BAY OF PLENTY REGIONAL COUNCIL
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River water quality state and trends in the Bay of Plenty: 2020 update

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2020 NERMN Water Quality Update

James Dare

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Part 1: Introduction

Overview

This report is an annual update describing water quality monitoring results from 59 long-term National Environmental Regional Monitoring Network (NERMN) water quality monitoring sites within the Bay of Plenty Region. This includes six sites monitored by the National Institute of Water and Atmospheric Research (NIWA) as part of the National River Water Quality Network (NRWQN). The overarching goal of this report is to provide readers with updated statistical analysis, and assessment against relevant reporting frameworks, including: Appendix 2 of the National Objectives Framework (MfE, 2020), and the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003).

Annual water quality updates form part of new reporting framework for river water quality that make NERMN river water quality data easier to access, as well as increasing the frequency of assessment against national frameworks and expert, region-wide interpretation (refer to Appendix A for more information).

Site reports

This report is based on automated site reports for each water quality monitoring site in the NERMN network, created using the R statistical language platform (R Core Team, 2017). Data are extracted directly from Bay of Plenty Regional Council's (BOPRC's) Aquarius Water Quality Database, and run through a series of analyses using R to produce a report for a site of interest. Each site report consists of the following:

- Summary statistics of water quality for the dataset from the site.
- Comparison plots showing median values of key variables in comparison to the percentile range of all other sites in the region.
- A graphical depiction of potential nutrient limitation by plotting seasonal dissolved nutrient concentrations.
- A grading of the site against the bands set in the National Objective Framework (NOF) of the National Policy Statement for Freshwater Management (NPS-FM) for total ammonia, nitrate, dissolved reactive phosphorus, suspended fine sediment, and *Escherichia coli* bacteria.
- Assessment against the Microbiological Guidelines, showing the percentage of samples falling into green, amber, and red modes.
- Time series plots for eight key water quality attributes: Total Nitrogen (TN), Total Phosphorus (TP), Nitrate Nitrite Nitrogen (NNN), Dissolved Reactive Phosphorus (DRP), Total Ammoniacal Nitrogen (NH4-N), Total Suspended Solids (TSS), *E. coli*, and Clarity.
- Statistical trend analysis for each of the water quality attributes above, over the following time periods: the most recent five years, the most recent ten years, and the entire dataset. Further information about each of these analyses is included in the methods section.

Report structure

The key components of this report are the analysis methods (Part 2), and water quality reports for each NERMN site (Part 3).

Water quality reports are ordered according to the nine Water Management Areas (WMAs), which have been allocated by BOPRC to give practical geographic areas for delivering on NPS-FM requirements. These are: Tauranga Moana (Tauranga Harbour), Kaituna Maketū & Pongakawa Waitahanui, Rotorua Lakes, Tarawera, Rangitāiki, Whakatāne, Ōhiwa Harbour & Waiotahe, Waioeka & Otara, and East Coast (Figure 1). Within each WMA section, sites are ordered from west to east and upstream to downstream where multiple sites on the same river.

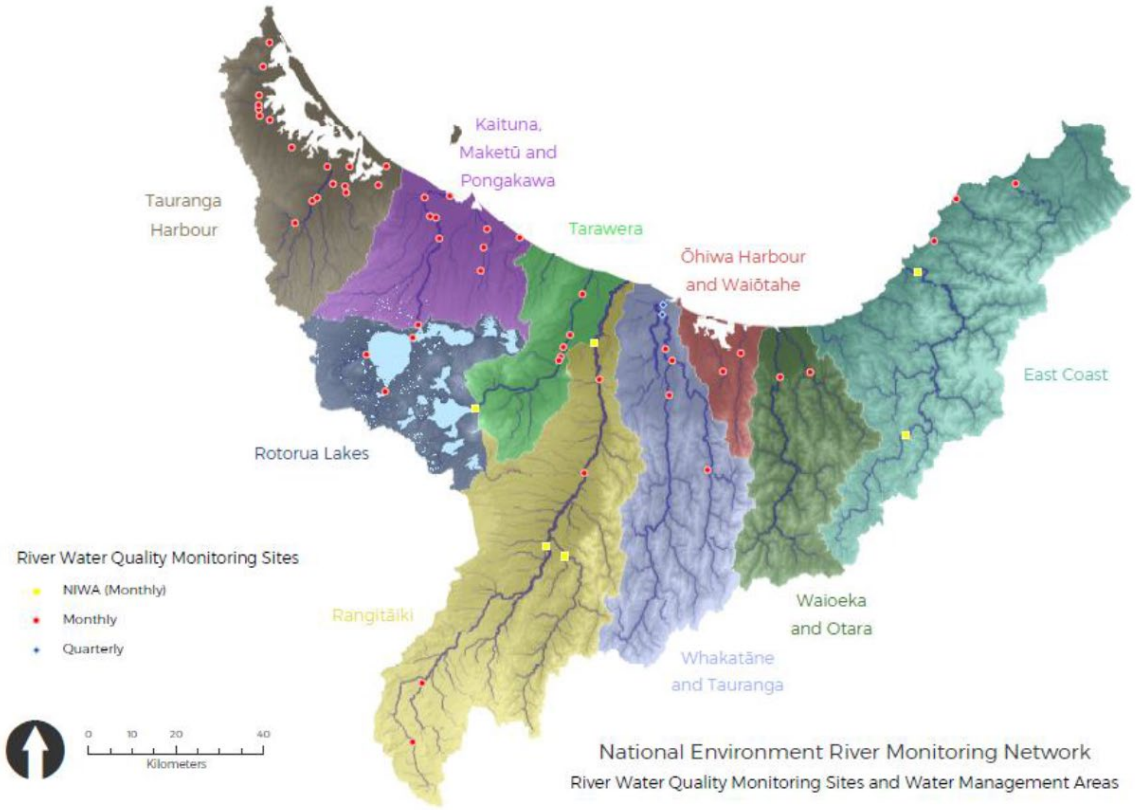


Figure 1 *Location of Water Management Areas and NERMN river water quality monitoring sites. Source: Hamill et al. (2020).*

Part 2:
Analysis methods

A summary of methods used for each analysis in the automated site reports is listed below. For a comprehensive description of analysis methods, refer to Hamill et al. (2020).

All analysis has been carried out in 'R' version 3.6.1.

Comparison plots

Comparison plots provide a way for readers to contextualise water quality results at a NERMN site with regard to other river water quality sites within the region.

A reference dataset has been constructed by extracting all available data for each of the main eight water quality parameters outlined in Appendix B, across all surface water sites in the BOPRC water quality database. This dataset is updated annually before the NERMN site reports are issued.

The empirical cumulative distribution of data for a given parameter is calculated using the 'ecdf' function from the base R 'stats' package. Median values of that parameter are calculated for the site of interest and compared to the cumulative distribution to provide a percentile value. The percentile value is displayed on a horizontal bar (Figure 2) split into four quartiles, which are coloured from worst (orange) to best (green). The process is repeated for the other seven water quality parameters.

Figure 2 *An example of a comparison plot where the median TP value is approximately equal to the 95th percentile (best 5%) of TP values recorded at surface water quality sites throughout the region*

Nutrient limitation plots

The intention of the Nutrient Limitation Plots is to show the relationship between bioavailable Dissolved Inorganic Nitrogen (DIN) and Dissolved Reactive Phosphorus (DRP) over time, and between summer and winter. DIN is not directly measured at BOPRC's laboratory and is therefore calculated from the sum of total ammoniacal nitrogen (NH_4-N) and nitrate nitrite nitrogen (NNN).

Median DIN and DRP values for the site of interest are calculated for summer (November-April) and winter (May-October) categories for each year, using aggregation and summary functions within the 'dplyr' package in R. The relationship between DIN and DRP are plotted against each other for each year/season category.

Reference categories of 'ultra-oligotrophic', 'oligotrophic', 'mesotrophic', and 'eutrophic' are provided for context. These are qualitative indicators from a study conducted in the Manawatu region (Kilroy et al., 2008) and therefore should only be used for indicative purposes.

When points are located in the top right of the graph, algae is likely to be replete in nutrients. Points located in the bottom left of the graph indicate very low concentrations of dissolved N and P and there may be potential co-limitation of algae growth.

NPS-FM assessment

Five NPS-FM attributes are reported for each NERMN monitoring site. These are:

- Table 5 – Ammonia (toxicity),
- Table 6 – Nitrate (toxicity),
- Table 8 – Suspended fine sediment,
- Table 9 – Escherichia coli (E. coli), and
- Table 20 – Dissolved reactive phosphorus.

Refer to the NPS-FM (MfE, 2020) for detailed descriptions of each table.

Data for each site were summarised using the 'dplyr' package to provide relevant statistics for each assessment. Assessment was carried out using custom functions developed in-house by BOPRC staff.

Each NPS-FM attribute specifies the time frame and minimum number of samples required for analysis. The automated site report provides analysis results over the specified time period, as well as other longer time periods which may be of interest to the reader. Attribute bands are calculated regardless of the number of samples, but asterisks are used to denote bands that were calculated using less than the required number of samples. This is in line with section 1.6 of the NPS-FM (2020) of using the best available information. The *E. coli* attribute is the only analysis carried out over a single time period, as it was deemed more appropriate to show historical context in the Microbiological Guidelines Assessment (following section).

Microbiological guidelines assessment

The Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MWQG) is intended for assessing bathing water quality sites, where weekly data is collected between the end of October and the beginning of April (MfE, 2003). However, given the general familiarity that the public has with Box 2 of the MWQG (Table 1), this framework can also provide a useful tool for assessing faecal contamination at non-bathing sites of interest.

Automated site reports provide the percentage of samples that fall into 'Green (Surveillance)', 'Amber (Alert)', and 'Red (Action) mode categories, for three different timeframes: five years, 10 years, and the entire dataset (all).

Table 1 *Box 2 in the Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas. Although this is designed for primary contact sites, the percentage of samples falling into each category at a given site provides useful context to faecal contamination.*

Mode	Single sample result
Surveillance/Green	< 260 *E. coli*/100 ml
Alert/Amber	≥260 & <550 *E. coli*/100 ml
Action/Red	>550 *E. coli*/100 ml

Trend analysis

Trend analysis was carried out using the Land Water People (LWP) Trend Analysis R package for eight key water quality attributes listed in Appendix 1. Flow adjustments were applied to each dataset if a significant relationship with flow was detected using a LOWESS regression model ($p<0.05$), and if the dataset contained enough flow-parameter pairs for meaningful analysis to be carried out. Site-parameters that failed these requirements were analysed using non-flow adjusted data. Site-parameter datasets were also checked for seasonality using a Kruskal Wallis test, with seasonal datasets being analysed using a Seasonal Kendall test rather than a Mann-Kendall test.

The Land Water People package uses Mann-Kendall and Seasonal-Kendall test routines that are equivalent to that used in the statistical software TimeTrends v6.3 (Jowett, 2016). The Mann-Kendall and seasonal-Kendall tests are non-parametric statistical tests which produce two outputs: an analysis of slope based on confidence limits, and a Kendall statistic S.

- The slope analysis looks at the magnitude of the trend using a Sen Slope estimator (SSE); essentially the median of all possible inter-observation slopes. If using a Seasonal Kendall, the seasonal SSE (SSSE) is the median of all inter-observational slopes within each season.

- The Kendall S statistic and p-value assess the confidence in the direction of the trend. The lower the *p*-value the more likely the trend is real and not due to chance, and the larger the Percent Annual Change, the larger the magnitude of the trend.

This trend method assumes there is always a trend, even if it is miniscule, but the ability to infer its direction depends on the power of the statistical analysis, as outlined in Larned et al (2016). If the confidence interval around the trend does not contain zero then the trend direction is 'established with confidence'. If the confidence interval does contain zero then the trend direction is 'indeterminate'.

A trend was categorised with confidence as increasing or decreasing when the probability from the Kendall test (p-value) was ≥95% or ≤5%. Rather than just accept a *p*-value to define statistical significance (e.g. *p*-value <0.05), the likelihood that the trend has a given direction was expressed in a more nuanced way using probability. Trends are declared to be 'confidently' detected when direction is established with 95% certainty. However, the direction can be determined with lower levels of confidence and a categorisation is used to convey that information.

The automated site reports use categorical levels of confidence to express the likelihood that water quality was improving or degrading at each site, which is consistent with the methodology using for Land and Water Aotearoa (LAWA) (https://www.lawa.org.nz/) (Table 2).

Table 2 Trend categories used for this report

Categorical Level of Confidence	Probability (%)
Very Likely Improving	95-100
Likely Improving	67-95
Indeterminate/Uncertain	33-67
Likely Degrading	5-33
Very Likely Degrading	0-5

Part 3:
Site water quality information

Water Management Area descriptions in this section are modified from Hamill et al. (2020).

Tauranga Harbour WMA

Tauranga Harbour WMA contains 27 major rivers and 46 minor streams. It starts from Pāpāmoa in the south, runs along the Kaimai Mamaku ranges and extends to Orokawa Bay, north of Waihī Beach. The WMA includes the city of Tauranga, and extensive horticultural and agricultural areas.

The rivers have an important influence on Te Awanui Tauranga Harbour, which is a highly valued and sensitive receiving environment.

Bay of Plenty Regional Council has developed a sub-catchment Action Plan for each of the 16 sub-catchments that contribute to Tauranga Harbour, including: Aongātete, Kaitemako, Kopurererua, Mangatawa, Oturu, Te Mania, Te Puna/Waipapa, Te Rereatukāhia, Tuapiro, Uretara, Waiau, Waimapu, Wainui, Wairoa, Waitekohe, and Welcome Bay.

Most of the sub-catchments in the Tauranga Harbour WMA are dominated by volcanic geology with the exception of Rocky. The Rocky stream is the major waterway within the Mangatawa Catchment, originating from the northern region of the Pāpāmoa hills and enters the ocean east of Rangataua Bay in the Tauranga Harbour. The Rocky Stream is highly modified. The geologic composition of the surrounding river catchment varies from Pāpāmoa ignimbrite, Minden Rhyolite and fluvial deposits in the upper reaches. It then flows through peat and fixed fore dunes.

Table 3 NERMN sites in the Tauranga Harbour WMA.

Site ID	Site Name	Easting	Northing	Bio-Physical Unit[1]	Class[2]	Catchment area (km^2)	Km to sea	Programme / Frequency[3]
Tauranga Harbour								
BQ708712	Te Rereatukahia at SH 2	1857084	5837121	VA/Steep	AE	18	1.5	M**
BQ711622	Te Mania at SH 2	1857111	5836225	VA/Gentle	AE	12	1.7	M
BQ723939	Uretara at Henry Road Ford	1857235	5839394	VA/Gentle	AE	24	3.4	M**

[1] **Bio-Physical Units** are a combination of geology (VA = Volcanic acidic, Non-VA = Non-volcanic) and slope (Steep, Gentle) classifications from the River Environmental Classification (REC) layer. Refer to Snelder et al. (2016) for rationale and methods.

[2] **Class** refers to the classification of the water quality site under Schedule 9 of the BOPRC Natural Resources Plan (2017). Classes are as follows: AE = aquatic ecosystem; CR = contact recreation; DEV = modified with ecological value; FP = fish purposes; FSP = fish spawning purposes; RBL = regional baseline; WS = water supply.

[3] **Programme/Frequency** falls into the following categories: M = monthly; M* = monthly but some historical monitoring was quarterly; M** = monthly but some historical monitoring was carried out on a rotation basis with other sites; NIWA M = monthly site operated by NIWA, Impact M = monthly site included as to determine the impact of a discharge; Q = quarterly, Impact Q = quarterly site included to determine the impact of a discharge.

Site ID	Site Name	Easting	Northing	Bio-Physical Unit[1]	Class[2]	Catchment area (km^2)	Km to sea	Programme / Frequency[3]
BQ739463	Waitekohe at SH 2	1857397	5834637	VA/Steep	AE	11	3.9	M
BQ966369	Aongatete at SH 2	1859660	5833690	VA/Steep	AE	43	3.7	M**
BR809582	Tuapiro at Hikurangi Road	1858127	5845878	VA/Steep	AE	44	2.5	M**
BS961133	Waiau at Waiau Road Ford	1859615	5851333	VA/Steep	AE	23	3.2	M**
CO543022	Ngamuwahine at Old Bridge	1865432	5810228	VA/Gentle	AE	41	22.4	M**
CO938527	Wairoa d/s Ruahihi Power Station	1869387	5815277	VA/Gentle	AE	308	11.8	M**
CP466747	Waipapa at Old Highway	1864663	5827478	VA/Gentle	CR	30	2.9	M**
DO047598	Omanawa at SH 29	1870477	5815980	VA/Gentle	AE	83	10.5	M
DO406909	Kopurererua at SH 29	1874065	5819093	VA/Gentle	AE	60	6.4	M
DO686858	Waimapu 100m d/s SH 29	1876865	5818584	VA/Gentle	CR	102	2.8	M
DO712717	Waimapu at Pukemapu Road	1877129	5817176	VA/Gentle	AE	60	6.7	M**
DP281304	Wairoa at SH 2	1872819	5823049	VA/Gentle	AE	449	2.4	M
DP784306	Kopurererua at SH 2	1877840	5823064	VA/Gentle	AE	73	0.6	M
EO451883	Waitao at Waitao Road	1884514	5818831	VA/Steep	AE	30	2.6	M**
EP623312	Rocky at Mangatawa Lane	1886234	5823121	Non_VA/Gentle	RBL	16	1	M**

Te Rereatukahia at SH 2

March 2021

Table 1 Site metadata

Aquarius ID:	BQ708712	**Labstar ID:**	BOP710025
LAWA ID:	EBOP-00027	**REC Reach:**	4000415
Easting:	1857084	**Northing:**	5837121
Longitude:	175.91119	**Latitude:**	-37.57709
Elevation:	9 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

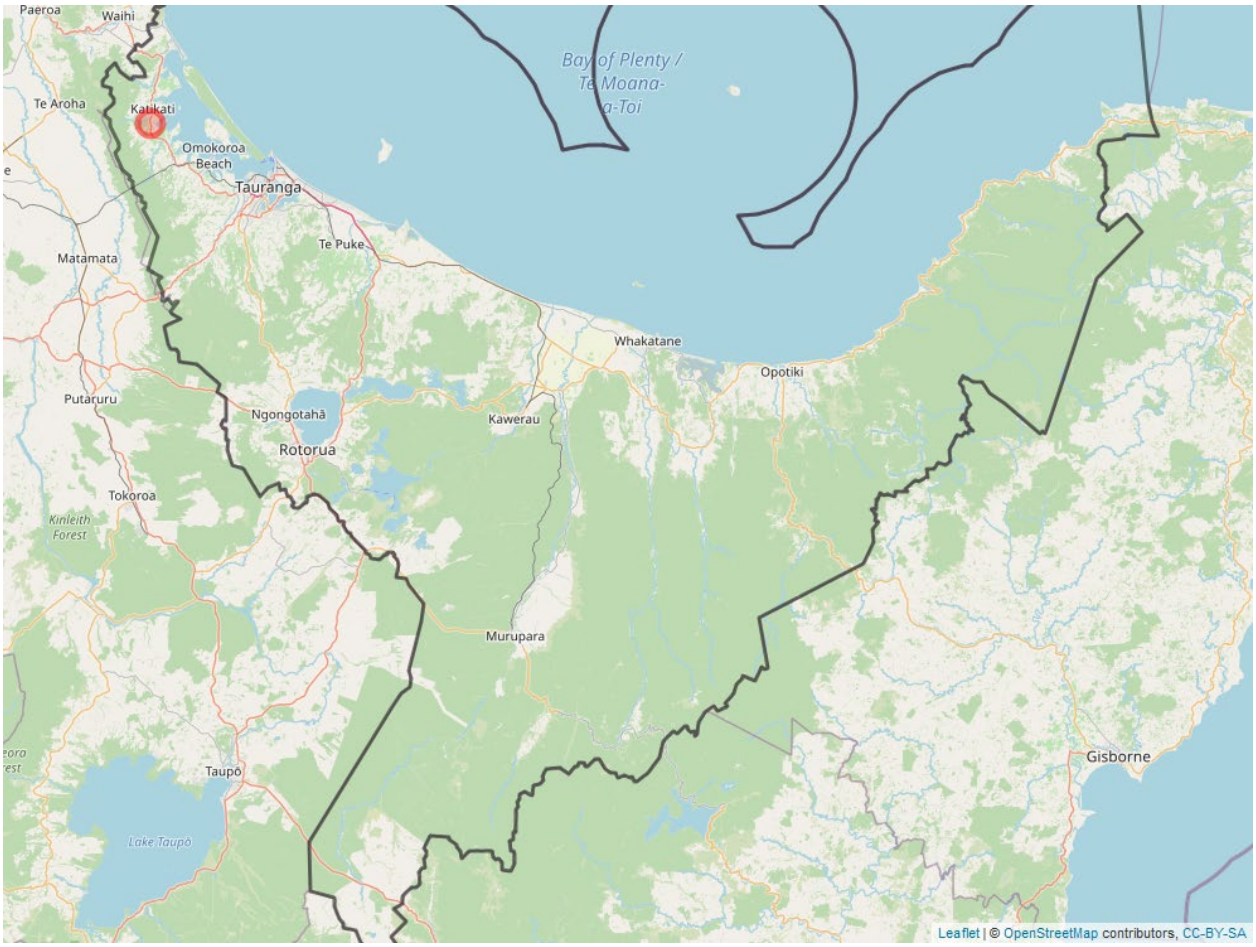


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	152	0.09	2.03	0.39	0.37	0.64	0.15	0.22	0.02
Nitrate Nitrite Nitrogen (g/m3)	154	0.02	0.81	0.31	0.30	0.60	0.05	0.17	0.01
Total Ammoniacal Nitrogen (g/m3)	163	<0.002	0.117	0.007	0.005	0.022	0.001	0.012	0.001
Total Phosphorus (g/m3)	160	<0.001	0.330	0.016	0.010	0.035	0.004	0.031	0.002
Dissolved Reactive Phosphorus (g/m3)	162	<0.001	0.052	0.006	0.005	0.014	0.002	0.005	0.000
Dissolved Oxygen Sat (%)	131	83.8	120.7	103.7	103.4	112.2	96.9	5.2	0.5
Dissolved Oxygen (g/m3)	152	7.73	12.90	10.47	10.45	11.78	9.23	0.82	0.07
Escherichia coli (cfu/100ml)	155	<1	33000	542	120	1190	18	2778	223
Total Suspended Solids (g/m3)	161	<1	77.00	2.35	0.80	3.67	0.20	8.10	0.64
Turbidity (NTU)	155	0.2	61.0	1.4	0.5	2.9	0.3	5.3	0.4
Water Clarity (m)	151	0.33	11.47	5.22	5.33	9.48	1.50	2.26	0.18
Conductivity (uS/cm)	163	40	652	73	70	84	58	46	4
pH (pH Units)	163	6.3	8.3	7.2	7.2	7.7	6.8	0.3	0.0
Water Temperature (degC)	158	8.9	23.1	15.3	15.0	21.0	10.5	3.5	0.3
Discharge (m3/s)	121	0.10	13.80	0.70	0.30	2.00	0.10	1.30	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

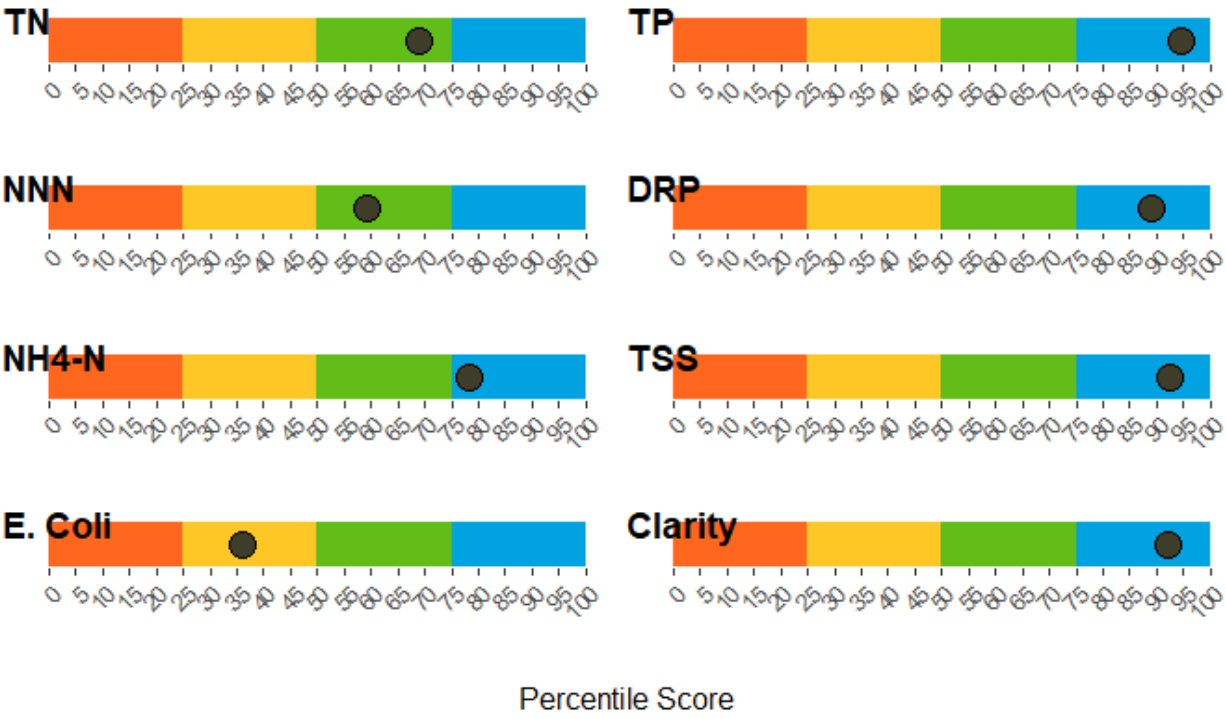


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

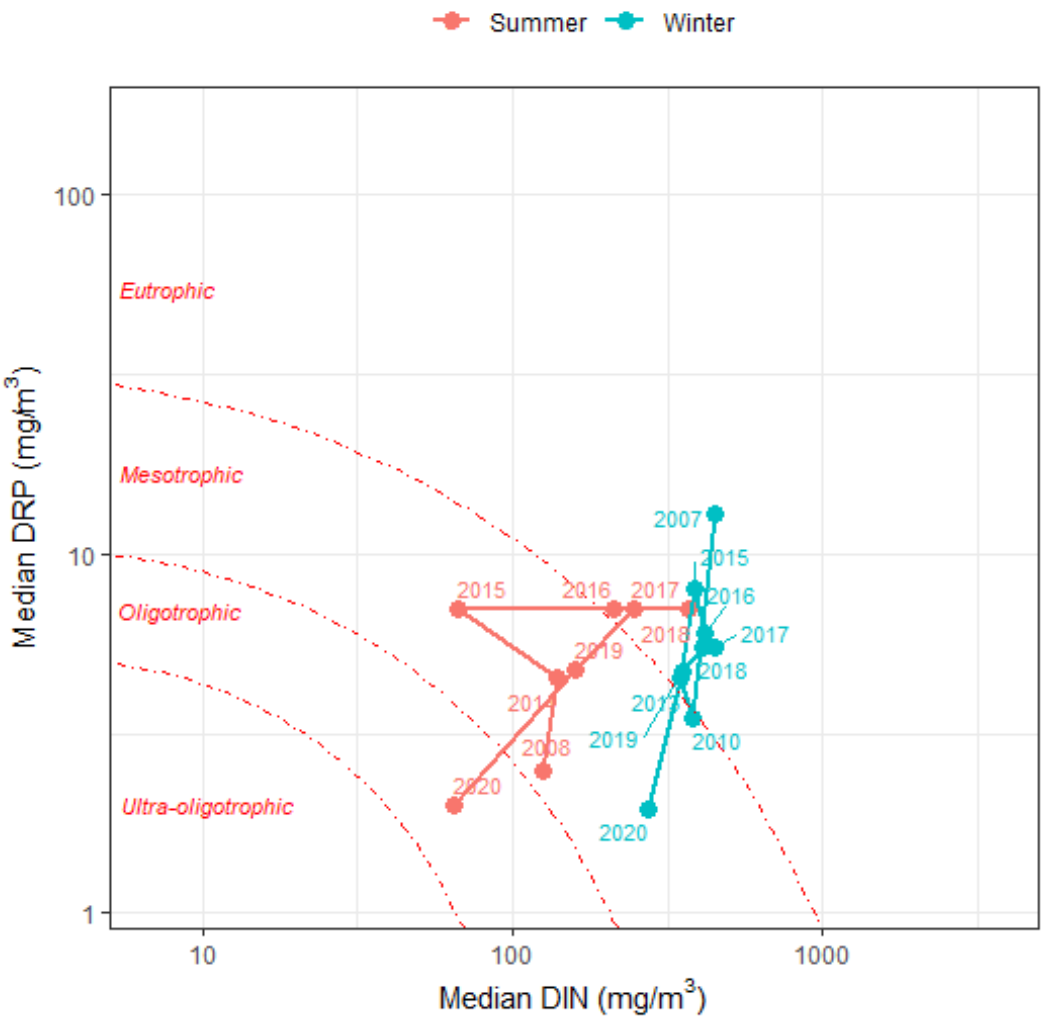


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	21	0.0020	0.010	A
5 Years	2015-12-11	2020-12-09	113	0.0020	0.010	A
10 Years	2010-12-12	2020-12-09	139	0.0020	0.012	A
All	1990-11-02	2020-12-09	163	0.0024	0.043	A

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	21	0.16	0.46	A
5 Years	2015-12-11	2020-12-09	113	0.31	0.59	A
10 Years	2010-12-12	2020-12-09	139	0.30	0.60	A
All	2007-08-09	2020-12-09	154	0.30	0.60	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	113	5.42	A
10 Years	2010-12-12	2020-12-09	138	5.43	A
All	2007-08-09	2020-12-09	149	5.35	A

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	113	0.005	0.009	A
10 Years	2010-12-12	2020-12-09	139	0.005	0.009	A
All	1990-11-02	2020-12-09	161	0.005	0.014	A

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc 95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	113	10.6	17.7	120	1220	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

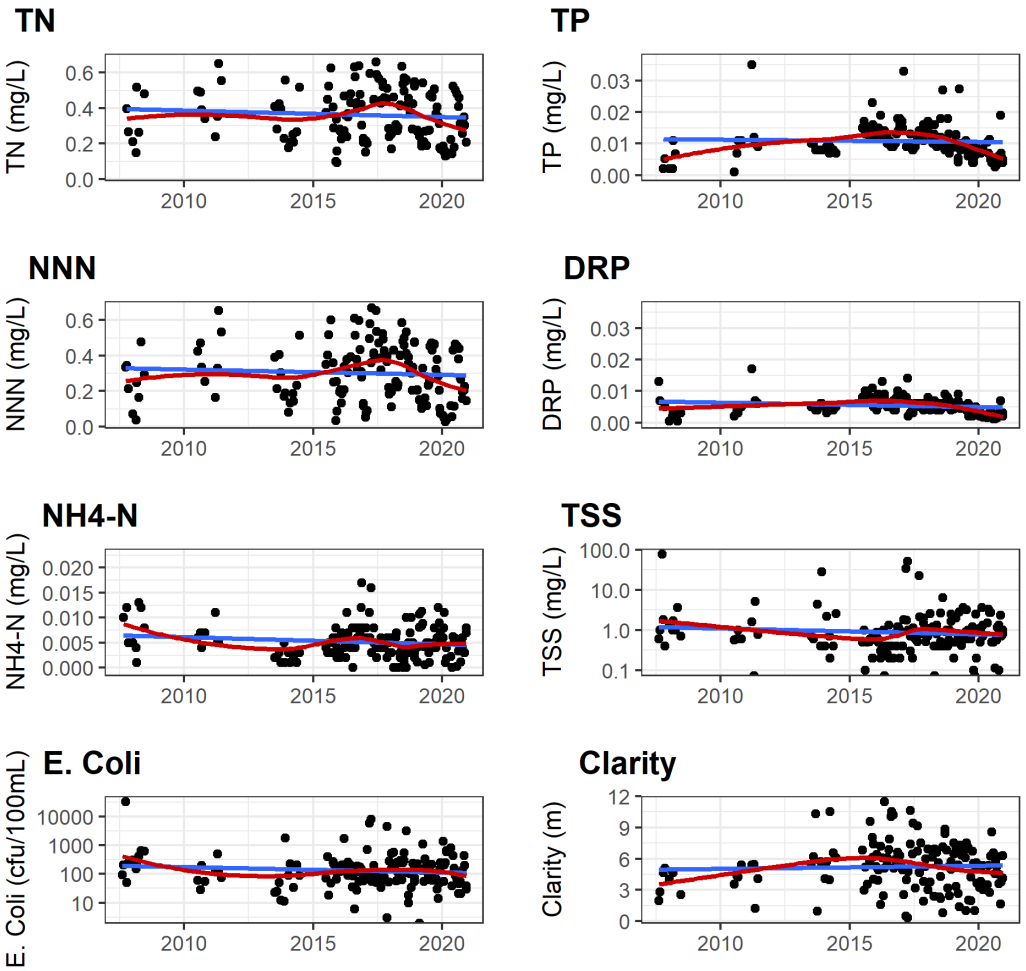
Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	113	120	1355	82.3	7.1	10.6
10 Years	2010-12-12	2020-12-09	139	113	1265	82.7	7.9	9.4
All	2007-08-09	2020-12-09	155	120	1325	81.3	8.4	10.3

Time series plots

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit



Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-12	2020-12-09	-0.0159	-3.89	<0.05	Decreasing	YES	YES	Very Likely Improving
TN	10 Years	2011-03-16	2020-12-09	-0.0014	-0.37	0.75	Indeterminant	YES	YES	Indeterminate/ Uncertain
TN	All	2007-08-09	2020-12-09	-0.0011	-0.31	0.78	Indeterminant	YES	YES	Indeterminate/ Uncertain
NNN	5 Years	2016-01-12	2020-12-09	-0.0124	-3.85	0.24	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2011-03-16	2020-12-09	-0.0031	-0.96	0.29	Indeterminant	YES	YES	Likely Improving
NNN	All	2007-08-09	2020-12-09	0.0004	0.14	0.93	Indeterminant	YES	YES	Indeterminate/ Uncertain
NH4N	5 Years	2016-01-12	2020-12-09	-0.0003	-5.22	0.28	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-03-16	2020-12-09	-0.0001	-1.67	0.60	Indeterminant	YES	YES	Likely Improving
NH4N	All	2007-08-09	2020-12-09	-0.0001	-2.24	0.36	Indeterminant	YES	YES	Likely Improving
TP	5 Years	2016-01-12	2020-12-09	-0.0018	-16.05	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-03-16	2020-12-09	-0.0008	-7.45	<0.001	Decreasing	YES	NO	Very Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TP	All	2007-08-09	2020-12-09	-0.0006	-5.84	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2016-01-12	2020-12-09	-0.0010	-20.39	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-03-16	2020-12-09	-0.0005	-9.61	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	All	2007-08-09	2020-12-09	-0.0003	-6.58	<0.05	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-12	2020-12-09	0.0014	0.07	1.00	Indeterminant	YES	YES	Indeterminate/ Uncertain
ECOLI	10 Years	2011-03-16	2020-12-09	0.0168	0.82	0.25	Indeterminant	YES	YES	Likely Degrading
ECOLI	All	2007-08-09	2020-12-09	-0.0033	-0.16	0.93	Indeterminant	YES	YES	Indeterminate/ Uncertain
TSS	5 Years	2016-01-12	2020-12-09	0.0117	4.59	0.37	Indeterminant	YES	NO	Likely Degrading
TSS	10 Years	2011-03-16	2020-12-09	0.0145	6.30	<0.05	Increasing	YES	NO	Very Likely Degrading
TSS	All	2007-08-09	2020-12-09	0.0057	2.46	0.28	Indeterminant	YES	NO	Likely Degrading
CLARITY	5 Years	2016-01-12	2020-12-09	-0.3778	-7.09	0.06	Decreasing	YES	NO	Very Likely Degrading
CLARITY	10 Years	2011-03-16	2020-12-09	-0.1323	-2.44	0.11	Indeterminant	YES	NO	Very Likely Degrading
CLARITY	All	2007-08-09	2020-12-09	-0.0395	-0.74	0.49	Indeterminant	YES	NO	Likely Degrading

Te Mania at SH 2

March 2021

Table 1. Site metadata.

Aquarius ID:	BQ711622	**Labstar ID:**	513505, BOP710022
LAWA ID:	EBOP-00026	**REC Reach:**	4000427
Easting:	1857111	**Northing:**	5836225
Longitude:	175.91110	**Latitude:**	-37.58476
Elevation:	8 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Low_VA		

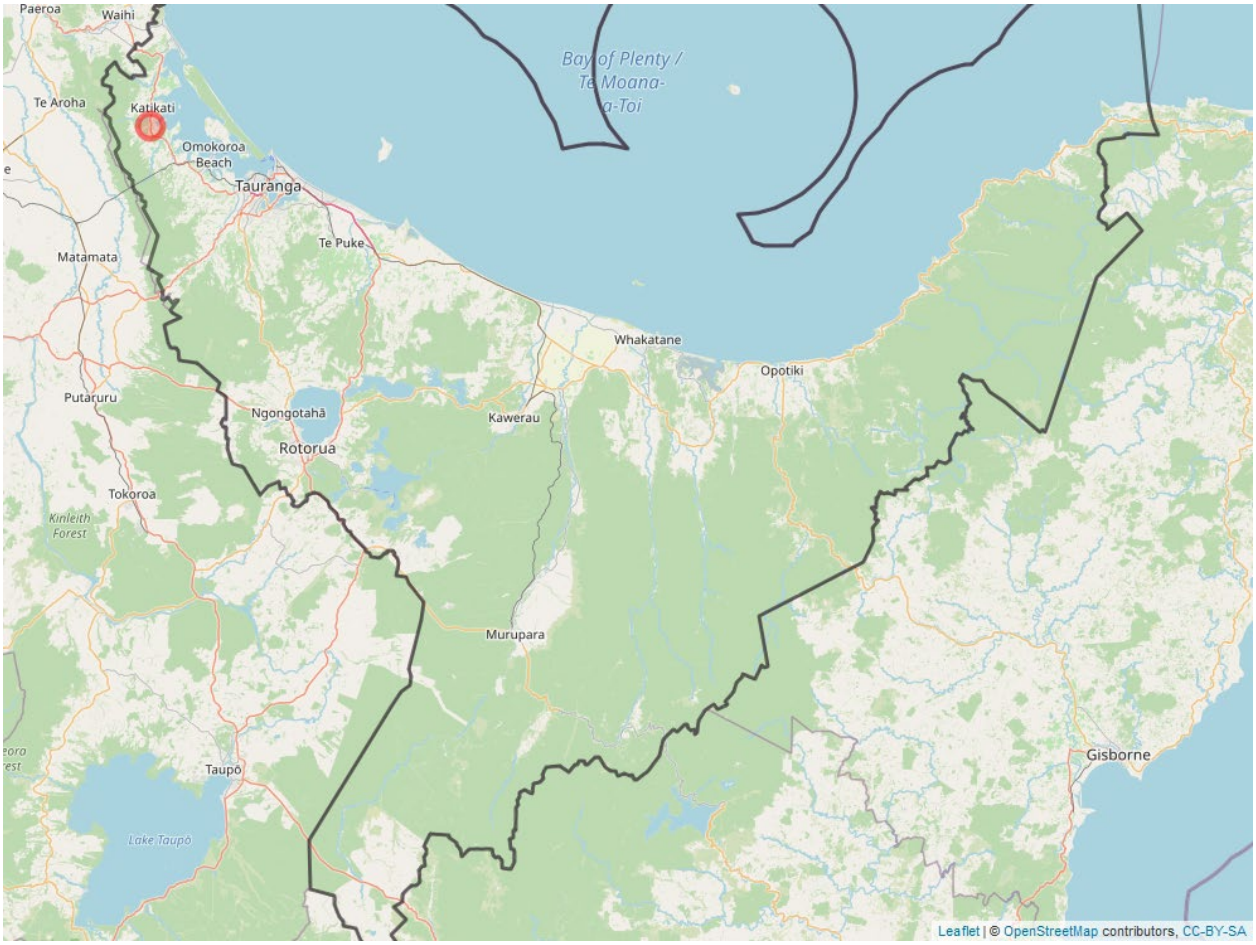


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2. Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	259	0.10	2.38	0.46	0.41	0.86	0.22	0.25	0.02
Nitrate Nitrite Nitrogen (g/m3)	261	<0.001	1.19	0.31	0.25	0.64	0.10	0.18	0.01
Total Ammoniacal Nitrogen (g/m3)	275	<0.002	0.245	0.021	0.018	0.039	0.007	0.020	0.001
Total Phosphorus (g/m3)	276	0.003	0.220	0.021	0.016	0.047	0.008	0.023	0.001
Dissolved Reactive Phosphorus (g/m3)	270	<0.001	0.044	0.008	0.007	0.017	0.002	0.005	0.000
Dissolved Oxygen Sat (%)	119	85.4	109.8	95.9	95.6	103.1	88.8	4.7	0.4
Dissolved Oxygen (g/m3)	268	6.80	11.59	9.64	9.70	10.92	8.40	0.79	0.05
Escherichia coli (cfu/100ml)	266	<1	25000	698	310	2275	68	1838	113
Total Suspended Solids (g/m3)	272	<1	292.00	11.00	5.55	32.90	1.46	23.45	1.42
Turbidity (NTU)	265	0.4	160.0	7.1	4.7	19.1	2.0	12.1	0.7
Water Clarity (m)	186	0.10	5.62	1.70	1.52	3.31	0.43	1.01	0.07
Conductivity (uS/cm)	275	49	119	75	74	88	62	9	1
pH (pH Units)	275	6.0	7.8	6.9	6.9	7.3	6.4	0.3	0.0
Water Temperature (degC)	274	7.8	22.5	14.9	14.7	19.4	10.2	2.9	0.2
Discharge (m3/s)	225	0.00	6.40	0.40	0.20	1.30	0.10	0.70	0.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

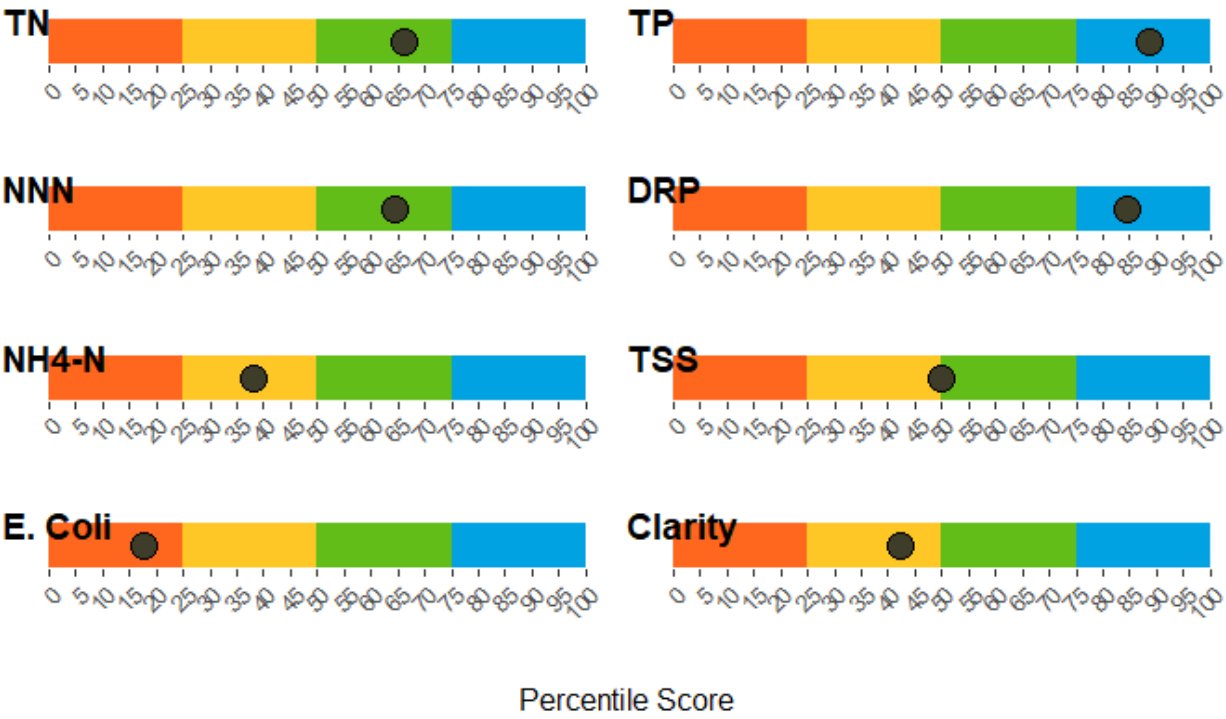


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

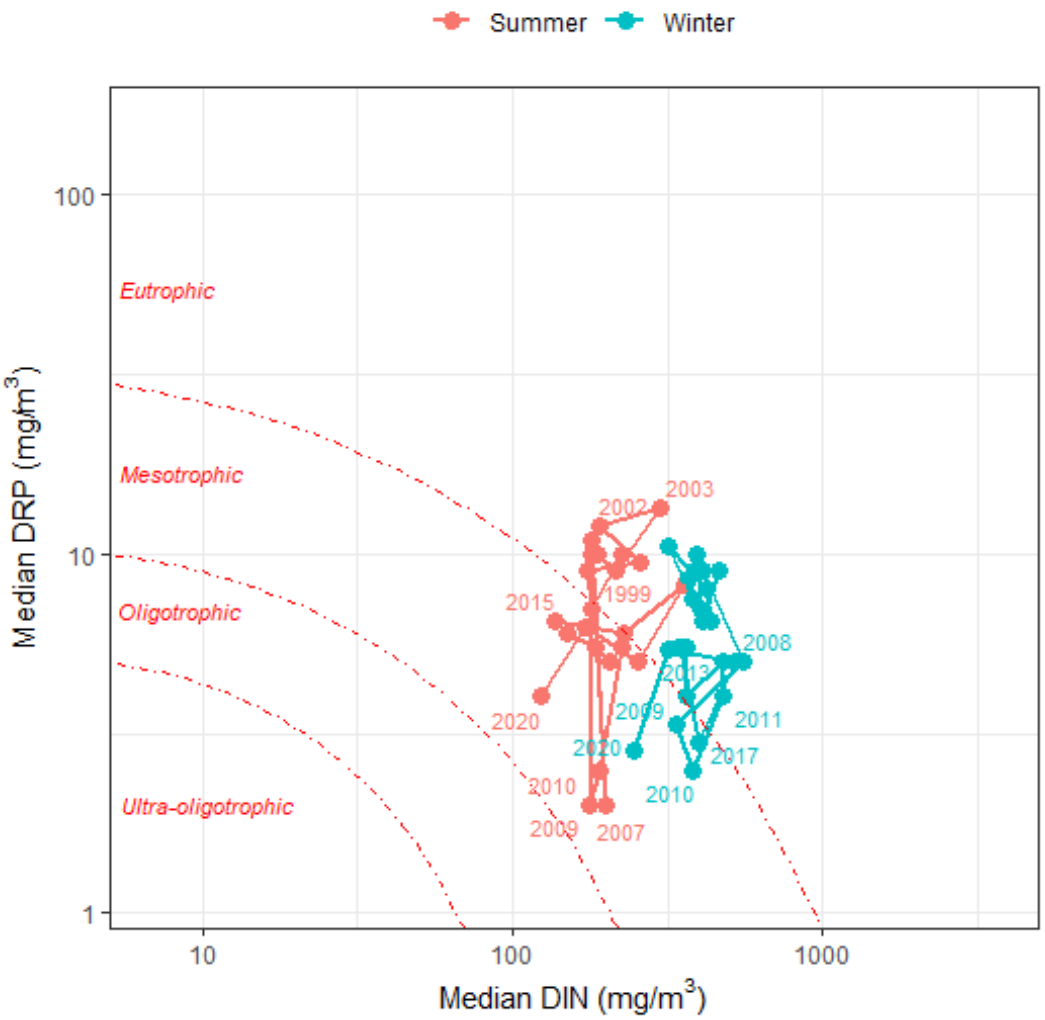


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	10	0.0060	0.016	A
5 Years	2015-12-11	2020-12-09	55	0.0060	0.016	A
10 Years	2010-12-12	2020-12-09	112	0.0060	0.041	A
All	1990-11-02	2020-12-09	273	0.0072	0.091	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	10	0.18	0.84	A
5 Years	2015-12-11	2020-12-09	55	0.25	0.64	A
10 Years	2010-12-12	2020-12-09	113	0.24	0.64	A
All	1993-12-13	2020-12-09	261	0.25	0.64	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	54	1.55	B*
10 Years	2010-12-12	2020-12-09	101	1.85	A
All	1993-09-16	2020-12-09	184	1.51	C

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	55	0.005	0.009	A
10 Years	2010-12-12	2020-12-09	113	0.005	0.009	A
All	1990-11-02	2020-12-09	269	0.007	0.017	B

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	55	32.7	81.8	430	5160	E*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8. Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	55	430	5250	18.2	49.1	30.9
10 Years	2010-12-12	2020-12-09	113	390	3880	32.7	38.1	28.3
All	1993-09-16	2020-12-09	266	310	2320	43.6	28.9	27.1

Time series plots

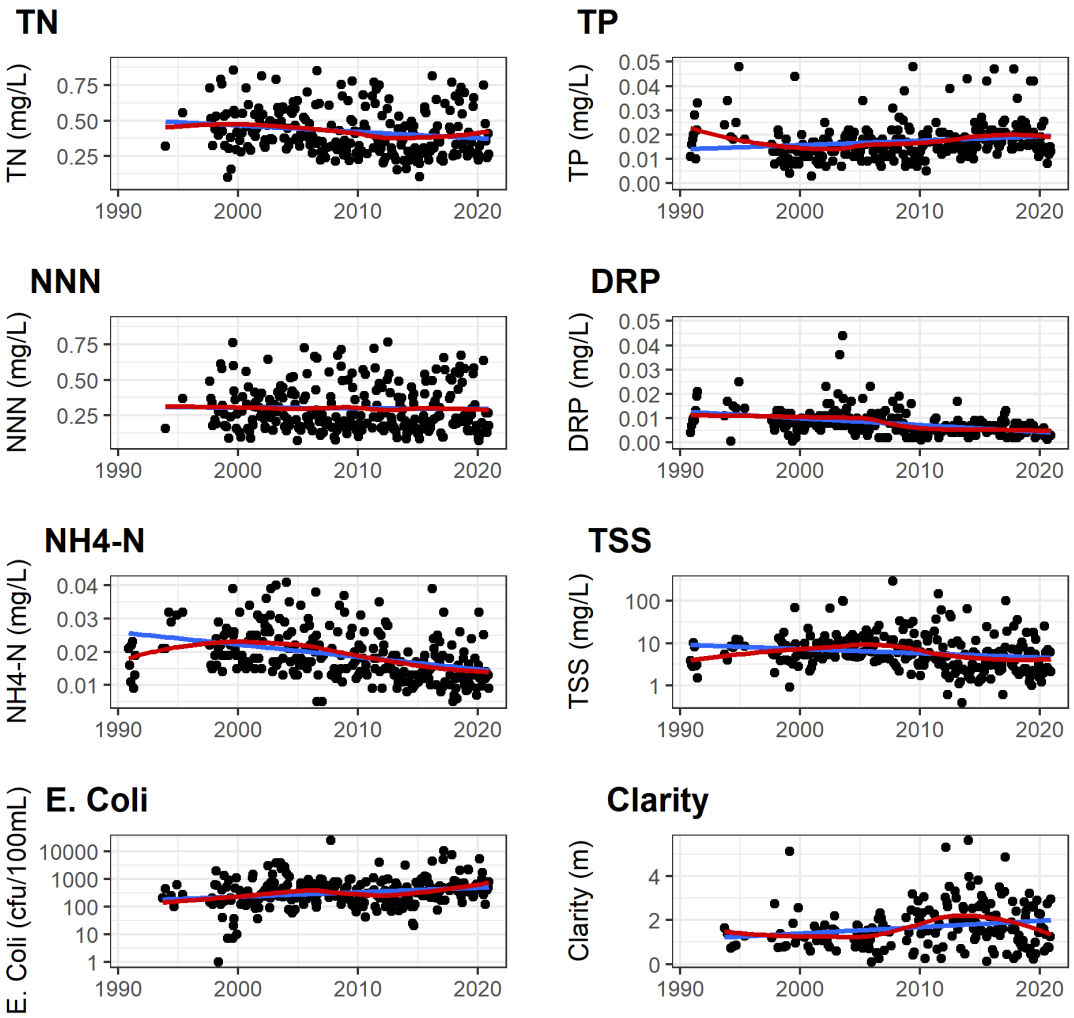


Figure 4 *Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.*

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-20	2020-12-09	0.0101	2.79	0.16	Indeterminant	YES	YES	Very Likely Degrading
TN	10 Years	2011-03-16	2020-12-09	0.0123	3.51	<0.001	Increasing	YES	YES	Very Likely Degrading
TN	All	1990-12-14	2020-12-09	-0.0041	-1.07	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-20	2020-12-09	0.0078	3.15	0.06	Increasing	YES	YES	Very Likely Degrading
NNN	10 Years	2011-03-16	2020-12-09	0.0105	4.43	<0.001	Increasing	YES	YES	Very Likely Degrading
NNN	All	1990-12-14	2020-12-09	0.0016	0.69	<0.05	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2016-01-20	2020-12-09	-0.0003	-2.10	0.74	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	10 Years	2011-03-16	2020-12-09	-0.0004	-3.32	0.15	Indeterminant	YES	NO	Likely Improving
NH4N	All	1990-12-14	2020-12-09	-0.0005	-2.98	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-20	2020-12-09	-0.0010	-5.51	0.06	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-03-16	2020-12-09	0.0001	0.42	0.77	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	1990-12-14	2020-12-09	0.0002	1.26	<0.01	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-20	2020-12-09	-0.0006	-12.85	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-03-16	2020-12-09	-0.0002	-3.70	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	1990-12-14	2020-12-09	-0.0002	-3.78	<0.001	Decreasing	YES	YES	Very Likely Improving
ECOLI	5 Years	2016-01-20	2020-12-09	0.0131	0.50	0.88	Indeterminant	YES	YES	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-03-16	2020-12-09	0.0397	1.53	<0.01	Increasing	YES	YES	Very Likely Degrading
ECOLI	All	1990-12-14	2020-12-09	0.0108	0.43	<0.01	Increasing	YES	YES	Very Likely Degrading
TSS	5 Years	2016-01-20	2020-12-09	-0.0151	-2.25	0.31	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-03-16	2020-12-09	0.0019	0.31	0.78	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	1990-12-14	2020-12-09	-0.0139	-1.72	<0.001	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2016-01-20	2020-12-09	-0.1108	-7.08	0.25	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2011-03-16	2020-12-09	-0.0682	-3.61	0.05	Decreasing	YES	NO	Very Likely Degrading
CLARITY	All	1990-12-14	2020-12-09	0.0299	1.93	<0.01	Increasing	YES	NO	Very Likely Improving

Uretara at Henry Road Ford

March 2021

Table 1 Site metadata.

Aquarius ID:	BQ723939	**Labstar ID:**	BOP210004
LAWA ID:	EBOP-00052	**REC Reach:**	4000360
Easting:	1857235	**Northing:**	5839394
Longitude:	175.91209	**Latitude:**	-37.55659
Elevation:	3.5 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

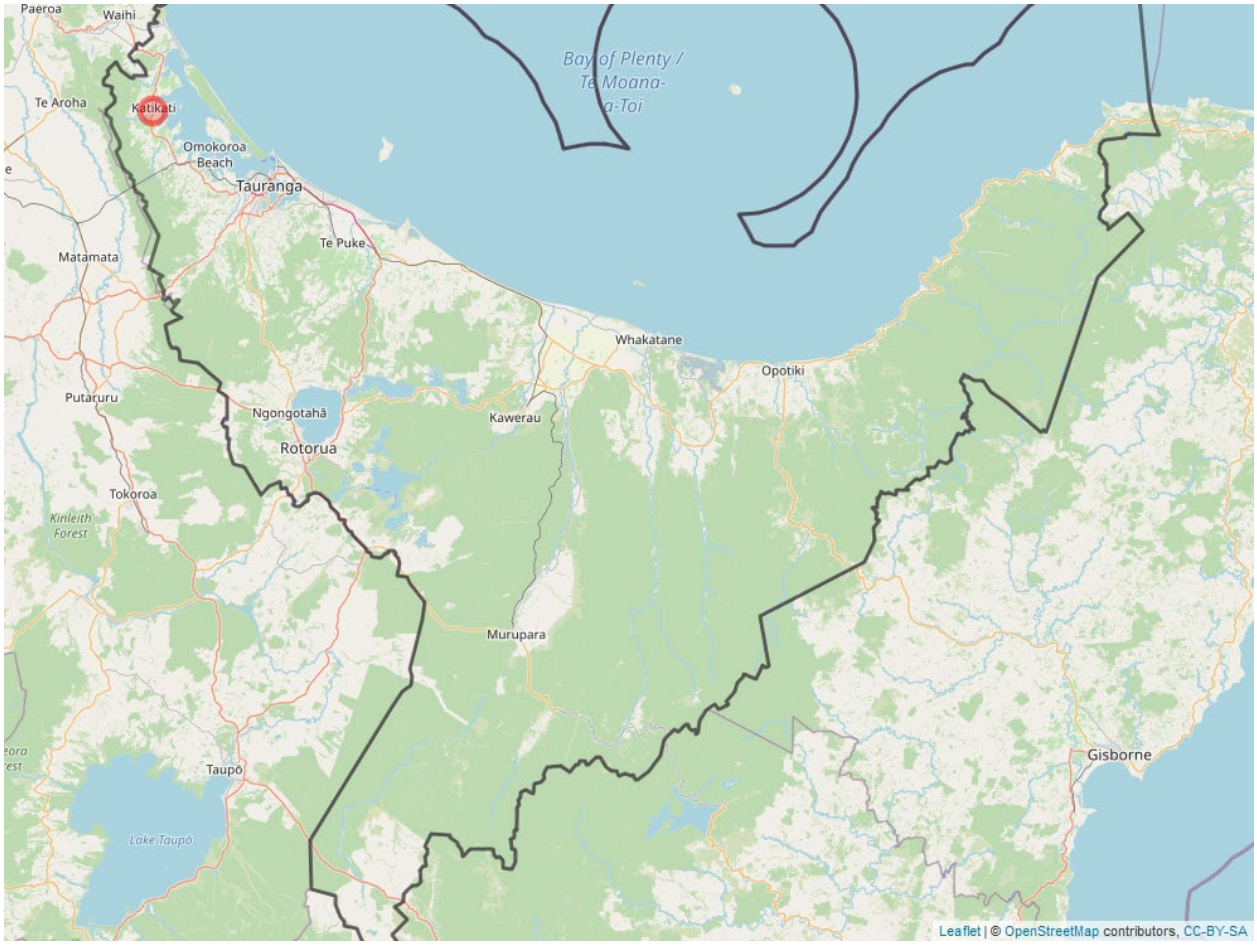


Figure 1. The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	132	0.07	0.78	0.27	0.26	0.57	0.09	0.15	0.01
Nitrate Nitrite Nitrogen (g/m3)	133	<0.001	0.68	0.21	0.18	0.50	0.03	0.15	0.01
Total Ammoniacal Nitrogen (g/m3)	135	<0.002	0.055	0.008	0.005	0.025	0.001	0.009	0.001
Total Phosphorus (g/m3)	135	<0.001	0.104	0.009	0.008	0.023	0.002	0.010	0.001
Dissolved Reactive Phosphorus (g/m3)	130	<0.001	0.048	0.005	0.004	0.010	0.002	0.005	0.000
Dissolved Oxygen Sat (%)	84	82.1	115.3	101.6	101.3	111.0	91.7	5.9	0.6
Dissolved Oxygen (g/m3)	133	7.41	12.13	10.09	10.10	11.57	8.57	0.91	0.08
Escherichia coli (cfu/100ml)	134	<1	3200	234	117	724	17	439	38
Total Suspended Solids (g/m3)	132	<1	55.00	3.11	1.00	11.44	0.20	7.02	0.61
Turbidity (NTU)	133	0.3	26.0	2.2	1.2	7.6	0.4	3.3	0.3
Water Clarity (m)	125	0.15	12.08	4.16	3.68	8.50	1.14	2.45	0.22
Conductivity (uS/cm)	133	39	111	66	66	75	56	8	1
pH (pH Units)	133	6.3	10.0	7.1	7.1	7.4	6.6	0.4	0.0
Water Temperature (degC)	135	8.8	24.9	15.7	15.6	20.8	10.2	3.5	0.3
Discharge (m3/s)	110	0.10	5.00	0.80	0.60	2.20	0.20	0.80	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

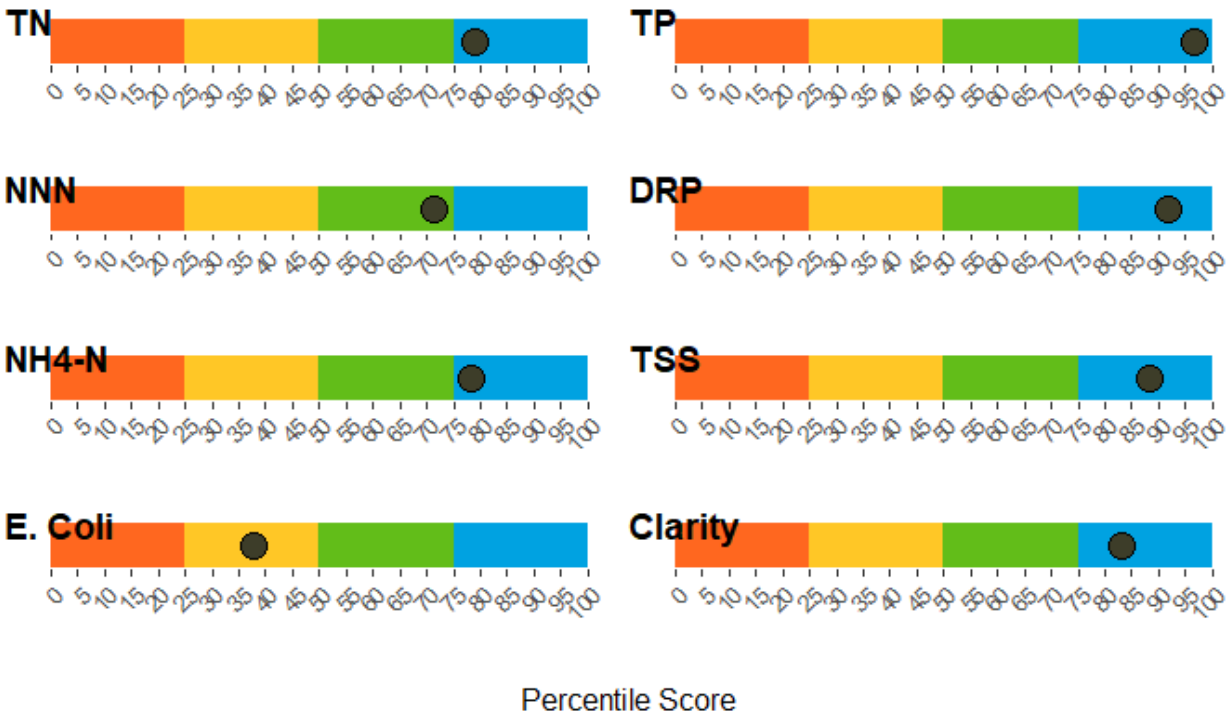


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

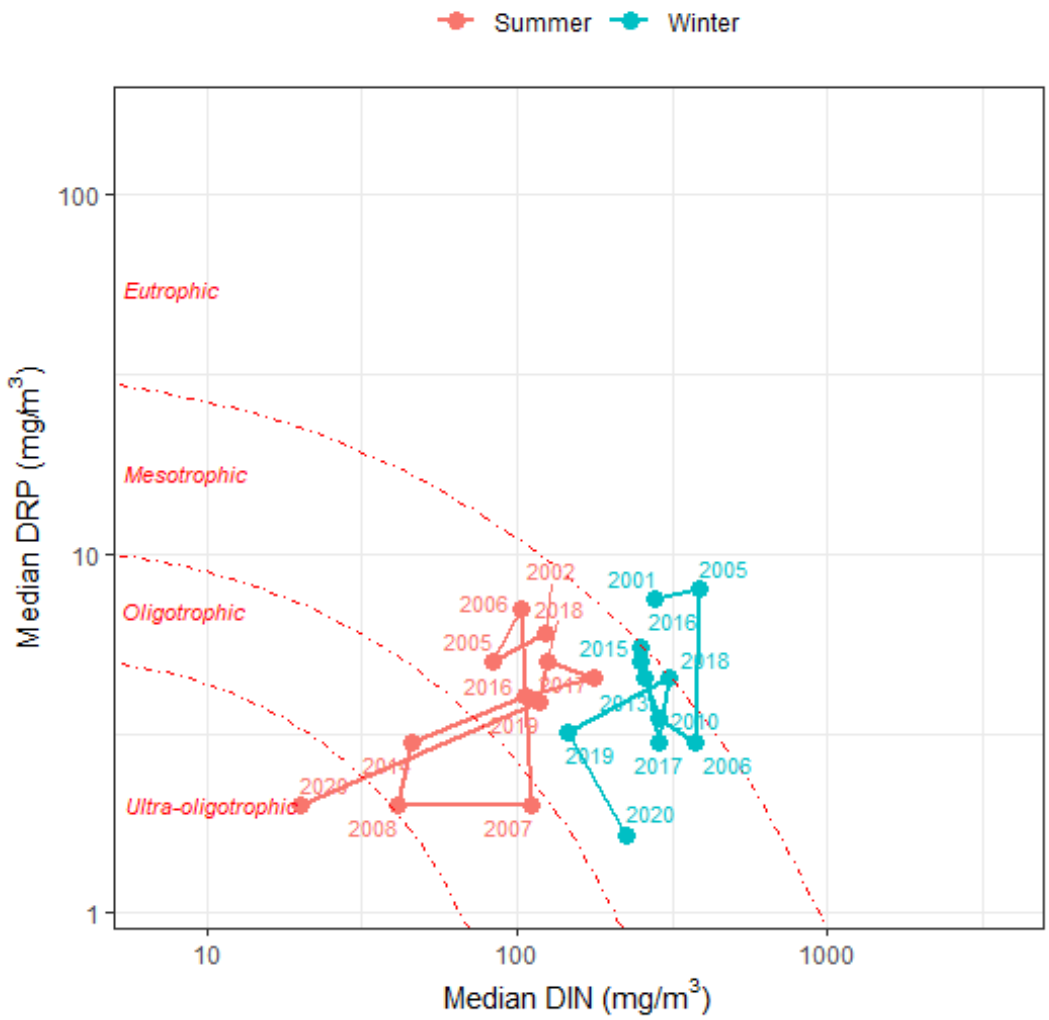


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	12	0.0020	0.004	A
5 Years	2015-12-11	2020-12-09	59	0.0020	0.015	A
10 Years	2010-12-12	2020-12-09	80	0.0020	0.016	A
All	2001-07-24	2020-12-09	133	0.0024	0.028	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	12	0.13	0.33	A
5 Years	2015-12-11	2020-12-09	60	0.19	0.50	A
10 Years	2010-12-12	2020-12-09	81	0.20	0.52	A
All	2001-07-24	2020-12-09	133	0.18	0.50	A

Table 5. Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	59	5.20	A*
10 Years	2010-12-12	2020-12-09	79	5.10	A
All	2001-07-24	2020-12-09	123	3.68	A

Table 6. Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	60	0.004	0.006	A
10 Years	2010-12-12	2020-12-09	81	0.004	0.006	A
All	2001-07-23	2020-12-09	129	0.004	0.010	A

Table 7. Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	60	11.7	25.0	117	1005	C	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8. Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	60	117	1050	75	13.3	11.7
10 Years	2010-12-12	2020-12-09	81	100	1045	80.2	9.9	9.9
All	2001-07-24	2020-12-09	134	117	756	79.9	11.9	8.2

Time series plots

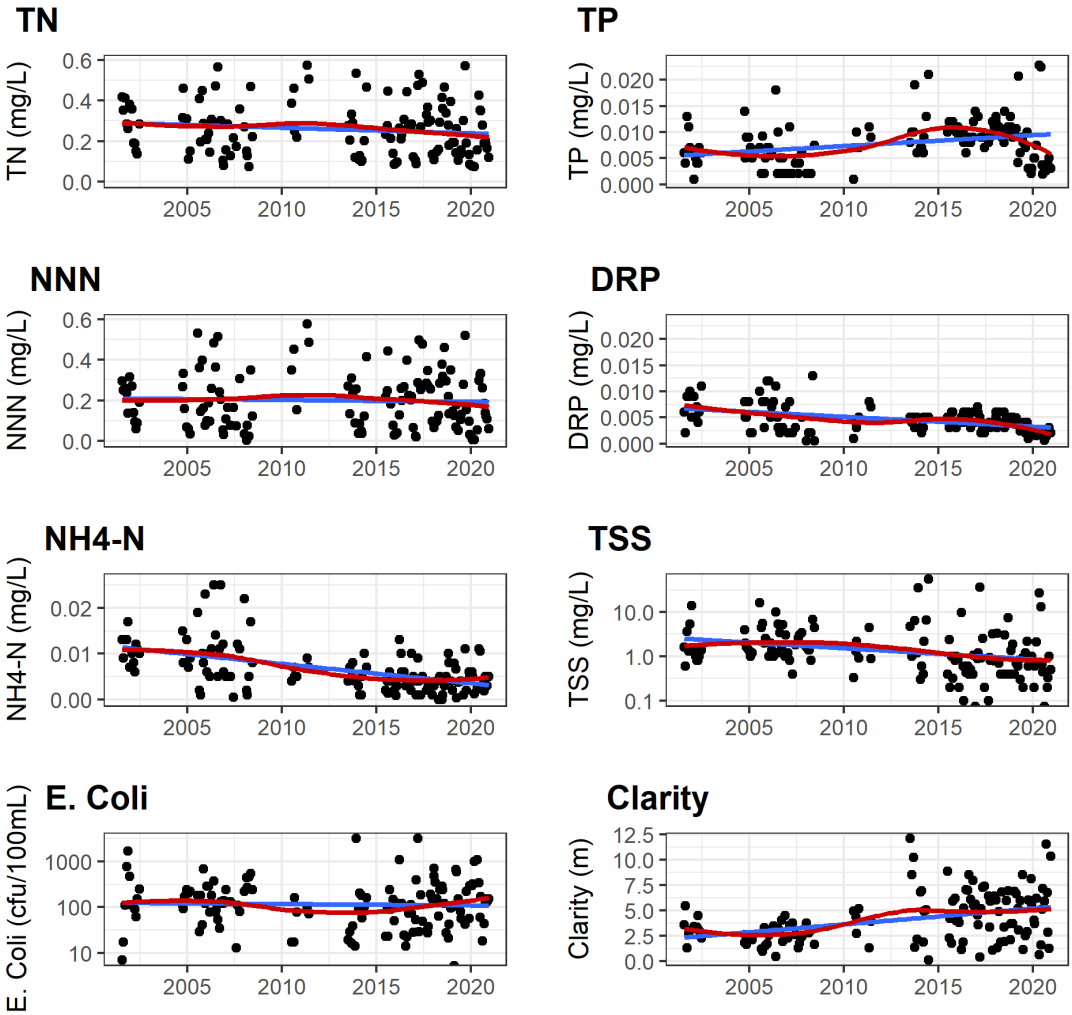


Figure 4 *Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.*

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-20	2020-12-09	-0.0233	-11.99	0.05	Decreasing	YES	YES	Very Likely Improving
TN	10 Years	2011-05-05	2020-12-09	-0.0075	-3.61	0.27	Indeterminant	YES	YES	Likely Improving
TN	All	2001-07-24	2020-12-09	-0.0031	-1.30	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-20	2020-12-09	-0.0227	-15.53	0.05	Decreasing	YES	YES	Very Likely Improving
NNN	10 Years	2011-05-05	2020-12-09	-0.0063	-3.77	0.32	Indeterminant	YES	YES	Likely Improving
NNN	All	2001-07-24	2020-12-09	-0.0006	-0.38	0.73	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	5 Years	2016-01-20	2020-12-09	-0.0001	-1.52	0.88	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	10 Years	2011-05-05	2020-12-09	-0.0001	-2.55	0.53	Indeterminant	YES	NO	Likely Improving
NH4N	All	2001-07-24	2020-12-09	-0.0003	-6.38	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-20	2020-12-09	-0.0010	-11.28	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-05-05	2020-12-09	-0.0006	-6.31	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	All	2001-07-24	2020-12-09	0.0001	1.09	0.19	Indeterminant	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-20	2020-12-09	-0.0006	-16.16	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-05-05	2020-12-09	-0.0004	-10.83	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	All	2001-07-24	2020-12-09	-0.0002	-4.73	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-20	2020-12-09	0.0696	3.34	0.15	Indeterminant	YES	YES	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-05-05	2020-12-09	0.0549	2.74	<0.05	Increasing	YES	YES	Very Likely Degrading
ECOLI	All	2001-07-24	2020-12-09	0.0000	0.00	1.00	Indeterminant	NO	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-20	2020-12-09	0.0183	7.93	0.17	Indeterminant	YES	NO	Very Likely Degrading
TSS	10 Years	2011-05-05	2020-12-09	0.0040	1.62	0.73	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	2001-07-24	2020-12-09	-0.0116	-3.84	<0.001	Decreasing	YES	NO	Very Likely Improving
CLARITY	5 Years	2016-01-20	2020-12-09	0.1805	3.36	0.45	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2011-05-05	2020-12-09	0.1253	2.46	0.38	Indeterminant	YES	NO	Likely Improving
CLARITY	All	2001-07-24	2020-12-09	0.1602	4.28	<0.001	Increasing	YES	NO	Very Likely Improving

Waitekohe at SH 2

March 2021

Table 1 Site metadata.

Aquarius ID:	BQ739463	**Labstar ID:**	BOP710023
LAWA ID:	EBOP-00040	**REC Reach:**	4000499
Easting:	1857397	**Northing:**	5834637
Longitude:	175.91535	**Latitude:**	-37.59934
Elevation:	19 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

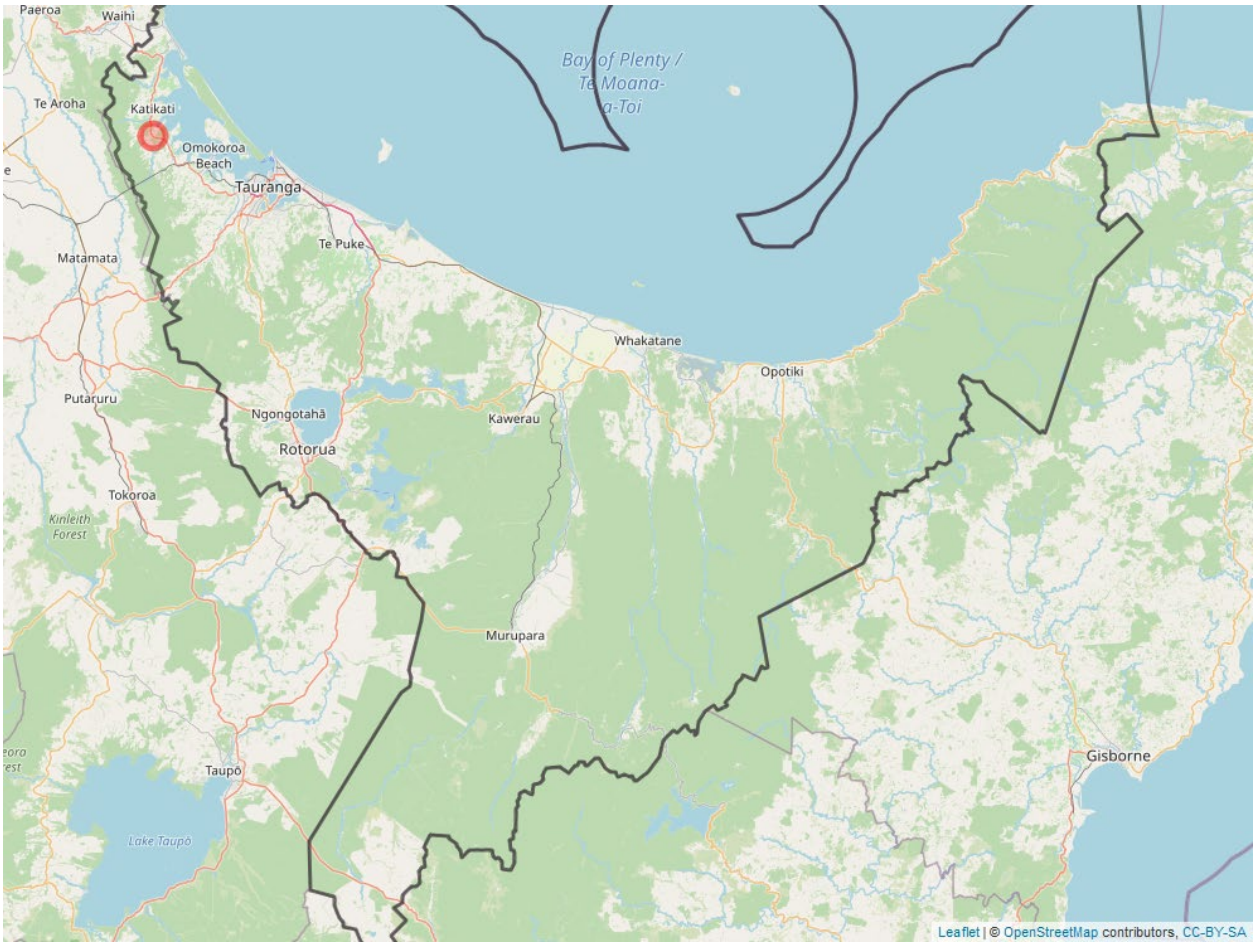


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	169	0.06	1.58	0.23	0.17	0.48	0.08	0.18	0.01
Nitrate Nitrite Nitrogen (g/m3)	169	<0.001	1.10	0.13	0.08	0.37	0.00	0.15	0.01
Total Ammoniacal Nitrogen (g/m3)	178	<0.002	0.165	0.006	0.005	0.014	0.000	0.013	0.001
Total Phosphorus (g/m3)	178	<0.001	0.091	0.012	0.010	0.024	0.003	0.012	0.001
Dissolved Reactive Phosphorus (g/m3)	174	<0.001	0.020	0.005	0.005	0.009	0.001	0.003	0.000
Dissolved Oxygen Sat (%)	135	94.2	137.0	108.2	107.0	120.0	99.8	6.9	0.6
Dissolved Oxygen (g/m3)	169	7.70	14.76	10.78	10.80	12.53	9.08	1.07	0.08
Escherichia coli (cfu/100ml)	166	<1	8400	319	70	1400	10	910	71
Total Suspended Solids (g/m3)	176	<1	105.00	3.59	1.30	9.10	0.30	11.13	0.84
Turbidity (NTU)	170	0.2	50.0	2.1	0.7	5.4	0.3	6.3	0.5
Water Clarity (m)	161	0.26	10.25	4.16	4.20	6.96	1.10	1.83	0.14
Conductivity (uS/cm)	178	44	160	80	80	94	61	13	1
pH (pH Units)	178	5.9	8.9	7.4	7.3	8.4	6.8	0.5	0.0
Water Temperature (degC)	173	7.0	26.7	15.5	15.2	22.5	9.9	4.1	0.3
Discharge (m3/s)	150	0.00	3.70	0.40	0.30	1.00	0.10	0.40	0.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty Region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

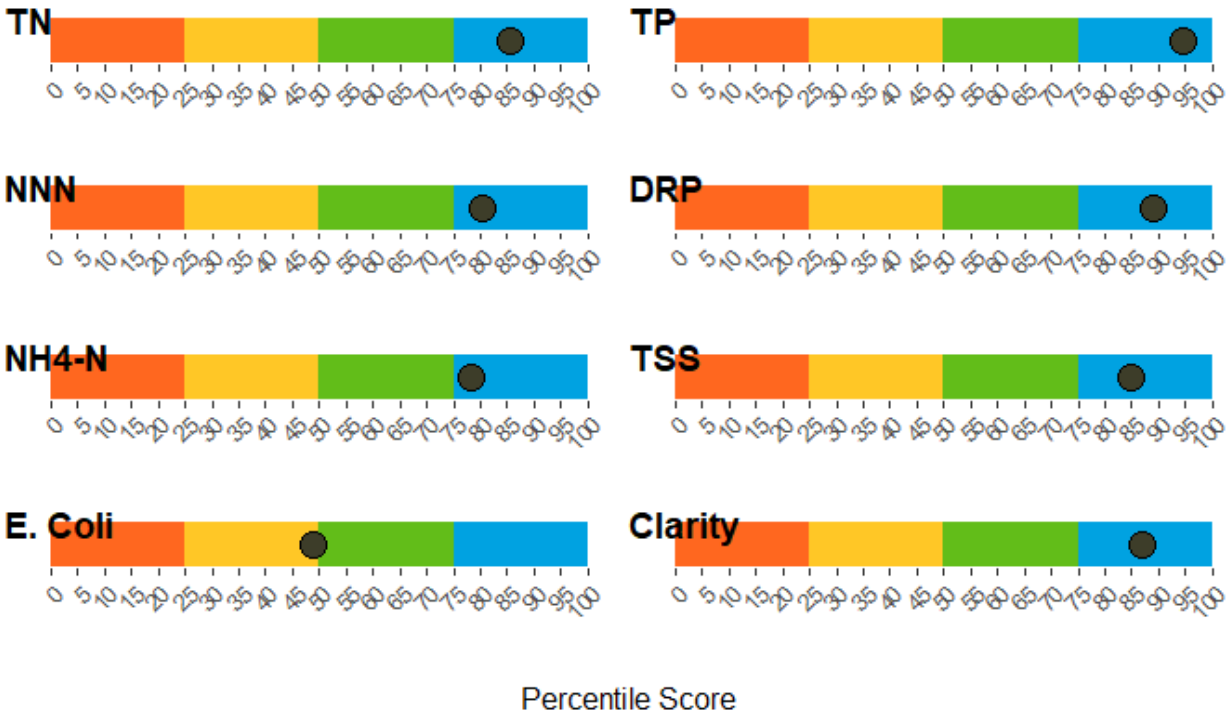


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

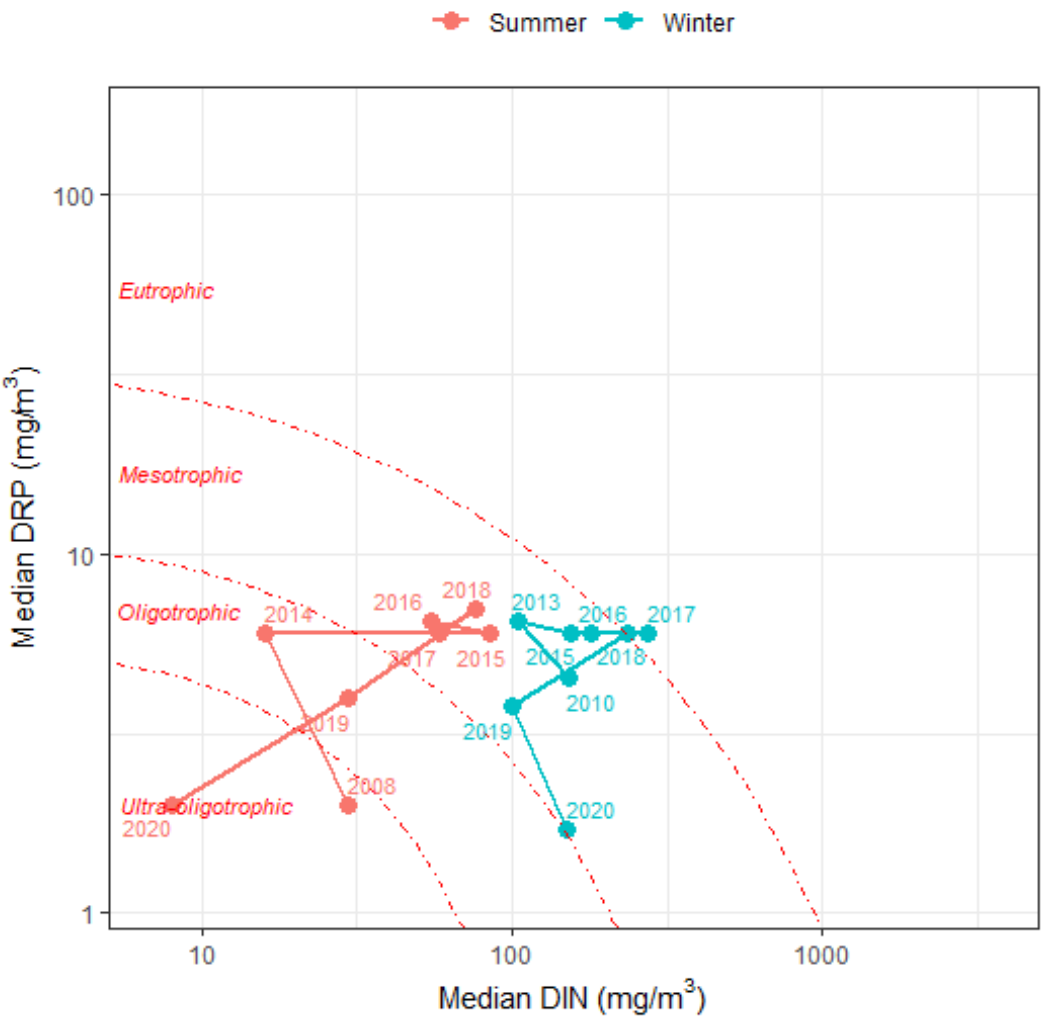


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	19	0.0040	0.006	A
5 Years	2015-12-11	2020-12-09	113	0.0020	0.126	B
10 Years	2010-12-12	2020-12-09	138	0.0020	0.126	B
All	1990-11-02	2020-12-09	178	0.0026	0.126	B

Table 4. Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	19	0.01	0.19	A
5 Years	2015-12-11	2020-12-09	113	0.09	0.37	A
10 Years	2010-12-12	2020-12-09	138	0.09	0.37	A
All	1995-08-24	2020-12-09	169	0.08	0.37	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	112	4.52	A
10 Years	2010-12-12	2020-12-09	133	4.42	A
All	1995-08-24	2020-12-09	160	4.22	A

Table 6. Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	113	0.005	0.009	A
10 Years	2010-12-12	2020-12-09	138	0.005	0.009	A
All	1990-11-02	2020-12-09	173	0.005	0.009	A

Table 7. Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	112	12.5	17.9	62	1490	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8. Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	112	62	1580	82.1	5.4	12.5
10 Years	2010-12-12	2020-12-09	137	64	1530	81.8	6.6	11.7
All	1995-08-24	2020-12-09	166	70	1440	80.7	7.8	11.4

Time series plots

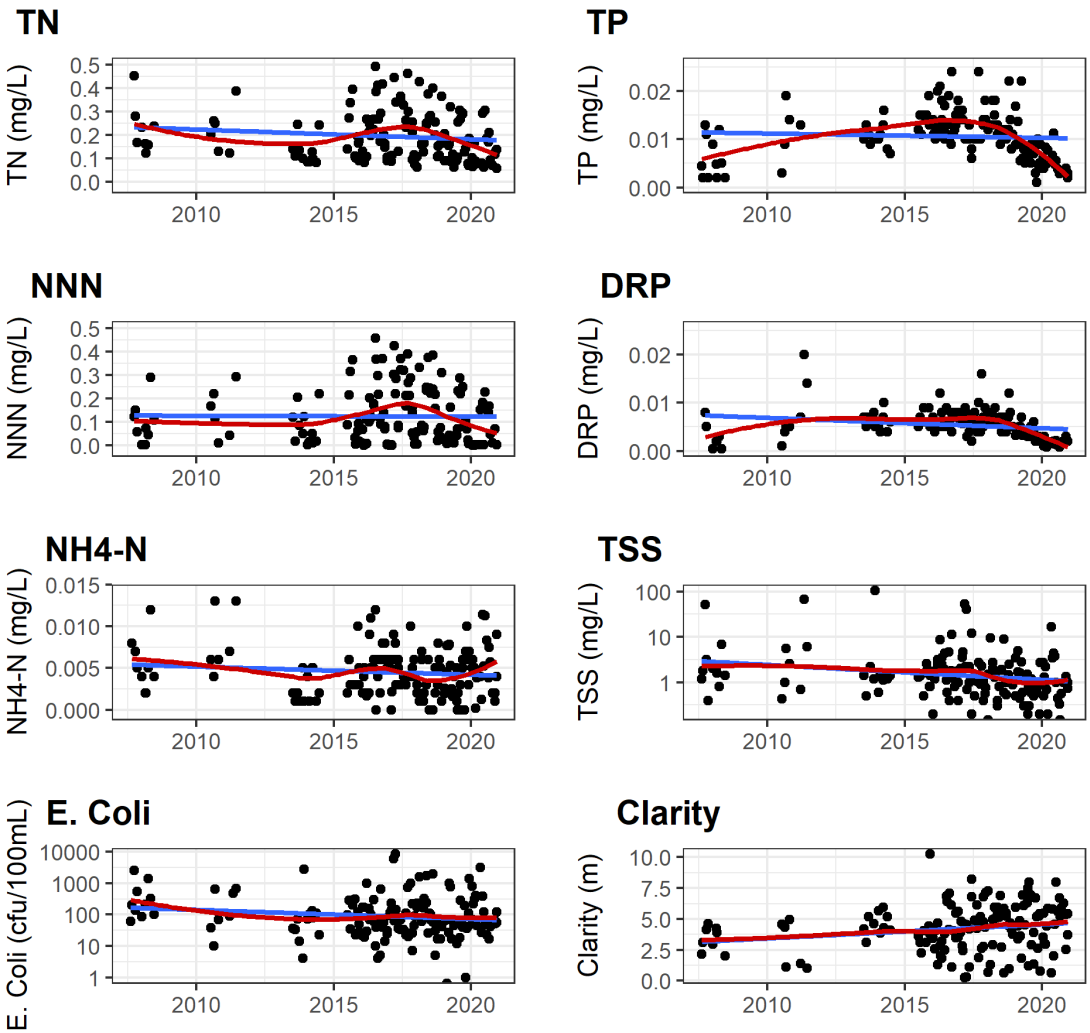


Figure 4 *Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.*

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-13	2020-12-09	-0.0090	-5.22	0.44	Indeterminant	YES	YES	Likely Improving
TN	10 Years	2011-03-16	2020-12-09	0.0018	1.11	0.84	Indeterminant	YES	YES	Indeterminate/Uncertain
TN	All	2007-08-09	2020-12-09	-0.0009	-0.53	0.87	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	5 Years	2016-01-13	2020-12-09	-0.0058	-6.55	0.44	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2011-03-16	2020-12-09	-0.0002	-0.20	0.92	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	All	2007-08-09	2020-12-09	0.0026	2.95	0.33	Indeterminant	YES	YES	Likely Degrading
NH4N	5 Years	2016-01-13	2020-12-09	-0.0002	-4.76	0.29	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2011-03-16	2020-12-09	0.0000	0.79	0.88	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	All	2007-08-09	2020-12-09	0.0000	-0.67	0.66	Indeterminant	YES	NO	Likely Improving
TP	5 Years	2016-01-13	2020-12-09	-0.0020	-18.43	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-03-16	2020-12-09	-0.0013	-10.48	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	All	2007-08-09	2020-12-09	-0.0004	-3.70	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2016-01-13	2020-12-09	-0.0011	-21.72	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-03-16	2020-12-09	-0.0007	-12.08	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	All	2007-08-09	2020-12-09	-0.0004	-7.44	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-13	2020-12-09	0.0540	3.01	0.22	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-03-16	2020-12-09	0.0120	0.67	0.67	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2007-08-09	2020-12-09	-0.0144	-0.78	0.34	Indeterminant	YES	NO	Likely Improving
TSS	5 Years	2016-01-13	2020-12-09	-0.0265	-8.21	0.13	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-03-16	2020-12-09	-0.0148	-4.31	0.08	Decreasing	YES	NO	Very Likely Improving
TSS	All	2007-08-09	2020-12-09	-0.0136	-3.76	<0.05	Decreasing	YES	NO	Very Likely Improving
CLARITY	5 Years	2016-01-13	2020-12-09	0.2415	5.53	0.12	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2011-03-16	2020-12-09	0.1419	3.32	0.13	Indeterminant	YES	NO	Likely Improving
CLARITY	All	2007-08-09	2020-12-09	0.0938	2.21	0.07	Increasing	YES	NO	Very Likely Improving

Aongatete at SH 2

March 2021

Table 1 Site metadata.

