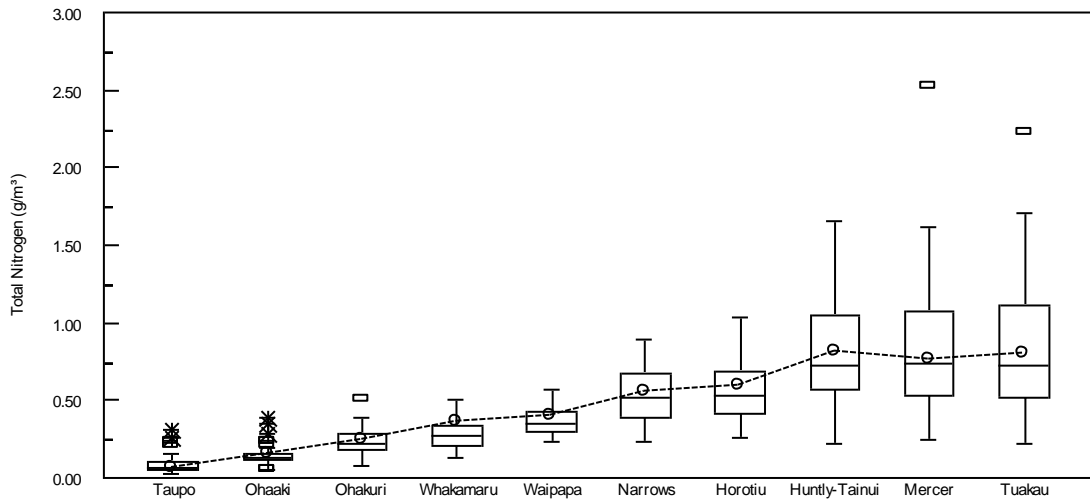
Black Disk, 2014-2018 Data. Dashed line is 2018 median.



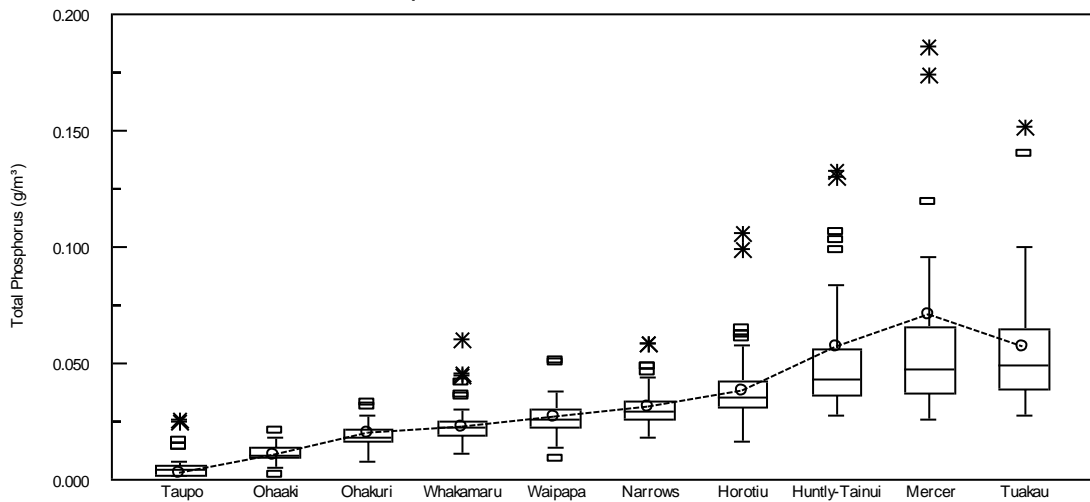
Colour (Munsell), 2014-2018 Data. Dashed line is 2018 median.



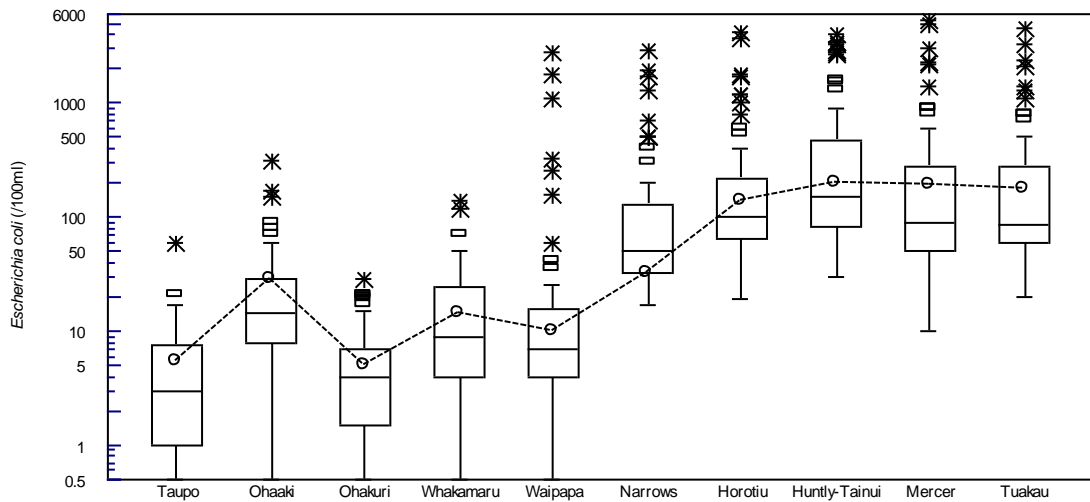
Total Nitrogen, 2014-2018 Data. Dashed line is 2018 median.

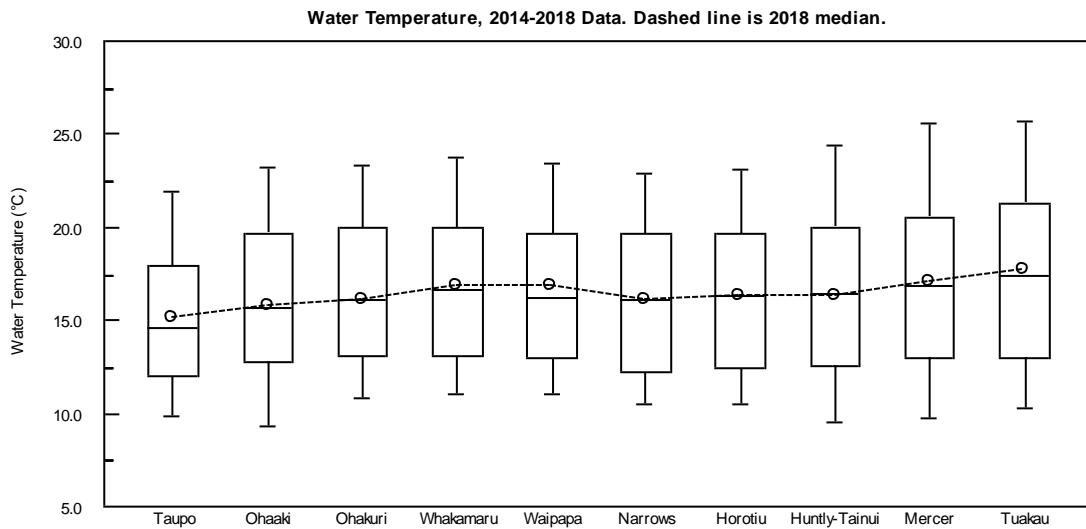
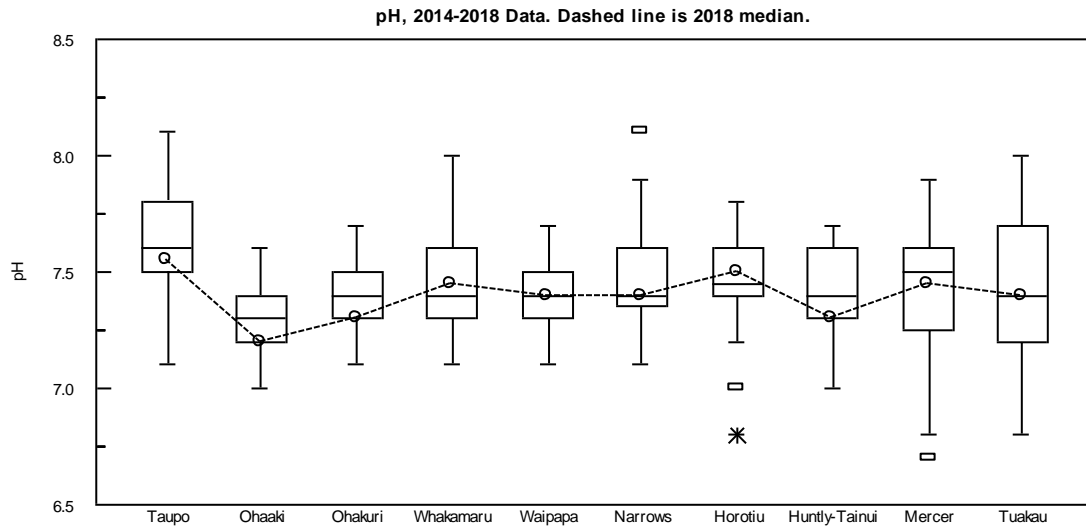
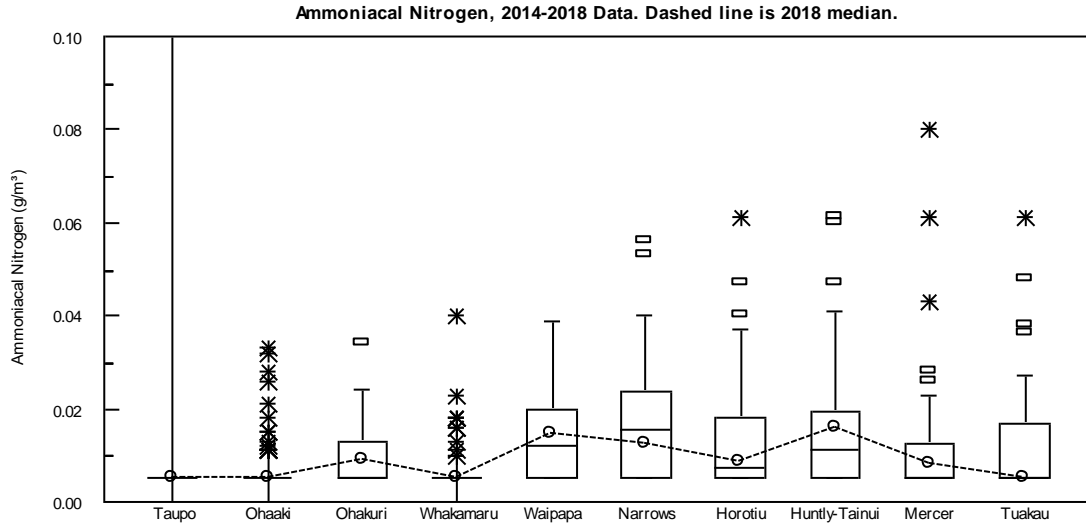


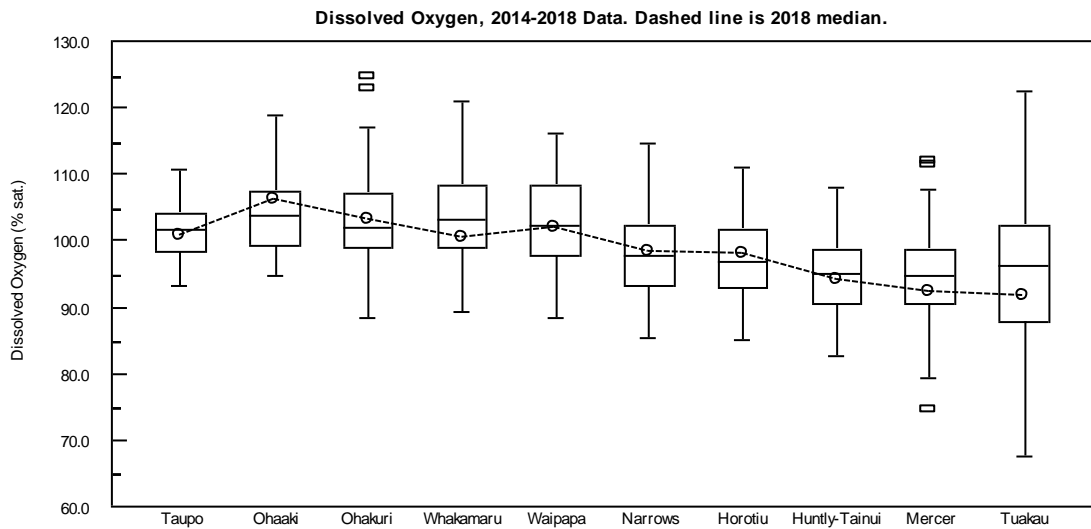
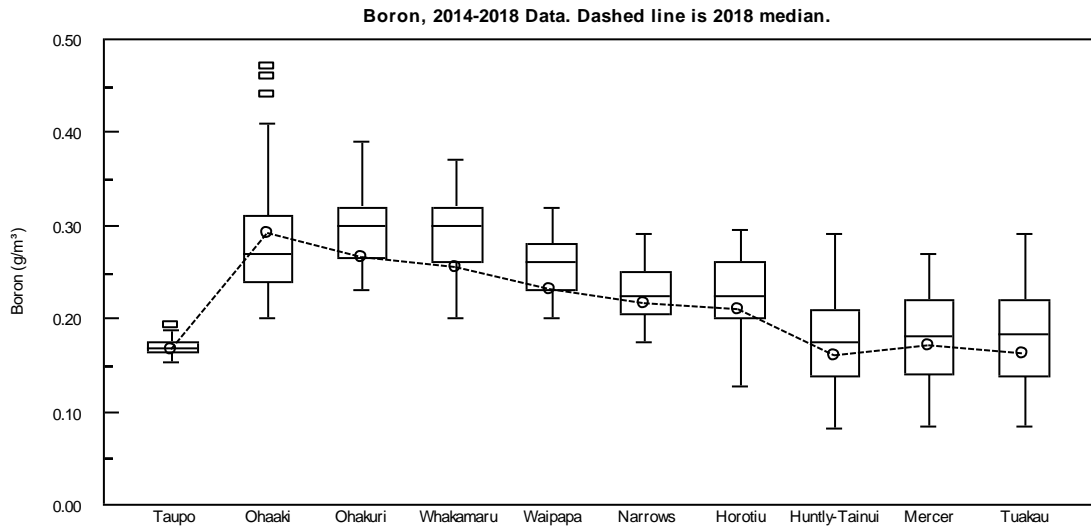
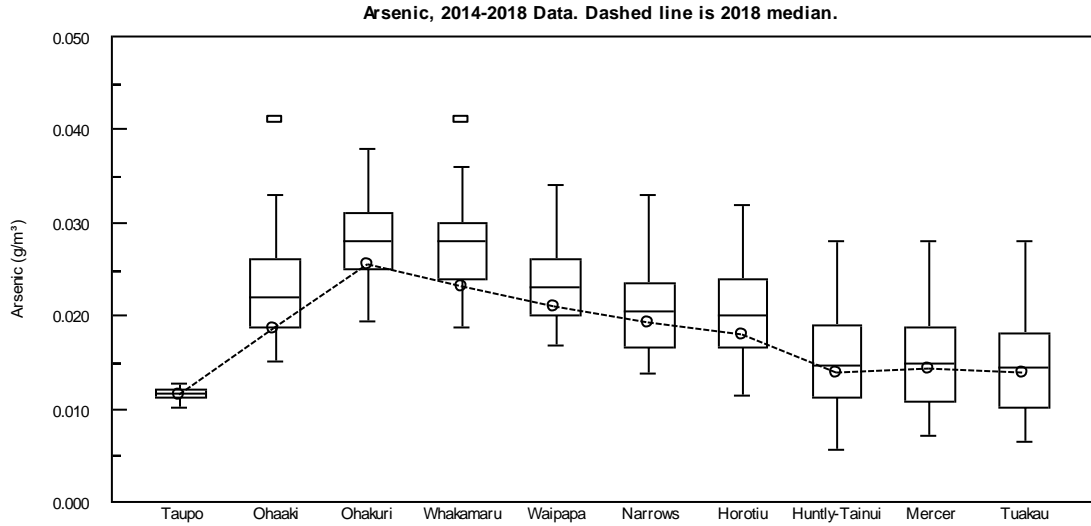
Total Phosphorus, 2014-2018 Data. Dashed line is 2018 median.



Escherichia coli, 2014-2018 Data. Dashed line is 2018 median.







Comparison with water quality standards

Table 4: Number of monthly samples (2018) complying with the "satisfactory" water quality guidelines and standards

Location	ECOLOGICAL HEALTH							HUMAN USES					
	DO	pH	Turb	NH ₄ N	Temp	TP	TN	Recreation			Water supply	Drinking water	
								BDisk	<i>E coli</i>	Median <i>E coli</i>	CHLa	As	B
Taupo Gates	12	12	12	12	8	12	12	-	12	Y	12	0	12
Ohaaki Br	12	12	12	12	7	12	12	11/11	12	Y	12	0	12
Ohakuri Tailrace Br	12	12	12	12	5	12	12	5/7	12	Y	11	0	12
Whakamaru Tailrace	12	12	12	12	6	11	12	8/9	12	Y	11	0	12
Waipapa Tailrace	12	12	12	12	6	11	12	8/9	11	Y	12	0	12
Narrows Boat Ramp	12	12	11	12	5	9	3	4/11	10	Y	12	0	12
Horotiu Br	12	12	10	12	6	6	1	1/11	8	N	12	0	12
Huntly-Tainui Br	12	12	4	12	5	4	0	0/9 ¹	8	N	12	2	12
Mercer Bridge	11	12	1	12	5	0	0	0/5 ⁵	9	N	11	2	12
Tuakau Br	11	12	0	12	5	0	0	0/10	8	N	11	4	12

Clarity samples excluded because flow exceeded the upper decile flow.

Superscripts denote the number of missing samples when there were fewer than 12 in the year.

Table 5: Number of monthly samples (2018) complying with the "excellent" water quality guidelines and standards

Location	ECOLOGICAL HEALTH							HUMAN USES					
	DO	pH	Turb	NH ₄ N	Temp	TP	TN	Recreation			Water supply	Drinking water	
								BDisk	<i>E coli</i>	Median <i>E coli</i>	CHLa	As	B
Taupo Gates	12	12	12	12	3	11	11	-	12	Y	12	n/a	n/a
Ohaaki Br	12	11	12	12	3	2	2	6/11	8	N	12	n/a	n/a
Ohakuri Tailrace Br	11	12	12	12	2	1	0	0/7	12	Y	7	n/a	n/a
Whakamaru Tailrace	12	12	11	12	1	0	0	0/9	12	Y	6	n/a	n/a
Waipapa Tailrace	12	12	12	12	1	0	0	0/9	10	Y	7	n/a	n/a
Narrows Boat Ramp	10	12	3	12	1	0	0	0/11	7	N	5	n/a	n/a
Horotiu Br	11	12	1	12	1	0	0	0/11	1	N	3	n/a	n/a
Huntly-Tainui Br	9	12	0	12	2	0	0	0/9 ¹	1	N	4	n/a	n/a
Mercer Bridge	8	11	0	12	2	0	0	0/5 ⁵	2	N	3	n/a	n/a
Tuakau Br	7	12	0	12	1	0	0	0/10	0	N	2	n/a	n/a

Clarity samples excluded because flow exceeded the upper decile flow.

Superscripts denote the number of missing samples when there were fewer than 12 in the year.

Raw data

Table 6: Raw data summary: Samples collected compared with the "satisfactory" water quality guidelines and standards in the year 2018

Date	Time	Flow	BDisk m	Colour	Cond mS/m	pH	Temp °C	DO g/m ³	DO% sat.	BOD-5d g/m ³	Turb NTU	TDS g/m ³	NNN g/m ³	NO ₃ -N g/m ³	NH ₄ N g/m ³
Satisfactory Water Quality			>1.6			6.5-9	<12May-Sep		>80		<5				<0.88
Guideline/Standard							<20Oct-Apr								
Taupo Gates upper decile flow = 263 m ³ /s, measured at Reid's farm															
9/1/18	08:28	80	-	-	11.9	7.6	17.8	9.3	100.9	0.7	0.5	91	0.003	0.001	0.01
7/2/18	08:55	147	-	-	11.8	7.9	<u>20.5</u>	8.9	101.8	0.2	0.3	91	0.001	0.001	0.01
6/3/18	08:32	213	-	-	11.8	7.8	<u>20.7</u>	8.9	103.6	0.4	0.3	85	0.003	0.001	0.01
3/4/18	08:55	231	-	-	11.7	7.6	<u>18.2</u>	9.5	103.8	0.6	0.6	91	0.001	0.001	0.01
1/5/18	09:04	86	-	-	11.8	7.5	15.6	9.3	98.1	0.2	0.3	96	0.001	0.001	0.01
5/6/18	08:59	167	-	-	11.8	7.5	13.0	9.9	99.5	0.5	0.3	80	0.003	0.001	0.01
3/7/18	08:49	241	-	-	11.8	7.5	9.9	10.8	97.8	2.0	0.4	85	0.001	0.001	0.01
7/8/18	08:55	276	-	-	11.9	7.5	10.3	10.3	95.7	0.8	0.3	84	0.001	0.001	0.01
4/9/18	08:54	285	-	-	12.7	7.5	10.7	10.7	100.6	0.9	1.4	96	0.002	0.001	0.01
2/10/18	08:16	213	-	-	12.0	7.4	12.8	10.1	98.7	0.7	0.3	88	0.001	0.001	0.01
6/11/18	08:03	190	-	-	11.8	7.9	14.6	10.0	102.0	0.9	0.4	70	0.001	0.001	0.01
4/12/18	08:04	218	-	-	12.1	8.0	16.2	9.9	105.5	0.5	0.3	84	0.001	0.001	0.01
Ohaaki Br upper decile flow = 259 m ³ /s, measured at Reid's farm															
9/1/18	09:12	89	3.7	45.0	15.4	7.0	<u>20.4</u>	8.5	96.8	0.6	0.7	111	0.100	0.001	0.01
7/2/18	09:44	89	3.3	40.0	17.8	7.1	<u>21.9</u>	8.4	98.6	0.2	1.1	127	0.084	0.001	0.03
6/3/18	09:27	196	5.0	52.5	13.8	7.5	<u>21.1</u>	8.8	102.7	0.8	0.8	103	0.192	0.001	0.01
3/4/18	09:43	172	5.3	42.5	14.2	7.1	19.0	9.4	104.4	0.9	0.6	102	0.044	0.001	0.01
1/5/18	09:56	176	7.0	40.0	14.1	6.9	16.4	9.8	104.8	0.2	0.5	103	0.050	0.001	0.02
5/6/18	09:52	151	3.6	50.0	16.9	7.0	14.2	10.5	107.7	0.5	1.1	116	0.068	0.001	0.03
3/7/18	09:41	210	6.0	42.5	15.0	7.2	9.3	12.5	110.4	2.0	0.9	108	0.054	0.001	0.02
7/8/18	09:50	221	4.8	60.0	13.8	7.3	11.6	11.5	108.7	1.0	0.6	95	0.046	0.001	0.01
4/9/18	09:47	262	(3.6)	52.5	13.0	7.3	11.2	12.1	113.7	1.0	1.1	128	0.033	0.001	0.01
2/10/18	08:55	198	5.2	52.5	13.8	7.3	12.8	11.4	109.7	1.1	1.1	91	0.048	0.001	0.01
6/11/18	08:47	-	4.1	52.5	14.2	7.2	15.4	10.2	104.9	0.8	0.8	93	0.073	0.001	0.01
4/12/18	08:50	-	4.0	55.0	14.5	7.5	16.2	10.4	110.1	0.5	0.7	102	0.034	0.001	0.01
Ohakuri Tailrace Br upper decile flow = 329 m ³ /s, measured at Ohakuri															
9/1/18	10:05	184	1.9	35.0	17.5	7.2	<u>20.5</u>	7.8	88.3	0.5	1.3	135	0.163	0.003	0.02
7/2/18	10:26	232	<u>1.1</u>	30.0	15.3	7.7	<u>21.4</u>	9.9	114.0	1.4	1.7	118	0.001	0.001	0.01
6/3/18	10:28	306	2.1	35.0	15.2	7.4	<u>21.8</u>	9.0	105.8	1.1	1.4	116	0.056	0.001	0.01
3/4/18	10:26	335	(3.0)	35.0	15.8	7.1	19.5	8.9	99.3	0.9	1.0	119	0.100	0.006	0.01
1/5/18	10:43	315	4.6	35.0	15.2	7.2	16.6	9.3	98.8	0.2	0.7	117	0.127	0.001	0.02
5/6/18	10:36	298	3.4	45.0	15.0	7.2	13.3	10.5	104.3	0.6	1.1	107	0.154	0.001	0.01
3/7/18	10:26	396	(3.5)	35.0	14.4	7.2	10.8	11.1	101.7	2.0	1.1	111	0.158	0.001	0.02
7/8/18	10:32	398	(3.2)	42.5	15.2	7.4	12.0	10.5	100.0	0.8	1.0	118	0.182	0.001	0.02
4/9/18	10:32	412	(2.8)	45.0	15.6	7.2	12.0	11.2	106.5	1.6	1.4	132	0.179	0.002	0.01
2/10/18	09:44	366	(<u>1.5</u>)	37.5	14.5	7.4	13.3	11.4	110.7	1.2	0.9	102	0.084	0.001	0.01
6/11/18	09:32	294	1.8	42.5	15.2	7.6	15.7	10.2	105.7	1.4	1.3	100	0.102	0.004	0.01
4/12/18	09:51	319	2.0	37.5	16.6	7.4	17.7	8.7	95.2	0.5	1.2	169	0.157	0.003	0.02
Whakamaru Tailrace upper decile flow = 315 m ³ /s, measured at Whakamaru															
9/1/18	10:38	172	2.1	35.0	16.8	7.4	<u>21.0</u>	8.8	100.4	1.0	1.5	130	0.184	0.002	0.02
7/2/18	11:10	95	<u>0.5</u>	27.5	14.9	8.0	<u>22.2</u>	10.4	120.8	2.7	2.7	108	0.006	0.001	0.01
6/3/18	11:21	243	2.8	40.0	15.5	7.4	<u>21.7</u>	8.5	99.1	0.7	1.0	125	0.184	0.001	0.01
3/4/18	11:04	263	3.7	37.5	15.7	7.1	19.8	8.7	96.1	1.0	0.5	116	0.210	0.003	0.01
1/5/18	11:26	315	3.9	37.5	15.6	7.3	16.9	8.8	93.8	0.2	0.6	111	0.200	0.001	0.01
5/6/18	11:34	319	(3.0)	37.5	13.9	7.5	13.1	10.5	103.5	0.5	1.0	133	0.220	0.002	0.01
3/7/18	11:06	347	(3.5)	40.0	14.3	7.5	11.0	10.8	98.5	2.0	1.5	108	0.250	0.001	0.01
7/8/18	11:13	280	3.5	37.5	15.0	7.3	11.9	10.9	100.5	1.0	1.0	156	0.260	0.001	0.01
4/9/18	11:25	317	(2.0)	35.0	15.4	7.3	12.4	11.0	105.2	0.9	1.3	127	0.260	0.001	0.01
2/10/18	10:25	263	1.8	42.5	14.7	7.5	13.8	11.3	110.1	1.2	1.0	105	0.188	0.001	0.01
6/11/18	10:14	216	2.3	40.0	15.4	7.6	16.7	9.6	100.4	1.0	1.3	102	0.185	0.004	0.01
4/12/18	10:29	265	2.2	37.5	16.1	7.6	18.5	9.8	107.4	0.9	1.6	135	0.144	0.001	0.01

Time is New Zealand standard time 24 h clock. < means less than value stated. Underlined bold values do not comply with "satisfactory" water quality standards.

Bracketed black disk measurements were carried out at flows above the upper decile and were not assessed for compliance.