Aquarius ID:	BQ966369	**Labstar ID:**	BOP710028
LAWA ID:	EBOP-00001	**REC Reach:**	4000490
Easting:	1859660	**Northing:**	5833690
Longitude:	175.94154	**Latitude:**	-37.60725
Elevation:	3 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

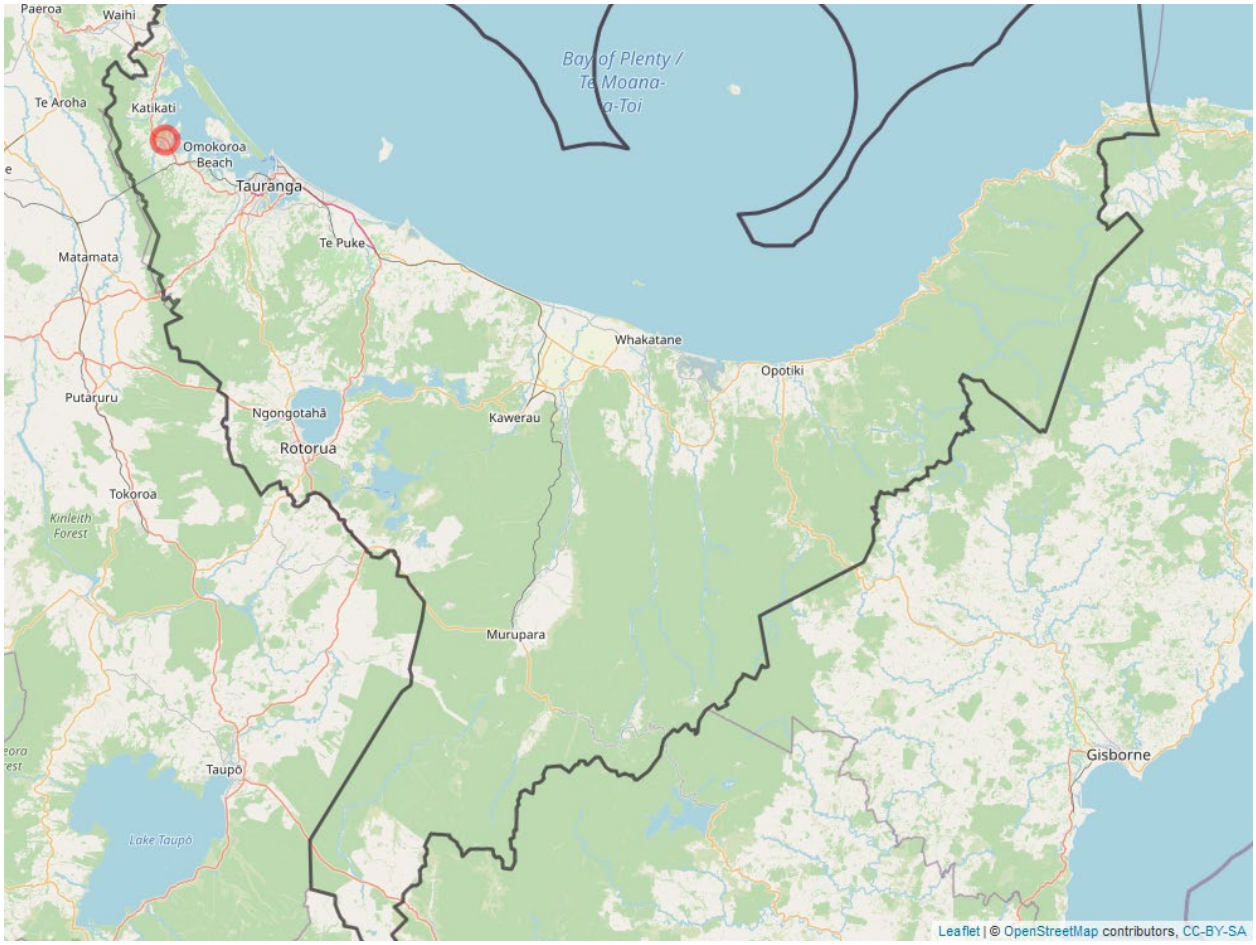


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2. Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	122	0.13	1.40	0.36	0.32	0.63	0.18	0.17	0.02
Nitrate Nitrite Nitrogen (g/m3)	122	0.02	1.34	0.28	0.23	0.61	0.09	0.18	0.02
Total Ammoniacal Nitrogen (g/m3)	131	<0.002	0.031	0.006	0.005	0.014	0.002	0.005	0.000
Total Phosphorus (g/m3)	131	<0.001	0.060	0.008	0.008	0.015	0.002	0.006	0.001
Dissolved Reactive Phosphorus (g/m3)	127	<0.001	0.021	0.004	0.003	0.008	0.001	0.003	0.000
Dissolved Oxygen Sat (%)	84	78.8	118.0	103.0	102.8	111.9	95.0	6.0	0.6
Dissolved Oxygen (g/m3)	125	7.22	13.10	10.27	10.30	11.37	9.21	0.77	0.07
Escherichia coli (cfu/100ml)	123	<1	7000	211	49	634	4	704	63
Total Suspended Solids (g/m3)	128	<1	135.00	2.53	0.80	5.20	0.10	12.04	1.06
Turbidity (NTU)	123	0.3	55.0	1.7	0.7	4.1	0.4	5.2	0.5
Water Clarity (m)	107	0.75	8.52	4.05	4.00	7.29	0.98	1.88	0.18
Conductivity (uS/cm)	129	33	976	67	59	72	49	82	7
pH (pH Units)	131	6.3	7.6	7.0	7.0	7.4	6.7	0.2	0.0
Water Temperature (degC)	129	8.1	24.8	16.1	15.6	22.6	11.0	3.8	0.3
Discharge (m3/s)	110	0.00	19.50	1.50	0.80	4.60	0.30	2.50	0.20

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

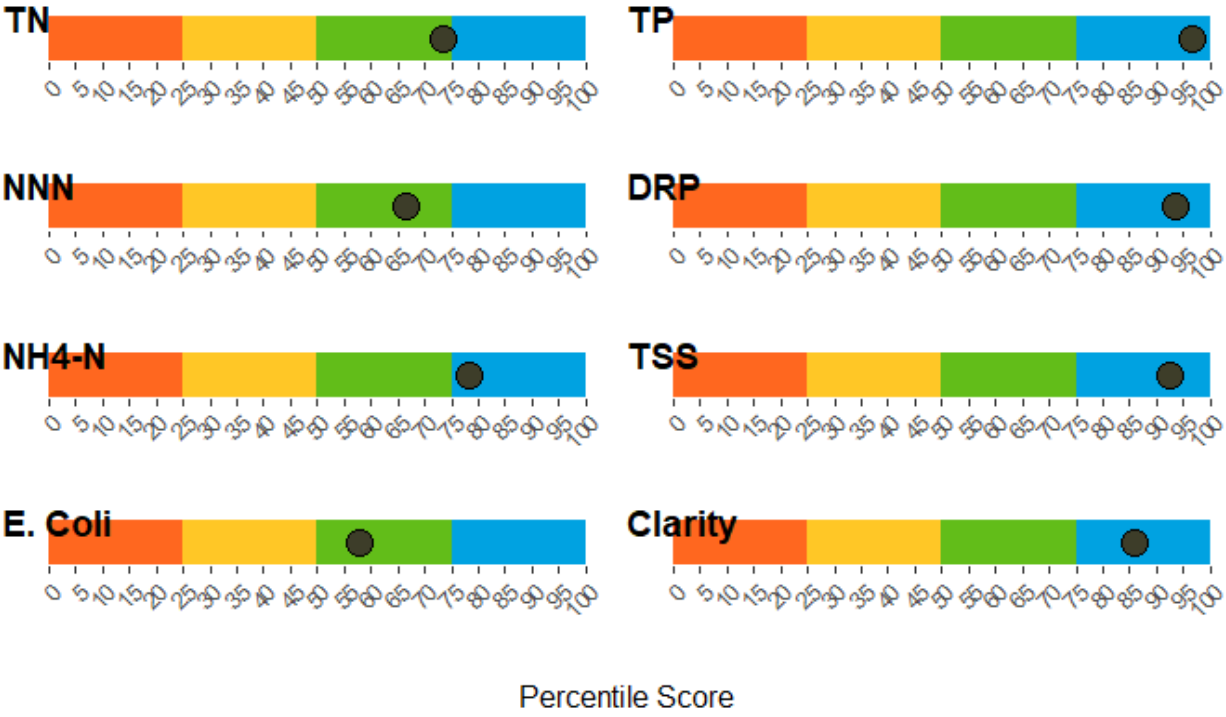


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

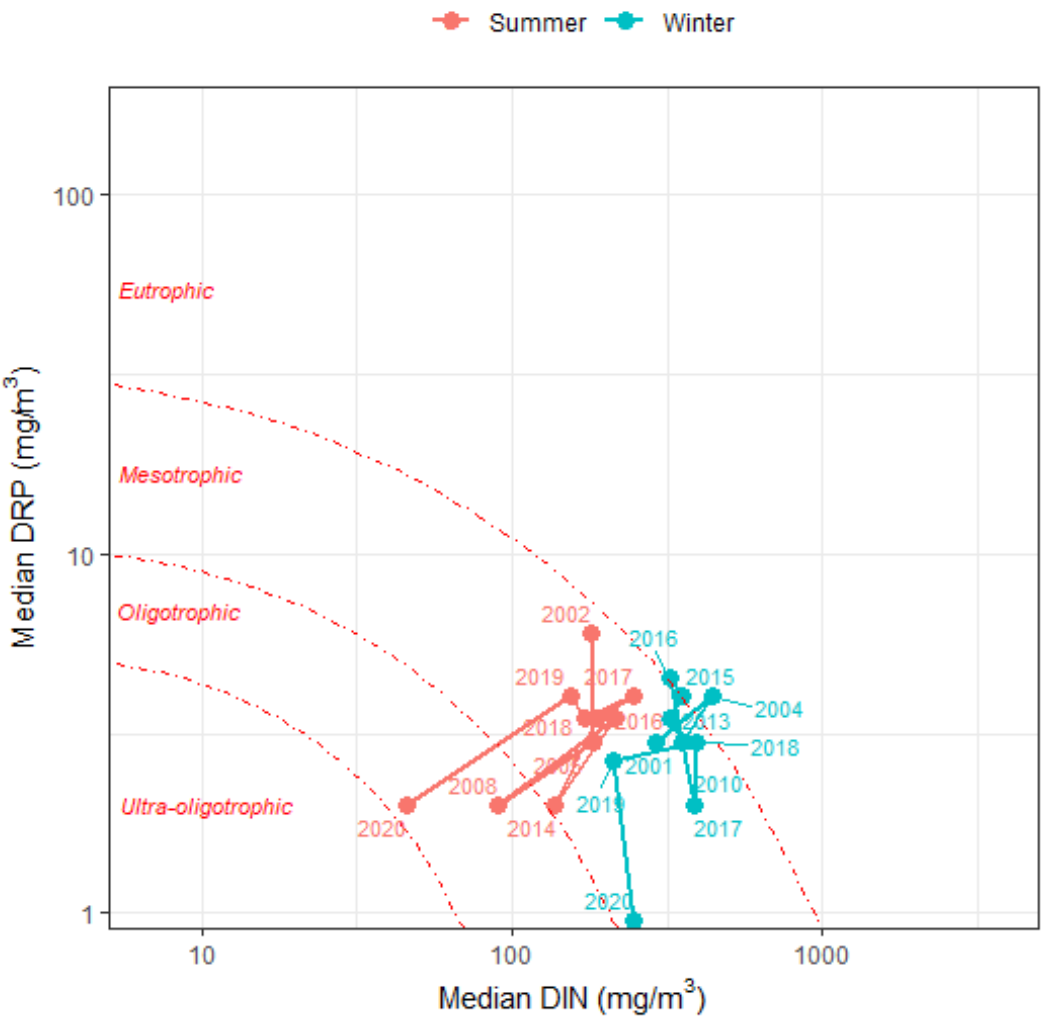


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	10	0.0030	0.006	A
5 Years	2015-12-11	2020-12-09	57	0.0020	0.006	A
10 Years	2010-12-12	2020-12-09	82	0.0020	0.019	A
All	1990-11-02	2020-12-09	131	0.0023	0.019	A

Table 4. Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	10	0.19	0.37	A
5 Years	2015-12-11	2020-12-09	57	0.21	0.63	A
10 Years	2010-12-12	2020-12-09	82	0.23	0.62	A
All	2001-07-24	2020-12-09	122	0.23	0.61	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	57	4.20	A*
10 Years	2010-12-12	2020-12-09	76	4.23	A
All	2001-07-24	2020-12-09	105	4.00	A

Table 6. Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	57	0.003	0.005	A
10 Years	2010-12-12	2020-12-09	82	0.003	0.005	A
All	1990-11-02	2020-12-09	126	0.003	0.008	A

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc 95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	57	7.0	17.5	50	624	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	57	50	723	82.5	10.5	7
10 Years	2010-12-12	2020-12-09	82	47	824	82.9	8.5	8.5
All	2001-07-24	2020-12-09	123	49	661	82.9	10.6	6.5

Time series plots

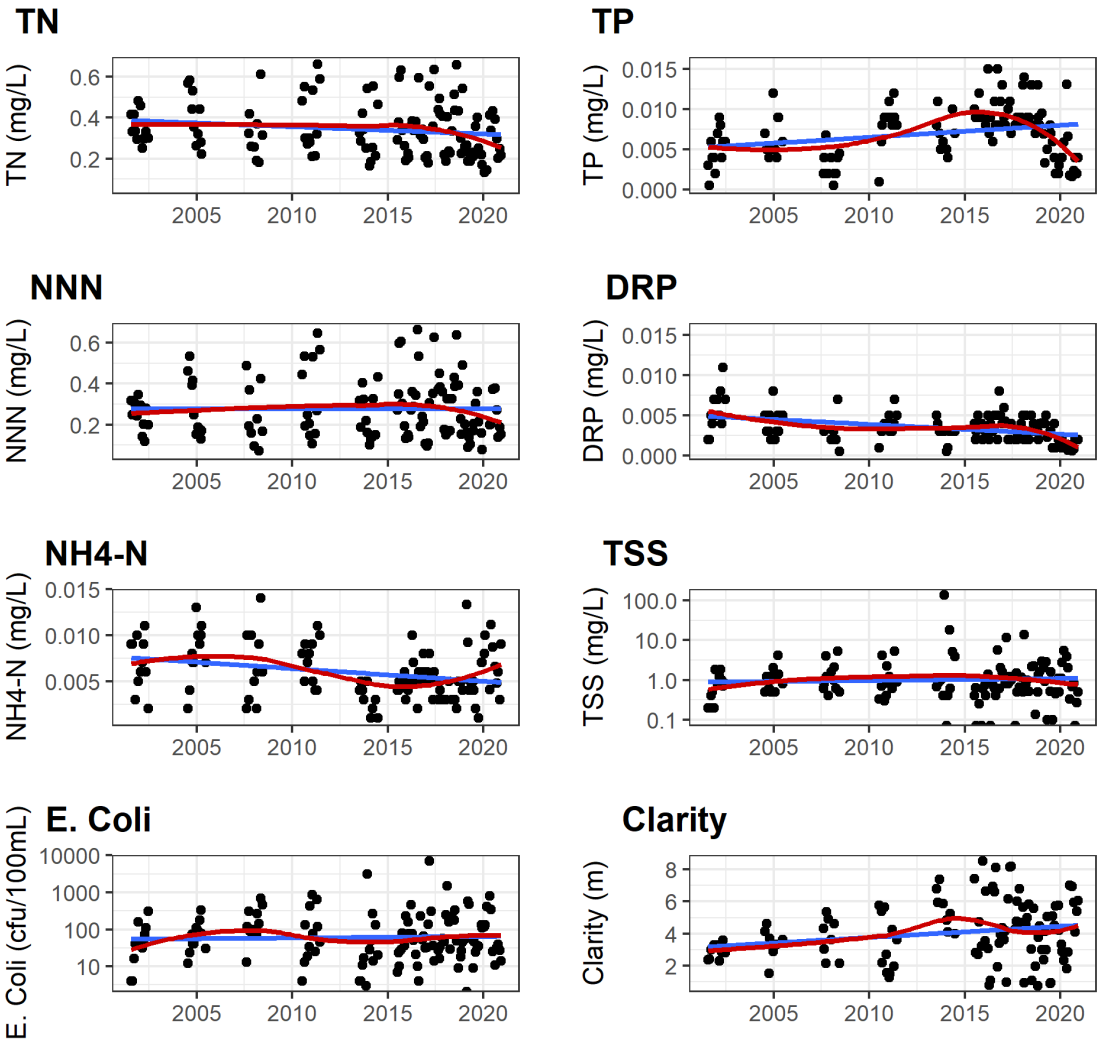


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-21	2020-12-09	-0.0103	-3.46	0.26	Indeterminant	YES	YES	Likely Improving
TN	10 Years	2011-01-19	2020-12-09	-0.0045	-1.47	0.45	Indeterminant	YES	YES	Likely Improving
TN	All	2001-07-24	2020-12-09	-0.0041	-1.31	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-21	2020-12-09	-0.0077	-3.71	0.15	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2011-01-19	2020-12-09	-0.0094	-4.22	0.19	Indeterminant	YES	YES	Likely Improving
NNN	All	2001-07-24	2020-12-09	-0.0014	-0.65	0.40	Indeterminant	YES	YES	Likely Improving
NH4N	5 Years	2016-01-21	2020-12-09	0.0000	-0.16	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	10 Years	2011-01-19	2020-12-09	-0.0001	-2.10	0.35	Indeterminant	YES	NO	Likely Improving
NH4N	All	2001-07-24	2020-12-09	-0.0002	-2.91	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-21	2020-12-09	-0.0013	-16.76	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-19	2020-12-09	-0.0007	-8.84	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	All	2001-07-24	2020-12-09	0.0001	0.76	0.32	Indeterminant	YES	NO	Likely Degrading
DRP	5 Years	2016-01-21	2020-12-09	-0.0005	-17.41	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-01-19	2020-12-09	-0.0002	-7.78	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	All	2001-07-24	2020-12-09	-0.0001	-3.57	<0.001	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2016-01-21	2020-12-09	-0.0189	-1.11	0.71	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-19	2020-12-09	0.0611	3.88	<0.05	Increasing	YES	YES	Very Likely Degrading
ECOLI	All	2001-07-24	2020-12-09	0.0044	0.27	0.46	Indeterminant	YES	YES	Likely Degrading
TSS	5 Years	2016-01-21	2020-12-09	-0.0113	-4.31	0.55	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-01-19	2020-12-09	0.0088	3.91	0.22	Indeterminant	YES	NO	Likely Degrading
TSS	All	2001-07-24	2020-12-09	-0.0026	-1.06	0.56	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2016-01-21	2020-12-09	0.1067	2.55	0.59	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2011-01-19	2020-12-09	-0.0491	-1.14	0.68	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	All	2001-07-24	2020-12-09	0.0662	1.68	0.07	Increasing	YES	NO	Very Likely Improving

Tuapiro at Hikurangi Road

March 2021

Table 1 Site metadata.

Aquarius ID:	BR809582	**Labstar ID:**	BOP710003
LAWA ID:	EBOP-00028	**REC Reach:**	4000160
Easting:	1858090	**Northing:**	5845826
Longitude:	175.91951	**Latitude:**	-37.49845
Elevation:	3 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

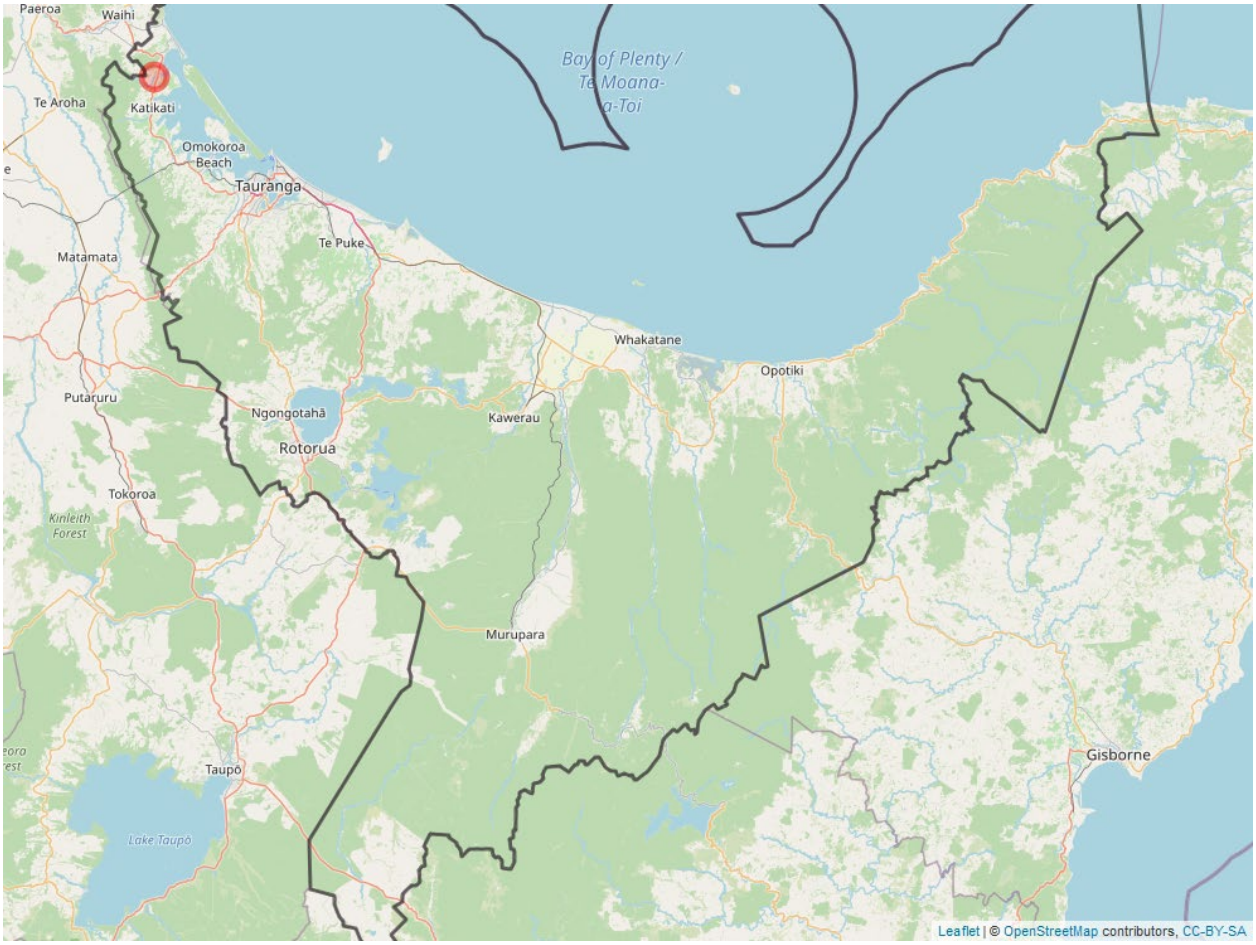


Figure 1. The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	116	0.05	0.64	0.18	0.15	0.37	0.07	0.11	0.01
Nitrate Nitrite Nitrogen (g/m3)	119	<0.001	0.50	0.09	0.07	0.24	0.00	0.09	0.01
Total Ammoniacal Nitrogen (g/m3)	127	<0.002	0.048	0.007	0.006	0.020	0.001	0.007	0.001
Total Phosphorus (g/m3)	126	<0.001	0.095	0.013	0.011	0.029	0.005	0.011	0.001
Dissolved Reactive Phosphorus (g/m3)	127	<0.001	0.032	0.006	0.006	0.013	0.002	0.004	0.000
Dissolved Oxygen Sat (%)	83	92.1	116.4	103.6	103.7	110.0	95.6	4.3	0.5
Dissolved Oxygen (g/m3)	124	8.00	12.80	10.39	10.38	11.83	8.74	0.94	0.08
Escherichia coli (cfu/100ml)	121	5	7200	318	110	800	12	902	82
Total Suspended Solids (g/m3)	126	<1	40.40	2.27	1.00	8.20	0.20	5.41	0.48
Turbidity (NTU)	121	0.3	31.0	1.8	0.9	4.0	0.5	3.5	0.3
Water Clarity (m)	113	0.38	10.20	4.22	3.88	7.88	1.02	2.11	0.20
Conductivity (uS/cm)	128	40	628	70	65	80	53	51	4
pH (pH Units)	127	6.4	7.6	7.2	7.2	7.6	6.8	0.2	0.0
Water Temperature (degC)	126	8.4	23.3	15.3	15.0	21.6	9.9	3.8	0.3
Discharge (m3/s)	107	0.20	13.30	1.30	0.90	3.60	0.40	1.50	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

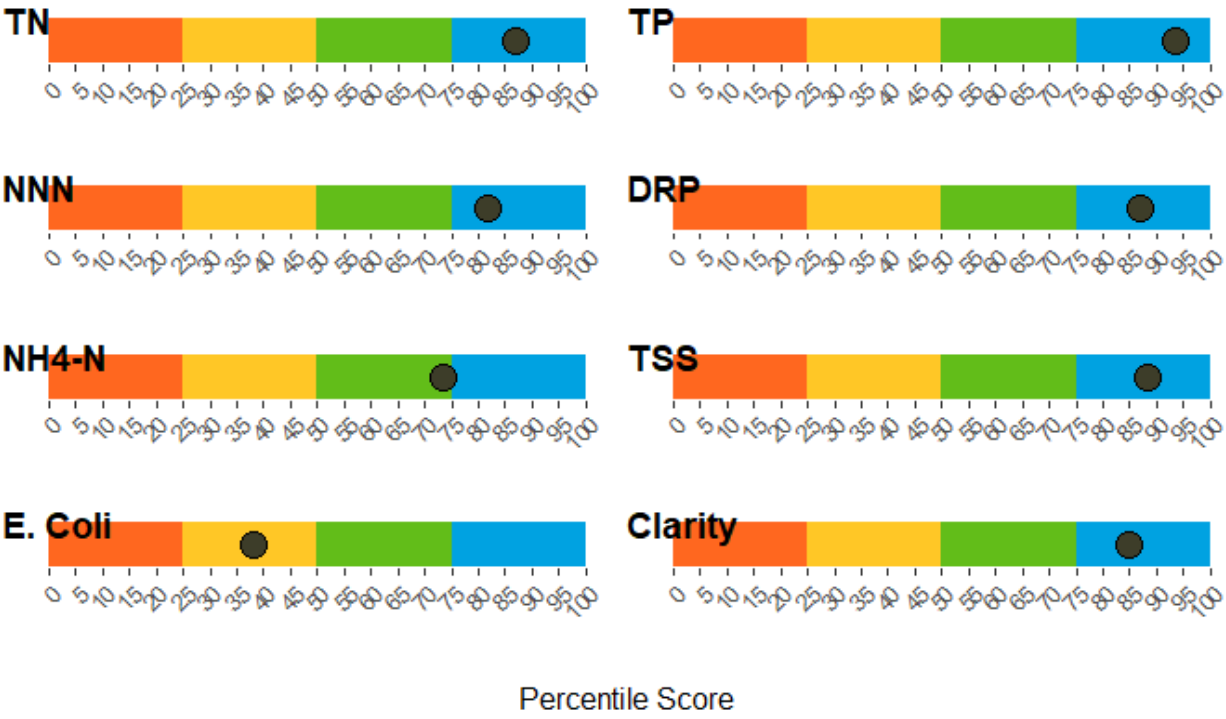


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

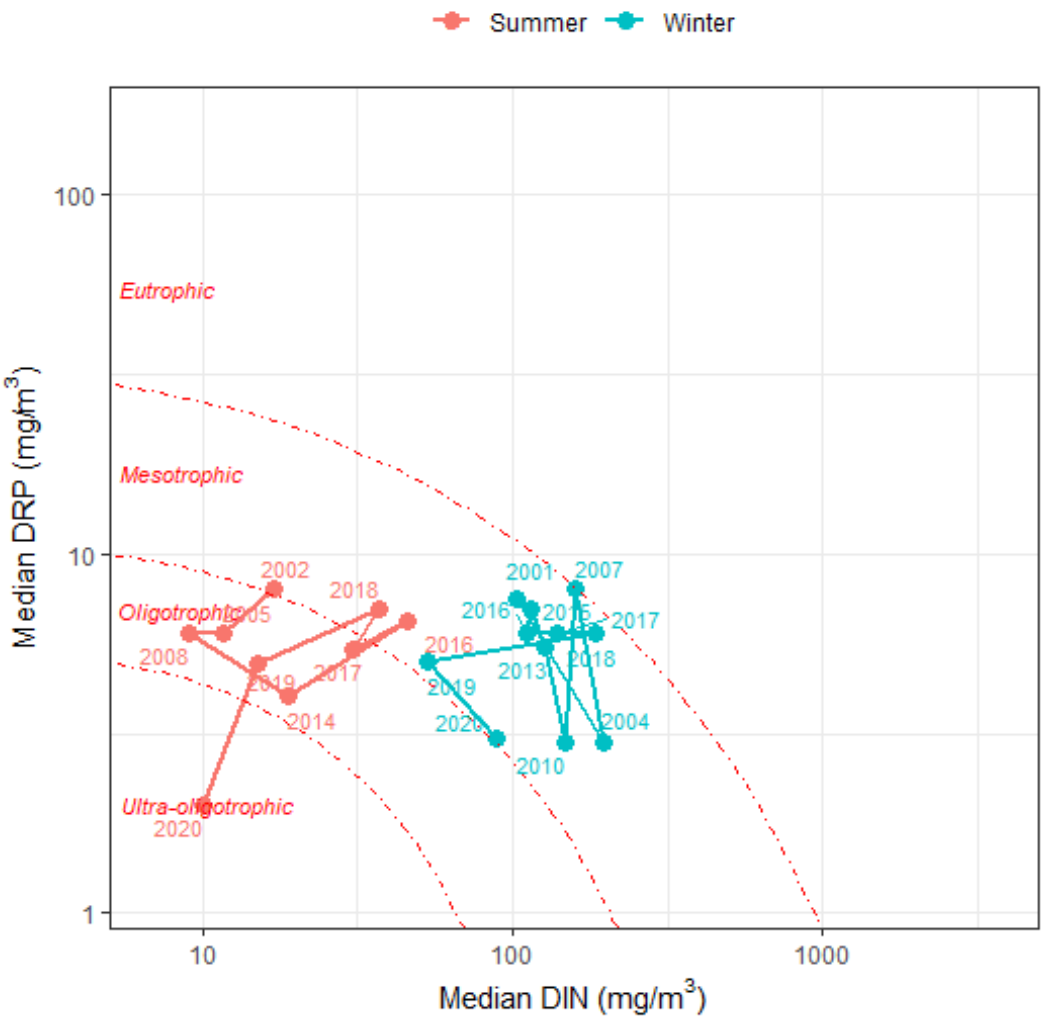


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	10	0.0020	0.005	A
5 Years	2015-12-11	2020-12-09	56	0.0020	0.013	A
10 Years	2010-12-12	2020-12-09	79	0.0020	0.023	A
All	1990-11-02	2020-12-09	126	0.0025	0.023	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	10	0.03	0.25	A
5 Years	2015-12-11	2020-12-09	57	0.05	0.24	A
10 Years	2010-12-12	2020-12-09	80	0.06	0.24	A
All	2001-08-17	2020-12-09	119	0.07	0.24	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	57	4.25	A*
10 Years	2010-12-12	2020-12-09	78	4.31	A
All	2001-07-24	2020-12-09	111	3.79	A

Table 6. Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	57	0.006	0.009	A
10 Years	2010-12-12	2020-12-09	80	0.006	0.009	A
All	1990-11-01	2020-12-09	126	0.006	0.013	A

Table 7. Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	57	15.8	26.3	132	860	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	57	132	995	73.7	10.5	15.8
10 Years	2010-12-12	2020-12-09	80	110	950	80	7.5	12.5
All	2001-07-24	2020-12-09	121	110	822	78.5	10.7	10.7

Time series plots

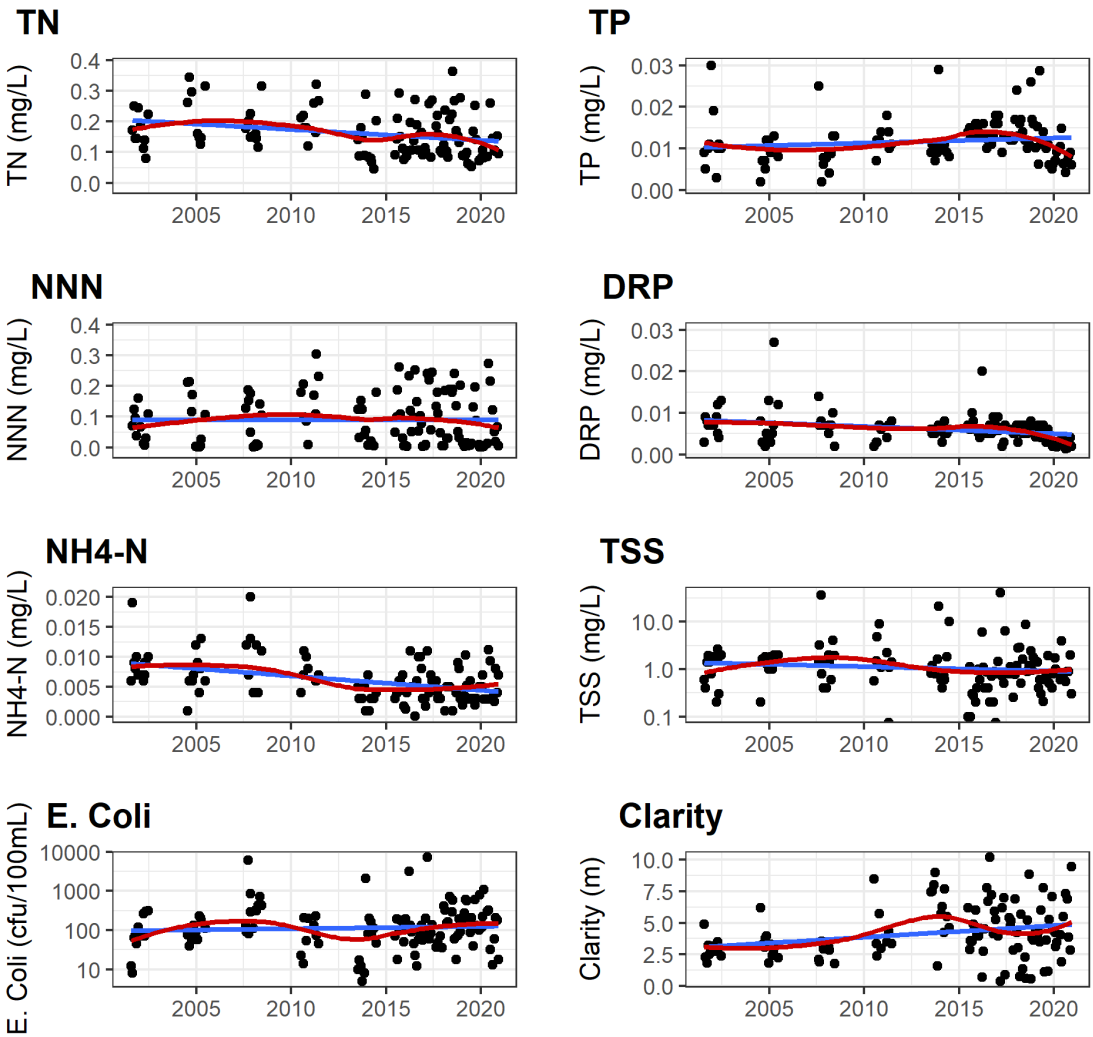


Figure 4. Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-20	2020-12-09	-0.0042	-3.81	0.19	Indeterminant	YES	NO	Likely Improving
TN	10 Years	2011-03-16	2020-12-09	-0.0008	-0.71	0.75	Indeterminant	YES	YES	Indeterminate/Uncertain
TN	All	2001-07-24	2020-12-09	-0.0023	-1.61	0.06	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-20	2020-12-09	-0.0036	-7.16	0.52	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2011-03-16	2020-12-09	-0.0032	-6.36	0.25	Indeterminant	YES	YES	Likely Improving
NNN	All	2001-07-24	2020-12-09	-0.0002	-0.42	0.79	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	5 Years	2016-01-20	2020-12-09	0.0002	4.27	0.60	Indeterminant	YES	NO	Likely Degrading
NH4N	10 Years	2011-03-16	2020-12-09	0.0000	0.00	0.50	Indeterminant	NO	NO	Likely Improving
NH4N	All	2001-07-24	2020-12-09	-0.0002	-3.87	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2016-01-20	2020-12-09	-0.0011	-9.54	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-03-16	2020-12-09	-0.0003	-2.71	0.10	Indeterminant	YES	NO	Likely Improving
TP	All	2001-07-24	2020-12-09	0.0000	0.07	0.95	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	5 Years	2016-01-20	2020-12-09	-0.0005	-8.85	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-03-16	2020-12-09	-0.0003	-4.76	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	2001-07-24	2020-12-09	-0.0002	-2.60	<0.001	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2016-01-20	2020-12-09	-0.0166	-0.78	0.63	Indeterminant	YES	YES	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-03-16	2020-12-09	0.0313	1.52	0.11	Indeterminant	YES	YES	Very Likely Degrading
ECOLI	All	2001-07-24	2020-12-09	0.0076	0.36	0.37	Indeterminant	YES	YES	Likely Degrading
TSS	5 Years	2016-01-20	2020-12-09	0.0028	1.09	0.84	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	10 Years	2011-03-16	2020-12-09	0.0081	3.17	0.30	Indeterminant	YES	NO	Likely Degrading
TSS	All	2001-07-24	2020-12-09	-0.0038	-1.36	0.26	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-20	2020-12-09	0.2109	4.93	0.30	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2011-03-16	2020-12-09	0.0333	0.77	0.73	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	All	2001-07-24	2020-12-09	0.0924	2.32	<0.01	Increasing	YES	NO	Very Likely Improving

Waiau at Waiau Road Ford

March 2021

Table 1 Site metadata.

Aquarius ID:	BS961133	**Labstar ID:**	BOP710040
LAWA ID:	EBOP-00030	**REC Reach:**	4000069
Easting:	1859615	**Northing:**	5851333
Longitude:	175.93480	**Latitude:**	-37.44845
Elevation:	4 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

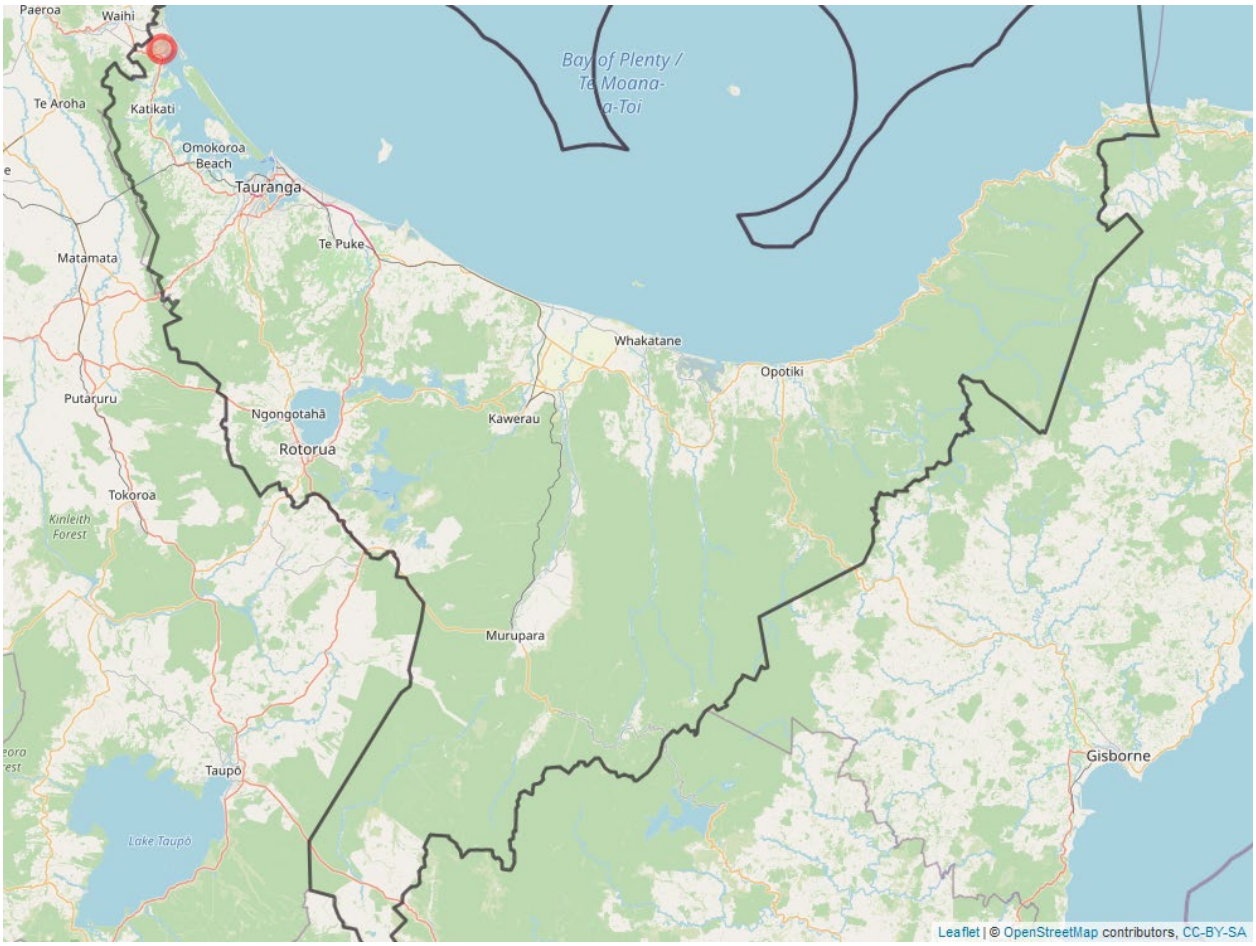


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	111	0.06	1.30	0.39	0.30	0.81	0.11	0.27	0.03
Nitrate Nitrite Nitrogen (g/m3)	111	<0.001	0.91	0.28	0.25	0.71	0.01	0.23	0.02
Total Ammoniacal Nitrogen (g/m3)	114	<0.002	0.079	0.011	0.008	0.028	0.003	0.010	0.001
Total Phosphorus (g/m3)	113	0.009	0.142	0.027	0.021	0.053	0.012	0.018	0.002
Dissolved Reactive Phosphorus (g/m3)	113	<0.001	0.027	0.012	0.012	0.021	0.005	0.005	0.001
Dissolved Oxygen Sat (%)	82	89.3	110.3	99.5	99.0	106.9	93.2	4.4	0.5
Dissolved Oxygen (g/m3)	111	8.20	12.00	9.94	9.90	11.41	8.54	0.87	0.08
Escherichia coli (cfu/100ml)	114	15	99990	1442	220	3105	33	9389	879
Total Suspended Solids (g/m3)	112	<1	111.60	5.87	2.35	21.98	0.76	13.32	1.26
Turbidity (NTU)	114	0.5	54.3	4.0	1.8	13.9	1.0	8.0	0.8
Water Clarity (m)	95	0.36	5.80	2.68	2.65	4.40	0.89	1.17	0.12
Conductivity (uS/cm)	114	60	280	88	86	100	72	20	2
pH (pH Units)	113	6.2	7.6	7.1	7.2	7.5	6.7	0.3	0.0
Water Temperature (degC)	113	9.3	22.7	15.5	15.4	20.7	10.6	3.2	0.3
Discharge (m3/s)	94	0.10	8.80	0.60	0.40	1.80	0.20	1.00	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

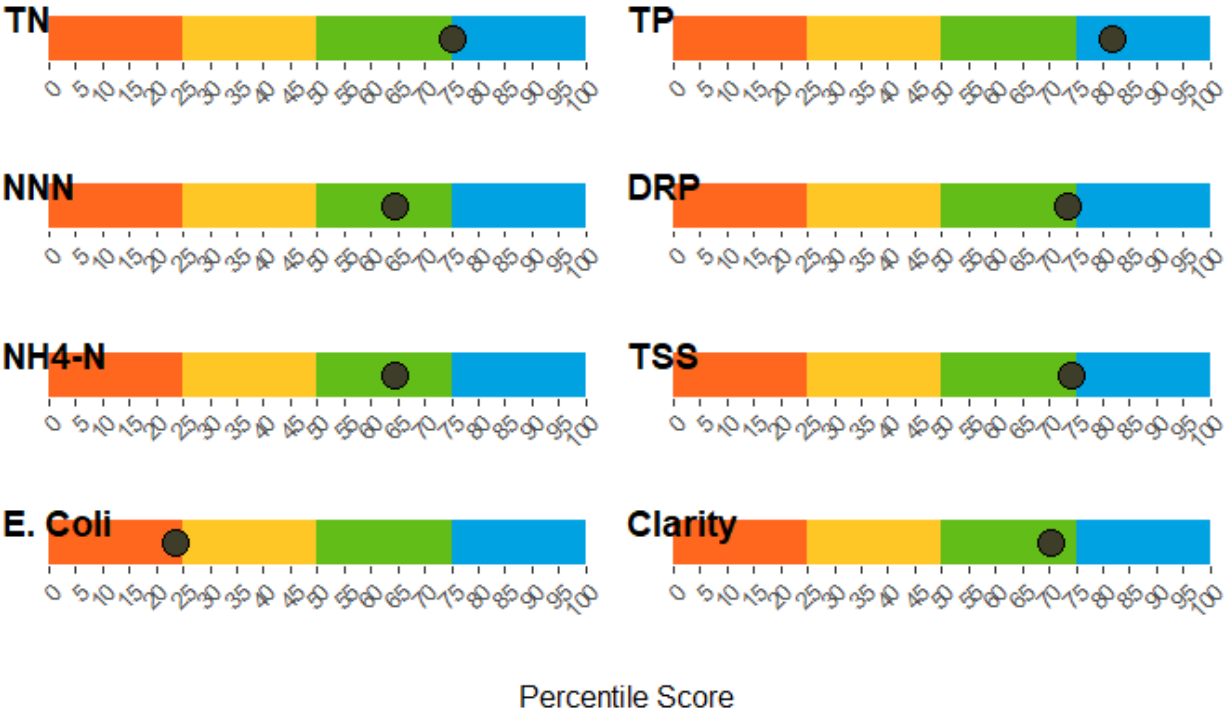


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

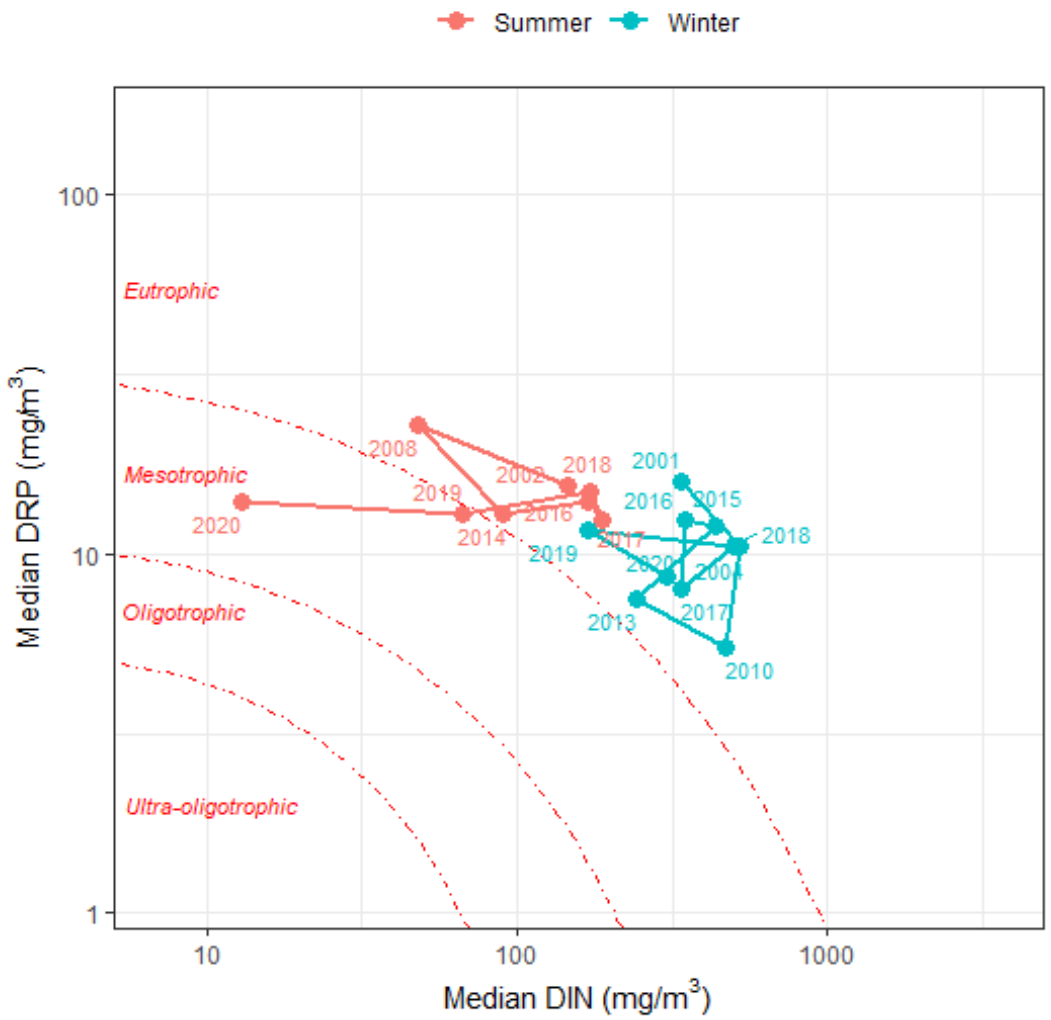


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	10	0.0040	0.033	A
5 Years	2015-12-11	2020-12-09	57	0.0030	0.033	A
10 Years	2010-12-12	2020-12-09	80	0.0030	0.033	A
All	2001-07-24	2020-12-09	113	0.0036	0.033	A

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	10	0.12	0.83	A
5 Years	2015-12-11	2020-12-09	57	0.25	0.74	A
10 Years	2010-12-12	2020-12-09	80	0.24	0.74	A
All	2001-07-24	2020-12-09	111	0.25	0.71	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	53	2.75	A*
10 Years	2010-12-12	2020-12-09	72	2.82	A
All	2001-07-24	2020-12-09	93	2.65	A

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	57	0.012	0.021	C
10 Years	2010-12-12	2020-12-09	80	0.011	0.021	C
All	2001-07-23	2020-12-09	112	0.012	0.021	C

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	57	28.1	54.4	330	4380	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	57	330	5010	45.6	26.3	26.3
10 Years	2010-12-12	2020-12-09	80	240	4100	53.8	23.8	21.2
All	2001-07-24	2020-12-09	114	220	3240	55.3	24.6	19.3

Time series plots

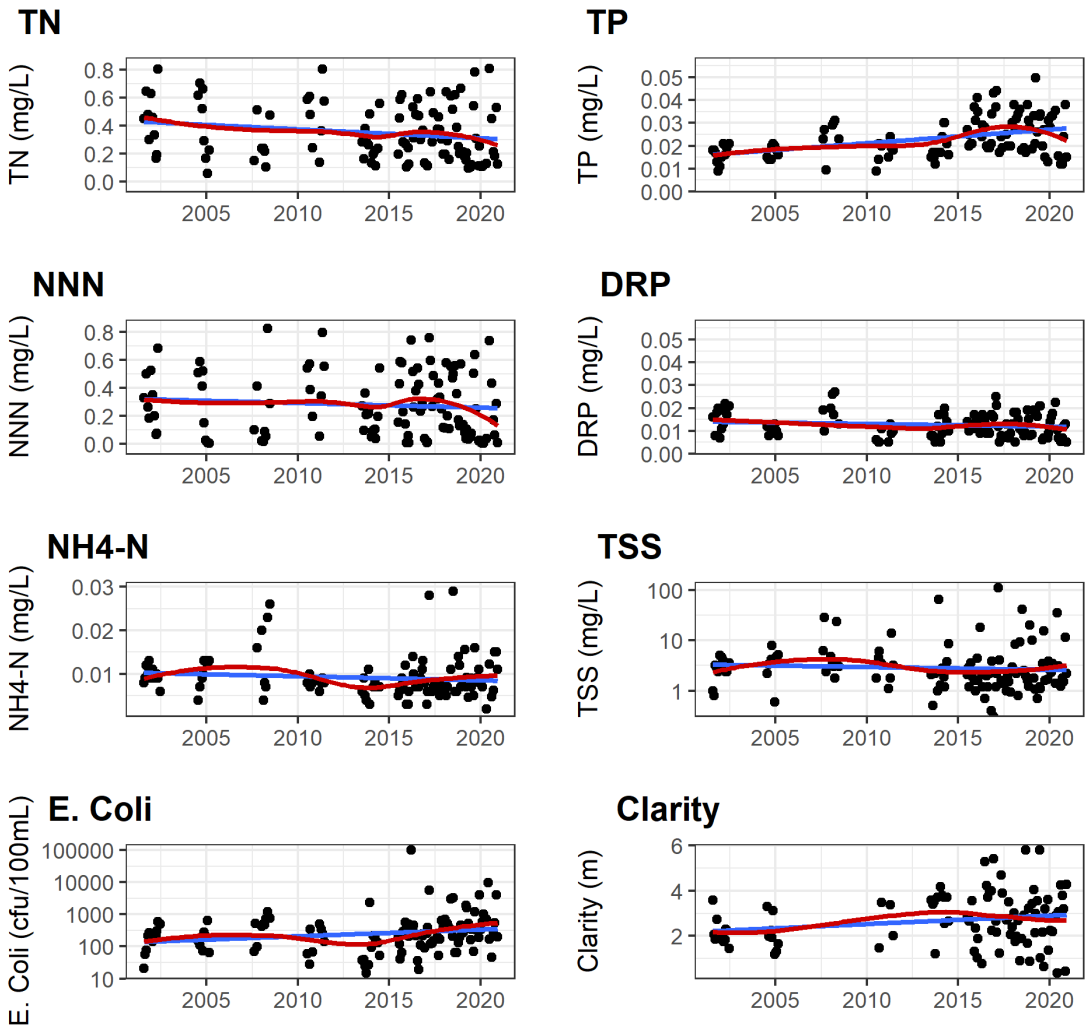


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-20	2020-12-09	0.0078	2.71	0.23	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2011-03-16	2020-12-09	0.0091	3.22	<0.05	Increasing	YES	YES	Very Likely Degrading
TN	All	2001-07-24	2020-12-09	-0.0016	-0.55	0.39	Indeterminant	YES	YES	Likely Improving
NNN	5 Years	2016-01-20	2020-12-09	0.0040	1.81	0.63	Indeterminant	YES	YES	Likely Degrading
NNN	10 Years	2011-03-16	2020-12-09	0.0061	2.90	0.20	Indeterminant	YES	YES	Likely Degrading
NNN	All	2001-07-24	2020-12-09	-0.0003	-0.13	0.83	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	5 Years	2016-01-20	2020-12-09	0.0009	13.15	0.05	Increasing	YES	NO	Very Likely Degrading
NH4N	10 Years	2011-03-16	2020-12-09	0.0004	5.62	0.09	Increasing	YES	NO	Very Likely Degrading
NH4N	All	2001-07-24	2020-12-09	0.0000	-0.48	0.65	Indeterminant	YES	NO	Likely Improving
TP	5 Years	2016-01-20	2020-12-09	-0.0011	-4.00	0.25	Indeterminant	YES	NO	Likely Improving
TP	10 Years	2011-03-16	2020-12-09	-0.0002	-0.79	0.59	Indeterminant	YES	YES	Likely Improving
TP	All	2001-07-24	2020-12-09	0.0005	2.33	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-20	2020-12-09	-0.0009	-7.01	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-03-16	2020-12-09	-0.0003	-2.21	0.25	Indeterminant	YES	NO	Likely Improving
DRP	All	2001-07-24	2020-12-09	-0.0002	-1.57	0.05	Decreasing	YES	YES	Very Likely Improving
ECOLI	5 Years	2016-01-20	2020-12-09	0.0636	2.54	0.10	Indeterminant	YES	NO	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-03-16	2020-12-09	0.0789	3.31	<0.001	Increasing	YES	YES	Very Likely Degrading
ECOLI	All	2001-07-24	2020-12-09	0.0195	0.83	<0.05	Increasing	YES	YES	Very Likely Degrading
TSS	5 Years	2016-01-20	2020-12-09	0.0510	11.41	<0.01	Increasing	YES	NO	Very Likely Degrading
TSS	10 Years	2011-03-16	2020-12-09	0.0188	4.07	<0.05	Increasing	YES	NO	Very Likely Degrading
TSS	All	2001-07-24	2020-12-09	-0.0055	-1.09	0.13	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-20	2020-12-09	0.0035	0.13	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2011-03-16	2020-12-09	-0.0088	-0.31	0.88	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	All	2001-07-24	2020-12-09	0.0356	1.32	0.06	Increasing	YES	NO	Very Likely Improving

Ngamuwahine at Old Bridge

March 2021

Table 1 Site metadata.

Aquarius ID:	CO543022	**Labstar ID:**	BOP110035
LAWA ID:	EBOP-00009	**REC Reach:**	4002930
Easting:	1865432	**Northing:**	5810228
Longitude:	176.01540	**Latitude:**	-37.81678
Elevation:	135 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Hill_VA		

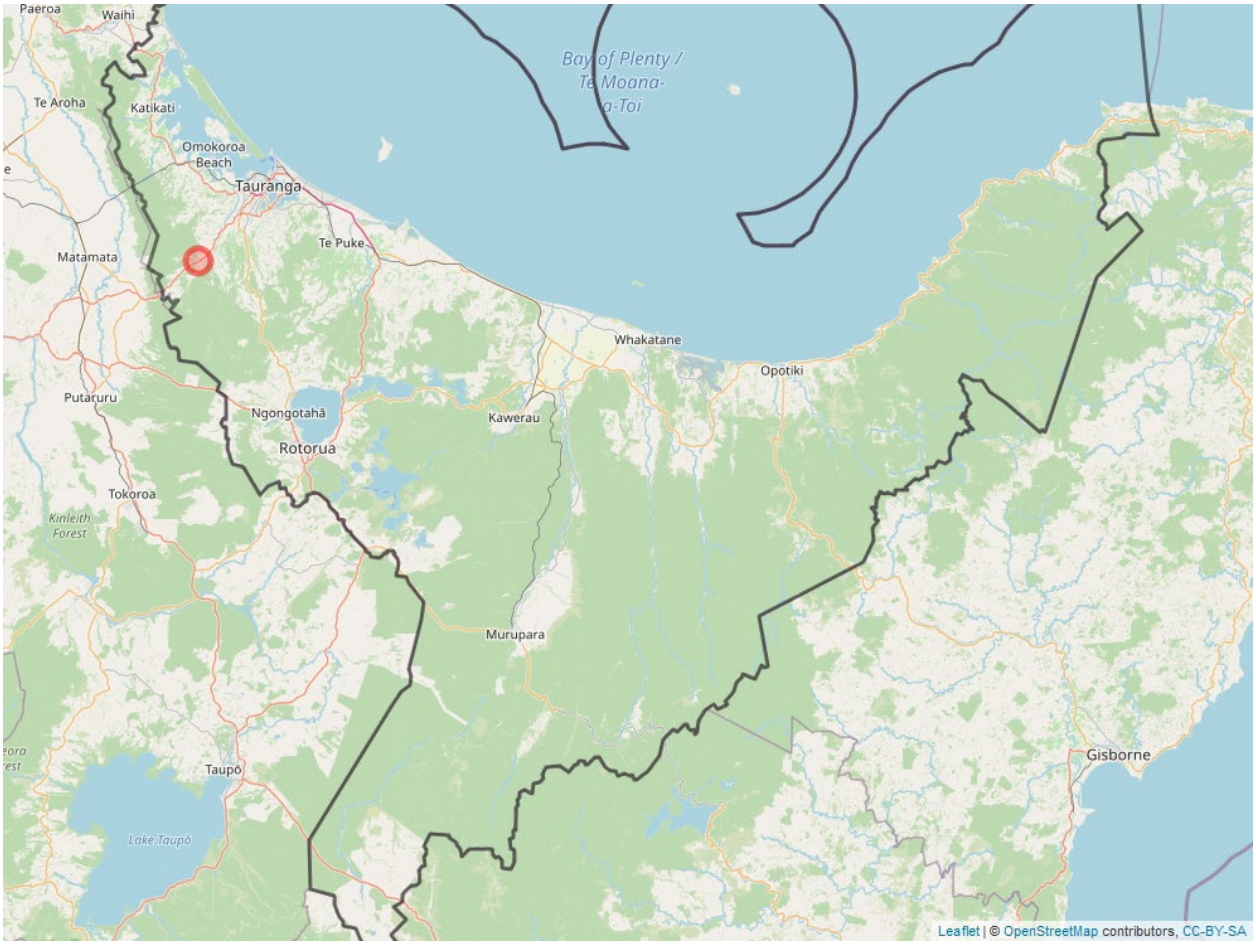


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	163	0.06	5.09	0.31	0.27	0.51	0.14	0.40	0.03
Nitrate Nitrite Nitrogen (g/m3)	163	<0.001	1.24	0.18	0.19	0.31	0.04	0.12	0.01
Total Ammoniacal Nitrogen (g/m3)	178	<0.002	0.044	0.006	0.005	0.012	0.001	0.005	0.000
Total Phosphorus (g/m3)	177	0.002	0.040	0.012	0.011	0.023	0.003	0.006	0.000
Dissolved Reactive Phosphorus (g/m3)	174	<0.001	0.016	0.006	0.005	0.012	0.002	0.003	0.000
Dissolved Oxygen Sat (%)	120	86.2	125.0	103.3	102.6	109.6	98.0	4.5	0.4
Dissolved Oxygen (g/m3)	173	7.20	12.60	10.52	10.48	11.94	9.21	0.91	0.07
Escherichia coli (cfu/100ml)	174	<1	10000	368	45	1835	6	1219	92
Total Suspended Solids (g/m3)	176	<1	66.56	2.22	1.20	5.93	0.30	5.40	0.41
Turbidity (NTU)	178	0.2	4.8	1.0	0.8	2.8	0.4	0.8	0.1
Water Clarity (m)	155	0.82	10.82	3.40	3.32	5.92	1.28	1.42	0.11
Conductivity (uS/cm)	178	29	66	45	45	57	34	7	1
pH (pH Units)	178	6.0	8.1	7.2	7.2	7.7	6.7	0.3	0.0
Water Temperature (degC)	175	5.7	22.5	13.8	13.3	19.8	8.8	3.6	0.3
Discharge (m3/s)	95	0.30	12.50	1.70	1.10	5.30	0.40	2.00	0.20

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

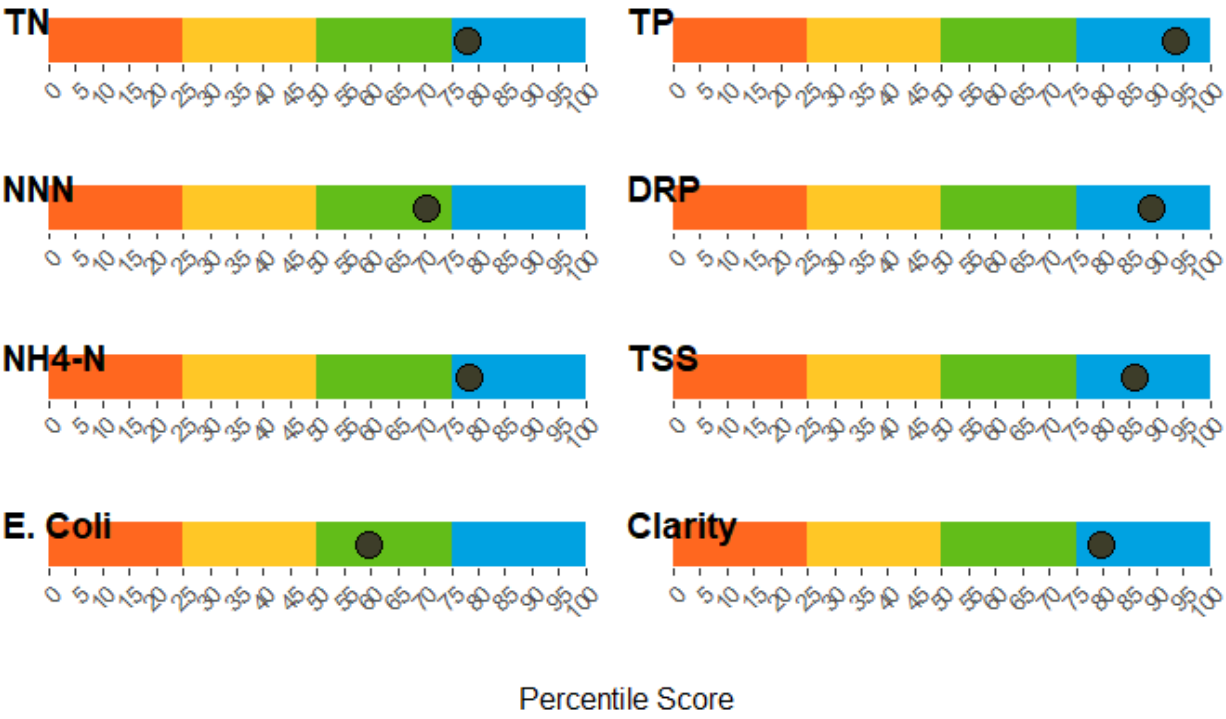


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

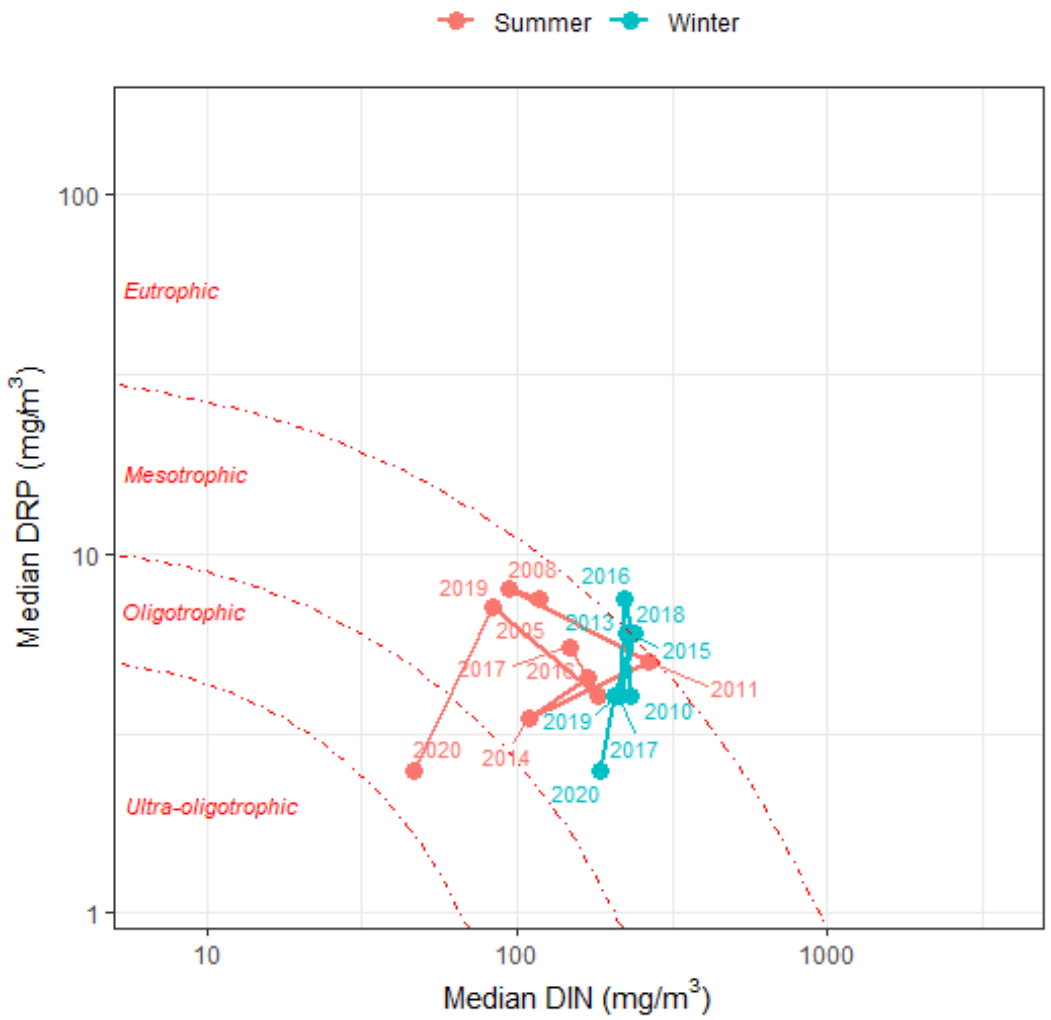


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	21	0.0030	0.008	A
5 Years	2015-12-12	2020-12-10	95	0.0020	0.008	A
10 Years	2010-12-13	2020-12-10	119	0.0020	0.008	A
All	1991-03-04	2020-12-10	178	0.0024	0.026	A

Table 4. Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	21	0.12	0.28	A
5 Years	2015-12-12	2020-12-10	94	0.17	0.28	A
10 Years	2010-12-13	2020-12-10	118	0.19	0.31	A
All	1993-06-29	2020-12-10	163	0.19	0.31	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-12	2020-12-10	85	3.40	A
10 Years	2010-12-13	2020-12-10	108	3.40	A
All	1992-09-09	2020-12-10	154	3.32	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-12	2020-12-10	95	0.004	0.010	A
10 Years	2010-12-13	2020-12-10	119	0.004	0.010	A
All	1991-03-04	2020-12-10	173	0.005	0.012	A

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	95	14.7	20.0	39	2200	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	95	39	2200	80	5.3	14.7
10 Years	2010-12-13	2020-12-10	119	40	2155	79.8	5.9	14.3
All	1991-03-04	2020-12-10	174	45	1880	82.2	5.7	12.1

Time series plots

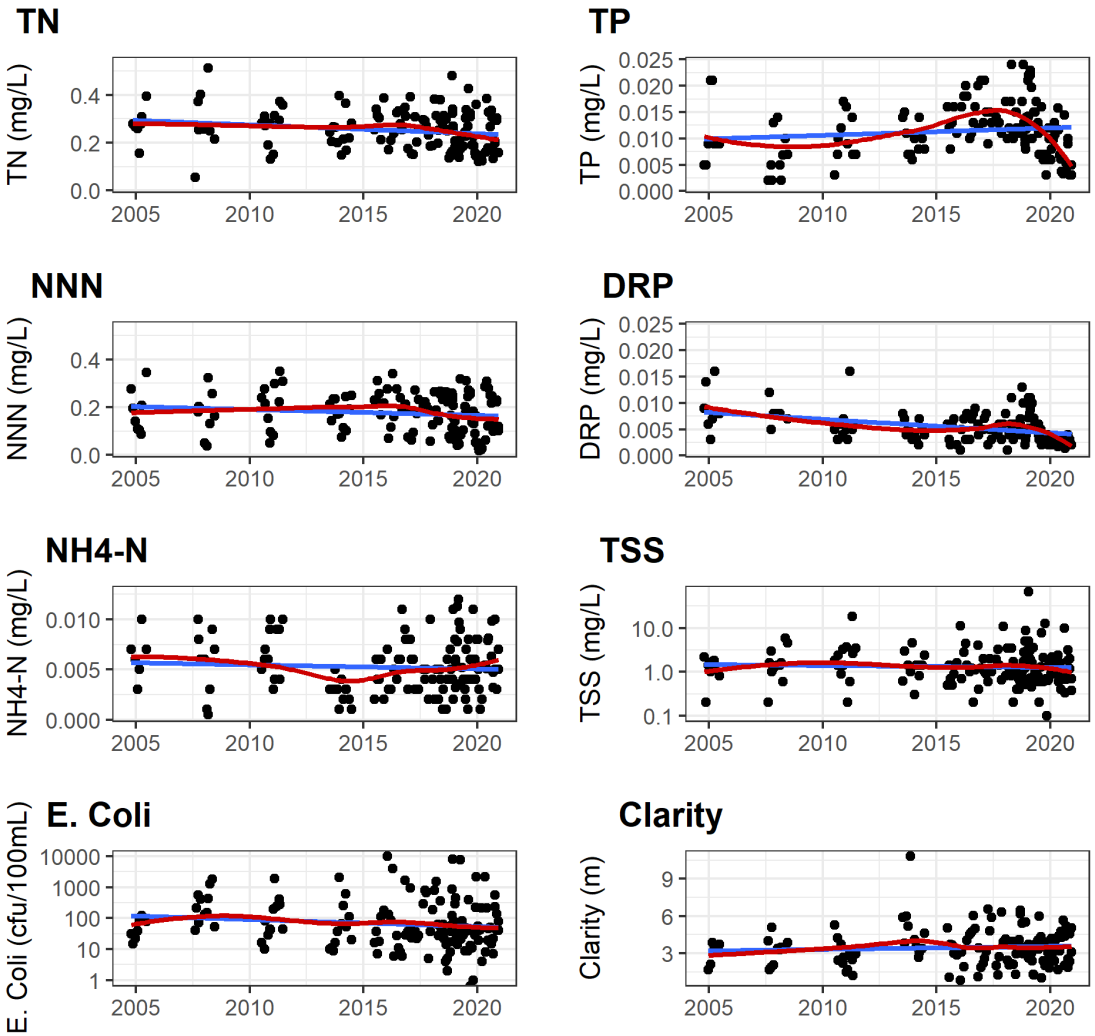


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-20	2020-12-10	0.0007	0.27	0.93	Indeterminant	YES	NO	Indeterminate/Uncertain
TN	10 Years	2011-01-18	2020-12-10	0.0066	2.53	0.08	Increasing	YES	NO	Very Likely Degrading
TN	All	2004-11-10	2020-12-10	0.0054	2.09	<0.05	Increasing	YES	NO	Very Likely Degrading
NNN	5 Years	2016-01-20	2020-12-10	-0.0170	-9.89	<0.05	Decreasing	Attempted	YES	Very Likely Improving
NNN	10 Years	2011-01-18	2020-12-10	-0.0108	-5.72	<0.01	Decreasing	Attempted	YES	Very Likely Improving
NNN	All	2004-11-10	2020-12-10	0.0006	0.31	0.72	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	5 Years	2016-01-20	2020-12-10	-0.0003	-5.33	0.38	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-01-18	2020-12-10	0.0002	3.52	0.22	Indeterminant	YES	NO	Likely Degrading
NH4N	All	2004-11-10	2020-12-10	0.0000	0.50	0.77	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	5 Years	2016-01-20	2020-12-10	-0.0010	-7.93	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-18	2020-12-10	-0.0001	-0.55	0.82	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	2004-11-10	2020-12-10	0.0002	1.84	0.26	Indeterminant	YES	NO	Likely Degrading
DRP	5 Years	2016-01-20	2020-12-10	-0.0007	-16.40	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-10	-0.0003	-5.33	0.05	Decreasing	YES	NO	Very Likely Improving
DRP	All	2004-11-10	2020-12-10	-0.0002	-3.53	<0.05	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-20	2020-12-10	0.0785	5.31	0.45	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-10	-0.0250	-1.55	0.50	Indeterminant	Attempted	YES	Likely Improving
ECOLI	All	2004-11-10	2020-12-10	0.0290	1.82	0.31	Indeterminant	YES	YES	Likely Degrading
TSS	5 Years	2016-01-20	2020-12-10	0.0018	0.53	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	10 Years	2011-01-18	2020-12-10	0.0155	4.68	0.24	Indeterminant	YES	NO	Likely Degrading
TSS	All	2004-11-10	2020-12-10	0.0106	2.79	0.21	Indeterminant	YES	NO	Likely Degrading
CLARITY	5 Years	2016-01-20	2020-12-10	-0.1916	-5.60	0.33	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2011-01-18	2020-12-10	-0.1535	-4.21	0.16	Indeterminant	YES	NO	Very Likely Degrading
CLARITY	All	2004-11-10	2020-12-10	-0.0674	-1.97	0.22	Indeterminant	YES	NO	Likely Degrading

Wairoa d/s Ruahihi Power Station

March 2021

Table 1 Site metadata.