TKN g/m ³	TN g/m ³	DRP g/m ³	TP g/m ³	CL g/m ³	As g/m ³	B g/m ³	Li g/m ³	A340F /cm	A440F /cm	ENT. /100ml	F coli /100ml	E coli /100ml	CHLa g/m ³	DOC g/m ³	TOC g/m ³
<0.5			<0.04		<0.01	<1.4				<77		<550	<0.02		

Taupo Gates

0.06	0.06	0.002	0.025	8.0	<u>0.012</u>	0.17	0.039	0.003	0.001	1	4	2	0.002	0.7	0.8
0.06	0.06	0.002	0.002	7.6	<u>0.011</u>	0.16	0.038	0.003	0.001	28	10	9	0.002	0.6	1.0
0.09	0.09	0.002	0.002	7.8	<u>0.011</u>	0.16	0.039	0.005	0.002	20	2	2	0.002	0.6	0.8
0.08	0.08	0.002	0.002	6.4	<u>0.011</u>	0.17	0.038	0.001	0.001	2	6	6	0.002	0.5	2.5
0.11	0.11	0.002	0.002	8.3	<u>0.011</u>	0.17	0.041	0.001	0.001	1	12	11	0.002	0.4	1.0
0.06	0.06	0.002	0.002	8.2	<u>0.011</u>	0.16	0.039	0.001	0.001	200	18	13	0.002	0.6	0.8
0.05	0.05	0.002	0.006	8.1	<u>0.012</u>	0.17	0.039	0.001	0.001	1	4	3	0.002	0.6	0.9
0.03	0.03	0.002	0.004	8.2	<u>0.012</u>	0.16	0.038	0.001	0.001	5	5	5	0.002	1.1	0.9
0.06	0.06	0.002	0.008	8.2	<u>0.012</u>	0.17	0.039	0.001	0.001	1	6	3	0.002	0.4	0.3
0.06	0.06	0.002	0.005	8.3	<u>0.011</u>	0.16	0.038	0.001	0.001	5	10	10	0.002	0.4	1.2
0.03	0.03	0.002	0.008	8.2	<u>0.012</u>	0.17	0.040	0.001	0.001	3	24	21	0.002	0.4	2.8
0.06	0.06	0.002	0.002	8.0	<u>0.011</u>	0.17	0.038	0.001	0.001	2	2	2	0.002	0.7	1.0

Ohaaki Br

0.10	0.20	0.010	0.016	15.7	<u>0.026</u>	0.29	0.081	0.004	0.001	18	60	40	0.002	1.9	0.9
0.11	0.19	0.007	0.018	20.0	<u>0.030</u>	0.44	0.106	0.007	0.001	18	27	21	0.002	0.4	1.1
0.19	0.38	0.002	0.005	11.5	<u>0.019</u>	0.22	0.065	0.003	0.001	100	44	28	0.002	0.6	0.9
0.07	0.11	0.004	0.005	12.7	<u>0.019</u>	0.29	0.069	0.003	0.001	180	230	150	0.002	0.2	0.7
0.13	0.18	0.006	0.011	13.3	<u>0.018</u>	0.29	0.065	0.003	0.001	26	59	59	0.002	0.9	0.7
0.12	0.19	0.006	0.015	20.0	<u>0.032</u>	0.46	0.092	0.007	0.001	19	70	60	0.002	0.8	1.4
0.10	0.15	0.004	0.010	13.9	<u>0.017</u>	0.32	0.066	0.004	0.001	3	14	12	0.002	0.3	0.8
0.03	0.07	0.002	0.010	12.3	<u>0.018</u>	0.25	0.063	0.003	0.001	5	5	5	0.002	0.9	0.8
0.03	0.06	0.005	0.010	10.5	<u>0.017</u>	0.22	0.053	0.002	0.001	4	27	16	0.002	0.7	0.4
0.10	0.15	0.005	0.015	11.9	<u>0.018</u>	0.25	0.063	0.001	0.001	5	5	5	0.002	0.5	1.2
0.07	0.14	0.006	0.014	12.5	<u>0.018</u>	0.29	0.062	0.004	0.001	11	40	30	0.002	0.2	1.0
0.11	0.14	0.002	0.010	14.0	<u>0.024</u>	0.27	0.073	0.003	0.001	50	190	170	0.002	0.3	1.0

Ohakuri Tailrace Br

0.14	0.30	0.017	0.033	19.8	<u>0.036</u>	0.33	0.112	0.009	0.001	1	4	4	0.006	1.0	1.4
0.20	0.20	0.002	0.020	13.7	<u>0.028</u>	0.26	0.085	0.007	0.007	10	13	13	<u>0.025</u>	1.2	1.7
0.20	0.26	0.002	0.014	14.0	<u>0.026</u>	0.26	0.083	0.007	0.001	5	2	2	0.009	0.7	1.2
0.11	0.21	0.005	0.008	15.0	<u>0.028</u>	0.30	0.094	0.006	0.001	2	3	2	0.004	0.8	1.2
0.16	0.29	0.011	0.020	14.6	<u>0.027</u>	0.28	0.085	0.004	0.001	1	4	4	0.002	0.8	0.9
0.08	0.23	0.008	0.020	14.5	<u>0.022</u>	0.24	0.078	0.005	0.001	33	9	7	0.002	0.6	0.8
0.08	0.24	0.010	0.020	12.6	<u>0.019</u>	0.24	0.069	0.005	0.001	1	5	5	0.002	0.8	0.8
0.07	0.25	0.010	0.018	14.4	<u>0.023</u>	0.27	0.080	0.006	0.001	5	5	5	0.002	1.0	1.2
0.10	0.28	0.008	0.018	13.9	<u>0.022</u>	0.25	0.077	0.005	0.001	2	9	8	0.002	0.7	0.5
0.15	0.23	0.005	0.021	12.3	<u>0.020</u>	0.25	0.073	0.004	0.001	5	5	5	0.006	0.6	1.4
0.12	0.22	0.002	0.020	14.3	<u>0.025</u>	0.28	0.085	0.006	0.001	1	5	4	0.005	0.5	1.2
0.15	0.31	0.018	0.028	16.5	<u>0.030</u>	0.31	0.103	0.008	0.001	9	18	14	0.002	0.5	1.2

Whakamaru Tailrace

0.18	0.36	0.010	<u>0.045</u>	19.2	<u>0.034</u>	0.30	0.103	0.008	0.002	19	14	11	0.014	1.1	1.4
0.40	0.41	0.002	0.030	13.9	<u>0.036</u>	0.25	0.084	0.009	0.001	10	20	8	<u>0.059</u>	1.1	2.3
0.23	0.41	0.010	0.021	14.8	<u>0.029</u>	0.26	0.088	0.008	0.001	9	23	18	0.006	0.9	1.4
0.19	0.40	0.009	0.018	15.4	<u>0.026</u>	0.30	0.097	0.007	0.001	8	17	6	0.002	0.7	1.2
0.17	0.37	0.012	0.022	15.8	<u>0.023</u>	0.28	0.091	0.007	0.001	39	50	47	0.002	1.1	1.2
0.20	0.42	0.011	0.025	12.9	<u>0.019</u>	0.20	0.067	0.039	0.007	45	60	40	0.002	2.9	3.6
0.11	0.36	0.013	0.024	12.2	<u>0.019</u>	0.24	0.075	0.007	0.001	1	3	3	0.002	0.8	1.2
0.07	0.33	0.011	0.022	14.3	<u>0.022</u>	0.24	0.080	0.007	0.001	5	20	20	0.002	1.1	1.2
0.08	0.34	0.010	0.020	14.0	<u>0.021</u>	0.25	0.080	0.007	0.001	12	40	27	0.005	0.6	0.8
0.14	0.33	0.005	0.022	13.5	<u>0.022</u>	0.25	0.080	0.005	0.001	5	5	5	0.006	0.2	1.4
0.20	0.39	0.006	0.014	14.8	<u>0.023</u>	0.28	0.088	0.007	0.001	3	6	4	0.008	0.8	1.6
0.17	0.31	0.008	0.022	16.4	<u>0.027</u>	0.29	0.092	0.008	0.001	8	51	49	0.004	0.6	1.4

Time is New Zealand standard time 24 h clock. < means less than value stated. Underlined bold values do not comply with "satisfactory" water quality standards.

Bracketed black disk measurements were carried out at flows above the upper decile and were not assessed for compliance.

Date	Time	Flow	BDisk m	Colour	Cond mS/m	pH	Temp °C	DO g/m ³	DO% sat.	BOD-5d g/m ³	Turb NTU	TDS g/m ³	NNN g/m ³	NO ₃ -N g/m ³	NH ₄ N g/m ³
Satisfactory Water Quality			>1.6			6.5-9	<12	May-Sep	>80		<5				<0.88
Guideline/Standard								<20	Oct-Apr						
Waipapa Tailrace upper decile flow = 360 m ³ /s, measured at Waipapa															
9/1/18	11:16	159	1.9	35.0	15.7	7.4	<u>21.5</u>	9.7	111.0	1.8	1.9	133	0.220	0.004	0.01
7/2/18	11:46	174	1.8	30.0	14.9	7.5	<u>21.7</u>	8.9	101.3	0.4	1.3	123	0.193	0.004	0.04
6/3/18	12:01	222	2.2	35.0	15.2	7.4	<u>21.4</u>	8.9	102.2	0.8	1.3	125	0.220	0.004	0.03
3/4/18	11:39	256	2.4	32.5	15.3	7.0	19.4	8.8	95.6	0.9	0.9	124	0.250	0.004	0.03
1/5/18	12:18	236	2.5	35.0	14.2	7.2	16.6	9.1	95.9	0.5	1.4	112	0.270	0.002	0.02
5/6/18	12:14	316	2.3	35.0	14.4	7.3	13.1	11.6	112.9	0.6	1.2	118	0.370	0.003	0.01
3/7/18	11:51	411	(2.5)	35.0	14.6	7.3	11.0	10.8	98.0	2.0	1.4	117	0.340	0.003	0.01
7/8/18	11:41	408	(2.6)	37.5	15.0	7.4	11.9	10.6	98.4	1.0	1.1	117	0.340	0.002	0.01
4/9/18	12:06	486	(1.9)	35.0	15.6	7.3	12.2	11.7	110.2	0.9	1.5	137	0.360	0.003	0.01
2/10/18	11:08	323	<u>1.1</u>	37.5	15.0	7.5	13.9	11.5	111.1	3.0	1.4	99	0.220	0.002	0.01
6/11/18	10:57	266	2.3	37.5	15.4	7.5	17.0	9.8	101.8	1.0	1.3	133	0.240	0.004	0.03
4/12/18	11:35	251	1.6	30.0	15.7	7.5	18.4	9.7	105.4	0.8	1.6	121	0.165	0.003	0.03
Narrows Boat Ramp upper decile flow = 360 m ³ /s, measured at Karapiro Tailrace															
10/1/18	06:53	161	1.9	35.0	14.9	7.3	<u>21.4</u>	8.0	89.8	0.9	2.1	125	0.330	0.007	0.02
8/2/18	06:59	190	<u>1.3</u>	35.0	15.4	7.7	<u>21.6</u>	9.5	106.0	0.9	2.1	118	0.169	0.004	0.01
7/3/18	10:19	249	2.0	40.0	15.3	7.5	<u>22.2</u>	8.5	98.5	0.9	1.9	125	0.340	0.005	0.01
4/4/18	08:13	245	2.2	35.0	15.2	7.4	19.5	8.4	90.6	1.0	1.9	110	0.340	0.004	0.03
2/5/18	08:17	246	<u>1.6</u>	37.5	14.4	7.3	16.1	9.2	93.0	0.6	2.6	111	0.420	0.004	0.02
6/6/18	08:35	298	<u>1.3</u>	32.5	14.0	7.2	12.2	10.8	101.2	0.8	3.4	119	0.660	0.006	0.02
4/7/18	08:29	358	2.0	35.0	14.8	7.1	10.7	10.8	95.2	2.0	1.9	119	0.610	0.003	0.01
8/8/18	08:20	343	<u>1.6</u>	35.0	14.8	7.4	12.1	10.6	98.0	1.0	2.3	122	0.570	0.002	0.01
5/9/18	08:48	389	(<u>1.1</u>)	35.0	14.1	7.4	12.2	11.1	103.2	0.5	3.3	131	0.540	0.003	0.01
3/10/18	07:50	314	<u>1.3</u>	37.5	14.5	7.8	13.9	11.9	113.8	1.1	2.0	96	0.270	0.003	0.01
7/11/18	07:38	226	1.8	37.5	14.5	7.7	16.0	10.7	107.7	0.9	2.5	118	0.280	0.003	0.01
5/12/18	08:16	278	<u>0.8</u>	30.0	15.2	7.6	18.6	8.3	88.7	0.9	<u>6.6</u>	121	0.280	0.007	0.04
Horotiu Br upper decile flow = 371 m ³ /s, measured at Hamilton Traffic															
10/1/18	07:26	174	<u>1.5</u>	35.0	15.2	7.4	<u>21.5</u>	8.6	96.7	0.7	2.9	117	0.340	0.005	0.01
8/2/18	07:52	186	<u>1.2</u>	35.0	15.8	7.6	<u>21.3</u>	9.2	102.9	0.7	2.4	127	0.210	0.004	0.01
7/3/18	10:58	278	1.8	37.5	15.7	7.6	<u>21.8</u>	8.6	98.5	0.8	2.2	155	0.370	0.005	0.01
4/4/18	09:10	255	<u>1.5</u>	32.5	15.6	7.4	19.6	8.4	90.8	0.7	3.8	110	0.360	0.004	0.02
2/5/18	09:09	312	<u>1.1</u>	35.0	14.5	7.7	16.5	9.5	96.4	0.4	3.5	110	0.430	0.003	0.02
6/6/18	09:20	352	<u>0.9</u>	35.0	14.1	7.2	12.5	11.1	104.4	1.0	<u>5.0</u>	128	0.660	0.005	0.02
4/7/18	09:11	346	1.7	35.0	14.9	7.2	10.5	10.8	95.0	2.0	2.1	120	0.630	0.003	0.01
8/8/18	09:06	298	<u>1.5</u>	35.0	15.0	7.8	11.3	10.7	97.4	1.0	2.8	127	0.570	0.003	0.01
5/9/18	09:27	429	(<u>1.3</u>)	30.0	14.2	7.4	12.3	11.1	103.2	0.6	3.7	117	0.560	0.003	0.01
3/10/18	08:28	267	<u>1.2</u>	37.5	14.7	7.8	13.6	11.7	110.9	1.0	2.0	116	0.290	0.003	0.01
7/11/18	08:21	232	<u>1.5</u>	35.0	14.9	7.7	16.1	10.6	107.2	0.8	3.3	126	0.290	0.002	0.01
5/12/18	08:57	256	<u>0.6</u>	30.0	15.4	7.4	18.5	8.2	88.1	0.8	<u>8.2</u>	115	0.310	0.006	0.04
Huntly-Tainui Br upper decile flow = 582 m ³ /s, measured at Huntly power station															
10/1/18	07:57	218	<u>0.8</u>	-	14.2	7.2	<u>21.7</u>	8.1	91.8	0.8	<u>6.9</u>	107	0.440	0.007	0.01
8/2/18	08:24	249	<u>0.8</u>	32.5	15.3	7.5	<u>21.4</u>	8.6	96.8	0.7	4.9	120	0.320	0.004	0.01
7/3/18	12:16	350	-	-	15.3	7.6	<u>21.7</u>	8.7	99.9	0.8	3.6	122	0.350	0.004	0.01
4/4/18	09:50	269	<u>1.3</u>	-	15.3	7.3	<u>20.1</u>	8.2	90.0	0.7	3.3	115	0.390	0.004	0.02
2/5/18	09:35	465	<u>0.4</u>	30.0	14.3	7.0	16.1	8.5	86.2	0.4	<u>13.9</u>	107	0.920	0.012	0.06
6/6/18	09:53	680	(<u>0.3</u>)	27.5	12.8	7.1	12.4	9.7	90.7	1.2	<u>23.0</u>	113	1.150	0.011	0.05
4/7/18	09:44	509	<u>0.5</u>	27.5	13.8	7.3	9.5	10.9	94.0	2.0	<u>11.8</u>	110	0.930	0.007	0.02
8/8/18	09:38	474	<u>0.5</u>	27.5	14.0	7.3	11.6	10.3	94.4	1.0	<u>11.2</u>	90	0.790	0.004	0.02
5/9/18	09:57	685	(<u>0.5</u>)	22.5	12.9	7.2	12.3	10.5	97.5	0.7	<u>18.9</u>	111	0.830	0.005	0.02
3/10/18	09:06	350	<u>0.9</u>	35.0	14.2	7.7	14.3	11.2	108.0	0.9	4.4	112	0.430	0.003	0.01
7/11/18	08:58	258	<u>0.7</u>	35.0	14.4	7.7	16.6	10.5	107.2	1.3	<u>5.9</u>	110	0.370	0.003	0.01
5/12/18	09:28	453	<u>0.3</u>	27.5	13.6	7.4	18.9	7.9	85.4	1.3	<u>20.0</u>	108	0.430	0.007	0.03

Time is New Zealand standard time 24 h clock. < means less than value stated. Underlined bold values do not comply with "satisfactory" water quality standards.

Bracketed black disk measurements were carried out at flows above the upper decile and were not assessed for compliance.

TKN g/m ³	TN g/m ³	DRP g/m ³	TP g/m ³	CL g/m ³	As g/m ³	B g/m ³	Li g/m ³	A340F /cm	A440F /cm	ENT. /100ml	F coli /100ml	E coli /100ml	CHLa g/m ³	DOC g/m ³	TOC g/m ³
<0.5			<0.04		<0.01	<1.4				<77		<550	<0.02		

Waipapa Tailrace

0.20	0.42	0.014	0.050	16.7	0.028	0.25	0.082	0.012	0.003	14	3100	1800	0.012	1.4	1.7
0.15	0.34	0.013	0.028	13.7	0.023	0.22	0.071	0.013	0.003	8	14	11	0.004	1.5	1.9
0.17	0.39	0.013	0.027	14.1	0.024	0.23	0.076	0.009	0.001	5	9	6	0.007	1.1	1.3
0.15	0.40	0.021	0.024	14.6	0.023	0.25	0.078	0.009	0.002	1	2	2	0.002	0.9	1.2
0.15	0.42	0.017	0.024	13.7	0.020	0.23	0.073	0.008	0.001	14	18	14	0.002	1.2	1.4
0.12	0.49	0.018	0.035	14.0	0.018	0.22	0.069	0.011	0.002	50	36	35	0.002	0.9	1.5
0.10	0.44	0.017	0.026	13.2	0.020	0.23	0.073	0.009	0.001	2	4	4	0.002	1.1	1.4
0.06	0.40	0.016	0.024	13.6	0.020	0.23	0.073	0.007	0.001	5	5	5	0.002	1.0	1.3
0.11	0.47	0.017	0.028	14.1	0.020	0.22	0.071	0.011	0.001	3	10	10	0.005	1.5	1.1
0.12	0.34	0.004	0.021	14.1	0.020	0.24	0.075	0.006	0.001	5	5	5	0.017	0.2	1.2
0.12	0.36	0.011	0.028	14.7	0.022	0.25	0.080	0.009	0.001	5	10	10	0.005	0.8	1.5
0.15	0.32	0.011	0.026	14.7	0.024	0.26	0.082	0.010	0.001	120	350	250	0.004	0.8	1.5

Narrows Boat Ramp

0.23	0.56	0.013	0.028	15.0	0.026	0.23	0.073	0.013	0.003	90	33	32	0.009	1.6	1.8
0.18	0.35	0.002	0.024	15.7	0.025	0.24	0.084	0.012	0.003	29	41	32	0.014	1.3	1.7
0.20	0.54	0.010	0.028	14.2	0.022	0.23	0.077	0.015	0.003	80	40	33	0.009	1.5	1.6
0.20	0.54	0.018	0.030	15.2	0.022	0.24	0.083	0.010	0.002	20	28	24	0.002	1.1	1.3
0.28	0.70	0.021	0.042	12.5	0.019	0.21	0.067	0.013	0.002	330	500	500	0.002	1.4	1.7
0.23	0.89	0.031	0.046	13.5	0.015	0.17	0.059	0.022	0.004	220	700	700	0.002	2.2	1.9
0.14	0.75	0.021	0.034	14.3	0.017	0.21	0.066	0.013	0.003	15	34	33	0.004	0.8	1.7
0.16	0.73	0.019	0.032	13.5	0.015	0.20	0.063	0.013	0.003	20	100	80	0.003	1.4	1.9
0.18	0.72	0.017	0.036	13.2	0.017	0.21	0.065	0.015	0.002	60	1000	300	0.008	1.4	1.3
0.22	0.49	0.005	0.018	13.6	0.017	0.22	0.065	0.008	0.001	13	30	18	0.014	1.2	1.6
0.20	0.48	0.009	0.020	13.4	0.019	0.21	0.063	0.009	0.001	40	40	30	0.007	0.7	1.6
0.24	0.52	0.014	0.048	14.2	0.025	0.22	0.070	0.018	0.005	900	1900	1700	0.005	1.1	2.1

Horotiu Br

0.21	0.55	0.014	0.031	14.8	0.025	0.21	0.068	0.015	0.003	110	140	140	0.013	1.2	2.0
0.18	0.39	0.006	0.024	15.9	0.025	0.25	0.081	0.012	0.003	40	90	70	0.011	1.4	2.0
0.23	0.60	0.014	0.033	14.8	0.022	0.23	0.079	0.016	0.003	80	130	130	0.009	1.5	1.7
0.17	0.53	0.019	0.035	15.3	0.012	0.13	0.042	0.011	0.002	430	580	520	0.002	1.0	1.4
0.25	0.68	0.022	0.046	13.2	0.019	0.20	0.063	0.014	0.002	320	1100	800	0.002	2.0	1.7
0.25	0.91	0.037	0.060	13.7	0.016	0.17	0.058	0.024	0.004	320	700	600	0.002	2.5	2.0
0.16	0.79	0.025	0.040	14.2	0.016	0.21	0.068	0.014	0.003	15	58	44	0.005	0.8	1.8
0.18	0.75	0.019	0.042	13.5	0.017	0.20	0.061	0.014	0.002	10	130	90	0.006	1.5	1.8
0.16	0.72	0.021	0.042	13.4	0.015	0.20	0.064	0.019	0.003	580	1400	1200	0.008	1.4	1.3
0.25	0.54	0.006	0.020	13.5	0.017	0.22	0.064	0.010	0.002	36	160	140	0.013	0.8	1.7
0.22	0.51	0.010	0.033	13.4	0.019	0.21	0.066	0.009	0.001	110	120	110	0.013	0.6	1.6
0.27	0.58	0.020	0.062	14.3	0.023	0.22	0.069	0.025	0.006	1300	2100	1800	0.005	1.4	2.2

Huntly-Tainui Br

0.33	0.77	0.021	0.054	13.9	0.018	0.17	0.051	0.024	0.005	70	130	120	0.010	1.8	2.8
0.23	0.55	0.009	0.038	15.3	0.021	0.22	0.071	0.018	0.003	43	130	130	0.008	1.6	2.1
0.23	0.58	0.011	0.036	15.1	0.019	0.21	0.072	0.018	0.004	100	190	140	0.013	1.6	1.9
0.18	0.57	0.025	0.035	14.9	0.021	0.22	0.073	0.013	0.003	48	160	100	0.002	1.1	1.6
0.42	1.34	0.027	0.078	13.1	0.013	0.15	0.045	0.030	0.006	430	1000	600	0.002	2.6	3.3
0.50	1.65	0.036	0.106	12.4	0.008	0.10	0.033	0.042	0.008	1100	3400	3400	0.002	3.9	3.6
0.37	1.30	0.024	0.066	13.6	0.012	0.15	0.045	0.026	0.004	150	300	260	0.002	1.5	2.8
0.35	1.14	0.022	0.060	12.6	0.011	0.14	0.045	0.026	0.005	150	350	290	0.005	2.3	3.1
0.40	1.23	0.024	0.072	11.9	0.010	0.13	0.040	0.038	0.007	160	2000	1500	0.007	2.3	3.6
0.25	0.68	0.005	0.030	13.5	0.014	0.18	0.055	0.015	0.003	30	60	50	0.014	1.1	1.8
0.22	0.59	0.013	0.045	13.2	0.016	0.17	0.055	0.017	0.003	40	120	80	0.008	1.3	2.3
0.42	0.85	0.020	0.098	12.6	0.014	0.15	0.045	0.045	0.010	1000	4100	3400	0.007	2.6	3.5

Time is New Zealand standard time 24 h clock. < means less than value stated. Underlined bold values do not comply with "satisfactory" water quality standards.

Bracketed black disk measurements were carried out at flows above the upper decile and were not assessed for compliance.

Date	Time	Flow	BDisk m	Colour	Cond mS/m	pH	Temp °C	DO g/m ³	DO% % sat.	BOD-5d g/m ³	Turb NTU	TDS g/m ³	NNN g/m ³	NO ₃ -N g/m ³	NH ₄ N g/m ³
Satisfactory Water Quality			>1.6			6.5-9	<12	May-Sep	>80		<5				<0.88
Guideline/Standard								<20	Oct-Apr						

Mercer Bridge upper decile flow = 658 m³/s measured at Mercer

10/1/18	08:44	249	-	-	14.4	7.2	<u>22.7</u>	8.1	92.8	1.0	<u>13.5</u>	108	0.450	0.007	0.01
8/2/18	09:13	249	-	-	15.7	7.6	<u>21.3</u>	8.2	91.8	0.6	<u>8.6</u>	125	0.370	0.002	0.01
7/3/18	12:57	318	-	-	15.6	7.6	<u>21.8</u>	8.4	96.1	1.2	<u>6.9</u>	125	0.400	0.002	0.01
4/4/18	10:37	258	-	-	15.4	7.5	<u>20.1</u>	8.5	93.3	0.7	<u>4.3</u>	109	0.410	0.002	0.01
2/5/18	10:22	478	-	-	14.3	7.9	16.2	8.4	85.2	0.4	<u>20.0</u>	110	1.090	0.011	0.03
6/6/18	10:54	766	(<u>0.2</u>)	25.0	14.1	6.8	12.4	8.5	<u>79.3</u>	1.9	<u>51.0</u>	134	1.590	0.015	0.08
4/7/18	10:41	556	<u>0.4</u>	25.0	14.4	7.2	9.7	10.4	90.0	2.0	<u>16.5</u>	114	0.960	0.005	0.02
8/8/18	10:20	504	<u>0.4</u>	25.0	14.6	7.3	11.8	10.0	91.8	1.0	<u>13.6</u>	127	0.860	0.005	0.01
5/9/18	10:55	731	(<u>0.3</u>)	25.0	13.5	7.1	12.5	9.9	92.5	0.8	<u>22.0</u>	121	0.840	0.005	0.01
3/10/18	09:57	363	<u>0.5</u>	32.5	14.5	7.7	14.9	10.8	105.8	1.1	<u>9.5</u>	117	0.330	0.002	0.01
7/11/18	09:51	271	<u>0.6</u>	32.5	14.5	7.7	17.9	10.2	106.7	1.2	<u>10.4</u>	115	0.320	0.001	0.01
5/12/18	10:42	456	<u>0.3</u>	20.0	14.0	7.4	19.1	7.8	84.6	1.0	<u>24.0</u>	103	0.400	0.005	0.01

Tuakau Br upper decile flow = 658 m³/s measured at, measured at Mercer

10/1/18	09:06	249	<u>0.7</u>	27.5	14.3	7.5	<u>23.3</u>	7.9	91.6	0.9	<u>8.8</u>	106	0.480	0.005	0.01
8/2/18	09:34	249	<u>0.6</u>	32.5	15.8	7.5	<u>21.5</u>	8.2	91.9	0.6	<u>9.2</u>	127	0.410	0.003	0.01
7/3/18	13:19	320	<u>0.8</u>	30.0	15.6	7.6	<u>22.2</u>	8.7	100.1	0.8	<u>6.3</u>	124	0.350	0.002	0.01
4/4/18	11:00	257	<u>1.0</u>	32.5	15.5	7.4	<u>20.5</u>	8.3	91.9	0.8	<u>5.1</u>	112	0.390	0.002	0.01
2/5/18	10:44	476	<u>0.4</u>	27.5	14.2	7.0	16.6	7.9	80.5	0.4	<u>16.8</u>	112	1.040	0.009	0.02
6/6/18	11:15	767	(<u>0.2</u>)	32.5	13.6	7.0	12.6	8.2	<u>76.9</u>	1.6	<u>48.0</u>	130	1.390	0.014	0.06
4/7/18	11:11	556	<u>0.4</u>	27.5	14.7	7.2	10.3	9.9	86.6	2.0	<u>14.6</u>	143	0.980	0.006	0.02
8/8/18	10:48	504	<u>0.4</u>	25.0	14.7	7.3	11.9	9.6	88.6	1.0	<u>16.4</u>	117	0.870	0.006	0.03
5/9/18	11:22	729	(<u>0.3</u>)	25.0	13.4	7.4	12.7	10.1	94.4	0.9	<u>23.0</u>	114	0.800	0.006	0.01
3/10/18	10:23	363	<u>0.5</u>	30.0	14.5	7.7	15.2	10.9	107.4	1.4	<u>10.6</u>	102	0.260	0.002	0.01
7/11/18	10:20	276	<u>0.6</u>	32.5	14.3	7.8	18.9	10.8	114.8	1.6	<u>10.6</u>	117	0.310	0.001	0.01
5/12/18	11:12	460	<u>0.2</u>	20.0	14.6	7.4	19.5	7.9	85.9	0.8	<u>43.0</u>	109	0.400	0.005	0.01

Time is New Zealand standard time 24 h clock. < means less than value stated. Underlined bold values do not comply with "satisfactory" water quality standards.

Bracketed black disk measurements were carried out at flows above the upper decile and were not assessed for compliance.