Aquarius ID:	CO938527	**Labstar ID:**	BOP110088
LAWA ID:	EBOP-00036	**REC Reach:**	4002072
Easting:	1869387	**Northing:**	5815277
Longitude:	176.05840	**Latitude:**	-37.77018
Elevation:	0 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	No
REC Class:	WW_Hill_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	182	0.13	2.91	0.50	0.46	0.67	0.33	0.24	0.02
Nitrate Nitrite Nitrogen (g/m3)	184	0.03	2.78	0.36	0.35	0.45	0.22	0.21	0.02
Total Ammoniacal Nitrogen (g/m3)	193	<0.002	0.040	0.011	0.010	0.022	0.005	0.005	0.000
Total Phosphorus (g/m3)	194	0.004	0.104	0.019	0.016	0.034	0.009	0.012	0.001
Dissolved Reactive Phosphorus (g/m3)	186	<0.001	0.063	0.013	0.012	0.021	0.005	0.006	0.000
Dissolved Oxygen Sat (%)	66	85.9	117.8	103.1	103.2	113.7	94.7	6.2	0.8
Dissolved Oxygen (g/m3)	190	7.20	13.60	10.38	10.25	11.78	9.20	0.89	0.06
Escherichia coli (cfu/100ml)	188	<1	7000	348	73	1730	12	900	66
Total Suspended Solids (g/m3)	193	<1	86.00	3.77	2.00	9.04	0.80	8.28	0.60
Turbidity (NTU)	193	0.5	35.0	1.9	1.3	4.9	0.7	2.9	0.2
Water Clarity (m)	155	0.25	6.84	2.70	2.67	4.23	1.08	1.01	0.08
Conductivity (uS/cm)	195	38	96	52	52	59	41	7	0
pH (pH Units)	195	6.2	7.6	7.0	7.0	7.3	6.7	0.2	0.0
Water Temperature (degC)	194	7.2	20.2	13.7	13.7	17.9	9.6	2.8	0.2
Discharge (m3/s)	191	0.40	101.80	19.60	19.00	34.50	8.70	12.60	0.90

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

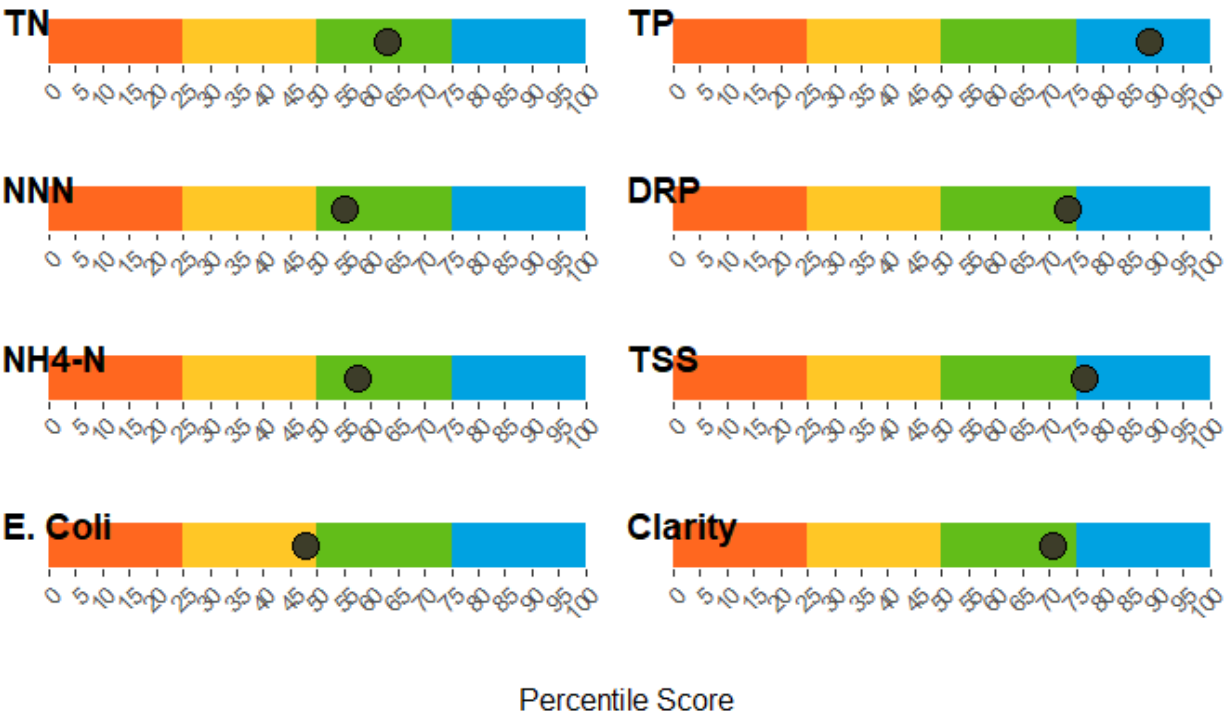


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

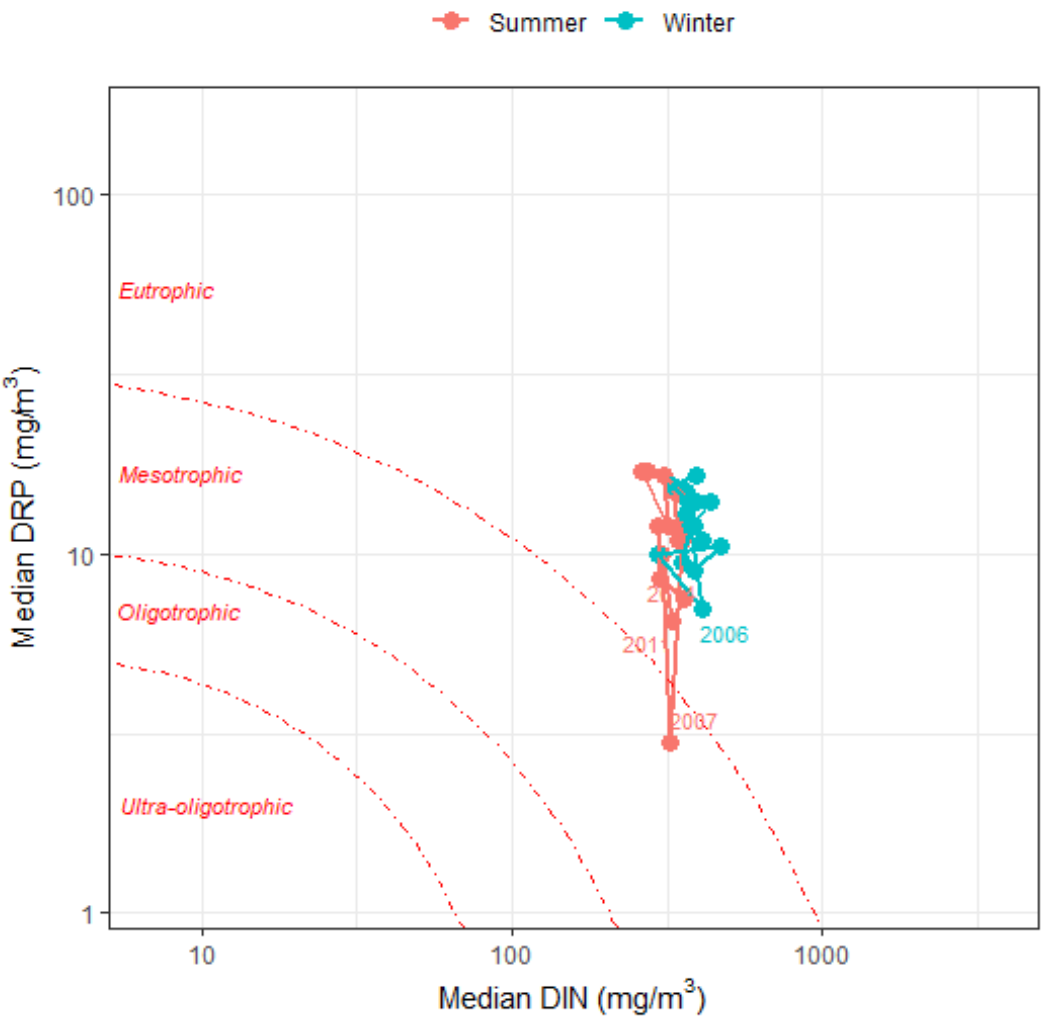


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2018-04-03	2019-04-03	13	0.0040	0.010	A
5 Years	2014-04-04	2019-04-03	46	0.0040	0.010	A
10 Years	2009-04-05	2019-04-03	68	0.0040	0.010	A
All	1993-09-15	2019-04-03	193	0.0041	0.017	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2018-04-03	2019-04-03	13	0.36	0.48	A
5 Years	2014-04-04	2019-04-03	47	0.36	0.46	A
10 Years	2009-04-05	2019-04-03	69	0.36	0.46	A
All	1993-09-15	2019-04-03	184	0.35	0.45	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2014-04-03	2019-04-03	45	2.42	A*
10 Years	2009-04-05	2019-04-03	62	2.55	A
All	1993-09-15	2019-04-03	155	2.67	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2014-04-03	2019-04-02	46	0.012	0.016	C
10 Years	2009-04-04	2019-04-02	68	0.012	0.016	C
All	1993-09-15	2019-04-02	185	0.012	0.021	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2014-04-04	2019-04-03	47	17.0	27.7	51	1810	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2014-04-04	2019-04-03	47	51	2100	72.3	10.6	17
10 Years	2009-04-05	2019-04-03	69	52	1935	72.5	11.6	15.9
All	1993-09-15	2019-04-03	188	73	1810	76.1	10.6	12.8

Time series plots

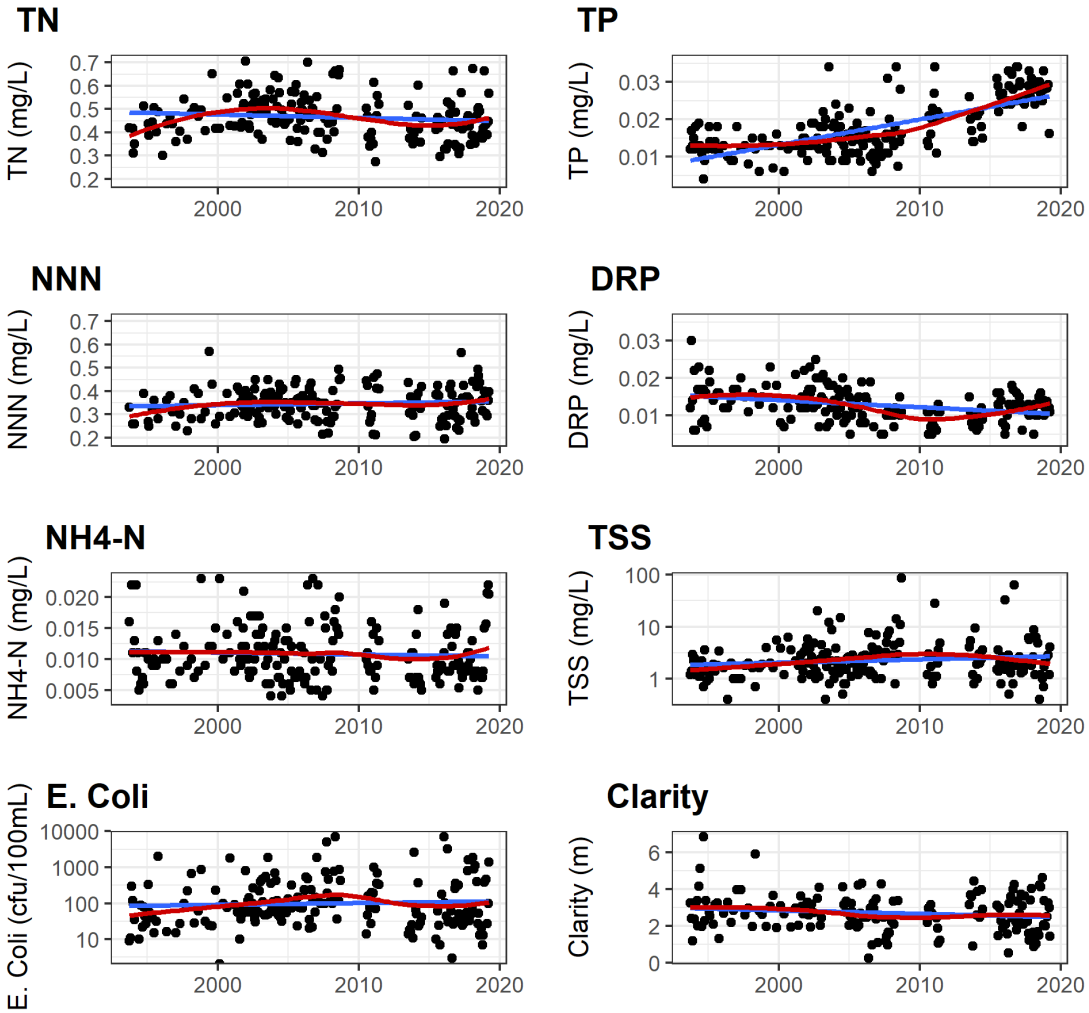


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2014-05-15	2019-04-03	0.0117	2.70	0.21	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2010-07-13	2019-04-03	0.0034	0.80	0.30	Indeterminant	YES	NO	Likely Degrading
TN	All	1993-10-26	2019-04-03	-0.0017	-0.38	0.06	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2014-05-15	2019-04-03	0.0153	4.26	<0.01	Increasing	YES	YES	Very Likely Degrading
NNN	10 Years	2010-07-13	2019-04-03	0.0080	2.23	<0.01	Increasing	YES	YES	Very Likely Degrading
NNN	All	1993-10-26	2019-04-03	0.0008	0.23	0.17	Indeterminant	YES	YES	Very Likely Degrading
NH4N	5 Years	2014-05-15	2019-04-03	0.0005	5.38	0.34	Indeterminant	YES	NO	Likely Degrading
NH4N	10 Years	2010-07-13	2019-04-03	0.0001	0.66	0.71	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	All	1993-10-26	2019-04-03	0.0000	-0.46	0.27	Indeterminant	YES	NO	Likely Improving
TP	5 Years	2014-05-15	2019-04-03	0.0014	5.10	<0.05	Increasing	YES	NO	Very Likely Degrading
TP	10 Years	2010-07-13	2019-04-03	0.0014	5.30	<0.001	Increasing	YES	NO	Very Likely Degrading
TP	All	1993-10-26	2019-04-03	0.0006	3.68	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2014-05-15	2019-04-03	0.0002	1.33	0.63	Indeterminant	YES	NO	Likely Degrading
DRP	10 Years	2010-07-13	2019-04-03	0.0006	4.96	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	All	1993-10-26	2019-04-03	-0.0002	-1.38	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2014-05-15	2019-04-03	0.0317	1.85	0.73	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-07-13	2019-04-03	0.0183	1.06	0.44	Indeterminant	YES	NO	Likely Degrading
ECOLI	All	1993-10-26	2019-04-03	-0.0001	0.00	0.99	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	5 Years	2014-05-15	2019-04-03	-0.0029	-0.61	0.83	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	10 Years	2010-07-13	2019-04-03	-0.0036	-0.75	0.71	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	1993-10-26	2019-04-03	0.0018	0.38	0.22	Indeterminant	YES	NO	Likely Degrading
CLARITY	5 Years	2014-05-15	2019-04-03	0.0790	3.27	0.67	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2010-07-13	2019-04-03	-0.0249	-0.98	0.63	Indeterminant	YES	NO	Likely Degrading
CLARITY	All	1993-10-26	2019-04-03	-0.0088	-0.33	0.33	Indeterminant	YES	NO	Likely Degrading

Waipapa at Old Highway

March 2021

Table 1 Site metadata.

Aquarius ID:	CP466747	**Labstar ID:**	BOP710011
LAWA ID:	EBOP-00035	**REC Reach:**	4000795
Easting:	1864663	**Northing:**	5827478
Longitude:	176.00040	**Latitude:**	-37.66174
Elevation:	9 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	119	0.10	1.08	0.59	0.56	0.93	0.27	0.21	0.02
Nitrate Nitrite Nitrogen (g/m3)	120	<0.001	1.10	0.50	0.49	0.90	0.20	0.22	0.02
Total Ammoniacal Nitrogen (g/m3)	130	<0.002	0.070	0.012	0.010	0.021	0.005	0.009	0.001
Total Phosphorus (g/m3)	130	0.007	0.061	0.025	0.022	0.044	0.011	0.011	0.001
Dissolved Reactive Phosphorus (g/m3)	129	<0.001	0.048	0.015	0.014	0.028	0.005	0.008	0.001
Dissolved Oxygen Sat (%)	83	64.0	111.4	96.8	97.6	106.0	84.8	7.3	0.8
Dissolved Oxygen (g/m3)	127	5.96	11.90	9.83	9.90	11.19	8.29	0.95	0.08
Escherichia coli (cfu/100ml)	122	10	6800	505	172	3019	16	1045	95
Total Suspended Solids (g/m3)	128	<1	36.50	2.88	1.38	13.11	0.40	5.63	0.50
Turbidity (NTU)	122	0.5	14.0	1.6	1.0	5.4	0.6	2.0	0.2
Water Clarity (m)	79	0.43	6.58	3.66	3.68	6.17	1.15	1.47	0.16
Conductivity (uS/cm)	129	20	185	69	68	87	50	15	1
pH (pH Units)	129	5.9	7.7	6.9	6.9	7.2	6.5	0.3	0.0
Water Temperature (degC)	129	9.5	22.5	15.6	15.5	19.8	11.4	2.8	0.2
Discharge (m3/s)	103	0.20	8.70	1.00	0.70	2.50	0.20	1.20	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

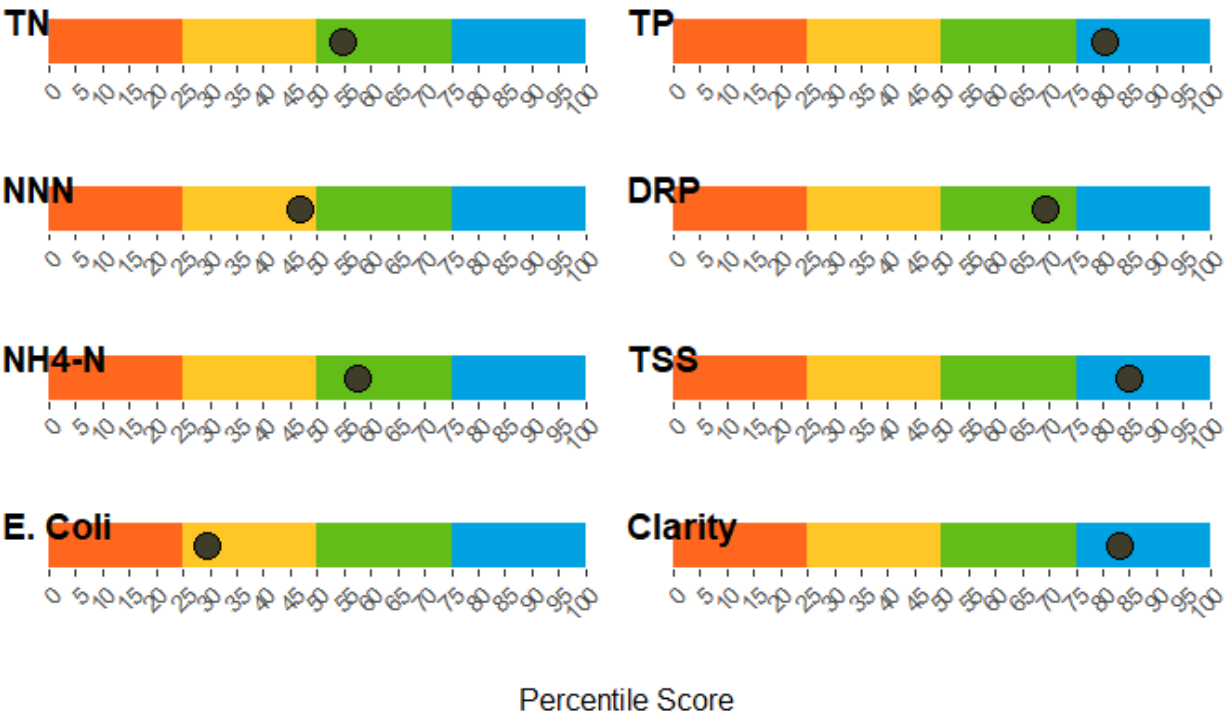


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

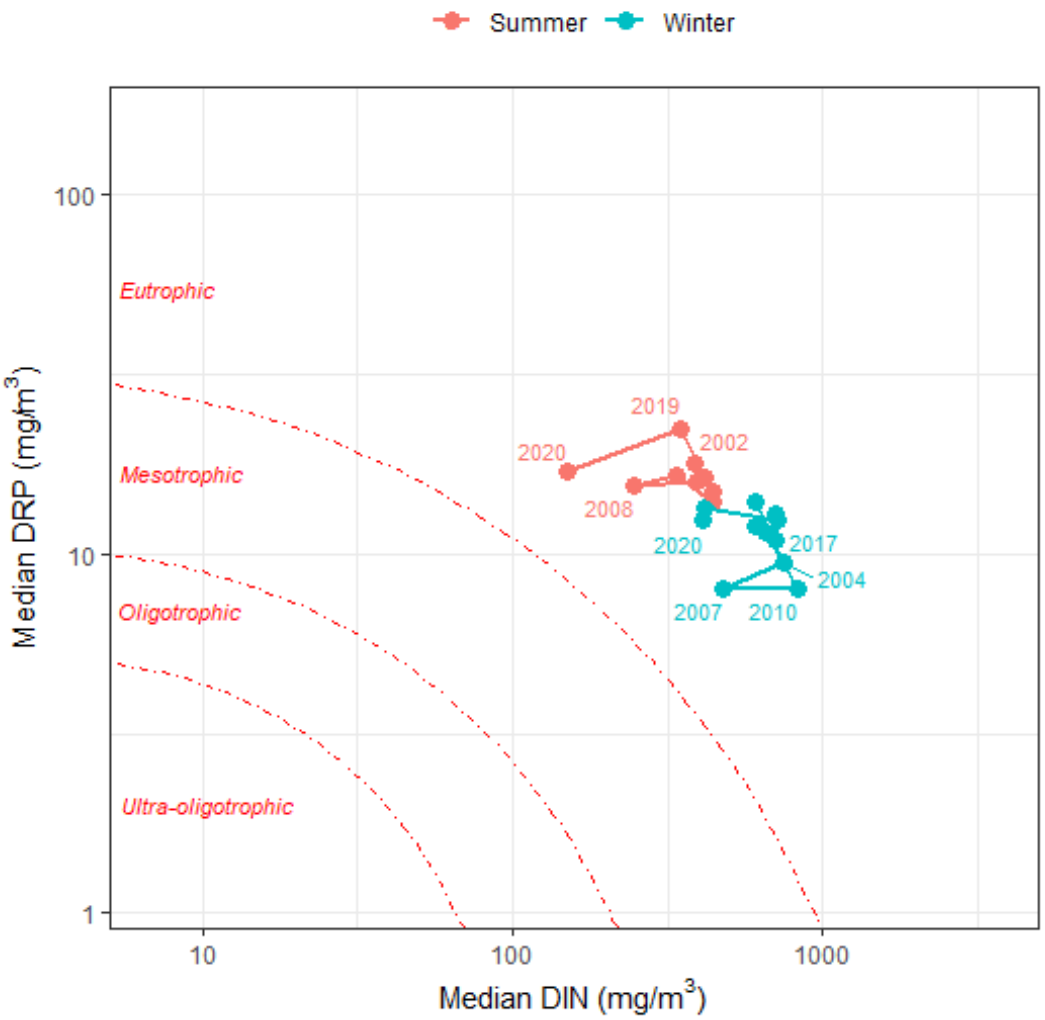


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-10	2020-12-09	10	0.004	0.008	A
5 Years	2015-12-11	2020-12-09	57	0.004	0.049	A
10 Years	2010-12-12	2020-12-09	80	0.004	0.049	A
All	1990-11-03	2020-12-09	129	0.004	0.049	A

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-10	2020-12-09	10	0.26	0.49	A
5 Years	2015-12-11	2020-12-09	57	0.48	0.85	A
10 Years	2010-12-12	2020-12-09	80	0.49	0.91	A
All	2001-07-23	2020-12-09	120	0.49	0.90	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-09	56	3.78	A*
10 Years	2010-12-12	2020-12-09	64	3.73	A
All	1999-05-26	2020-12-09	78	3.67	A

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	57	0.014	0.025	C
10 Years	2010-12-12	2020-12-09	80	0.013	0.024	C
All	1990-11-02	2020-12-09	128	0.014	0.028	C

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc 540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-11	2020-12-09	57	19.3	43.9	240	3260	D*	Not Swimmable

* Attribute requires 60 samples over five years but only 40-60 samples were available. Bands *should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-11	2020-12-09	57	240	3620	56.1	24.6	19.3
10 Years	2010-12-12	2020-12-09	80	200	3060	65	20	15
All	1999-05-26	2020-12-09	122	172	3052	66.4	18.9	14.8

Time series plots

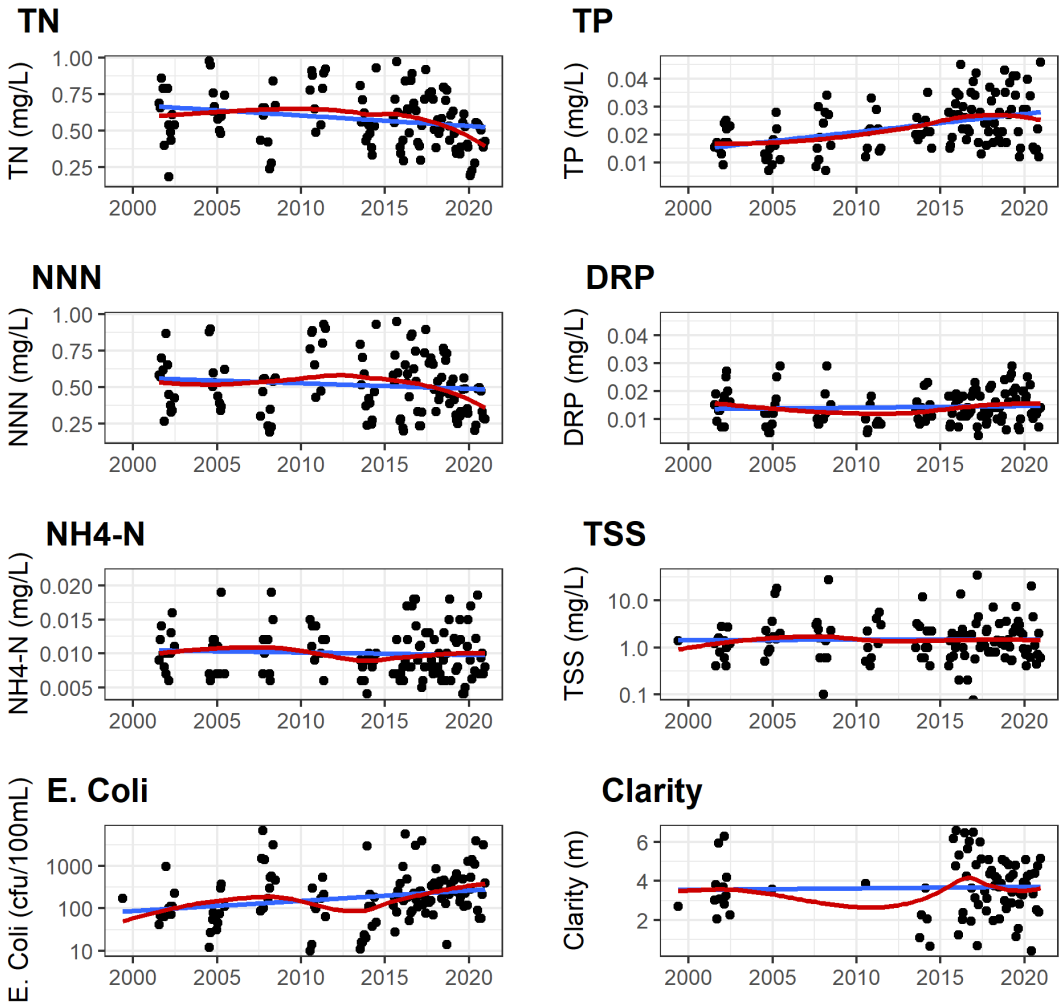


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

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Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-20	2020-12-09	-0.0447	-8.27	<0.001	Decreasing	YES	NO	Very Likely Improving
TN	10 Years	2011-03-16	2020-12-09	-0.0106	-1.94	<0.05	Decreasing	YES	YES	Very Likely Improving
TN	All	2001-07-23	2020-12-09	-0.0096	-1.73	<0.01	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-20	2020-12-09	-0.0326	-6.71	<0.05	Decreasing	YES	NO	Very Likely Improving
NNN	10 Years	2011-03-16	2020-12-09	-0.0122	-2.51	0.19	Indeterminant	YES	YES	Likely Improving
NNN	All	2001-07-23	2020-12-09	-0.0056	-1.16	<0.05	Decreasing	YES	YES	Very Likely Improving
NH4N	5 Years	2016-01-20	2020-12-09	-0.0003	-3.75	0.35	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-03-16	2020-12-09	0.0001	1.59	0.47	Indeterminant	YES	NO	Likely Degrading
NH4N	All	2001-07-23	2020-12-09	-0.0001	-0.74	0.30	Indeterminant	YES	NO	Likely Improving
TP	5 Years	2016-01-20	2020-12-09	-0.0025	-9.12	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-03-16	2020-12-09	-0.0003	-1.06	0.66	Indeterminant	YES	YES	Likely Improving
TP	All	2001-07-23	2020-12-09	0.0005	2.27	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-20	2020-12-09	-0.0004	-2.91	0.24	Indeterminant	YES	NO	Likely Improving
DRP	10 Years	2011-03-16	2020-12-09	0.0000	-0.07	0.97	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	All	2001-07-23	2020-12-09	0.0001	0.40	0.46	Indeterminant	YES	NO	Likely Degrading
ECOLI	5 Years	2016-01-20	2020-12-09	-0.0247	-1.02	0.38	Indeterminant	YES	YES	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-03-16	2020-12-09	0.0326	1.38	0.19	Indeterminant	YES	YES	Very Likely Degrading
ECOLI	All	2001-07-23	2020-12-09	0.0222	0.98	<0.01	Increasing	YES	YES	Very Likely Degrading
TSS	5 Years	2016-01-20	2020-12-09	-0.0098	-2.48	0.55	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-03-16	2020-12-09	-0.0056	-1.48	0.50	Indeterminant	YES	NO	Likely Improving
TSS	All	2001-07-23	2020-12-09	-0.0022	-0.59	0.41	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-20	2020-12-09	0.0002	0.01	0.99	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2011-03-16	2020-12-09	-0.0203	-0.55	0.86	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	All	2001-07-23	2020-12-09	0.0240	0.66	0.54	Indeterminant	YES	NO	Likely Improving

Omanawa at SH 29

March 2021

Table 1 Site metadata.

Aquarius ID:	DO047598	**Labstar ID:**	BOP110036
LAWA ID:	EBOP-00013	**REC Reach:**	4002044
Easting:	1870477	**Northing:**	5815980
Longitude:	176.07050	**Latitude:**	-37.76353
Elevation:	1 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Hill_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	260	0.27	1.59	1.18	1.21	1.40	0.91	0.18	0.01
Nitrate Nitrite Nitrogen (g/m3)	263	0.10	1.41	1.07	1.10	1.30	0.77	0.19	0.01
Total Ammoniacal Nitrogen (g/m3)	284	<0.002	0.050	0.009	0.008	0.020	0.004	0.006	0.000
Total Phosphorus (g/m3)	286	0.014	0.190	0.039	0.034	0.064	0.024	0.018	0.001
Dissolved Reactive Phosphorus (g/m3)	275	0.002	0.064	0.025	0.025	0.037	0.015	0.007	0.000
Dissolved Oxygen Sat (%)	129	83.0	131.2	98.8	98.3	106.5	90.3	5.5	0.5
Dissolved Oxygen (g/m3)	281	7.20	13.48	10.10	10.10	11.19	9.00	0.69	0.04
Escherichia coli (cfu/100ml)	280	3	10000	325	120	812	25	939	56
Total Suspended Solids (g/m3)	283	<1	340.00	18.86	11.00	59.00	3.20	30.79	1.83
Turbidity (NTU)	284	1.0	140.0	6.6	3.8	18.0	1.5	12.6	0.7
Water Clarity (m)	234	0.05	4.89	1.41	1.30	2.60	0.39	0.74	0.05
Conductivity (uS/cm)	287	34	222	74	75	81	62	11	1
pH (pH Units)	287	5.9	7.5	7.1	7.1	7.4	6.8	0.2	0.0
Water Temperature (degC)	284	8.7	21.0	14.2	14.2	17.9	10.8	2.3	0.1
Discharge (m3/s)	229	0.80	3.10	1.50	1.40	1.80	1.10	0.30	0.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

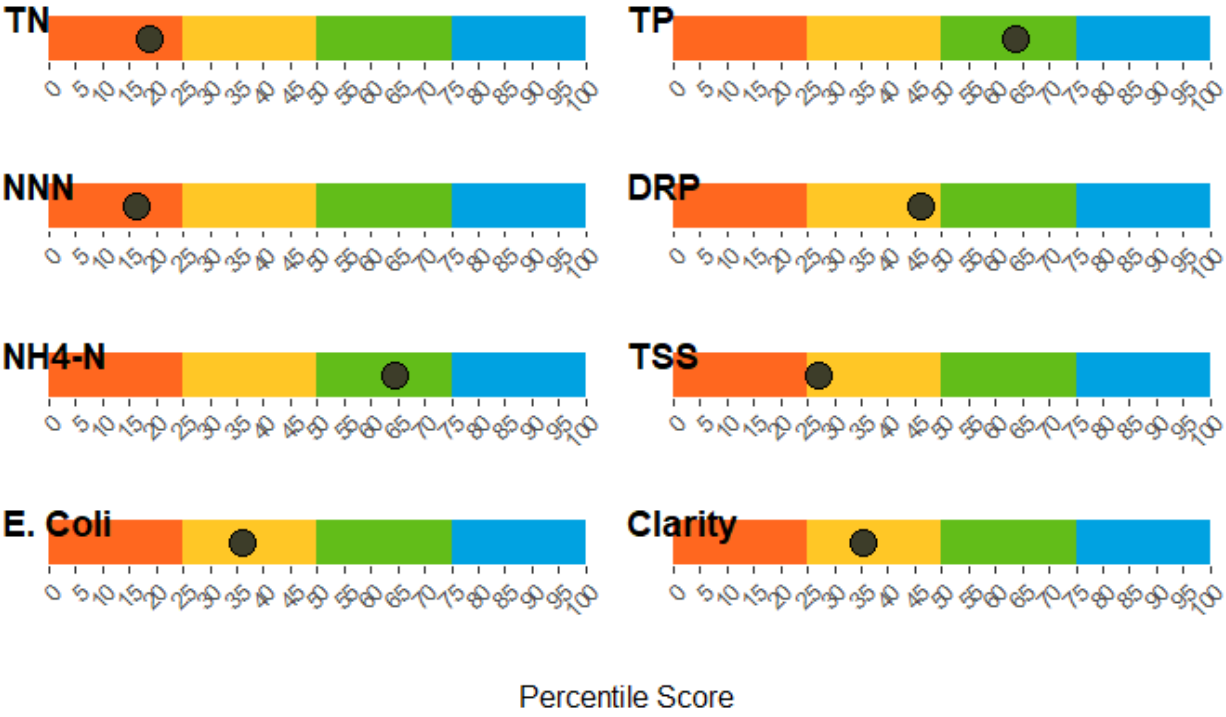

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

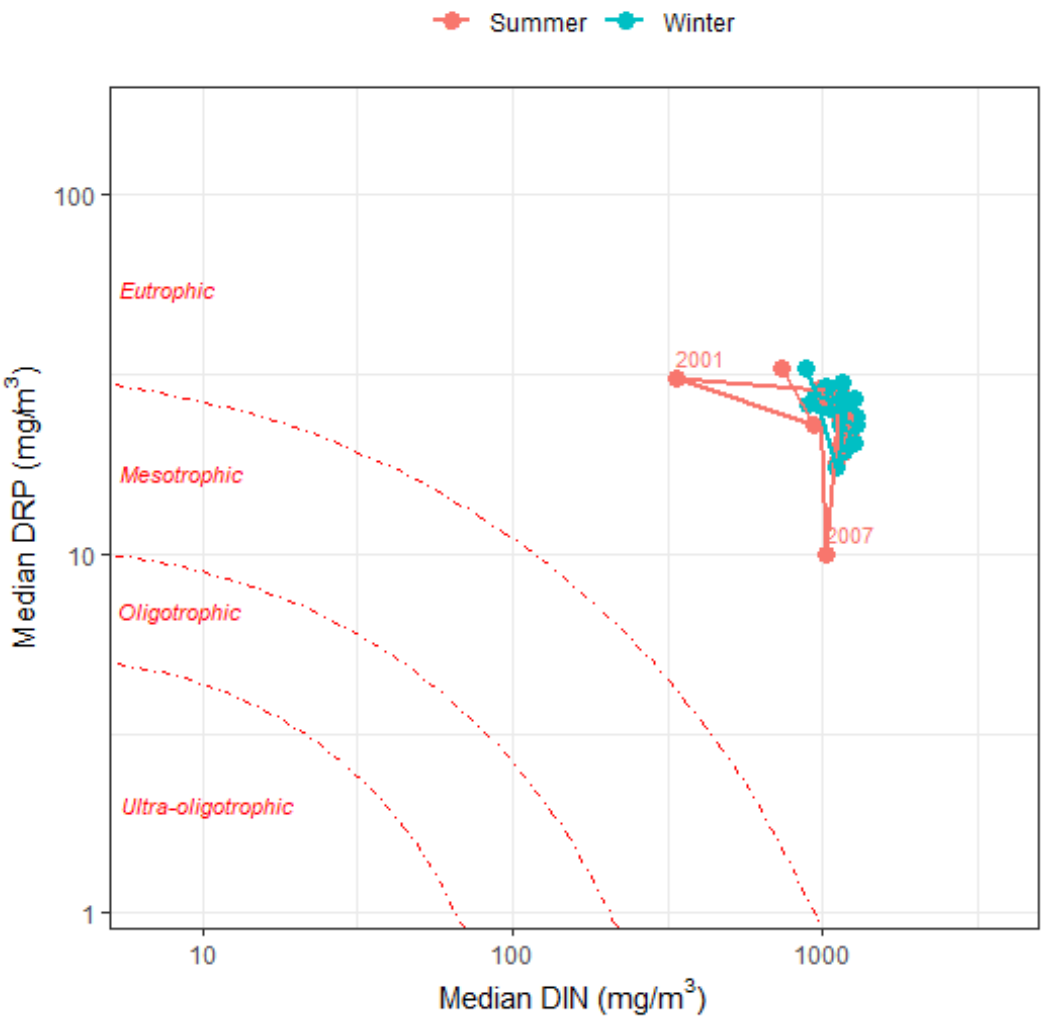

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.0030	0.007	A
5 Years	2015-12-12	2020-12-10	64	0.0030	0.007	A
10 Years	2010-12-13	2020-12-10	123	0.0030	0.019	A
All	1991-03-04	2020-12-10	284	0.0034	0.019	A

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	10	1.2	1.2	B
5 Years	2015-12-12	2020-12-10	64	1.2	1.3	B
10 Years	2010-12-13	2020-12-10	123	1.2	1.3	B
All	1993-06-29	2020-12-10	263	1.1	1.3	B

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-12	2020-12-10	54	1.88	A*
10 Years	2010-12-13	2020-12-10	111	1.55	C
All	1992-09-10	2020-12-10	232	1.30	D

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-12	2020-12-10	63	0.025	0.032	D
10 Years	2010-12-13	2020-12-10	122	0.023	0.031	D
All	1991-03-04	2020-12-10	274	0.025	0.037	D

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	64	10.9	21.9	115	3185	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	64	115	3560	78.1	10.9	10.9
10 Years	2010-12-13	2020-12-10	123	110	2135	77.2	12.2	9.8
All	1991-03-04	2020-12-10	280	120	830	79.6	12.5	7.5

Time series plots

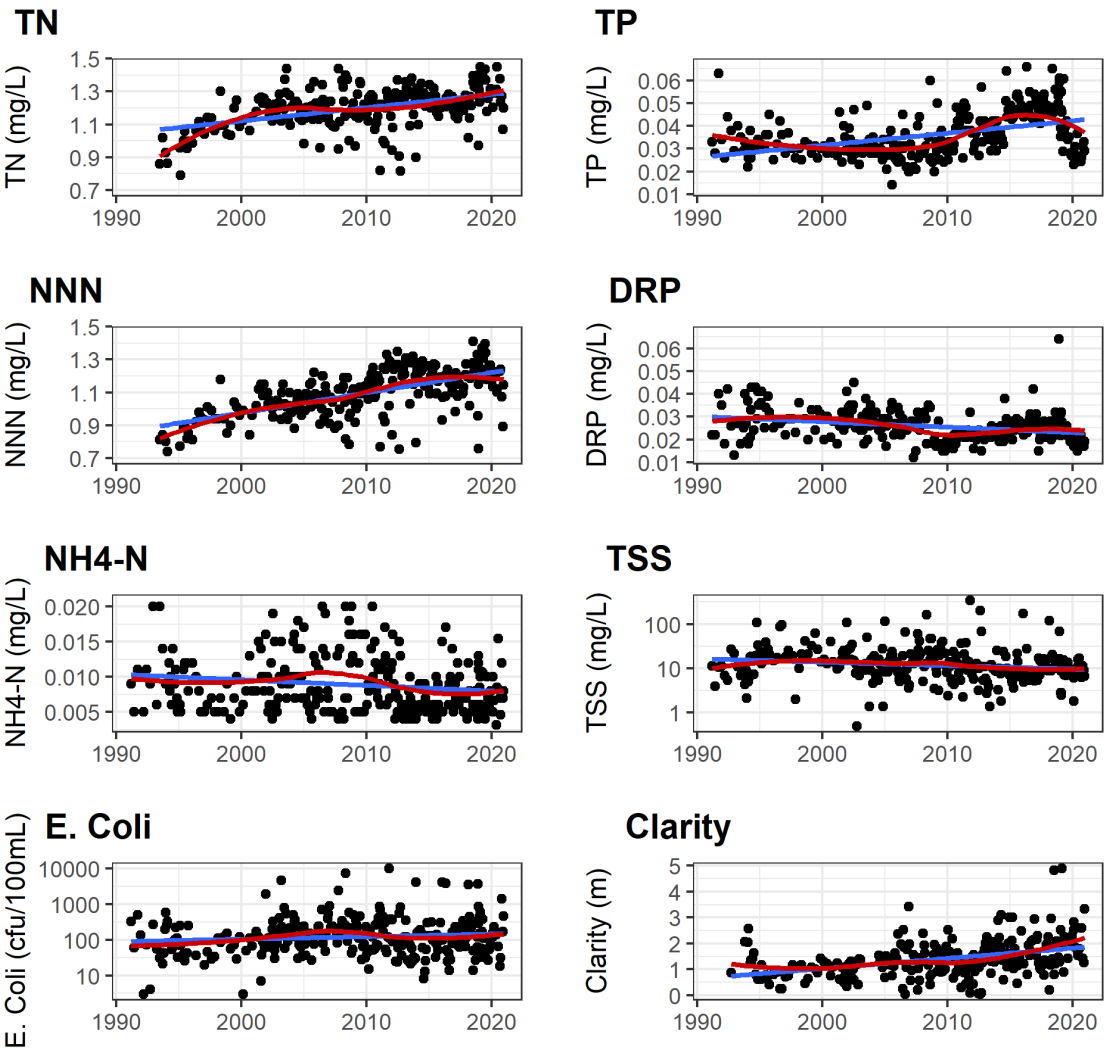

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-10	0.0174	1.37	0.06	Increasing	NO	NO	Very Likely Degrading
TN	10 Years	2011-01-18	2020-12-10	0.0091	0.72	<0.01	Increasing	YES	NO	Very Likely Degrading
TN	All	1991-06-05	2020-12-10	0.0082	0.68	<0.001	Increasing	YES	NO	Very Likely Degrading
NNN	5 Years	2016-01-19	2020-12-10	0.0081	0.67	0.39	Indeterminant	YES	NO	Likely Degrading
NNN	10 Years	2011-01-18	2020-12-10	0.0046	0.38	0.15	Indeterminant	YES	NO	Very Likely Degrading
NNN	All	1991-06-05	2020-12-10	0.0131	1.19	<0.001	Increasing	YES	NO	Very Likely Degrading
NH4N	5 Years	2016-01-19	2020-12-10	0.0000	0.00	0.59	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2011-01-18	2020-12-10	0.0001	1.60	0.32	Indeterminant	YES	NO	Likely Degrading
NH4N	All	1991-06-05	2020-12-10	-0.0001	-1.18	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-19	2020-12-10	-0.0053	-11.56	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-18	2020-12-10	-0.0005	-1.12	0.29	Indeterminant	YES	NO	Likely Improving
TP	All	1991-06-05	2020-12-10	0.0004	1.22	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-19	2020-12-10	-0.0016	-7.10	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-10	-0.0002	-0.87	0.16	Indeterminant	YES	NO	Likely Improving
DRP	All	1991-06-05	2020-12-10	-0.0002	-0.92	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-19	2020-12-10	0.0347	1.70	0.62	Indeterminant	YES	YES	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-10	0.0120	0.58	0.22	Indeterminant	YES	YES	Likely Degrading
ECOLI	All	1991-06-05	2020-12-10	0.0014	0.07	0.75	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-19	2020-12-10	-0.0006	-0.06	0.91	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	10 Years	2011-01-18	2020-12-10	0.0175	1.75	<0.01	Increasing	YES	NO	Very Likely Degrading
TSS	All	1991-06-05	2020-12-10	-0.0100	-0.93	<0.001	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2016-01-19	2020-12-10	0.1560	8.03	<0.05	Increasing	YES	NO	Very Likely Improving
CLARITY	10 Years	2011-01-18	2020-12-10	0.0690	4.31	<0.01	Increasing	YES	NO	Very Likely Improving
CLARITY	All	1991-06-05	2020-12-10	0.0428	3.29	<0.001	Increasing	YES	NO	Very Likely Improving

Kopurererua at SH 29

March 2021

Table 1 Site metadata.

Aquarius ID:	DO406909	**Labstar ID:**	BOP710008, BOP710008F
LAWA ID:		**REC Reach:**	4001570
Easting:	1874065	**Northing:**	5819093
Longitude:	176.11000	**Latitude:**	-37.73445
Elevation:	5 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	205	0.30	1.97	1.06	1.06	1.19	0.89	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	205	0.01	1.12	0.91	0.94	1.06	0.68	0.14	0.01
Total Ammoniacal Nitrogen (g/m3)	225	<0.002	0.117	0.020	0.015	0.051	0.005	0.016	0.001
Total Phosphorus (g/m3)	226	0.022	0.525	0.046	0.038	0.081	0.026	0.044	0.003
Dissolved Reactive Phosphorus (g/m3)	225	0.004	0.051	0.020	0.018	0.035	0.010	0.008	0.001
Dissolved Oxygen Sat (%)	141	71.5	126.7	97.1	96.8	106.0	88.3	6.6	0.6
Dissolved Oxygen (g/m3)	226	7.10	13.06	10.09	10.14	11.14	8.80	0.76	0.05
Escherichia coli (cfu/100ml)	212	22	8100	543	260	1745	52	1064	73
Total Suspended Solids (g/m3)	222	2.20	685.00	29.37	16.95	69.37	5.05	57.82	3.88
Turbidity (NTU)	204	1.5	442.0	13.4	5.9	31.8	2.4	38.2	2.7
Water Clarity (m)	172	0.10	2.34	0.98	0.97	1.86	0.37	0.47	0.04
Conductivity (uS/cm)	212	44	107	73	73	80	63	6	0
pH (pH Units)	212	6.3	7.6	7.0	7.0	7.3	6.7	0.2	0.0
Water Temperature (degC)	227	8.6	20.2	13.6	13.5	17.0	10.2	2.2	0.1
Discharge (m3/s)	225	1.00	18.10	1.90	1.70	2.90	1.30	1.30	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

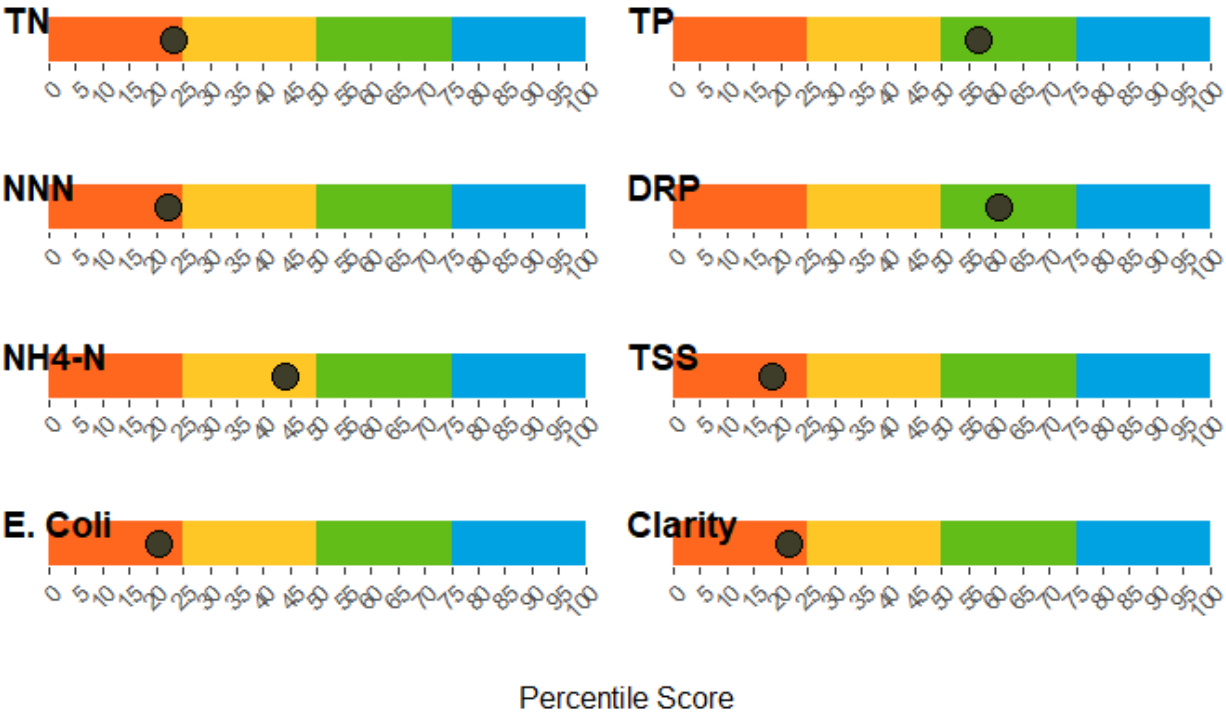

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

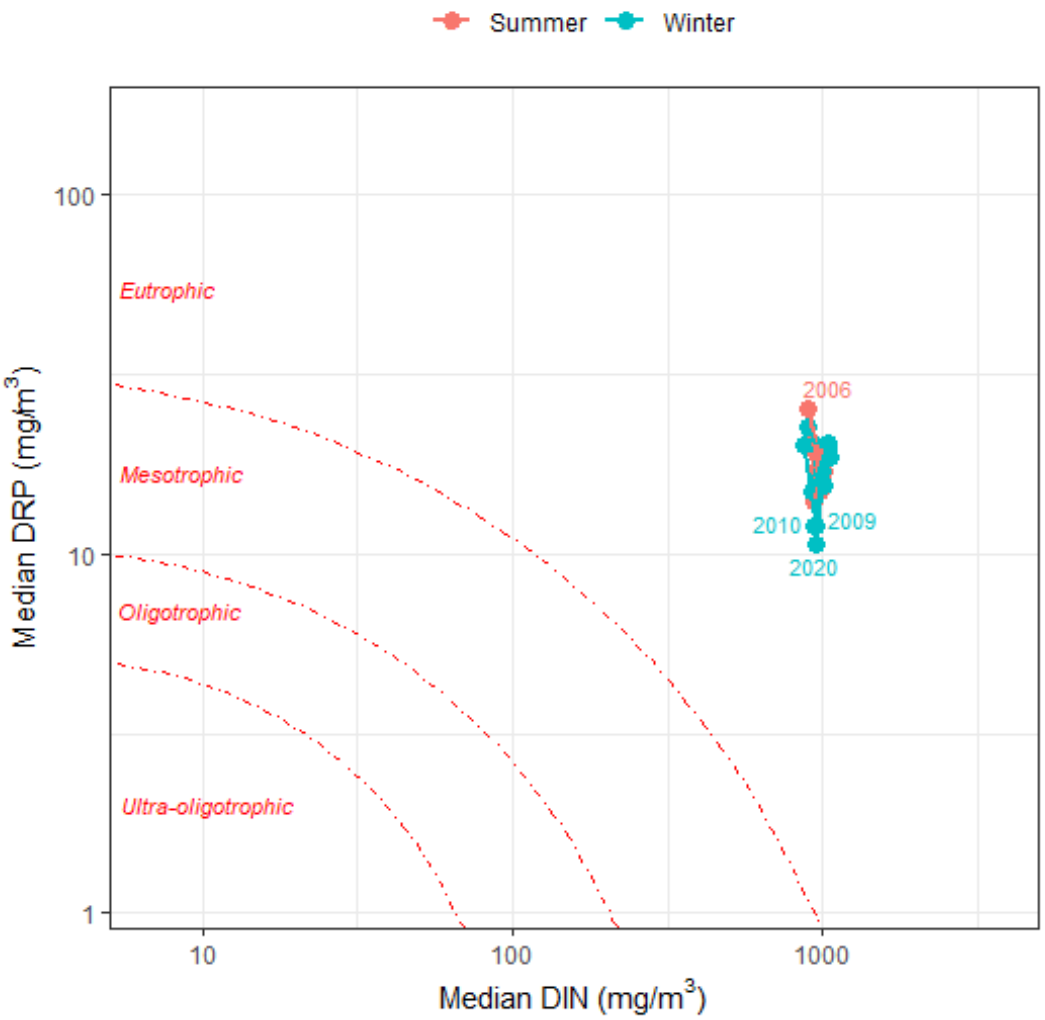

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.0070	0.023	A
5 Years	2015-12-12	2020-12-10	57	0.0120	0.050	B
10 Years	2010-12-13	2020-12-10	116	0.0080	0.050	B
All	1990-11-02	2020-12-10	210	0.0063	0.050	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-22	2020-12-21	18	0.94	1.1	A
5 Years	2015-12-23	2020-12-21	72	0.97	1.1	A
10 Years	2010-12-24	2020-12-21	131	0.97	1.1	A
All	1993-09-15	2020-12-21	205	0.94	1.1	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-23	2020-12-21	68	1.03	D
10 Years	2010-12-24	2020-12-21	115	1.02	D
All	1993-10-26	2020-12-21	171	0.96	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-23	2020-12-21	72	0.016	0.025	C
10 Years	2010-12-24	2020-12-21	131	0.017	0.025	C
All	1990-11-01	2020-12-21	224	0.018	0.035	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-23	2020-12-21	72	25.0	55.6	280	4115	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-23	2020-12-21	72	280	4130	44.4	30.6	23.6
10 Years	2010-12-24	2020-12-21	131	270	3645	47.3	28.2	23.7
All	1993-09-15	2020-12-21	212	260	1790	52.4	25	21.7

Time series plots

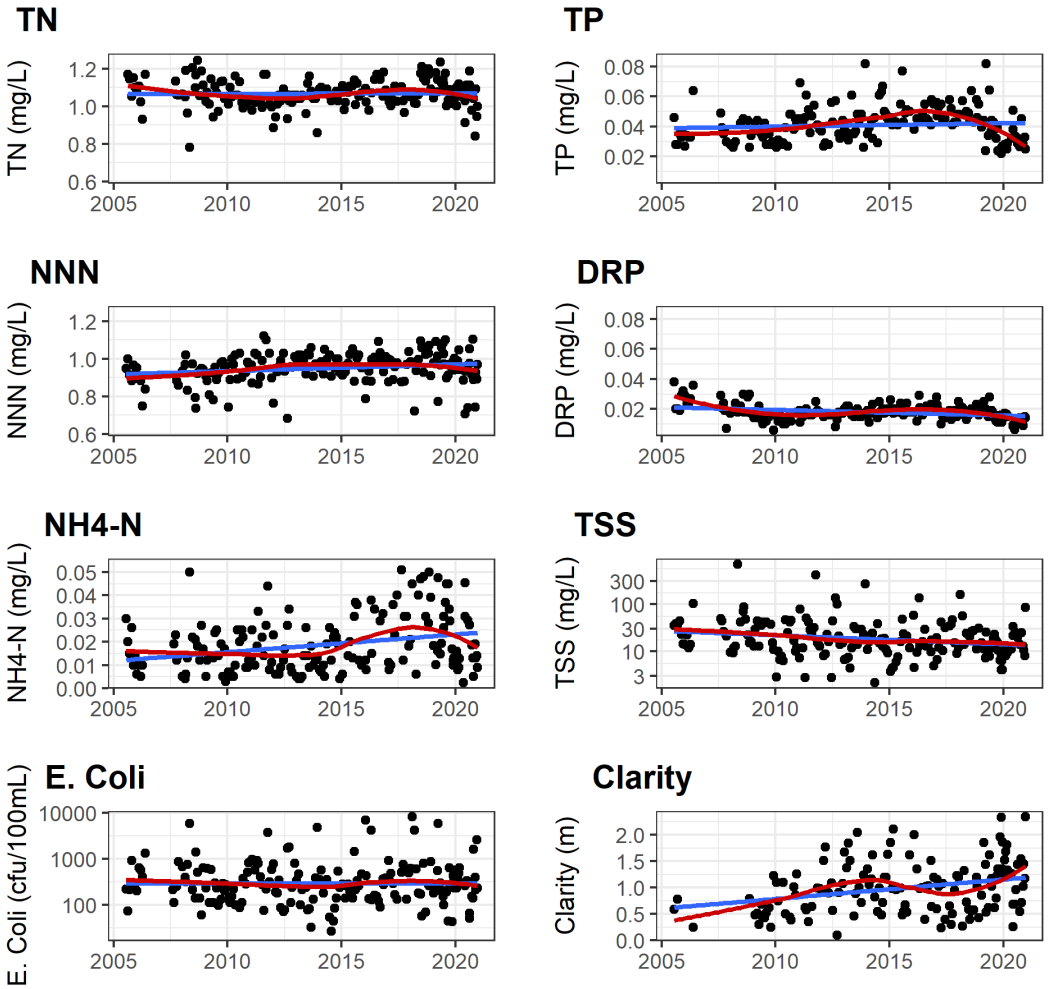

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-21	-0.0068	-0.63	0.38	Indeterminant	YES	NO	Likely Improving
TN	10 Years	2011-01-18	2020-12-21	0.0050	0.47	<0.05	Increasing	YES	YES	Very Likely Degrading
TN	All	2005-08-17	2020-12-21	0.0011	0.10	0.40	Indeterminant	YES	NO	Likely Degrading
NNN	5 Years	2016-01-19	2020-12-21	-0.0053	-0.55	0.49	Indeterminant	YES	NO	Likely Improving
NNN	10 Years	2011-01-18	2020-12-21	-0.0040	-0.41	0.06	Decreasing	YES	NO	Very Likely Improving
NNN	All	2005-08-17	2020-12-21	0.0040	0.41	<0.01	Increasing	YES	NO	Very Likely Degrading
NH4N	5 Years	2016-01-19	2020-12-21	-0.0022	-8.32	0.21	Indeterminant	YES	YES	Likely Improving
NH4N	10 Years	2011-01-18	2020-12-21	0.0018	10.08	<0.001	Increasing	YES	YES	Very Likely Degrading
NH4N	All	2005-08-17	2020-12-21	0.0008	4.74	<0.001	Increasing	YES	YES	Very Likely Degrading
TP	5 Years	2016-01-19	2020-12-21	-0.0050	-11.57	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-18	2020-12-21	-0.0007	-1.57	0.12	Indeterminant	YES	NO	Likely Improving
TP	All	2005-08-17	2020-12-21	0.0003	0.81	0.13	Indeterminant	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-19	2020-12-21	-0.0015	-9.23	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-21	-0.0002	-1.32	0.14	Indeterminant	YES	NO	Likely Improving
DRP	All	2005-08-17	2020-12-21	-0.0002	-0.99	0.09	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-19	2020-12-21	0.0300	1.23	0.16	Indeterminant	YES	YES	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-21	0.0164	0.68	0.19	Indeterminant	YES	YES	Very Likely Degrading
ECOLI	All	2005-08-17	2020-12-21	0.0007	0.03	0.96	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-19	2020-12-21	-0.0075	-0.64	0.60	Indeterminant	YES	YES	Likely Improving
TSS	10 Years	2011-01-18	2020-12-21	-0.0008	-0.07	0.89	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	All	2005-08-17	2020-12-21	-0.0189	-1.54	<0.001	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2016-01-19	2020-12-21	0.0769	7.12	<0.05	Increasing	YES	YES	Very Likely Improving
CLARITY	10 Years	2011-01-18	2020-12-21	-0.0009	-0.09	0.82	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	2005-08-17	2020-12-21	0.0233	2.35	<0.01	Increasing	YES	YES	Very Likely Improving

Waimapu 100 m d/s SH 29

March 2021

Table 1 Site metadata.

Aquarius ID:	DO686858	**Labstar ID:**	BOP160121
LAWA ID:	EBOP-00033	**REC Reach:**	4001685
Easting:	1876865	**Northing:**	5818584
Longitude:	176.14190	**Latitude:**	-37.73819
Elevation:	1 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	155	0.22	2.06	0.95	0.94	1.23	0.66	0.23	0.02
Nitrate Nitrite Nitrogen (g/m3)	155	0.01	1.17	0.77	0.79	1.05	0.46	0.19	0.02
Total Ammoniacal Nitrogen (g/m3)	153	<0.002	0.240	0.023	0.020	0.043	0.007	0.021	0.002
Total Phosphorus (g/m3)	156	0.011	0.288	0.038	0.030	0.059	0.017	0.037	0.003
Dissolved Reactive Phosphorus (g/m3)	152	<0.001	0.099	0.012	0.012	0.019	0.006	0.008	0.001
Dissolved Oxygen Sat (%)	126	71.2	129.3	94.4	94.8	102.0	85.7	6.4	0.6
Dissolved Oxygen (g/m3)	155	3.70	13.30	9.63	9.78	11.19	8.01	1.13	0.09
Escherichia coli (cfu/100ml)	154	39	7600	724	350	3197	89	1325	107
Total Suspended Solids (g/m3)	151	<1	265.00	13.84	7.20	36.00	2.62	29.02	2.36
Turbidity (NTU)	155	1.3	100.0	5.8	3.1	15.9	1.6	11.0	0.9
Water Clarity (m)	68	0.31	3.13	1.62	1.61	2.75	0.58	0.69	0.08
Conductivity (uS/cm)	155	41	907	92	74	127	59	93	7
pH (pH Units)	156	6.0	7.7	7.0	7.0	7.2	6.7	0.2	0.0
Water Temperature (degC)	156	7.5	38.5	14.5	13.9	19.9	9.5	3.7	0.3
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

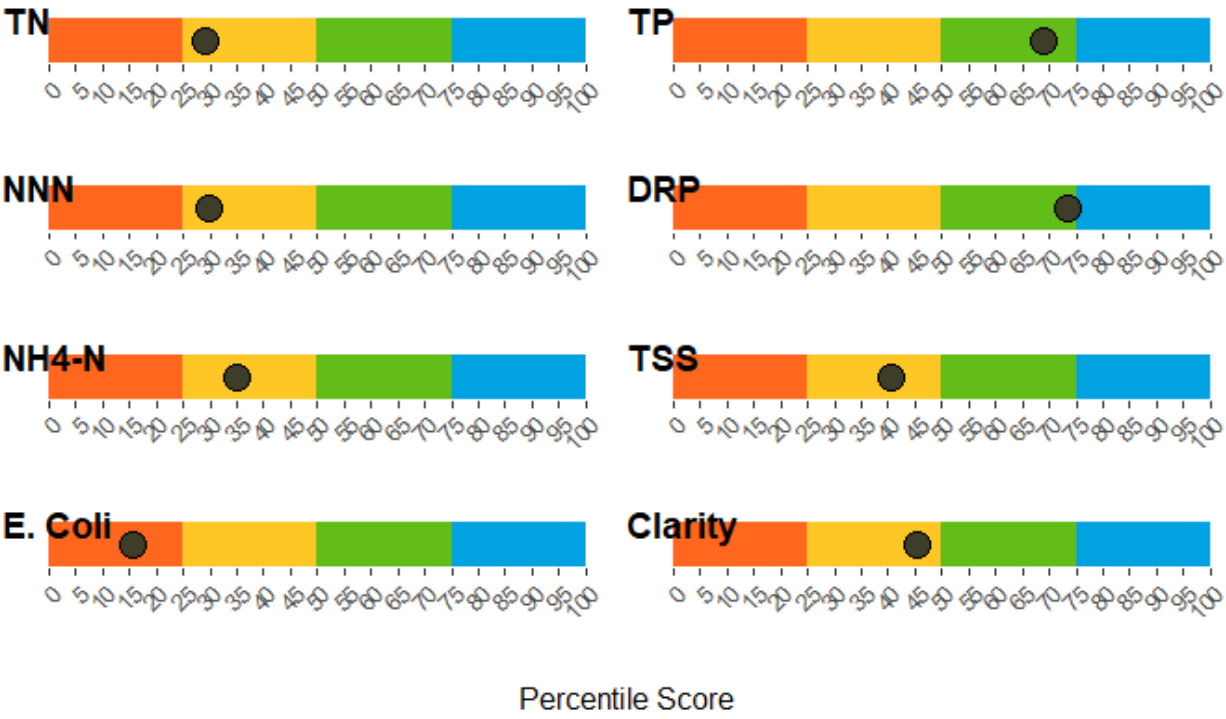

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

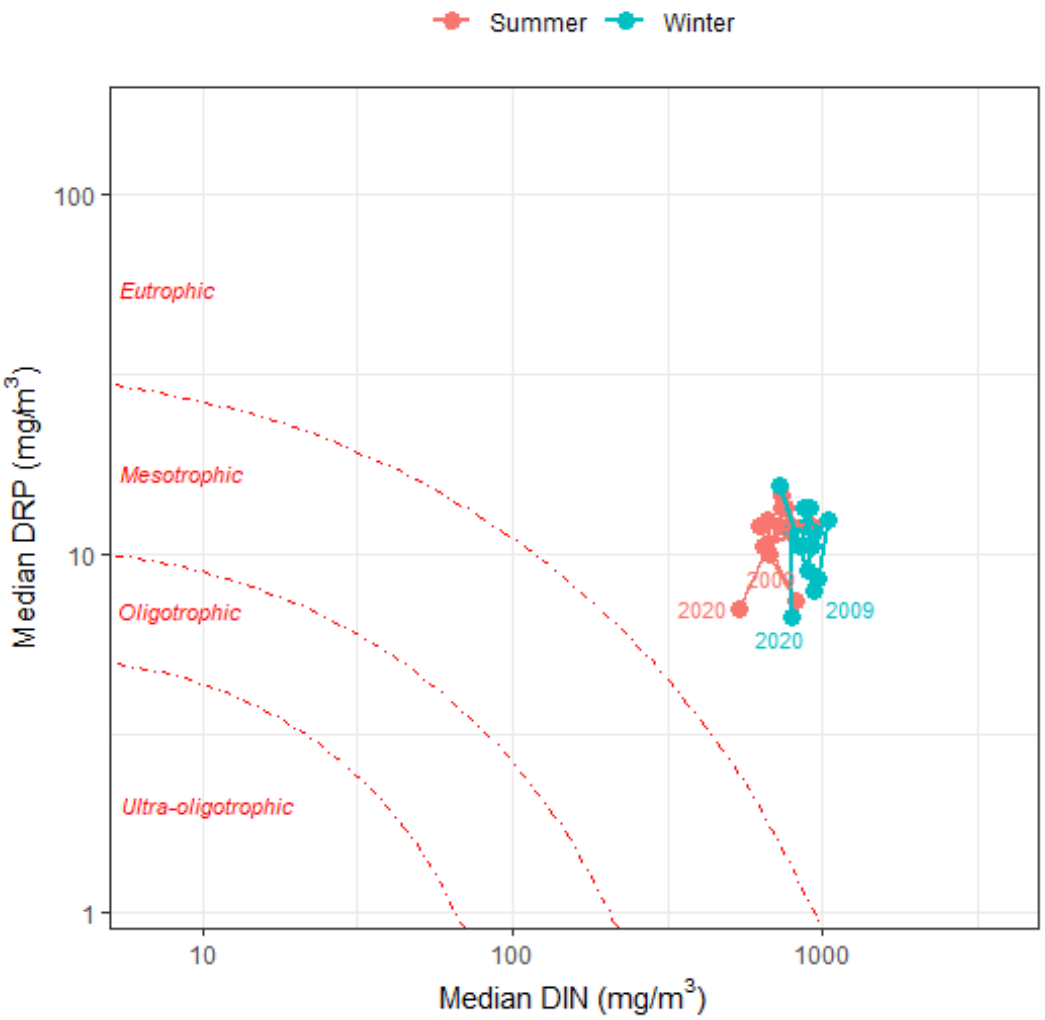

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.0090	0.017	A
5 Years	2015-12-12	2020-12-10	57	0.0080	0.025	A
10 Years	2010-12-13	2020-12-10	116	0.0070	0.025	A
All	2007-08-08	2020-12-10	153	0.0083	0.084	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	10	0.71	0.88	A
5 Years	2015-12-12	2020-12-10	57	0.79	1.02	A
10 Years	2010-12-13	2020-12-10	116	0.80	1.06	A
All	2007-08-08	2020-12-10	155	0.79	1.05	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-12	2020-12-10	53	1.69	B*
10 Years	2010-12-13	2020-12-10	58	1.72	B*
All	2007-08-08	2020-12-10	67	1.60	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-12	2020-12-10	57	0.011	0.017	C
10 Years	2010-12-13	2020-12-10	116	0.012	0.018	C
All	2007-08-08	2020-12-10	151	0.012	0.019	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	57	33.3	73.7	380	6840	E*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	57	380	6930	26.3	40.4	33.3
10 Years	2010-12-13	2020-12-10	116	355	5060	29.3	41.4	28.4
All	2007-08-08	2020-12-10	154	350	3707	32.5	39	27.9

Time series plots

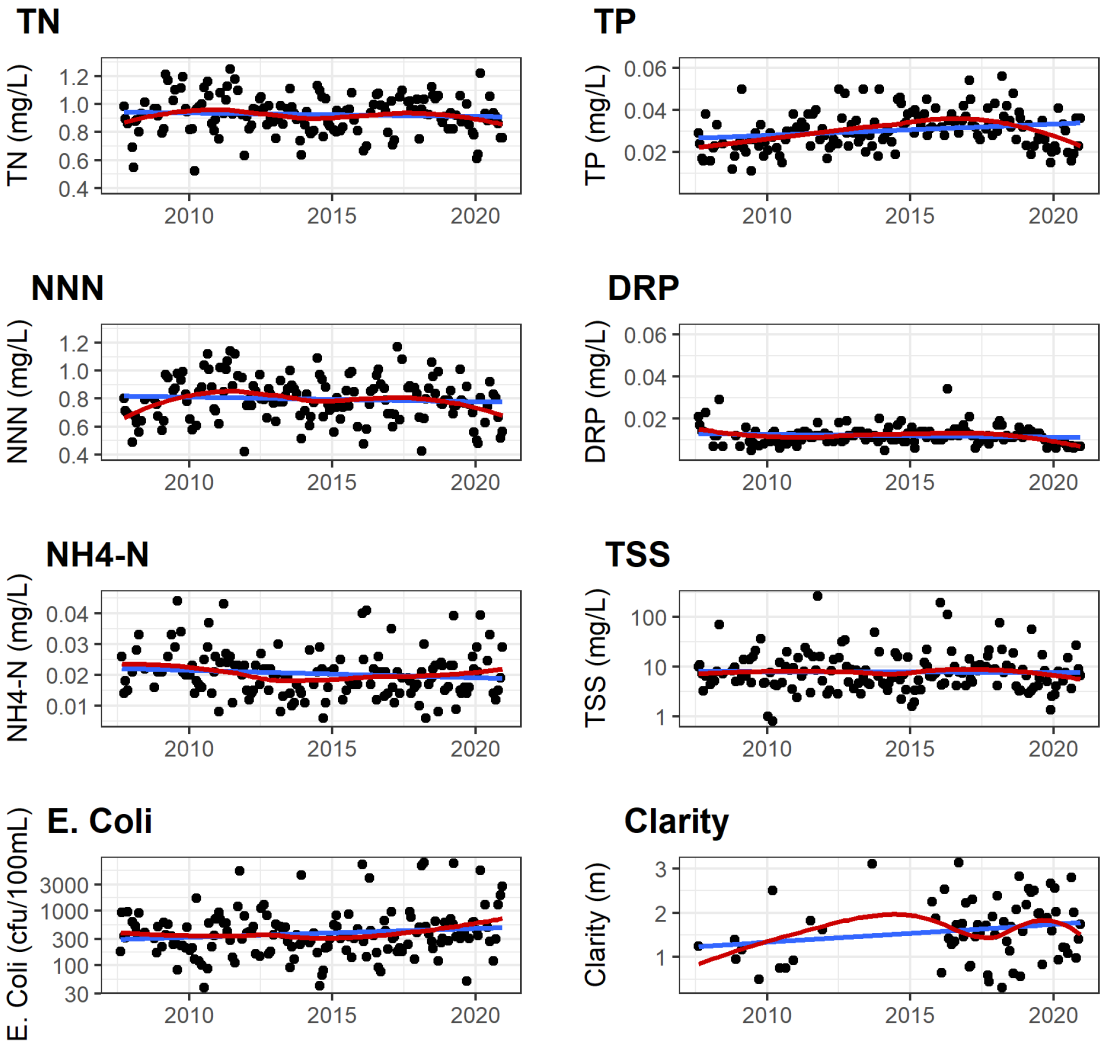

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-10	-0.0294	-3.13	<0.01	Decreasing	NO	YES	Very Likely Improving
TN	10 Years	2011-01-18	2020-12-10	-0.0079	-0.85	<0.05	Decreasing	NO	YES	Very Likely Improving
TN	All	2007-08-08	2020-12-10	-0.0052	-0.56	<0.05	Decreasing	NO	YES	Very Likely Improving
NNN	5 Years	2016-01-19	2020-12-10	-0.0289	-3.66	<0.01	Decreasing	NO	YES	Very Likely Improving
NNN	10 Years	2011-01-18	2020-12-10	-0.0147	-1.84	<0.01	Decreasing	NO	YES	Very Likely Improving
NNN	All	2007-08-08	2020-12-10	-0.0036	-0.45	0.31	Indeterminant	NO	YES	Likely Improving
NH4N	5 Years	2016-01-19	2020-12-10	-0.0003	-1.61	0.65	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2011-01-18	2020-12-10	0.0000	0.00	0.76	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	All	2007-08-08	2020-12-10	-0.0004	-2.03	<0.05	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2016-01-19	2020-12-10	-0.0033	-10.04	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2011-01-18	2020-12-10	-0.0001	-0.40	0.57	Indeterminant	NO	NO	Likely Improving
TP	All	2007-08-08	2020-12-10	0.0005	1.77	<0.05	Increasing	NO	NO	Very Likely Degrading
DRP	5 Years	2016-01-19	2020-12-10	-0.0014	-12.47	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-10	-0.0003	-2.26	<0.05	Decreasing	NO	NO	Very Likely Improving
DRP	All	2007-08-08	2020-12-10	0.0000	0.00	0.39	Indeterminant	NO	NO	Likely Improving
ECOLI	5 Years	2016-01-19	2020-12-10	0.0665	2.57	0.10	Increasing	NO	NO	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-10	0.0176	0.69	0.21	Indeterminant	NO	YES	Likely Degrading
ECOLI	All	2007-08-08	2020-12-10	0.0138	0.54	0.08	Increasing	NO	YES	Very Likely Degrading
TSS	5 Years	2016-01-19	2020-12-10	-0.0409	-4.37	0.07	Decreasing	NO	NO	Very Likely Improving
TSS	10 Years	2011-01-18	2020-12-10	-0.0057	-0.61	0.55	Indeterminant	NO	NO	Likely Improving
TSS	All	2007-08-08	2020-12-10	-0.0024	-0.27	0.48	Indeterminant	NO	YES	Likely Improving
CLARITY	5 Years	2016-01-19	2020-12-10	0.0693	4.07	0.36	Indeterminant	NO	NO	Likely Improving
CLARITY	10 Years	2011-01-18	2020-12-10	0.0081	0.47	0.92	Indeterminant	NO	NO	Indeterminate/Uncertain
CLARITY	All	2007-08-08	2020-12-10	0.0431	2.68	0.14	Indeterminant	NO	NO	Likely Improving

Waimapu at Pukemapu Road

March 2021

Table 1 Site metadata.

Aquarius ID:	DO712717	**Labstar ID:**	BOP160212
LAWA ID:	EBOP-00032	**REC Reach:**	4001685
Easting:	1877129	**Northing:**	5817176
Longitude:	176.14545	**Latitude:**	-37.75078
Elevation:	5 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	136	0.19	2.14	0.80	0.76	1.24	0.53	0.24	0.02
Nitrate Nitrite Nitrogen (g/m3)	136	<0.001	1.36	0.62	0.59	0.99	0.34	0.21	0.02
Total Ammoniacal Nitrogen (g/m3)	140	<0.002	0.148	0.014	0.010	0.038	0.004	0.016	0.001
Total Phosphorus (g/m3)	140	0.006	0.289	0.031	0.023	0.059	0.012	0.035	0.003
Dissolved Reactive Phosphorus (g/m3)	134	0.002	0.038	0.013	0.012	0.022	0.005	0.006	0.000
Dissolved Oxygen Sat (%)	86	61.6	142.2	99.7	100.5	106.7	93.1	8.1	0.9
Dissolved Oxygen (g/m3)	139	6.07	14.62	10.18	10.26	11.66	8.75	1.07	0.09
Escherichia coli (cfu/100ml)	139	32	10000	699	220	3740	59	1576	134
Total Suspended Solids (g/m3)	138	<1	196.00	7.64	3.00	21.35	1.19	19.25	1.64
Turbidity (NTU)	140	0.7	48.3	3.9	1.9	10.7	0.9	7.0	0.6
Water Clarity (m)	123	0.13	8.96	2.25	2.15	3.96	0.60	1.14	0.10
Conductivity (uS/cm)	140	42	90	68	68	77	55	7	1
pH (pH Units)	139	6.6	7.5	7.1	7.1	7.4	6.8	0.2	0.0
Water Temperature (degC)	140	7.6	21.9	14.2	13.8	19.6	9.0	3.3	0.3
Discharge (m3/s)	62	0.50	27.00	2.50	1.70	4.40	0.90	3.50	0.40

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

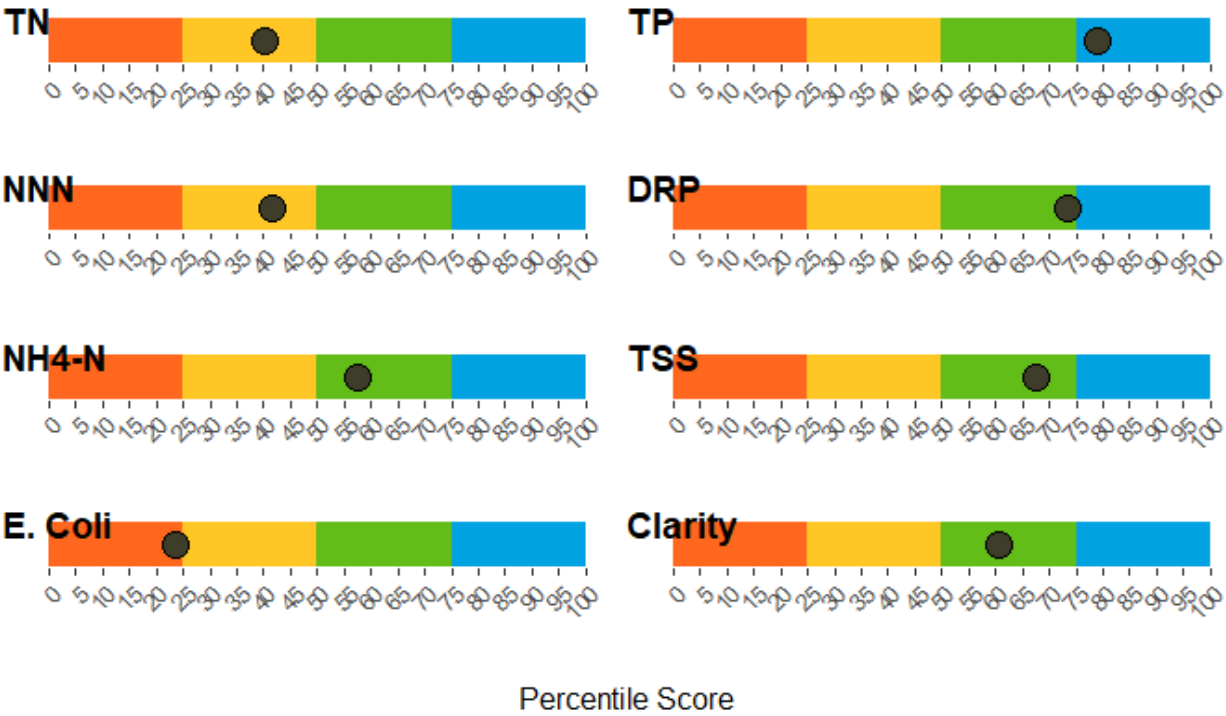

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

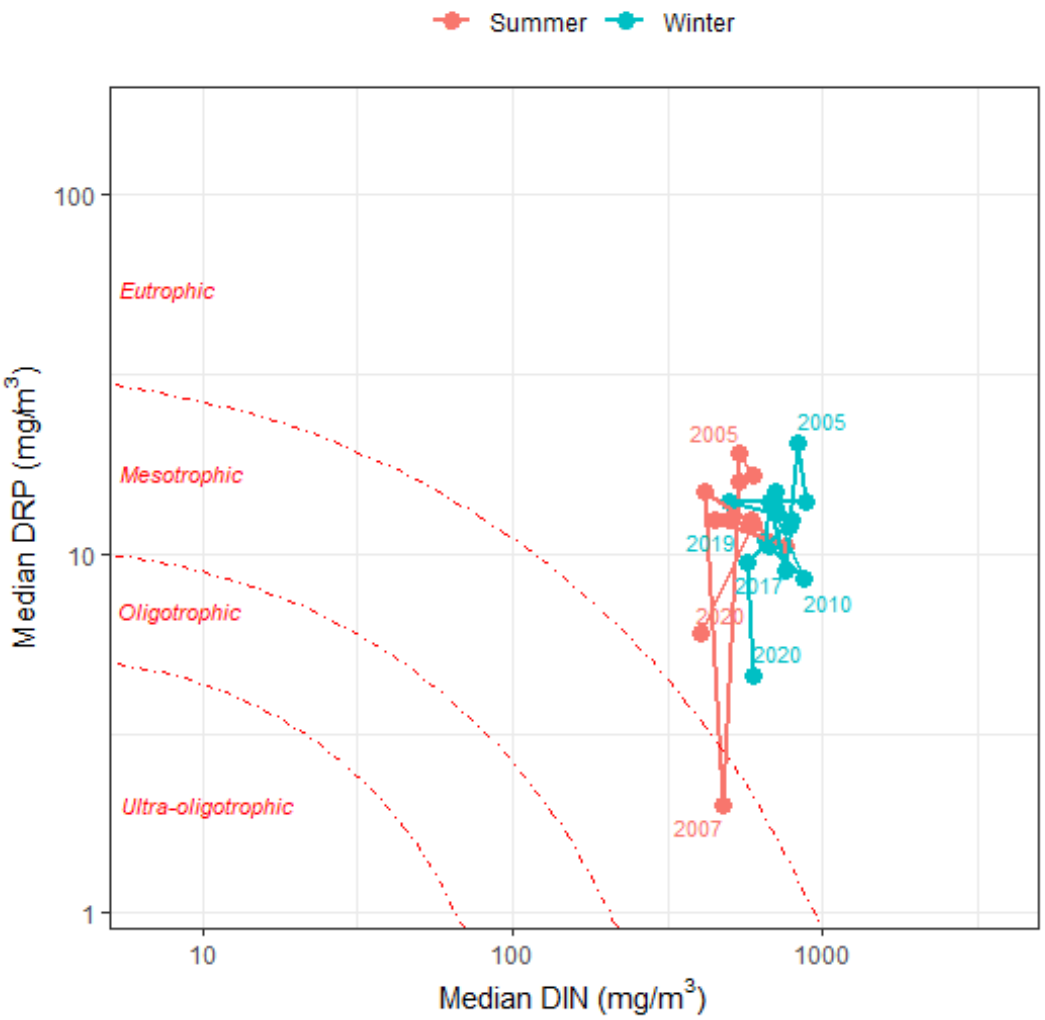

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.0060	0.021	A
5 Years	2015-12-12	2020-12-10	57	0.0040	0.021	A
10 Years	2010-12-13	2020-12-10	81	0.0040	0.021	A
All	2001-07-23	2020-12-10	139	0.0045	0.057	B

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	10	0.54	0.89	A
5 Years	2015-12-12	2020-12-10	57	0.61	0.91	A
10 Years	2010-12-13	2020-12-10	81	0.62	0.98	A
All	2001-07-23	2020-12-10	136	0.59	0.99	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-12	2020-12-10	55	2.29	A*
10 Years	2010-12-13	2020-12-10	73	2.20	A
All	2001-07-23	2020-12-10	122	2.15	A

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-12	2020-12-10	57	0.011	0.018	C
10 Years	2010-12-13	2020-12-10	81	0.011	0.018	C
All	2001-07-23	2020-12-10	133	0.012	0.022	C

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	57	19.3	38.6	190	6200	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	57	190	6425	61.4	19.3	19.3
10 Years	2010-12-13	2020-12-10	81	210	5330	59.3	19.8	21
All	2001-07-23	2020-12-10	139	220	3770	59	19.4	21.6

Time series plots

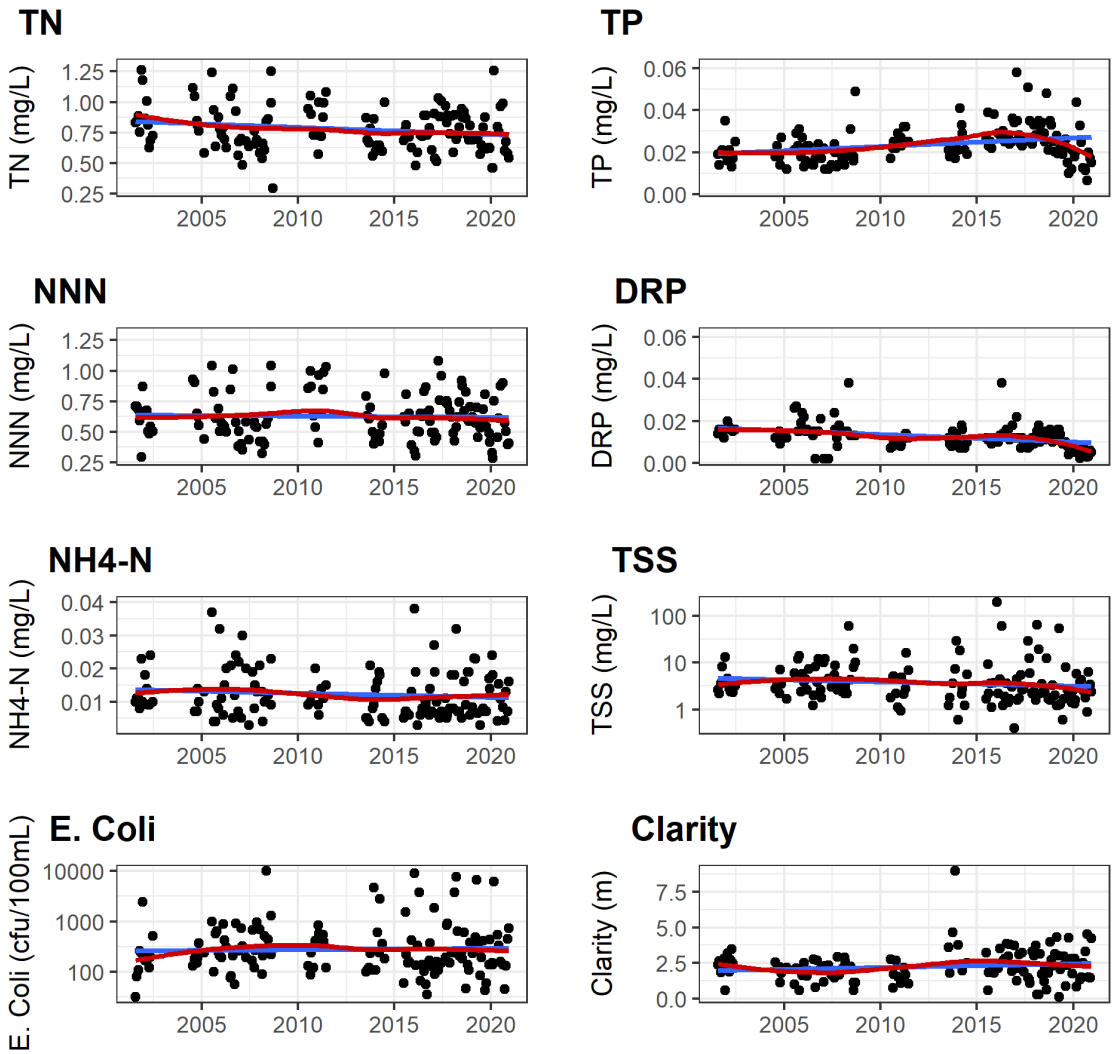

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-10	-0.0202	-2.69	0.14	Indeterminant	YES	NO	Likely Improving
TN	10 Years	2011-01-18	2020-12-10	-0.0131	-1.75	0.31	Indeterminant	YES	NO	Likely Improving
TN	All	2001-08-16	2020-12-10	-0.0131	-1.75	0.31	Indeterminant	YES	NO	Likely Improving
NNN	5 Years	2016-01-19	2020-12-10	-0.0194	-3.21	0.13	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2011-01-18	2020-12-10	-0.0184	-2.99	0.15	Indeterminant	YES	YES	Likely Improving
NNN	All	2001-08-16	2020-12-10	-0.0184	-2.99	0.15	Indeterminant	YES	YES	Likely Improving
NH4N	5 Years	2016-01-19	2020-12-10	0.0000	-0.04	1.00	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	10 Years	2011-01-18	2020-12-10	0.0003	3.61	0.36	Indeterminant	YES	YES	Likely Degrading
NH4N	All	2001-08-16	2020-12-10	0.0003	3.61	0.36	Indeterminant	YES	YES	Likely Degrading
TP	5 Years	2016-01-19	2020-12-10	-0.0037	-14.11	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-18	2020-12-10	-0.0028	-10.47	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	All	2001-08-16	2020-12-10	-0.0028	-10.47	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2016-01-19	2020-12-10	-0.0018	-16.04	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-10	-0.0014	-12.60	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	All	2001-08-16	2020-12-10	-0.0014	-12.60	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-19	2020-12-10	0.0264	1.16	0.48	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-10	0.0506	2.22	0.43	Indeterminant	YES	YES	Likely Degrading
ECOLI	All	2001-08-16	2020-12-10	0.0506	2.22	0.43	Indeterminant	YES	YES	Likely Degrading
TSS	5 Years	2016-01-19	2020-12-10	-0.0108	-2.03	0.60	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-01-18	2020-12-10	-0.0023	-0.43	0.93	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	2001-08-16	2020-12-10	-0.0023	-0.43	0.93	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	5 Years	2016-01-19	2020-12-10	-0.0161	-0.66	0.81	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2011-01-18	2020-12-10	0.0127	0.55	0.85	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	All	2001-08-16	2020-12-10	0.0127	0.55	0.85	Indeterminant	YES	NO	Indeterminate/Uncertain

Wairoa at SH 2

March 2021

Table 1 Site metadata.