TKN g/m ³	TN g/m ³	DRP g/m ³	TP g/m ³	CL g/m ³	As g/m ³	B g/m ³	Li g/m ³	A340F /cm	A440F /cm	ENT. /100ml	F coli /100ml	E coli /100ml	CHLa g/m ³	DOC g/m ³	TOC g/m ³
<0.5			<0.04		<0.01	<1.4				<77		<550	<0.02		

Mercer Bridge

0.33	<u>0.78</u>	0.013	<u>0.067</u>	14.2	<u>0.016</u>	0.17	0.046	0.030	0.007	24	80	80	0.016	2.3	3.5
0.24	<u>0.61</u>	0.013	<u>0.053</u>	15.5	<u>0.019</u>	0.22	0.068	0.020	0.004	30	130	130	0.008	2.1	2.8
0.28	<u>0.68</u>	0.016	<u>0.047</u>	14.5	<u>0.018</u>	0.21	0.067	0.018	0.004	46	150	100	0.011	1.8	2.1
0.17	<u>0.58</u>	0.024	<u>0.045</u>	15.3	<u>0.019</u>	0.22	0.073	0.014	0.003	35	73	37	0.004	1.2	1.6
0.52	<u>1.61</u>	0.022	<u>0.096</u>	12.4	<u>0.013</u>	0.14	0.047	0.036	0.007	<u>380</u>	700	400	0.002	3.0	3.7
0.93	<u>2.52</u>	0.034	<u>0.186</u>	12.6	0.007	0.08	0.027	0.074	0.012	<u>2100</u>	5000	<u>5000</u>	0.003	6.4	6.7
0.38	<u>1.34</u>	0.024	<u>0.074</u>	14.4	<u>0.010</u>	0.14	0.039	0.036	0.007	<u>90</u>	330	260	0.005	2.4	3.9
0.41	<u>1.27</u>	0.023	<u>0.076</u>	13.6	<u>0.010</u>	0.14	0.043	0.039	0.007	70	270	220	0.007	3.3	4.5
0.52	<u>1.36</u>	0.024	<u>0.096</u>	12.9	0.010	0.12	0.037	0.054	0.009	<u>180</u>	1300	<u>600</u>	0.010	3.8	4.5
0.33	<u>0.66</u>	0.005	<u>0.046</u>	13.5	<u>0.014</u>	0.19	0.053	0.020	0.004	5	50	50	<u>0.023</u>	1.4	2.8
0.24	<u>0.56</u>	0.013	<u>0.057</u>	13.4	<u>0.015</u>	0.18	0.054	0.019	0.004	13	190	160	0.009	1.1	2.5
0.34	<u>0.74</u>	0.020	<u>0.084</u>	12.8	<u>0.016</u>	0.17	0.050	0.035	0.007	<u>1300</u>	2800	<u>2200</u>	0.006	2.2	2.8

Tuakau Br

0.36	<u>0.84</u>	0.014	<u>0.049</u>	14.4	<u>0.015</u>	0.15	0.046	0.031	0.006	25	140	140	0.013	2.5	3.4
0.27	<u>0.68</u>	0.017	<u>0.047</u>	15.2	<u>0.018</u>	0.22	0.067	0.024	0.004	18	110	90	0.010	3.1	2.7
0.22	<u>0.57</u>	0.014	<u>0.044</u>	15.2	<u>0.017</u>	0.20	0.063	0.022	0.004	<u>290</u>	200	160	0.011	1.3	2.2
0.31	<u>0.70</u>	0.022	<u>0.046</u>	15.6	<u>0.020</u>	0.21	0.068	0.014	0.003	25	80	60	0.006	1.3	1.9
0.49	<u>1.53</u>	0.023	<u>0.084</u>	12.4	<u>0.013</u>	0.14	0.047	0.035	0.007	<u>350</u>	1500	<u>800</u>	0.002	2.7	3.6
0.84	<u>2.23</u>	0.025	<u>0.152</u>	12.5	0.006	0.09	0.025	0.072	0.012	<u>1500</u>	4200	<u>3300</u>	0.002	5.9	6.8
0.43	<u>1.41</u>	0.019	<u>0.062</u>	14.8	0.009	0.12	0.036	0.044	0.008	41	290	190	0.005	3.1	4.4
0.42	<u>1.29</u>	0.022	<u>0.078</u>	13.8	0.010	0.13	0.040	0.048	0.008	<u>130</u>	370	280	0.007	3.9	4.5
0.53	<u>1.33</u>	0.021	<u>0.091</u>	12.7	0.009	0.12	0.036	0.055	0.010	<u>160</u>	800	<u>800</u>	0.009	4.0	4.7
0.33	<u>0.59</u>	0.002	<u>0.046</u>	13.4	<u>0.014</u>	0.18	0.052	0.021	0.004	20	80	70	<u>0.029</u>	1.5	3.2
0.32	<u>0.63</u>	0.009	<u>0.051</u>	13.6	<u>0.014</u>	0.19	0.048	0.020	0.004	6	150	130	0.019	1.3	2.7
0.36	<u>0.76</u>	0.015	<u>0.090</u>	13.7	<u>0.015</u>	0.17	0.052	0.035	0.007	<u>340</u>	1500	<u>1100</u>	0.009	2.8	3.3

Time is New Zealand standard time 24 h clock. < means less than value stated. Underlined bold values do not comply with "satisfactory" water quality standards.

Bracketed black disk measurements were carried out at flows above the upper decile and were not assessed for compliance.

Pesticide Data

Table 7: Results for the one pesticide that was detectable (Terbuthylazine) at 3 of the 6 sites (values shown in bold). All other pesticides analysed (Table 8 below) were below detection limits. Terbuthylazine LC50 for fish <3.4g/m³ fish, EC50 for invertebrates <50.0g/m³.

DATE dd/mm/yyyy	TIME* hh:mm	Terbuthylazine g/m ³
1131-107 Waikato River at Ohakuri Tailrace Br		
7/02/2018	10:46	< 0.00002
5/06/2018	10:36	0.00002
7/08/2018	10:44	< 0.00002
6/11/2018	9:35	< 0.00002
1131-143 Waikato River at Waipapa Tailrace		
7/02/2018	11:16	< 0.00002
5/06/2018	12:14	< 0.00002
7/08/2018	11:45	< 0.00002
6/11/2018	10:58	0.00002
1131-133 Waikato River at Tuakau Br		
8/02/2018	9:35	< 0.00002
6/06/2018	11:15	0.00002
8/08/2018	10:49	< 0.00002
7/11/2018	10:21	< 0.00002

< = less than the value stated

- No result due to unacceptable performance of ONOP analyses method for Iprodione detection

*Time = New Zealand Standard Time

Table 8: Organochlorine, organonitrogen and organophosphorus pesticides analysed including methods and detection limits (DL).

Code	Parameter	#DL	*Method	Code	Parameter	#DL	*Method	Code	Parameter	#DL	*Method	Detection limits (g/m ³)	
2,4"-DDD	2,4"-DDD	a	GC-ECD	Dicloran	Dicloran	g	GC-MS	Oxadiazol	Oxadiazon	b	GC-MS	a	0.00001
2,4"-DDE	2,4"-DDE	a	GC-ECD	Dieldrin	Dieldrin	c	GC-ECD	Oxyfluof	Oxyfluofen	e	GC-MS	b	0.00004
2,4"-DDT	2,4"-DDT	a	GC-ECD	Difenoco	Difenoconazole	d	GC-MS	Paclobut	Paclobutrazol	b	GC-MS	c	0.000005
4,4"-DDD	4,4"-DDD	a	GC-ECD	Dimethoa	Dimethoate	d	GC-MS	Parathie	Parathion-ethyl	b	GC-MS	d	0.00008
4,4"-DDE	4,4"-DDE	a	GC-ECD	Diphenyl	Diphenylamine	d	GC-MS	Parathim	Parathion-methyl	b	GC-MS	e	0.00002
4,4"-DDT	4,4"-DDT	a	GC-ECD	Diuron	Diuron	b	GC-MS	Pendimet	Pendimethalin	b	GC-MS	f	0.00006
Acetochl	Acetochlor	b	GC-MS	Endosul	Endosulfan I	a	GC-ECD	Permethr	Permethrin	e	GC-MS	g	0.0002
Alachlor	Alachlor	b	GC-MS	Endosull	Endosulfan II	a	GC-ECD	Pirimica	Pirimicarb	b	GC-MS	h	0.00005
Aldrin	Aldrin	a	GC-ECD	Endosulp	Endosulfan sulphate	a	GC-ECD	Pirimiph	Pirimiphos Methyl	b	GC-MS		
Alpha-BH	Alpha-BHC	a	GC-ECD	Endrin	Endrin	c	GC-ECD	ppDDT	ppDDT	f	GC-ECD?		
Atrazind	Atrazine-desethyl	b	GC-MS	Endrin a	Endrin aldehyde	c	GC-ECD	Prochlor	Prochloraz	g	GC-MS		
Atrazine	Atrazine	b	GC-MS	Endrin K	Endrin Ketone	a	GC-ECD	Procymid	Procymidone	b	GC-MS		
Atrazini	Atrazinisoooprop	d	GC-MS	Fenpropi	Fenpropimorph	b	GC-MS	Propachl	Propachlor	b	GC-MS		
Azaconaz	Azaconazole	e	GC-MS	Fluazifo	Fluazifop-p-butyl	b	GC-MS	Propanil	Propanil	g	GC-ECD		
Azinphos	Azinphos-methyl	d	GC-MS	Fluometu	Fluometuron	b	GC-MS	Propazin	Propazine	e	GC-MS		
Benalaxy	Benalaxyl	e	GC-MS	Flusilaz	Flusilazole	b	GC-MS	Propicon	Propiconazole	b	GC-MS		
Beta-BHC	Beta-BHC	a	GC-ECD	Fluvalin	Fluvalinate	b	GC-MS	Pyriprox	Pyriproxifen	b	GC-MS		
Bitertan	Bitertanol	d	GC-MS	Furalaxy	Furalaxyl	e	GC-MS	Quizalet	Quizalofop-ethyl	b	GC-MS		
Bromacil	Bromacil	b	GC-MS	Gamma-BH	Gamma-BHC (Lindane)	a	GC-ECD	Simazine	Simazine	b	GC-MS		
Bromopro	Bromopropylate	b	GC-MS	Haloxypm	Haloxypop-methyl	b	GC-MS	Simetryn	Simetryn	b	GC-MS		
Butachlo	Butachlor	b	GC-MS	Heptachl	Heptachlor	c	GC-ECD	Sulfentr	Sulfentrazone	g	GC-MS		
Captan	Captan	d	GC-MS	Heptaepo	Heptachlor epoxide	c	GC-ECD	TCMTB	TCMTB	d	GC-MS		
Carbaryl	Carbaryl	b	GC-MS	Hexachlo	Hexachlorobenzene	b	GC-ECD	Tebucona	Tebuconazole	b	GC-MS		
Carbofenothion	Carbofenothion	d	GC-MS	Hexacona	Hexaconazole	b	GC-MS	Terbacil	Terbacil	b	GC-MS		
Carbofur	Carbofuran	b	GC-MS	Hexazino	Hexazinone	e	GC-MS	Terbufos	Terbufos	b	GC-MS		
Chlorflu	Chlorfluazuron	b	GC-MS	IPBC	IPBC (3-Iodo-2-propynyl -n-butylcarbamate)	g	GC-MS	Terbumet	Terbumeton	b	GC-MS		
Chloroth	Chlorothalonil	b	GC-MS	Kresoxim	Kresoxim-methyl	e	GC-MS	Terbutde	Terbuthylazine desethyl	b	GC-MS		
Chlorpyf	Chlorpyrifos	b	GC-MS	Linuron	Linuron	h	GC-MS	Terbuthy	Terbuthylazine	e	GC-MS		
Chlorpym	Chlorpyrifos-methyl	b	GC-MS	Malathio	Malathion	b	GC-MS	Terbutry	Terbutryn	b	GC-MS		
Chlortol	Chlortoluron	d	GC-MS	Metalaxy	Metalaxyl	b	GC-MS	Thiabend	Thiabendazole	g	GC-MS		
cis-Chlo	cis-Chlordane	c	GC-ECD	Methoxyc	Methoxychlor	c	GC-ECD	Thiobenc	Thiobencarb	b	GC-MS		
Cynanazi	Cynanazine	b	GC-MS	Metolach	Metolachlor	b	GC-MS	Tolyflua	Tolyfluanid	e	GC-MS		
Cyfluthr	Cyfluthrin	b	GC-MS	Metribuz	Metribuzin	b	GC-MS	Total Ch	Total Chlordane (cis+trans)*100/42	e	GC-ECD		
Cyhaloth	Cyhalothrin	b	GC-MS	Molinate	Molinate	d	GC-MS	trans-Ch	trans-Chlordane	c	GC-ECD		
Cypermet	Cypermethrin	d	GC-MS	Myclobut	Myclobutanil	b	GC-MS	Triazoph	Triazophos	b	GC-MS		
Delta-BH	Delta-BHC	a	GC-ECD	Naled	Naled	g	GC-MS	Triflura	Trifluralin	b	GC-MS		
Deltamet	Deltamethrin	f	GC-MS	Norflura	Norflurazon	d	GC-MS	Vinclozo	Vinclozolin	b	GC-MS		
Diazinon	Diazinon	e	GC-MS										
Dichlofl	Dichlofluanid	b	GC-MS										
Dichlorv	Dichlorvos	d	GC-MS										

***Method**

GC-MS: Solid phase or liquid extraction, GPC (if required), GC-MS analysis

GC-ECD: Solid phase or liquid extraction, SPE cleanup (if required), dual column GC-ECD analysis

References

Tulagi A 2013. Waikato River water quality monitoring programme data report 2012. Waikato Regional Council Technical Report 2013/12. Hamilton, Waikato Regional Council.

Tulagi A 2017. Waikato River water quality monitoring programme data report 2015. Waikato Regional Council Technical Report 2017/14. Hamilton, Waikato Regional Council.

Vant B 2013. Trends in river water quality in the Waikato region, 1993-2012. Waikato Regional Council Technical Report 2013/20. Hamilton, Waikato Regional Council.

Vant B 2018. Trends in river water quality in the Waikato Region, 1993–2017. Waikato Regional Council Technical Report 2018/30. Hamilton, Waikato Regional Council.

Appendix I:

Flow information

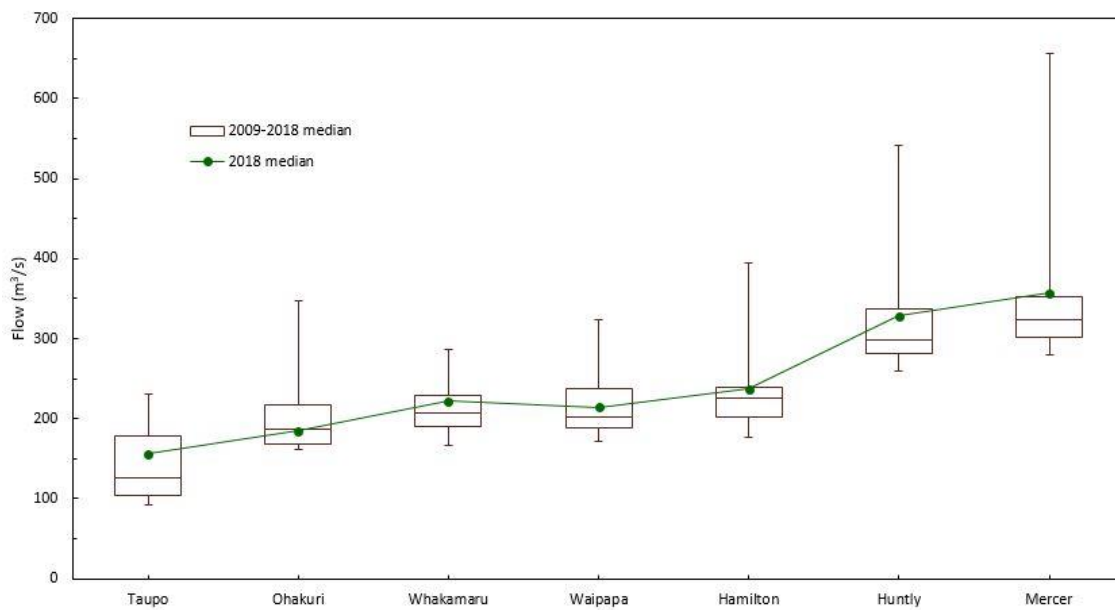
Median Flows of the Waikato River and Main Tributaries

Location	DISTANCE		FLOW RATE+ (m ³ /s)									10 YEAR	
	km		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEDIAN
Taupo	4.2		134	104	185	194	93	99	104	117	204	156	125
Ohakuri	75.8		162	192	225	229	163	163	184	190	282	185	187
Whakamaru	105.0		196	209	242	232	168	167	189	206	258	222	208
Waipapa	126.1		194	198	250	245	175	171	186	205	281	214	201
Hamilton	211.5		224	205	241	261	177	195	201	228	317	237	226
Huntly	246.5		301	296	339	346	263	260	281	285	439	328	298
Mercer	286.3		334	304	341	358	286	280	302	314	505	357	324
Waioatapu Stm	46.6		2.7	3.3	3.8	3.5	2.5	2.4	2.6	2.8	5	3.2	3.0
Waipa River	232.7		53	41	61	62	47	55	53	59	86	60	57

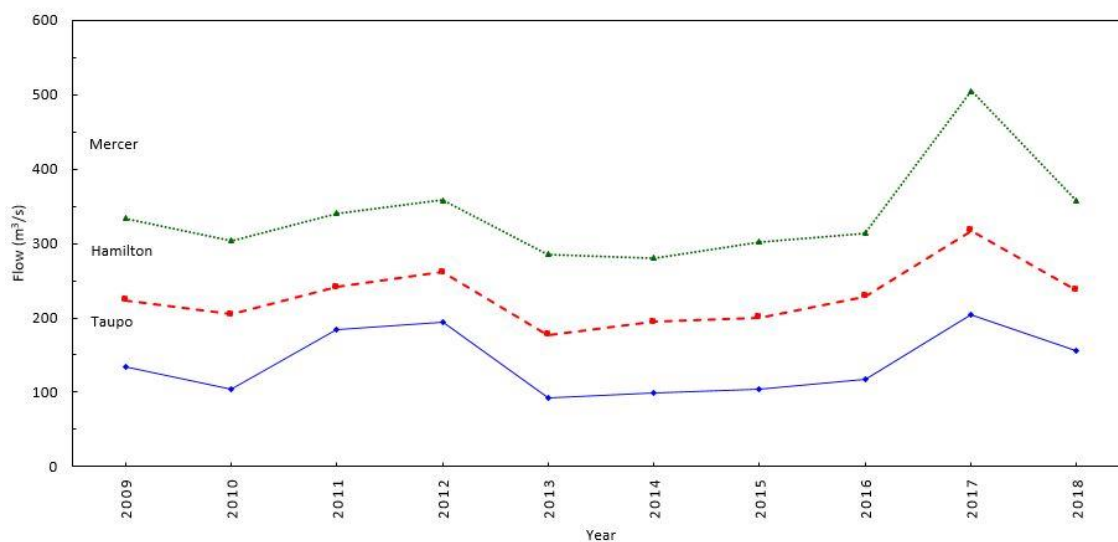
+Rating curve errors mean estimates of flow are ± 8%

*Historical flow data updated due to rating changes from updated data received

Flow



Yearly Flow Record (Median) at Taupo, Hamilton, and Mercer

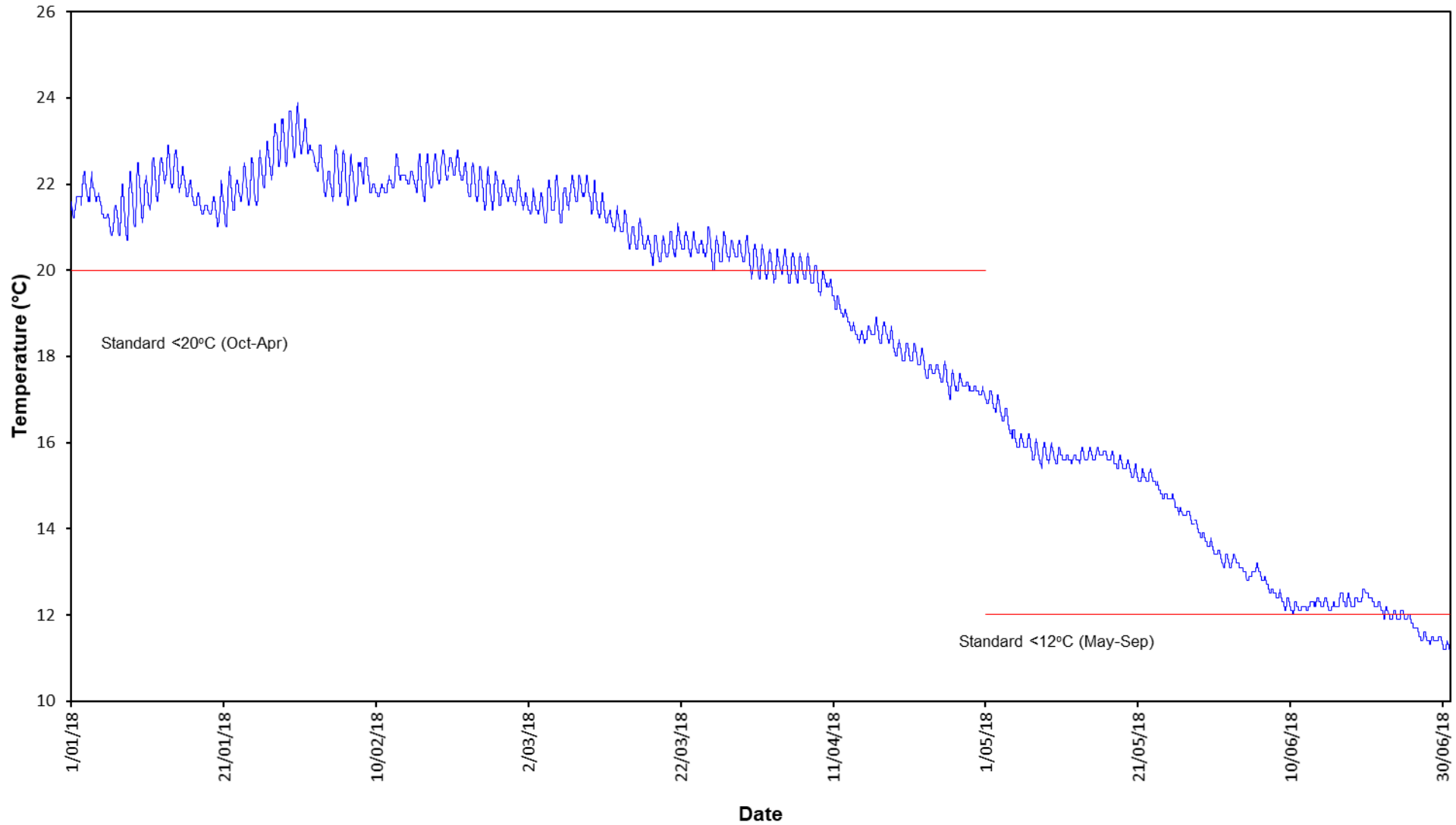


Appendix II:

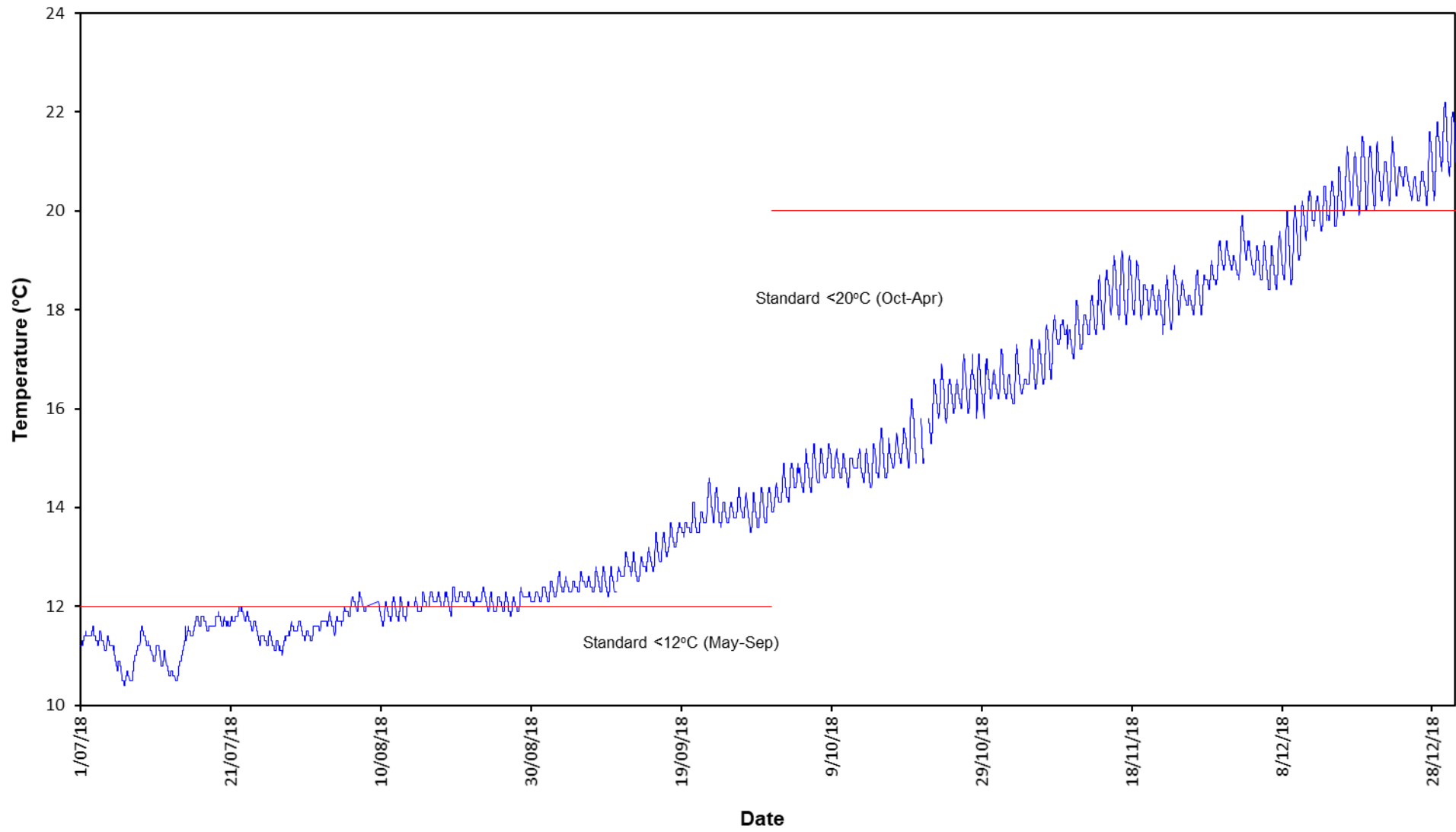
Datasonde deployment in Hamilton: selected water quality parameters

Datasonde deployment in Hamilton: selected water quality parameters

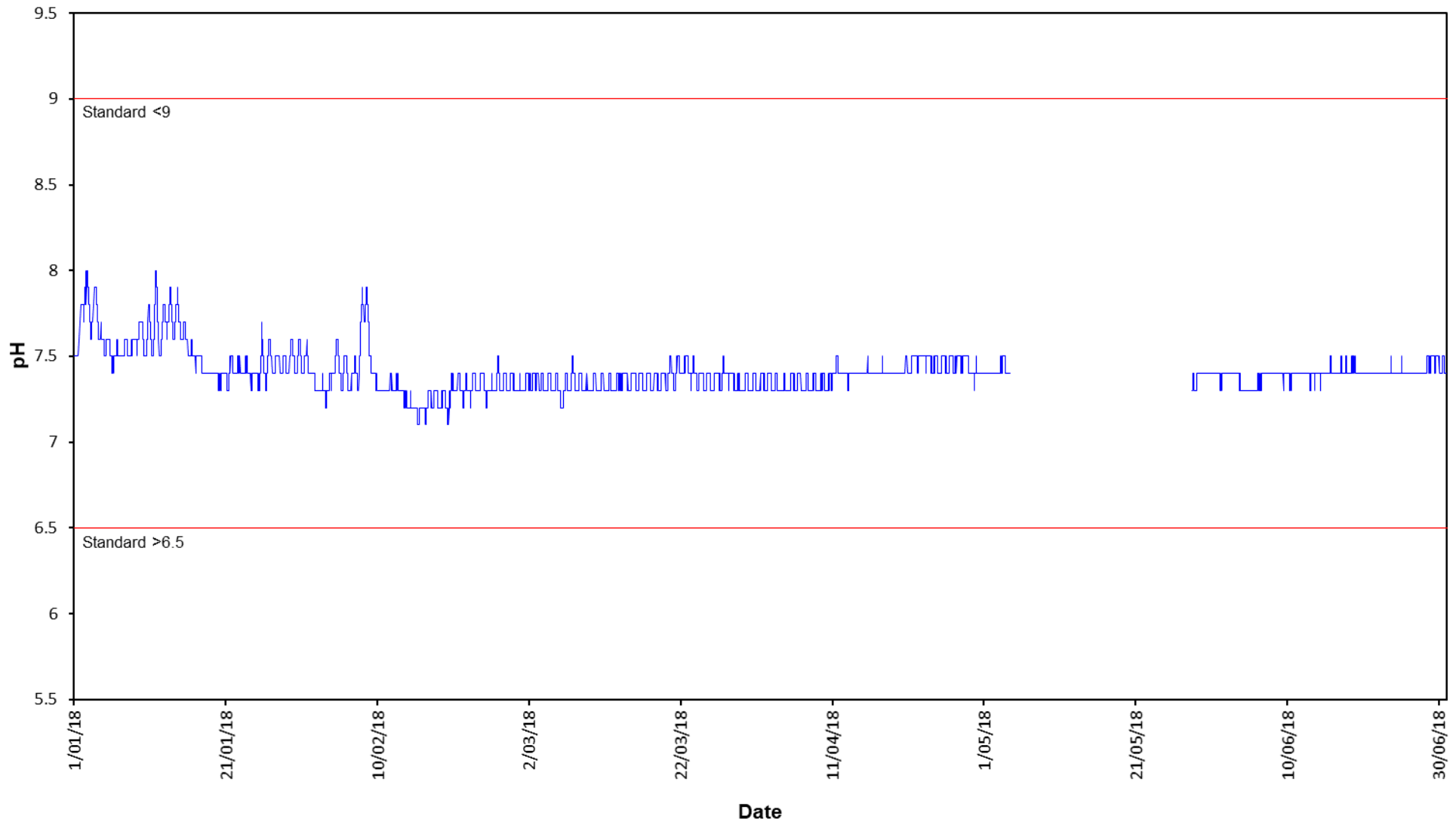
Temperature: Lower Waikato at Hamilton (January - June)