Aquarius ID:	DP281304	**Labstar ID:**	BOP110034, BOP710010, BOP160122
LAWA ID:	EBOP-00037	**REC Reach:**	4001128
Easting:	1872819	**Northing:**	5823049
Longitude:	176.09441	**Latitude:**	-37.69922
Elevation:	1 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	154	0.32	1.76	0.60	0.57	0.87	0.44	0.17	0.01
Nitrate Nitrite Nitrogen (g/m3)	154	0.16	1.23	0.42	0.42	0.54	0.25	0.11	0.01
Total Ammoniacal Nitrogen (g/m3)	163	<0.002	0.101	0.016	0.014	0.033	0.003	0.012	0.001
Total Phosphorus (g/m3)	166	0.006	0.220	0.035	0.029	0.073	0.016	0.026	0.002
Dissolved Reactive Phosphorus (g/m3)	162	0.002	0.026	0.011	0.010	0.018	0.004	0.005	0.000
Dissolved Oxygen Sat (%)	121	44.8	117.2	98.4	98.8	111.8	87.2	8.6	0.8
Dissolved Oxygen (g/m3)	161	4.55	15.50	10.07	10.19	11.36	8.68	1.10	0.09
Escherichia coli (cfu/100ml)	165	<1	10000	517	80	2947	15	1419	110
Total Suspended Solids (g/m3)	162	<1	166.00	13.04	8.43	40.86	2.03	17.54	1.38
Turbidity (NTU)	166	0.8	55.0	5.5	3.8	15.5	1.3	6.5	0.5
Water Clarity (m)	87	0.29	4.23	1.35	1.15	2.94	0.50	0.80	0.09
Conductivity (uS/cm)	166	36	10700	408	222	1084	53	966	75
pH (pH Units)	166	6.1	7.4	7.0	7.0	7.2	6.6	0.2	0.0
Water Temperature (degC)	163	8.6	22.3	15.0	14.7	20.4	10.1	3.4	0.3
Discharge (m3/s)	152	0.40	112.20	19.70	17.90	35.70	1.20	14.90	1.20

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

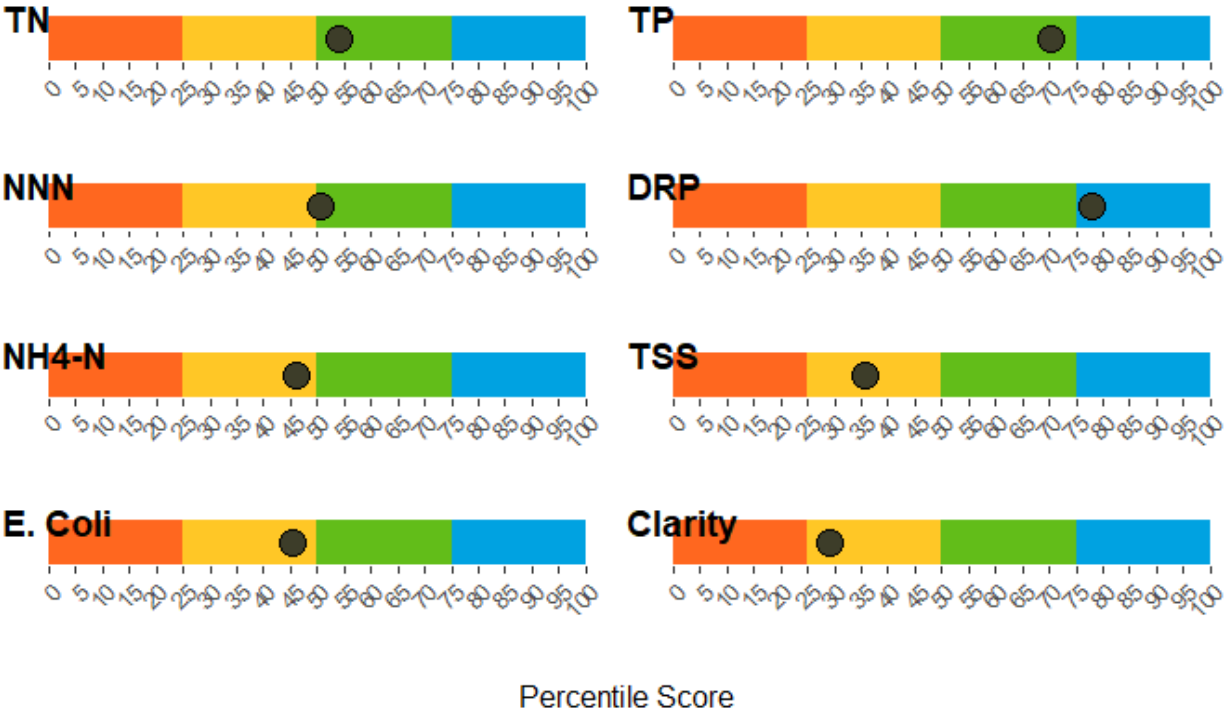

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

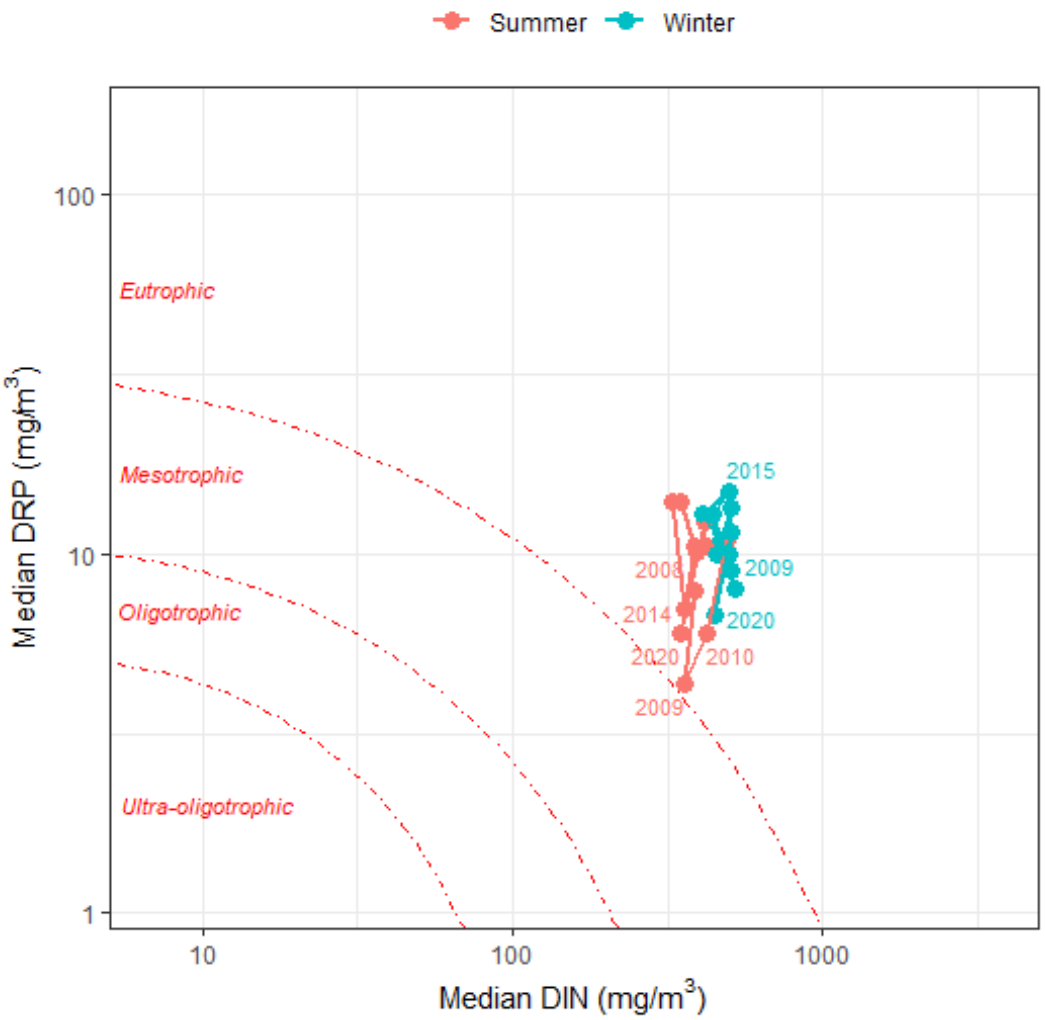

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.0050	0.013	A
5 Years	2015-12-12	2020-12-10	57	0.0050	0.020	A
10 Years	2010-12-13	2020-12-10	115	0.0050	0.038	A
All	1991-03-04	2020-12-10	163	0.0057	0.038	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	10	0.41	0.48	A
5 Years	2015-12-12	2020-12-10	57	0.42	0.53	A
10 Years	2010-12-13	2020-12-10	115	0.42	0.54	A
All	1993-06-29	2020-12-10	154	0.42	0.54	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-12	2020-12-10	54	1.42	C*
10 Years	2010-12-13	2020-12-10	70	1.31	D
All	1992-09-10	2020-12-10	85	1.14	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-12	2020-12-10	57	0.011	0.017	C
10 Years	2010-12-13	2020-12-10	115	0.011	0.017	C
All	1991-03-04	2020-12-10	161	0.010	0.018	B

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	57	15.8	28.1	90	3860	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	57	90	3995	71.9	12.3	15.8
10 Years	2010-12-13	2020-12-10	115	93	3608	72.2	9.6	18.3
All	1991-03-04	2020-12-10	165	80	3200	75.8	8.5	15.8

Time series plots

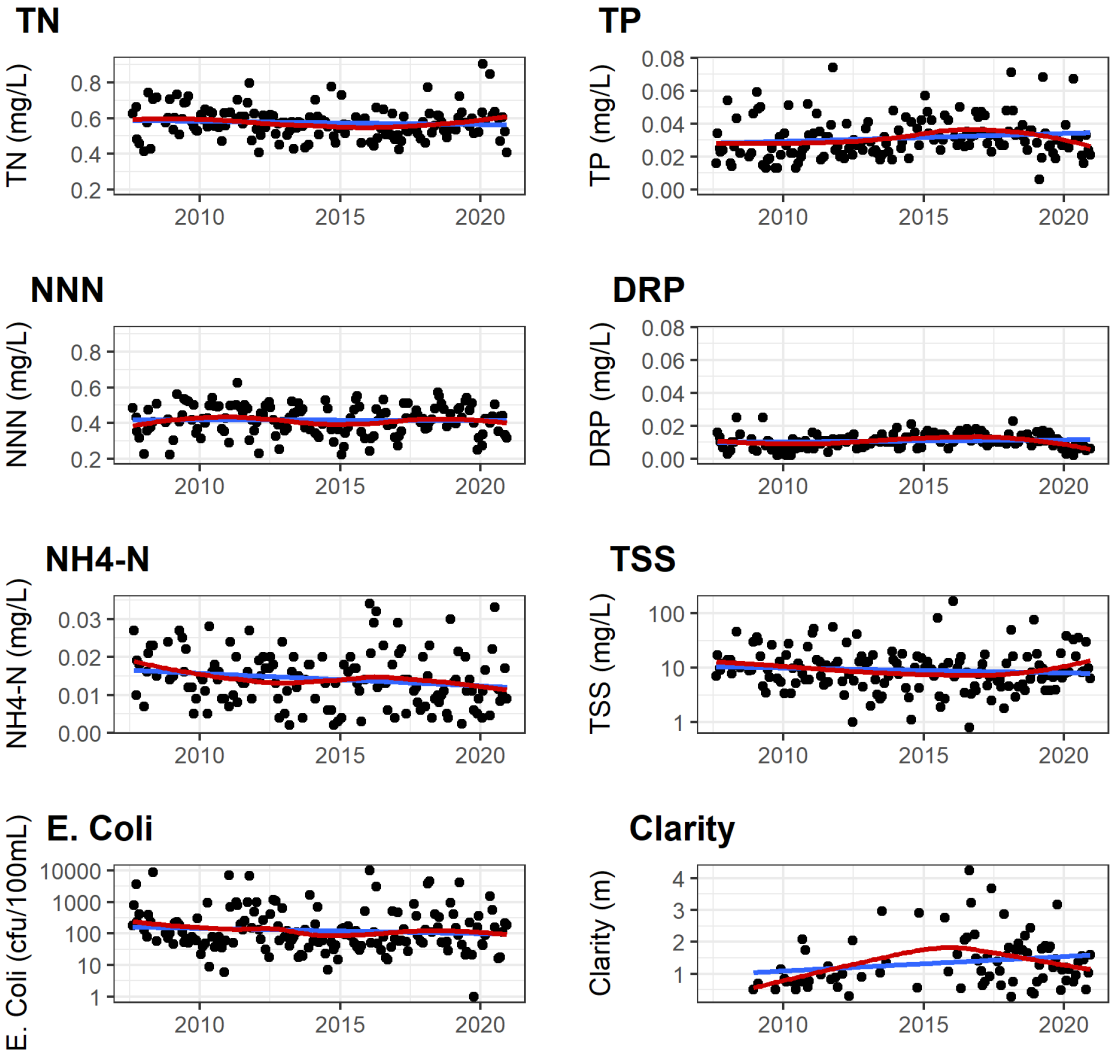

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-10	0.0132	2.38	0.15	Indeterminant	YES	NO	Very Likely Degrading
TN	10 Years	2011-01-18	2020-12-10	-0.0016	-0.28	0.57	Indeterminant	YES	NO	Likely Improving
TN	All	2007-08-09	2020-12-10	-0.0031	-0.54	0.13	Indeterminant	YES	NO	Likely Improving
NNN	5 Years	2016-01-19	2020-12-10	-0.0009	-0.20	0.82	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	10 Years	2011-01-18	2020-12-10	-0.0009	-0.22	0.72	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	All	2007-08-09	2020-12-10	-0.0015	-0.35	0.28	Indeterminant	YES	YES	Likely Improving
NH4N	5 Years	2016-01-19	2020-12-10	-0.0003	-2.64	0.60	Indeterminant	YES	YES	Likely Improving
NH4N	10 Years	2011-01-18	2020-12-10	-0.0003	-2.63	0.19	Indeterminant	YES	NO	Likely Improving
NH4N	All	2007-08-09	2020-12-10	-0.0004	-2.71	<0.05	Decreasing	YES	YES	Very Likely Improving
TP	5 Years	2016-01-19	2020-12-10	-0.0021	-6.61	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-18	2020-12-10	0.0004	1.12	0.39	Indeterminant	YES	YES	Likely Degrading
TP	All	2007-08-09	2020-12-10	0.0007	2.50	<0.05	Increasing	YES	YES	Very Likely Degrading
DRP	5 Years	2016-01-19	2020-12-10	-0.0013	-12.03	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-10	-0.0001	-0.54	0.64	Indeterminant	YES	YES	Likely Improving
DRP	All	2007-08-09	2020-12-10	0.0001	1.41	0.19	Indeterminant	YES	YES	Very Likely Degrading
ECOLI	5 Years	2016-01-19	2020-12-10	0.0134	0.68	0.68	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-10	-0.0134	-0.67	0.41	Indeterminant	YES	NO	Likely Improving
ECOLI	All	2007-08-09	2020-12-10	-0.0161	-0.82	0.14	Indeterminant	YES	NO	Likely Improving
TSS	5 Years	2016-01-19	2020-12-10	0.0358	3.79	0.16	Indeterminant	YES	NO	Very Likely Degrading
TSS	10 Years	2011-01-18	2020-12-10	-0.0015	-0.15	0.91	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	2007-08-09	2020-12-10	-0.0086	-0.87	0.18	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-19	2020-12-10	-0.1326	-9.33	0.06	Decreasing	YES	NO	Very Likely Degrading
CLARITY	10 Years	2011-01-18	2020-12-10	-0.0161	-1.23	0.69	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	All	2007-08-09	2020-12-10	0.0219	1.91	0.28	Indeterminant	YES	NO	Likely Improving

Kopurererua at SH 2

March 2021

Table 1 Site metadata.

Aquarius ID:	DP784306	**Labstar ID:**	BOP710009
LAWA ID:	EBOP-00006	**REC Reach:**	4001195
Easting:	1877840	**Northing:**	5823064
Longitude:	176.15126	**Latitude:**	-37.69757
Elevation:	2 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	203	0.16	2.65	1.15	1.12	1.48	0.91	0.25	0.02
Nitrate Nitrite Nitrogen (g/m3)	203	<0.001	1.21	0.89	0.93	1.09	0.57	0.18	0.01
Total Ammoniacal Nitrogen (g/m3)	211	<0.002	0.432	0.080	0.061	0.194	0.009	0.066	0.005
Total Phosphorus (g/m3)	214	0.006	0.322	0.046	0.040	0.088	0.021	0.031	0.002
Dissolved Reactive Phosphorus (g/m3)	211	0.002	0.043	0.016	0.015	0.025	0.007	0.006	0.000
Dissolved Oxygen Sat (%)	137	58.4	116.4	89.6	89.5	106.6	71.9	10.6	0.9
Dissolved Oxygen (g/m3)	210	4.96	12.40	9.20	9.38	10.70	7.23	1.13	0.08
Escherichia coli (cfu/100ml)	205	8	6600	449	190	1700	37	863	60
Total Suspended Solids (g/m3)	206	1.40	350.00	23.31	13.00	63.25	3.93	39.63	2.76
Turbidity (NTU)	191	0.5	203.0	12.9	6.8	30.1	3.0	25.8	1.9
Water Clarity (m)	110	0.12	2.96	0.97	0.91	1.73	0.24	0.52	0.05
Conductivity (uS/cm)	198	64	59200	597	184	1139	75	4205	299
pH (pH Units)	196	6.1	7.4	6.9	7.0	7.2	6.6	0.2	0.0
Water Temperature (degC)	212	8.8	21.8	15.0	15.0	19.6	10.6	2.9	0.2
Discharge (m3/s)	213	1.00	18.60	2.00	1.80	2.90	1.30	1.30	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

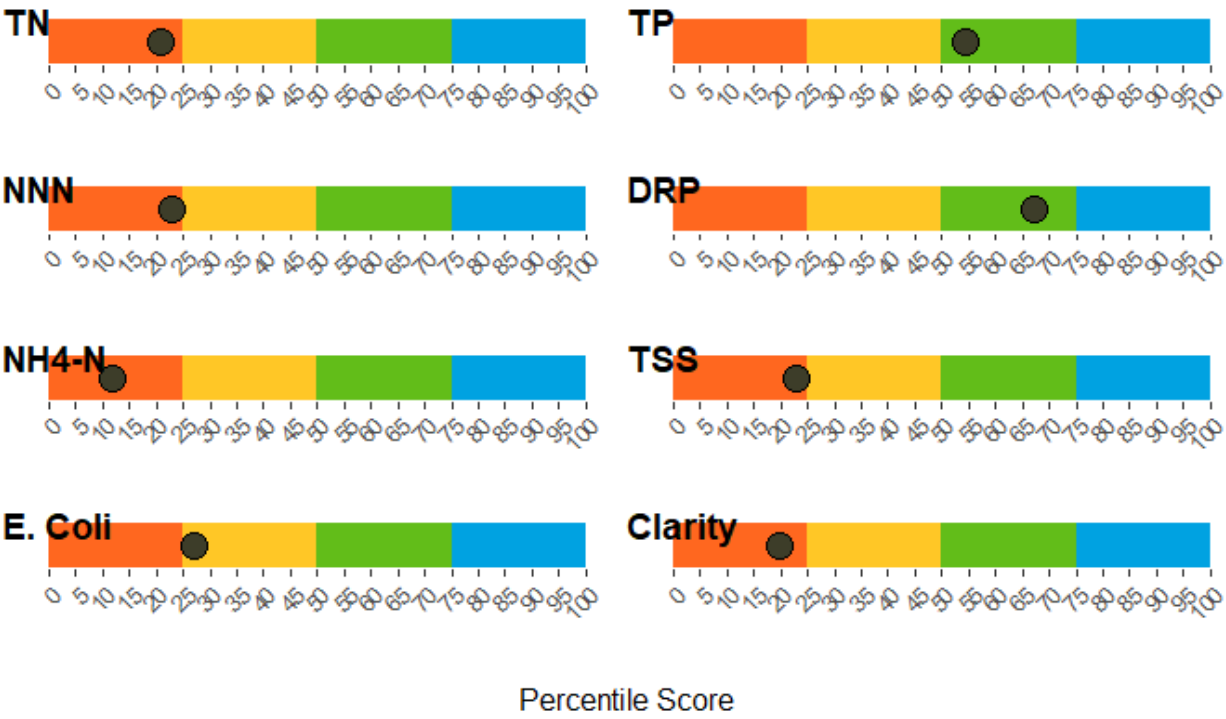

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

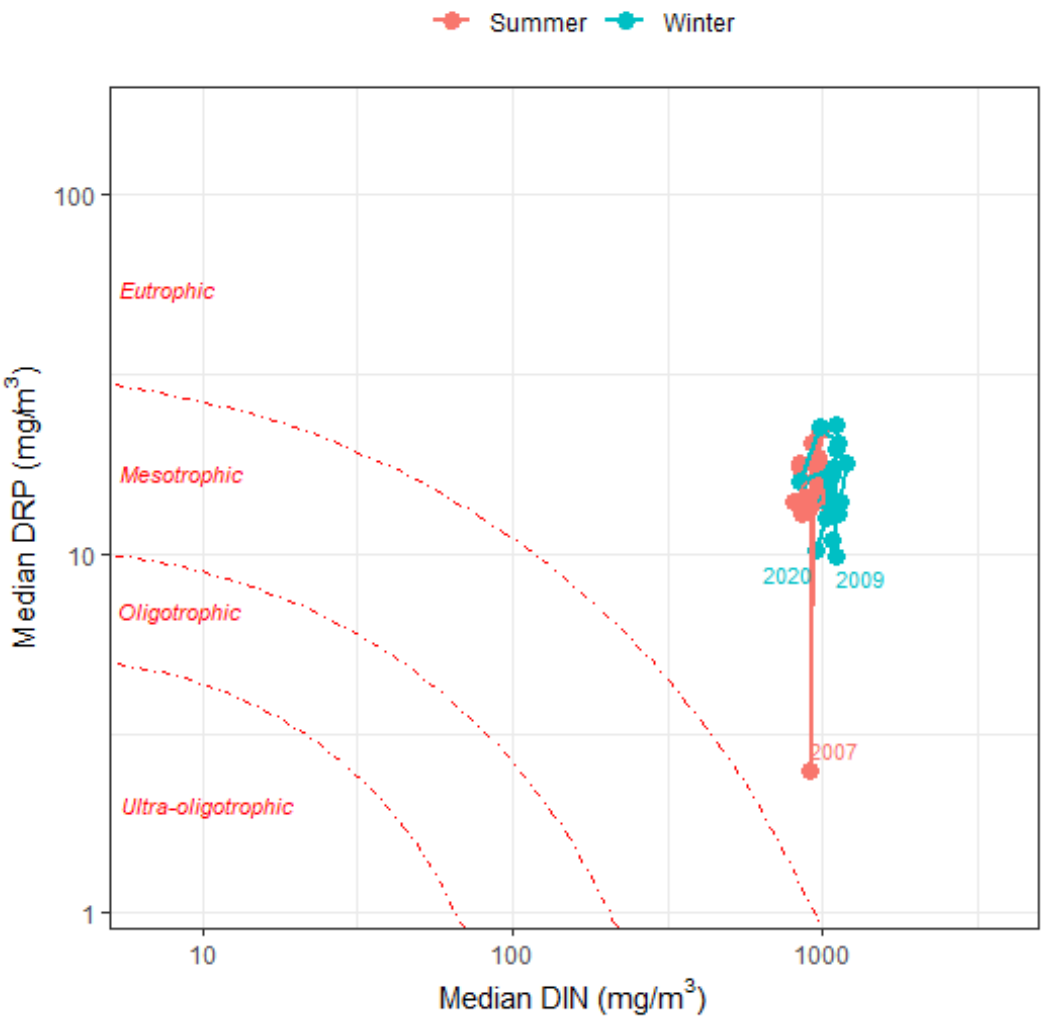

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.027	0.06	B
5 Years	2015-12-12	2020-12-10	56	0.027	0.17	B
10 Years	2010-12-13	2020-12-10	113	0.024	0.17	B
All	1990-11-02	2020-12-10	193	0.025	0.17	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-22	2020-12-21	18	0.81	0.99	A
5 Years	2015-12-23	2020-12-21	72	0.90	1.09	A
10 Years	2010-12-24	2020-12-21	130	0.92	1.12	A
All	2001-07-24	2020-12-21	203	0.93	1.09	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-23	2020-12-21	67	1.00	D
10 Years	2010-12-24	2020-12-21	90	0.93	D
All	2007-02-14	2020-12-21	109	0.91	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-23	2020-12-21	72	0.014	0.022	C
10 Years	2010-12-24	2020-12-21	130	0.015	0.022	C
All	1990-11-01	2020-12-21	210	0.015	0.025	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-23	2020-12-21	72	19.4	47.2	245	1970	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-23	2020-12-21	72	245	2240	52.8	27.8	19.4
10 Years	2010-12-24	2020-12-21	130	200	2300	60.8	22.3	16.9
All	2001-07-24	2020-12-21	205	190	1825	63.4	21	15.6

Time series plots

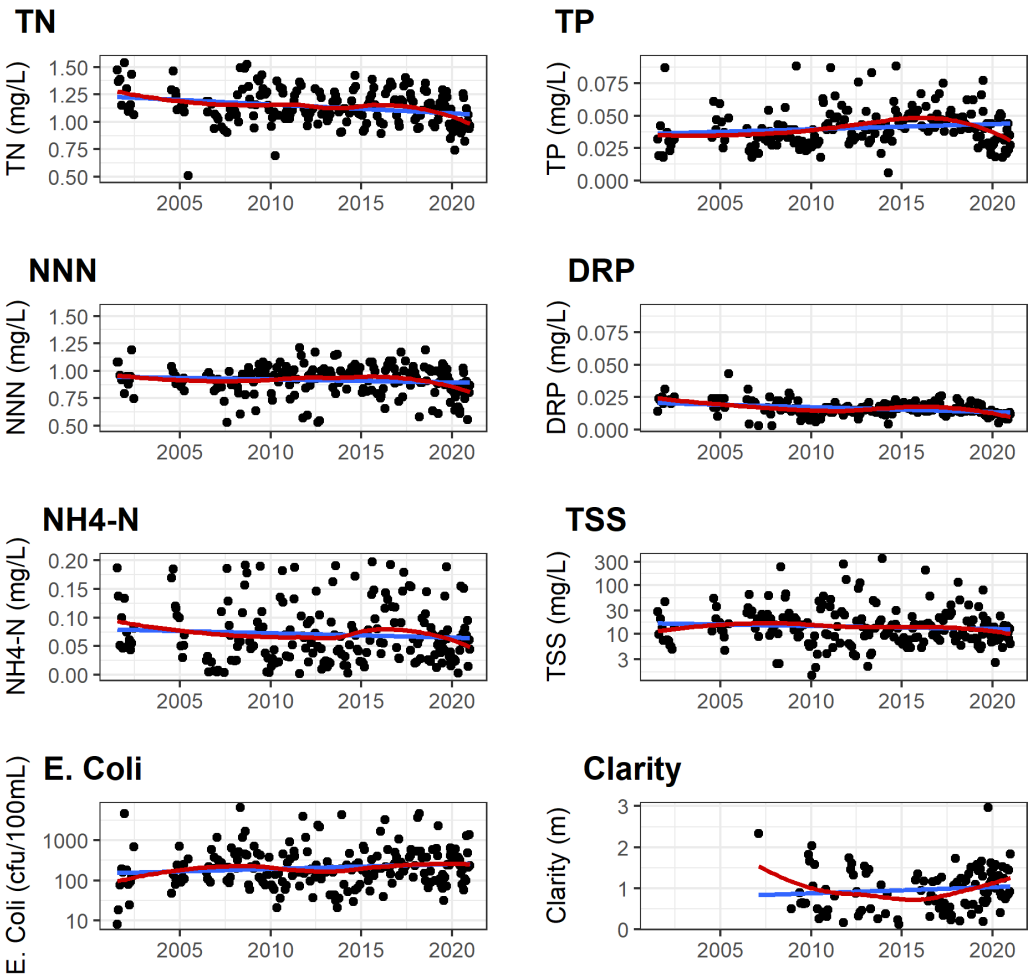

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-21	-0.0545	-4.98	<0.001	Decreasing	YES	YES	Very Likely Improving
TN	10 Years	2011-01-19	2020-12-21	-0.0074	-0.67	0.06	Decreasing	YES	YES	Very Likely Improving
TN	All	2001-07-24	2020-12-21	-0.0067	-0.60	<0.01	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-19	2020-12-21	-0.0385	-4.31	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	10 Years	2011-01-19	2020-12-21	-0.0126	-1.36	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	All	2001-07-24	2020-12-21	-0.0009	-0.10	0.59	Indeterminant	YES	YES	Likely Improving
NH4N	5 Years	2016-01-19	2020-12-21	-0.0132	-22.79	<0.01	Decreasing	YES	YES	Very Likely Improving
NH4N	10 Years	2011-01-19	2020-12-21	0.0008	1.34	0.53	Indeterminant	YES	YES	Likely Degrading
NH4N	All	2001-07-24	2020-12-21	-0.0001	-0.15	0.92	Indeterminant	YES	YES	Indeterminate/Uncertain
TP	5 Years	2016-01-19	2020-12-21	-0.0046	-11.03	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-19	2020-12-21	-0.0005	-1.25	0.26	Indeterminant	YES	NO	Likely Improving
TP	All	2001-07-24	2020-12-21	0.0005	1.37	<0.01	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-19	2020-12-21	-0.0015	-10.67	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-01-19	2020-12-21	-0.0003	-2.10	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	All	2001-07-24	2020-12-21	-0.0003	-1.82	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-19	2020-12-21	0.0386	1.62	0.51	Indeterminant	YES	YES	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-19	2020-12-21	0.0326	1.41	<0.05	Increasing	YES	YES	Very Likely Degrading
ECOLI	All	2001-07-24	2020-12-21	0.0103	0.45	0.09	Increasing	YES	YES	Very Likely Degrading
TSS	5 Years	2016-01-19	2020-12-21	-0.0301	-2.73	0.06	Decreasing	YES	NO	Very Likely Improving
TSS	10 Years	2011-01-19	2020-12-21	0.0018	0.17	0.89	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	All	2001-07-24	2020-12-21	-0.0075	-0.66	0.05	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2016-01-19	2020-12-21	0.0782	7.69	0.05	Increasing	YES	NO	Very Likely Improving
CLARITY	10 Years	2011-01-19	2020-12-21	0.0132	1.32	0.50	Indeterminant	YES	NO	Likely Improving
CLARITY	All	2001-07-24	2020-12-21	0.0132	1.45	0.22	Indeterminant	YES	YES	Likely Improving

Waitao at Waitao Road

March 2021

Table 1 Site metadata.

Aquarius ID:	EO451883	**Labstar ID:**	BOP710004
LAWA ID:	EBOP-00039	**REC Reach:**	4001643
Easting:	1884514	**Northing:**	5818831
Longitude:	176.22850	**Latitude:**	-37.73362
Elevation:	2 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

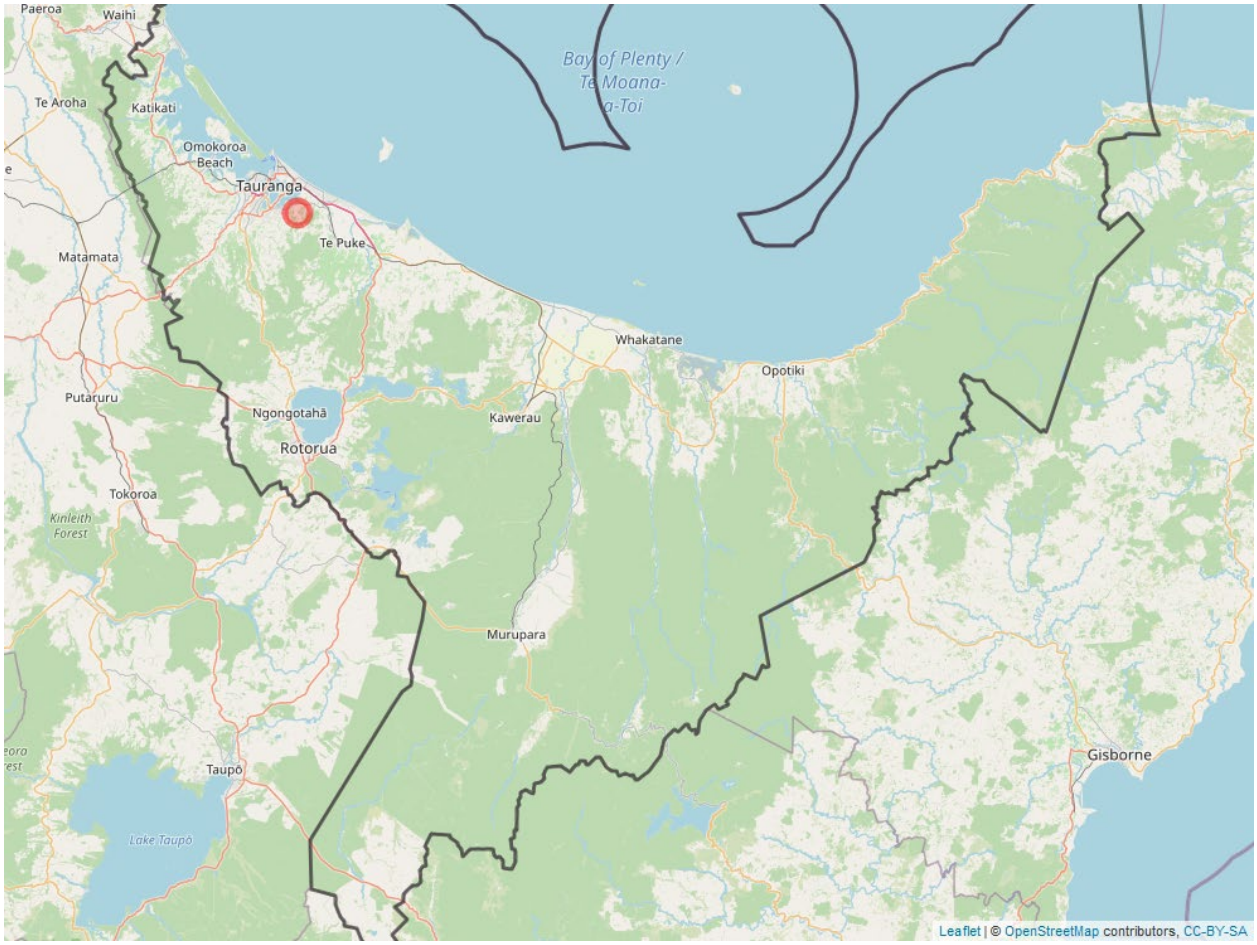

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	160	0.14	1.19	0.56	0.54	0.91	0.27	0.20	0.02
Nitrate Nitrite Nitrogen (g/m3)	159	<0.001	0.97	0.43	0.41	0.77	0.17	0.20	0.02
Total Ammoniacal Nitrogen (g/m3)	169	<0.002	0.155	0.023	0.021	0.039	0.010	0.014	0.001
Total Phosphorus (g/m3)	170	0.006	0.135	0.026	0.022	0.052	0.011	0.019	0.001
Dissolved Reactive Phosphorus (g/m3)	166	<0.001	0.028	0.009	0.008	0.017	0.003	0.004	0.000
Dissolved Oxygen Sat (%)	125	77.2	132.1	96.0	95.2	105.9	88.1	6.6	0.6
Dissolved Oxygen (g/m3)	168	7.70	13.55	9.95	9.88	11.63	8.55	1.03	0.08
Escherichia coli (cfu/100ml)	161	21	12000	873	360	4500	80	1700	134
Total Suspended Solids (g/m3)	166	<1	124.00	10.27	5.65	34.75	1.80	14.08	1.09
Turbidity (NTU)	162	1.3	42.2	4.6	2.8	14.0	1.5	5.9	0.5
Water Clarity (m)	151	0.25	5.12	1.85	1.86	2.98	0.61	0.80	0.06
Conductivity (uS/cm)	170	48	638	91	87	109	68	44	3
pH (pH Units)	169	6.1	7.8	6.9	7.0	7.4	6.6	0.3	0.0
Water Temperature (degC)	170	6.6	21.8	13.8	13.6	19.1	8.6	3.3	0.3
Discharge (m3/s)	133	0.10	2.00	0.60	0.50	1.60	0.20	0.40	0.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

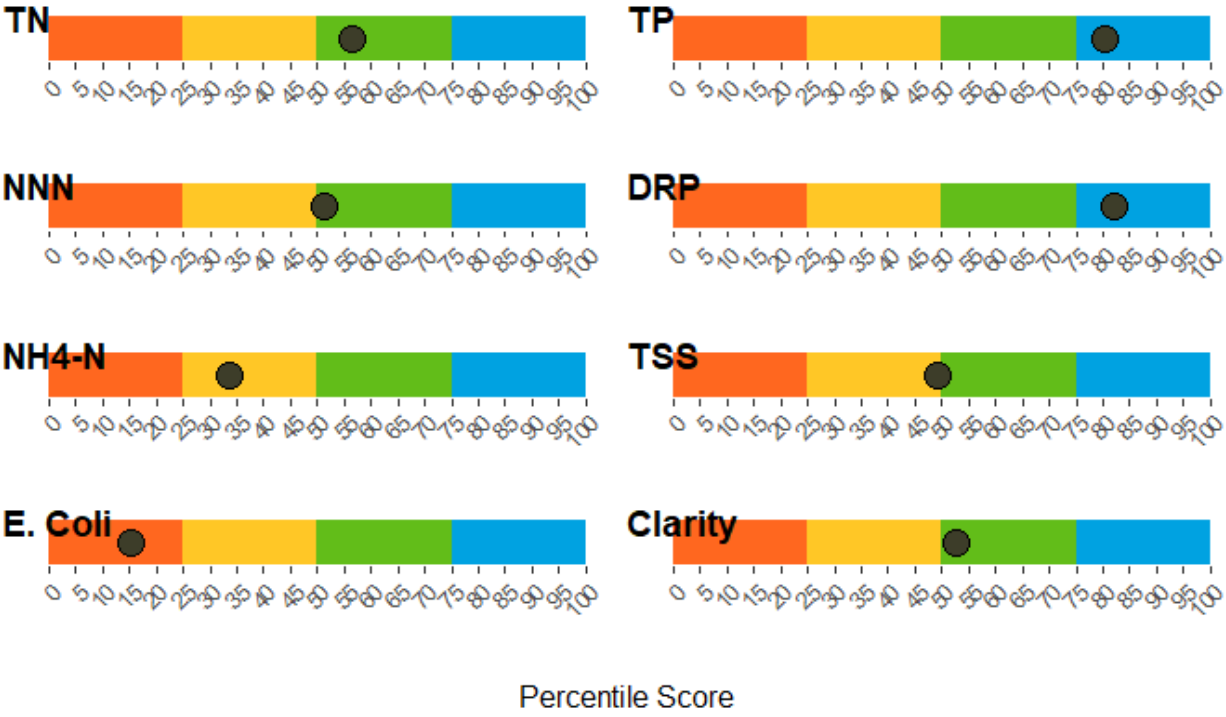

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

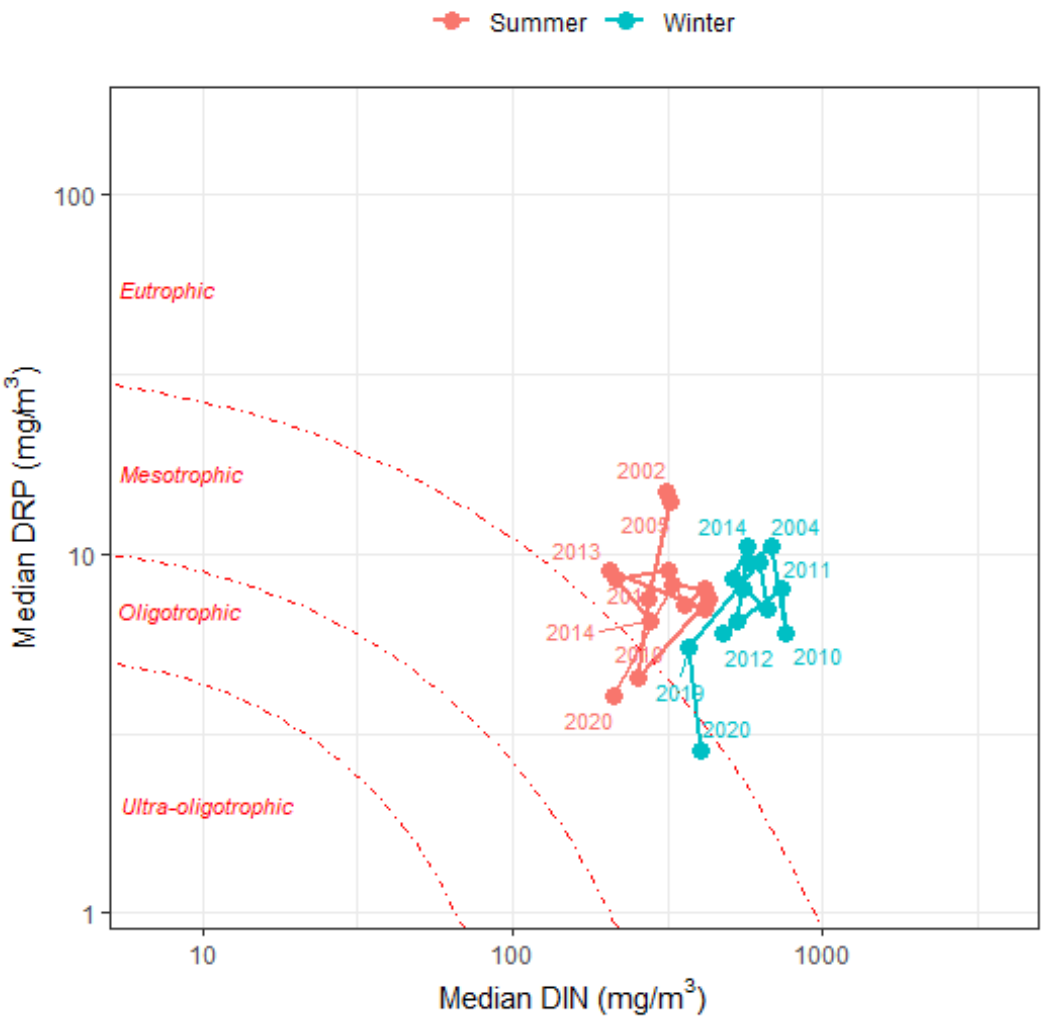

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	10	0.0070	0.012	A
5 Years	2015-12-12	2020-12-10	56	0.0080	0.020	A
10 Years	2010-12-13	2020-12-10	116	0.0080	0.020	A
All	1990-11-01	2020-12-10	168	0.0087	0.067	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	10	0.29	0.66	A
5 Years	2015-12-12	2020-12-10	56	0.41	0.72	A
10 Years	2010-12-13	2020-12-10	115	0.42	0.76	A
All	2001-07-23	2020-12-10	159	0.41	0.77	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-12	2020-12-10	55	1.69	B*
10 Years	2010-12-13	2020-12-10	108	1.99	A
All	2001-07-23	2020-12-10	150	1.88	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-12	2020-12-10	56	0.007	0.013	B
10 Years	2010-12-13	2020-12-10	116	0.007	0.013	B
All	1990-11-01	2020-12-10	165	0.008	0.017	B

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	56	41.1	76.8	430	5425	E*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	56	430	5470	23.2	35.7	41.1
10 Years	2010-12-13	2020-12-10	116	360	4780	34.5	30.2	35.3
All	2001-07-23	2020-12-10	161	360	4545	34.2	28.6	37.3

Time series plots

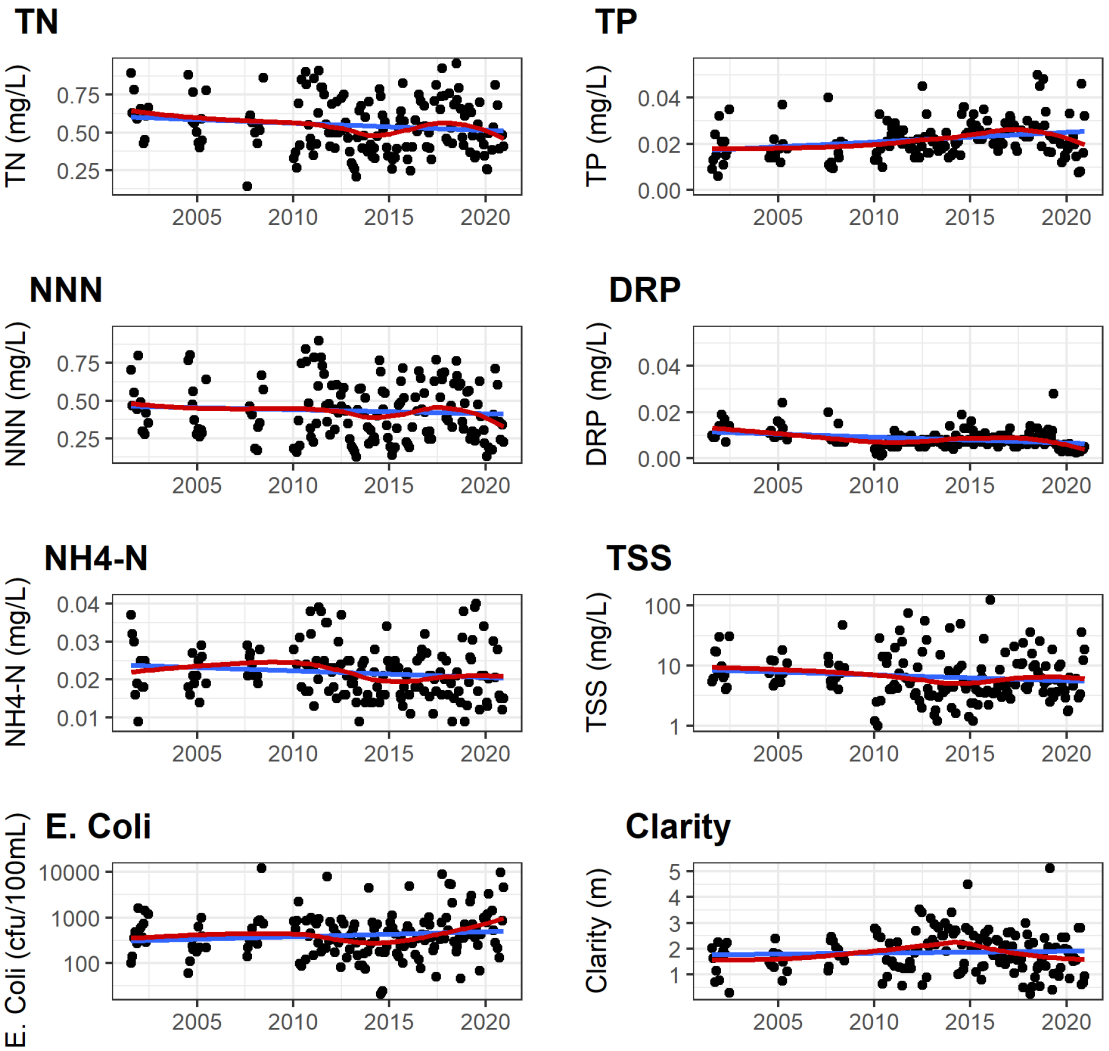

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-19	2020-12-10	-0.0131	-2.49	0.38	Indeterminant	YES	NO	Likely Improving
TN	10 Years	2011-01-18	2020-12-10	0.0001	0.02	0.95	Indeterminant	YES	YES	Indeterminate/Uncertain
TN	All	2001-08-16	2020-12-10	-0.0046	-0.89	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-19	2020-12-10	-0.0260	-6.41	<0.05	Decreasing	Attempted	YES	Very Likely Improving
NNN	10 Years	2011-01-18	2020-12-10	-0.0013	-0.31	0.89	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	All	2001-08-16	2020-12-10	-0.0020	-0.50	0.27	Indeterminant	YES	YES	Likely Improving
NH4N	5 Years	2016-01-19	2020-12-10	-0.0002	-0.80	0.80	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	10 Years	2011-01-18	2020-12-10	-0.0001	-0.55	0.62	Indeterminant	YES	NO	Likely Improving
NH4N	All	2001-08-16	2020-12-10	-0.0002	-1.06	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-19	2020-12-10	-0.0013	-5.63	0.33	Indeterminant	YES	NO	Likely Improving
TP	10 Years	2011-01-18	2020-12-10	-0.0002	-0.70	0.67	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	2001-08-16	2020-12-10	0.0003	1.34	0.09	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-19	2020-12-10	-0.0010	-14.44	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-01-18	2020-12-10	-0.0003	-3.96	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	2001-08-16	2020-12-10	-0.0003	-3.64	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-19	2020-12-10	0.1278	4.85	<0.01	Increasing	Attempted	YES	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-18	2020-12-10	0.0471	1.84	<0.01	Increasing	YES	YES	Very Likely Degrading
ECOLI	All	2001-08-16	2020-12-10	0.0157	0.61	<0.05	Increasing	YES	YES	Very Likely Degrading
TSS	5 Years	2016-01-19	2020-12-10	0.0141	1.80	0.43	Indeterminant	YES	NO	Likely Degrading
TSS	10 Years	2011-01-18	2020-12-10	0.0083	1.08	0.21	Indeterminant	YES	NO	Likely Degrading
TSS	All	2001-08-16	2020-12-10	-0.0068	-0.87	0.11	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2016-01-19	2020-12-10	-0.0994	-5.81	0.11	Indeterminant	YES	NO	Very Likely Degrading
CLARITY	10 Years	2011-01-18	2020-12-10	-0.0591	-2.99	<0.05	Decreasing	YES	NO	Very Likely Degrading
CLARITY	All	2001-08-16	2020-12-10	-0.0042	-0.22	0.74	Indeterminant	YES	NO	Indeterminate/Uncertain

Rocky at Mangatawa Lane

March 2021

Table 1 Site metadata.

Aquarius ID:	EP623312	**Labstar ID:**	BOP710032
LAWA ID:	EBOP-00023	**REC Reach:**	4001197
Easting:	1886234	**Northing:**	5823121
Longitude:	176.24631	**Latitude:**	-37.69448
Elevation:	3 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_Al		

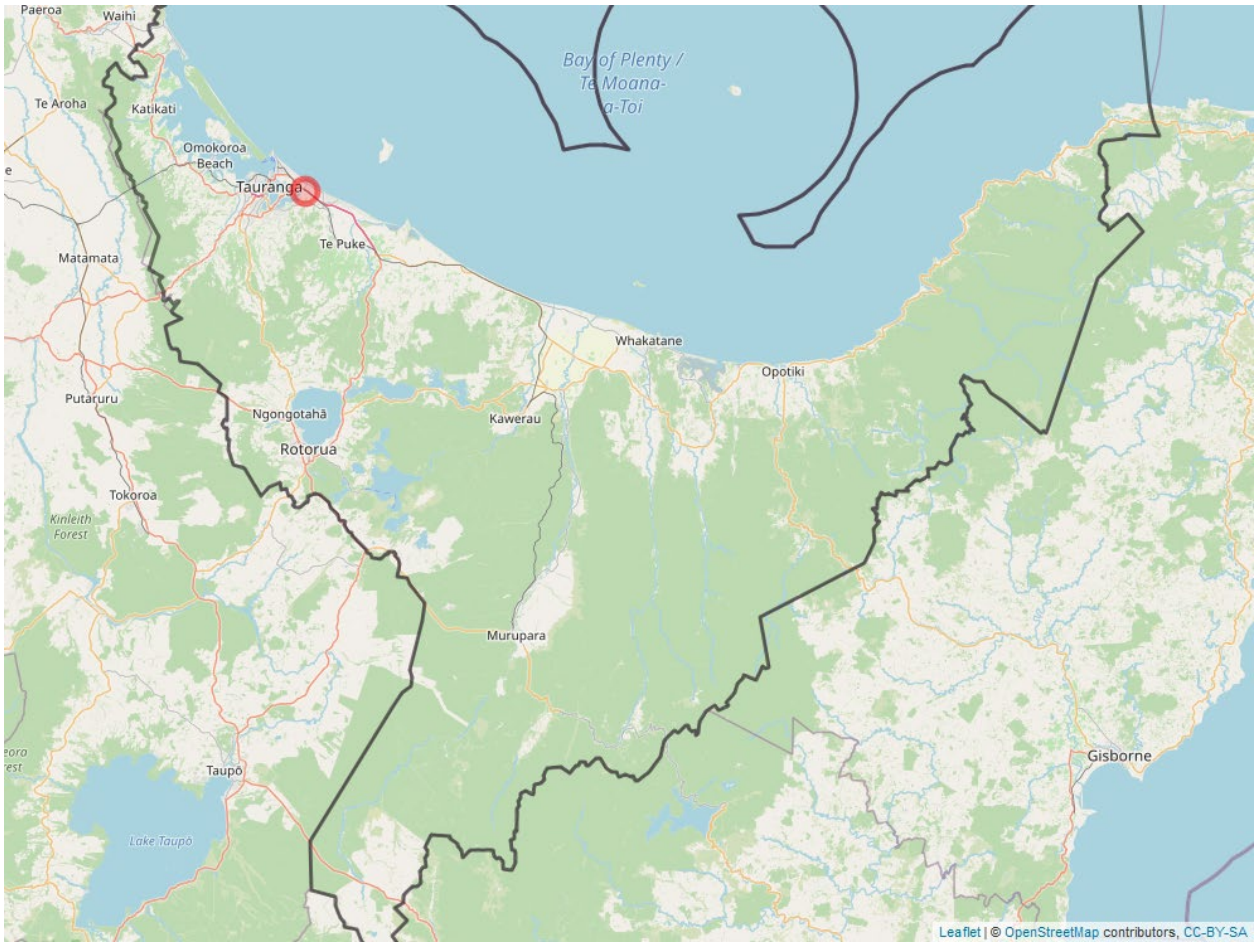

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	159	0.30	5.26	1.29	1.23	2.22	0.48	0.63	0.05
Nitrate Nitrite Nitrogen (g/m3)	160	0.01	4.66	0.76	0.75	1.27	0.08	0.47	0.04
Total Ammoniacal Nitrogen (g/m3)	167	<0.002	0.541	0.134	0.106	0.382	0.010	0.126	0.010
Total Phosphorus (g/m3)	168	0.014	0.230	0.051	0.042	0.114	0.023	0.035	0.003
Dissolved Reactive Phosphorus (g/m3)	166	<0.001	0.063	0.016	0.014	0.030	0.004	0.009	0.001
Dissolved Oxygen Sat (%)	83	3.8	168.0	82.0	84.6	124.3	19.1	30.1	3.3
Dissolved Oxygen (g/m3)	162	0.39	17.80	7.90	8.51	11.50	2.67	2.60	0.20
Escherichia coli (cfu/100ml)	159	11	5200	484	230	1730	44	828	66
Total Suspended Solids (g/m3)	166	<1	140.00	10.81	4.35	49.15	0.98	20.42	1.58
Turbidity (NTU)	161	0.5	110.0	12.6	8.1	43.3	2.5	15.0	1.2
Water Clarity (m)	96	0.05	3.62	1.07	0.96	2.53	0.22	0.71	0.07
Conductivity (uS/cm)	169	66	313	181	180	220	141	29	2
pH (pH Units)	169	6.1	8.7	6.8	6.8	7.1	6.4	0.3	0.0
Water Temperature (degC)	165	7.9	26.1	16.3	16.2	21.3	11.1	3.4	0.3
Discharge (m3/s)	136	0.00	1.70	0.20	0.10	0.60	0.00	0.20	0.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

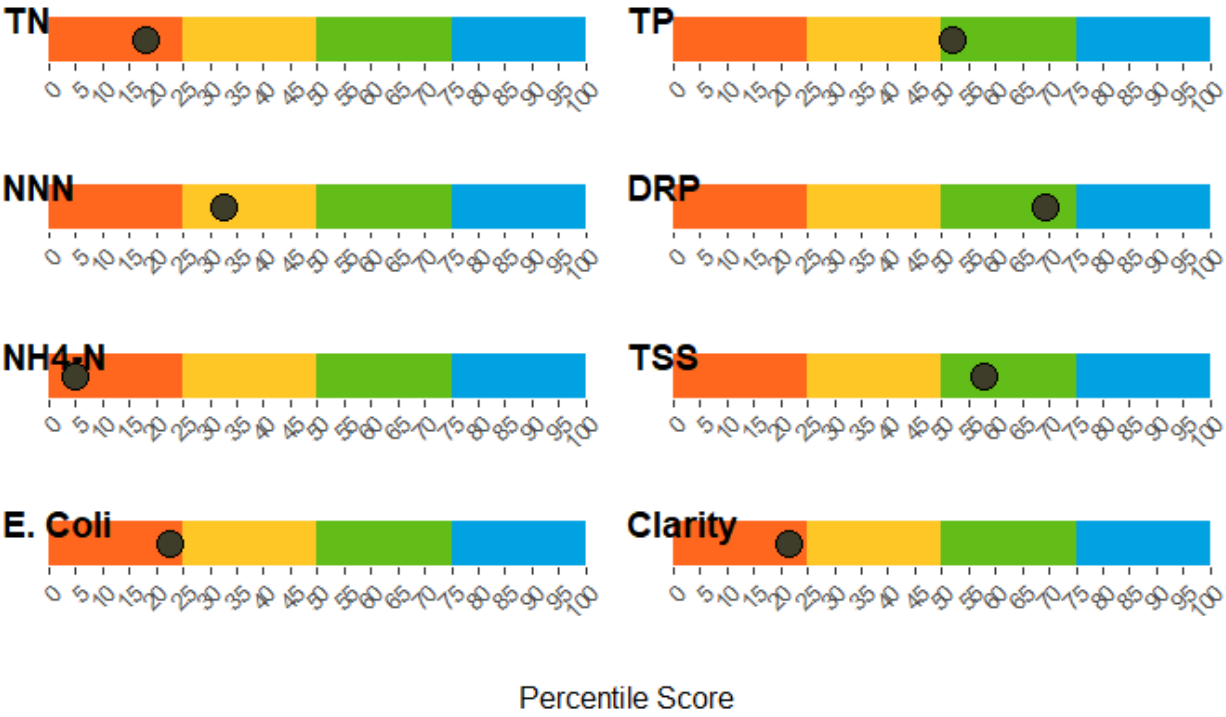

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

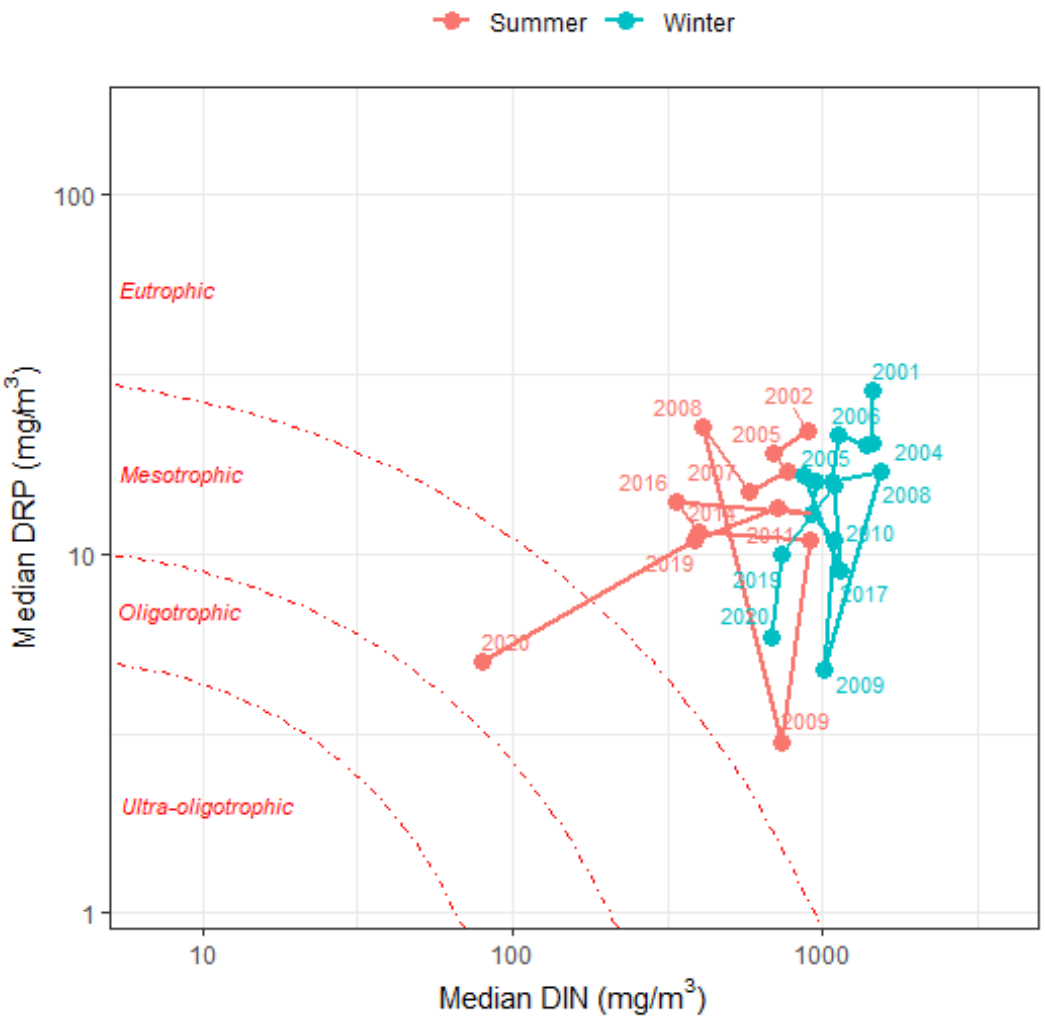

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-11	2020-12-10	11	0.040	0.12	B
5 Years	2015-12-12	2020-12-10	58	0.027	0.12	B
10 Years	2010-12-13	2020-12-10	82	0.036	0.12	B
All	1990-11-02	2020-12-10	167	0.041	0.20	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-11	2020-12-10	11	0.45	0.77	A
5 Years	2015-12-12	2020-12-10	58	0.69	1.11	A
10 Years	2010-12-13	2020-12-10	82	0.69	1.13	A
All	2001-07-24	2020-12-10	160	0.75	1.27	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-11	2020-12-10	54	1.02	A*
10 Years	2010-12-13	2020-12-10	71	0.93	B
All	2001-07-24	2020-12-10	95	0.96	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-11	2020-12-09	57	0.011	0.022	C
10 Years	2010-12-12	2020-12-09	81	0.012	0.022	C
All	1990-11-02	2020-12-09	165	0.014	0.030	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-12	2020-12-10	58	13.8	36.2	190	3730	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-12	2020-12-10	58	190	3820	63.8	22.4	13.8
10 Years	2010-12-13	2020-12-10	82	190	3780	65.9	22	12.2
All	2001-07-24	2020-12-10	159	230	1865	52.8	28.9	18.2

Time series plots

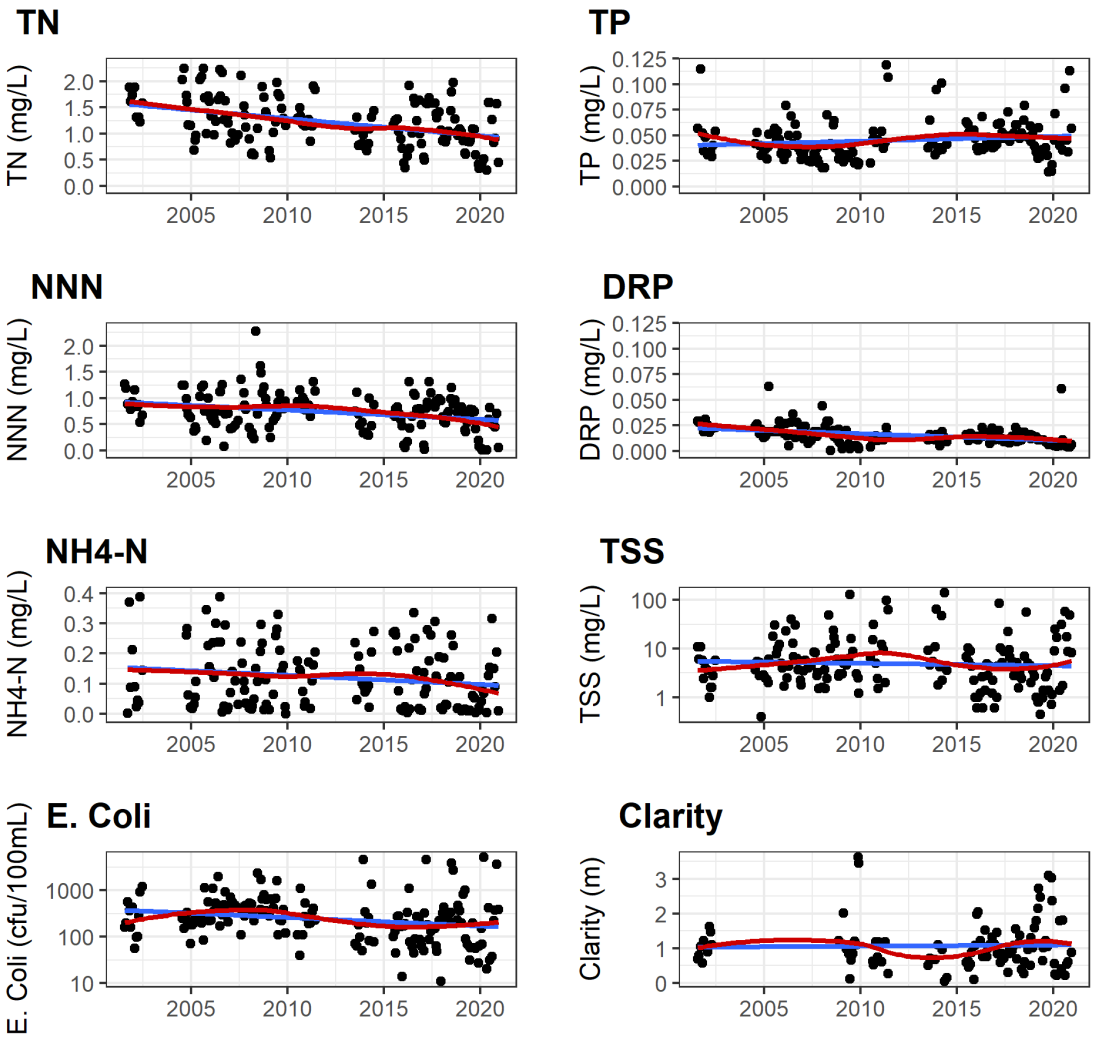

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-21	2020-12-10	-0.1038	-10.21	<0.05	Decreasing	Attempted	YES	Very Likely Improving
TN	10 Years	2011-02-03	2020-12-10	0.0169	1.64	0.18	Indeterminant	YES	YES	Very Likely Degrading
TN	All	2001-07-24	2020-12-10	-0.0305	-2.49	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-21	2020-12-10	-0.1054	-15.33	<0.01	Decreasing	Attempted	YES	Very Likely Improving
NNN	10 Years	2011-02-03	2020-12-10	0.0005	0.07	0.95	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	All	2001-07-24	2020-12-10	-0.0139	-1.89	<0.001	Decreasing	YES	YES	Very Likely Improving
NH4N	5 Years	2016-01-21	2020-12-10	0.0015	2.90	0.52	Indeterminant	YES	NO	Likely Degrading
NH4N	10 Years	2011-02-03	2020-12-10	-0.0008	-1.20	0.86	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	All	2001-07-24	2020-12-10	-0.0037	-3.43	<0.01	Decreasing	YES	YES	Very Likely Improving
TP	5 Years	2016-01-21	2020-12-10	0.0001	0.26	0.87	Indeterminant	NO	NO	Indeterminate/Uncertain
TP	10 Years	2011-02-03	2020-12-10	-0.0005	-1.13	0.47	Indeterminant	YES	NO	Likely Improving
TP	All	2001-07-24	2020-12-10	0.0004	1.05	<0.05	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-21	2020-12-10	-0.0014	-12.68	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-02-03	2020-12-10	-0.0005	-4.82	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	2001-07-24	2020-12-10	-0.0006	-4.33	<0.001	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-21	2020-12-10	0.0189	0.83	0.79	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-02-03	2020-12-10	-0.0021	-0.09	0.91	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2001-07-24	2020-12-10	-0.0186	-0.79	<0.01	Decreasing	YES	NO	Very Likely Improving
TSS	5 Years	2016-01-21	2020-12-10	0.0579	9.99	0.10	Increasing	YES	NO	Very Likely Degrading
TSS	10 Years	2011-02-03	2020-12-10	-0.0139	-2.23	0.57	Indeterminant	YES	NO	Likely Improving
TSS	All	2001-07-24	2020-12-10	-0.0035	-0.50	0.38	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2016-01-21	2020-12-10	-0.0948	-8.91	0.33	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2011-02-03	2020-12-10	0.0577	5.77	0.23	Indeterminant	YES	NO	Likely Improving
CLARITY	All	2001-07-24	2020-12-10	0.0038	0.38	0.72	Indeterminant	YES	NO	Indeterminate/Uncertain

Kaituna, Maketū and Pongakawa WMA

The Kaituna, Maketū and Pongakawa WMA incorporate the catchments of two estuaries that are sensitive receiving environments for many of the streams in the WMA. The Ongatoro / Maketū Estuary has important ecological values for birds, fishing, shellfish gathering and biodiversity. The lower estuary is in reasonable ecological health, but large areas of the inner estuary are highly degraded. The main rivers feeding Maketū estuary are the Kaituna River and the much smaller Waitipuia Stream.

The Kaituna River is the largest river in the WMA. It originates at the outlet of Lake Rotoiti and about half the water in the Kaituna comes from Lake Rotoiti (see Rotorua WMA). The first 25 km of the Kaituna River below Rotoiti outlet is steep and fast flowing over waterfalls and through an incised gorge. The lower catchment is flat and low lying; used predominantly for agricultural purposes that has been converted on top of volcanic ash soil. There are also fragments of native and exotic bush scattered throughout the catchment. The Paraiti River is a major tributary to the Kaituna River that enters about halfway down the catchment.

A number of works have been implemented as part of the Kaituna River and Ōngātoro/Maketu Estuary Strategy to improve the health of the Kaituna River and Maketū Estuary. This includes extensive wetland restoration and re-diversion of more of the Kaituna River back into the Maketū Estuary to maximise the ecological and cultural benefits.

The main rivers feeding the Waihi Estuary are the Pongakawa River, Pokopoko Stream, and Wharere Stream. The Pongakawa River is a spring-fed stream with relatively stable flows.

Table 4 NERMN sites in the Kaituna, Maketū, and Pongakawa WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Kaituna, Maketū and Pongakawa								
FN834668	Kaituna at Maungarangi Road	1898345	5806689	VA/Gentle	AE	712	22.2	M
FO497605	Kaituna at Clarkes	1894979	5816054	VA/Gentle	CR	1138	7.8	Impact M
FO620177	Kaituna at Te Matai	1896202	5811773	VA/Gentle	CR	971	13	M
FO761142	Kaituna at AFFCO Intake	1897610	5811421	VA/Gentle	AE	937	15.4	Impact M
GM781934	Pongakawa at Pumphouse	1907814	5799349	VA/Gentle	AE	55	19.2	M
GN849464	Pongakawa at Old Coach Road	1908494	5804645	VA/Gentle	AE	102	12.3	M
GN922883	Pongakawa at SH 2	1909225	5808837	VA/Gentle	DEV	120	6.5	M
GO089653	Kaituna at Te Tumu	1900764	5816420	VA/Gentle	CR	1198	1.6	
HN674689	Waitahanui at Otamarakau Marae	1916743	5806891	VA/Steep	AE	118	1.4	M

Kaituna at Maungarangi Road

March 2021

Table 1 Site metadata.

Aquarius ID:	FN834668	**Labstar ID:**	BOP110027
LAWA ID:	EBOP-00003	**REC Reach:**	4003662
Easting:	1898345	**Northing:**	5806689
Longitude:	176.39020	**Latitude:**	-37.83847
Elevation:	8 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Lake_VA		

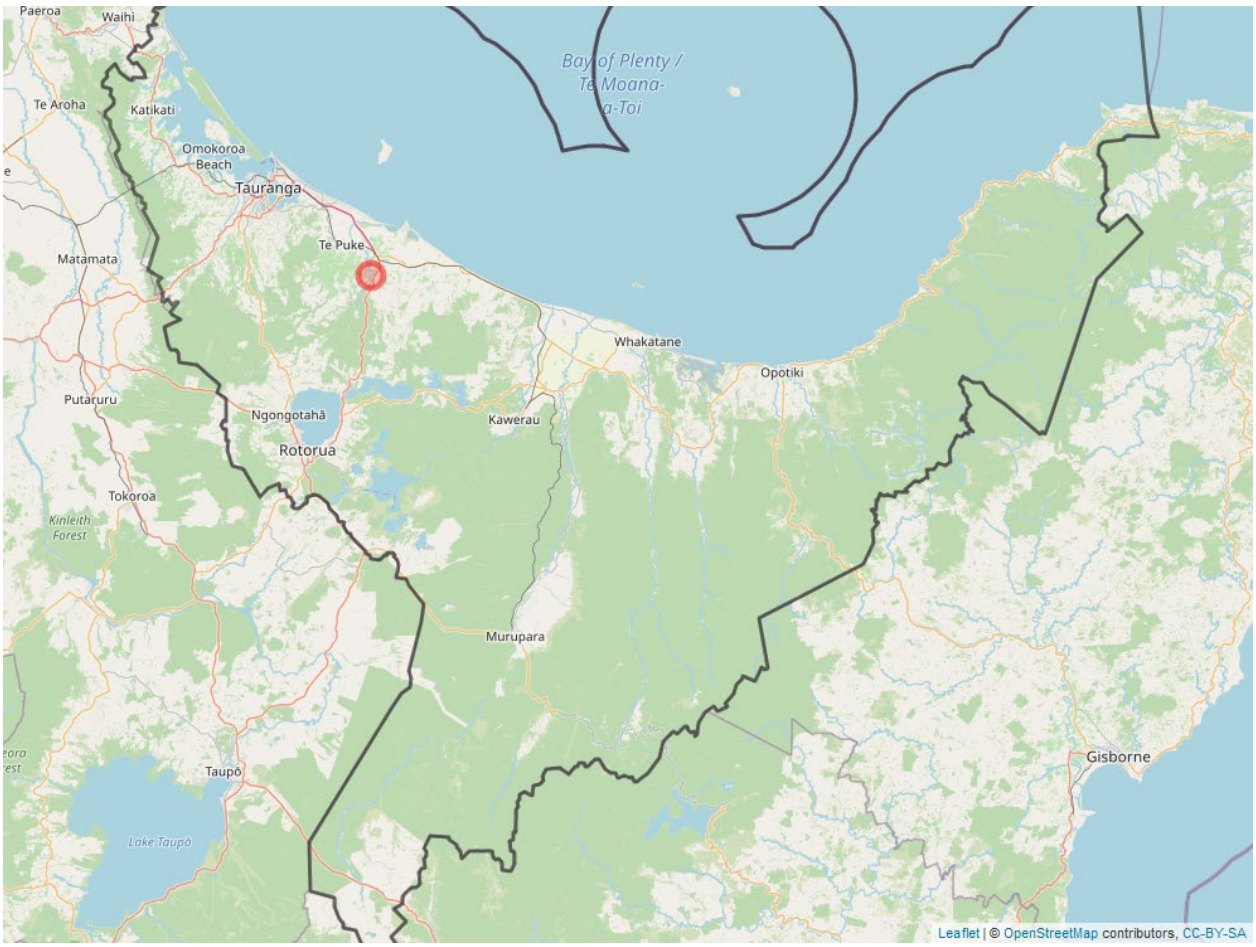

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	192	0.31	2.51	0.47	0.45	0.60	0.36	0.18	0.01
Nitrate Nitrite Nitrogen (g/m3)	192	0.11	2.18	0.26	0.26	0.36	0.15	0.15	0.01
Total Ammoniacal Nitrogen (g/m3)	214	<0.002	2.500	0.026	0.008	0.028	0.001	0.180	0.012
Total Phosphorus (g/m3)	215	0.024	0.227	0.039	0.036	0.053	0.027	0.019	0.001
Dissolved Reactive Phosphorus (g/m3)	216	0.002	0.067	0.019	0.018	0.029	0.009	0.007	0.000
Dissolved Oxygen Sat (%)	123	87.4	116.2	101.2	100.9	108.6	95.3	4.0	0.4
Dissolved Oxygen (g/m3)	211	7.90	11.97	10.06	10.11	11.32	8.71	0.80	0.05
Escherichia coli (cfu/100ml)	196	<1	5400	96	25	240	5	449	32
Total Suspended Solids (g/m3)	213	<1	107.20	8.50	5.30	25.20	1.90	10.94	0.75
Turbidity (NTU)	204	0.4	60.8	2.7	1.8	6.4	0.8	4.8	0.3
Water Clarity (m)	85	0.60	4.20	2.32	2.29	3.60	1.12	0.74	0.08
Conductivity (uS/cm)	214	84	205	169	169	186	149	13	1
pH (pH Units)	203	6.2	7.5	6.9	6.9	7.2	6.5	0.2	0.0
Water Temperature (degC)	213	10.2	107.0	16.3	16.2	21.0	11.2	7.1	0.5
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

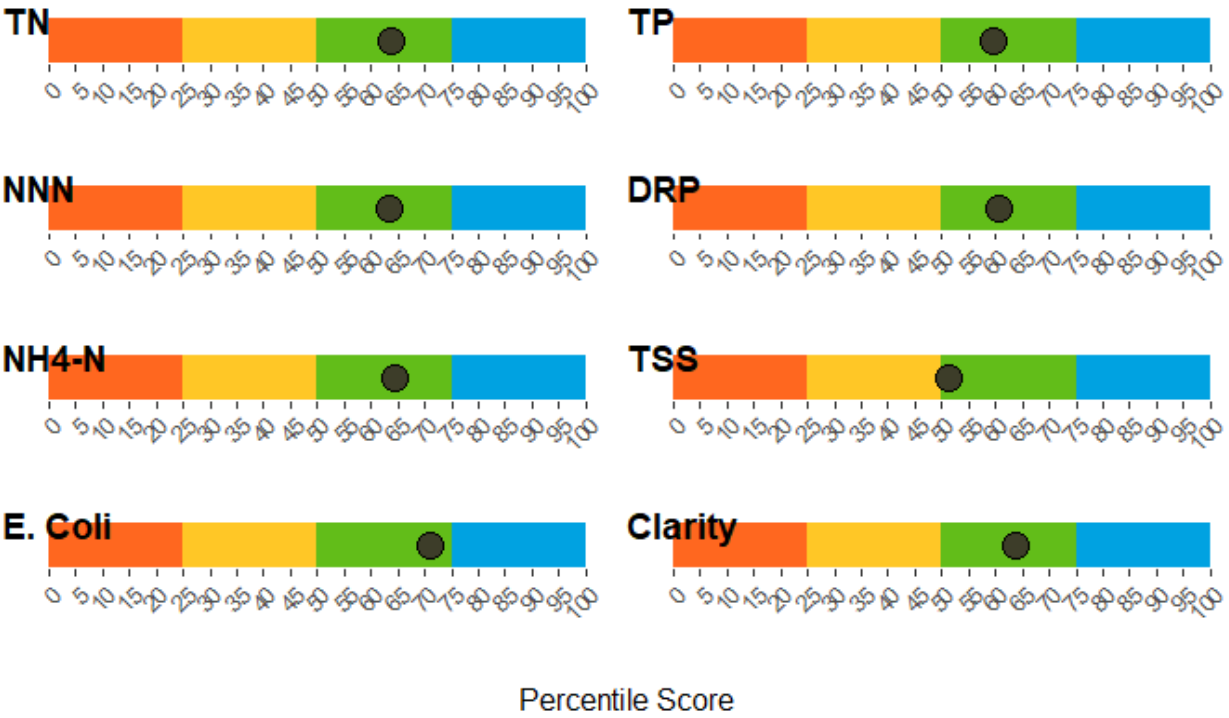

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

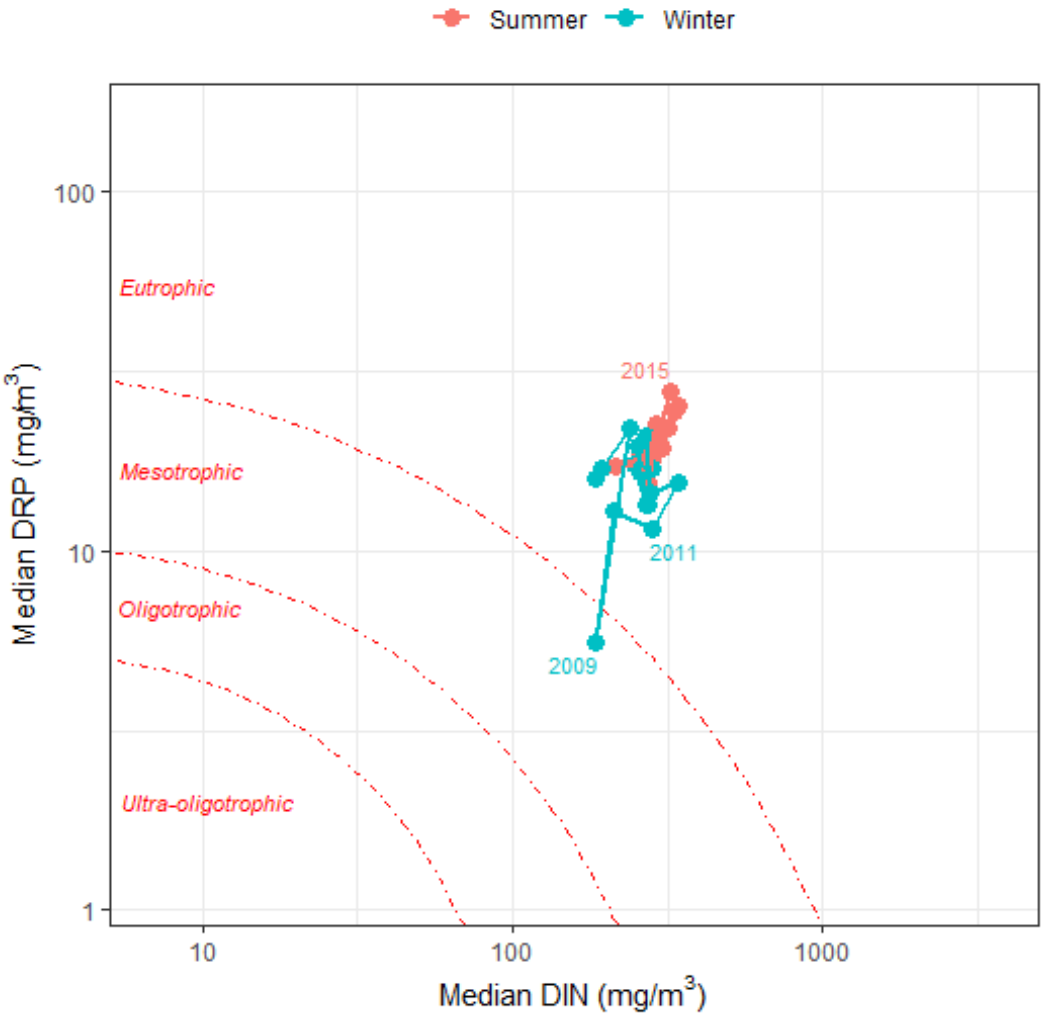

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.0030	0.007	A
5 Years	2015-12-04	2020-12-02	57	0.0040	0.018	A
10 Years	2010-12-05	2020-12-02	115	0.0030	0.018	A
All	1991-02-26	2020-12-02	201	0.0034	0.996	C

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	0.30	0.34	A
5 Years	2015-12-04	2020-12-02	59	0.26	0.35	A
10 Years	2010-12-05	2020-12-02	117	0.28	0.36	A
All	1993-03-04	2020-12-02	192	0.26	0.36	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	58	2.35	C*
10 Years	2010-12-05	2020-12-02	60	2.35	C
All	1992-09-03	2020-12-02	84	2.29	C

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	59	0.017	0.026	C
10 Years	2010-12-05	2020-12-02	117	0.018	0.029	C
All	1985-12-17	2020-12-02	215	0.018	0.029	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	58	5.2	5.2	26	276	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	58	26	474	94.8	0	5.2
10 Years	2010-12-05	2020-12-02	114	26	234	95.6	1.8	2.6
All	1991-02-26	2020-12-02	196	25	240	95.9	2	2

Time series plots

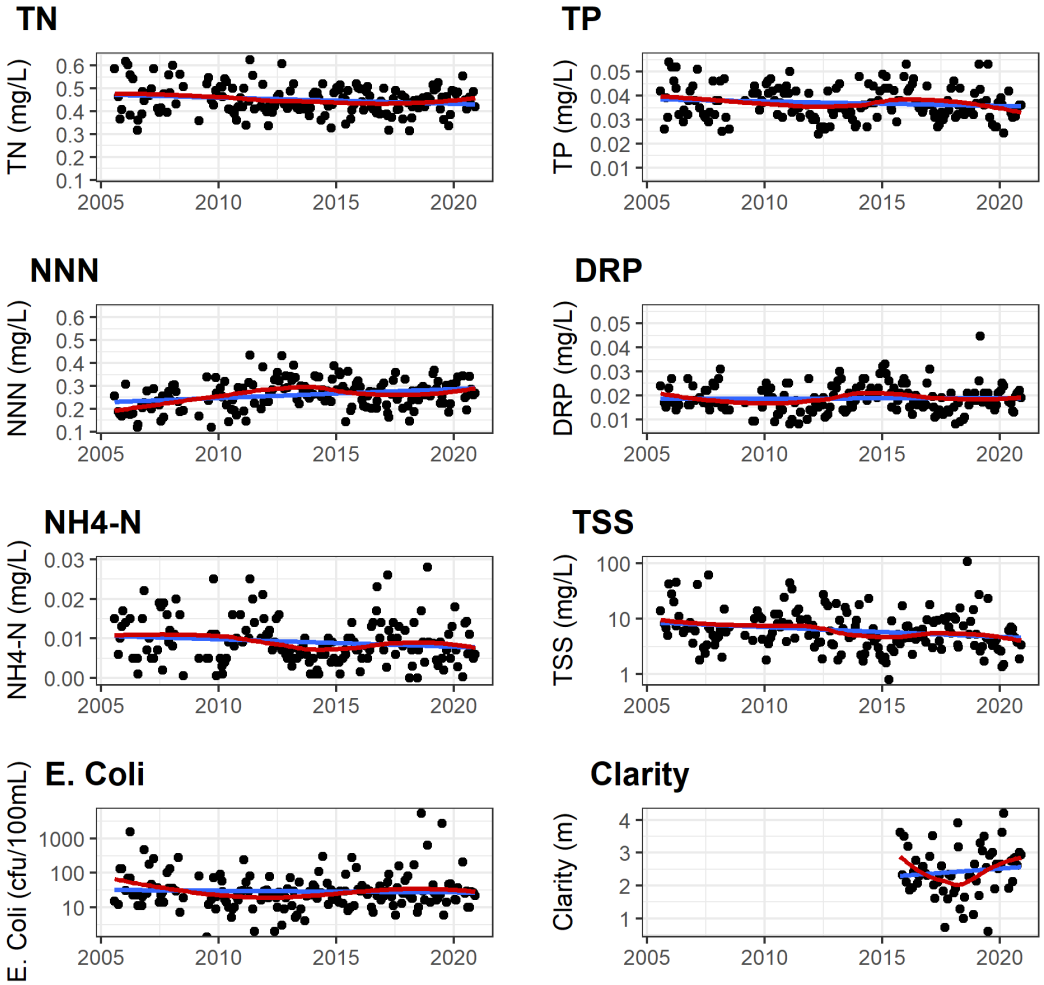

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-02	0.0046	1.04	0.35	Indeterminant	NO	NO	Likely Degrading
TN	10 Years	2010-12-06	2020-12-02	0.0006	0.15	0.69	Indeterminant	NO	NO	Indeterminate/Uncertain
TN	All	2005-07-28	2020-12-02	-0.0020	-0.44	0.12	Indeterminant	NO	NO	Likely Improving
NNN	5 Years	2015-12-10	2020-12-02	0.0084	3.16	0.09	Increasing	NO	NO	Very Likely Degrading
NNN	10 Years	2010-12-06	2020-12-02	-0.0024	-0.88	0.20	Indeterminant	NO	NO	Likely Improving
NNN	All	2005-07-28	2020-12-02	0.0036	1.38	<0.01	Increasing	NO	NO	Very Likely Degrading
NH4N	5 Years	2015-12-10	2020-12-02	-0.0004	-4.92	0.41	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2010-12-06	2020-12-02	-0.0002	-1.93	0.28	Indeterminant	NO	NO	Likely Improving
NH4N	All	2005-07-28	2020-12-02	-0.0003	-3.14	<0.05	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2015-12-10	2020-12-02	-0.0012	-3.43	<0.05	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2010-12-06	2020-12-02	0.0000	0.00	0.59	Indeterminant	NO	NO	Likely Degrading
TP	All	2005-07-28	2020-12-02	-0.0001	-0.33	0.23	Indeterminant	NO	YES	Likely Improving
DRP	5 Years	2015-12-10	2020-12-02	0.0004	2.35	0.28	Indeterminant	NO	NO	Likely Degrading
DRP	10 Years	2010-12-06	2020-12-02	0.0000	0.00	0.87	Indeterminant	NO	YES	Indeterminate/Uncertain
DRP	All	2005-07-28	2020-12-02	0.0000	0.23	0.43	Indeterminant	NO	YES	Likely Degrading
ECOLI	5 Years	2015-12-10	2020-12-02	-0.0124	-0.87	0.65	Indeterminant	NO	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-12-06	2020-12-02	0.0058	0.40	0.60	Indeterminant	NO	NO	Likely Degrading
ECOLI	All	2005-07-28	2020-12-02	-0.0078	-0.55	0.27	Indeterminant	NO	YES	Likely Improving
TSS	5 Years	2015-12-10	2020-12-02	-0.0400	-5.05	0.06	Decreasing	NO	NO	Very Likely Improving
TSS	10 Years	2010-12-06	2020-12-02	-0.0158	-2.03	0.08	Decreasing	NO	NO	Very Likely Improving
TSS	All	2005-07-28	2020-12-02	-0.0129	-1.56	<0.01	Decreasing	NO	NO	Very Likely Improving
CLARITY	5 Years	2015-12-10	2020-12-02	0.0969	4.10	0.15	Indeterminant	NO	NO	Likely Improving
CLARITY	10 Years	2010-12-06	2020-12-02	0.0692	2.93	0.30	Indeterminant	NO	NO	Likely Improving
CLARITY	All	2005-07-28	2020-12-02	0.0692	2.93	0.30	Indeterminant	NO	NO	Likely Improving

Kaituna at Clarkes

March 2021

Table 1. Site metadata.