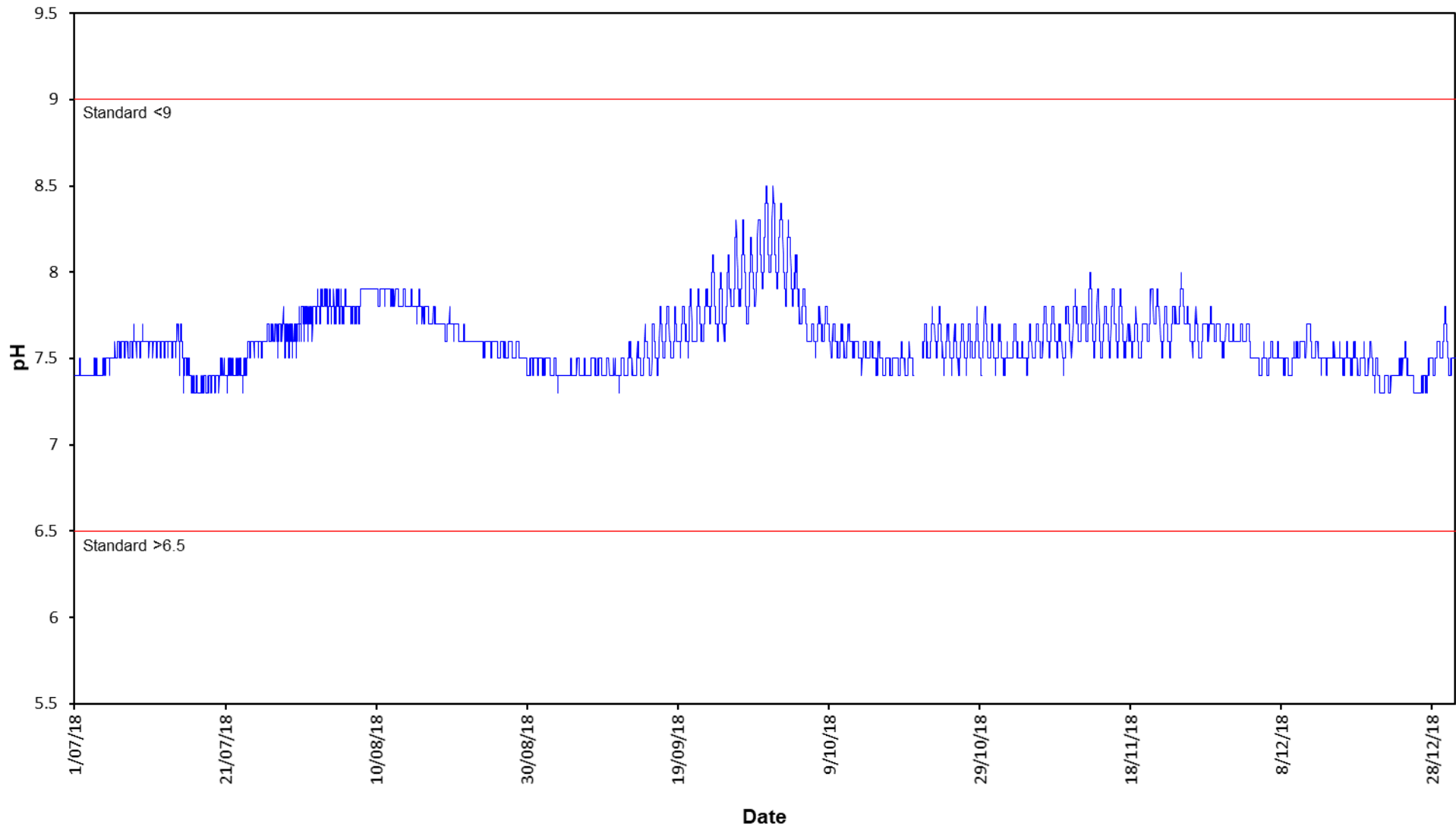
Temperature: Lower Waikato in Hamilton (July - December)



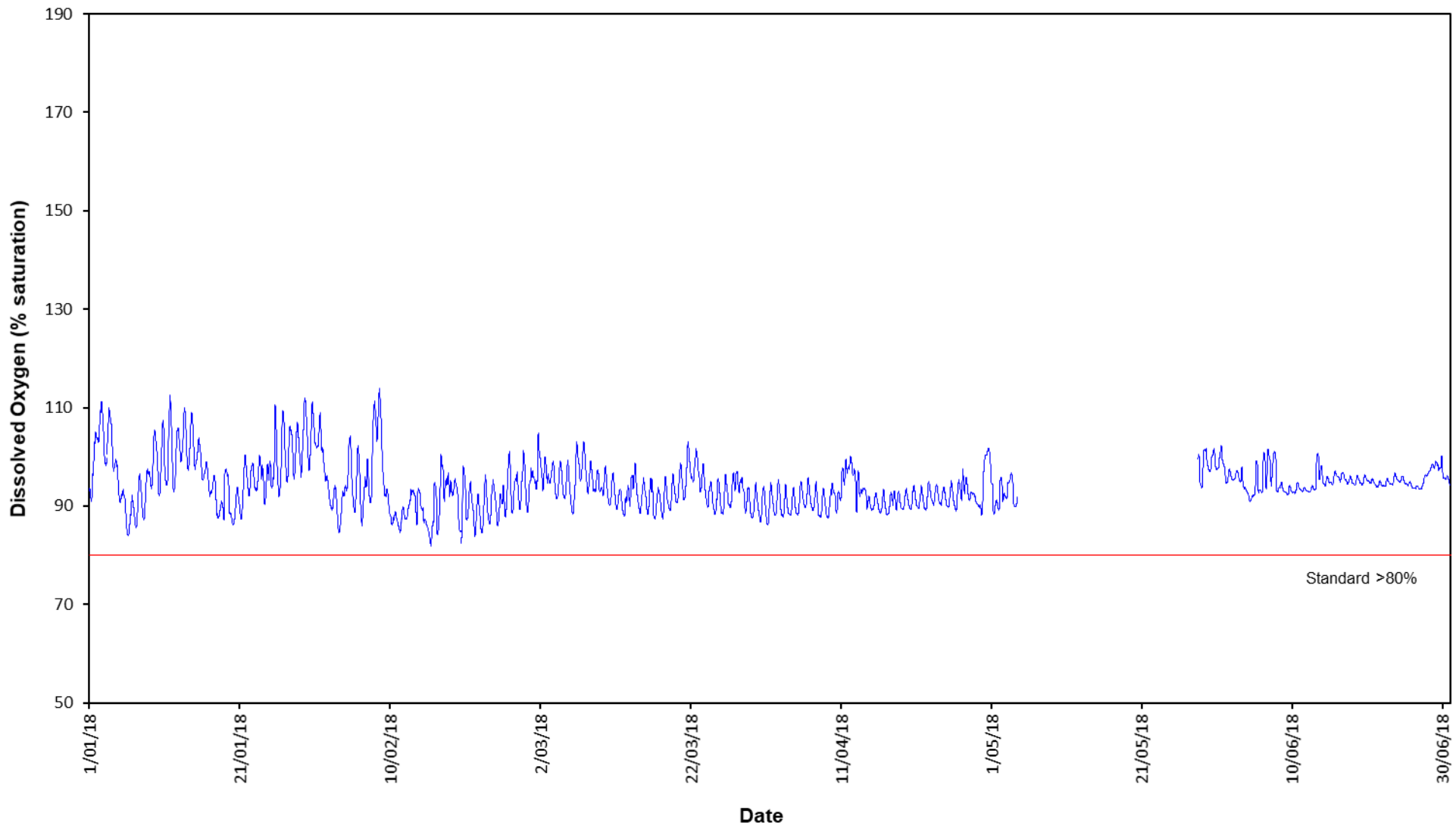
pH: Lower Waikato in Hamilton (January - June)



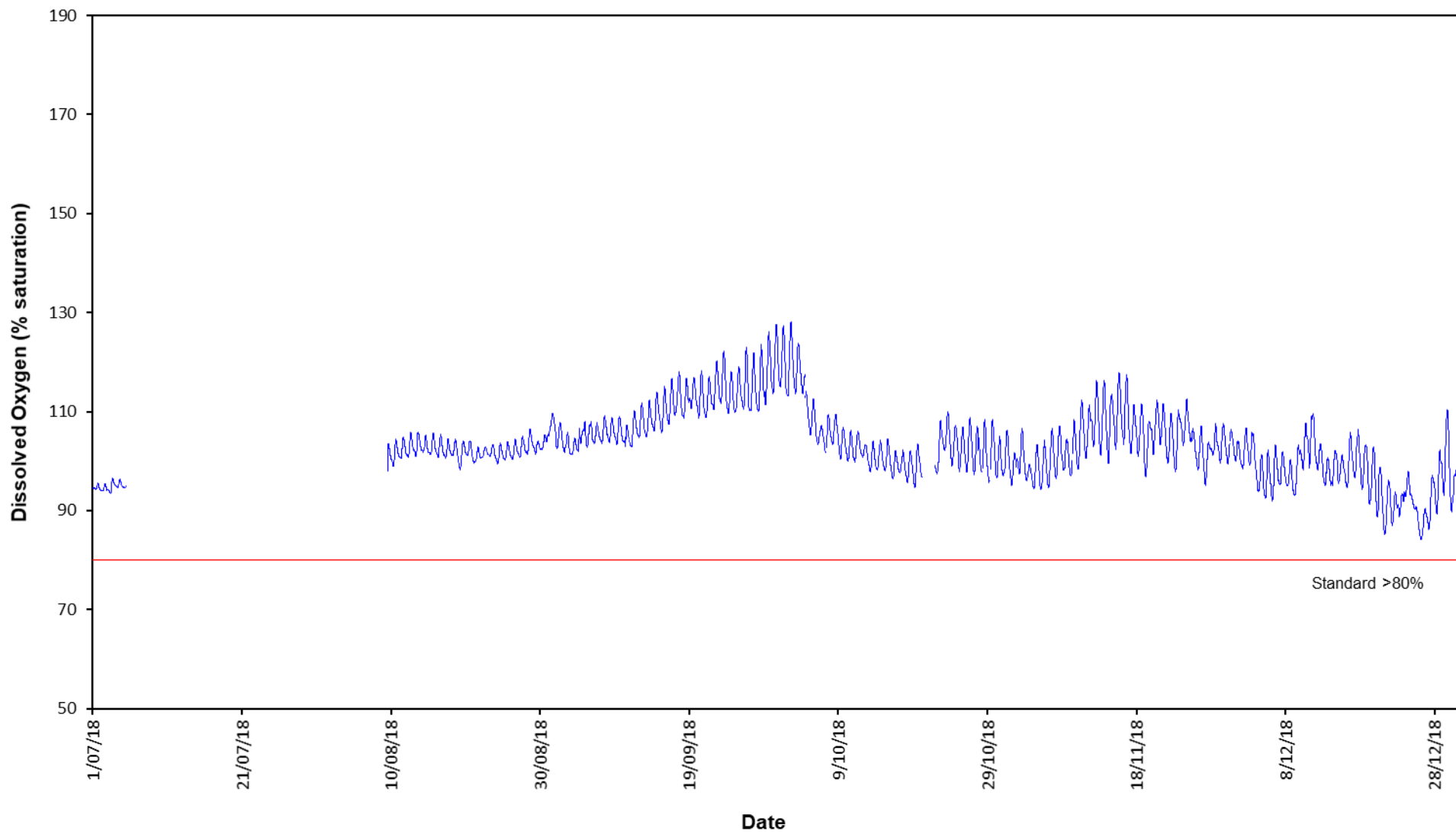
pH: Lower Waikato in Hamilton (July - December)