Aquarius ID:	FO497605	**Labstar ID:**	BOP110139
LAWA ID:	LAWA-102384	**REC Reach:**	4002033
Easting:	1894979	**Northing:**	5816054
Longitude:	176.34821	**Latitude:**	-37.75530
Elevation:	1 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	Yes
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	171	0.40	1.94	0.74	0.72	0.97	0.56	0.18	0.01
Nitrate Nitrite Nitrogen (g/m3)	171	0.01	1.42	0.53	0.51	0.69	0.36	0.14	0.01
Total Ammoniacal Nitrogen (g/m3)	171	<0.002	0.129	0.035	0.027	0.080	0.007	0.024	0.002
Total Phosphorus (g/m3)	172	0.011	0.248	0.050	0.046	0.074	0.033	0.022	0.002
Dissolved Reactive Phosphorus (g/m3)	171	0.002	0.130	0.027	0.026	0.045	0.012	0.012	0.001
Dissolved Oxygen Sat (%)	117	31.4	137.7	97.1	97.4	117.8	77.4	13.8	1.3
Dissolved Oxygen (g/m3)	166	3.30	12.75	9.66	9.78	11.28	7.86	1.27	0.10
Escherichia coli (cfu/100ml)	169	3	7167	337	100	1060	13	885	68
Total Suspended Solids (g/m3)	169	<1	101.00	7.66	4.50	17.64	1.44	11.77	0.91
Turbidity (NTU)	171	0.6	53.0	3.1	2.1	7.1	0.9	5.1	0.4
Water Clarity (m)	61	0.48	4.99	2.47	2.52	3.83	0.86	0.96	0.12
Conductivity (uS/cm)	170	53	209	142	144	161	113	17	1
pH (pH Units)	172	6.2	8.8	6.9	6.9	7.3	6.5	0.3	0.0
Water Temperature (degC)	169	8.4	21.7	15.8	16.1	20.6	11.4	3.0	0.2
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

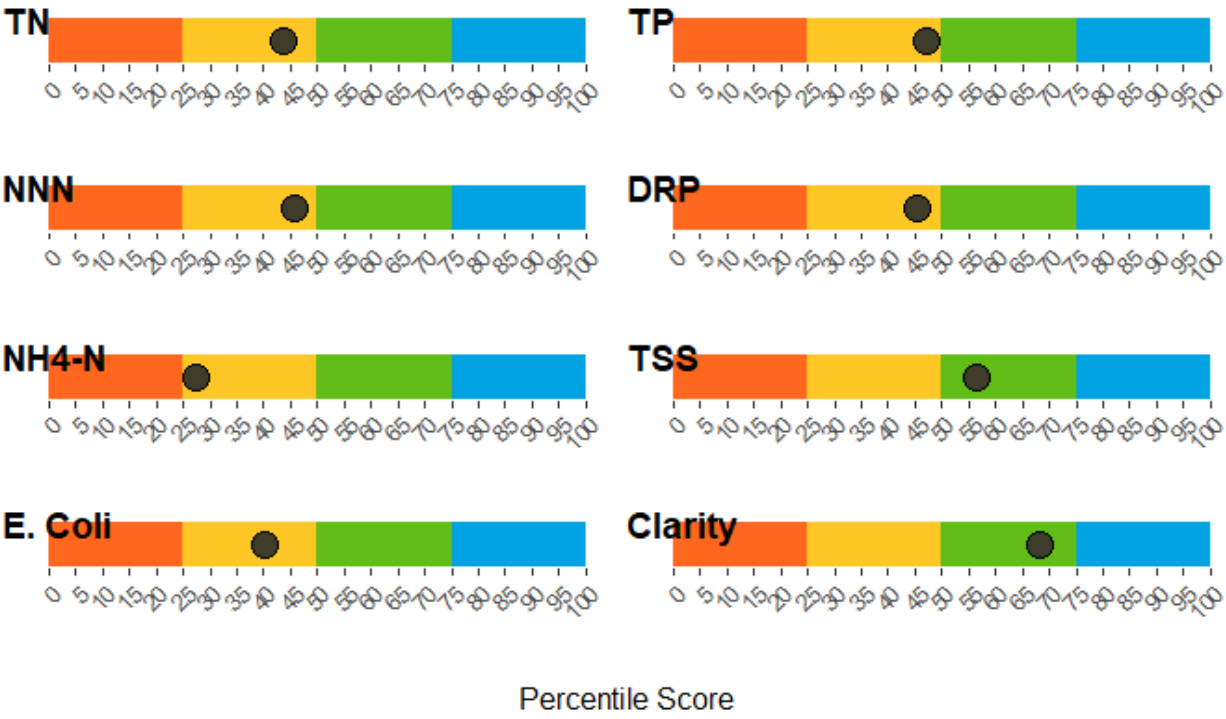

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

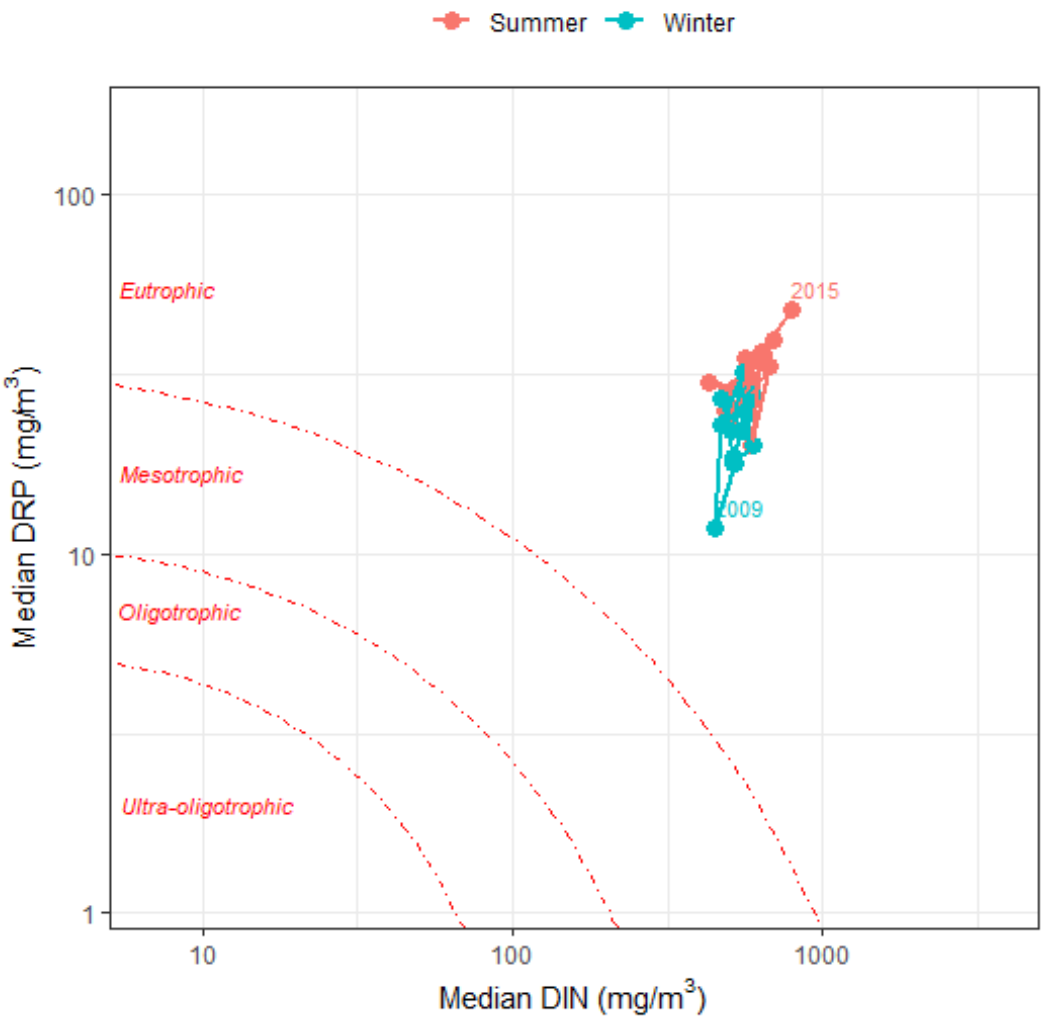

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.013	0.017	A
5 Years	2015-12-04	2020-12-02	58	0.009	0.027	A
10 Years	2010-12-05	2020-12-02	114	0.010	0.048	A
All	2005-07-28	2020-12-02	171	0.011	0.053	B

Table 4. Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	0.57	0.67	A
5 Years	2015-12-04	2020-12-02	58	0.52	0.67	A
10 Years	2010-12-05	2020-12-02	114	0.52	0.72	A
All	2005-07-28	2020-12-02	171	0.51	0.69	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	58	2.51	A*
10 Years	2010-12-05	2020-12-02	NA	NA	
All	2015-10-13	2020-12-02	60	2.52	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	58	0.027	0.042	D
10 Years	2010-12-05	2020-12-02	114	0.024	0.046	D
All	2005-07-27	2020-12-02	170	0.026	0.045	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	57	21.1	35.1	187	1600	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	57	187	1825	64.9	14	21.1
10 Years	2010-12-05	2020-12-02	112	125	1090	75	10.7	14.3
All	2005-07-28	2020-12-02	169	100	1115	77.5	10.1	12.4

Time series plots

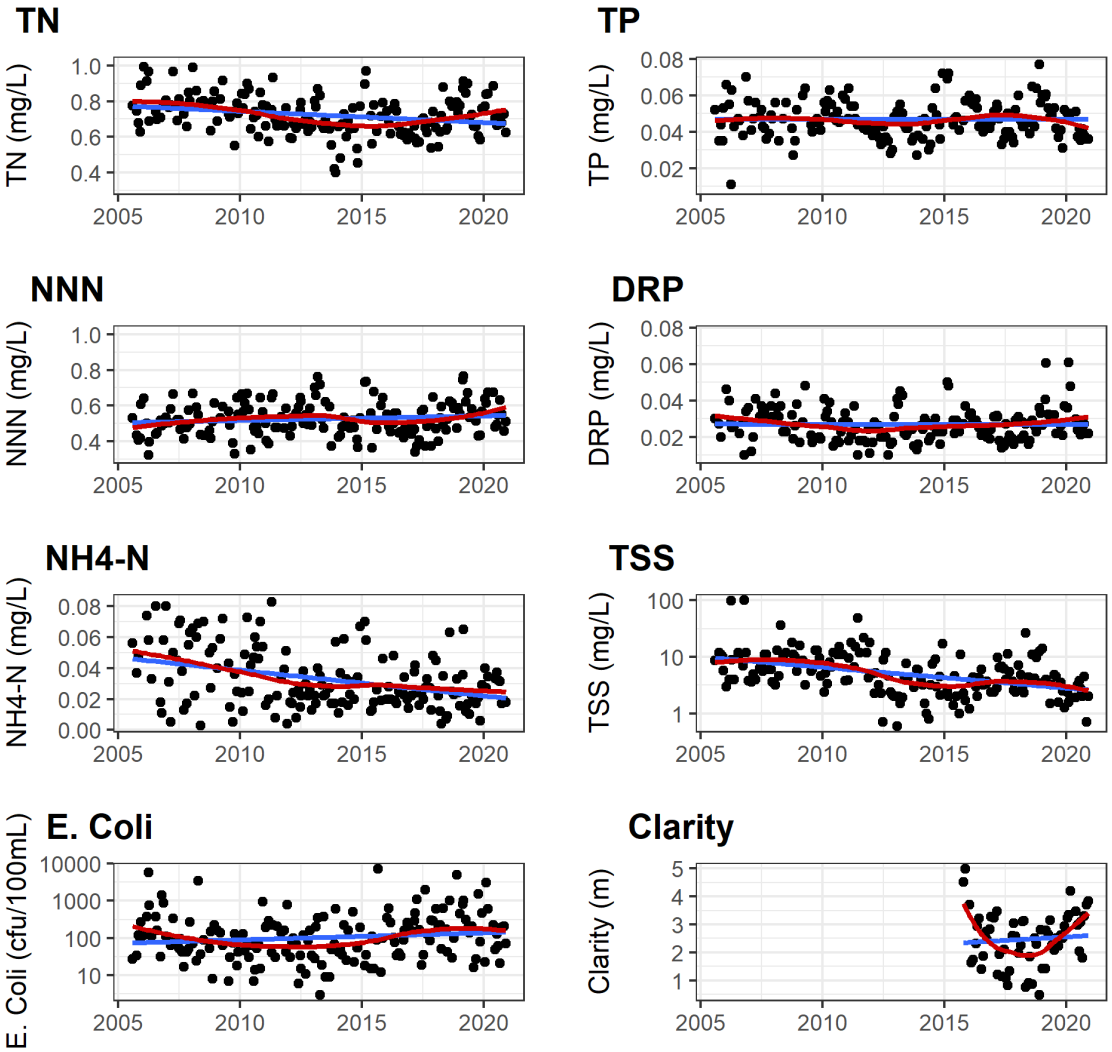

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

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Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-11	2020-12-02	0.0203	2.94	0.10	Indeterminant	NO	NO	Very Likely Degrading
TN	10 Years	2010-12-07	2020-12-02	0.0019	0.27	0.61	Indeterminant	NO	NO	Likely Degrading
TN	All	2005-07-28	2020-12-02	-0.0073	-1.01	<0.01	Decreasing	NO	NO	Very Likely Improving
NNN	5 Years	2016-01-11	2020-12-02	0.0217	4.23	0.07	Increasing	NO	NO	Very Likely Degrading
NNN	10 Years	2010-12-07	2020-12-02	0.0032	0.62	0.59	Indeterminant	NO	NO	Likely Degrading
NNN	All	2005-07-28	2020-12-02	0.0038	0.75	0.12	Indeterminant	NO	NO	Very Likely Degrading
NH4N	5 Years	2016-01-11	2020-12-02	-0.0001	-0.48	0.87	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	10 Years	2010-12-07	2020-12-02	-0.0006	-2.45	0.25	Indeterminant	NO	NO	Likely Improving
NH4N	All	2005-07-28	2020-12-02	-0.0023	-8.39	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2016-01-11	2020-12-02	-0.0005	-1.05	0.32	Indeterminant	NO	YES	Likely Improving
TP	10 Years	2010-12-07	2020-12-02	0.0000	0.00	0.93	Indeterminant	NO	YES	Indeterminate/Uncertain
TP	All	2005-07-28	2020-12-02	-0.0003	-0.66	<0.05	Decreasing	NO	YES	Very Likely Improving
DRP	5 Years	2016-01-11	2020-12-02	0.0014	5.19	0.27	Indeterminant	NO	YES	Likely Degrading
DRP	10 Years	2010-12-07	2020-12-02	0.0006	2.49	<0.05	Increasing	NO	YES	Very Likely Degrading
DRP	All	2005-07-28	2020-12-02	0.0001	0.28	0.83	Indeterminant	NO	YES	Indeterminate/Uncertain
ECOLI	5 Years	2016-01-11	2020-12-02	0.0205	0.90	0.39	Indeterminant	NO	YES	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-12-07	2020-12-02	0.0518	2.49	<0.05	Increasing	NO	YES	Very Likely Degrading
ECOLI	All	2005-07-28	2020-12-02	0.0188	0.94	0.08	Increasing	NO	YES	Very Likely Degrading
TSS	5 Years	2016-01-11	2020-12-02	-0.0318	-4.82	0.11	Indeterminant	NO	NO	Likely Improving
TSS	10 Years	2010-12-07	2020-12-02	-0.0238	-3.54	0.05	Decreasing	NO	NO	Very Likely Improving
TSS	All	2005-07-28	2020-12-02	-0.0268	-3.62	<0.001	Decreasing	NO	YES	Very Likely Improving
CLARITY	5 Years	2016-01-11	2020-12-02	0.1119	4.45	0.27	Indeterminant	NO	YES	Likely Improving
CLARITY	10 Years	2010-12-07	2020-12-02	0.0429	1.71	0.65	Indeterminant	NO	YES	Likely Improving
CLARITY	All	2005-07-28	2020-12-02	0.0429	1.71	0.65	Indeterminant	NO	YES	Likely Improving

Kaituna at Te Matai

March 2021

Table 1 Site metadata.

Aquarius ID:	FO620177	**Labstar ID:**	514614, BOP120000
LAWA ID:	EBOP-00057	**REC Reach:**	4002337
Easting:	1896202	**Northing:**	5811773
Longitude:	176.36380	**Latitude:**	-37.79342
Elevation:	10 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Lake_VA		

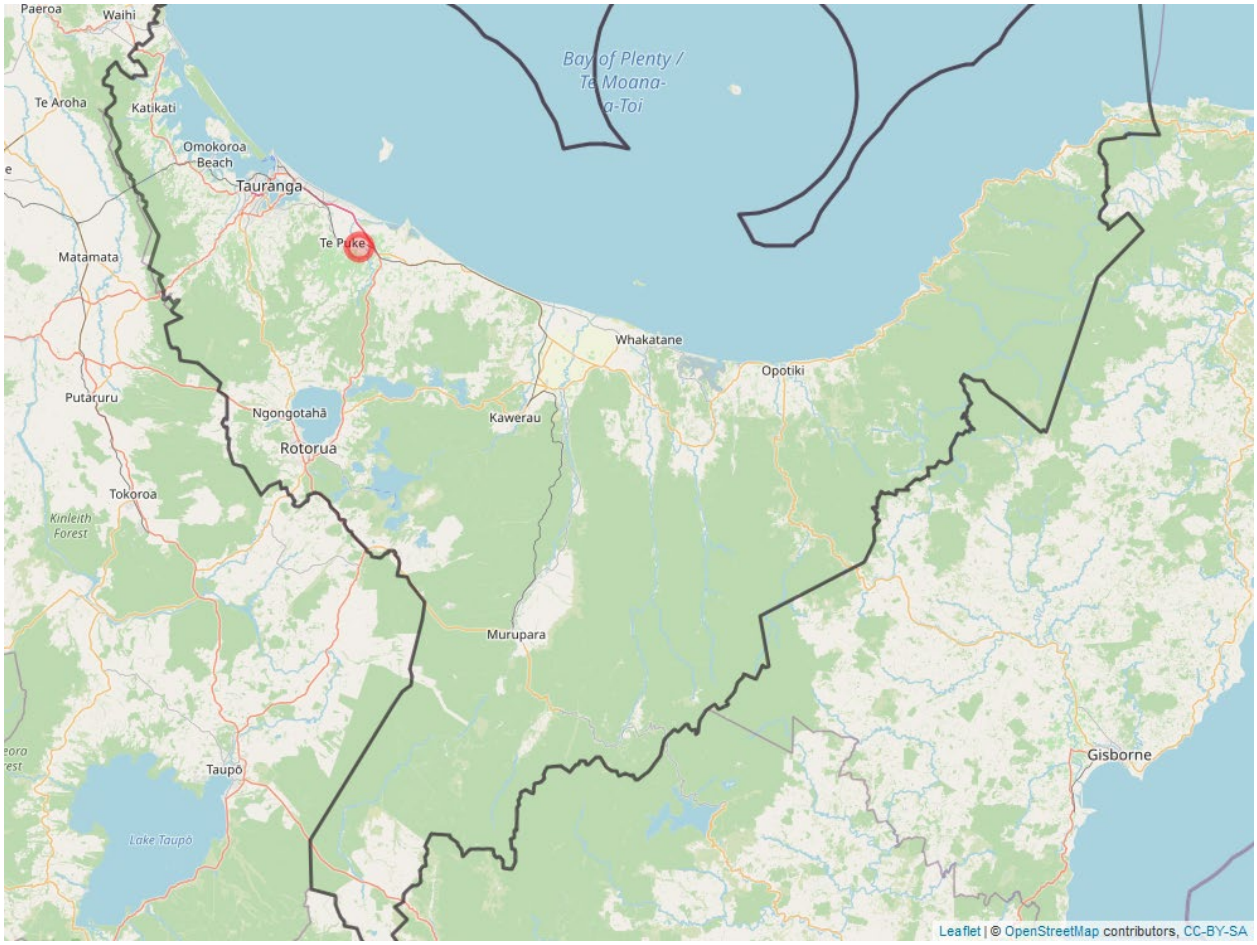

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	227	0.49	2.19	0.76	0.74	0.95	0.59	0.16	0.01
Nitrate Nitrite Nitrogen (g/m3)	226	0.19	1.38	0.52	0.51	0.70	0.34	0.12	0.01
Total Ammoniacal Nitrogen (g/m3)	239	<0.002	0.477	0.058	0.047	0.127	0.010	0.046	0.003
Total Phosphorus (g/m3)	240	0.029	1.180	0.057	0.050	0.072	0.036	0.075	0.005
Dissolved Reactive Phosphorus (g/m3)	239	0.002	0.919	0.035	0.030	0.050	0.016	0.058	0.004
Dissolved Oxygen Sat (%)	123	78.9	112.1	98.2	98.1	105.9	91.9	4.8	0.4
Dissolved Oxygen (g/m3)	231	6.00	14.20	9.79	9.83	10.96	8.55	0.83	0.05
Escherichia coli (cfu/100ml)	228	<1	7000	295	60	970	9	815	54
Total Suspended Solids (g/m3)	237	<1	133.50	9.56	6.80	24.41	2.22	11.03	0.72
Turbidity (NTU)	238	0.6	38.3	3.0	2.2	7.5	1.0	3.3	0.2
Water Clarity (m)	71	0.42	4.28	2.20	2.11	3.57	0.89	0.87	0.10
Conductivity (uS/cm)	234	72	213	147	148	164	127	14	1
pH (pH Units)	238	6.3	7.8	6.9	6.9	7.1	6.6	0.2	0.0
Water Temperature (degC)	235	9.6	22.5	15.4	15.6	19.5	11.4	2.7	0.2
Discharge (m3/s)	112	22.10	95.20	38.50	36.40	64.60	24.00	13.00	1.20

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

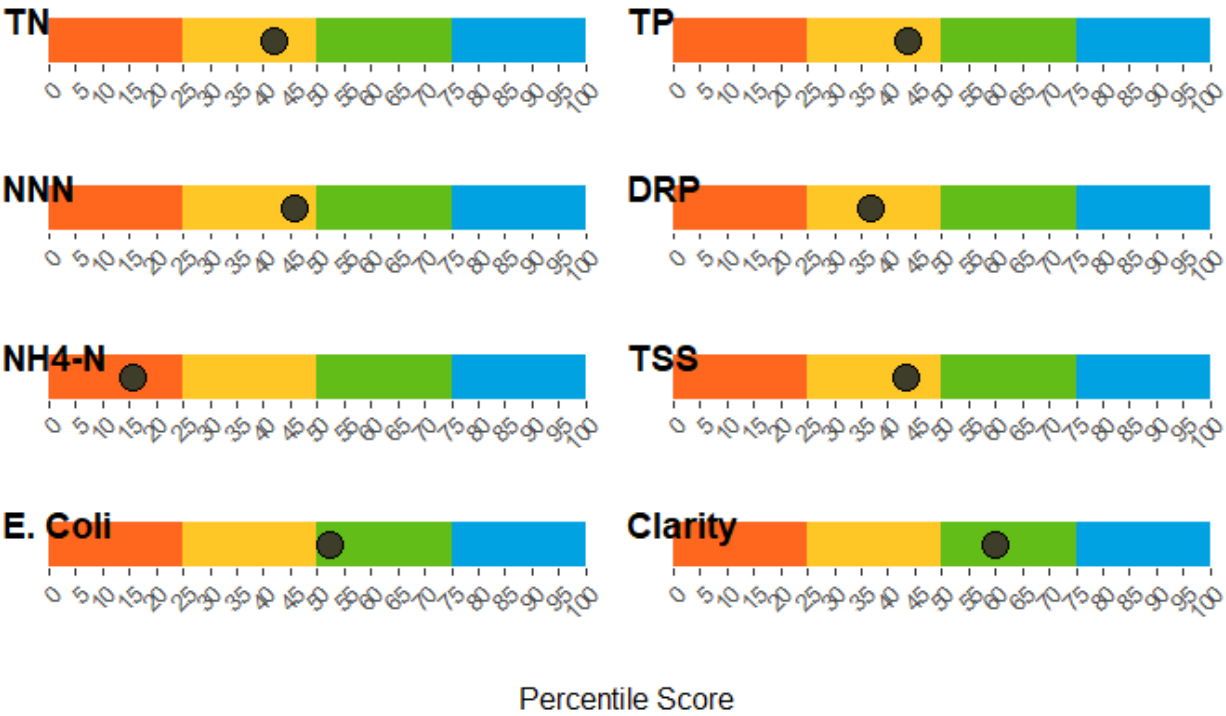

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

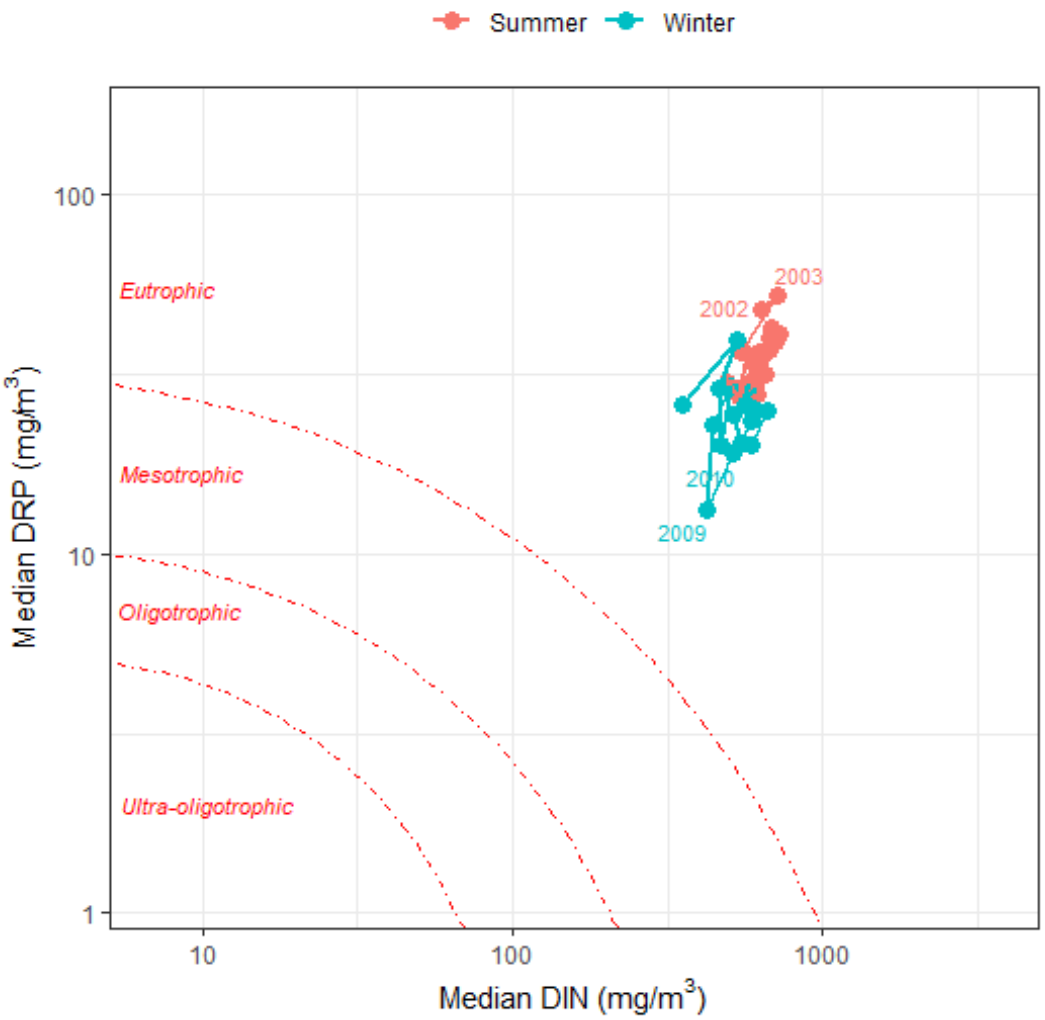

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.018	0.037	A
5 Years	2015-12-04	2020-12-02	59	0.015	0.037	A
10 Years	2010-12-05	2020-12-02	120	0.014	0.175	B
All	1991-02-26	2020-12-02	237	0.019	0.175	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	0.61	0.67	A
5 Years	2015-12-04	2020-12-02	59	0.55	0.69	A
10 Years	2010-12-05	2020-12-02	120	0.56	0.72	A
All	1993-09-16	2020-12-02	226	0.51	0.70	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	58	2.24	C*
10 Years	2010-12-05	2020-12-02	60	2.26	C
All	1992-09-04	2020-12-02	69	2.11	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	59	0.027	0.043	D
10 Years	2010-12-05	2020-12-02	121	0.029	0.046	D
All	1991-02-25	2020-12-02	238	0.030	0.050	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	58	6.9	12.1	50	577	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	58	50	658	87.9	5.2	5.2
10 Years	2010-12-05	2020-12-02	116	46	508	89.7	5.2	4.3
All	1991-02-26	2020-12-02	228	60	973	80.3	6.6	12.7

Time series plots

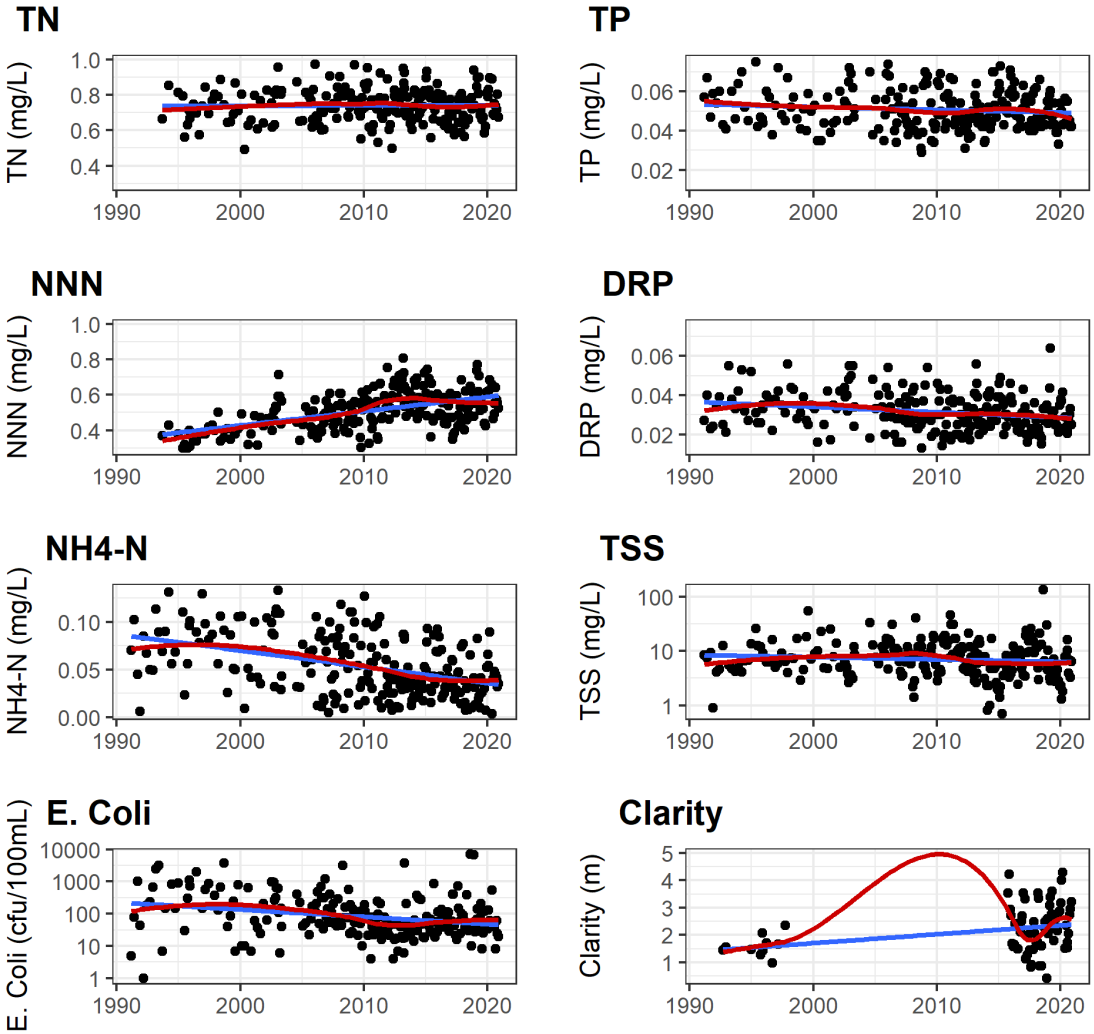

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-02	0.0066	0.92	0.34	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2010-12-07	2020-12-02	-0.0048	-0.65	0.10	Decreasing	YES	NO	Very Likely Improving
TN	All	1991-02-26	2020-12-02	-0.0048	-0.65	0.10	Decreasing	YES	NO	Very Likely Improving
NNN	5 Years	2015-12-10	2020-12-02	0.0155	2.84	<0.05	Increasing	YES	NO	Very Likely Degrading
NNN	10 Years	2010-12-07	2020-12-02	-0.0071	-1.26	<0.05	Decreasing	YES	NO	Very Likely Improving
NNN	All	1991-02-26	2020-12-02	-0.0071	-1.26	<0.05	Decreasing	YES	NO	Very Likely Improving
NH4N	5 Years	2015-12-10	2020-12-02	-0.0021	-5.92	<0.05	Decreasing	YES	YES	Very Likely Improving
NH4N	10 Years	2010-12-07	2020-12-02	-0.0005	-1.45	0.25	Indeterminant	YES	YES	Likely Improving
NH4N	All	1991-02-26	2020-12-02	-0.0005	-1.45	0.25	Indeterminant	YES	YES	Likely Improving
TP	5 Years	2015-12-10	2020-12-02	-0.0013	-2.64	0.21	Indeterminant	YES	YES	Likely Improving
TP	10 Years	2010-12-07	2020-12-02	-0.0002	-0.39	0.50	Indeterminant	YES	YES	Likely Improving
TP	All	1991-02-26	2020-12-02	-0.0002	-0.39	0.50	Indeterminant	YES	YES	Likely Improving
DRP	5 Years	2015-12-10	2020-12-02	0.0004	1.59	0.78	Indeterminant	YES	YES	Indeterminate/Uncertain
DRP	10 Years	2010-12-07	2020-12-02	-0.0004	-1.34	0.19	Indeterminant	YES	YES	Likely Improving
DRP	All	1991-02-26	2020-12-02	-0.0004	-1.34	0.19	Indeterminant	YES	YES	Likely Improving
ECOLI	5 Years	2015-12-10	2020-12-02	-0.0327	-1.91	0.30	Indeterminant	YES	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-12-07	2020-12-02	0.0161	0.96	0.17	Indeterminant	YES	NO	Very Likely Degrading
ECOLI	All	1991-02-26	2020-12-02	0.0161	0.96	0.17	Indeterminant	YES	NO	Very Likely Degrading
TSS	5 Years	2015-12-10	2020-12-02	-0.0481	-5.46	<0.05	Decreasing	YES	NO	Very Likely Improving
TSS	10 Years	2010-12-07	2020-12-02	0.0026	0.31	0.74	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	1991-02-26	2020-12-02	0.0026	0.31	0.74	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	5 Years	2015-12-10	2020-12-02	0.1453	6.47	<0.05	Increasing	YES	NO	Very Likely Improving
CLARITY	10 Years	2010-12-07	2020-12-02	0.1087	4.80	0.10	Increasing	YES	NO	Very Likely Improving
CLARITY	All	1991-02-26	2020-12-02	0.1087	4.80	0.10	Increasing	YES	NO	Very Likely Improving

Kaituna at AFFCO Intake Pontoons

March 2021

Table 1 Site metadata.

Aquarius ID:	FO761142	**Labstar ID:**	BOP210050, BOP270031
LAWA ID:	LAWA-102383	**REC Reach:**	4002830
Easting:	1897610	**Northing:**	5811421
Longitude:	176.37990	**Latitude:**	-37.79613
Elevation:	3 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	No
REC Class:	WW_Lake_VA		

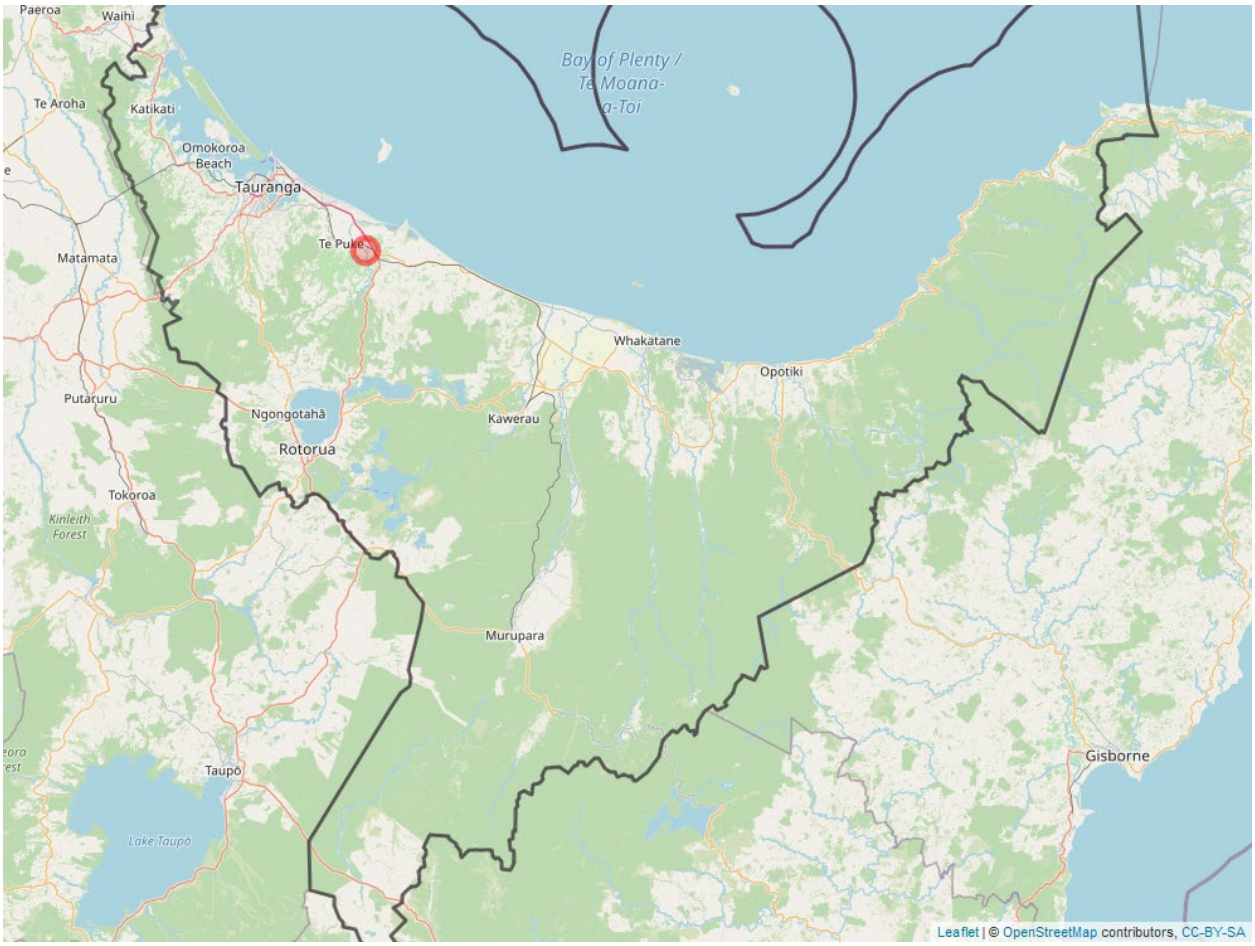

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	184	0.23	1.03	0.64	0.64	0.77	0.51	0.10	0.01
Nitrate Nitrite Nitrogen (g/m3)	185	<0.001	0.71	0.44	0.44	0.61	0.30	0.10	0.01
Total Ammoniacal Nitrogen (g/m3)	185	<0.002	0.244	0.012	0.009	0.026	0.001	0.019	0.001
Total Phosphorus (g/m3)	185	0.018	0.083	0.043	0.042	0.056	0.032	0.008	0.001
Dissolved Reactive Phosphorus (g/m3)	185	0.002	0.055	0.024	0.024	0.035	0.013	0.008	0.001
Dissolved Oxygen Sat (%)	99	84.3	109.7	99.5	99.4	106.8	93.9	3.9	0.4
Dissolved Oxygen (g/m3)	168	6.20	11.71	9.89	9.87	11.19	8.60	0.81	0.06
Escherichia coli (cfu/100ml)	167	3	2600	116	40	475	10	268	21
Total Suspended Solids (g/m3)	184	<1	49.00	8.68	6.83	19.91	2.51	6.39	0.47
Turbidity (NTU)	186	0.6	13.0	2.5	2.1	5.5	1.0	1.7	0.1
Water Clarity (m)	34	0.80	4.00	2.21	2.23	3.51	0.92	0.82	0.14
Conductivity (uS/cm)	169	83	217	148	149	165	126	15	1
pH (pH Units)	186	6.2	7.5	6.9	6.9	7.2	6.5	0.2	0.0
Water Temperature (degC)	170	9.6	24.5	15.5	15.6	20.0	11.2	3.0	0.2
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

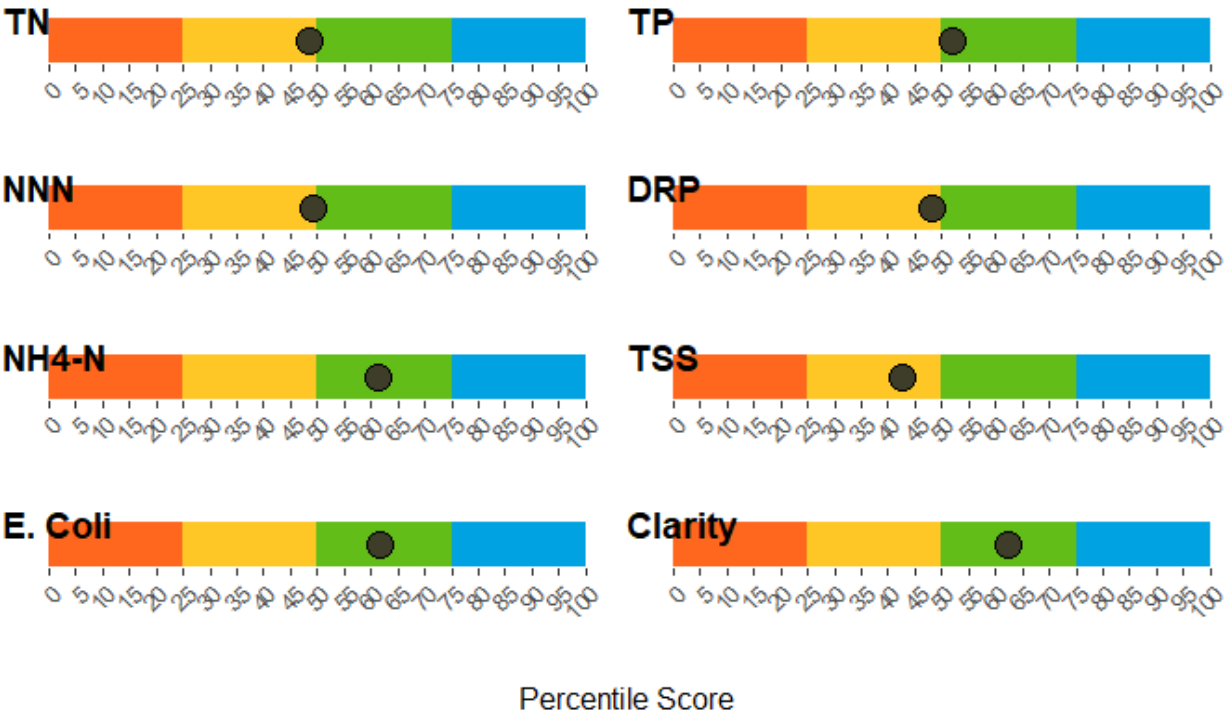

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

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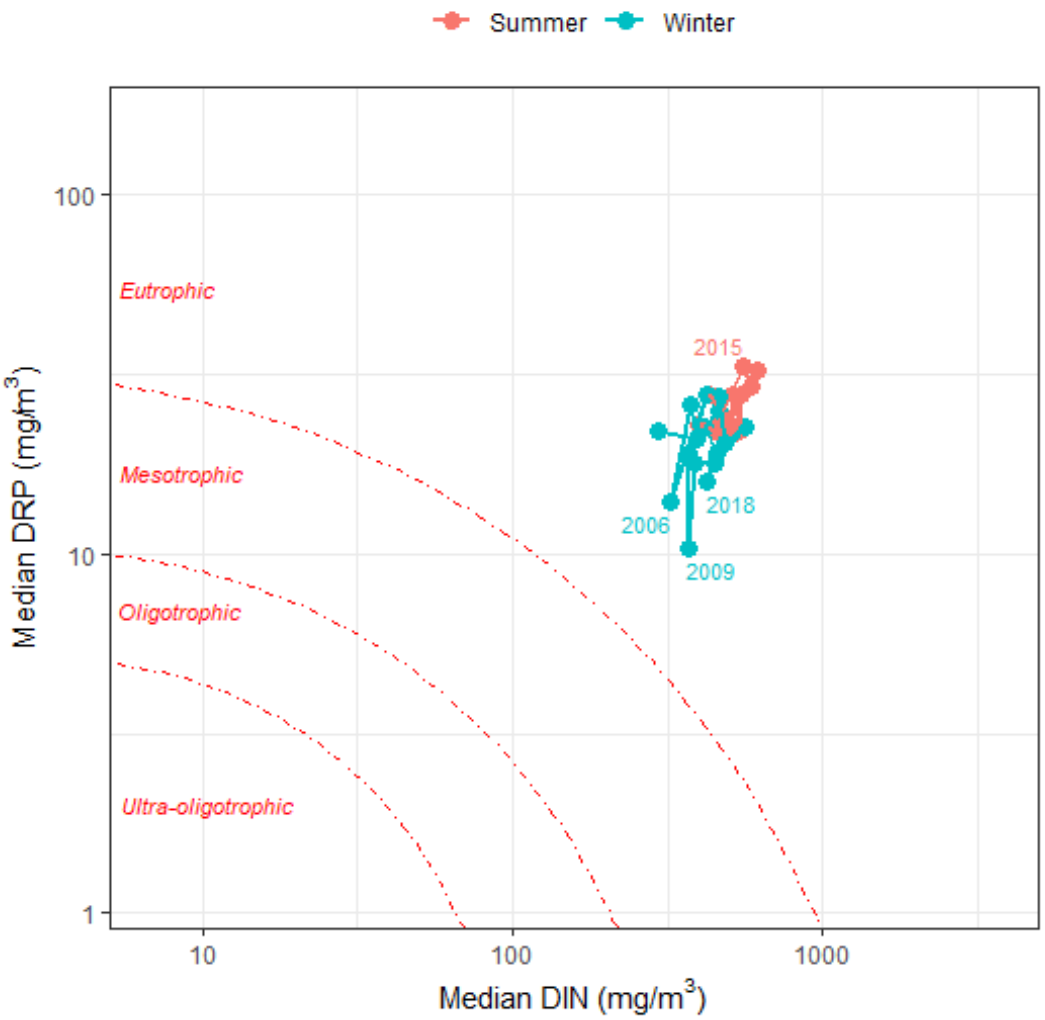


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2017-07-03	2018-07-03	12	0.0030	0.011	A
5 Years	2013-07-04	2018-07-03	60	0.0030	0.011	A
10 Years	2008-07-05	2018-07-03	114	0.0030	0.029	A
All	1993-09-16	2018-07-03	185	0.0034	0.097	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2017-07-03	2018-07-03	12	0.43	0.56	A
5 Years	2013-07-04	2018-07-03	60	0.48	0.60	A
10 Years	2008-07-05	2018-07-03	115	0.48	0.62	A
All	1993-09-16	2018-07-03	185	0.44	0.61	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2013-07-04	2018-07-03	NA	NA	NA
10 Years	2008-07-05	2018-07-03	NA	NA	
All	2015-10-13	2018-07-03	33	2.26	C**

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2013-07-04	2018-07-03	60	0.025	0.034	D
10 Years	2008-07-05	2018-07-03	114	0.024	0.036	D
All	1993-09-16	2018-07-03	184	0.024	0.035	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2013-07-04	2018-07-03	58	3.4	12.1	37	448	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2013-07-04	2018-07-03	58	37	470	87.9	8.6	3.4
10 Years	2008-07-05	2018-07-03	113	36	374	92.9	4.4	2.7
All	1997-09-26	2018-07-03	167	40	501	90.4	4.8	4.8

Time series plots

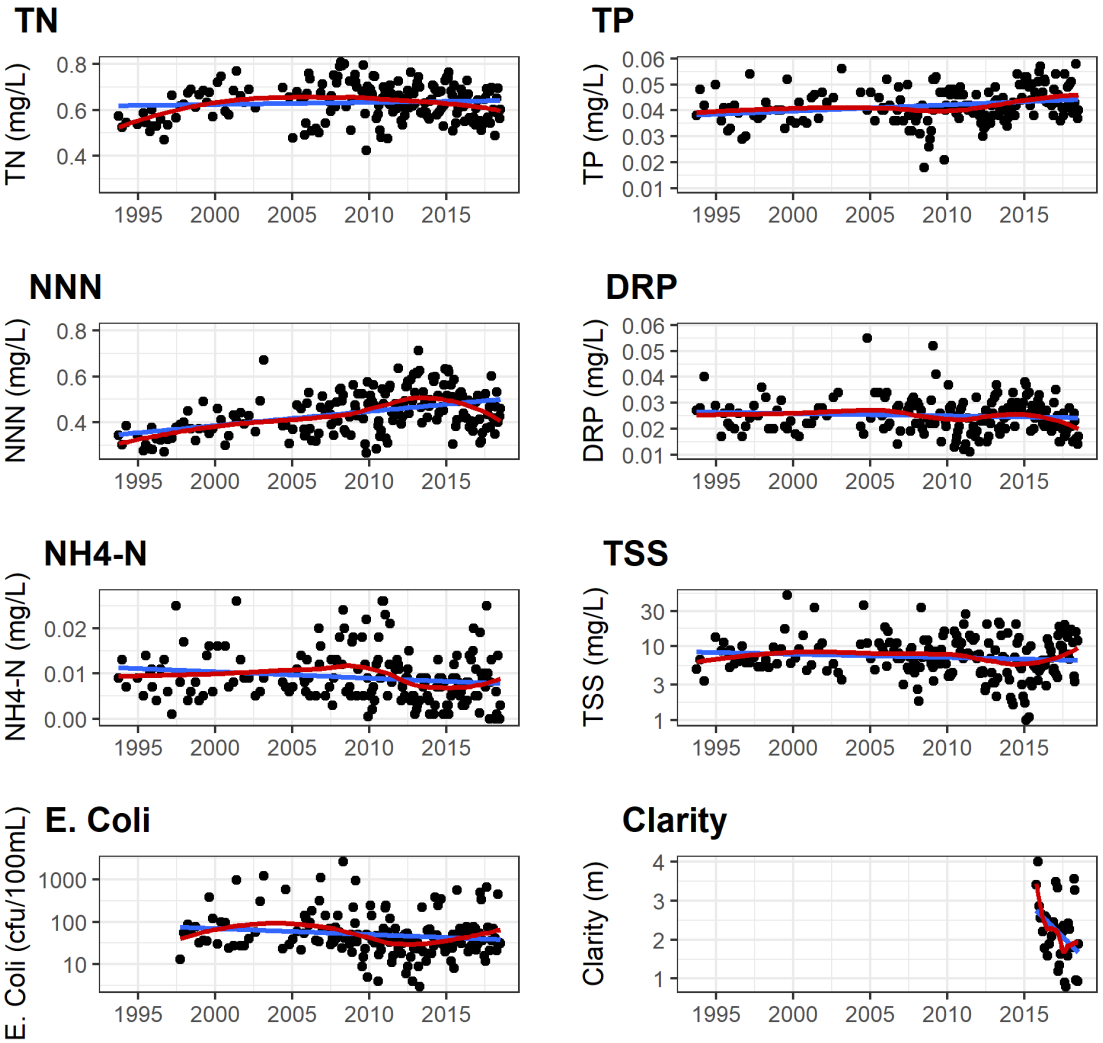


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2013-07-04	2018-07-03	-0.0063	-1.03	0.38	Indeterminant	NO	NO	Likely Improving
TN	10 Years	2008-09-25	2018-07-03	-0.0089	-1.40	<0.01	Decreasing	NO	NO	Very Likely Improving
TN	All	1993-09-16	2018-07-03	0.0014	0.22	0.23	Indeterminant	NO	YES	Likely Degrading
NNN	5 Years	2013-07-04	2018-07-03	-0.0237	-5.04	<0.05	Decreasing	NO	NO	Very Likely Improving
NNN	10 Years	2008-09-25	2018-07-03	-0.0014	-0.30	0.69	Indeterminant	NO	NO	Indeterminate/Uncertain
NNN	All	1993-09-16	2018-07-03	0.0067	1.54	<0.001	Increasing	NO	YES	Very Likely Degrading
NH4N	5 Years	2013-07-04	2018-07-03	0.0010	14.32	0.09	Increasing	NO	YES	Very Likely Degrading
NH4N	10 Years	2008-09-25	2018-07-03	-0.0005	-6.20	0.05	Decreasing	NO	YES	Very Likely Improving
NH4N	All	1993-09-16	2018-07-03	-0.0001	-1.31	0.06	Decreasing	NO	YES	Very Likely Improving
TP	5 Years	2013-07-04	2018-07-03	-0.0003	-0.73	0.74	Indeterminant	NO	NO	Indeterminate/Uncertain
TP	10 Years	2008-09-25	2018-07-03	0.0002	0.49	0.38	Indeterminant	NO	NO	Likely Degrading
TP	All	1993-09-16	2018-07-03	0.0002	0.44	<0.05	Increasing	NO	YES	Very Likely Degrading
DRP	5 Years	2013-07-04	2018-07-03	-0.0023	-9.37	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2008-09-25	2018-07-03	-0.0003	-1.45	0.30	Indeterminant	NO	YES	Likely Improving
DRP	All	1993-09-16	2018-07-03	-0.0001	-0.25	0.35	Indeterminant	NO	YES	Likely Improving
ECOLI	5 Years	2013-07-04	2018-07-03	0.0132	0.83	0.81	Indeterminant	NO	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2008-09-25	2018-07-03	0.0028	0.18	0.75	Indeterminant	NO	NO	Indeterminate/Uncertain
ECOLI	All	1993-09-16	2018-07-03	-0.0085	-0.53	0.12	Indeterminant	NO	NO	Likely Improving
TSS	5 Years	2013-07-04	2018-07-03	0.0720	8.29	<0.05	Increasing	NO	NO	Very Likely Degrading
TSS	10 Years	2008-09-25	2018-07-03	-0.0008	-0.09	0.93	Indeterminant	NO	YES	Indeterminate/Uncertain
TSS	All	1993-09-16	2018-07-03	-0.0024	-0.27	0.44	Indeterminant	NO	YES	Likely Improving
CLARITY	5 Years	2013-07-04	2018-07-03	-0.5772	-25.86	<0.05	Decreasing	NO	NO	Very Likely Degrading
CLARITY	10 Years	2008-09-25	2018-07-03							
CLARITY	All	1993-09-16	2018-07-03							

Pongakawa at Pumphouse

March 2021

Table 1 Site metadata.

Aquarius ID:	GM781934	**Labstar ID:**	BOP110118
LAWA ID:	EBOP-00047	**REC Reach:**	4005072
Easting:	1907814	**Northing:**	5799349
Longitude:	176.50073	**Latitude:**	-37.90136
Elevation:	23 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

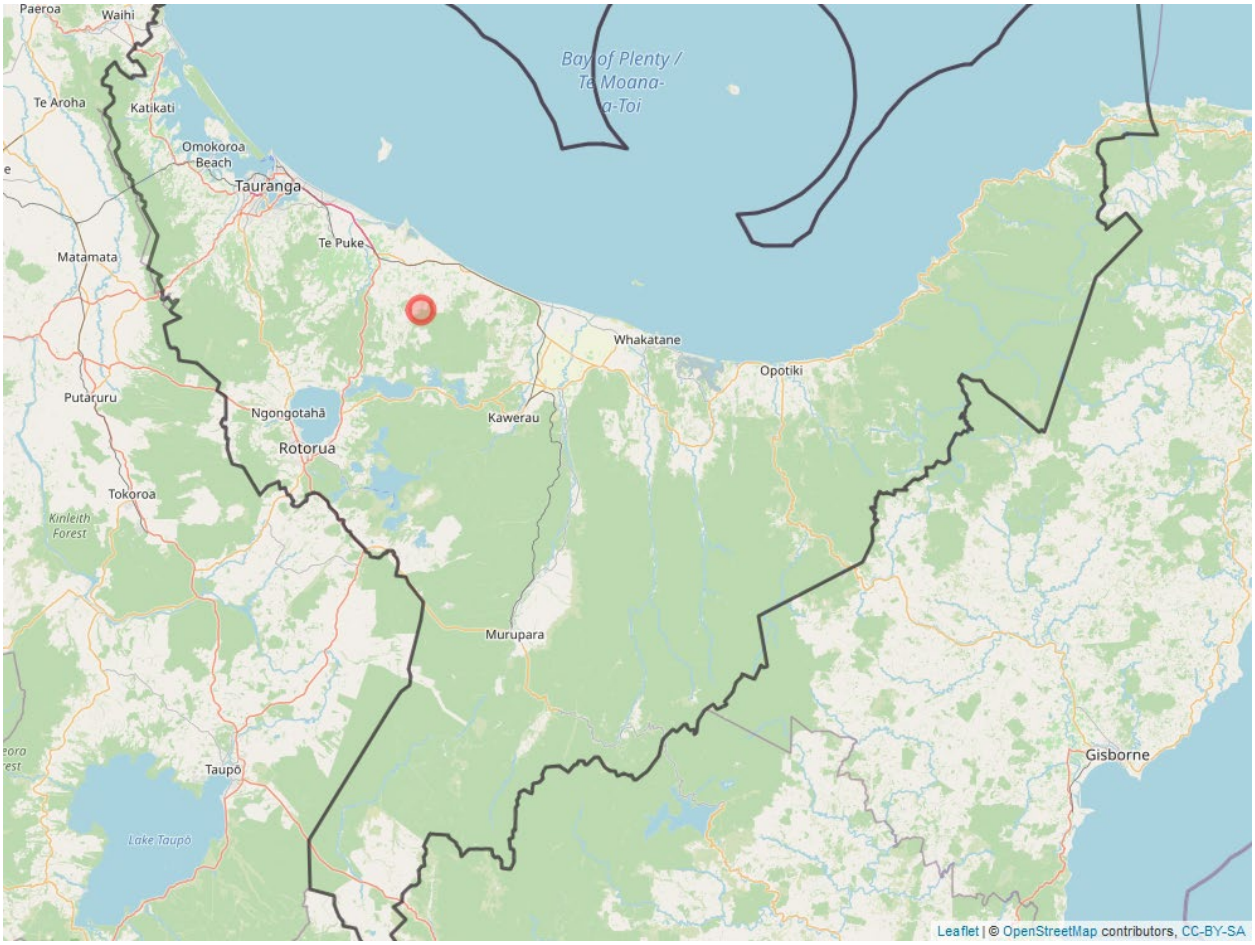


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	87	1.03	1.60	1.34	1.35	1.51	1.11	0.12	0.01
Nitrate Nitrite Nitrogen (g/m3)	88	0.93	1.47	1.28	1.32	1.44	1.02	0.13	0.01
Total Ammoniacal Nitrogen (g/m3)	84	<0.002	0.025	0.004	0.002	0.012	0.000	0.004	0.000
Total Phosphorus (g/m3)	87	0.065	0.190	0.122	0.119	0.157	0.098	0.021	0.002
Dissolved Reactive Phosphorus (g/m3)	86	0.064	0.127	0.104	0.105	0.115	0.085	0.010	0.001
Dissolved Oxygen Sat (%)	60	77.9	105.2	92.6	91.8	100.6	86.8	4.5	0.6
Dissolved Oxygen (g/m3)	86	7.92	11.20	9.45	9.40	10.40	8.76	0.52	0.06
Escherichia coli (cfu/100ml)	88	7	560	47	28	92	8	72	8
Total Suspended Solids (g/m3)	89	<1	175.00	16.56	8.70	58.08	2.50	25.13	2.66
Turbidity (NTU)	89	0.3	32.4	2.9	1.4	9.2	0.5	4.8	0.5
Water Clarity (m)	51	0.09	14.55	3.71	3.24	7.66	0.86	2.52	0.35
Conductivity (uS/cm)	89	78	173	110	110	119	95	10	1
pH (pH Units)	88	6.3	7.7	6.7	6.7	7.2	6.4	0.2	0.0
Water Temperature (degC)	86	10.1	16.0	14.4	14.4	15.6	13.1	0.9	0.1
Discharge (m3/s)	60	2.70	5.20	3.30	3.10	4.40	2.80	0.50	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

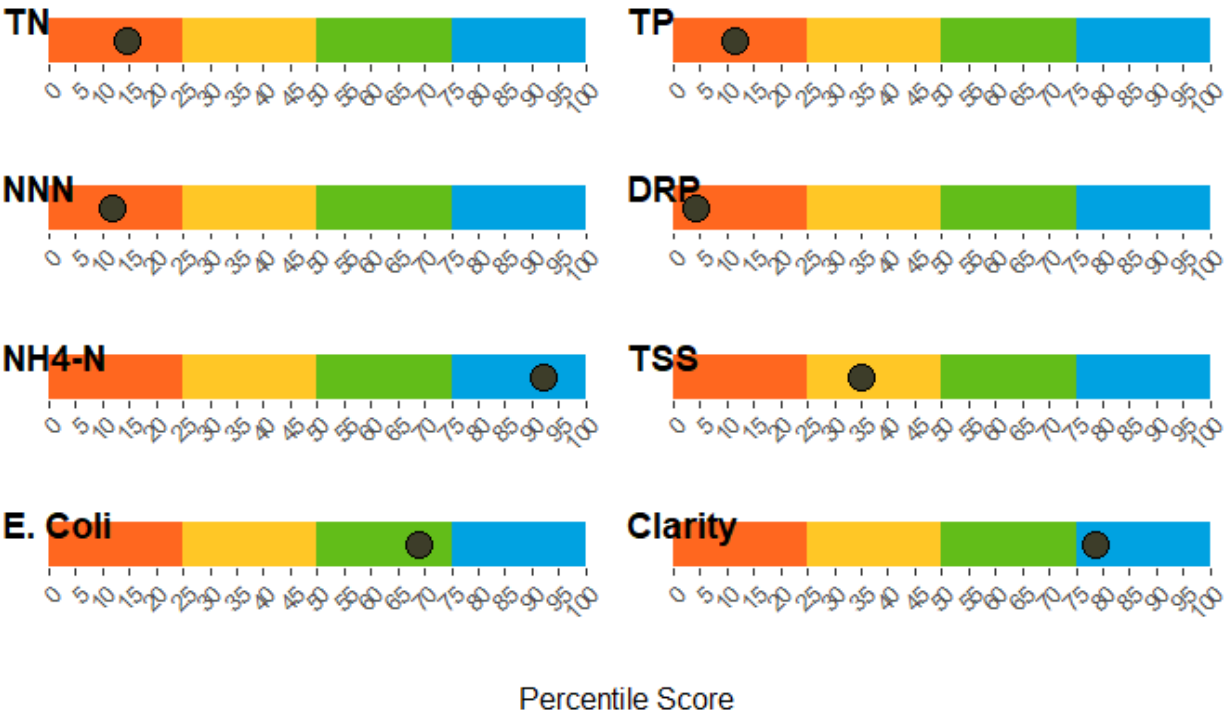


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

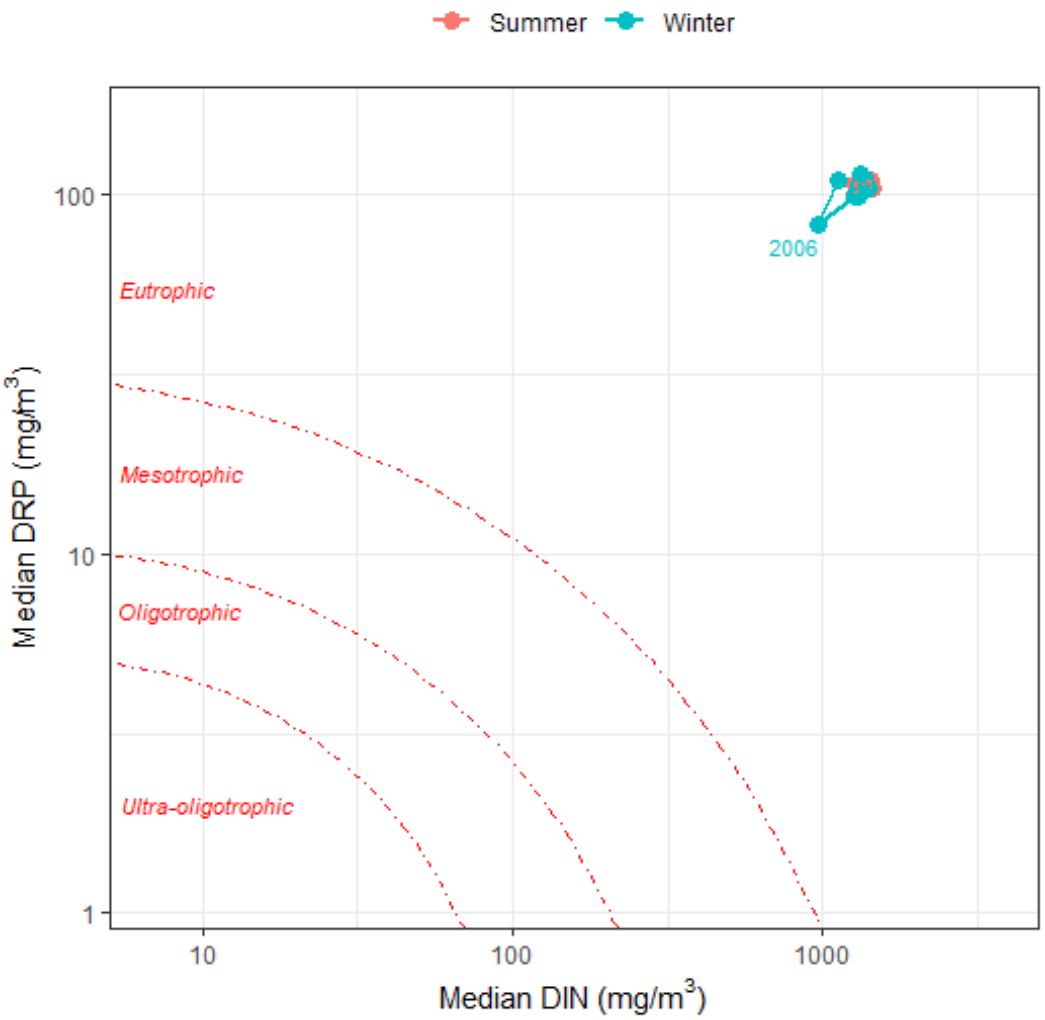


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-11-03	2020-11-02	5	0.0010	0.0030	A
5 Years	2015-11-04	2020-11-02	30	0.0010	0.0030	A
10 Years	2010-11-05	2020-11-02	54	0.0010	0.0030	A
All	1999-10-07	2020-11-02	83	0.0009	0.0093	A

Table 4. Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-11-03	2020-11-02	5	1.3	1.4	B
5 Years	2015-11-04	2020-11-02	32	1.3	1.4	B
10 Years	2010-11-05	2020-11-02	59	1.4	1.4	B
All	1999-10-07	2020-11-02	88	1.3	1.4	B

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-11-04	2020-11-02	30	3.25	A**
10 Years	2010-11-05	2020-11-02	42	3.12	A*
All	2009-09-17	2020-11-02	49	3.24	A*

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-11-04	2020-11-02	31	0.105	0.113	D
10 Years	2010-11-05	2020-11-02	58	0.108	0.115	D
All	1999-10-07	2020-11-02	85	0.105	0.115	D

Table 7. Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-11-04	2020-11-02	31	0.0	0.0	38	68	A**	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-11-04	2020-11-02	31	38	79	100	0	0
10 Years	2010-11-05	2020-11-02	58	36	87	98.3	1.7	0
All	1999-10-07	2020-11-02	88	28	97	97.7	1.1	1.1

Time series plots

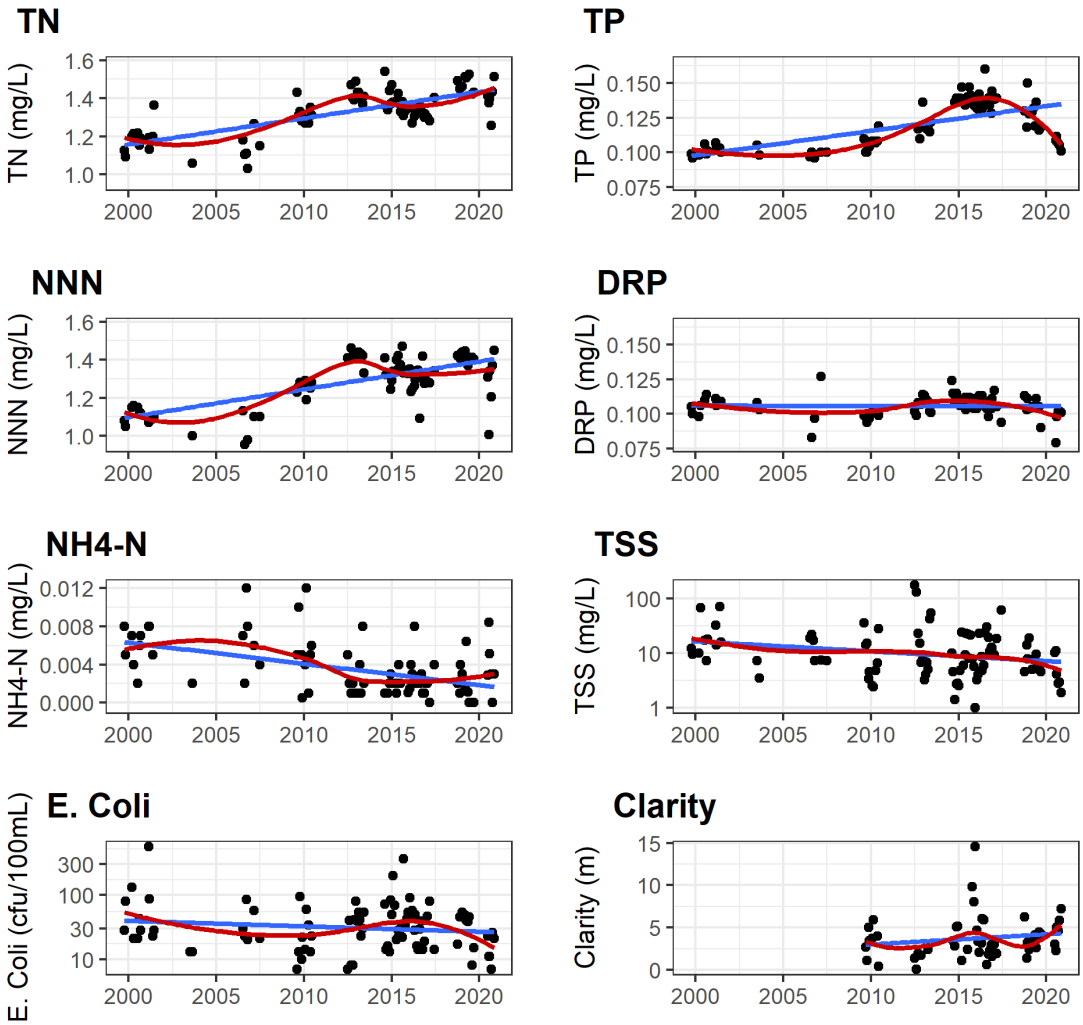


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-11-12	2020-11-02	0.0011	0.08	0.89	Indeterminant	YES	NO	Indeterminate/Uncertain
TN	10 Years	2012-07-03	2020-11-02	-0.0013	-0.09	0.75	Indeterminant	YES	NO	Indeterminate/Uncertain
TN	All	1999-11-04	2020-11-02	0.0021	0.16	0.44	Indeterminant	YES	NO	Likely Degrading
NNN	5 Years	2015-11-12	2020-11-02	0.0208	1.55	<0.05	Increasing	NO	NO	Very Likely Degrading
NNN	10 Years	2012-07-03	2020-11-02	-0.0010	-0.07	0.80	Indeterminant	YES	NO	Indeterminate/Uncertain
NNN	All	1999-11-04	2020-11-02	0.0045	0.34	0.05	Increasing	YES	NO	Very Likely Degrading
NH4N	5 Years	2015-11-12	2020-11-02	0.0000	0.00	0.85	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	10 Years	2012-07-03	2020-11-02	0.0000	0.00	0.77	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	All	1999-11-04	2020-11-02	-0.0003	-12.94	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2015-11-12	2020-11-02	-0.0030	-2.28	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2012-07-03	2020-11-02	-0.0026	-1.94	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	All	1999-11-04	2020-11-02	0.0009	0.67	0.31	Indeterminant	YES	NO	Likely Degrading
DRP	5 Years	2015-11-12	2020-11-02	-0.0004	-0.42	0.60	Indeterminant	YES	NO	Likely Improving
DRP	10 Years	2012-07-03	2020-11-02	-0.0011	-1.05	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	All	1999-11-04	2020-11-02	0.0001	0.07	0.83	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	5 Years									Not Analysed

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2012-07-03	2020-11-02	-0.0316	-2.01	0.20	Indeterminant	YES	YES	Likely Improving
ECOLI	All	1999-11-04	2020-11-02	-0.0116	-0.78	0.59	Indeterminant	YES	YES	Likely Improving
TSS	5 Years	2015-11-12	2020-11-02	-0.0496	-5.22	0.19	Indeterminant	NO	NO	Likely Improving
TSS	10 Years	2012-07-03	2020-11-02	-0.0150	-1.60	0.54	Indeterminant	YES	NO	Likely Improving
TSS	All	1999-11-04	2020-11-02	-0.0239	-2.61	0.35	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2015-11-12	2020-11-02	0.1658	5.09	0.52	Indeterminant	NO	NO	Likely Improving
CLARITY	10 Years	2012-07-03	2020-11-02	0.0926	2.86	0.61	Indeterminant	YES	NO	Likely Improving
CLARITY	All	1999-11-04	2020-11-02	0.1109	3.26	0.22	Indeterminant	YES	NO	Likely Improving

Pongakawa at Old Coach Road

March 2021

Table 1 Site metadata.

Aquarius ID:	GN849464	**Labstar ID:**	BOP110112
LAWA ID:	EBOP-00017	**REC Reach:**	4004139
Easting:	1908494	**Northing:**	5804645
Longitude:	176.50620	**Latitude:**	-37.85348
Elevation:	5 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Low_VA		

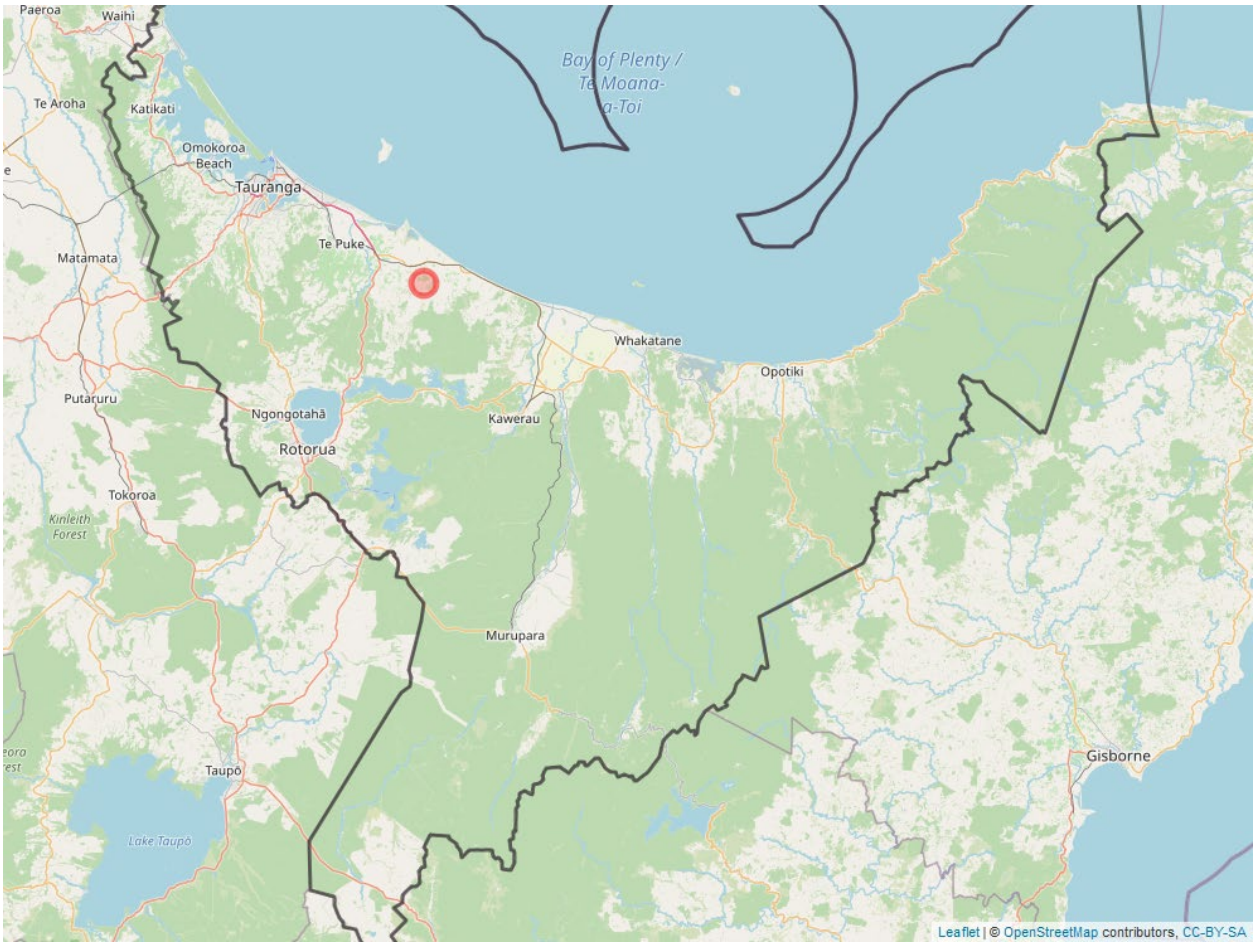


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	145	0.19	1.94	1.57	1.57	1.80	1.43	0.18	0.01
Nitrate Nitrite Nitrogen (g/m3)	145	<0.001	1.73	1.49	1.51	1.67	1.31	0.19	0.02
Total Ammoniacal Nitrogen (g/m3)	145	<0.002	0.047	0.011	0.009	0.029	0.004	0.008	0.001
Total Phosphorus (g/m3)	145	0.059	0.241	0.133	0.130	0.169	0.108	0.022	0.002
Dissolved Reactive Phosphorus (g/m3)	141	0.058	0.138	0.109	0.109	0.125	0.097	0.011	0.001
Dissolved Oxygen Sat (%)	90	10.3	104.5	93.9	94.8	100.6	88.5	9.6	1.0
Dissolved Oxygen (g/m3)	139	8.76	11.50	9.66	9.70	10.31	8.98	0.44	0.04
Escherichia coli (cfu/100ml)	144	9	4067	265	110	807	26	546	46
Total Suspended Solids (g/m3)	144	<1	193.80	18.30	11.93	50.95	2.93	20.89	1.74
Turbidity (NTU)	145	0.5	49.0	3.7	2.4	8.6	0.8	5.1	0.4
Water Clarity (m)	97	0.12	6.31	2.05	1.74	4.28	0.50	1.29	0.13
Conductivity (uS/cm)	145	77	329	114	111	129	102	21	2
pH (pH Units)	145	6.2	7.9	6.9	6.9	7.3	6.6	0.2	0.0
Water Temperature (degC)	141	12.8	17.2	14.8	14.8	16.4	13.3	0.9	0.1
Discharge (m3/s)	119	4.00	7.50	5.00	4.90	6.10	4.30	0.60	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

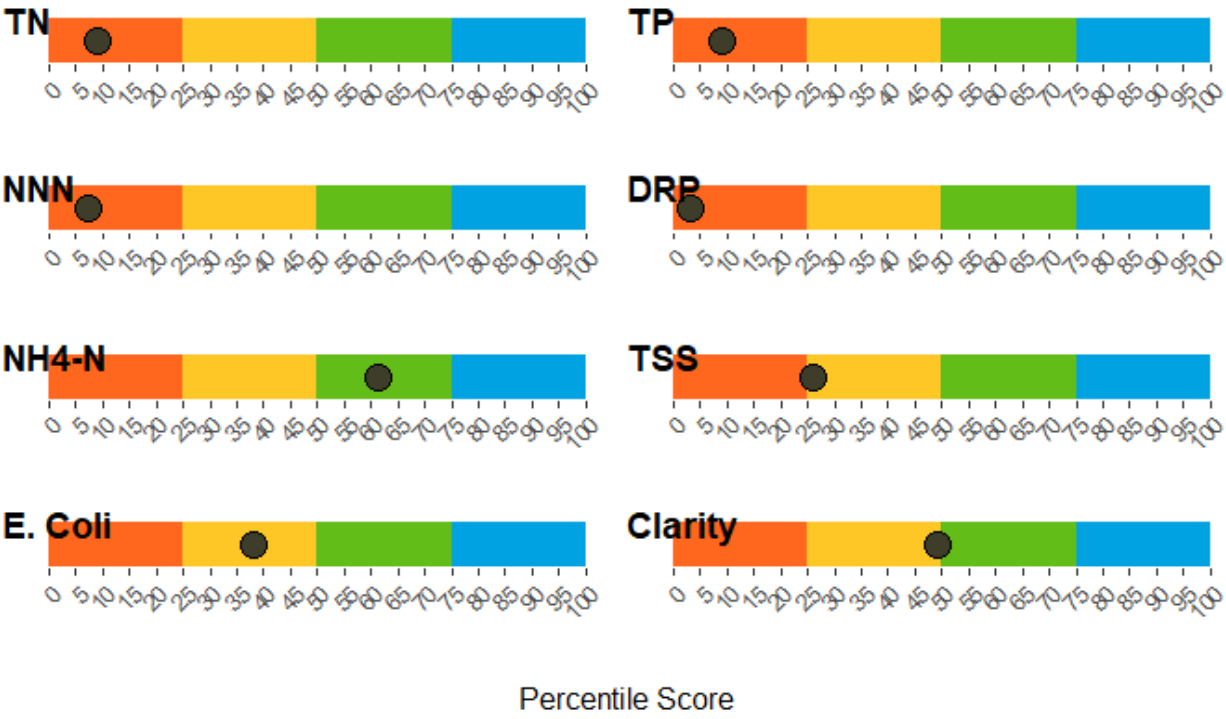


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

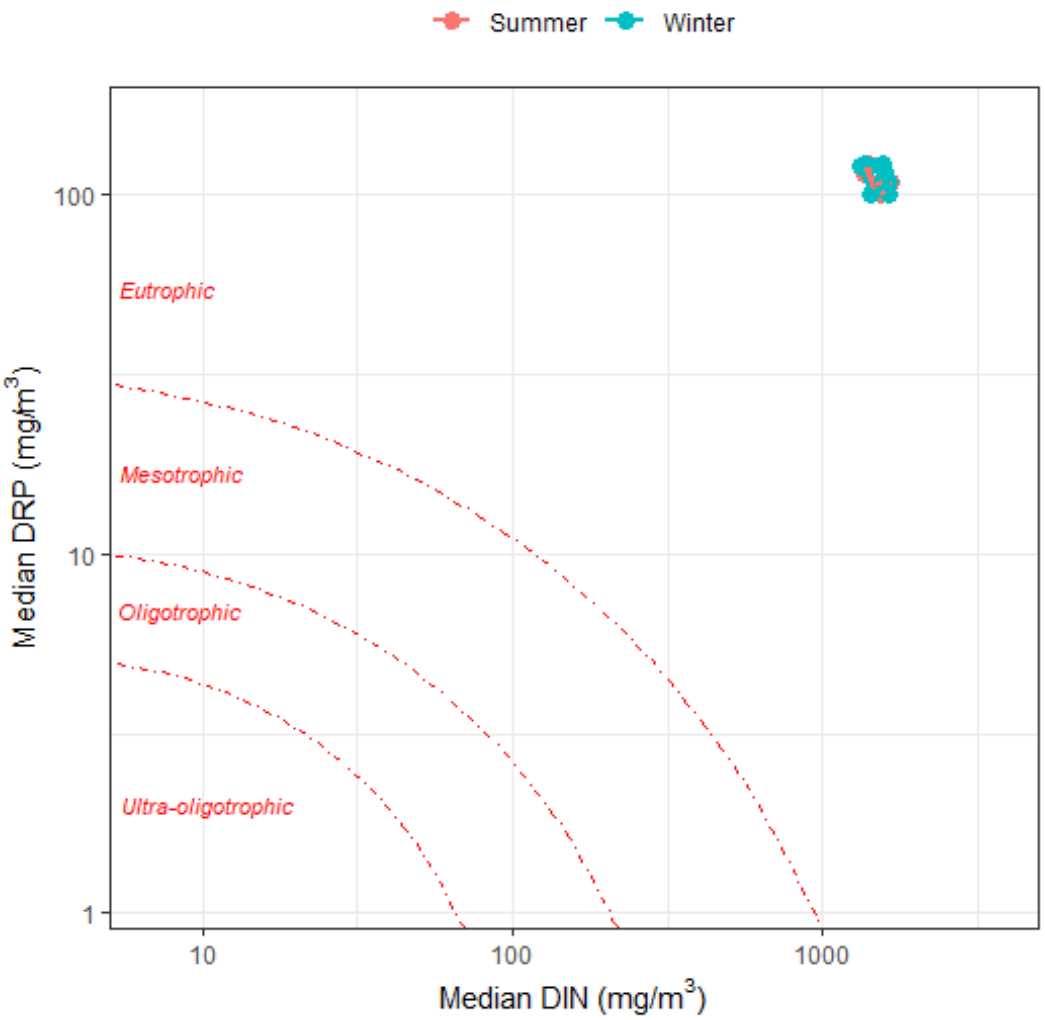


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.0030	0.006	A
5 Years	2015-12-04	2020-12-02	61	0.0030	0.015	A
10 Years	2010-12-05	2020-12-02	90	0.0030	0.015	A
All	1999-07-14	2020-12-02	145	0.0038	0.019	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	1.6	1.6	B
5 Years	2015-12-04	2020-12-02	61	1.6	1.7	B
10 Years	2010-12-05	2020-12-02	90	1.6	1.7	B
All	1999-07-14	2020-12-02	145	1.5	1.7	B

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	58	1.50	C*
10 Years	2010-12-05	2020-12-02	83	1.74	B
All	2007-01-31	2020-12-02	96	1.72	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	61	0.107	0.117	D
10 Years	2010-12-05	2020-12-02	90	0.108	0.119	D
All	1999-07-14	2020-12-02	140	0.109	0.125	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	60	11.7	35.0	190	1620	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8. Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	60	190	1800	65	23.3	11.7
10 Years	2010-12-05	2020-12-02	89	130	1620	69.7	18	12.4
All	1999-07-14	2020-12-02	144	110	851	77.1	14.6	7.6

Time series plots

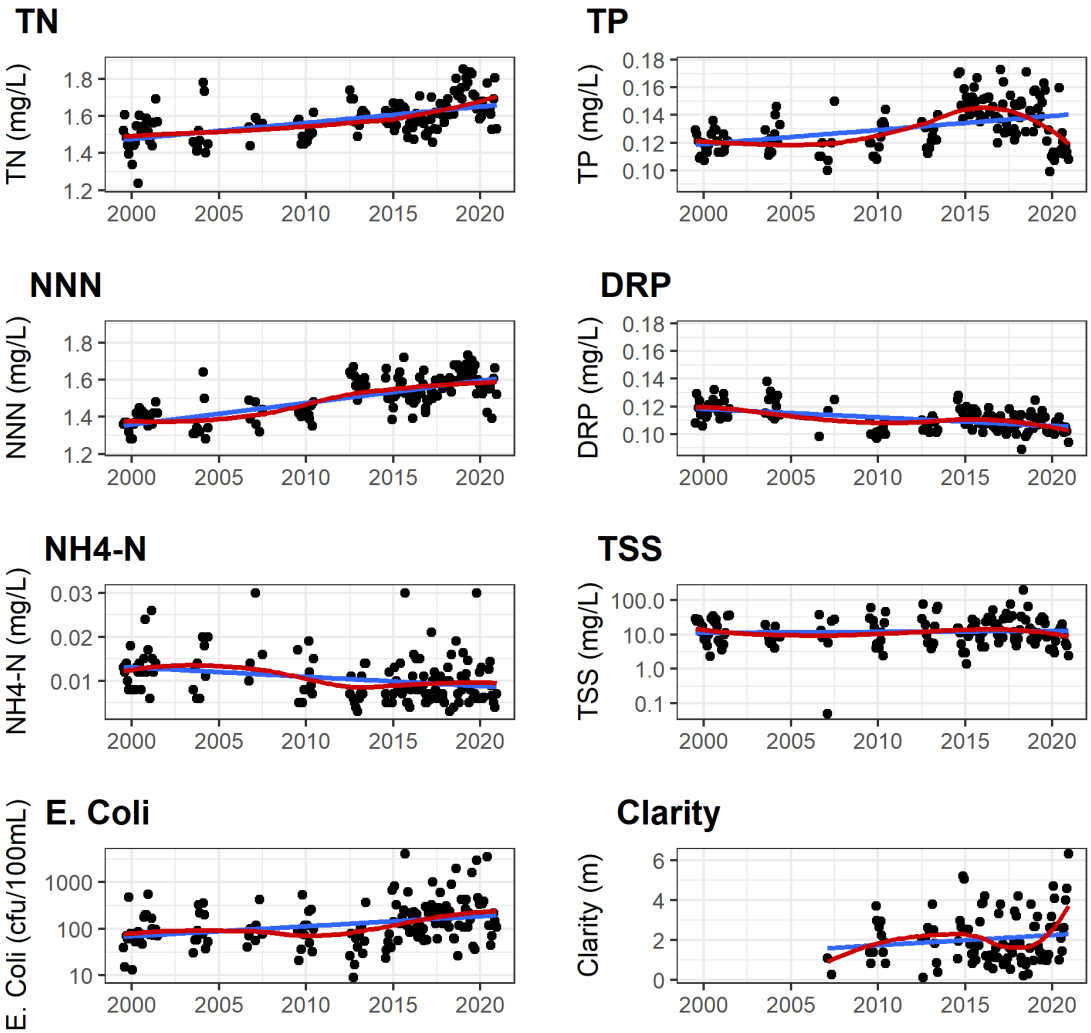


Figure 4 *Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.*

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-02	0.0081	0.50	0.19	Indeterminant	YES	NO	Very Likely Degrading
TN	10 Years	2012-07-02	2020-12-02	0.0111	0.69	<0.01	Increasing	YES	NO	Very Likely Degrading
TN	All	1999-08-10	2020-12-02	0.0059	0.37	<0.001	Increasing	YES	NO	Very Likely Degrading
NNN	5 Years	2015-12-10	2020-12-02	-0.0006	-0.04	0.88	Indeterminant	YES	NO	Indeterminate/Uncertain
NNN	10 Years	2012-07-02	2020-12-02	0.0034	0.22	0.18	Indeterminant	YES	NO	Very Likely Degrading
NNN	All	1999-08-10	2020-12-02	0.0078	0.51	<0.001	Increasing	YES	NO	Very Likely Degrading
NH4N	5 Years	2015-12-10	2020-12-02	-0.0002	-2.44	0.62	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2012-07-02	2020-12-02	0.0002	2.83	0.20	Indeterminant	YES	NO	Very Likely Degrading
NH4N	All	1999-08-10	2020-12-02	-0.0001	-1.43	0.10	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2015-12-10	2020-12-02	-0.0039	-2.83	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2012-07-02	2020-12-02	-0.0014	-1.00	0.22	Indeterminant	YES	NO	Likely Improving
TP	All	1999-08-10	2020-12-02	0.0007	0.51	<0.05	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2015-12-10	2020-12-02	-0.0010	-0.93	0.07	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2012-07-02	2020-12-02	-0.0008	-0.76	<0.01	Decreasing	NO	NO	Very Likely Improving
DRP	All	1999-08-10	2020-12-02	-0.0004	-0.37	<0.01	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2015-12-10	2020-12-02	0.0078	0.34	0.90	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2012-07-02	2020-12-02	0.0612	2.89	<0.01	Increasing	YES	NO	Very Likely Degrading
ECOLI	All	1999-08-10	2020-12-02	0.0222	1.06	<0.01	Increasing	YES	NO	Very Likely Degrading
TSS	5 Years	2015-12-10	2020-12-02	-0.0732	-6.08	<0.001	Decreasing	YES	YES	Very Likely Improving
TSS	10 Years	2012-07-02	2020-12-02	-0.0071	-0.62	0.65	Indeterminant	YES	YES	Likely Improving
TSS	All	1999-08-10	2020-12-02	-0.0037	-0.32	0.23	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2015-12-10	2020-12-02	0.2687	18.84	<0.001	Increasing	YES	YES	Very Likely Improving
CLARITY	10 Years	2012-07-02	2020-12-02	0.0369	2.17	0.66	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	1999-08-10	2020-12-02	0.0484	2.92	0.20	Indeterminant	YES	YES	Likely Improving

Pongakawa at SH 2

March 2021

Table 1 Site metadata.