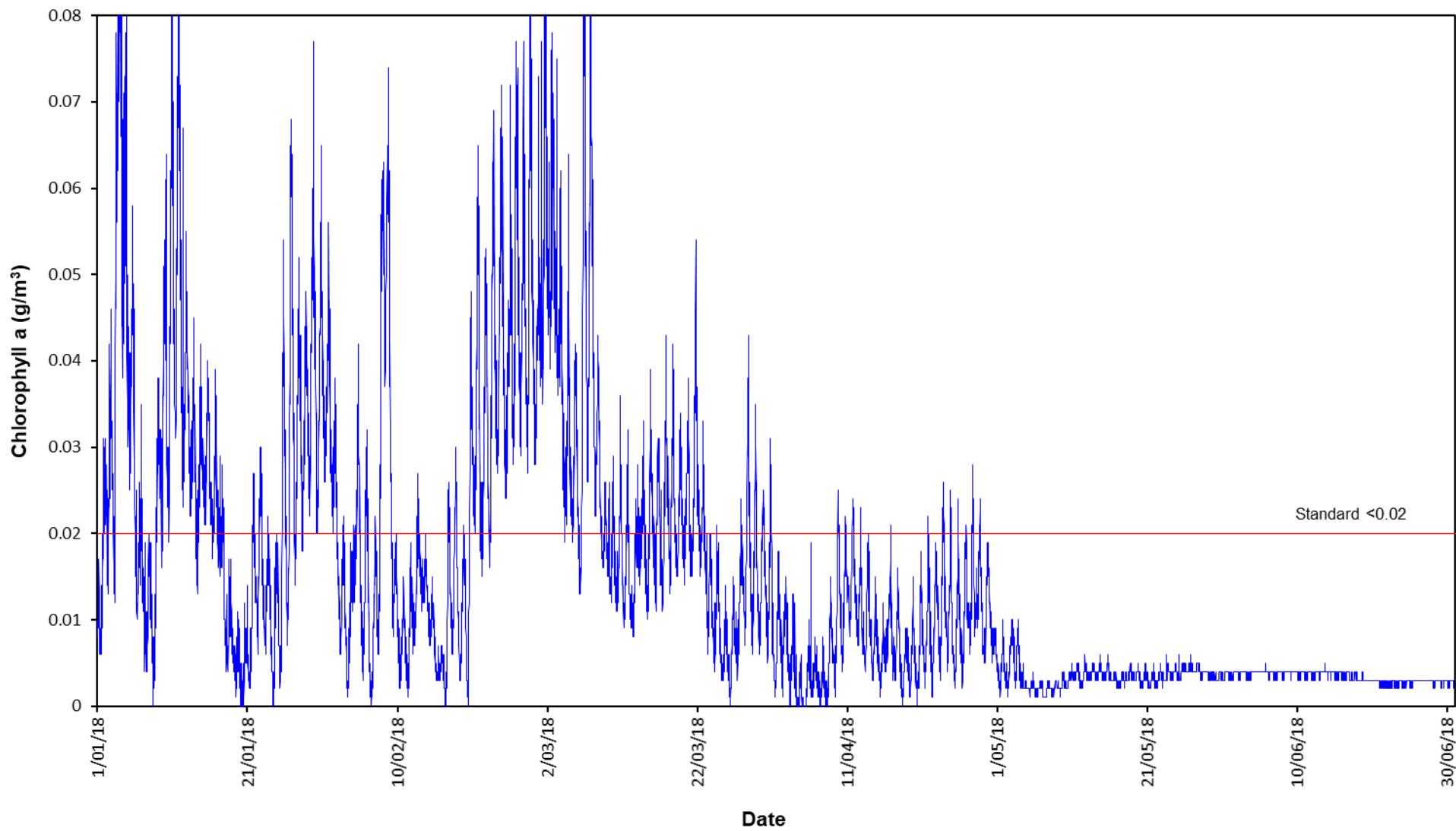
Dissolved Oxygen (% saturation): Lower Waikato in Hamilton (January - June)



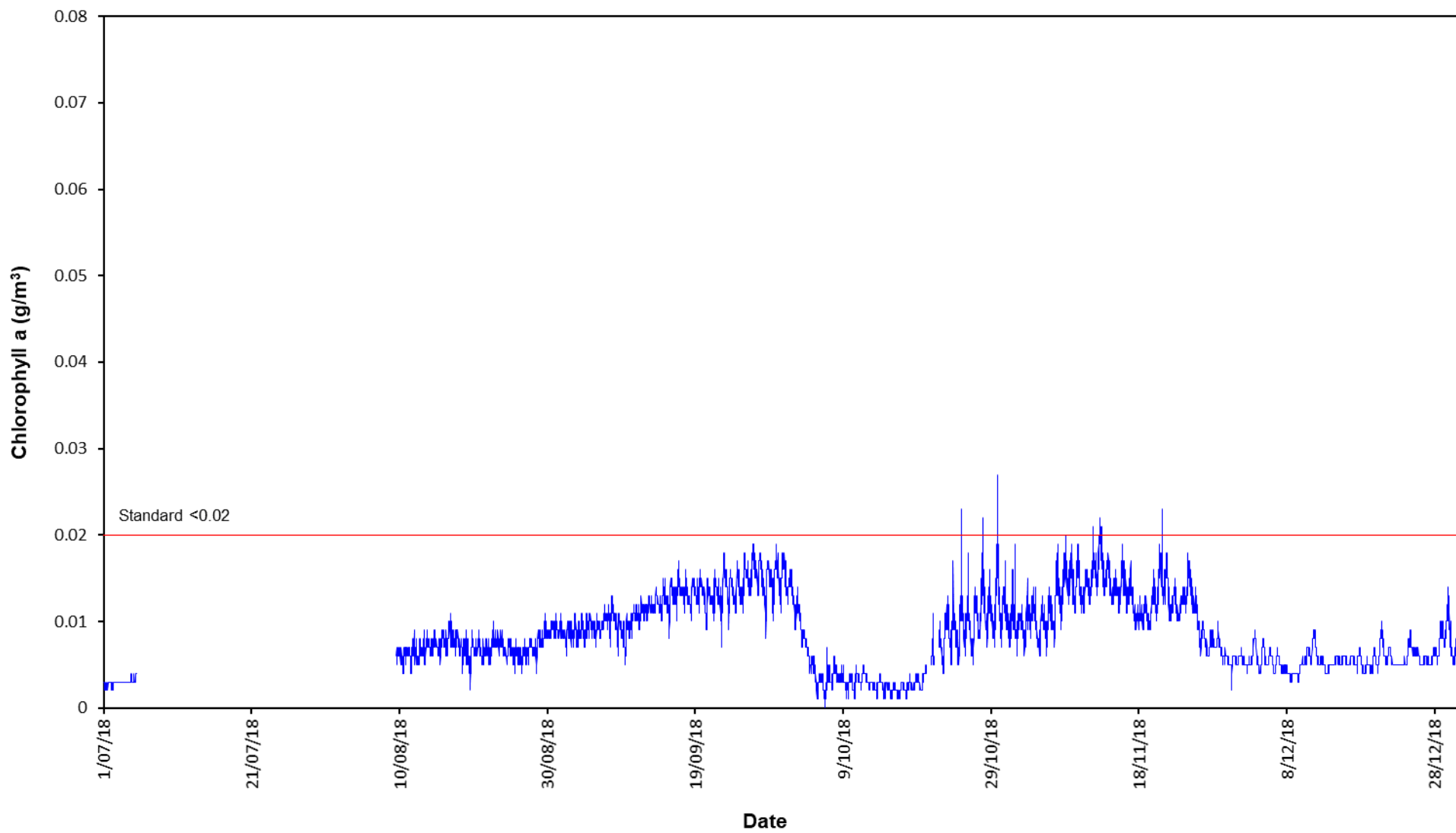
Dissolved Oxygen (% saturation): Lower Waikato in Hamilton (July - December)



Chlorophyll a: Lower Waikato in Hamilton (January - June)



Chlorophyll a: Lower Waikato in Hamilton (July - December)



Appendix III:

Water quality parameters

Guidelines and standards

Analytical methods

Waikato River water quality parameters

Water quality parameter	Reason for monitoring	Parameter monitored ¹	Comments ²
Dissolved oxygen	- requirement for aquatic life	DO (conc.)	routine (field)
	- indicator of organic pollution	DO (%sat.)	routine (field)
	- indicator of photosynthesis (plant growth)		
Temperature	- indicator of biological activity	Temperature	routine (field)
	- requirement for aquatic life		
	- mixing processes		
	- modelling studies (e.g. nutrient uptake)		
Conductivity	- indicator of total salts dissolved in water	Conductivity	routine
	- indicator for geothermal input	TDS	routine
pH	- aquatic life protection	pH	routine
	- indicator of industrial discharges, mining		
Clarity - turbidity - black disk (visual clarity)	- aesthetic appearance	Turbidity	routine
	- light availability for excessive plant growth	Black disk	routine (field)
	- aquatic life protection		
	- indicator of catchment condition, land use		
Colour - light absorption	- aesthetic appearance	Munsell colour	routine (field)
	- light availability for excessive plant growth	Absorbance at:	routine
	- indicator of presence of organic matter	340,440,780nm	
Nutrients (N and P) chlorophyll <i>a</i>	- enrichment, excessive plant growth	NO ₃ -N+NO ₂ -N	routine
	- nutrient limitation for plant/algal growth	NH ₄ -N,TKN	
		DRP, TP, Chl <i>a</i>	
Geothermal contaminants	- indicators of geothermal inflows	Cl, Li, B, As	routine
	- aquatic life protection (ecotoxicity)		
	- drinking water (human health aspects)		
Organic carbon	- indicator of organic pollution	BOD ₅	routine
	- catchment characteristics	TOC/DOC	routine
Faecal bacteria - E. coli - enterococci - faecal coliforms	- indicator of pollution with faecal matter	E. Coli	routine
	- disease risk for swimming etc.	ENT	routine
		FC	routine

¹ see last page of Appendix III for the meaning of the abbreviations.

² routine means sampled monthly.

Guidelines and standards

Details of water quality standards and guidelines for “satisfactory” water quality

Parameter	Critical value(s)	Source
Dissolved oxygen	>80% of saturation concentration	RMA Third Schedule, Classes AE, F, and FS.
pH	6.5–9	ANZECC (1992) and Canadian guidelines for freshwater aquatic life (1987).
Turbidity	<5 NTU	Studies of adverse effects on underwater light—and thus on plant and invertebrate production—in certain South Island streams (Davies-Colley 1991).
Ammoniacal-nitrogen	<0.88 g/m ³	USEPA (1998) value for 1-hour exposure at pH 9.
Temperature	<12°C (May – Sep) <20°C (Oct – Apr)	Waikato Regional Council Proposed Regional Plan standards for trout fisheries and trout spawning (1998).
Total phosphorus	<0.04 g/m ³	From upper quartile values for 77 New Zealand rivers in NIWA’s National Water Quality Network (after Smith & Maasdam 1994)—note that the guidelines for “excellent” conditions are the lower quartile concentrations for these rivers.
Total nitrogen	<0.5 g/m ³	From upper quartile values for 77 New Zealand rivers in NIWA’s National Water Quality Network (after Smith & Maasdam 1994)—note that the guidelines for “excellent” conditions are the lower quartile concentrations for these rivers.
Water clarity at baseflow	>1.6 m	“Baseflow” defined as flows less than the upper decile flow. Guideline from Ministry for the Environment (1994).
<i>Escherichia coli</i>	<550/100 mL	Ministry for the Environment (2003) guidelines for the management of recreational and marine shellfish-gathering waters.
Median <i>Escherichia coli</i>	<126/100 mL	Ministry for the Environment (1999) guidelines for the management of recreational and marine shellfish-gathering waters.
Enterococci	<77/100 mL	Department of Health (1992) guidelines for “moderate” level of recreational use.
Chlorophyll <i>a</i>	<0.02 g/m ³	Ministry for the Environment (1992).
Arsenic	<0.01 g/m ³	Ministry of Health (2001).
Boron	<1.4 g/m ³	Ministry of Health (2001).

Analytical methods

Waikato River monitoring programme - water quality parameters and analytical methods

Id ¹	Parameter	Short name ²	Method
A340F	Absorbance (340nm)	A340F	Spectrophotometer, 1 cm path length, APHA method 5910B
A440F	Absorbance (440nm)	A440F	Spectrophotometer, 1 cm path length, APHA method 5910B
A780F	Absorbance (780nm)	A780F	Spectrophotometer, 1 cm path length, APHA method 5910B
Arsenic	Arsenic	As	Nitric acid digestion, ICP-MS, APHA method 3125 B / USEPA 200B, uses Tt or TR if Tr not available or average if both available
BDisk	Black Disk	BDisk	Field measurement, horizontal water transparency (20mm, 60mm, 100mm, 200mm disk) in river or trough (20mm only)
BOD5Dil	Biochemical Oxygen Demand 5 day	BOD-5d	Incubation 5 days at 20°C, DO-meter, No nitrification inhibitor added, unseeded, APHA method 5210 B
Boron	Boron	B	ICP-MS, APHA method 3125 B. Uses either TR or Tt or average if both available
CHLA	Chlorophyll <i>a</i>	CHL <i>a</i>	Acetone extraction. Spectroscopy. APHA method 10200 H (modified)
Cl Diss	Chloride Dissolved	CL	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed.
Colour Munsell	Colour (Munsell)	Colour	Field measurement, Munsell colour patches
DO	Dissolved Oxygen	DO	Field measurement (Hach DO meter, model HQ 30d)
DO_Percent	Dissolved Oxygen	DO%	Field measurement (Hach DO meter, model HQ 30d)
DOC	Dissolved Organic Carbon	DOC	Filtration, acidification, purging to remove inorganic C, persulphate oxidation, IR detection. APHA method 5310 C (modified)
DRP	Dissolved Reactive Phosphorus	DRP	Filtration, Molybdenum Blue Colorimetry. Discrete analyser. APHA 4500 PE (modified)
EC25	Conductivity at 25 DegC	Cond	ab Meter @ 25°C. APHA method 2510B
EColi	<i>Escherichia coli</i>	<i>E coli</i>	Membrane Filtration (mFC Agar) confirmation by MUG Agar. APHA method 9222 G
ENT	Enterococci	ENT.	Membrane Filtration (mE Agar) confirmation by EIA Agar. APHA method 9230 C
FColi	Faecal Coliforms	F coli	Membrane Filtration (mFC Agar). APHA method 9222 D
Flow	Flow	Flow	Calculated from rating curve ± 8%
Li	Lithium	Li	ICP-MS, method APHA 3125 B
NH4	Ammoniacal Nitrogen	NH ₄ N	Filtration, Pheno/Hypochlorite Colorimetry. Discrete analyser. APHA method 4500-NH ₃ F (modified).
NitriteNitrogen	Nitrite Nitrogen	NO ₂ -N	Calculation: (Nitrate-N + Nitrite - N) - Nitrite - N
NNN	Nitrate/Nitrite Nitrogen	NNN	Automated Cadmium reduction. Flow injection analyser. APHA method 4500 - NO ₃ -I (modified).
pH	pH	pH	Lab Meter @ 25°C. APHA method 4500-H ⁺ B
TDSMisc	Total Dissolved Solids	TDS	Filtration, gravimetric. APHA 2540 C (modified)
TKN	Total Kjeldahl Nitrogen	TKN	Acid digestion. Pheno/Hypochlorite colorimetry. Discrete analyser. APHA method 4500-Norg D
TN	Total Nitrogen	TN	Calculated from NNN + TKN (Nitrite/Nitrate Nitrogen + Total Kjeldahl-Nitrogen)
TOC	Total Organic Carbon	TOC	Acidification, purging to remove inorganic C, persulphate oxidation, IR detection. APHA method 5310 C (modified)
TP	Total Phosphorus	TP	Acid persulphate digestion, Colorimetry. Discrete Analyser. APHA method 4500-P B E (modified). Also modified to include the use of reductant to eliminate interference from arsenic present in the sample. NAWASCA Pub 38, 1982
Turb_NTU	Turbidity	Turb	Turbidity Meter Hach 2100N. APHA method 2130 B
WT	Water Temperature	Temp	Field measurement (Hach DO meter, model HQ 30d)

¹Water quality parameter identification code refers to Waikato Regional Council's water quality database (WISKI) parameter short name.

²Water quality parameter short name used in this report

APHA = Standards Methods for the Examination of Water and Wastewater, 22nd Edition, 2012, APHA, AWWA, WEF

ICP-MS = Inductively Coupled Plasma – Mass Spectroscopy