Aquarius ID:	GN922883	**Labstar ID:**	BOP110030, BOP_NERM_033
LAWA ID:	EBOP-00016	**REC Reach:**	4003250
Easting:	1909225	**Northing:**	5808837
Longitude:	176.51270	**Latitude:**	-37.81552
Elevation:	1 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

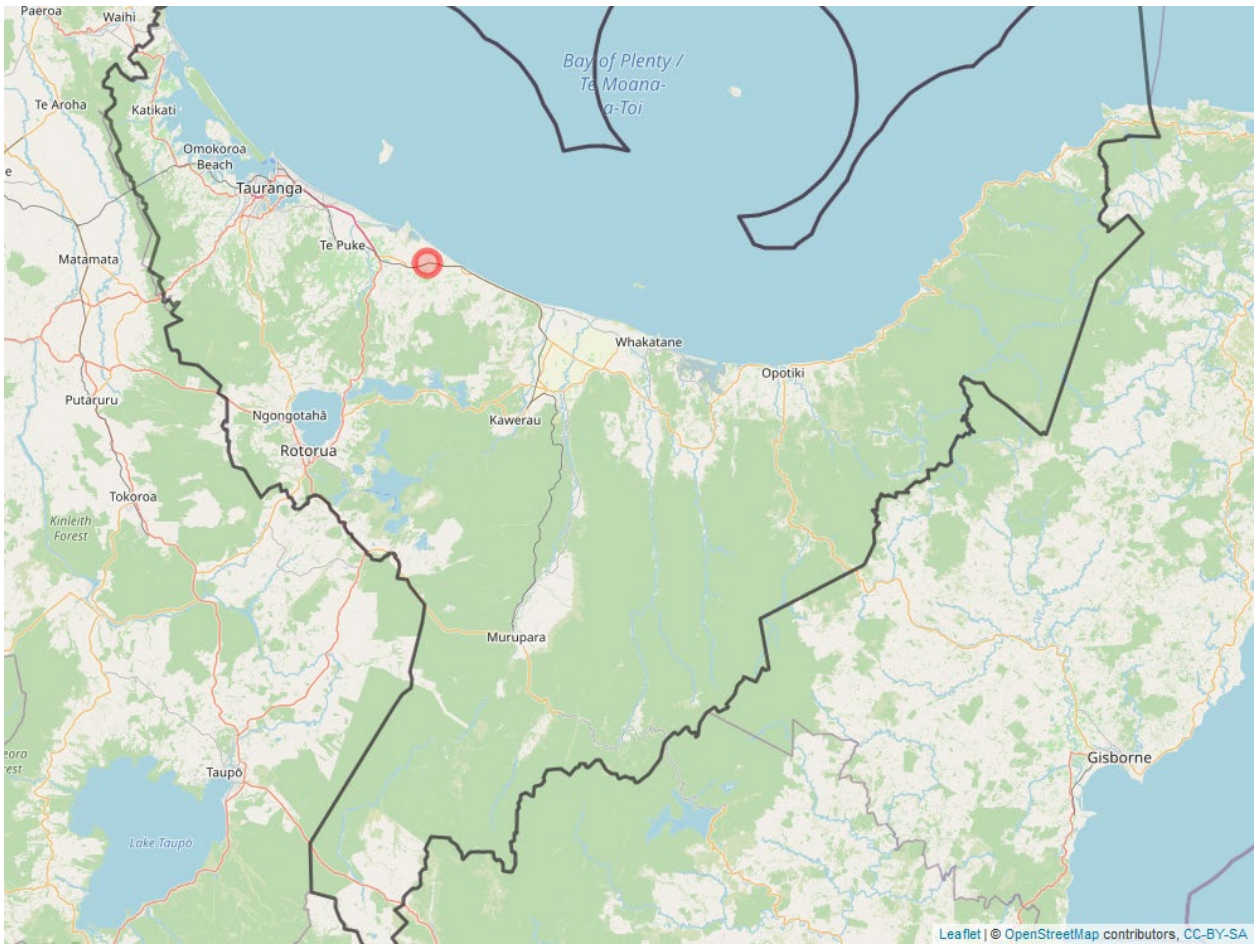


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	167	0.52	1.97	1.55	1.57	1.81	1.29	0.19	0.01
Nitrate Nitrite Nitrogen (g/m3)	168	0.33	2.00	1.42	1.44	1.66	1.15	0.20	0.02
Total Ammoniacal Nitrogen (g/m3)	181	<0.002	0.111	0.018	0.012	0.048	0.004	0.016	0.001
Total Phosphorus (g/m3)	180	0.095	0.226	0.134	0.130	0.180	0.107	0.022	0.002
Dissolved Reactive Phosphorus (g/m3)	179	0.026	0.168	0.110	0.110	0.128	0.092	0.015	0.001
Dissolved Oxygen Sat (%)	87	84.6	115.8	98.3	98.7	109.0	87.7	6.7	0.7
Dissolved Oxygen (g/m3)	173	7.90	12.10	9.78	9.80	10.66	8.70	0.63	0.05
Escherichia coli (cfu/100ml)	177	<1	7800	285	83	690	17	863	65
Total Suspended Solids (g/m3)	179	<1	140.00	16.31	11.00	48.36	2.08	18.39	1.37
Turbidity (NTU)	181	0.6	26.9	3.7	2.6	9.8	0.8	3.7	0.3
Water Clarity (m)	124	0.10	6.31	2.08	1.67	4.79	0.53	1.31	0.12
Conductivity (uS/cm)	180	78	280	118	114	142	106	21	2
pH (pH Units)	180	6.2	7.8	7.1	7.1	7.5	6.7	0.3	0.0
Water Temperature (degC)	177	11.5	18.5	15.1	15.0	17.0	12.8	1.2	0.1
Discharge (m3/s)	111	3.90	9.80	5.10	4.90	6.30	4.20	0.80	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

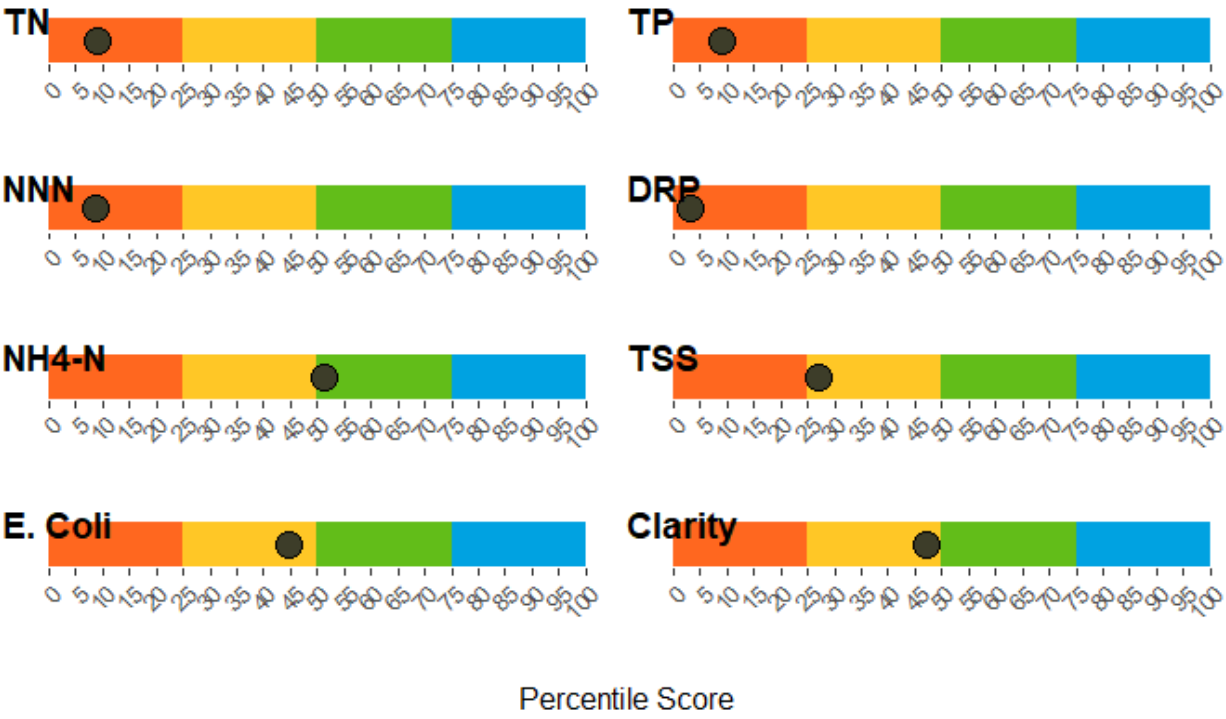


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

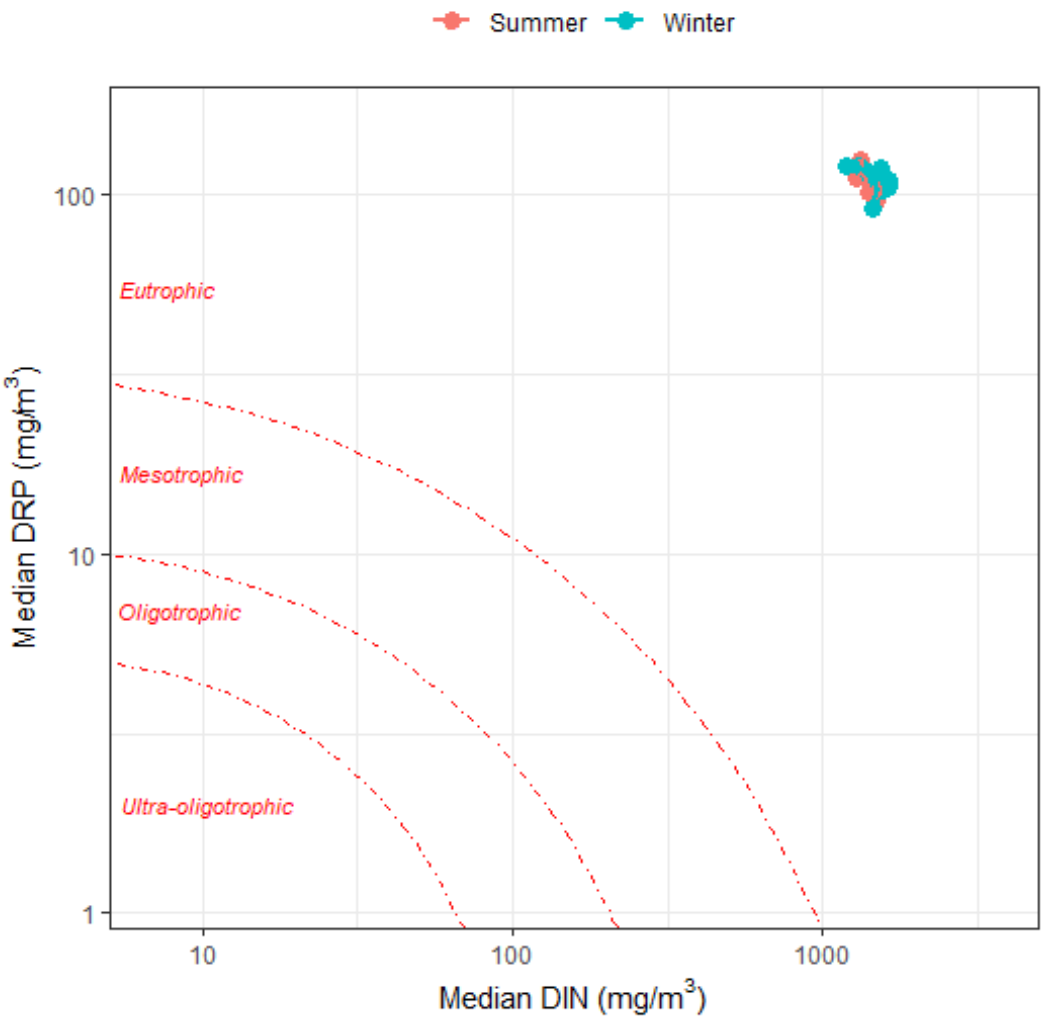


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°Cs.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.0040	0.014	A
5 Years	2015-12-04	2020-12-02	59	0.0050	0.046	A
10 Years	2010-12-05	2020-12-02	88	0.0040	0.046	A
All	1991-02-26	2020-12-02	180	0.0054	0.046	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	1.5	1.6	B
5 Years	2015-12-04	2020-12-02	59	1.6	1.7	B
10 Years	2010-12-05	2020-12-02	88	1.6	1.7	B
All	1993-09-16	2020-12-02	168	1.4	1.7	B

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	58	1.65	B*
10 Years	2010-12-05	2020-12-02	81	1.68	B
All	1992-09-04	2020-12-02	122	1.67	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	59	0.105	0.118	D
10 Years	2010-12-05	2020-12-02	88	0.106	0.124	D
All	1991-02-25	2020-12-02	178	0.110	0.128	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	58	10.3	24.1	90	2235	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	58	90	2640	75.9	13.8	10.3
10 Years	2010-12-05	2020-12-02	87	80	2235	77	11.5	11.5
All	1991-02-26	2020-12-02	177	83	848	82.5	11.3	6.2

Time series plots

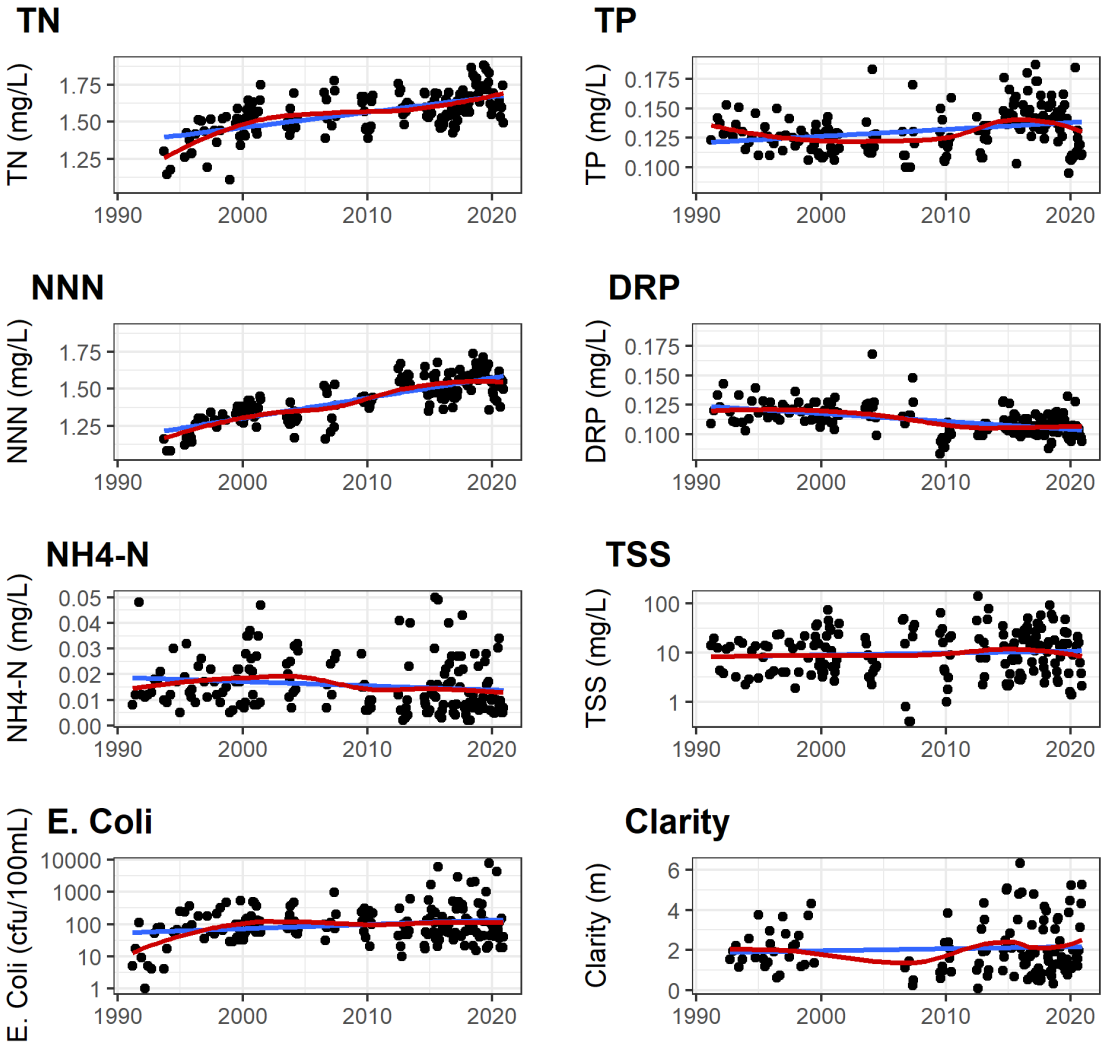


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-11	2020-12-02	0.0134	0.82	0.19	Indeterminant	YES	NO	Very Likely Degrading
TN	10 Years	2012-07-02	2020-12-02	0.0156	0.97	<0.001	Increasing	YES	YES	Very Likely Degrading
TN	All	1991-02-26	2020-12-02	0.0098	0.61	<0.001	Increasing	YES	YES	Very Likely Degrading
NNN	5 Years	2015-12-11	2020-12-02	0.0060	0.38	0.45	Indeterminant	YES	NO	Likely Degrading
NNN	10 Years	2012-07-02	2020-12-02	0.0048	0.31	0.09	Increasing	YES	YES	Very Likely Degrading
NNN	All	1991-02-26	2020-12-02	0.0085	0.56	<0.001	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2015-12-11	2020-12-02	-0.0011	-10.76	0.29	Indeterminant	YES	YES	Likely Improving
NH4N	10 Years	2012-07-02	2020-12-02	0.0008	8.13	0.16	Indeterminant	YES	YES	Very Likely Degrading
NH4N	All	1991-02-26	2020-12-02	0.0000	-0.38	0.56	Indeterminant	YES	YES	Likely Improving
TP	5 Years	2015-12-11	2020-12-02	-0.0058	-4.10	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2012-07-02	2020-12-02	-0.0001	-0.09	0.92	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	1991-02-26	2020-12-02	0.0000	-0.03	0.85	Indeterminant	YES	YES	Indeterminate/Uncertain
DRP	5 Years	2015-12-11	2020-12-02	-0.0009	-0.83	0.22	Indeterminant	YES	NO	Likely Improving
DRP	10 Years	2012-07-02	2020-12-02	-0.0003	-0.32	0.42	Indeterminant	YES	NO	Likely Improving
DRP	All	1991-02-26	2020-12-02	-0.0002	-0.22	0.06	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2015-12-11	2020-12-02	-0.0555	-2.91	0.12	Indeterminant	YES	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2012-07-02	2020-12-02	0.0097	0.51	0.65	Indeterminant	YES	NO	Likely Degrading
ECOLI	All	1991-02-26	2020-12-02	0.0098	0.52	0.10	Indeterminant	YES	NO	Very Likely Degrading
TSS	5 Years	2015-12-11	2020-12-02	-0.0746	-6.27	<0.05	Decreasing	YES	YES	Very Likely Improving
TSS	10 Years	2012-07-02	2020-12-02	0.0082	0.71	0.69	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	All	1991-02-26	2020-12-02	-0.0023	-0.20	0.25	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2015-12-11	2020-12-02	0.2007	12.18	<0.05	Increasing	YES	YES	Very Likely Improving
CLARITY	10 Years	2012-07-02	2020-12-02	-0.0138	-0.82	0.78	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	1991-02-26	2020-12-02	0.0137	0.82	0.07	Increasing	YES	YES	Very Likely Improving

Kaituna at Te Tumu

March 2021

Table 1 Site metadata.

Aquarius ID:	GO081642	**Labstar ID:**	BOP110029
LAWA ID:		**REC Reach:**	4002050
Easting:	1900810	**Northing:**	5816420
Longitude:	176.41412	**Latitude:**	-37.75010
Elevation:	1 m	**Biophysical Unit:**	Unknown
Flow:	No	**Water Level:**	No
REC Class:	WW_Lake_VA		

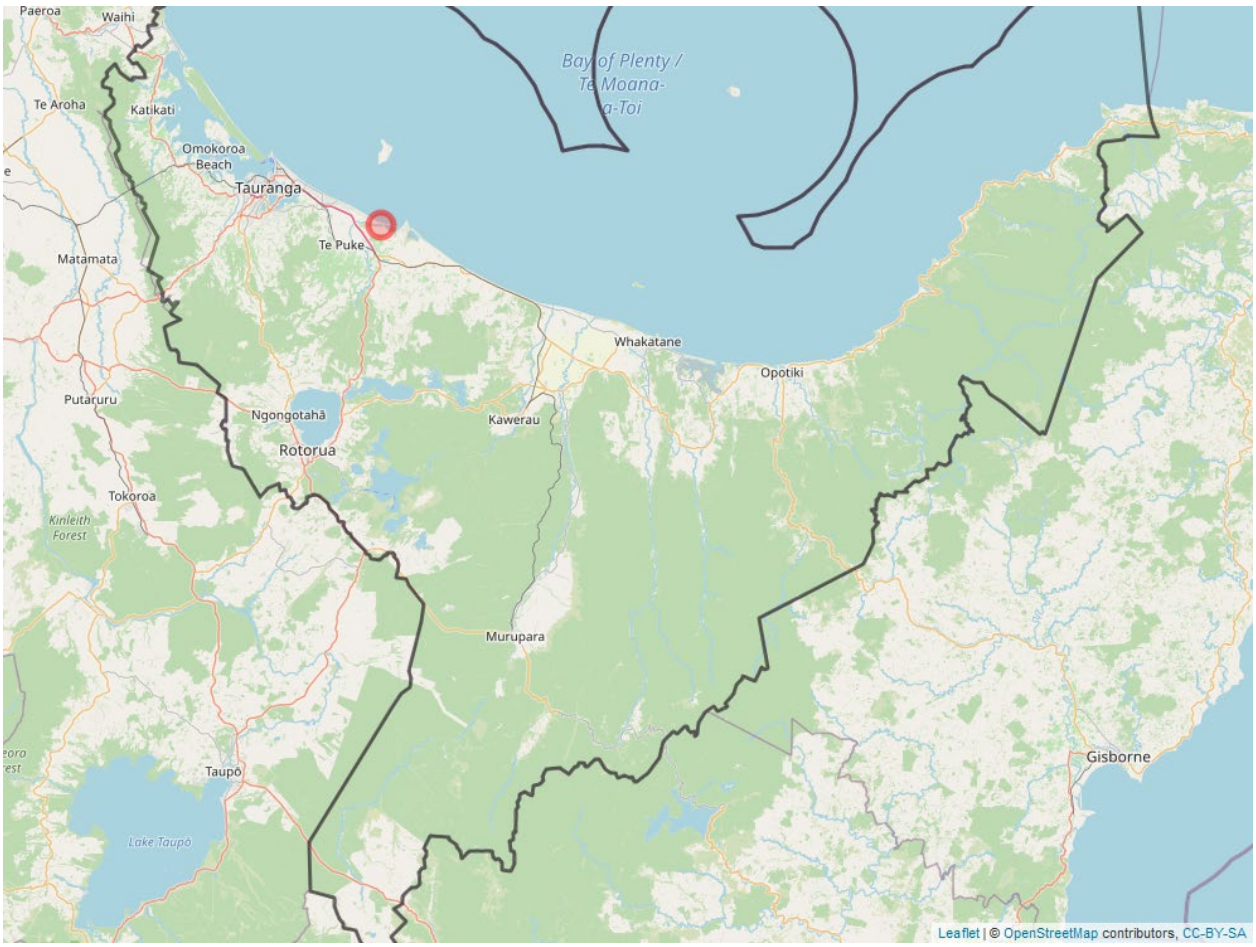


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	161	0.30	2.02	0.80	0.79	1.11	0.60	0.18	0.01
Nitrate Nitrite Nitrogen (g/m3)	163	0.02	0.80	0.57	0.59	0.76	0.30	0.14	0.01
Total Ammoniacal Nitrogen (g/m3)	174	<0.002	0.760	0.056	0.042	0.104	0.012	0.077	0.006
Total Phosphorus (g/m3)	174	0.027	0.867	0.058	0.048	0.082	0.035	0.067	0.005
Dissolved Reactive Phosphorus (g/m3)	174	<0.001	0.128	0.028	0.027	0.044	0.012	0.013	0.001
Dissolved Oxygen Sat (%)	116	71.2	109.2	93.4	93.7	101.2	84.5	5.4	0.5
Dissolved Oxygen (g/m3)	169	6.40	11.13	9.23	9.29	10.40	7.72	0.82	0.06
Escherichia coli (cfu/100ml)	161	<1	5000	355	80	2000	11	795	63
Total Suspended Solids (g/m3)	163	<1	76.40	10.26	6.80	27.18	2.30	11.06	0.87
Turbidity (NTU)	176	0.6	29.7	4.2	2.7	11.0	1.2	4.3	0.3
Water Clarity (m)	53	0.46	3.53	1.72	1.61	3.14	0.58	0.79	0.11
Conductivity (uS/cm)	155	75	16800	3017	1170	12322	289	3927	315
pH (pH Units)	168	6.2	8.1	6.9	6.9	7.5	6.5	0.3	0.0
Water Temperature (degC)	173	10.6	22.6	16.0	16.0	20.8	11.7	2.9	0.2
Discharge (m3/s)	174	22.70	95.40	37.50	35.30	58.90	24.10	11.60	0.90

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

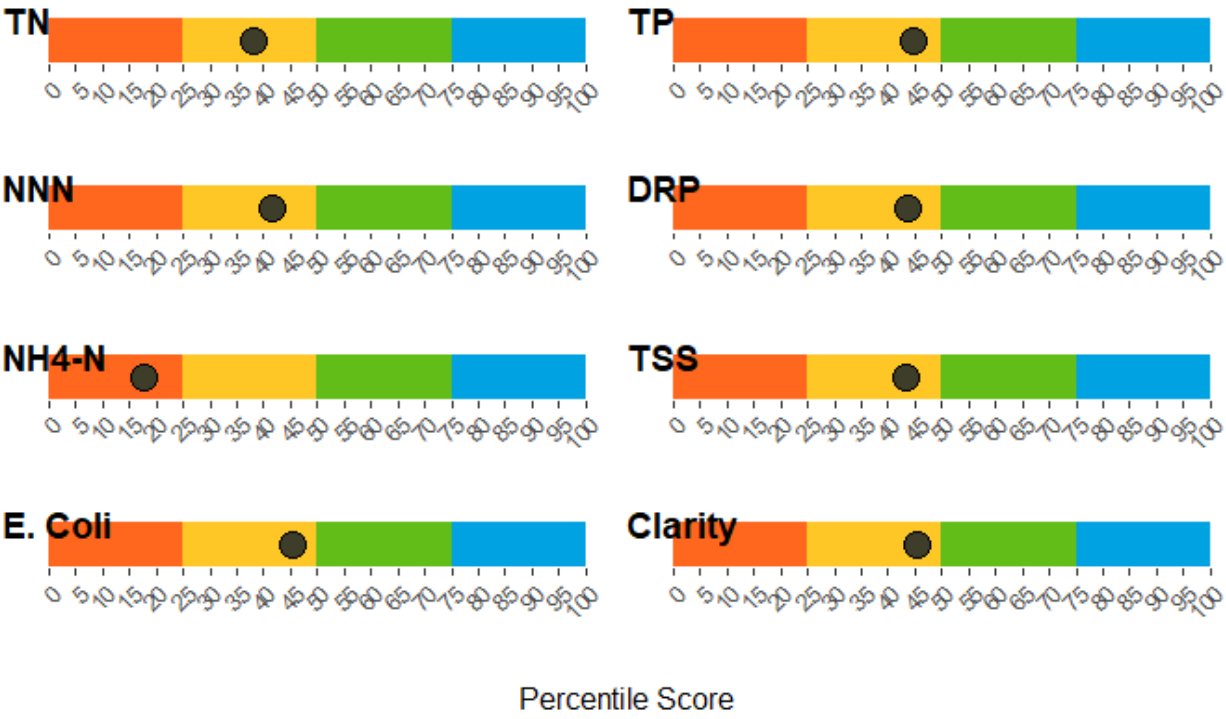


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

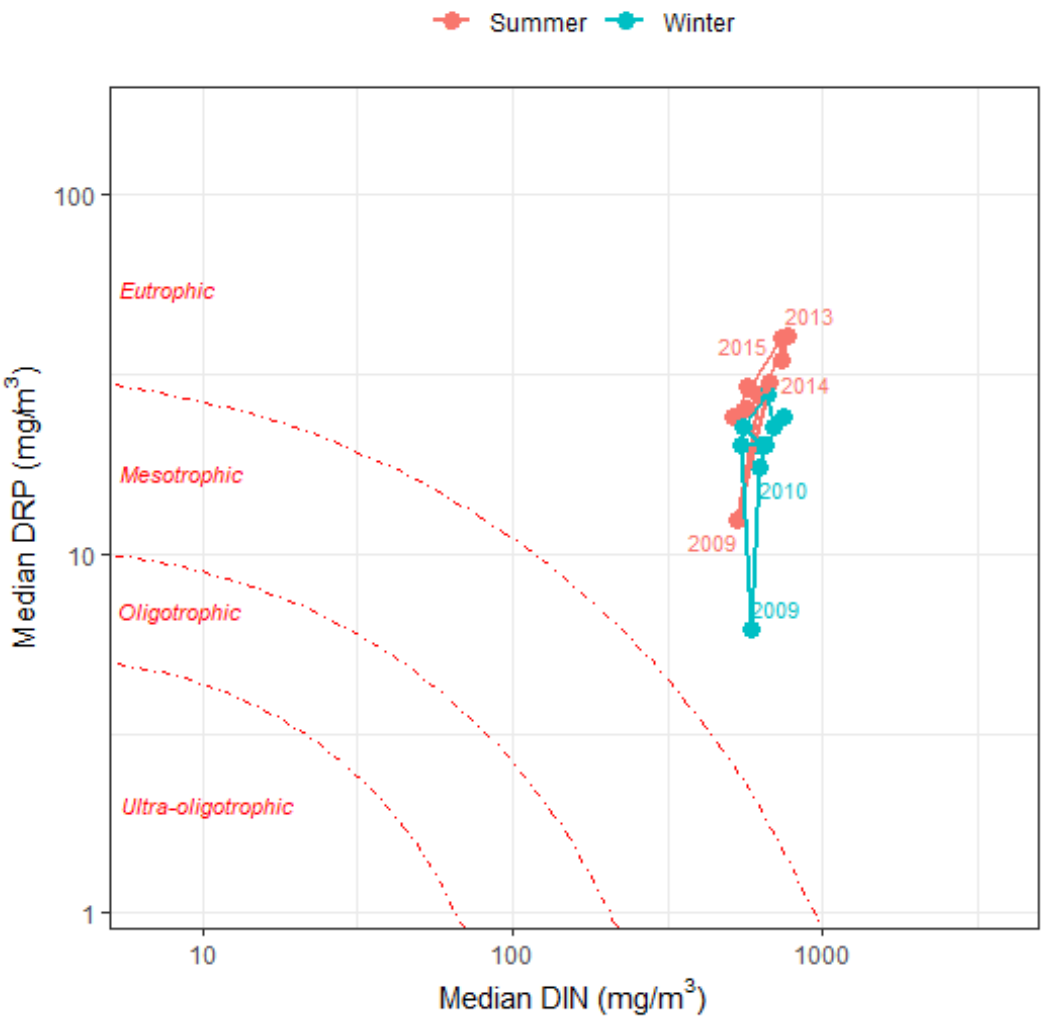


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	9	0.020	0.032	A
5 Years	2015-12-04	2020-12-02	47	0.017	0.080	B
10 Years	2010-12-05	2020-12-02	117	0.016	0.137	B
All	1991-02-26	2020-12-02	166	0.017	0.281	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	9	0.55	0.63	A
5 Years	2015-12-04	2020-12-02	47	0.53	0.62	A
10 Years	2010-12-05	2020-12-02	123	0.60	0.76	A
All	1993-09-16	2020-12-02	163	0.59	0.76	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	42	1.62	D*
10 Years	2010-12-05	2020-12-02	44	1.71	D*
All	1992-09-04	2020-12-02	51	1.61	D*

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	47	0.023	0.040	D
10 Years	2010-12-05	2020-12-02	124	0.028	0.044	D
All	1991-02-25	2020-12-02	173	0.027	0.044	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	47	17.0	25.5	100	2640	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8. Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	47	100	2910	74.5	8.5	17
10 Years	2010-12-05	2020-12-02	115	73	2367	77.4	7.8	14.8
All	1991-02-26	2020-12-02	161	80	2120	77	9.3	13.7

Time series plots

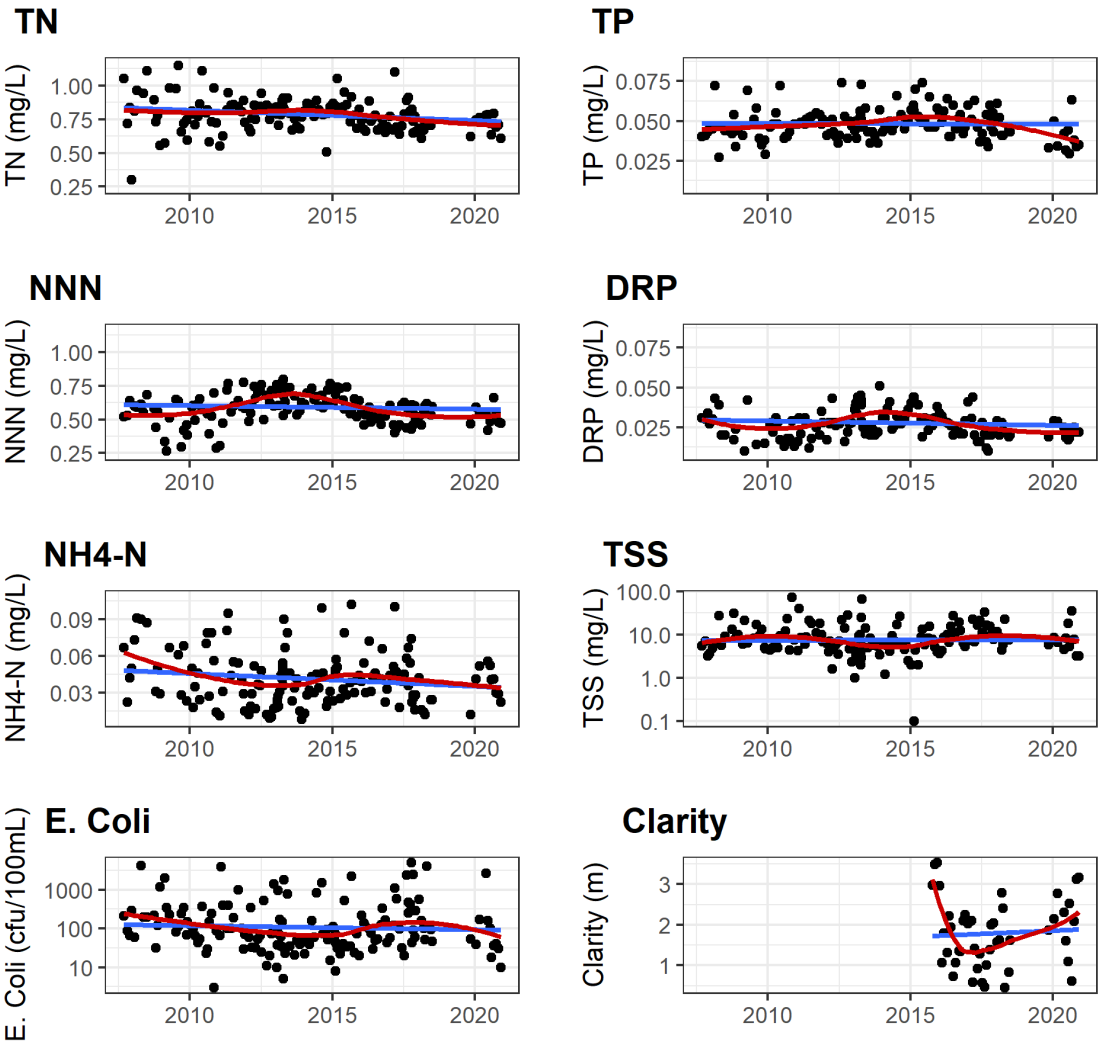


Figure 4. Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-02	-0.0057	-0.78	0.28	Indeterminant	YES	NO	Likely Improving
TN	10 Years	2010-12-06	2020-12-02	-0.0143	-1.78	<0.001	Decreasing	YES	YES	Very Likely Improving
TN	All	2007-09-07	2020-12-02	-0.0113	-1.41	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2015-12-10	2020-12-02	-0.0025	-0.47	0.66	Indeterminant	YES	NO	Indeterminate/Uncertain
NNN	10 Years	2010-12-06	2020-12-02	-0.0134	-2.18	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	All	2007-09-07	2020-12-02	-0.0012	-0.20	0.61	Indeterminant	YES	YES	Likely Improving
NH4N	5 Years	2015-12-10	2020-12-02	-0.0031	-7.67	0.09	Decreasing	YES	NO	Very Likely Improving
NH4N	10 Years	2010-12-06	2020-12-02	-0.0001	-0.17	0.95	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	All	2007-09-07	2020-12-02	-0.0016	-4.02	<0.01	Decreasing	YES	YES	Very Likely Improving
TP	5 Years	2015-12-10	2020-12-02	-0.0033	-7.13	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2010-12-06	2020-12-02	-0.0009	-1.88	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	All	2007-09-07	2020-12-02	-0.0001	-0.28	0.81	Indeterminant	YES	YES	Indeterminate/Uncertain
DRP	5 Years	2015-12-10	2020-12-02	-0.0011	-4.60	0.07	Decreasing	YES	YES	Very Likely Improving
DRP	10 Years	2010-12-06	2020-12-02	-0.0008	-2.90	<0.01	Decreasing	YES	YES	Very Likely Improving
DRP	All	2007-09-07	2020-12-02	0.0000	0.06	0.82	Indeterminant	YES	YES	Indeterminate/Uncertain
ECOLI	5 Years	2015-12-10	2020-12-02	-0.0048	-0.24	0.93	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-12-06	2020-12-02	0.0074	0.40	0.67	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2007-09-07	2020-12-02	-0.0272	-1.45	<0.05	Decreasing	YES	NO	Very Likely Improving
TSS	5 Years	2015-12-10	2020-12-02	-0.0364	-3.77	0.08	Decreasing	YES	NO	Very Likely Improving
TSS	10 Years	2010-12-06	2020-12-02	0.0092	1.03	0.15	Indeterminant	YES	YES	Very Likely Degrading
TSS	All	2007-09-07	2020-12-02	-0.0014	-0.16	0.69	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	5 Years	2015-12-10	2020-12-02	0.1106	6.84	0.08	Increasing	YES	NO	Very Likely Improving
CLARITY	10 Years	2010-12-06	2020-12-02	0.0773	4.30	0.24	Indeterminant	YES	NO	Likely Improving
CLARITY	All	2007-09-07	2020-12-02	0.0773	4.30	0.24	Indeterminant	YES	NO	Likely Improving

Waitahanui at Otamarakau Marae

March 2021

Table 1 Site metadata.

Aquarius ID:	HN674689	**Labstar ID:**	BOP110136, BOP110095
LAWA ID:	EBOP-00038	**REC Reach:**	4003723
Easting:	1916743	**Northing:**	5806891
Longitude:	176.59880	**Latitude:**	-37.83045
Elevation:	1 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	123	0.13	3.56	0.86	0.83	1.07	0.69	0.29	0.03
Nitrate Nitrite Nitrogen (g/m3)	122	<0.001	1.34	0.73	0.74	0.91	0.59	0.13	0.01
Total Ammoniacal Nitrogen (g/m3)	122	<0.002	0.117	0.012	0.008	0.039	0.001	0.014	0.001
Total Phosphorus (g/m3)	123	0.080	1.272	0.128	0.117	0.159	0.093	0.106	0.010
Dissolved Reactive Phosphorus (g/m3)	121	0.009	0.132	0.089	0.089	0.106	0.069	0.015	0.001
Dissolved Oxygen Sat (%)	87	86.9	113.9	99.6	99.2	108.1	92.0	5.1	0.5
Dissolved Oxygen (g/m3)	119	8.40	13.10	10.05	10.07	10.91	9.00	0.63	0.06
Escherichia coli (cfu/100ml)	122	<1	10100	442	120	1500	24	1226	111
Total Suspended Solids (g/m3)	122	<1	384.00	19.08	11.25	44.48	2.05	36.42	3.30
Turbidity (NTU)	123	0.8	231.0	6.3	3.2	11.9	1.0	20.9	1.9
Water Clarity (m)	88	0.18	5.70	1.77	1.64	3.54	0.36	1.06	0.11
Conductivity (uS/cm)	123	83	220	180	183	198	156	16	1
pH (pH Units)	123	6.7	8.4	7.4	7.4	7.7	7.0	0.2	0.0
Water Temperature (degC)	119	10.8	18.6	14.8	14.8	17.1	11.8	1.7	0.2
Discharge (m3/s)	86	4.40	9.40	5.80	5.70	7.10	4.70	0.80	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

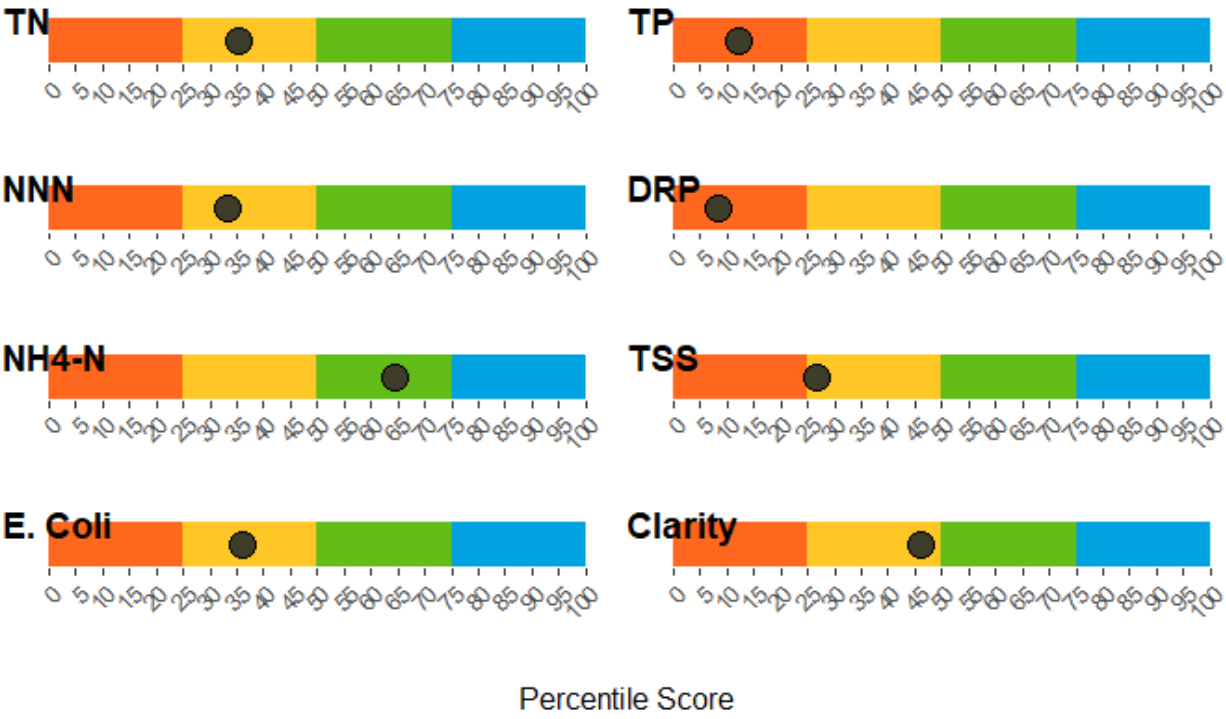


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

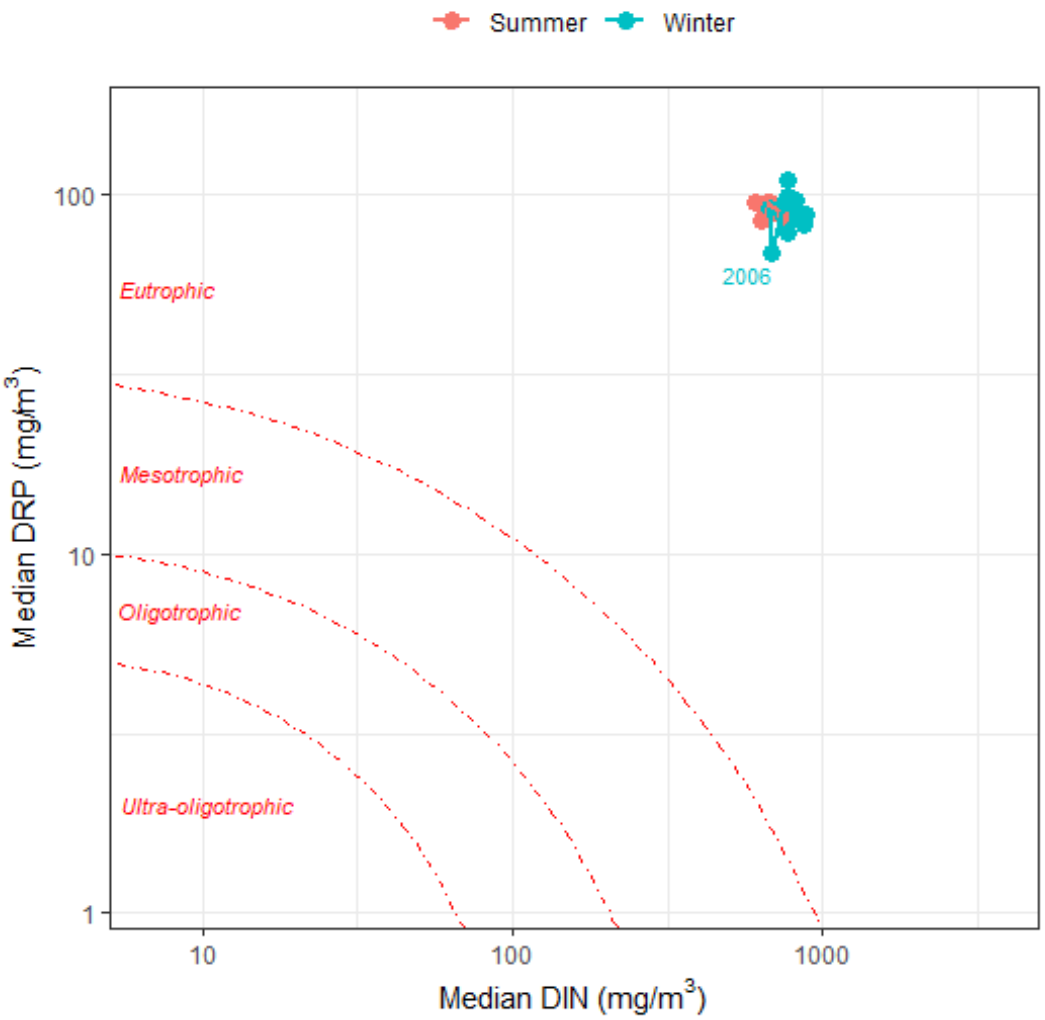


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-04	2020-12-03	12	0.0050	0.012	A
5 Years	2015-12-05	2020-12-03	60	0.0050	0.048	A
10 Years	2010-12-06	2020-12-03	87	0.0040	0.048	A
All	2003-07-10	2020-12-03	122	0.0047	0.048	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-04	2020-12-03	12	0.75	0.83	A
5 Years	2015-12-05	2020-12-03	60	0.78	0.92	A
10 Years	2010-12-06	2020-12-03	87	0.76	0.91	A
All	2003-07-10	2020-12-03	122	0.74	0.91	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-03	59	1.75	B*
10 Years	2010-12-06	2020-12-03	72	1.71	B
All	2006-07-13	2020-12-03	88	1.64	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	59	0.088	0.101	D
10 Years	2010-12-05	2020-12-02	86	0.091	0.105	D
All	2003-07-10	2020-12-02	120	0.090	0.106	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-05	2020-12-03	59	15.3	18.6	97	2120	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-05	2020-12-03	59	97	3110	81.4	3.4	15.3
10 Years	2010-12-06	2020-12-03	87	83	1900	80.5	4.6	14.9
All	2003-07-10	2020-12-03	122	120	1660	72.1	14.8	13.1

Time series plots

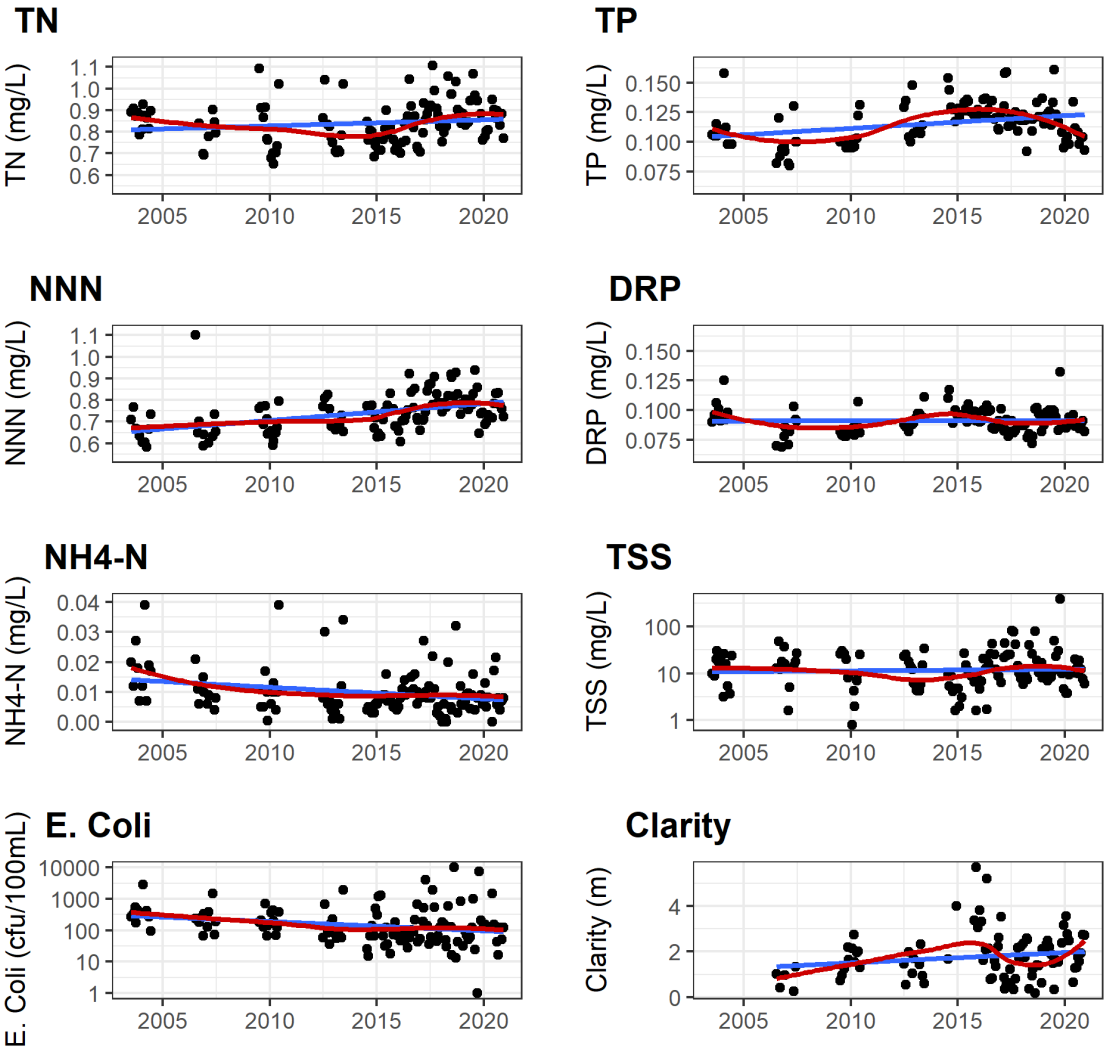


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-11	2020-12-03	-0.0065	-0.74	0.16	Indeterminant	YES	YES	Likely Improving
TN	10 Years	2012-07-02	2020-12-03	0.0126	1.51	<0.001	Increasing	YES	YES	Very Likely Degrading
TN	All	2003-08-25	2020-12-03	0.0126	1.51	<0.001	Increasing	YES	YES	Very Likely Degrading
NNN	5 Years	2015-12-11	2020-12-03	-0.0076	-0.97	0.12	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2012-07-02	2020-12-03	0.0102	1.35	<0.001	Increasing	YES	YES	Very Likely Degrading
NNN	All	2003-08-25	2020-12-03	0.0102	1.35	<0.001	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2015-12-11	2020-12-03	-0.0007	-9.16	0.10	Decreasing	YES	NO	Very Likely Improving
NH4N	10 Years	2012-07-02	2020-12-03	0.0001	0.98	0.68	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	All	2003-08-25	2020-12-03	0.0001	0.98	0.68	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	5 Years	2015-12-11	2020-12-03	-0.0032	-2.71	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2012-07-02	2020-12-03	-0.0021	-1.77	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	All	2003-08-25	2020-12-03	-0.0021	-1.77	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2015-12-11	2020-12-03	0.0004	0.44	0.54	Indeterminant	YES	NO	Likely Degrading
DRP	10 Years	2012-07-02	2020-12-03	-0.0011	-1.17	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	2003-08-25	2020-12-03	-0.0011	-1.17	<0.01	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2015-12-11	2020-12-03	-0.0330	-1.66	0.48	Indeterminant	YES	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2012-07-02	2020-12-03	-0.0037	-0.19	0.82	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2003-08-25	2020-12-03	-0.0037	-0.19	0.82	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	5 Years	2015-12-11	2020-12-03	-0.0574	-5.28	<0.01	Decreasing	YES	YES	Very Likely Improving
TSS	10 Years	2012-07-02	2020-12-03	0.0040	0.38	0.87	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	All	2003-08-25	2020-12-03	0.0040	0.38	0.87	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	5 Years	2015-12-11	2020-12-03	0.1531	8.76	<0.01	Increasing	YES	YES	Very Likely Improving
CLARITY	10 Years	2012-07-02	2020-12-03	0.0676	3.89	0.07	Increasing	YES	YES	Very Likely Improving
CLARITY	All	2003-08-25	2020-12-03	0.0676	3.89	0.07	Increasing	YES	YES	Very Likely Improving

Rotorua Lakes WMA

The Rotorua Lakes WMA encompasses numerous lakes that are highly valued and sensitive receiving environments. The Rotorua Te Arawa Lakes Programme is a partnership between the Rotorua District Council, Bay of Plenty Regional Council and Te Arawa Lakes Trust. The Rotorua Te Arawa Lakes Programme was established to protect and restore water quality in 12 of the lakes in the Rotorua district: Rotorua, Rotoiti, Tarawera, Rotomā, Ōkāreka, Ōkaro, Rerewhakaaitu, Rotoehu, Rotokākahi, Ōkataina, Rotomahana and Tikitapu. Management actions have been directed by the Lakes Management Strategy Action Plan, and Plan Change 10 of the Regional Natural Resources Plan.

Nine inflows to Lake Rotorua are monitored and reported to support management of the lake (Dare, 2018), however only two of these inflows are part of the NERMN monitoring programme reported here.

Lake Rotorua flows to Lake Rotoiti via the Ohau channel and the outflow of Lake Rotoiti forms the Kaituna River. The outflow of Lake Tarawera forms the headwaters of the Tarawera River.

Table 5 NERMN sites in the Rotorua Lakes WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Rotorua Lakes								
EK598179	Puarenga at FRI	1885980	5771792	VA/Gentle	AE	73	69.6	M
EL174017	Ngongotaha at SH 36	1881743	5780173	VA/Gentle	AE	77	67.1	M
FL230406	Ohau Channel at SH 33	1892304	5784064	VA/Gentle	AE	500	53.8	M
FL356693	Kaituna at Rotoiti Outlet	1893562	5786935	VA/Gentle	AE	624	49.6	M
GJ662805	Tarawera at Lake Outlet (NIWA)	1906622	5768057	VA/Gentle	FSP	187	58	NIWA M

Puarenga at FRI

March 2021

Table 1. Site metadata.

Aquarius ID:	EK598179	**Labstar ID:**	BOP110058, BOP110058F
LAWA ID:	EBOP-00019	**REC Reach:**	4013244
Easting:	1885980	**Northing:**	5771792
Longitude:	176.26379	**Latitude:**	-38.15644
Elevation:	290 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2. Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	313	0.19	2.02	1.11	1.09	1.48	0.80	0.24	0.01
Nitrate Nitrite Nitrogen (g/m3)	313	<0.001	1.28	0.84	0.84	1.15	0.56	0.20	0.01
Total Ammoniacal Nitrogen (g/m3)	331	<0.002	0.227	0.072	0.069	0.115	0.040	0.025	0.001
Total Phosphorus (g/m3)	334	0.035	0.249	0.078	0.072	0.123	0.053	0.026	0.001
Dissolved Reactive Phosphorus (g/m3)	328	0.004	0.099	0.042	0.042	0.063	0.024	0.013	0.001
Dissolved Oxygen Sat (%)	122	82.7	109.3	96.0	96.5	102.1	88.8	4.3	0.4
Dissolved Oxygen (g/m3)	326	7.26	12.10	9.19	9.20	10.20	8.20	0.64	0.04
Escherichia coli (cfu/100ml)	313	<1	16000	331	110	1200	20	1092	62
Total Suspended Solids (g/m3)	332	<1	732.00	12.75	7.20	28.45	4.00	41.74	2.29
Turbidity (NTU)	330	1.5	77.0	7.4	5.6	15.3	3.2	7.5	0.4
Water Clarity (m)	263	0.10	2.03	1.02	1.03	1.67	0.38	0.38	0.02
Conductivity (uS/cm)	330	64	352	245	244	308	188	40	2
pH (pH Units)	334	4.6	7.5	6.7	6.7	7.0	6.4	0.2	0.0
Water Temperature (degC)	330	9.9	21.3	16.3	16.4	20.0	12.3	2.4	0.1
Discharge (m3/s)	132	1.10	16.20	2.20	1.90	3.20	1.40	1.40	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

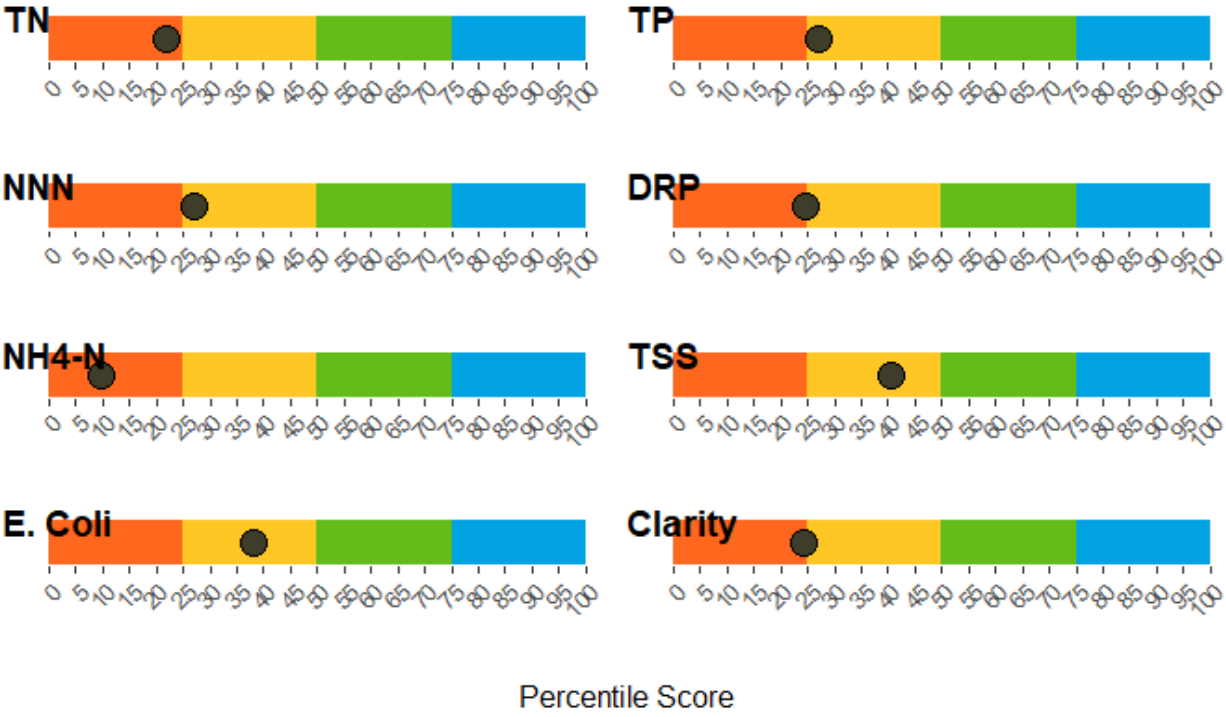


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

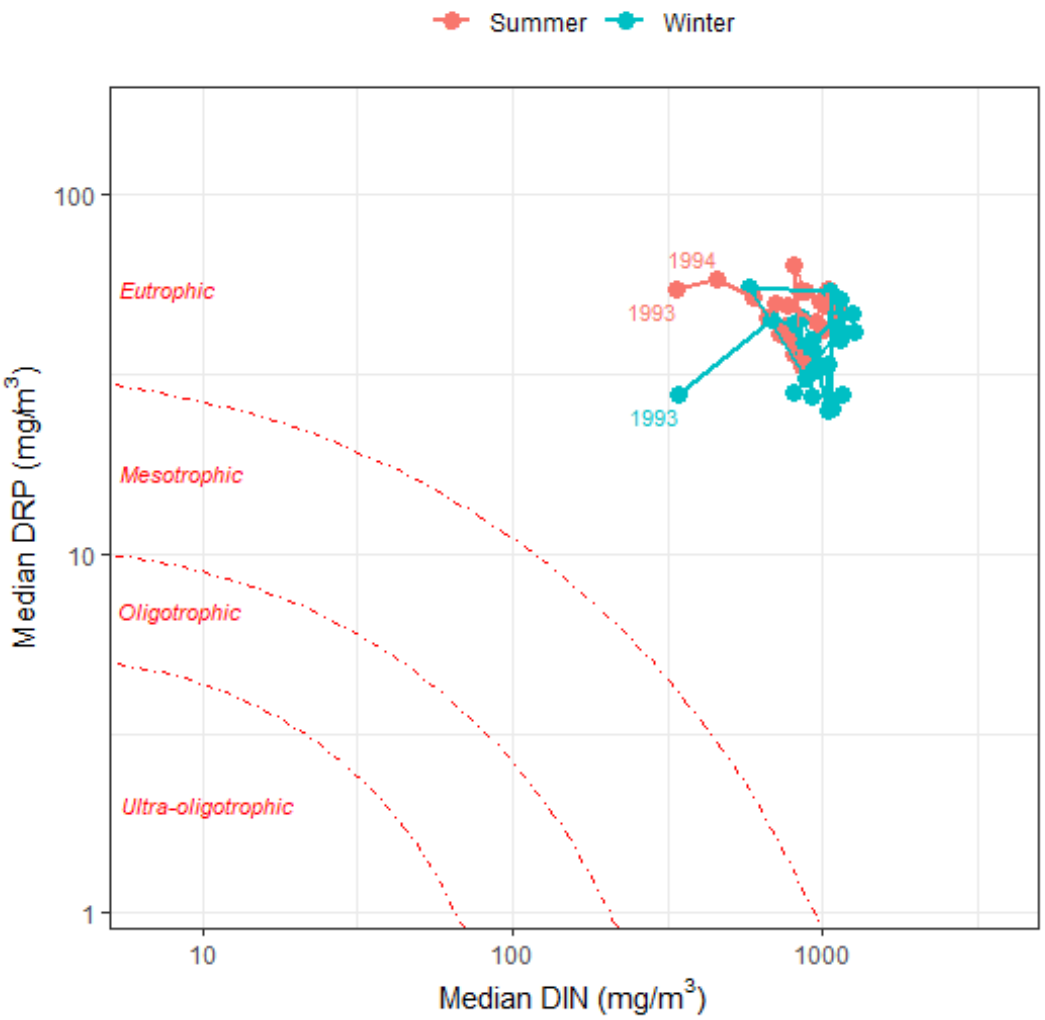


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-08	2020-12-07	10	0.024	0.030	A
5 Years	2015-12-09	2020-12-07	59	0.027	0.055	B
10 Years	2010-12-10	2020-12-07	119	0.027	0.217	B
All	1992-08-20	2020-12-07	331	0.027	0.252	B

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-08	2020-12-07	10	0.76	0.81	A
5 Years	2015-12-09	2020-12-07	59	0.80	1.04	A
10 Years	2010-12-10	2020-12-07	119	0.81	1.05	A
All	1992-12-02	2020-12-07	313	0.84	1.15	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-09	2020-12-07	57	0.95	D*
10 Years	2010-12-10	2020-12-07	114	1.00	D
All	1995-07-27	2020-12-07	262	1.03	D

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-09	2020-12-07	59	0.034	0.051	D
10 Years	2010-12-10	2020-12-07	119	0.035	0.047	D
All	1992-08-19	2020-12-07	327	0.042	0.063	D

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-09	2020-12-07	57	15.8	19.3	73	1513	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-09	2020-12-07	57	73	1843	80.7	3.5	15.8
10 Years	2010-12-10	2020-12-07	116	71	1163	86.2	4.3	9.5
All	1992-08-20	2020-12-07	313	110	1200	80.5	7.3	12.1

Time series plots

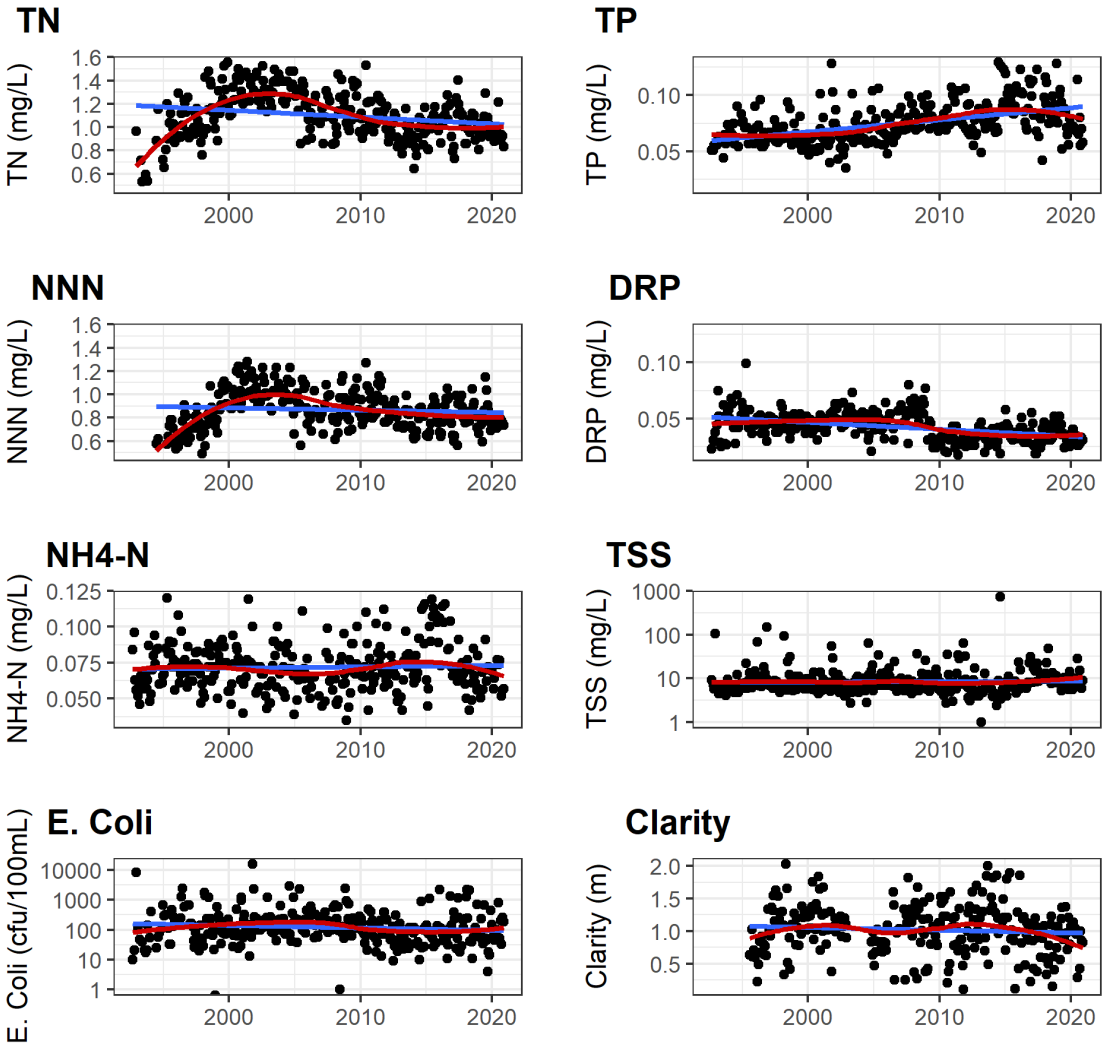


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-07	-0.0235	-2.33	<0.05	Decreasing	YES	YES	Very Likely Improving
TN	10 Years	2010-12-13	2020-12-07	-0.0023	-0.23	0.44	Indeterminant	YES	YES	Likely Improving
TN	All	1992-08-20	2020-12-07	-0.0078	-0.78	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2015-12-10	2020-12-07	-0.0037	-0.47	0.67	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	10 Years	2010-12-13	2020-12-07	-0.0040	-0.49	0.24	Indeterminant	YES	YES	Likely Improving
NNN	All	1992-08-20	2020-12-07	-0.0086	-1.06	<0.01	Decreasing	YES	YES	Very Likely Improving
NH4N	5 Years	2015-12-10	2020-12-07	-0.0089	-12.79	<0.001	Decreasing	NO	NO	Very Likely Improving
NH4N	10 Years	2010-12-13	2020-12-07	-0.0011	-1.51	0.07	Decreasing	YES	YES	Very Likely Improving
NH4N	All	1992-08-20	2020-12-07	-0.0006	-0.86	0.23	Indeterminant	YES	YES	Likely Improving
TP	5 Years	2015-12-10	2020-12-07	-0.0068	-8.07	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2010-12-13	2020-12-07	-0.0006	-0.68	0.36	Indeterminant	YES	NO	Likely Improving
TP	All	1992-08-20	2020-12-07	0.0002	0.19	0.72	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	5 Years	2015-12-10	2020-12-07	-0.0009	-2.62	0.13	Indeterminant	YES	NO	Likely Improving
DRP	10 Years	2010-12-13	2020-12-07	0.0002	0.50	0.33	Indeterminant	YES	YES	Likely Degrading
DRP	All	1992-08-20	2020-12-07	0.0005	1.53	<0.01	Increasing	YES	YES	Very Likely Degrading
ECOLI	5 Years	2015-12-10	2020-12-07	-0.0222	-1.19	0.69	Indeterminant	NO	NO	Indeterminate/Uncertain
ECOLI	10 Years	2010-12-13	2020-12-07	0.0147	0.79	0.27	Indeterminant	YES	YES	Likely Degrading
ECOLI	All	1992-08-20	2020-12-07	0.0033	0.18	0.82	Indeterminant	YES	YES	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	5 Years	2015-12-10	2020-12-07	-0.0109	-1.10	0.34	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2010-12-13	2020-12-07	0.0202	2.15	<0.001	Increasing	YES	NO	Very Likely Degrading
TSS	All	1992-08-20	2020-12-07	0.0137	1.46	<0.01	Increasing	YES	NO	Very Likely Degrading
CLARITY	5 Years	2015-12-10	2020-12-07	-0.0121	-1.31	0.64	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2010-12-13	2020-12-07	-0.0316	-3.18	<0.01	Decreasing	YES	NO	Very Likely Degrading
CLARITY	All	1992-08-20	2020-12-07	-0.0216	-2.16	<0.05	Decreasing	YES	NO	Very Likely Degrading

Ngongotaha at SH 36

March 2021

Table 1 Site metadata.

Aquarius ID:	EL174017	**Labstar ID:**	BOP110013
LAWA ID:	EBOP-00010	**REC Reach:**	4010395
Easting:	1881743	**Northing:**	5780173
Longitude:	176.21220	**Latitude:**	-38.08236
Elevation:	284 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	No
REC Class:	CW_Hill_VA		

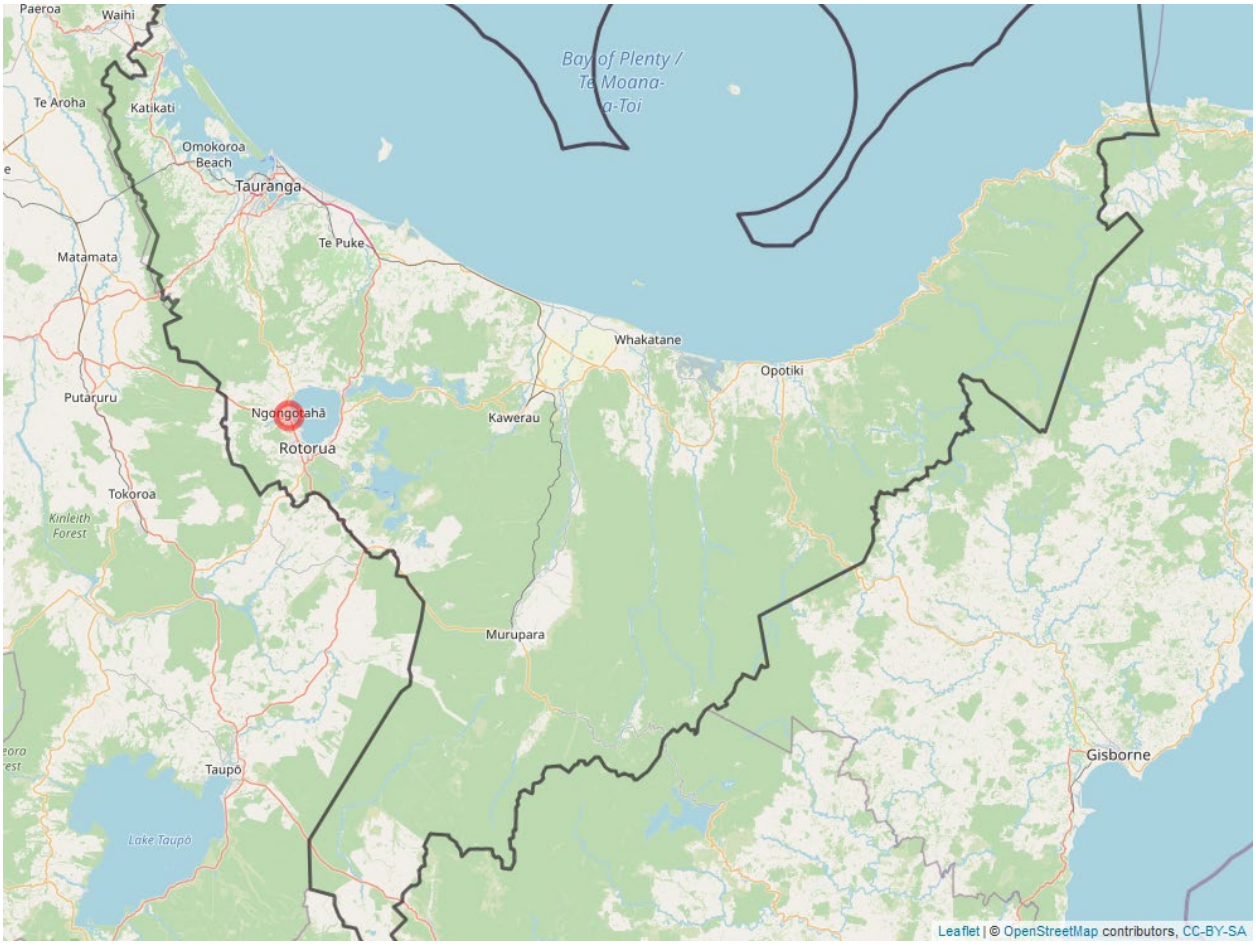


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	326	0.19	2.31	0.96	0.94	1.28	0.77	0.20	0.01
Nitrate Nitrite Nitrogen (g/m3)	329	0.02	1.23	0.78	0.79	0.93	0.66	0.12	0.01
Total Ammoniacal Nitrogen (g/m3)	357	<0.002	0.159	0.017	0.014	0.029	0.006	0.014	0.001
Total Phosphorus (g/m3)	361	0.016	0.408	0.056	0.049	0.101	0.034	0.032	0.002
Dissolved Reactive Phosphorus (g/m3)	354	0.004	0.080	0.032	0.032	0.047	0.019	0.010	0.001
Dissolved Oxygen Sat (%)	136	80.1	105.7	94.8	94.6	101.0	90.6	3.5	0.3
Dissolved Oxygen (g/m3)	356	7.00	13.00	9.90	9.90	10.90	9.00	0.61	0.03
Escherichia coli (cfu/100ml)	342	<1	60110	738	220	2295	40	3438	186
Total Suspended Solids (g/m3)	358	<1	1007.20	16.77	8.85	35.30	3.47	61.80	3.27
Turbidity (NTU)	355	0.5	67.5	4.6	3.3	10.9	1.5	6.3	0.3
Water Clarity (m)	288	0.05	3.64	1.53	1.58	2.41	0.42	0.60	0.04
Conductivity (uS/cm)	358	19	273	66	66	71	58	14	1
pH (pH Units)	362	6.2	7.9	7.0	7.0	7.2	6.7	0.2	0.0
Water Temperature (degC)	359	7.3	16.4	12.1	12.2	15.0	8.7	1.9	0.1
Discharge (m3/s)	363	1.00	16.90	1.70	1.50	2.60	1.10	1.00	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

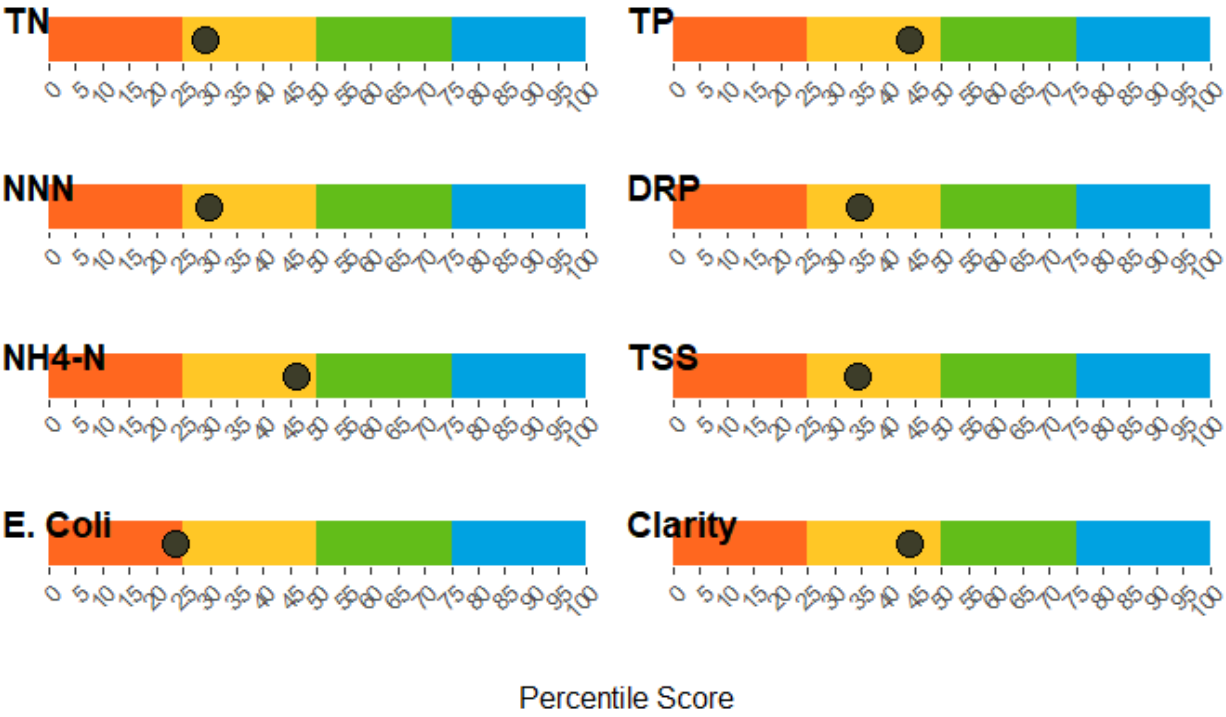


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

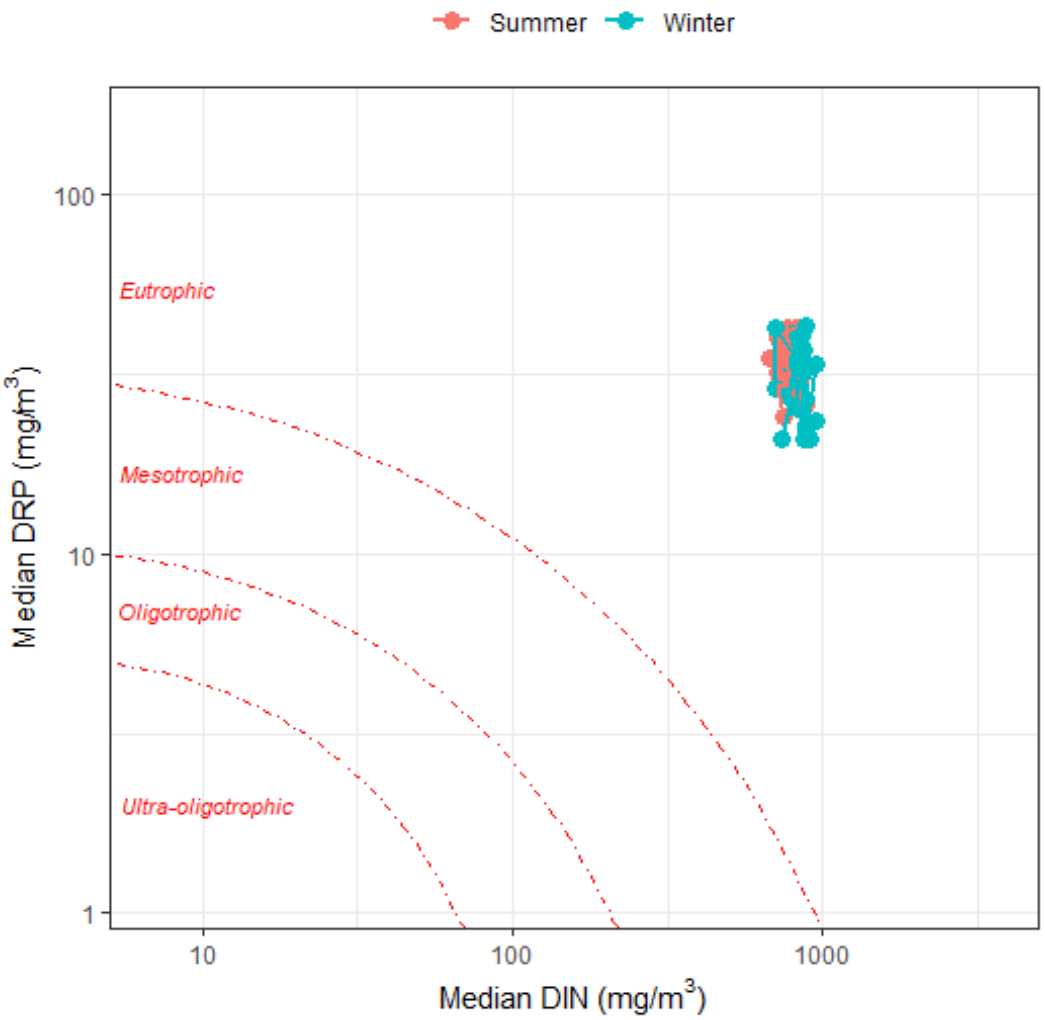


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis, has been split relevant time periods, but refer to the NPS-FM to determine which period is most appropriate for official analysis.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-18	2020-12-17	20	0.007	0.012	A
5 Years	2015-12-19	2020-12-17	72	0.006	0.059	B
10 Years	2010-12-20	2020-12-17	131	0.006	0.059	B
All	1991-02-02	2020-12-17	356	0.006	0.061	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-18	2020-12-17	20	0.73	0.78	A
5 Years	2015-12-19	2020-12-17	72	0.78	0.91	A
10 Years	2010-12-20	2020-12-17	132	0.81	0.92	A
All	1992-12-01	2020-12-17	329	0.79	0.93	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-19	2020-12-17	72	1.71	B
10 Years	2010-12-20	2020-12-17	129	1.68	B
All	1994-12-14	2020-12-17	287	1.58	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-19	2020-12-17	72	0.026	0.035	D
10 Years	2010-12-20	2020-12-17	132	0.027	0.035	D
All	1991-02-01	2020-12-17	353	0.032	0.047	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-19	2020-12-17	71	22.5	49.3	260	2400	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-19	2020-12-17	71	260	2490	50.7	26.8	22.5
10 Years	2010-12-20	2020-12-17	129	210	2310	61.2	20.2	18.6
All	1991-02-25	2020-12-17	342	220	2340	57.6	23.7	18.4

Time series plots

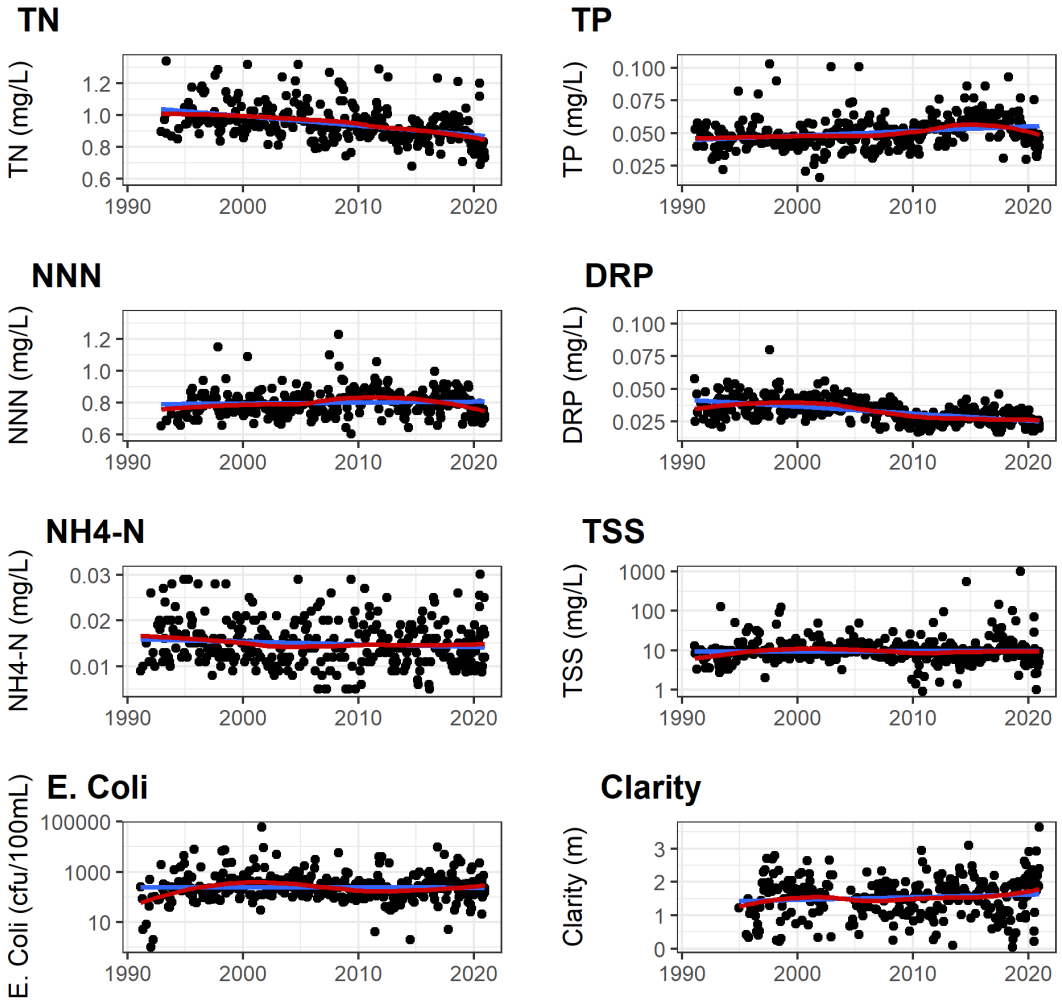


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-12	2020-12-17	-0.0066	-0.76	0.41	Indeterminant	YES	NO	Likely Improving
TN	10 Years	2011-01-10	2020-12-17	-0.0037	-0.41	0.30	Indeterminant	YES	YES	Likely Improving
TN	All	1991-02-02	2020-12-17	-0.0047	-0.50	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-12	2020-12-17	-0.0074	-0.95	0.20	Indeterminant	YES	NO	Likely Improving
NNN	10 Years	2011-01-10	2020-12-17	-0.0056	-0.69	<0.01	Decreasing	YES	NO	Very Likely Improving
NNN	All	1991-02-02	2020-12-17	0.0018	0.23	<0.001	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2016-01-12	2020-12-17	0.0000	-0.37	1.00	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	10 Years	2011-01-10	2020-12-17	-0.0004	-3.09	<0.05	Decreasing	YES	YES	Very Likely Improving
NH4N	All	1991-02-02	2020-12-17	-0.0001	-0.83	<0.01	Decreasing	YES	YES	Very Likely Improving
TP	5 Years	2016-01-12	2020-12-17	-0.0030	-5.58	0.08	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-10	2020-12-17	-0.0001	-0.15	0.83	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	1991-02-02	2020-12-17	0.0005	0.95	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-12	2020-12-17	-0.0011	-4.18	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-10	2020-12-17	0.0000	-0.11	0.89	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	All	1991-02-02	2020-12-17	-0.0005	-1.53	<0.001	Decreasing	YES	YES	Very Likely Improving
ECOLI	5 Years	2016-01-12	2020-12-17	-0.0408	-1.69	0.31	Indeterminant	YES	NO	Likely Improving
ECOLI	10 Years	2011-01-10	2020-12-17	0.0307	1.32	<0.05	Increasing	YES	NO	Very Likely Degrading
ECOLI	All	1991-02-02	2020-12-17	-0.0021	-0.09	0.49	Indeterminant	YES	YES	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	5 Years	2016-01-12	2020-12-17	-0.0197	-2.06	0.27	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-01-10	2020-12-17	0.0138	1.46	<0.01	Increasing	YES	NO	Very Likely Degrading
TSS	All	1991-02-02	2020-12-17	0.0003	0.03	0.74	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	5 Years	2016-01-12	2020-12-17	0.0510	2.96	0.28	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2011-01-10	2020-12-17	-0.0095	-0.56	0.53	Indeterminant	YES	NO	Likely Degrading
CLARITY	All	1991-02-02	2020-12-17	0.0015	0.10	0.66	Indeterminant	YES	NO	Likely Improving

Ohau Channel at SH 33

March 2021

Table 1 Site metadata.

Aquarius ID:	FL230406	**Labstar ID:**	BOP110025, BOP160119
LAWA ID:	EBOP-00012	**REC Reach:**	4008791
Easting:	1892304	**Northing:**	5784064
Longitude:	176.33084	**Latitude:**	-38.04400
Elevation:	280 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Lake_VA		

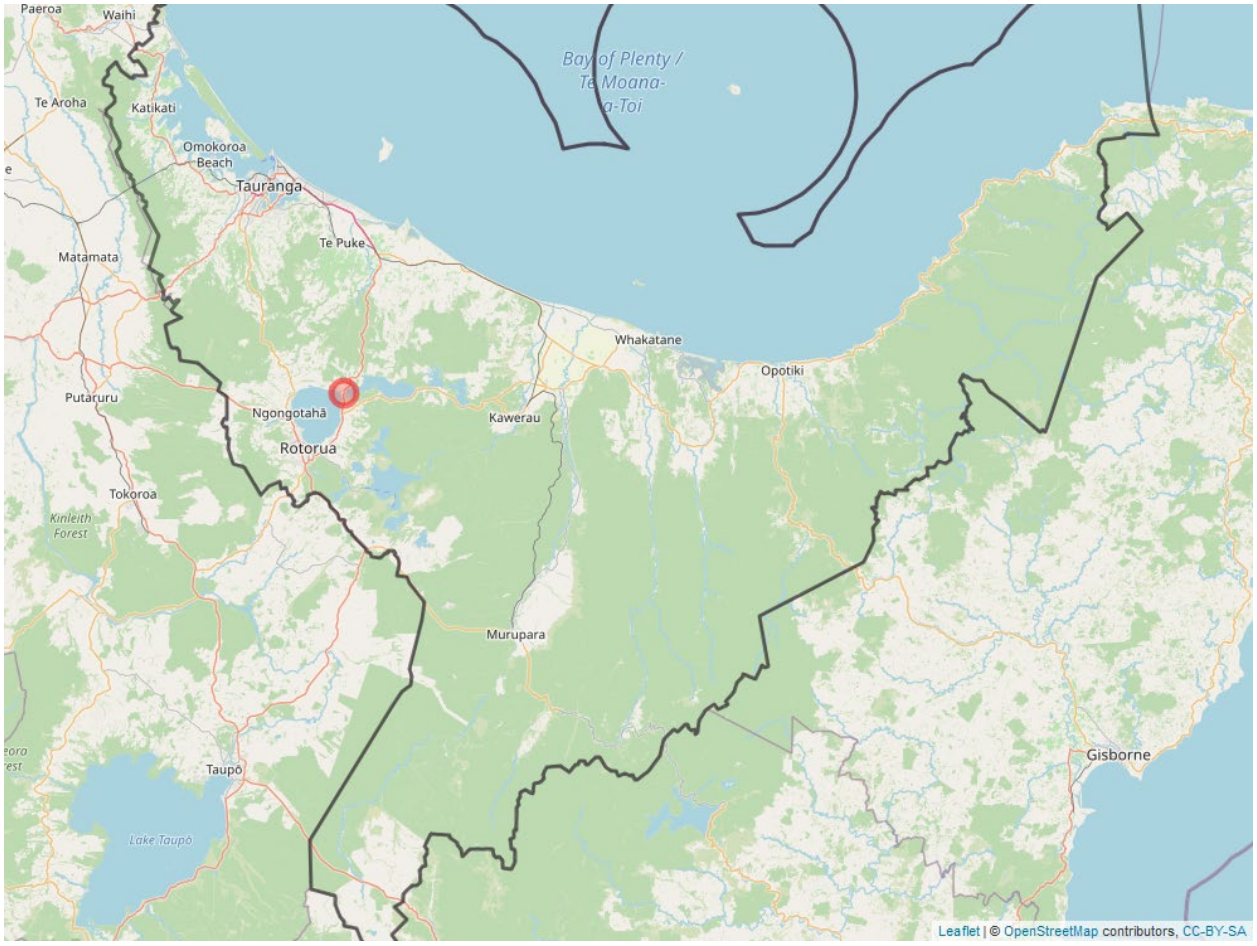


Figure 1. The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	314	0.05	1.52	0.41	0.37	0.69	0.24	0.17	0.01
Nitrate Nitrite Nitrogen (g/m3)	317	<0.001	1.47	0.07	0.04	0.24	0.00	0.12	0.01
Total Ammoniacal Nitrogen (g/m3)	363	<0.002	0.506	0.024	0.013	0.087	0.003	0.037	0.002
Total Phosphorus (g/m3)	367	0.005	0.154	0.037	0.032	0.074	0.014	0.020	0.001
Dissolved Reactive Phosphorus (g/m3)	363	<0.001	0.089	0.008	0.005	0.027	0.001	0.009	0.000
Dissolved Oxygen Sat (%)	122	18.6	118.1	96.2	96.8	107.8	85.9	9.5	0.9
Dissolved Oxygen (g/m3)	360	1.94	12.10	9.39	9.50	11.10	7.70	1.14	0.06
Escherichia coli (cfu/100ml)	315	<1	4147	42	11	120	0	238	13
Total Suspended Solids (g/m3)	359	<1	57.20	7.38	5.40	19.82	1.90	6.88	0.36
Turbidity (NTU)	327	0.2	15.0	3.0	2.2	8.3	1.0	2.4	0.1
Water Clarity (m)	276	0.37	4.19	1.74	1.69	3.05	0.61	0.73	0.04
Conductivity (uS/cm)	339	61	338	201	202	228	173	21	1
pH (pH Units)	356	4.3	8.2	6.9	6.9	7.4	6.4	0.4	0.0
Water Temperature (degC)	364	6.9	29.1	15.2	15.3	21.4	9.0	4.1	0.2
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

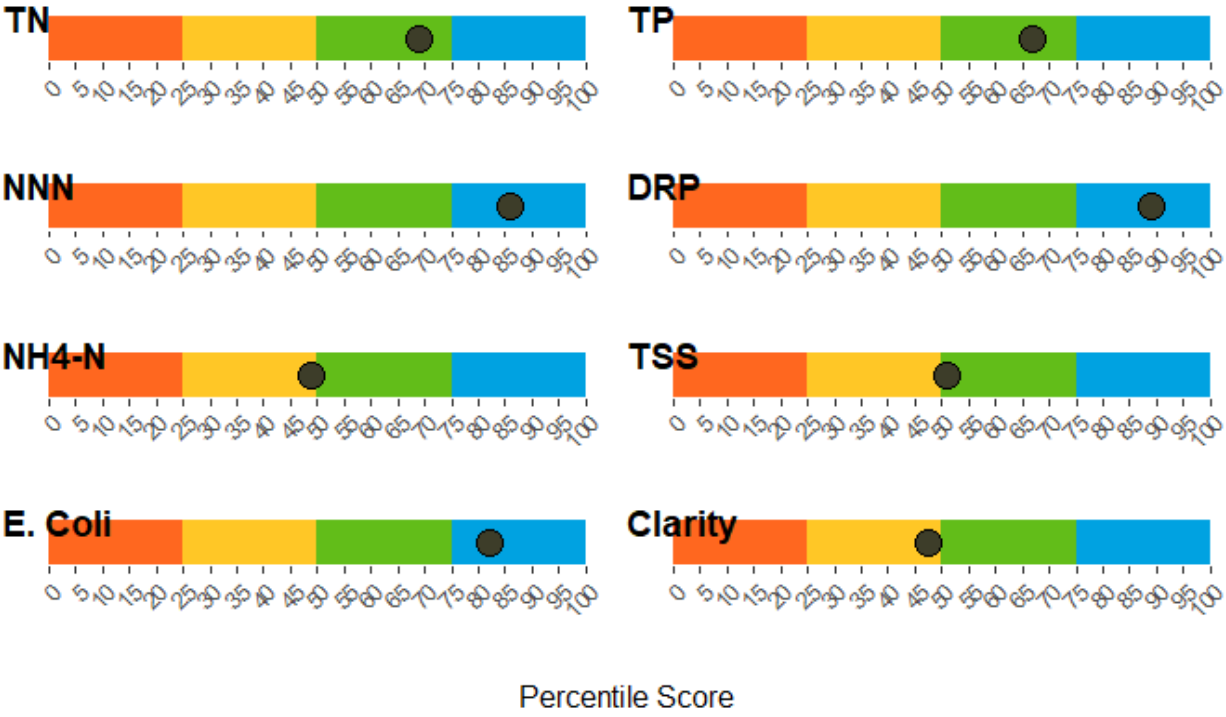


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

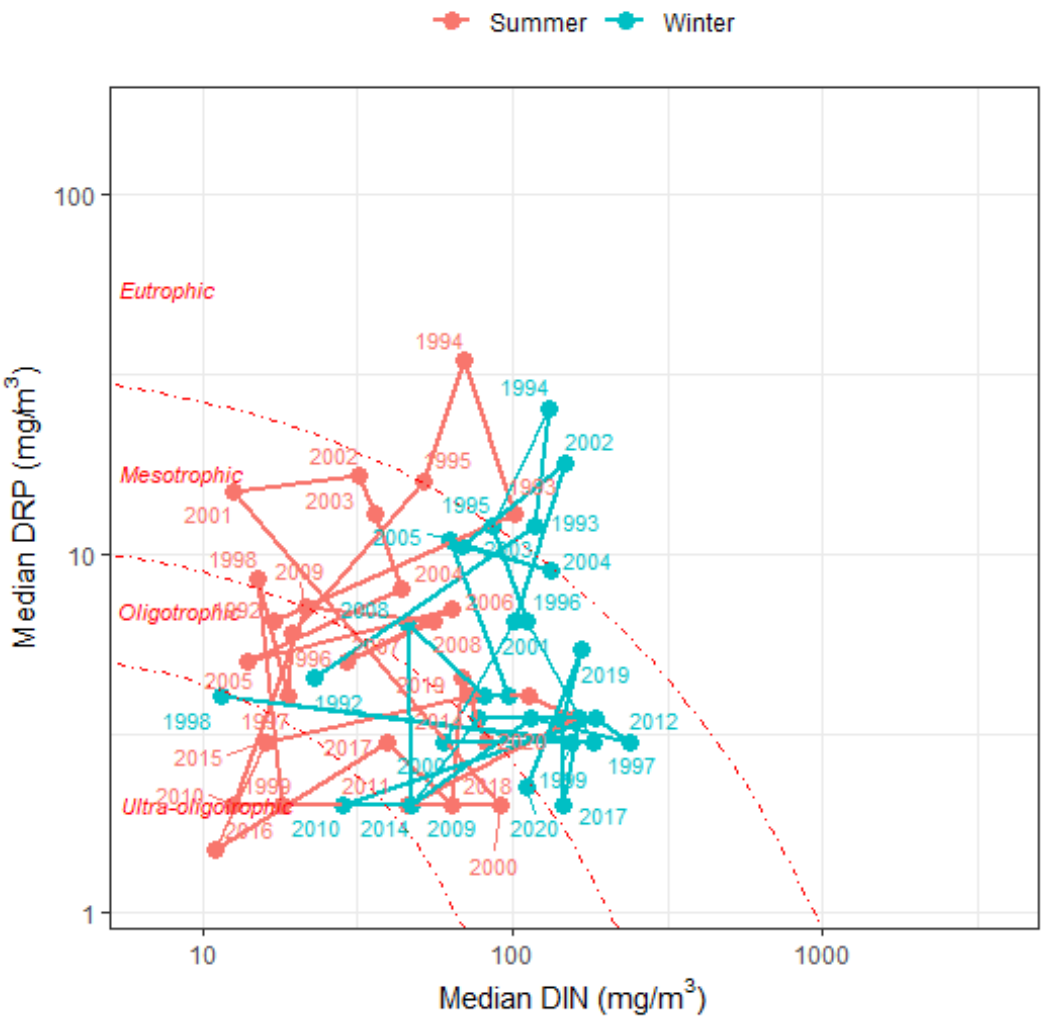


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-08	2020-12-07	10	0.0070	0.042	A
5 Years	2015-12-09	2020-12-07	59	0.0060	0.183	B
10 Years	2010-12-10	2020-12-07	119	0.0060	0.229	B
All	1991-02-25	2020-12-07	351	0.0053	0.246	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-08	2020-12-07	10	0.06	0.15	A
5 Years	2015-12-09	2020-12-07	59	0.06	0.25	A
10 Years	2010-12-10	2020-12-07	119	0.06	0.26	A
All	1992-10-06	2020-12-07	317	0.04	0.24	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-09	2020-12-07	59	2.00	D*
10 Years	2010-12-10	2020-12-07	113	2.00	D
All	1992-09-03	2020-12-07	275	1.68	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-09	2020-12-07	59	0.002	0.007	A
10 Years	2010-12-10	2020-12-07	119	0.003	0.008	A
All	1985-12-17	2020-12-07	362	0.005	0.027	B

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-09	2020-12-07	58	0.0	1.7	14	144	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-09	2020-12-07	58	14	158	98.3	1.7	0
10 Years	2010-12-10	2020-12-07	117	12	163	98.3	1.7	0
All	1991-02-25	2020-12-07	315	11	120	98.7	1	0.3

Time series plots

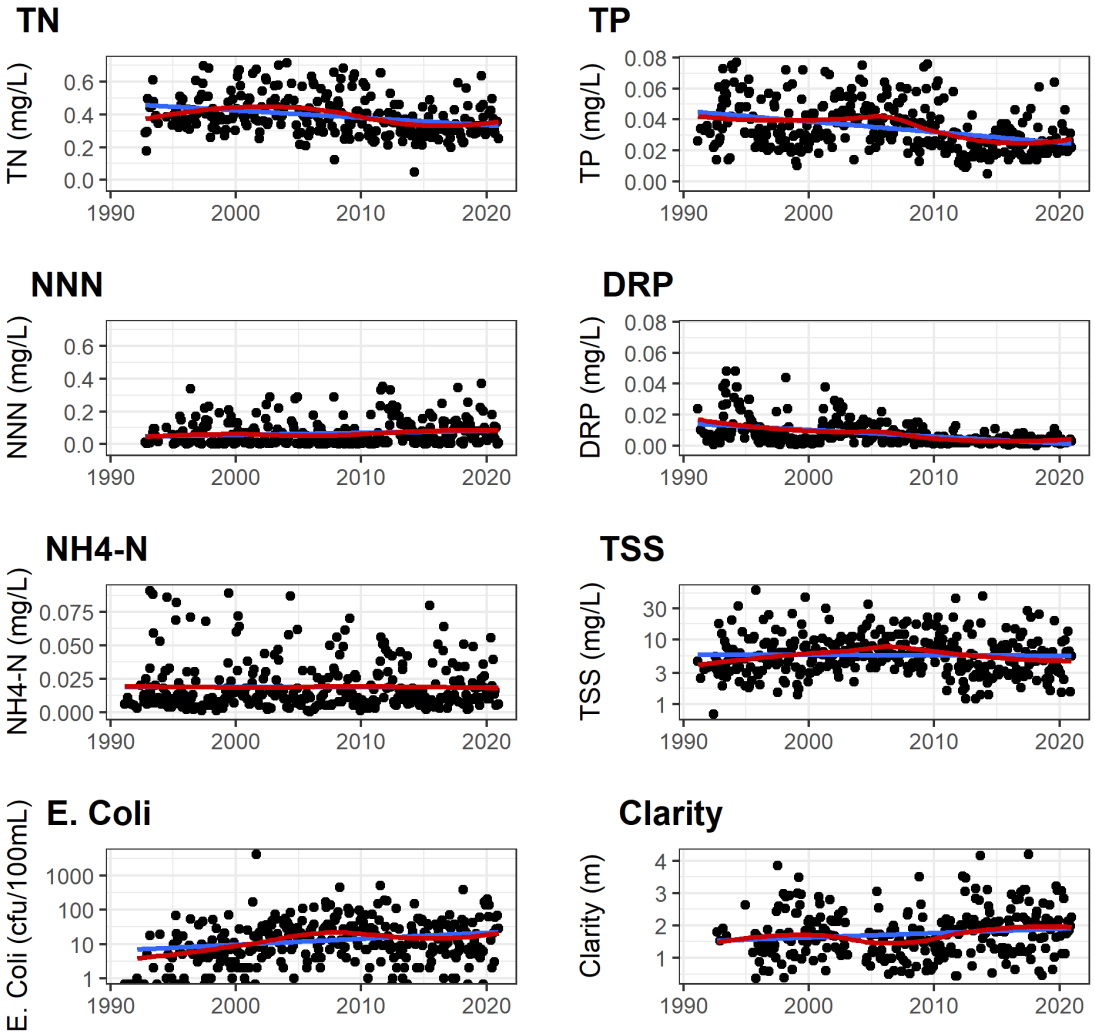


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-07	0.0036	1.10	0.67	Indeterminant	NO	YES	Indeterminate/Uncertain
TN	10 Years	2010-12-13	2020-12-07	0.0000	0.00	0.96	Indeterminant	NO	YES	Indeterminate/Uncertain
TN	All	1991-02-25	2020-12-07	-0.0043	-1.16	<0.001	Decreasing	NO	YES	Very Likely Improving
NNN	5 Years	2015-12-10	2020-12-07	0.0048	7.89	0.12	Indeterminant	NO	YES	Very Likely Degrading
NNN	10 Years	2010-12-13	2020-12-07	0.0000	0.00	0.96	Indeterminant	NO	YES	Indeterminate/Uncertain
NNN	All	1991-02-25	2020-12-07	0.0005	1.51	<0.01	Increasing	NO	YES	Very Likely Degrading
NH4N	5 Years	2015-12-10	2020-12-07	0.0003	1.90	0.78	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	10 Years	2010-12-13	2020-12-07	-0.0002	-1.71	0.50	Indeterminant	NO	NO	Likely Improving
NH4N	All	1991-02-25	2020-12-07	0.0000	0.00	0.49	Indeterminant	NO	YES	Likely Degrading
TP	5 Years	2015-12-10	2020-12-07	0.0009	3.71	0.20	Indeterminant	NO	NO	Very Likely Degrading
TP	10 Years	2010-12-13	2020-12-07	0.0005	2.48	<0.05	Increasing	NO	NO	Very Likely Degrading
TP	All	1991-02-25	2020-12-07	-0.0007	-2.08	<0.001	Decreasing	NO	YES	Very Likely Improving
DRP	5 Years	2015-12-10	2020-12-07	0.0002	8.39	0.08	Increasing	NO	NO	Very Likely Degrading
DRP	10 Years	2010-12-13	2020-12-07	0.0000	0.00	0.58	Indeterminant	NO	NO	Likely Improving
DRP	All	1991-02-25	2020-12-07	-0.0002	-4.01	<0.001	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2015-12-10	2020-12-07	0.0860	7.31	<0.05	Increasing	NO	YES	Very Likely Degrading
ECOLI	10 Years	2010-12-13	2020-12-07	0.0246	2.21	0.08	Increasing	NO	YES	Very Likely Degrading
ECOLI	All	1991-02-25	2020-12-07	0.0209	1.94	<0.001	Increasing	NO	YES	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	5 Years	2015-12-10	2020-12-07	-0.0039	-0.52	0.93	Indeterminant	NO	NO	Indeterminate/Uncertain
TSS	10 Years	2010-12-13	2020-12-07	-0.0027	-0.39	0.68	Indeterminant	NO	YES	Indeterminate/Uncertain
TSS	All	1991-02-25	2020-12-07	-0.0007	-0.08	0.64	Indeterminant	NO	YES	Likely Improving
CLARITY	5 Years	2015-12-10	2020-12-07	-0.0167	-0.82	0.69	Indeterminant	NO	NO	Indeterminate/Uncertain
CLARITY	10 Years	2010-12-13	2020-12-07	0.0297	1.49	0.10	Indeterminant	NO	YES	Likely Improving
CLARITY	All	1991-02-25	2020-12-07	0.0158	0.93	<0.01	Increasing	NO	YES	Very Likely Improving

Kaituna at Rotoiti Outlet

March 2021

Table 1 Site metadata.

Aquarius ID:	FL356693	**Labstar ID:**	BOP110026
LAWA ID:	EBOP-00007	**REC Reach:**	4008095
Easting:	1893562	**Northing:**	5786935
Longitude:	176.34398	**Latitude:**	-38.01776
Elevation:	279 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Lake_VA		

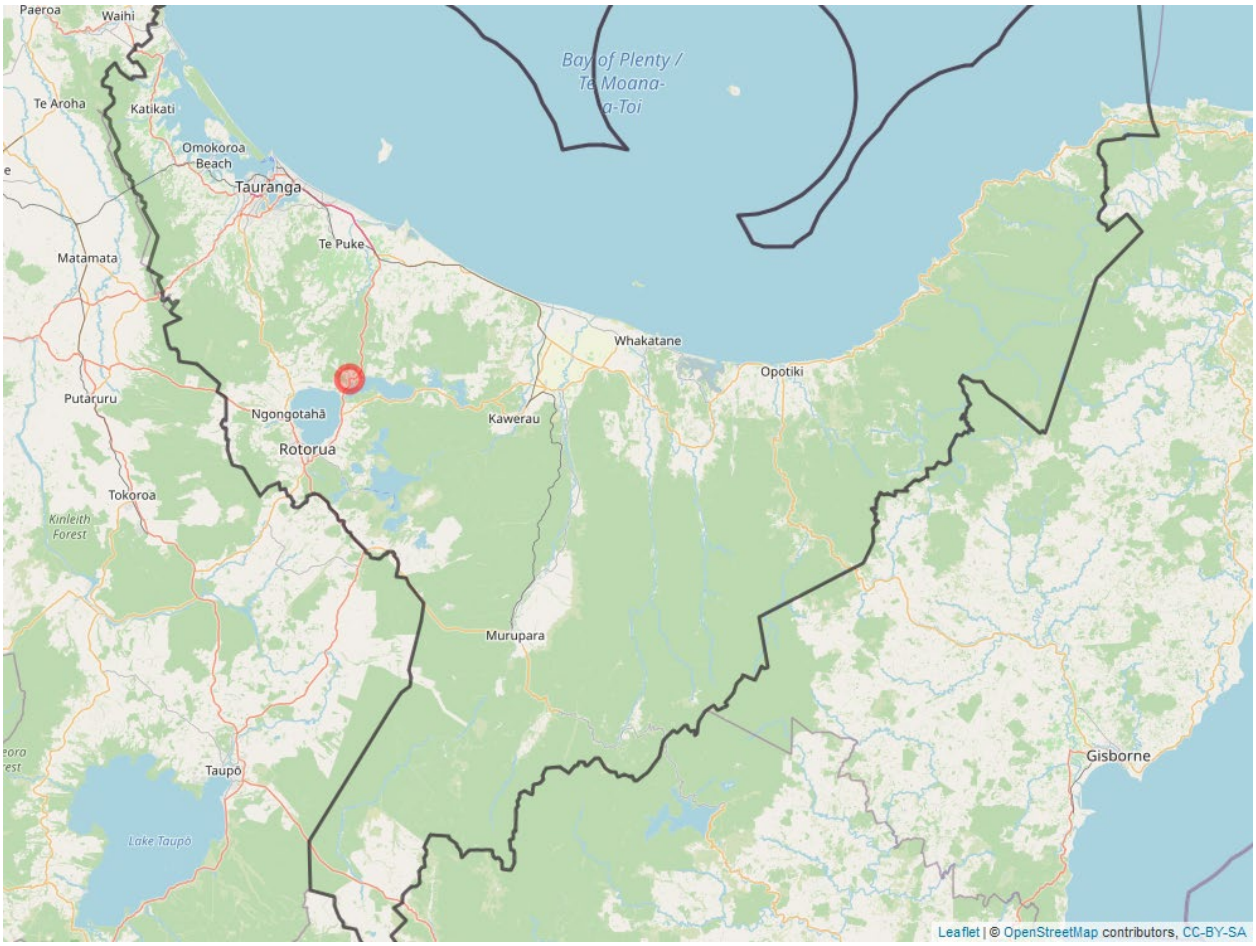


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	267	0.06	1.74	0.32	0.30	0.50	0.22	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	269	<0.001	1.47	0.06	0.03	0.18	0.00	0.12	0.01
Total Ammoniacal Nitrogen (g/m3)	283	<0.002	0.115	0.016	0.013	0.038	0.003	0.014	0.001
Total Phosphorus (g/m3)	286	0.008	0.145	0.025	0.023	0.039	0.013	0.011	0.001
Dissolved Reactive Phosphorus (g/m3)	281	<0.001	0.063	0.005	0.004	0.012	0.001	0.005	0.000
Dissolved Oxygen Sat (%)	122	74.5	106.9	96.2	96.2	104.6	87.5	5.5	0.5
Dissolved Oxygen (g/m3)	280	6.23	11.70	9.46	9.53	10.81	7.98	0.92	0.05
Escherichia coli (cfu/100ml)	265	<1	390	15	5	41	0	39	2
Total Suspended Solids (g/m3)	284	<1	20.00	3.14	2.60	6.37	1.10	2.12	0.13
Turbidity (NTU)	280	0.3	8.1	1.6	1.4	3.3	0.6	1.0	0.1
Water Clarity (m)	148	0.41	5.90	2.21	2.16	3.60	1.02	0.90	0.07
Conductivity (uS/cm)	278	62	262	186	188	203	165	16	1
pH (pH Units)	286	5.4	8.8	7.0	7.0	7.4	6.6	0.3	0.0
Water Temperature (degC)	283	8.1	24.4	15.7	15.5	22.2	10.0	4.1	0.2
Discharge (m3/s)	287	2.60	43.00	21.00	19.80	36.60	12.40	7.30	0.40

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

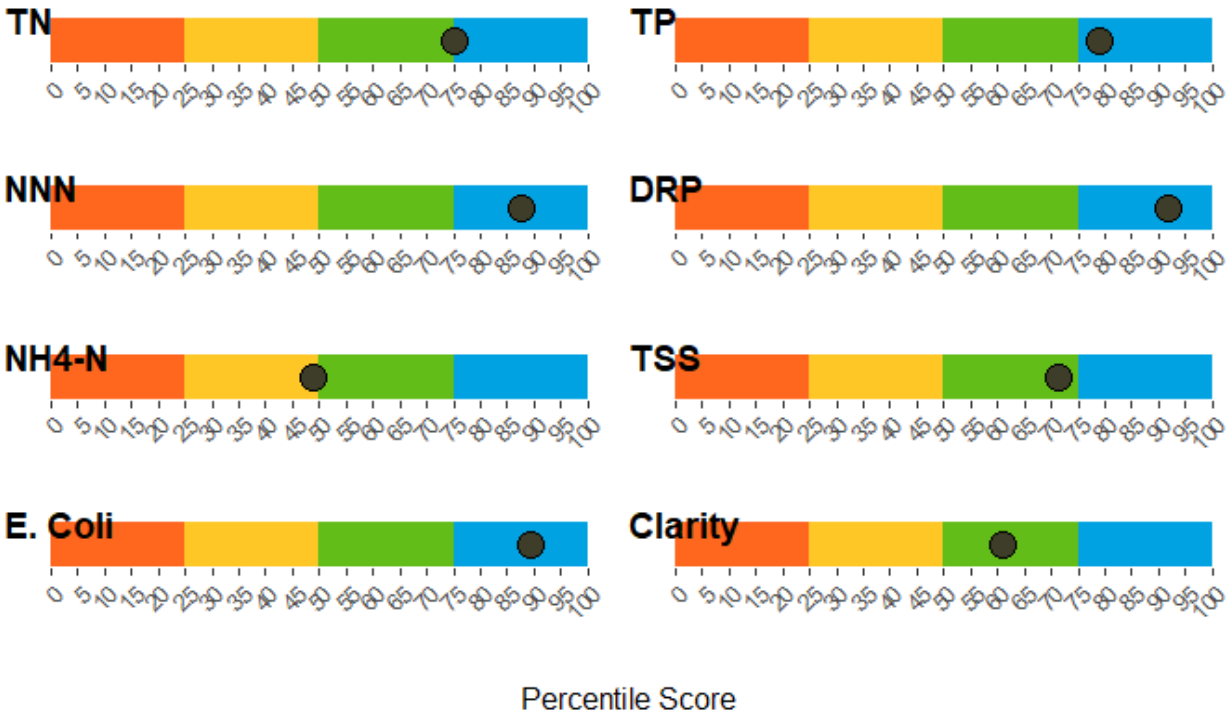


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

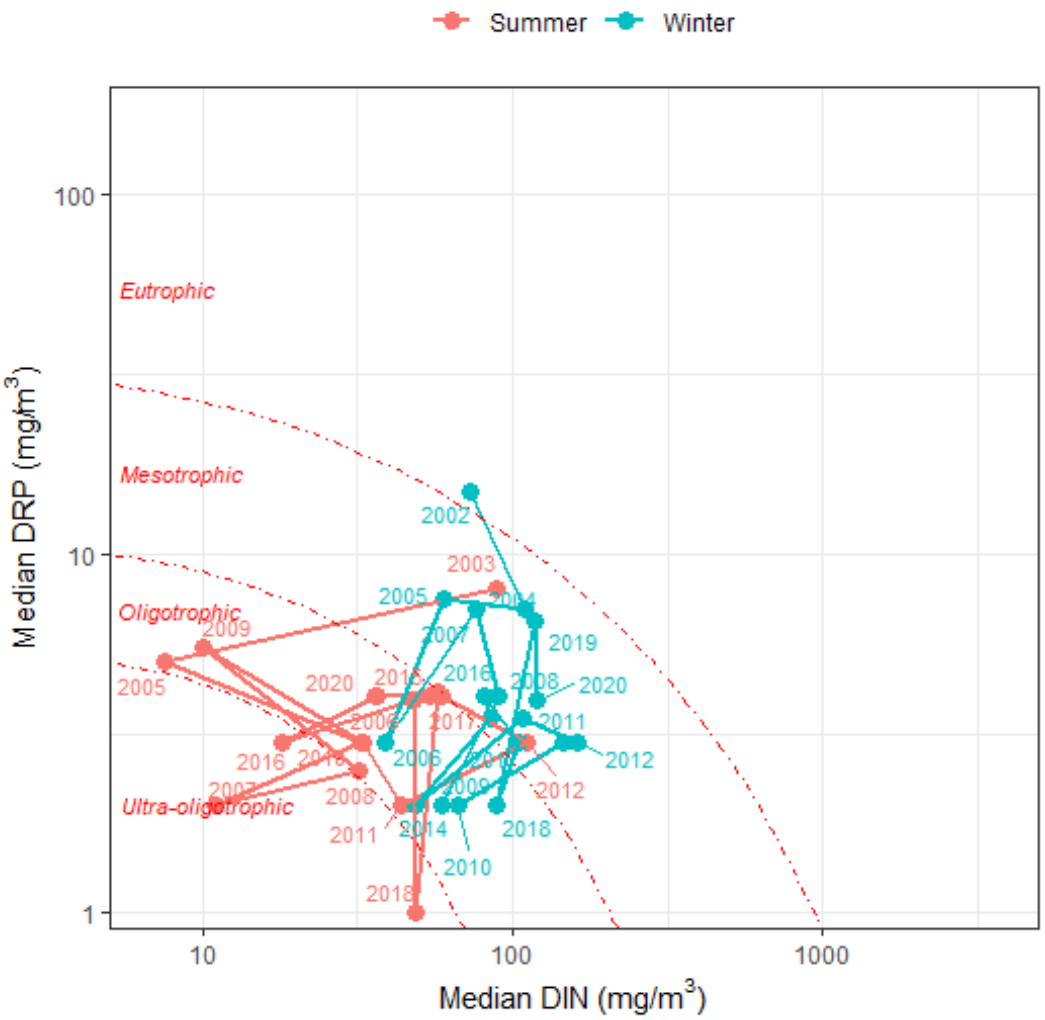


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-08	2020-12-07	10	0.0070	0.013	A
5 Years	2015-12-09	2020-12-07	59	0.0050	0.031	A
10 Years	2010-12-10	2020-12-07	119	0.0060	0.037	A
All	1991-02-25	2020-12-07	282	0.0055	0.048	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-08	2020-12-07	10	0.06	0.18	A
5 Years	2015-12-09	2020-12-07	59	0.05	0.19	A
10 Years	2010-12-10	2020-12-07	119	0.04	0.19	A
All	1992-10-06	2020-12-07	269	0.03	0.18	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-09	2020-12-07	59	2.35	C*
10 Years	2010-12-10	2020-12-07	65	2.33	C
All	1992-09-03	2020-12-07	147	2.18	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-09	2020-12-07	59	0.003	0.007	A
10 Years	2010-12-10	2020-12-07	119	0.003	0.007	A
All	1991-02-25	2020-12-07	280	0.004	0.012	A

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-09	2020-12-07	58	0.0	0.0	6	27	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-09	2020-12-07	58	6	28	100	0	0
10 Years	2010-12-10	2020-12-07	117	5	30	100	0	0
All	1991-02-25	2020-12-07	265	5	42	99.2	0.8	0

Time series plots

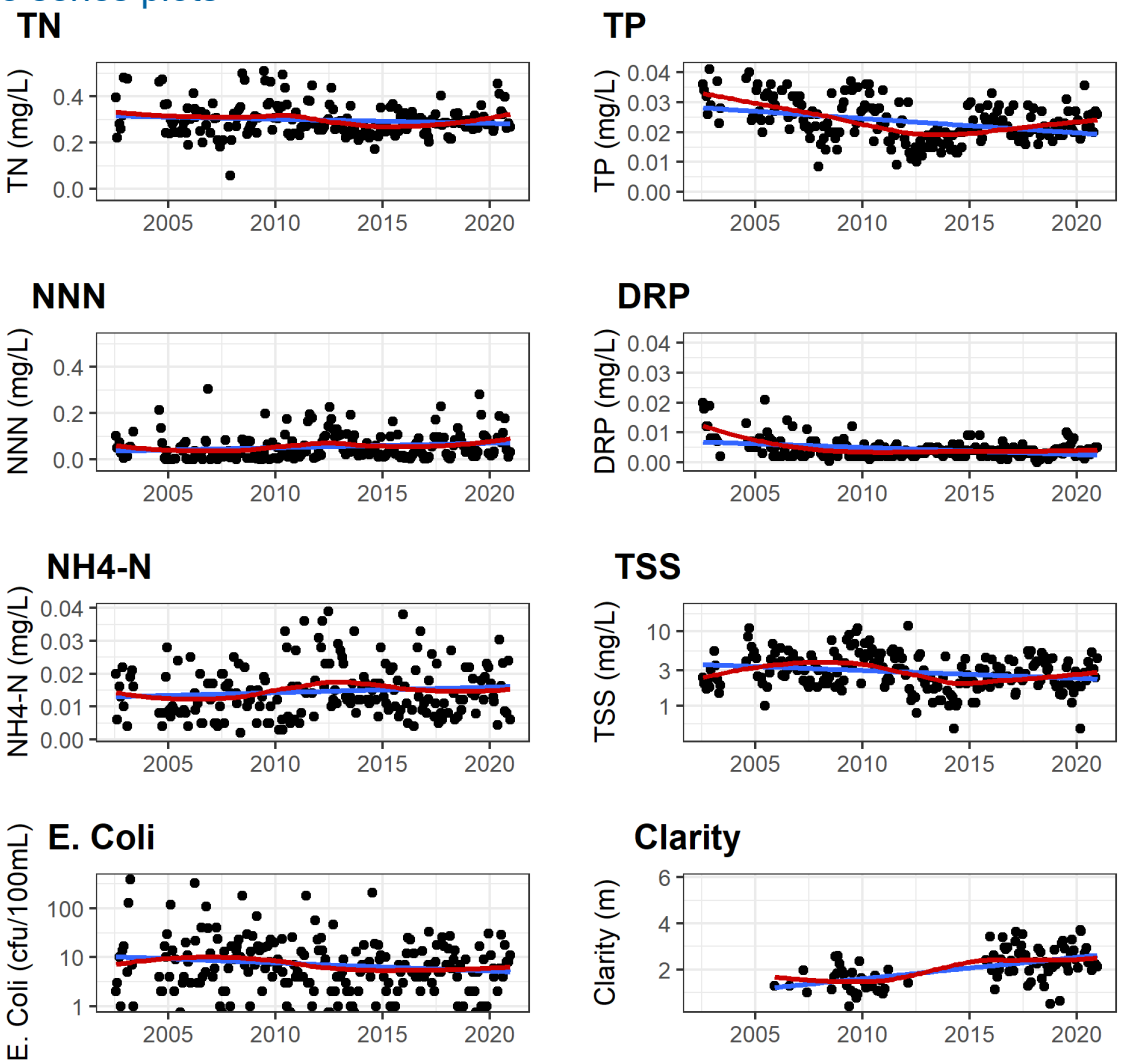


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-10	2020-12-07	0.0033	1.16	0.44	Indeterminant	NO	YES	Likely Degrading
TN	10 Years	2010-12-13	2020-12-07	0.0026	0.94	0.05	Increasing	YES	YES	Very Likely Degrading
TN	All	2002-07-23	2020-12-07	-0.0020	-0.70	<0.05	Decreasing	NO	NO	Very Likely Improving
NNN	5 Years	2015-12-10	2020-12-07	0.0074	15.81	<0.05	Increasing	YES	YES	Very Likely Degrading
NNN	10 Years	2010-12-13	2020-12-07	-0.0004	-0.89	0.80	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	All	2002-07-23	2020-12-07	0.0016	4.48	<0.05	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2015-12-10	2020-12-07	0.0006	4.82	0.46	Indeterminant	YES	NO	Likely Degrading
NH4N	10 Years	2010-12-13	2020-12-07	-0.0006	-4.49	<0.05	Decreasing	YES	NO	Very Likely Improving
NH4N	All	2002-07-23	2020-12-07	0.0001	0.94	0.33	Indeterminant	YES	NO	Likely Degrading
TP	5 Years	2015-12-10	2020-12-07	-0.0002	-0.97	0.47	Indeterminant	YES	NO	Likely Improving
TP	10 Years	2010-12-13	2020-12-07	0.0007	3.34	<0.001	Increasing	YES	NO	Very Likely Degrading
TP	All	2002-07-23	2020-12-07	-0.0005	-2.15	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2015-12-10	2020-12-07	0.0002	6.44	0.16	Indeterminant	YES	NO	Very Likely Degrading
DRP	10 Years	2010-12-13	2020-12-07	0.0000	0.69	0.49	Indeterminant	YES	NO	Likely Degrading
DRP	All	2002-07-23	2020-12-07	-0.0001	-2.32	<0.001	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2015-12-10	2020-12-07	-0.0334	-3.95	0.31	Indeterminant	YES	NO	Likely Improving
ECOLI	10 Years	2010-12-13	2020-12-07	0.0070	0.90	0.51	Indeterminant	YES	NO	Likely Degrading
ECOLI	All	2002-07-23	2020-12-07	-0.0110	-1.31	0.08	Decreasing	NO	YES	Very Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	5 Years	2015-12-10	2020-12-07	-0.0041	-0.75	0.73	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	10 Years	2010-12-13	2020-12-07	0.0048	0.91	0.24	Indeterminant	YES	YES	Likely Degrading
TSS	All	2002-07-23	2020-12-07	-0.0078	-1.34	<0.01	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2015-12-10	2020-12-07	0.0064	0.27	0.91	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2010-12-13	2020-12-07	0.0585	2.51	0.20	Indeterminant	YES	NO	Likely Improving
CLARITY	All	2002-07-23	2020-12-07	0.0866	4.09	<0.001	Increasing	NO	NO	Very Likely Improving

Tarawera at Lake Outlet

March 2021

Table 1 Site metadata.

Aquarius ID:	GJ662805	**Labstar ID:**	BOP110020
LAWA ID:	EBOP-00051	**REC Reach:**	4014379
Easting:	1906622	**Northing:**	5768057
Longitude:	176.50060	**Latitude:**	-38.18326
Elevation:	298 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Lake_VA		

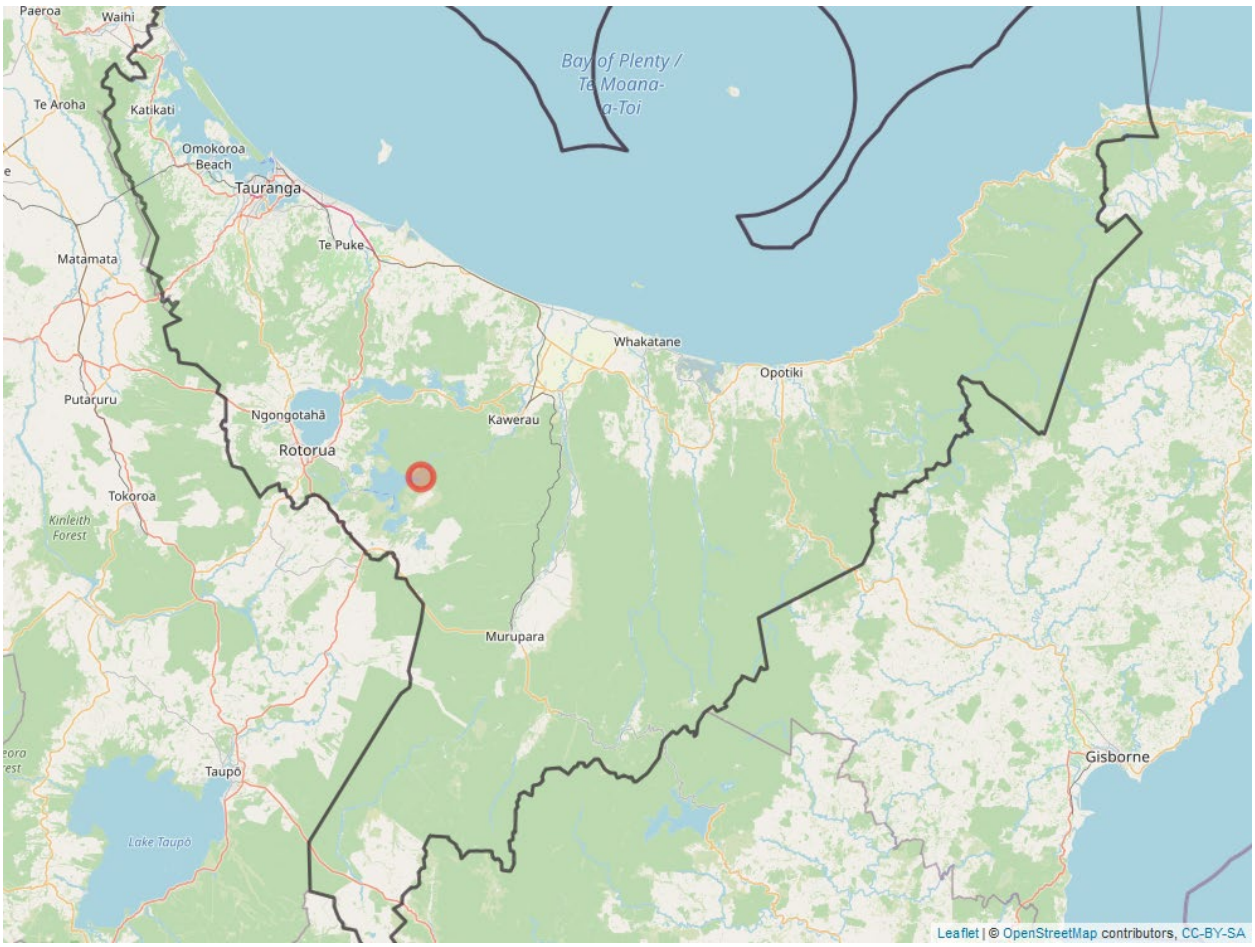


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	376	<0.01	0.23	0.09	0.09	0.13	0.06	0.02	0.00
Nitrate Nitrite Nitrogen (g/m3)	375	<0.001	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Total Ammoniacal Nitrogen (g/m3)	386	<0.002	0.011	0.002	0.001	0.006	0.000	0.002	0.000
Total Phosphorus (g/m3)	397	<0.001	0.024	0.008	0.008	0.012	0.005	0.003	0.000
Dissolved Reactive Phosphorus (g/m3)	396	<0.001	0.076	0.003	0.002	0.006	0.001	0.004	0.000
Dissolved Oxygen Sat (%)	386	91.5	123.5	106.6	107.0	115.0	98.0	5.1	0.3
Dissolved Oxygen (g/m3)	384	8.30	12.10	10.16	10.10	11.30	9.10	0.70	0.04
Escherichia coli (cfu/100ml)	198	<1	156	4	1	17	0	14	1
Total Suspended Solids (g/m3)	16	<1	2.20	1.06	0.94	1.97	0.42	0.56	0.14
Turbidity (NTU)	383	0.2	3.3	0.6	0.5	1.2	0.3	0.4	0.0
Water Clarity (m)	379	1.28	10.66	5.49	5.57	7.60	2.91	1.37	0.07
Conductivity (uS/cm)	117	390	585	542	544	557	524	19	2
pH (pH Units)	398	6.1	8.5	8.1	8.1	8.4	7.8	0.2	0.0
Water Temperature (degC)	398	10.4	23.3	16.0	15.8	21.8	11.0	3.7	0.2
Discharge (m3/s)	234	4.10	11.60	6.80	6.70	9.50	4.60	1.50	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

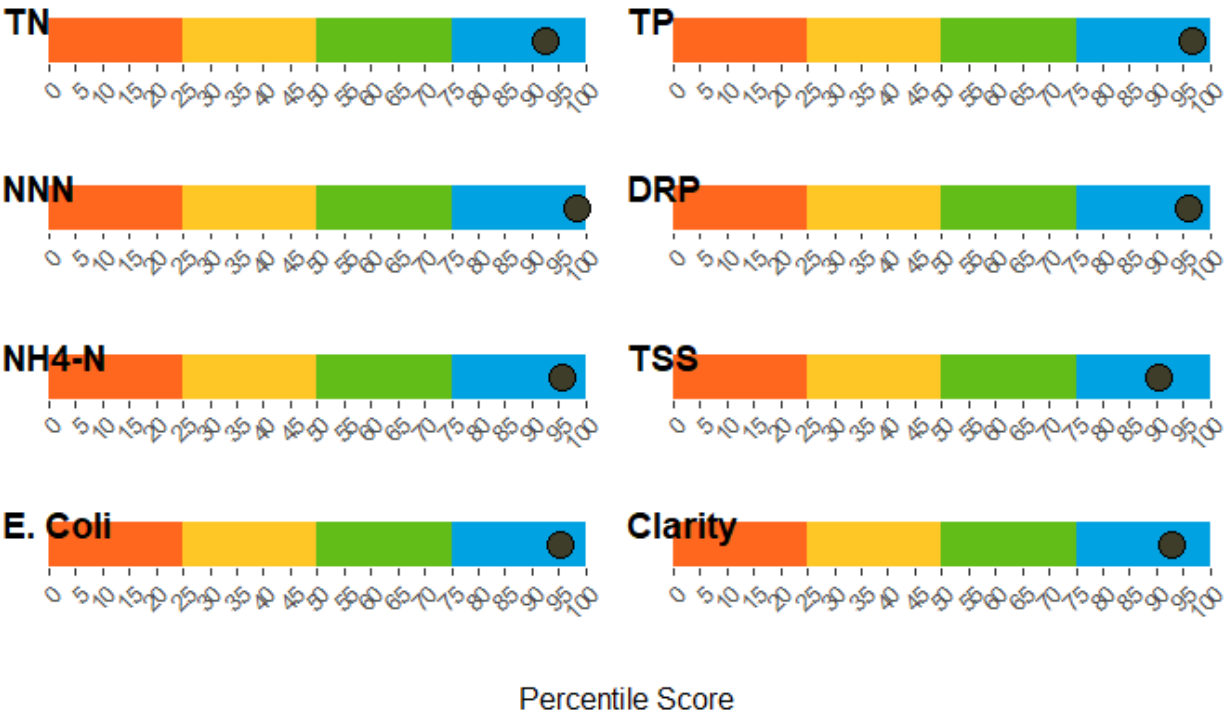


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

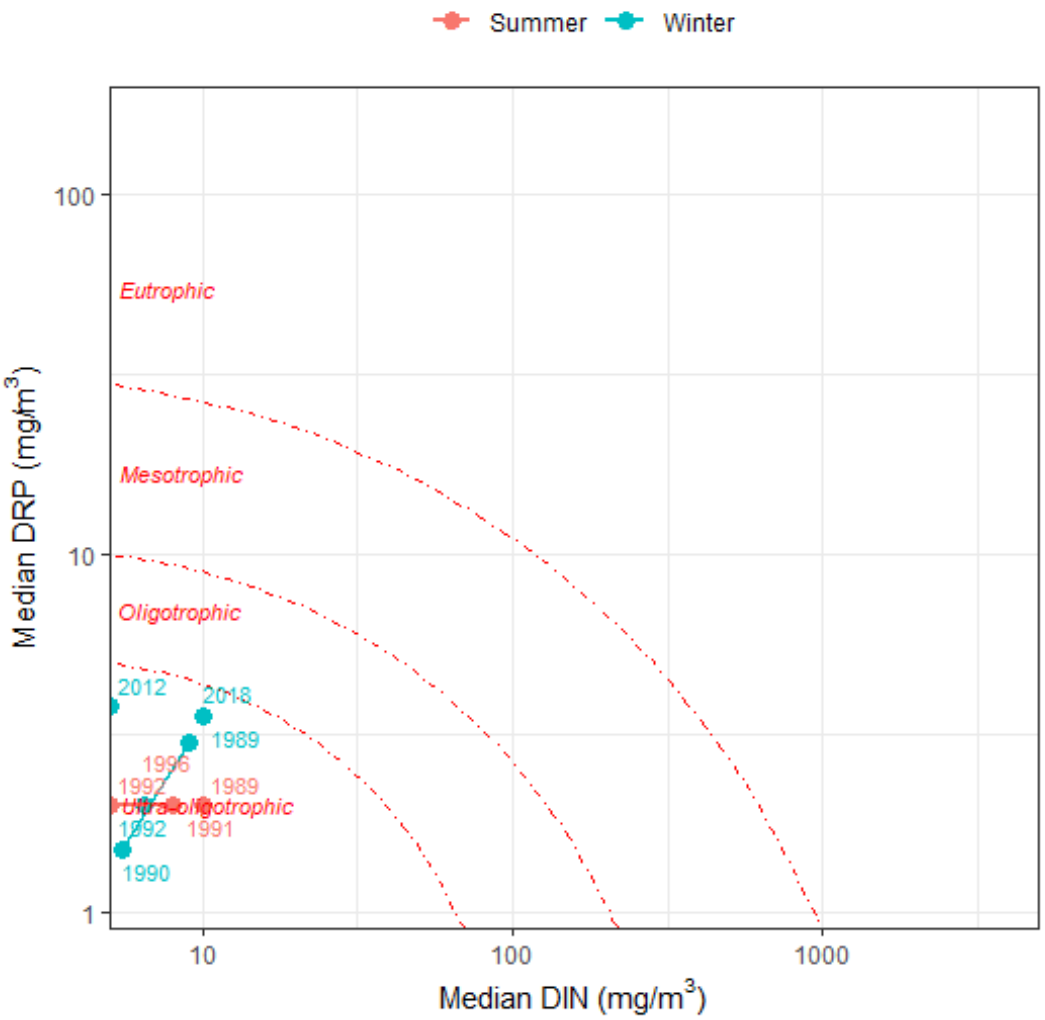


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-06-19	2020-06-18	9	0.0020	0.006	A
5 Years	2015-06-20	2020-06-18	57	0.0020	0.008	A
10 Years	2010-06-21	2020-06-18	116	0.0010	0.008	A
All	1989-02-15	2020-06-18	386	0.0016	0.018	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-06-19	2020-06-18	9	0	0.00	A
5 Years	2015-06-20	2020-06-18	57	0	0.01	A
10 Years	2010-06-21	2020-06-18	116	0	0.01	A
All	1989-02-15	2020-06-18	375	0	0.00	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-06-19	2020-06-18	56	5.15	A*
10 Years	2010-06-21	2020-06-18	116	5.25	A
All	1989-02-15	2020-06-18	379	5.57	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-06-19	2020-06-17	56	0.002	0.007	A
10 Years	2010-06-20	2020-06-17	115	0.002	0.007	A
All	1989-02-15	2020-06-17	395	0.002	0.006	A

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-06-20	2020-06-18	57	0.0	0.0	1	13	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-06-20	2020-06-18	57	1	15	100	0	0
10 Years	2010-06-21	2020-06-18	117	1	19	100	0	0
All	1991-02-07	2020-06-18	198	1	17	100	0	0

Time series plots

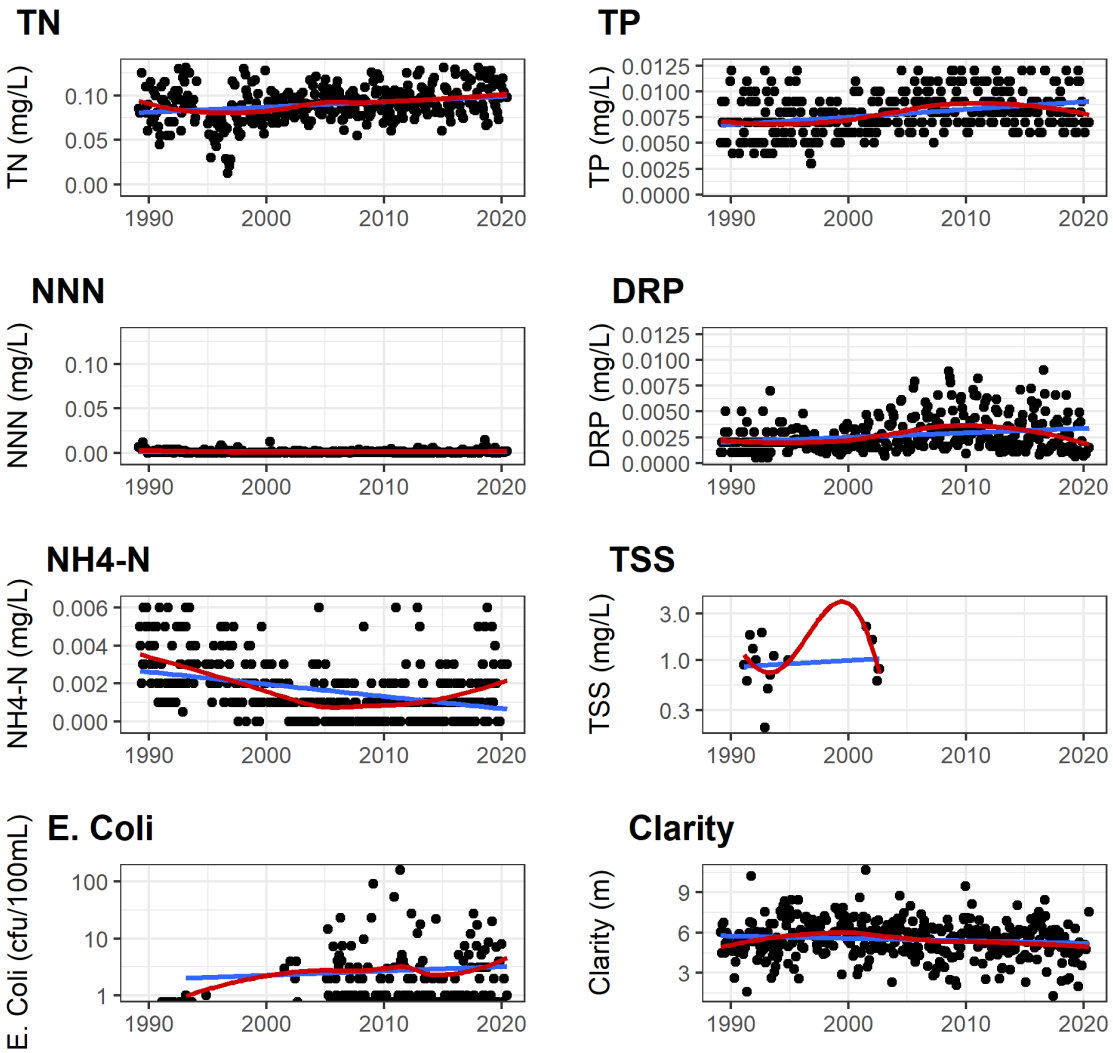


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-07-16	2020-06-18	0.0001	0.13	0.88	Indeterminant	Attempted	YES	Indeterminate/Uncertain
TN	10 Years	2010-07-13	2020-06-18	0.0016	1.72	<0.05	Increasing	YES	YES	Very Likely Degrading
TN	All	1989-03-15	2020-06-18	0.0008	0.93	<0.001	Increasing	YES	YES	Very Likely Degrading
NNN	5 Years	2015-07-16	2020-06-18	0.0001	10.33	0.65	Indeterminant	YES	NO	Likely Degrading
NNN	10 Years	2010-07-13	2020-06-18	0.0001	10.82	<0.05	Increasing	YES	NO	Very Likely Degrading
NNN	All	1989-03-15	2020-06-18	0.0000	-0.05	0.84	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	5 Years	2015-07-16	2020-06-18	0.0000	0.00	<0.05	Increasing	NO	NO	Very Likely Degrading
NH4N	10 Years	2010-07-13	2020-06-18	0.0001	5.70	0.18	Indeterminant	YES	NO	Very Likely Degrading
NH4N	All	1989-03-15	2020-06-18	-0.0001	-3.73	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2015-07-16	2020-06-18	0.0000	0.00	0.11	Indeterminant	Attempted	YES	Likely Improving
TP	10 Years	2010-07-13	2020-06-18	0.0000	0.47	0.71	Indeterminant	YES	YES	Indeterminate/Uncertain
TP	All	1989-03-15	2020-06-18	0.0001	0.97	<0.001	Increasing	YES	YES	Very Likely Degrading
DRP	5 Years	2015-07-16	2020-06-18	-0.0003	-15.67	<0.001	Decreasing	Attempted	YES	Very Likely Improving
DRP	10 Years	2010-07-13	2020-06-18	-0.0001	-5.39	0.16	Indeterminant	YES	YES	Likely Improving
DRP	All	1989-03-15	2020-06-18	0.0000	0.71	0.17	Indeterminant	YES	YES	Very Likely Degrading
ECOLI	5 Years	2015-07-16	2020-06-18	0.0036	1.19	0.97	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	10 Years	2010-07-13	2020-06-18	0.0136	4.52	0.41	Indeterminant	YES	NO	Likely Degrading
ECOLI	All	1989-03-15	2020-06-18	0.0019	0.63	0.46	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	5 Years									Not Analysed
TSS	10 Years									Not Analysed
TSS	All									Not Analysed
CLARITY	5 Years	2015-07-16	2020-06-18	-0.1895	-3.65	0.24	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2010-07-13	2020-06-18	-0.0312	-0.58	0.56	Indeterminant	YES	NO	Likely Degrading
CLARITY	All	1989-03-15	2020-06-18	-0.0059	-0.10	0.55	Indeterminant	YES	NO	Likely Degrading

Tarawera WMA

The Tarawera River and Tarawera WMA starts at the outlet to Lake Tarawera (also see Rotorua Lakes WMA) and flows 65 km from Lake Tarawera to the ocean at Matatā, past the town of Kawerau to enter the ocean just 6 km west of Edgecumbe. The upper catchment is largely covered in indigenous forest and exotic forest. The lower catchment is influenced by pastural farming and there are some significant point source discharges near Kawerau that effect the river water quality.

Table 6 NERMN sites in the Tarawera WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Tarawera								
IK555889	Tarawera at Kawerau Bridge	1925589	5778832	VA/Steep	FSP	550	30.5	M
IK604969	Tarawera at Caxton Foot Bridge	1926048	5779695	VA/Steep	FP	550	30.5	Impact M
IL663193	Tarawera at Onepū Springs Road	1926636	5781936	VA/Steep	FP	598	2.4	Impact M
IL818464	Tarawera at SH 30	1928182	5784643	VA/Steep	FP	620	18.2	Impact M
JM102399	Tarawera at Awakaponga	1931027	5793990	VA/Steep	FP	701	9.2	M

Tarawera at Kawerau Bridge

March 2021

Table 1 Site metadata.

Aquarius ID:	IK555889	**Labstar ID:**	BOP110021
LAWA ID:	EBOP-00024	**REC Reach:**	4010551
Easting:	1925555	**Northing:**	5778893
Longitude:	176.71174	**Latitude:**	-38.07880
Elevation:	21 m	**Biophysical Unit:**	Unknown
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Lake_VA		

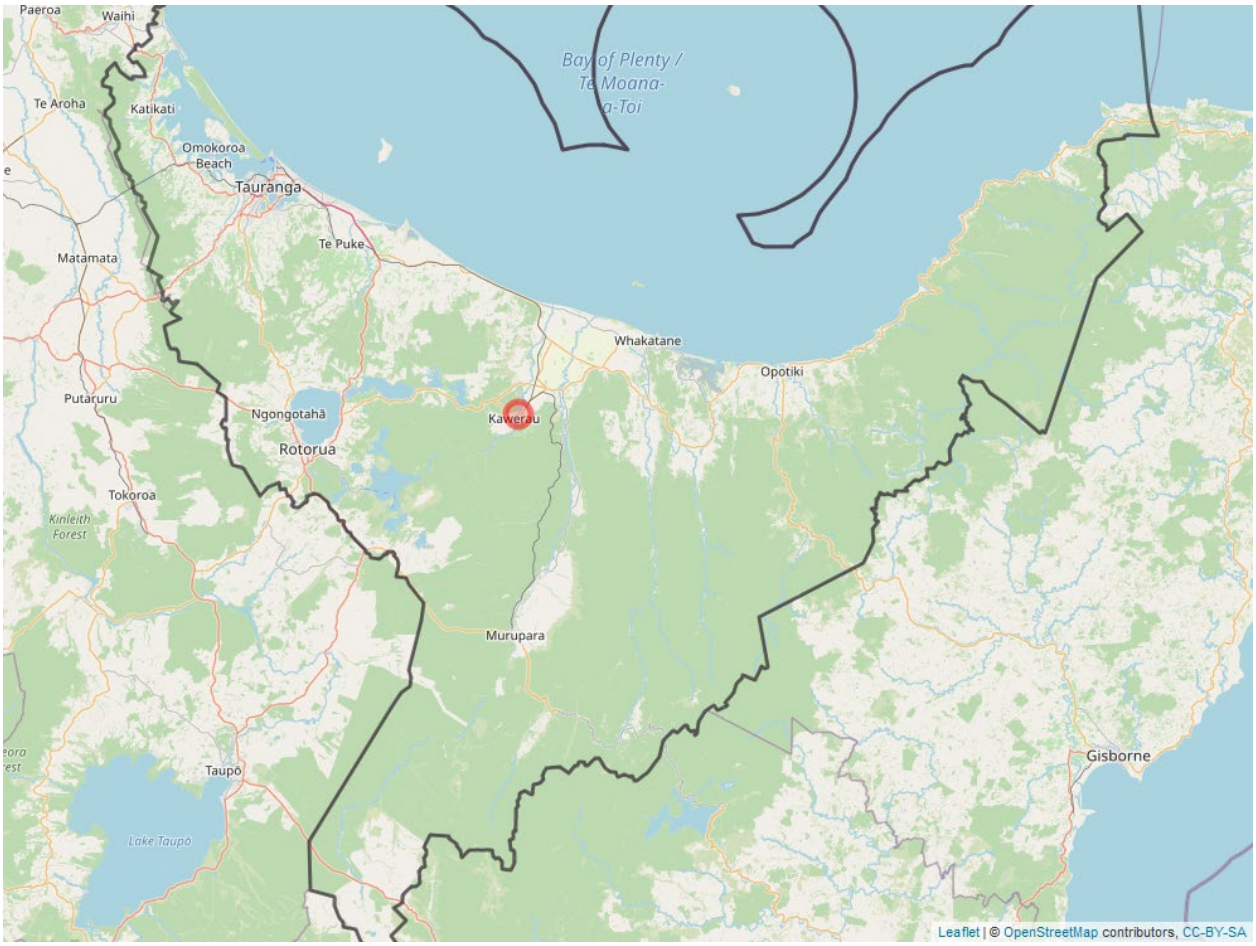


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	247	0.10	2.24	0.35	0.33	0.44	0.27	0.14	0.01
Nitrate Nitrite Nitrogen (g/m3)	246	<0.001	0.43	0.26	0.26	0.31	0.20	0.04	0.00
Total Ammoniacal Nitrogen (g/m3)	262	<0.002	0.080	0.009	0.008	0.021	0.002	0.008	0.000
Total Phosphorus (g/m3)	262	0.039	0.144	0.066	0.064	0.088	0.050	0.013	0.001
Dissolved Reactive Phosphorus (g/m3)	259	0.005	0.085	0.051	0.051	0.063	0.040	0.009	0.001
Dissolved Oxygen Sat (%)	129	91.7	117.3	99.3	98.4	107.7	93.6	4.3	0.4
Dissolved Oxygen (g/m3)	260	7.43	12.30	10.00	9.93	10.90	9.20	0.57	0.04
Escherichia coli (cfu/100ml)	257	<1	2100	111	61	276	13	193	12
Total Suspended Solids (g/m3)	261	<1	56.00	8.05	5.30	22.00	2.40	7.82	0.48
Turbidity (NTU)	257	0.5	19.0	2.6	2.2	5.3	1.3	1.8	0.1
Water Clarity (m)	227	0.02	5.29	2.10	2.13	3.21	1.00	0.74	0.05
Conductivity (uS/cm)	257	239	378	316	319	346	283	20	1
pH (pH Units)	262	6.0	7.8	7.3	7.4	7.6	6.9	0.3	0.0
Water Temperature (degC)	259	10.9	19.5	14.7	14.7	17.8	12.0	1.8	0.1
Discharge (m3/s)	110	16.70	57.60	26.50	23.70	52.20	17.70	9.10	0.90

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

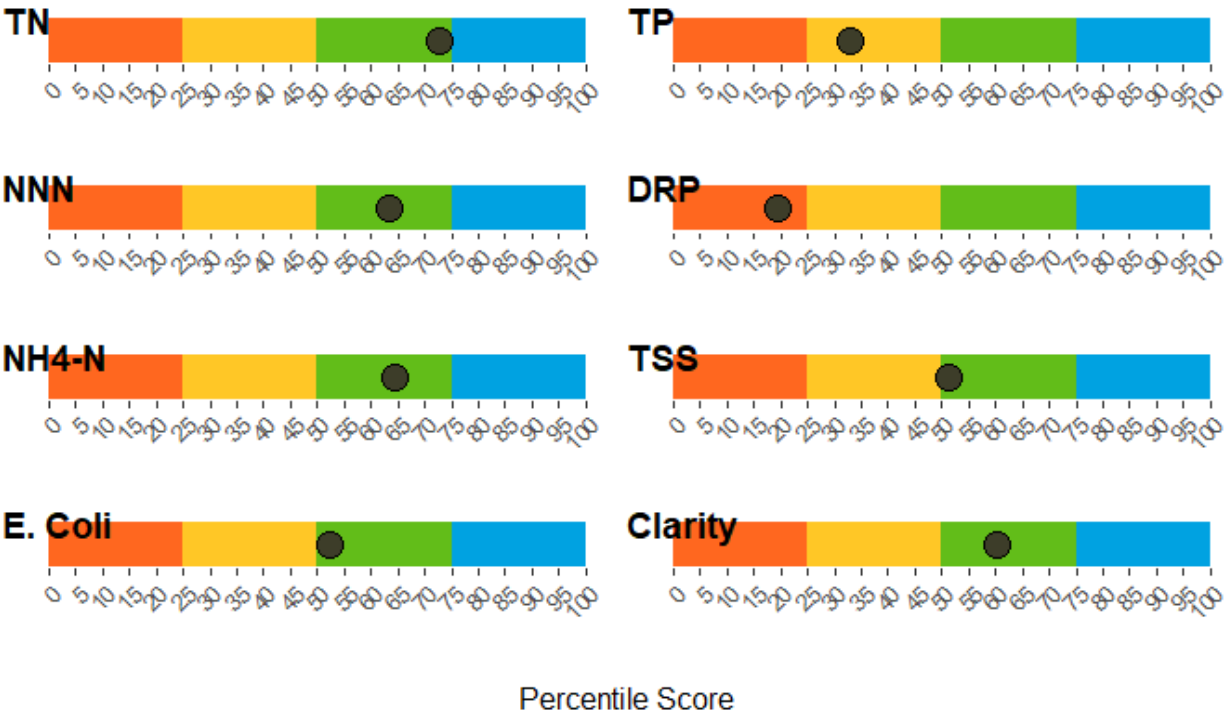


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

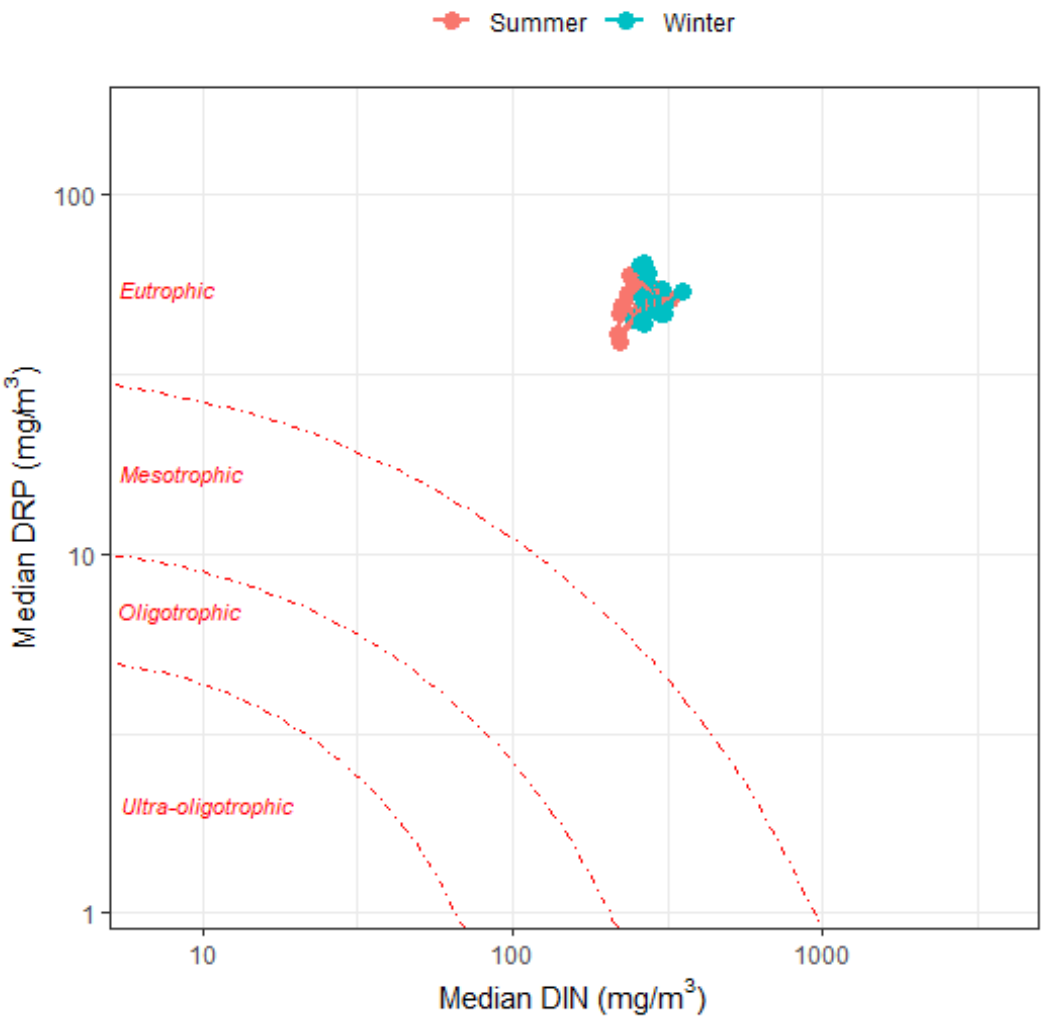


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	12	0.0040	0.011	A
5 Years	2015-12-16	2020-12-14	60	0.0030	0.038	A
10 Years	2010-12-17	2020-12-14	120	0.0030	0.038	A
All	1991-02-07	2020-12-14	261	0.0039	0.038	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	12	0.28	0.30	A
5 Years	2015-12-16	2020-12-14	60	0.28	0.31	A
10 Years	2010-12-17	2020-12-14	119	0.28	0.32	A
All	1993-02-10	2020-12-14	246	0.26	0.31	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	59	2.40	C*
10 Years	2010-12-17	2020-12-14	117	2.22	D
All	1992-08-12	2020-12-14	226	2.12	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	60	0.055	0.065	D
10 Years	2010-12-17	2020-12-14	120	0.055	0.067	D
All	1991-02-07	2020-12-14	258	0.051	0.063	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	59	1.7	3.4	59	211	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	59	59	215	96.6	1.7	1.7
10 Years	2010-12-04	2020-12-01	119	52	210	97.5	0.8	1.7
All	1991-02-07	2020-12-01	257	61	289	94.6	3.1	2.3

Time series plots

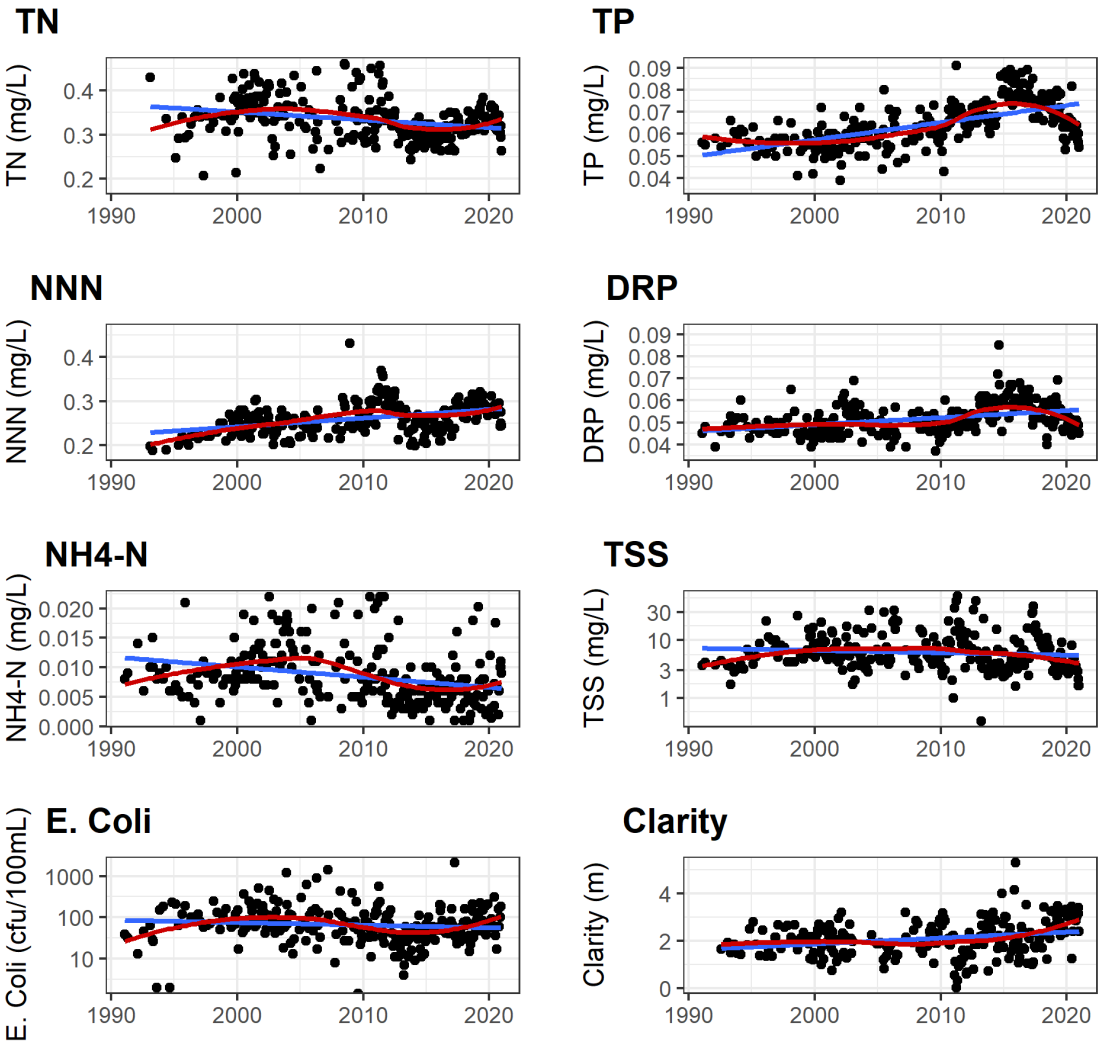


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-25	2020-12-14	-0.0010	-0.33	0.80	Indeterminant	YES	NO	Indeterminate/Uncertain
TN	10 Years	2011-01-10	2020-12-14	-0.0016	-0.51	0.11	Indeterminant	YES	NO	Likely Improving
TN	All	1991-04-30	2020-12-14	-0.0032	-1.01	<0.001	Decreasing	YES	NO	Very Likely Improving
NNN	5 Years	2016-01-25	2020-12-14	0.0070	2.51	<0.01	Increasing	Attempted	YES	Very Likely Degrading
NNN	10 Years	2011-01-10	2020-12-14	-0.0026	-0.96	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	All	1991-04-30	2020-12-14	-0.0023	-0.86	<0.01	Decreasing	YES	YES	Very Likely Improving
NH4N	5 Years	2016-01-25	2020-12-14	-0.0005	-10.37	0.40	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-01-10	2020-12-14	-0.0001	-2.70	0.53	Indeterminant	YES	NO	Likely Improving
NH4N	All	1991-04-30	2020-12-14	-0.0003	-5.55	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-25	2020-12-14	-0.0028	-3.69	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-10	2020-12-14	0.0005	0.73	0.09	Increasing	YES	NO	Very Likely Degrading
TP	All	1991-04-30	2020-12-14	0.0010	1.34	<0.001	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-25	2020-12-14	-0.0014	-2.55	0.07	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-10	2020-12-14	0.0002	0.41	0.36	Indeterminant	YES	NO	Likely Degrading
DRP	All	1991-04-30	2020-12-14	0.0007	1.35	<0.001	Increasing	YES	NO	Very Likely Degrading
ECOLI	5 Years	2016-01-25	2020-12-14	-0.0011	-0.06	1.00	Indeterminant	Attempted	YES	Indeterminate/Uncertain
ECOLI	10 Years	2011-01-10	2020-12-14	0.0266	1.61	0.07	Increasing	YES	NO	Very Likely Degrading
ECOLI	All	1991-04-30	2020-12-14	0.0030	0.18	0.80	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-25	2020-12-14	-0.0399	-4.71	<0.05	Decreasing	YES	NO	Very Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	10 Years	2011-01-10	2020-12-14	-0.0019	-0.23	0.78	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	1991-04-30	2020-12-14	-0.0133	-1.60	<0.05	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2016-01-25	2020-12-14	0.1583	7.22	<0.05	Increasing	YES	NO	Very Likely Improving
CLARITY	10 Years	2011-01-10	2020-12-14	0.0883	4.11	<0.01	Increasing	YES	NO	Very Likely Improving
CLARITY	All	1991-04-30	2020-12-14	0.0792	3.76	<0.001	Increasing	YES	NO	Very Likely Improving

Tarawera at Caxton Foot Bridge

March 2021

Table 1 Site metadata.

Aquarius ID:	IK604969	**Labstar ID:**	
LAWA ID:		**REC Reach:**	
Easting:	1926048	**Northing:**	5779695
Longitude:	176.71660	**Latitude:**	-38.07178
Elevation:	19 m	**Biophysical Unit:**	VA/Steep
Flow:	No	**Water Level:**	No
REC Class:	CW_Lake_VA		

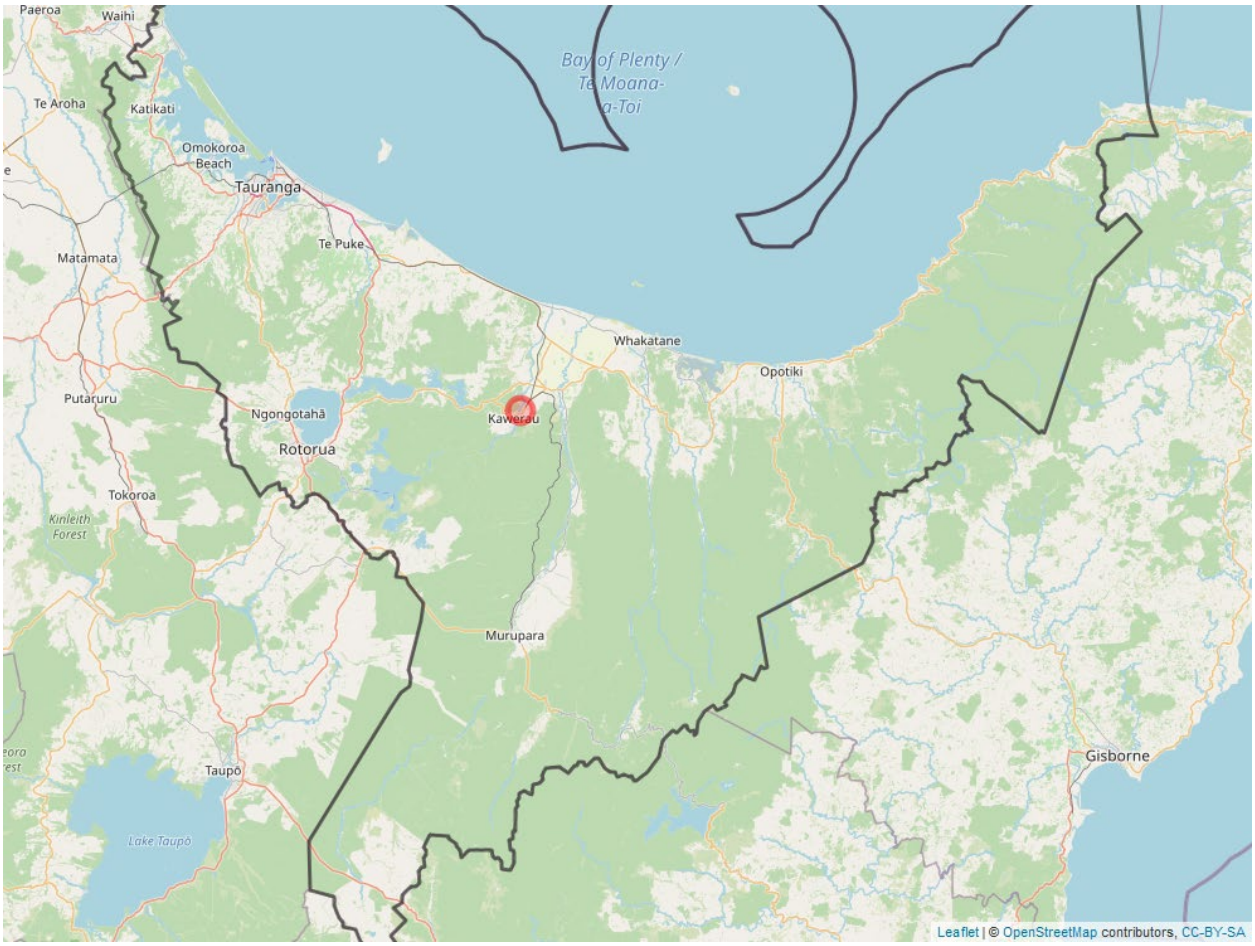


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	199	0.16	266.26	1.71	0.35	0.50	0.29	18.85	1.34
Nitrate Nitrite Nitrogen (g/m3)	200	0.14	266.00	1.59	0.26	0.32	0.21	18.79	1.33
Total Ammoniacal Nitrogen (g/m3)	211	<0.002	0.124	0.031	0.029	0.056	0.010	0.015	0.001
Total Phosphorus (g/m3)	210	0.033	0.146	0.072	0.071	0.090	0.055	0.013	0.001
Dissolved Reactive Phosphorus (g/m3)	211	0.006	0.082	0.054	0.054	0.067	0.042	0.008	0.001
Dissolved Oxygen Sat (%)	127	90.8	120.4	98.4	97.9	105.9	93.1	4.0	0.4
Dissolved Oxygen (g/m3)	203	8.20	12.20	9.95	9.90	10.80	9.10	0.58	0.04
Escherichia coli (cfu/100ml)	195	<1	8700	444	67	2430	17	1132	81
Total Suspended Solids (g/m3)	210	<1	67.00	7.94	5.40	21.00	2.43	8.30	0.57
Turbidity (NTU)	201	0.8	18.0	2.9	2.5	5.5	1.4	1.9	0.1
Water Clarity (m)	62	0.25	5.02	2.59	2.64	3.63	1.27	0.81	0.10
Conductivity (uS/cm)	206	238	470	318	321	345	281	23	2
pH (pH Units)	202	6.6	7.9	7.3	7.3	7.5	7.1	0.2	0.0
Water Temperature (degC)	203	10.9	19.0	14.7	14.7	17.8	12.0	1.9	0.1
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

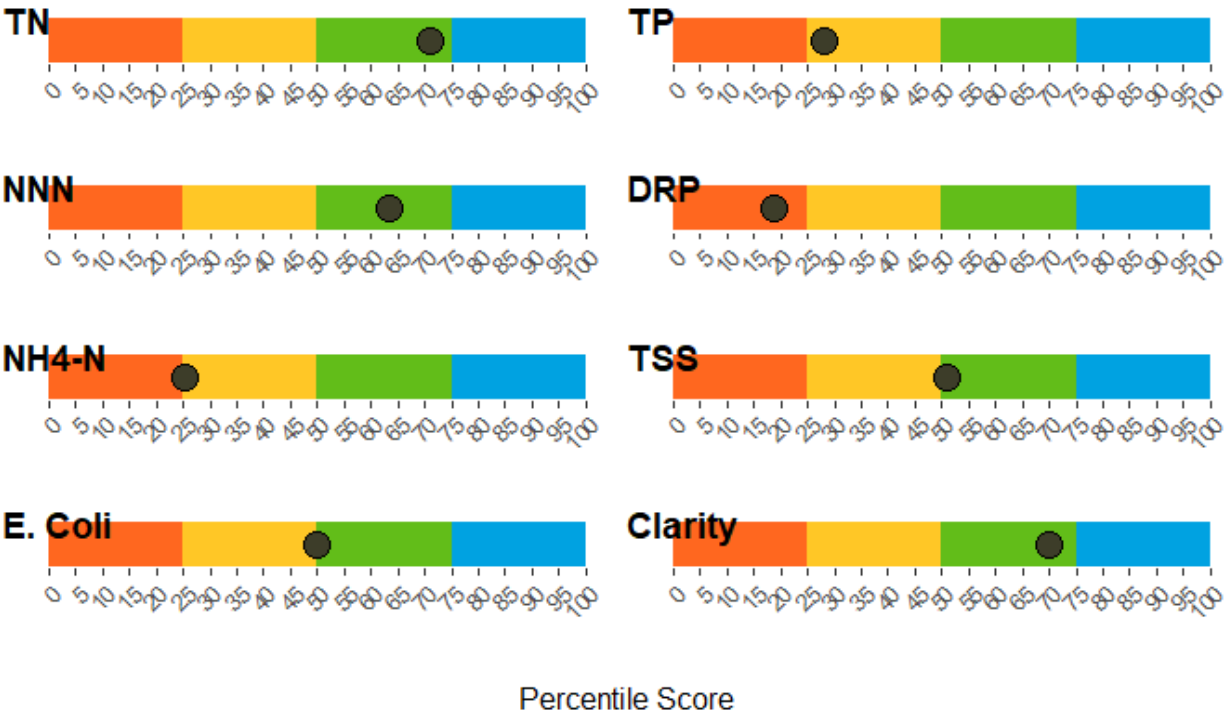


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

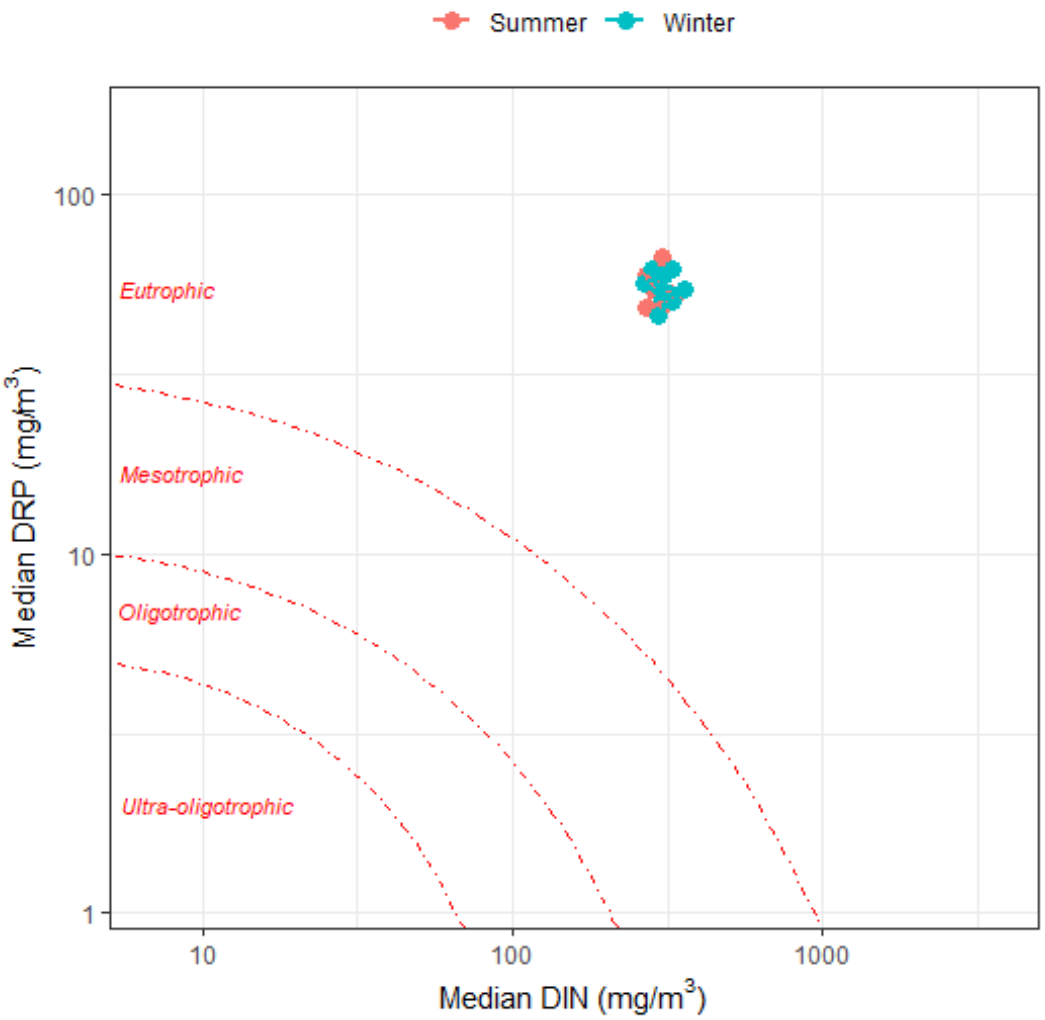


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-02	2020-12-01	11	0.014	0.020	A
5 Years	2015-12-03	2020-12-01	59	0.012	0.020	A
10 Years	2010-12-04	2020-12-01	119	0.013	0.029	A
All	1994-02-24	2020-12-01	202	0.014	0.056	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-02	2020-12-01	11	0.27	0.30	A
5 Years	2015-12-03	2020-12-01	59	0.28	0.31	A
10 Years	2010-12-04	2020-12-01	119	0.28	0.32	A
All	1994-02-24	2020-12-01	200	0.26	0.32	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-03	2020-12-01	58	2.58	B*
10 Years	2010-12-04	2020-12-01	60	2.64	B
All	2010-07-20	2020-12-01	61	2.58	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-03	2020-12-01	59	0.054	0.063	D
10 Years	2010-12-04	2020-12-01	119	0.054	0.065	D
All	1985-12-13	2020-12-01	210	0.054	0.067	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	59	1.7	1.7	58	205	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	59	58	227	98.3	0	1.7
10 Years	2010-12-04	2020-12-01	119	50	191	98.3	0.8	0.8
All	1996-11-08	2020-12-01	195	67	2475	80	3.6	16.4

Time series plots

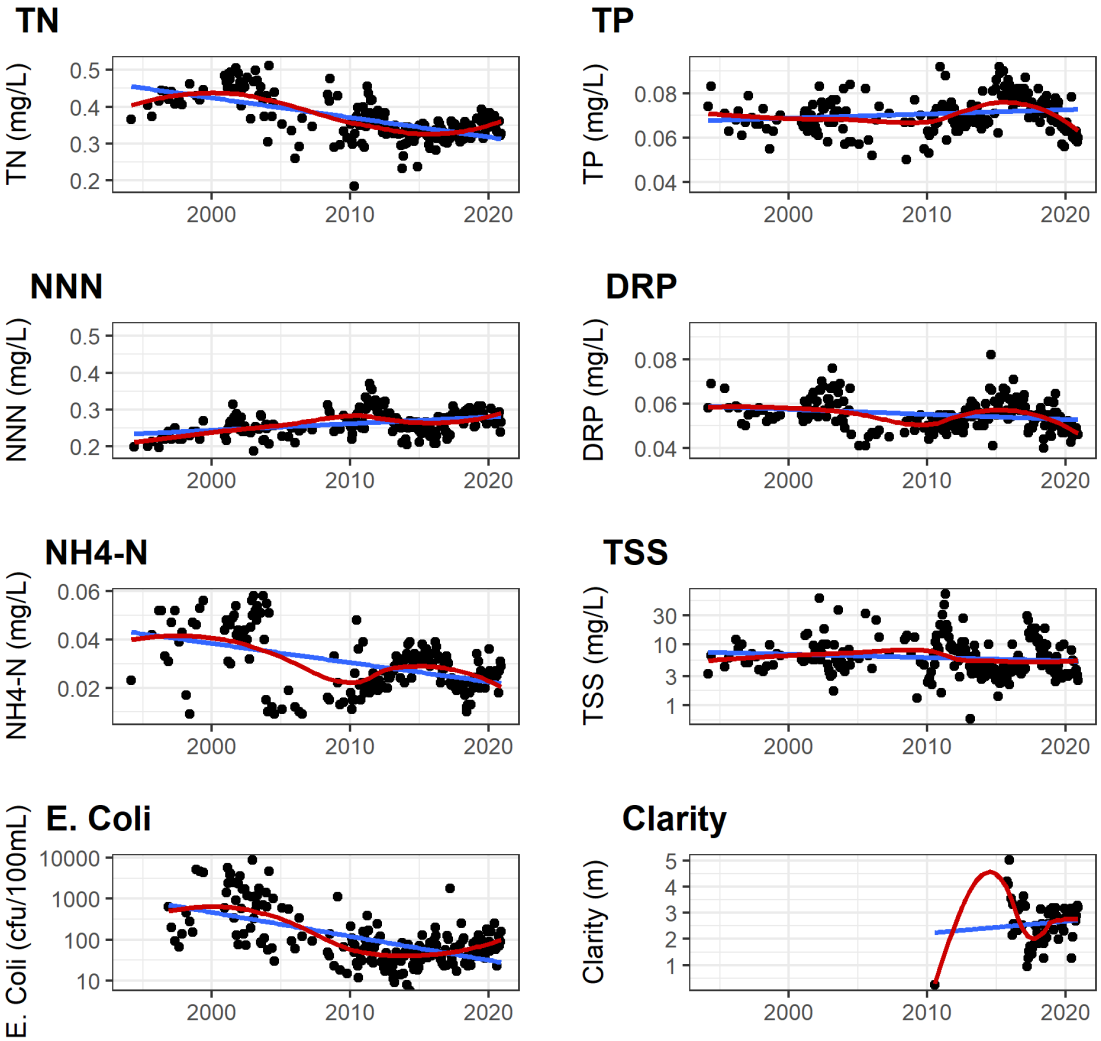


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-09	2020-12-01	0.0036	1.08	<0.05	Increasing	NO	YES	Very Likely Degrading
TN	10 Years	2010-12-08	2020-12-01	0.0000	0.00	1.00	Indeterminant	NO	YES	Indeterminate/Uncertain
TN	All	1994-02-24	2020-12-01	-0.0050	-1.41	<0.001	Decreasing	NO	NO	Very Likely Improving
NNN	5 Years	2015-12-09	2020-12-01	0.0077	2.77	0.14	Indeterminant	NO	YES	Very Likely Degrading
NNN	10 Years	2010-12-08	2020-12-01	0.0006	0.20	0.73	Indeterminant	NO	YES	Indeterminate/Uncertain
NNN	All	1994-02-24	2020-12-01	0.0023	0.87	<0.001	Increasing	NO	YES	Very Likely Degrading
NH4N	5 Years	2015-12-09	2020-12-01	-0.0013	-5.64	0.26	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2010-12-08	2020-12-01	-0.0003	-1.12	0.51	Indeterminant	NO	NO	Likely Improving
NH4N	All	1994-02-24	2020-12-01	-0.0009	-3.05	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2015-12-09	2020-12-01	-0.0043	-5.79	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2010-12-08	2020-12-01	-0.0011	-1.51	0.06	Decreasing	NO	NO	Very Likely Improving
TP	All	1994-02-24	2020-12-01	0.0002	0.27	0.06	Increasing	NO	NO	Very Likely Degrading
DRP	5 Years	2015-12-09	2020-12-01	-0.0031	-5.69	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2010-12-08	2020-12-01	-0.0004	-0.83	0.11	Indeterminant	NO	NO	Likely Improving
DRP	All	1994-02-24	2020-12-01	-0.0002	-0.29	<0.05	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2015-12-09	2020-12-01	0.0401	2.26	0.73	Indeterminant	NO	YES	Indeterminate/Uncertain
ECOLI	10 Years	2010-12-08	2020-12-01	0.0181	1.06	0.21	Indeterminant	NO	YES	Likely Degrading
ECOLI	All	1994-02-24	2020-12-01	-0.0446	-2.43	<0.001	Decreasing	NO	YES	Very Likely Improving
TSS	5 Years	2015-12-09	2020-12-01	-0.0202	-2.60	0.63	Indeterminant	NO	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TSS	10 Years	2010-12-08	2020-12-01	-0.0237	-3.17	0.06	Decreasing	NO	YES	Very Likely Improving
TSS	All	1994-02-24	2020-12-01	-0.0042	-0.52	0.07	Decreasing	NO	YES	Very Likely Improving
CLARITY	5 Years	2015-12-09	2020-12-01	-0.0738	-2.86	0.65	Indeterminant	NO	YES	Likely Degrading
CLARITY	10 Years	2010-12-08	2020-12-01	-0.0738	-2.74	0.65	Indeterminant	NO	YES	Likely Degrading
CLARITY	All	1994-02-24	2020-12-01	0.0253	0.96	1.00	Indeterminant	NO	YES	Indeterminate/Uncertain

Tarawera at Onepu Springs Road

March 2021

Table 1 Site metadata.

Aquarius ID:	IL663193	**Labstar ID:**	BOP110102A
LAWA ID:		**REC Reach:**	4009544
Easting:	1926636	**Northing:**	5781936
Longitude:	176.72231	**Latitude:**	-38.05141
Elevation:	16 m	**Biophysical Unit:**	VA/Steep
Flow:	No	**Water Level:**	No
REC Class:	WW_Lake_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	81	0.29	0.42	0.36	0.36	0.40	0.33	0.02	0.00
Nitrate Nitrite Nitrogen (g/m3)	81	0.22	0.33	0.28	0.28	0.32	0.23	0.03	0.00
Total Ammoniacal Nitrogen (g/m3)	81	<0.002	0.071	0.042	0.042	0.061	0.025	0.012	0.001
Total Phosphorus (g/m3)	81	0.054	0.120	0.077	0.077	0.090	0.061	0.011	0.001
Dissolved Reactive Phosphorus (g/m3)	81	0.036	0.081	0.054	0.054	0.066	0.045	0.007	0.001
Dissolved Oxygen Sat (%)	80	89.0	109.5	96.5	96.0	104.8	91.6	3.7	0.4
Dissolved Oxygen (g/m3)	81	8.44	12.71	9.75	9.74	10.42	8.90	0.59	0.07
Escherichia coli (cfu/100ml)	81	16	1200	111	63	240	23	144	16
Total Suspended Solids (g/m3)	81	1.80	31.80	7.50	6.01	16.80	2.60	5.29	0.59
Turbidity (NTU)	80	1.1	6.0	2.6	2.3	5.2	1.4	1.1	0.1
Water Clarity (m)	70	0.64	4.81	2.40	2.51	3.45	1.09	0.76	0.09
Conductivity (uS/cm)	81	268	390	347	349	375	311	22	2
pH (pH Units)	81	7.0	7.7	7.4	7.4	7.6	7.2	0.1	0.0
Water Temperature (degC)	80	11.6	18.8	15.3	14.9	18.3	12.8	1.9	0.2
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

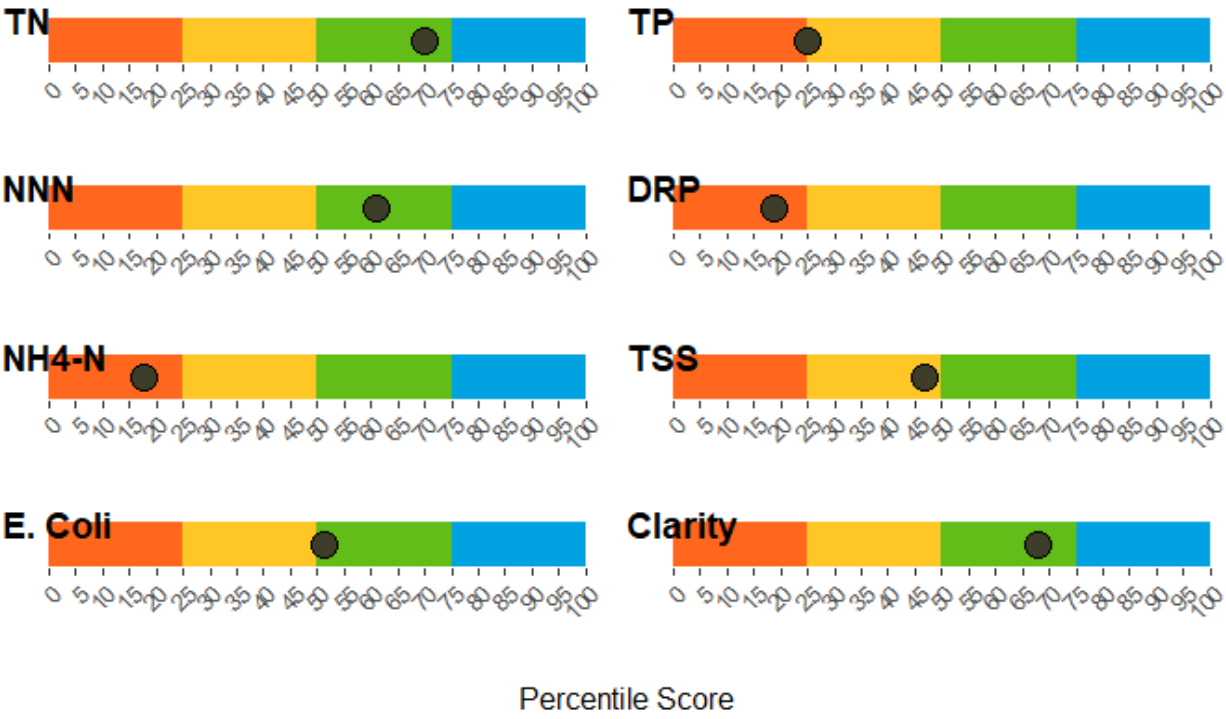


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

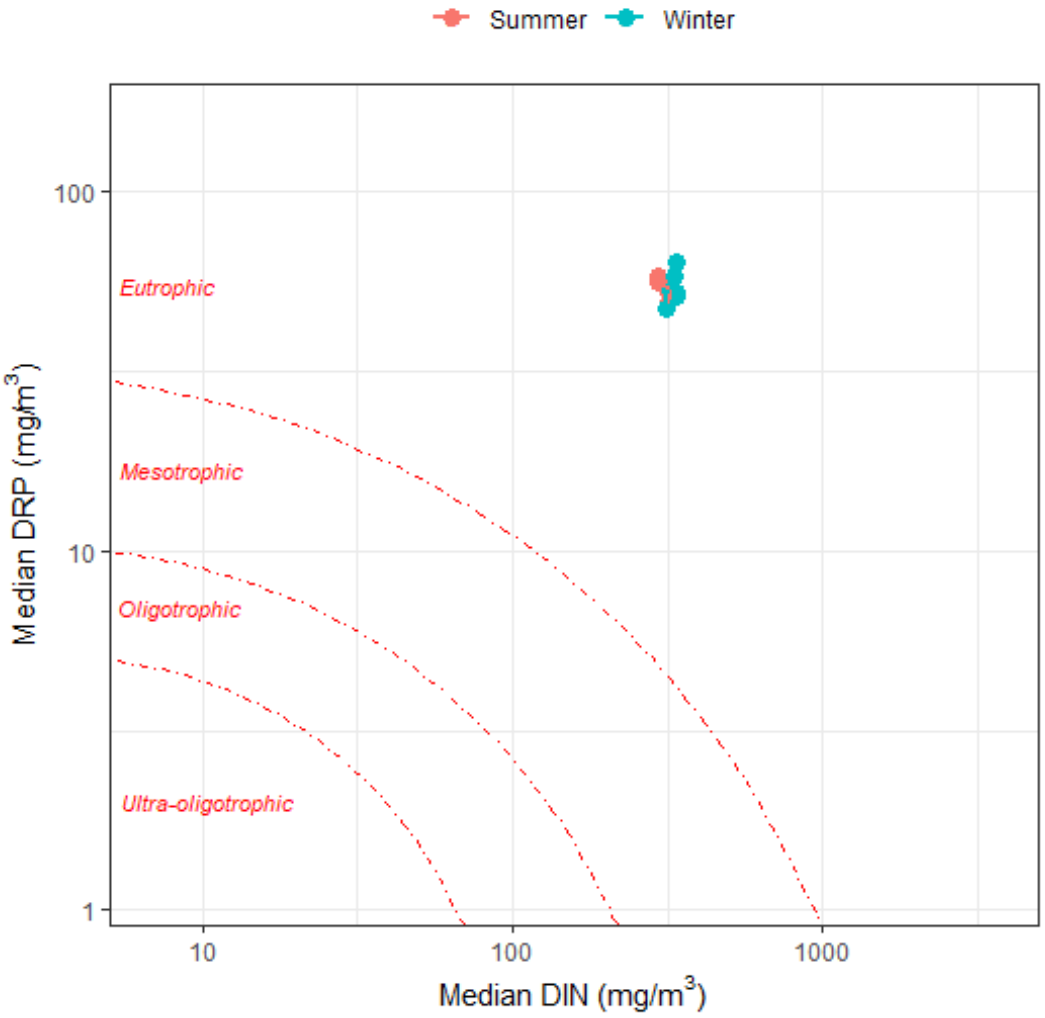


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-02	2020-12-01	11	0.024	0.031	A
5 Years	2015-12-03	2020-12-01	58	0.021	0.031	A
10 Years	2010-12-04	2020-12-01	NA	NA	NA	NA
All	2013-12-03	2020-12-01	81	0.0221	0.0429	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-02	2020-12-01	11	0.28	0.31	A
5 Years	2015-12-03	2020-12-01	58	0.29	0.32	A
10 Years	2010-12-04	2020-12-01	NA	NA	NA	NA
All	2013-12-03	2020-12-01	81	0.28	0.32	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-03	2020-12-01	58	2.49	C*
10 Years	2010-12-04	2020-12-01	NA	NA	
All	2013-12-03	2020-12-01	69	2.50	C

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-03	2020-12-01	58	0.052	0.062	D
10 Years	2010-12-04	2020-12-01	NA	NA	NA	
All	2013-12-03	2020-12-01	80	0.054	0.066	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	58	1.7	5.2	70	252	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	58	70	288	94.8	3.4	1.7
10 Years	2010-12-04	2020-12-01	NA	NA	NA			
All	2013-12-03	2020-12-01	81	63	254	95.1	3.7	1.2

Time series plots

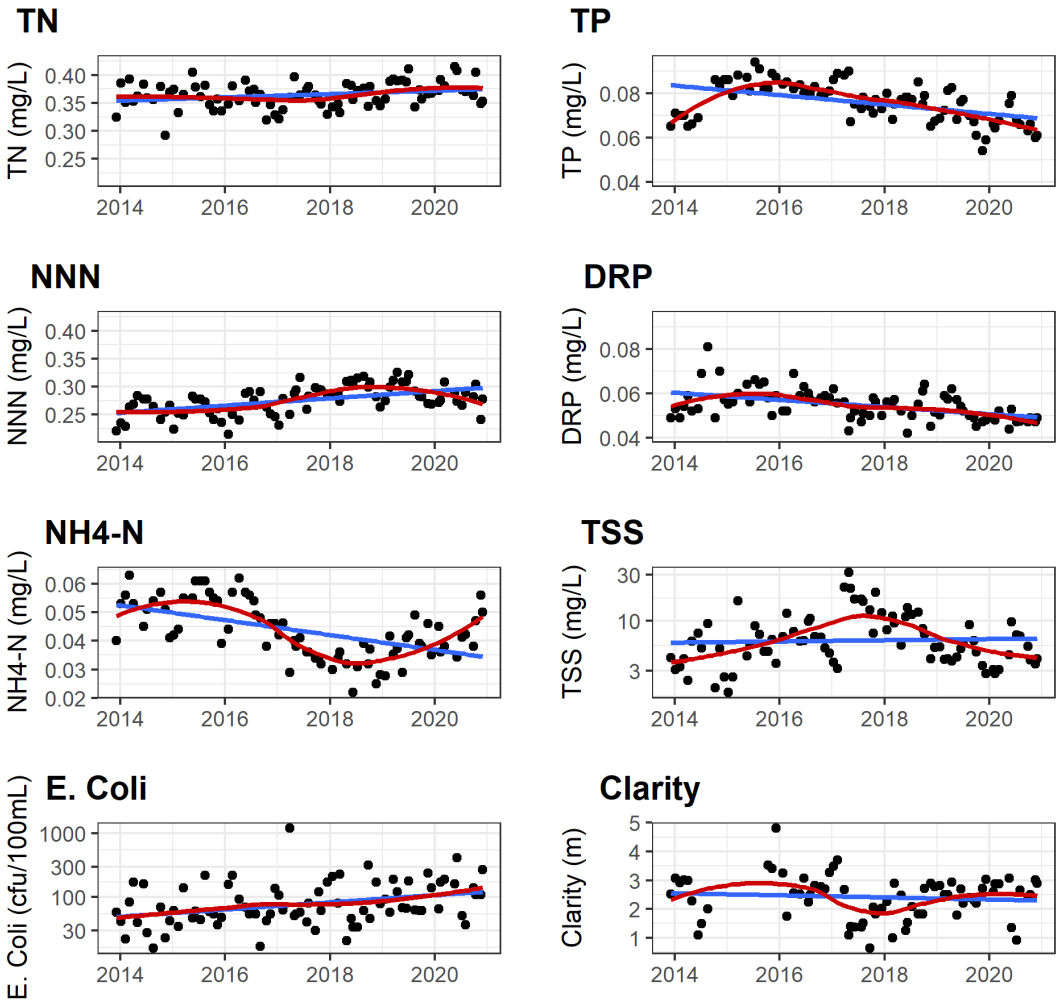


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-09	2020-12-01	0.0060	1.64	<0.05	Increasing	NO	YES	Very Likely Degrading
TN	10 Years	2013-12-03	2020-12-01	0.0036	0.98	<0.05	Increasing	NO	YES	Very Likely Degrading
TN	All	2013-12-03	2020-12-01	0.0036	0.98	<0.05	Increasing	NO	YES	Very Likely Degrading
NNN	5 Years	2015-12-09	2020-12-01	0.0069	2.41	0.14	Indeterminant	NO	YES	Very Likely Degrading
NNN	10 Years	2013-12-03	2020-12-01	0.0067	2.42	<0.001	Increasing	NO	YES	Very Likely Degrading
NNN	All	2013-12-03	2020-12-01	0.0067	2.42	<0.001	Increasing	NO	YES	Very Likely Degrading
NH4N	5 Years	2015-12-09	2020-12-01	-0.0024	-6.22	0.16	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2013-12-03	2020-12-01	-0.0033	-8.01	<0.001	Decreasing	NO	NO	Very Likely Improving
NH4N	All	2013-12-03	2020-12-01	-0.0033	-8.01	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2015-12-09	2020-12-01	-0.0043	-5.62	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2013-12-03	2020-12-01	-0.0035	-4.49	<0.01	Decreasing	NO	NO	Very Likely Improving
TP	All	2013-12-03	2020-12-01	-0.0035	-4.49	<0.01	Decreasing	NO	NO	Very Likely Improving
DRP	5 Years	2015-12-09	2020-12-01	-0.0021	-4.02	<0.01	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2013-12-03	2020-12-01	-0.0014	-2.53	<0.01	Decreasing	NO	NO	Very Likely Improving
DRP	All	2013-12-03	2020-12-01	-0.0014	-2.53	<0.01	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2015-12-09	2020-12-01	0.0327	1.76	0.26	Indeterminant	NO	YES	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2013-12-03	2020-12-01	0.0421	2.33	<0.05	Increasing	NO	NO	Very Likely Degrading
ECOLI	All	2013-12-03	2020-12-01	0.0421	2.33	<0.05	Increasing	NO	NO	Very Likely Degrading
TSS	5 Years	2015-12-09	2020-12-01	-0.0497	-5.60	0.26	Indeterminant	NO	YES	Likely Improving
TSS	10 Years	2013-12-03	2020-12-01	0.0097	1.14	0.57	Indeterminant	NO	YES	Likely Degrading
TSS	All	2013-12-03	2020-12-01	0.0097	1.14	0.57	Indeterminant	NO	YES	Likely Degrading
CLARITY	5 Years	2015-12-09	2020-12-01	0.0306	1.23	0.65	Indeterminant	NO	YES	Likely Improving
CLARITY	10 Years	2013-12-03	2020-12-01	0.0314	1.25	0.54	Indeterminant	NO	YES	Likely Improving
CLARITY	All	2013-12-03	2020-12-01	0.0314	1.25	0.54	Indeterminant	NO	YES	Likely Improving

Tarawera at SH 30

March 2021

Table 1 Site metadata.

Aquarius ID:	IL818464	**Labstar ID:**	BOP110023
LAWA ID:	EBOP-00025	**REC Reach:**	4008565
Easting:	1928182	**Northing:**	5784643
Longitude:	176.73860	**Latitude:**	-38.02650
Elevation:	11 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Lake_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	174	0.35	1.15	0.57	0.54	0.77	0.45	0.12	0.01
Nitrate Nitrite Nitrogen (g/m3)	173	0.15	0.38	0.28	0.28	0.33	0.21	0.04	0.00
Total Ammoniacal Nitrogen (g/m3)	207	0.005	0.332	0.100	0.086	0.199	0.036	0.056	0.004
Total Phosphorus (g/m3)	206	0.064	0.268	0.125	0.121	0.173	0.088	0.026	0.002
Dissolved Reactive Phosphorus (g/m3)	207	0.015	0.203	0.076	0.074	0.106	0.045	0.021	0.001
Dissolved Oxygen Sat (%)	130	78.9	112.7	89.4	89.2	95.7	83.2	4.9	0.4
Dissolved Oxygen (g/m3)	203	6.40	11.38	8.57	8.61	9.71	7.20	0.80	0.06
Escherichia coli (cfu/100ml)	190	9	3300	359	92	1944	25	610	44
Total Suspended Solids (g/m3)	203	<1	143.00	13.48	9.60	33.60	4.42	13.94	0.98
Turbidity (NTU)	180	1.2	22.0	4.7	4.1	9.4	2.3	2.5	0.2
Water Clarity (m)	89	0.32	2.23	1.18	1.32	1.87	0.44	0.48	0.05
Conductivity (uS/cm)	184	300	536	392	389	472	329	44	3
pH (pH Units)	197	6.0	8.1	7.3	7.3	7.6	7.0	0.2	0.0
Water Temperature (degC)	203	12.2	21.9	16.1	16.0	19.6	13.2	2.1	0.1
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

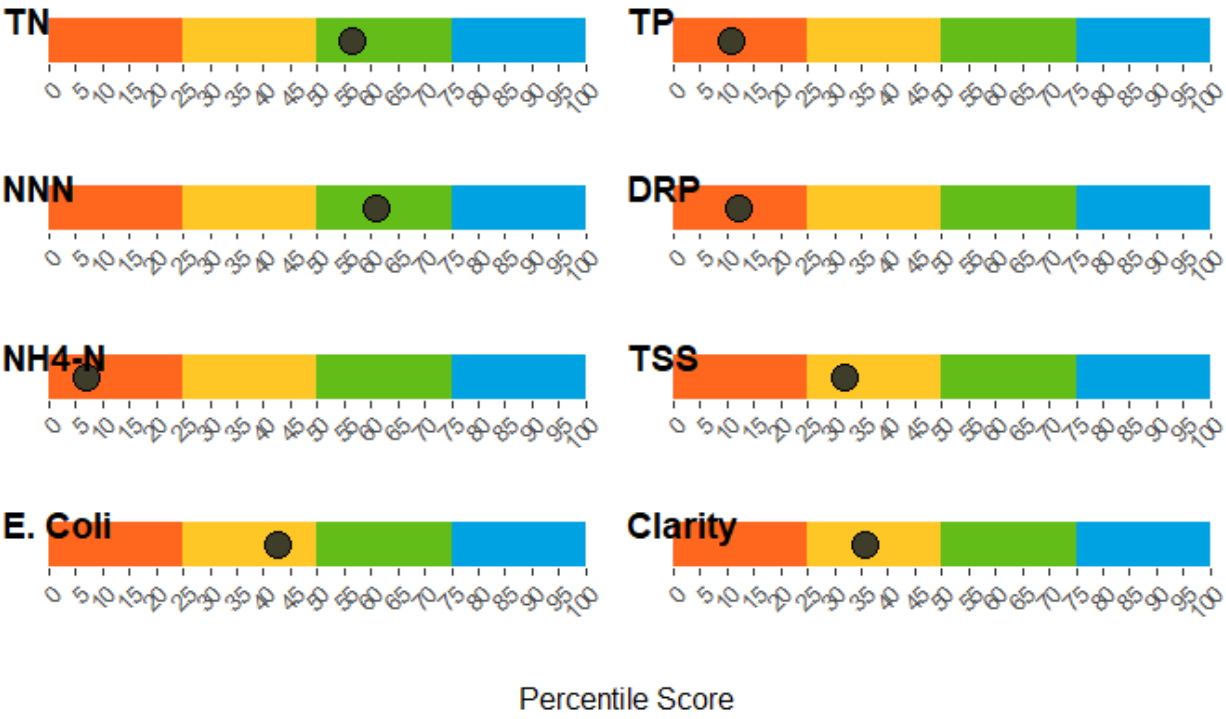


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

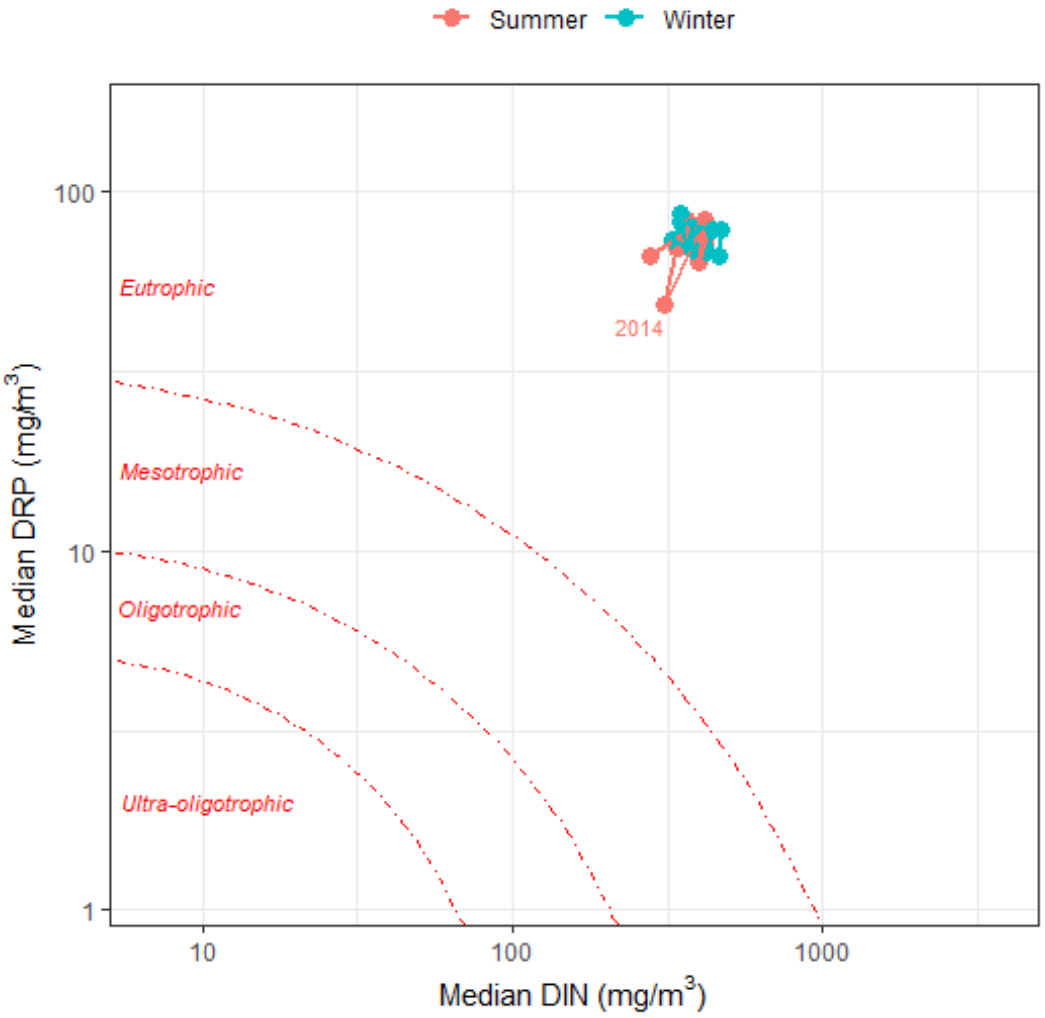


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	12	0.045	0.066	B
5 Years	2015-12-16	2020-12-14	60	0.039	0.074	B
10 Years	2010-12-17	2020-12-14	120	0.039	0.170	B
All	1991-02-08	2020-12-14	197	0.043	0.170	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	12	0.28	0.30	A
5 Years	2015-12-16	2020-12-14	60	0.28	0.32	A
10 Years	2010-12-17	2020-12-14	120	0.28	0.33	A
All	1993-04-14	2020-12-14	173	0.28	0.33	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	60	1.38	D
10 Years	2010-12-17	2020-12-14	63	1.41	D
All	1992-08-12	2020-12-14	88	1.31	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	60	0.075	0.096	D
10 Years	2010-12-17	2020-12-14	120	0.074	0.096	D
All	1985-12-13	2020-12-14	206	0.074	0.106	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	59	3.4	3.4	73	241	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	59	73	245	96.6	0	3.4
10 Years	2010-12-04	2020-12-01	119	62	361	93.3	3.4	3.4
All	1991-02-08	2020-12-01	190	92	1980	74.7	5.8	19.5

Time series plots

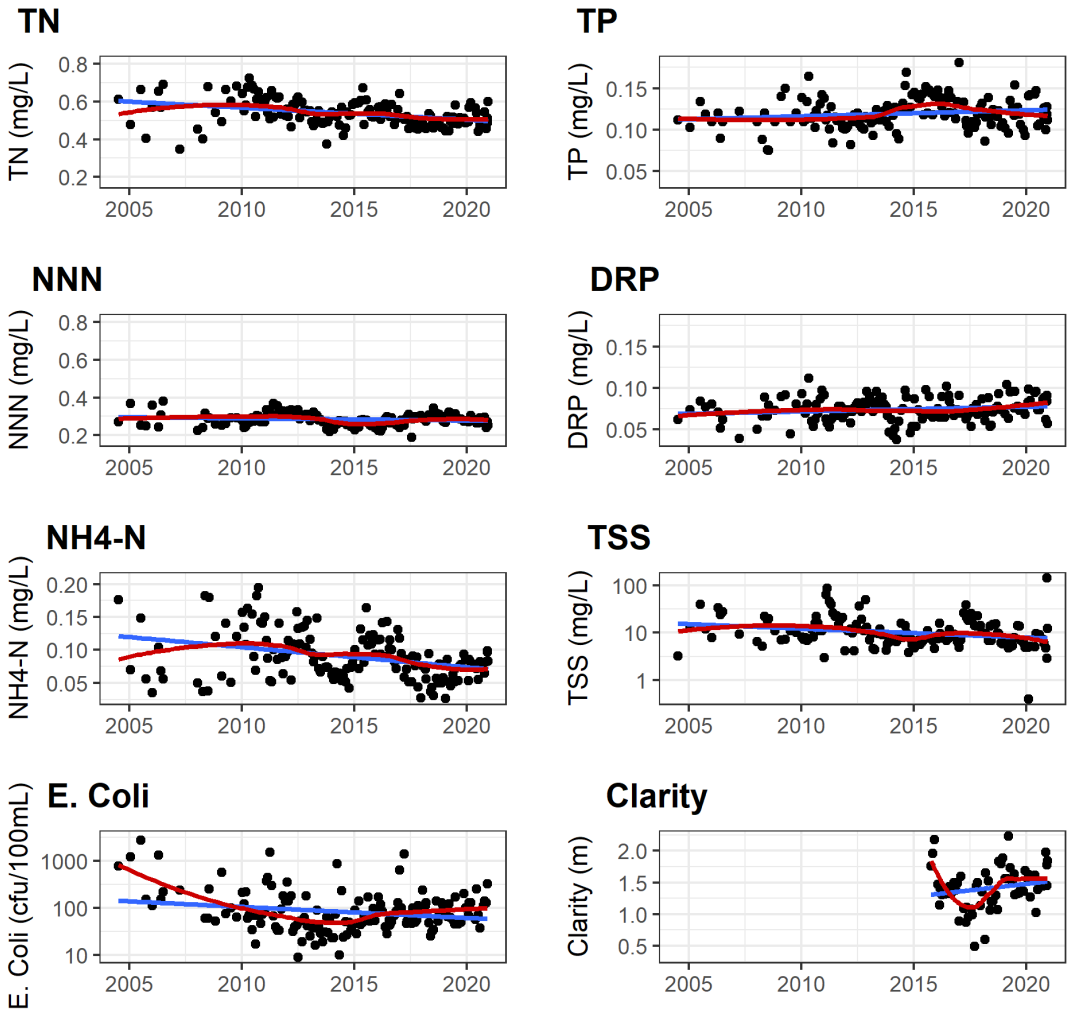


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-25	2020-12-14	-0.0087	-1.72	0.28	Indeterminant	NO	NO	Likely Improving
TN	10 Years	2011-01-10	2020-12-14	-0.0066	-1.27	<0.01	Decreasing	NO	NO	Very Likely Improving
TN	All	2004-07-09	2020-12-14	-0.0080	-1.50	<0.001	Decreasing	NO	NO	Very Likely Improving
NNN	5 Years	2016-01-25	2020-12-14	0.0049	1.71	0.39	Indeterminant	NO	YES	Likely Degrading
NNN	10 Years	2011-01-10	2020-12-14	-0.0023	-0.79	0.47	Indeterminant	NO	YES	Likely Improving
NNN	All	2004-07-09	2020-12-14	0.0002	0.07	0.79	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	5 Years	2016-01-25	2020-12-14	-0.0082	-10.75	0.15	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2011-01-10	2020-12-14	-0.0036	-4.44	<0.05	Decreasing	NO	NO	Very Likely Improving
NH4N	All	2004-07-09	2020-12-14	-0.0020	-2.42	<0.05	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2016-01-25	2020-12-14	-0.0029	-2.40	0.45	Indeterminant	NO	NO	Likely Improving
TP	10 Years	2011-01-10	2020-12-14	0.0009	0.80	0.19	Indeterminant	NO	NO	Very Likely Degrading
TP	All	2004-07-09	2020-12-14	0.0006	0.53	0.14	Indeterminant	NO	NO	Very Likely Degrading
DRP	5 Years	2016-01-25	2020-12-14	0.0025	3.34	0.06	Increasing	NO	NO	Very Likely Degrading
DRP	10 Years	2011-01-10	2020-12-14	0.0011	1.43	<0.05	Increasing	NO	NO	Very Likely Degrading
DRP	All	2004-07-09	2020-12-14	0.0005	0.72	0.13	Indeterminant	NO	NO	Very Likely Degrading
ECOLI	5 Years	2016-01-25	2020-12-14	0.0315	1.67	0.14	Indeterminant	NO	YES	Very Likely Degrading
ECOLI	10 Years	2011-01-10	2020-12-14	0.0289	1.60	0.13	Indeterminant	NO	YES	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	All	2004-07-09	2020-12-14	-0.0231	-1.25	<0.05	Decreasing	NO	YES	Very Likely Improving
TSS	5 Years	2016-01-25	2020-12-14	-0.0384	-3.95	<0.05	Decreasing	NO	NO	Very Likely Improving
TSS	10 Years	2011-01-10	2020-12-14	-0.0217	-2.22	<0.01	Decreasing	NO	YES	Very Likely Improving
TSS	All	2004-07-09	2020-12-14	-0.0149	-1.49	<0.01	Decreasing	NO	YES	Very Likely Improving
CLARITY	5 Years	2016-01-25	2020-12-14	0.0878	6.33	0.18	Indeterminant	NO	YES	Likely Improving
CLARITY	10 Years	2011-01-10	2020-12-14	0.0515	3.62	0.50	Indeterminant	NO	YES	Likely Improving
CLARITY	All	2004-07-09	2020-12-14	0.0515	3.62	0.50	Indeterminant	NO	YES	Likely Improving

Tarawera at Awakaponga

March 2021

Table 1 Site metadata.

Aquarius ID:	JM102399	**Labstar ID:**	BOP110052
LAWA ID:	EBOP-00075	**REC Reach:**	4005289
Easting:	1931027	**Northing:**	5793990
Longitude:	176.76669	**Latitude:**	-37.94141
Elevation:	5 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Lake_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	456	0.08	1.18	0.62	0.61	0.77	0.49	0.09	0.00
Nitrate Nitrite Nitrogen (g/m3)	457	0.01	0.52	0.37	0.38	0.45	0.28	0.06	0.00
Total Ammoniacal Nitrogen (g/m3)	480	0.003	0.122	0.049	0.047	0.081	0.020	0.020	0.001
Total Phosphorus (g/m3)	490	0.005	0.337	0.118	0.113	0.161	0.086	0.029	0.001
Dissolved Reactive Phosphorus (g/m3)	491	<0.001	0.244	0.070	0.068	0.104	0.046	0.020	0.001
Dissolved Oxygen Sat (%)	461	44.7	107.9	77.0	78.7	90.0	60.2	9.7	0.5
Dissolved Oxygen (g/m3)	478	4.20	10.90	7.49	7.70	9.10	5.40	1.14	0.05
Escherichia coli (cfu/100ml)	285	9	7701	199	73	796	23	545	32
Total Suspended Solids (g/m3)	107	4.00	36.90	12.65	10.90	25.68	5.60	6.96	0.67
Turbidity (NTU)	454	1.3	32.0	4.0	3.5	7.2	2.0	2.4	0.1
Water Clarity (m)	445	0.00	2.50	0.88	0.83	1.63	0.36	0.39	0.02
Conductivity (uS/cm)	187	210	506	382	380	462	308	49	4
pH (pH Units)	491	6.1	8.3	7.3	7.3	7.5	7.2	0.1	0.0
Water Temperature (degC)	490	12.2	22.1	16.4	16.4	19.9	13.1	2.2	0.1
Discharge (m3/s)	211	17.70	52.70	27.10	25.70	38.50	19.60	6.00	0.40

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

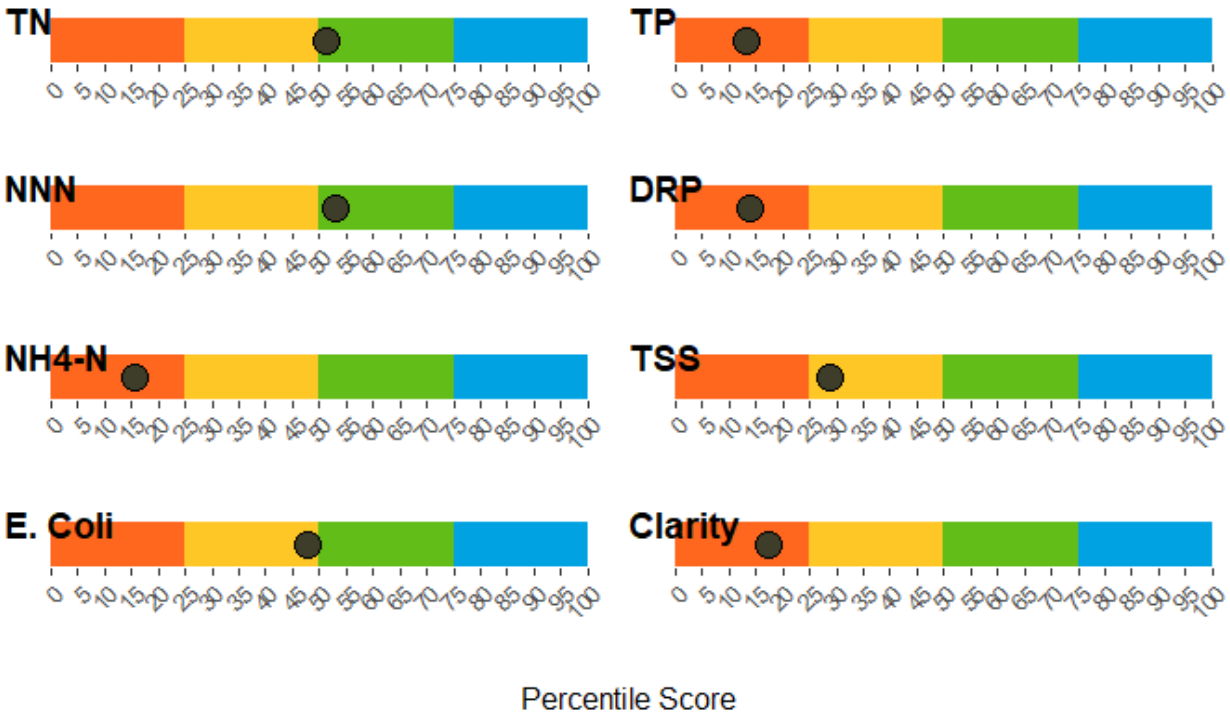


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

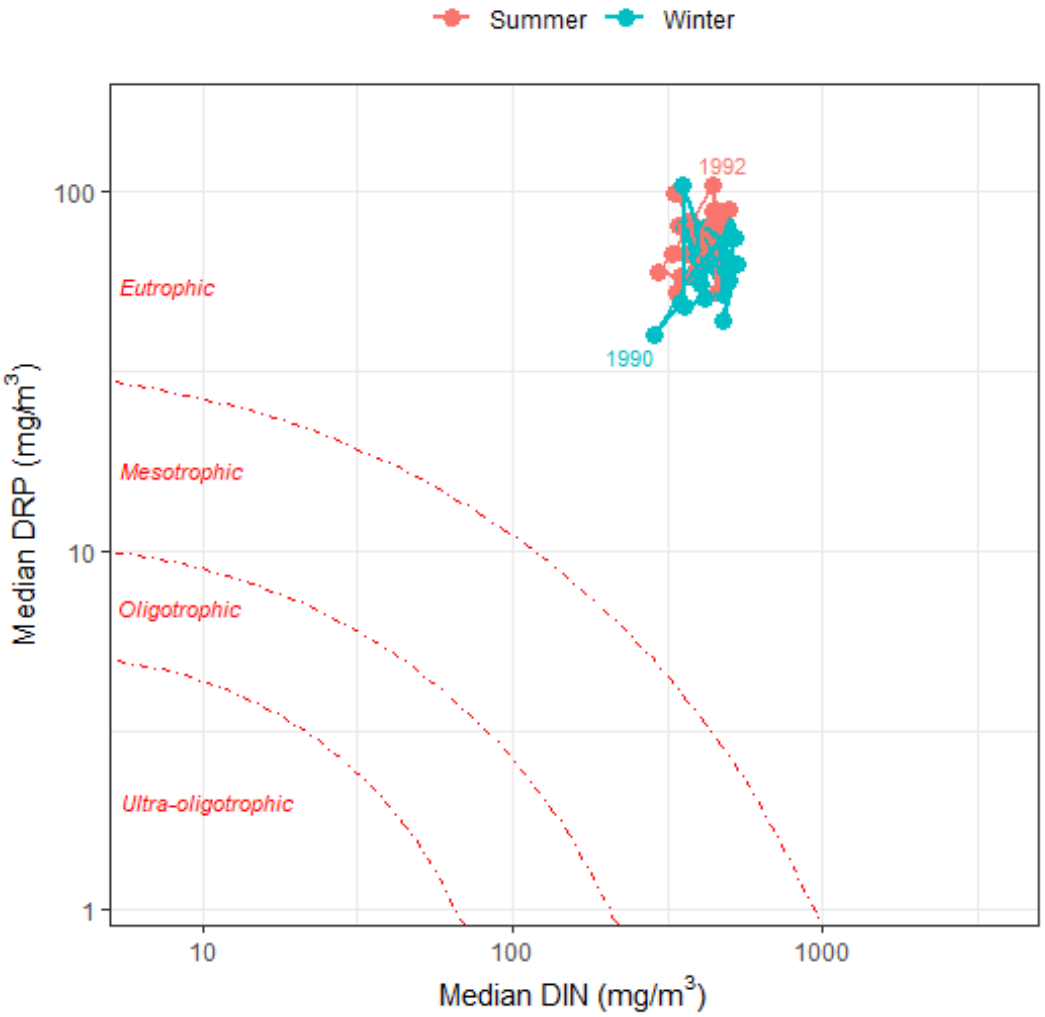


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	17	0.020	0.047	A
5 Years	2015-12-16	2020-12-14	117	0.021	0.047	A
10 Years	2010-12-17	2020-12-14	188	0.022	0.047	A
All	1989-02-15	2020-12-14	480	0.024	0.061	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	17	0.38	0.40	A
5 Years	2015-12-16	2020-12-14	116	0.40	0.44	A
10 Years	2010-12-17	2020-12-14	187	0.40	0.44	A
All	1989-02-15	2020-12-14	457	0.38	0.45	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	113	1.26	D
10 Years	2010-12-17	2020-12-14	177	1.16	D
All	1989-02-16	2020-12-14	443	0.83	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	117	0.068	0.090	D
10 Years	2010-12-17	2020-12-14	188	0.066	0.089	D
All	1989-02-15	2020-12-14	490	0.068	0.104	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	116	1.7	5.2	77	256	A	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	116	77	268	94.8	3.4	1.7
10 Years	2010-12-04	2020-12-01	185	65	351	93.5	3.8	2.7
All	1991-05-01	2020-12-01	285	73	820	86.3	6.3	7.4

Time series plots

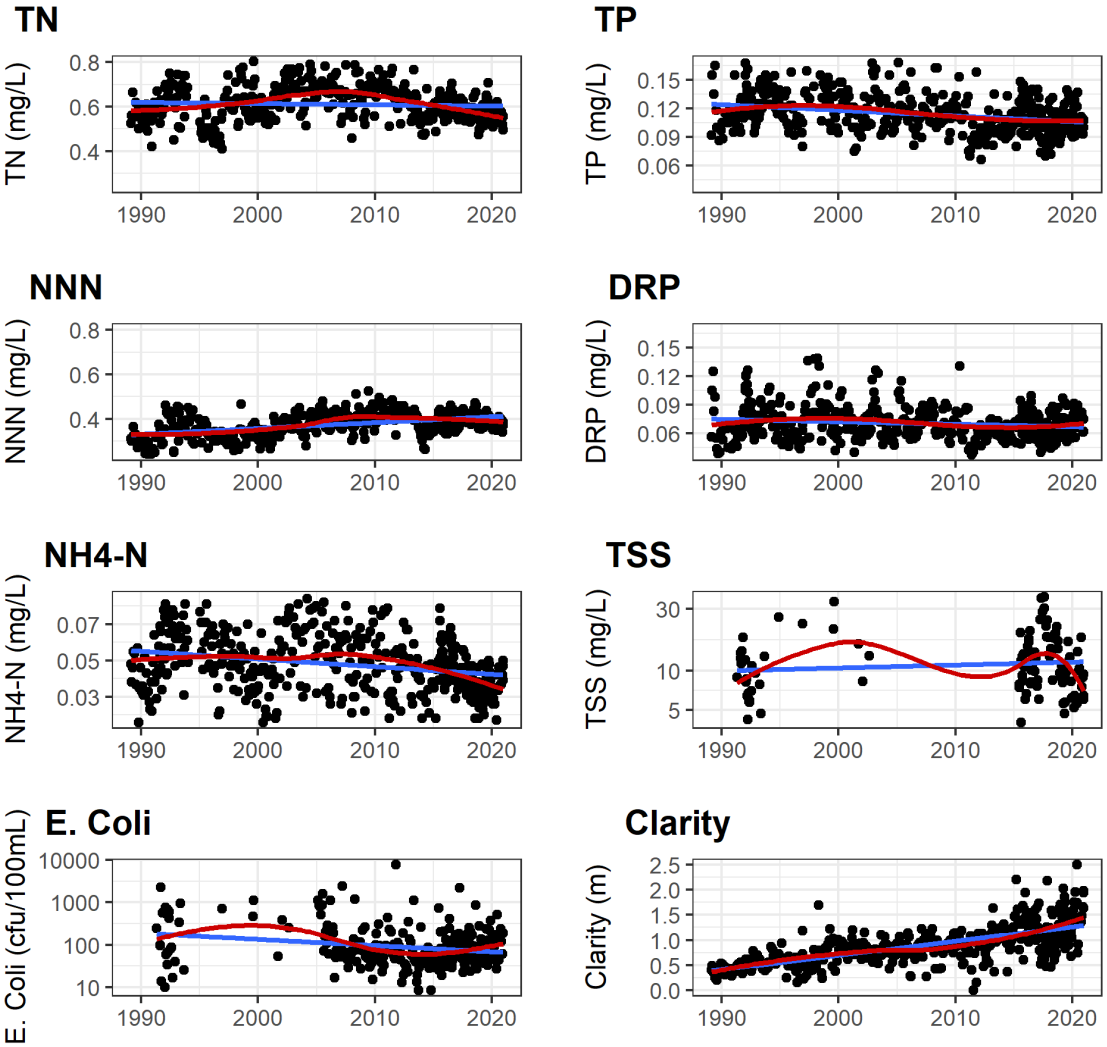


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-14	2020-12-14	-0.0097	-1.70	<0.05	Decreasing	YES	YES	Very Likely Improving
TN	10 Years	2011-01-19	2020-12-14	-0.0097	-1.70	<0.001	Decreasing	YES	YES	Very Likely Improving
TN	All	1989-02-16	2020-12-14	-0.0018	-0.30	<0.01	Decreasing	YES	NO	Very Likely Improving
NNN	5 Years	2016-01-14	2020-12-14	0.0002	0.06	0.94	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	10 Years	2011-01-19	2020-12-14	-0.0015	-0.38	0.40	Indeterminant	YES	YES	Likely Improving
NNN	All	1989-02-16	2020-12-14	0.0018	0.47	<0.001	Increasing	YES	NO	Very Likely Degrading
NH4N	5 Years	2016-01-14	2020-12-14	-0.0045	-10.72	<0.001	Decreasing	YES	NO	Very Likely Improving
NH4N	10 Years	2011-01-19	2020-12-14	-0.0043	-10.07	<0.001	Decreasing	YES	NO	Very Likely Improving
NH4N	All	1989-02-16	2020-12-14	-0.0007	-1.39	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-14	2020-12-14	-0.0034	-2.98	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-19	2020-12-14	-0.0033	-2.92	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	All	1989-02-16	2020-12-14	-0.0003	-0.29	<0.05	Decreasing	YES	YES	Very Likely Improving
DRP	5 Years	2016-01-14	2020-12-14	0.0004	0.49	0.66	Indeterminant	YES	NO	Likely Degrading
DRP	10 Years	2011-01-19	2020-12-14	0.0005	0.61	0.41	Indeterminant	YES	NO	Likely Degrading
DRP	All	1989-02-16	2020-12-14	0.0003	0.40	<0.01	Increasing	YES	YES	Very Likely Degrading
ECOLI	5 Years	2016-01-14	2020-12-14	0.0164	0.87	0.54	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-19	2020-12-14	0.0198	1.05	0.36	Indeterminant	YES	NO	Likely Degrading
ECOLI	All	1989-02-16	2020-12-14	-0.0081	-0.42	0.23	Indeterminant	YES	NO	Likely Improving
TSS	5 Years	2016-01-14	2020-12-14	-0.0358	-3.23	<0.01	Decreasing	YES	NO	Very Likely Improving
TSS	10 Years	2011-01-19	2020-12-14	-0.0295	-2.68	<0.01	Decreasing	YES	NO	Very Likely Improving
TSS	All	1989-02-16	2020-12-14	-0.0040	-0.37	<0.05	Decreasing	YES	YES	Very Likely Improving
CLARITY	5 Years	2016-01-14	2020-12-14	0.0345	2.50	0.08	Increasing	YES	NO	Very Likely Improving
CLARITY	10 Years	2011-01-19	2020-12-14	0.0432	3.13	0.08	Increasing	YES	NO	Very Likely Improving
CLARITY	All	1989-02-16	2020-12-14	0.0323	4.32	<0.001	Increasing	YES	NO	Very Likely Improving

Rangitāiki WMA

The Rangitāiki River is the longest river in the Bay of Plenty (155 km long) and the Rangitāiki WMA is the largest WMA in the Bay of Plenty. The river flows north from the Kaimanawa Ranges and discharges to the coast near Thornton at the Rangitāiki River Estuary. The river originally discharged via two outlets: the Old Rangitāiki Channel to the Tarawera River in the west, and the Orini Canal in the east. The Thornton cut was put through in 1913 as part of drainage works on the Rangitāiki Plains. A number of large tributaries such as the Wheao, Whirinaki and Horomanga Rivers join the Rangitāiki in the upper half of its catchment.

There are three hydro-electric power schemes on the Rangitāiki River: the Wheao and Flaxy Scheme, the Anawhenua Dam and the Matahina Dam. These influence the hydrology of the river and the hydro-lakes themselves are sensitive to nutrient enrichment and eutrophication.

The headwaters of the Rangitāiki catchment are predominantly pasture and exotic forest. The Whirinaki River that enters south of Murapara is in predominantly native forest. Much of the Galatea floodplains is in dairy farming and the Rangitāiki plains are in agricultural landuse, however, even at Te Teko, pastoral landuse remains a relatively small proportion of the catchment (16%) compared to the upper catchment sites of Rangitāiki at SH 5 and Otamatea River which have 61% and 67% pastoral landuse respectively.

Table 7 NERMN sites in the Rangataiki WMA.

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Rangitāiki								
FC231176	Rangitaiki at SH 5	1892311	5691766	VA/Gentle	AE	104	181.8	M *
FD445529	Otamatea at Wairere Road	1894459	5705298	VA/Gentle	AE	120	155.9	M *
IG265664	Rangitaiki at Murupara (NIWA)	1922660	5736647	VA/Gentle	AE	1149	94.1	NIWA M
IG691428	Whirinaki at Galatea (NIWA)	1926915	5734286	VA/Steep	AE	507	98.3	NIWA M
JI148319	Rangitaiki at Inlet to Aniwhenua	1931488	5753195	VA/Gentle	AE	2423	64.9	M
JK491452	Rangitaiki at Matahina Dam	1934919	5774526	VA/Steep	AE	2817	37.4	M
JL350292	Rangitaiki at Te Teko (NIWA)	1933508	5782922	VA/Gentle	AE	2883	26.0	NIWA M

Rangitaiki at SH 5

March 2021

Table 1 Site metadata.

Aquarius ID:	FC231176	**Labstar ID:**	BOP110104
LAWA ID:		**REC Reach:**	4028177
Easting:	1892311	**Northing:**	5691766
Longitude:	176.36937	**Latitude:**	-38.87438
Elevation:	706 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	110	0.74	3.00	1.41	1.37	1.96	0.90	0.36	0.03
Nitrate Nitrite Nitrogen (g/m3)	110	0.61	2.36	1.30	1.29	1.82	0.77	0.34	0.03
Total Ammoniacal Nitrogen (g/m3)	110	<0.002	0.036	0.016	0.015	0.030	0.005	0.007	0.001
Total Phosphorus (g/m3)	110	0.011	0.189	0.035	0.033	0.049	0.018	0.020	0.002
Dissolved Reactive Phosphorus (g/m3)	110	0.003	0.038	0.015	0.015	0.028	0.006	0.006	0.001
Dissolved Oxygen Sat (%)	83	86.5	104.9	94.5	94.6	101.6	88.5	3.7	0.4
Dissolved Oxygen (g/m3)	102	7.50	11.60	9.64	9.60	10.41	8.93	0.58	0.06
Escherichia coli (cfu/100ml)	108	<1	1100	81	24	286	4	180	17
Total Suspended Solids (g/m3)	109	<1	66.00	12.99	8.50	36.00	3.04	11.76	1.13
Turbidity (NTU)	109	1.2	16.0	3.4	3.0	6.7	1.4	2.1	0.2
Water Clarity (m)	76	0.45	3.50	1.61	1.50	3.00	0.75	0.67	0.08
Conductivity (uS/cm)	105	48	650	87	80	103	69	57	6
pH (pH Units)	109	6.3	7.6	6.9	6.9	7.2	6.6	0.2	0.0
Water Temperature (degC)	106	7.4	15.8	11.2	11.1	13.8	8.5	1.7	0.2
Discharge (m3/s)	93	1.40	7.40	3.20	2.90	6.30	1.60	1.40	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

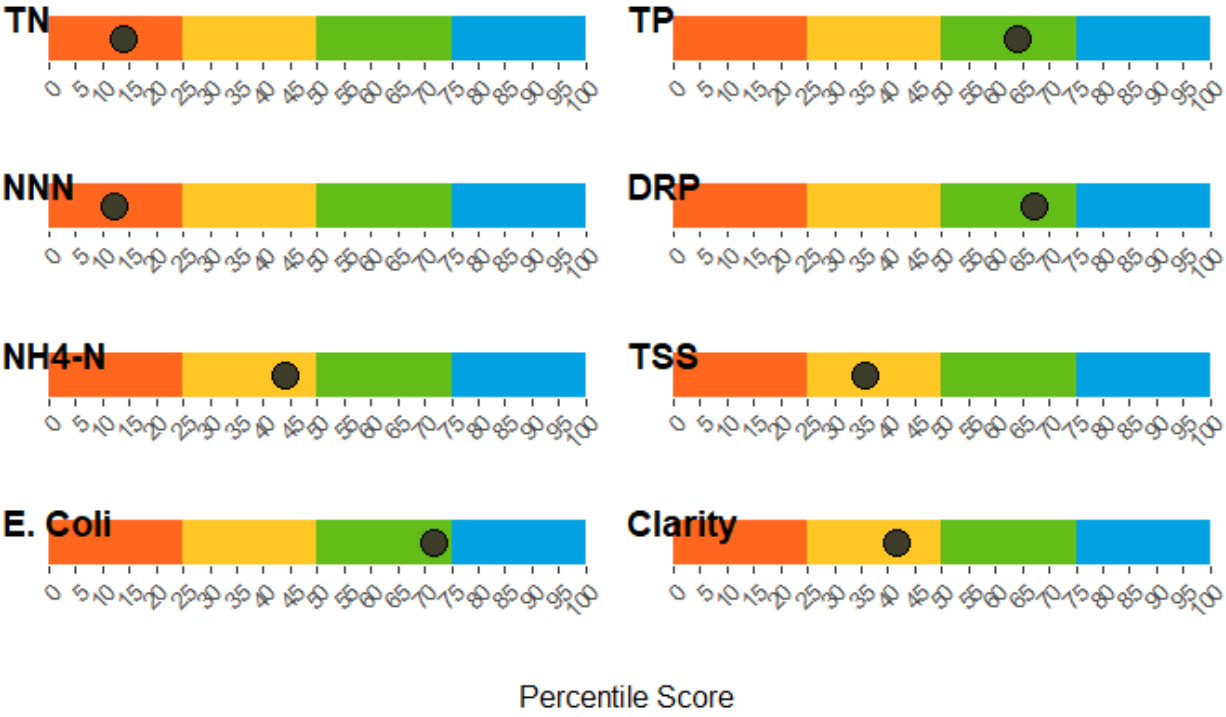


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

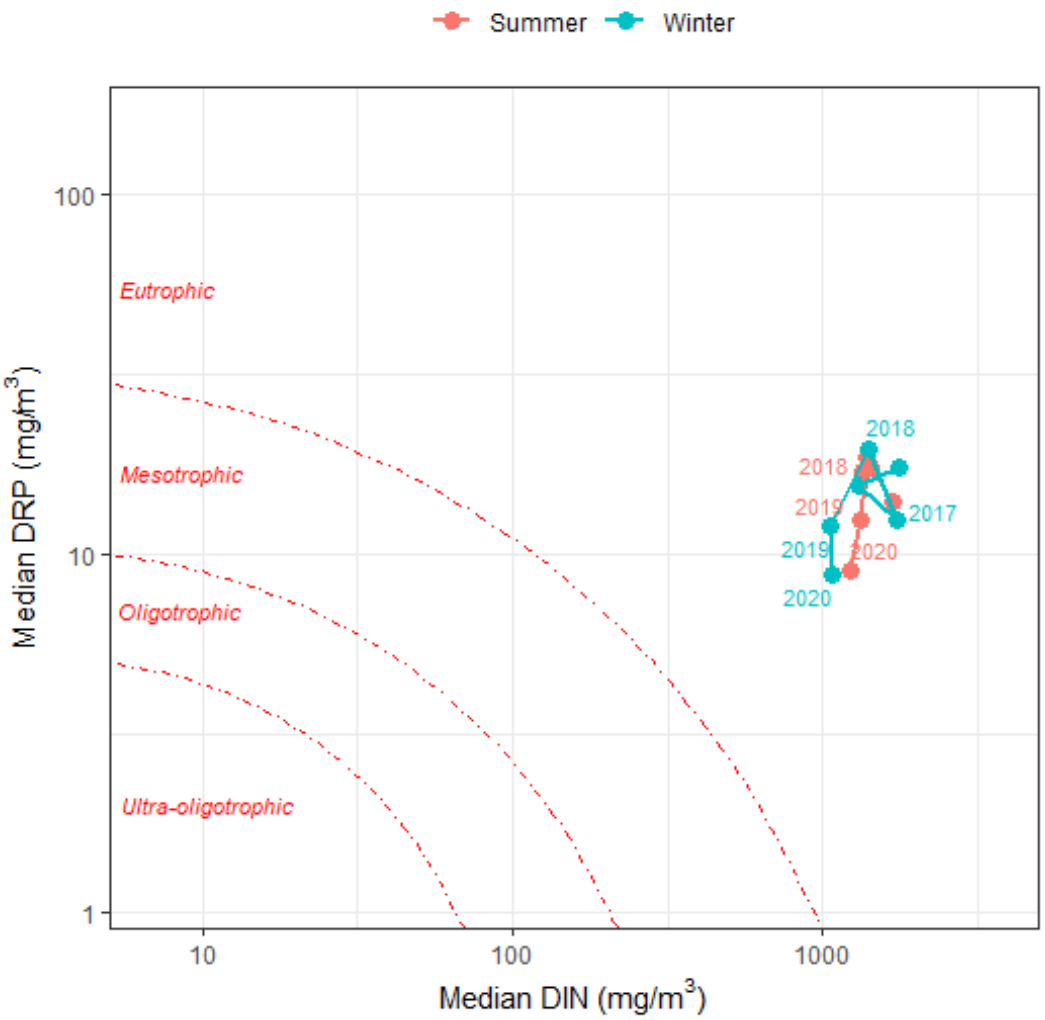


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-02	2020-12-01	15	0.0060	0.013	A
5 Years	2015-12-03	2020-12-01	63	0.0060	0.014	A
10 Years	2010-12-04	2020-12-01	86	0.0060	0.016	A
All	1999-07-08	2020-12-01	109	0.0061	0.015	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-02	2020-12-01	15	1.2	1.4	B
5 Years	2015-12-03	2020-12-01	63	1.4	1.8	B
10 Years	2010-12-04	2020-12-01	86	1.3	1.8	B
All	1999-07-08	2020-12-01	110	1.3	1.8	B

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-03	2020-12-01	55	1.45	C*
10 Years	2010-12-04	2020-12-01	72	1.50	C
All	2010-04-22	2020-12-01	74	1.50	C

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-03	2020-12-01	63	0.013	0.022	C
10 Years	2010-12-04	2020-12-01	86	0.014	0.022	C
All	1999-07-07	2020-12-01	109	0.015	0.028	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	61	4.9	6.6	29	340	A	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	61	29	439	93.4	1.6	4.9
10 Years	2010-12-04	2020-12-01	84	28	312	94	2.4	3.6
All	1999-07-08	2020-12-01	108	24	304	94.4	1.9	3.7

Time series plots

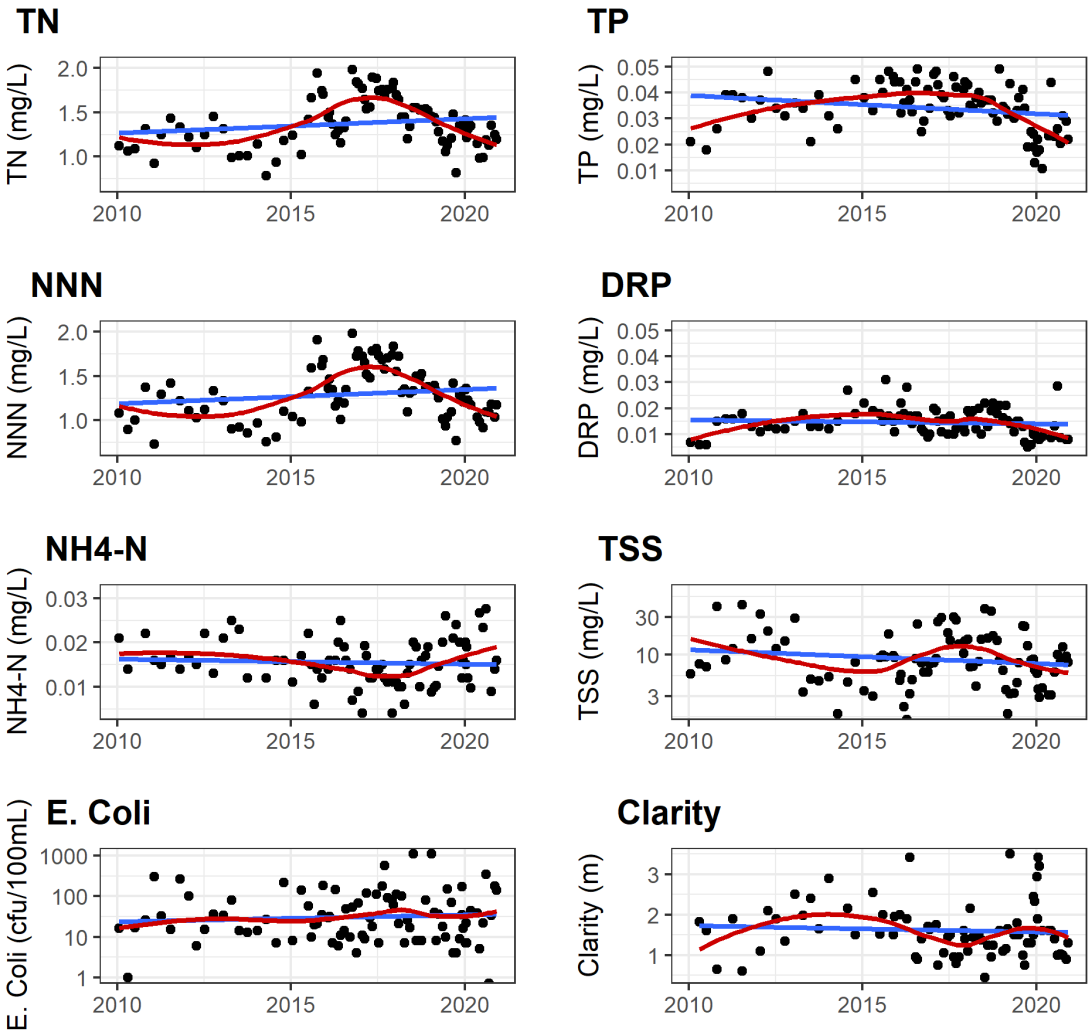


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-26	2020-12-01	-0.0735	-5.09	<0.001	Decreasing	YES	NO	Very Likely Improving
TN	10 Years	2011-01-27	2020-12-01	-0.0132	-0.95	0.19	Indeterminant	YES	NO	Likely Improving
TN	All	2010-04-22	2020-12-01	-0.0087	-0.63	0.42	Indeterminant	YES	NO	Likely Improving
NNN	5 Years	2016-01-26	2020-12-01	-0.0788	-5.81	<0.001	Decreasing	YES	NO	Very Likely Improving
NNN	10 Years	2011-01-27	2020-12-01	-0.0152	-1.14	0.21	Indeterminant	YES	NO	Likely Improving
NNN	All	2010-04-22	2020-12-01	-0.0077	-0.58	0.46	Indeterminant	YES	NO	Likely Improving
NH4N	5 Years	2016-01-26	2020-12-01	0.0015	9.95	<0.05	Increasing	NO	NO	Very Likely Degrading
NH4N	10 Years	2011-01-27	2020-12-01	0.0002	1.33	0.58	Indeterminant	NO	YES	Likely Degrading
NH4N	All	2010-04-22	2020-12-01	0.0000	0.00	0.97	Indeterminant	NO	YES	Indeterminate/Uncertain
TP	5 Years	2016-01-26	2020-12-01	-0.0026	-7.70	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-27	2020-12-01	-0.0015	-4.12	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	All	2010-04-22	2020-12-01	-0.0014	-3.82	<0.01	Decreasing	NO	NO	Very Likely Improving
DRP	5 Years	2016-01-26	2020-12-01	-0.0018	-13.02	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-27	2020-12-01	-0.0007	-4.49	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	2010-04-22	2020-12-01	-0.0005	-3.92	<0.05	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-26	2020-12-01	0.0118	0.79	0.84	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-27	2020-12-01	0.0009	0.06	0.97	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2010-04-22	2020-12-01	0.0147	1.00	0.63	Indeterminant	YES	NO	Likely Degrading
TSS	5 Years	2016-01-26	2020-12-01	-0.0004	-0.04	1.00	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	10 Years	2011-01-27	2020-12-01	-0.0144	-1.47	0.08	Decreasing	YES	YES	Very Likely Improving
TSS	All	2010-04-22	2020-12-01	-0.0143	-1.47	0.20	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years									Not Analysed
CLARITY	10 Years	2011-01-27	2020-12-01	-0.1030	-6.86	<0.001	Decreasing	YES	YES	Very Likely Degrading
CLARITY	All	2010-04-22	2020-12-01	-0.0846	-5.64	<0.001	Decreasing	YES	YES	Very Likely Degrading

Otamatea at Wairere Road

March 2021

Table 1 Site metadata.

Aquarius ID:	FD445529	**Labstar ID:**	BOP110000
LAWA ID:	LAWA-100658	**REC Reach:**	4027190
Easting:	1894459	**Northing:**	5705298
Longitude:	176.38831	**Latitude:**	-38.75193
Elevation:	628 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Hill_VA		

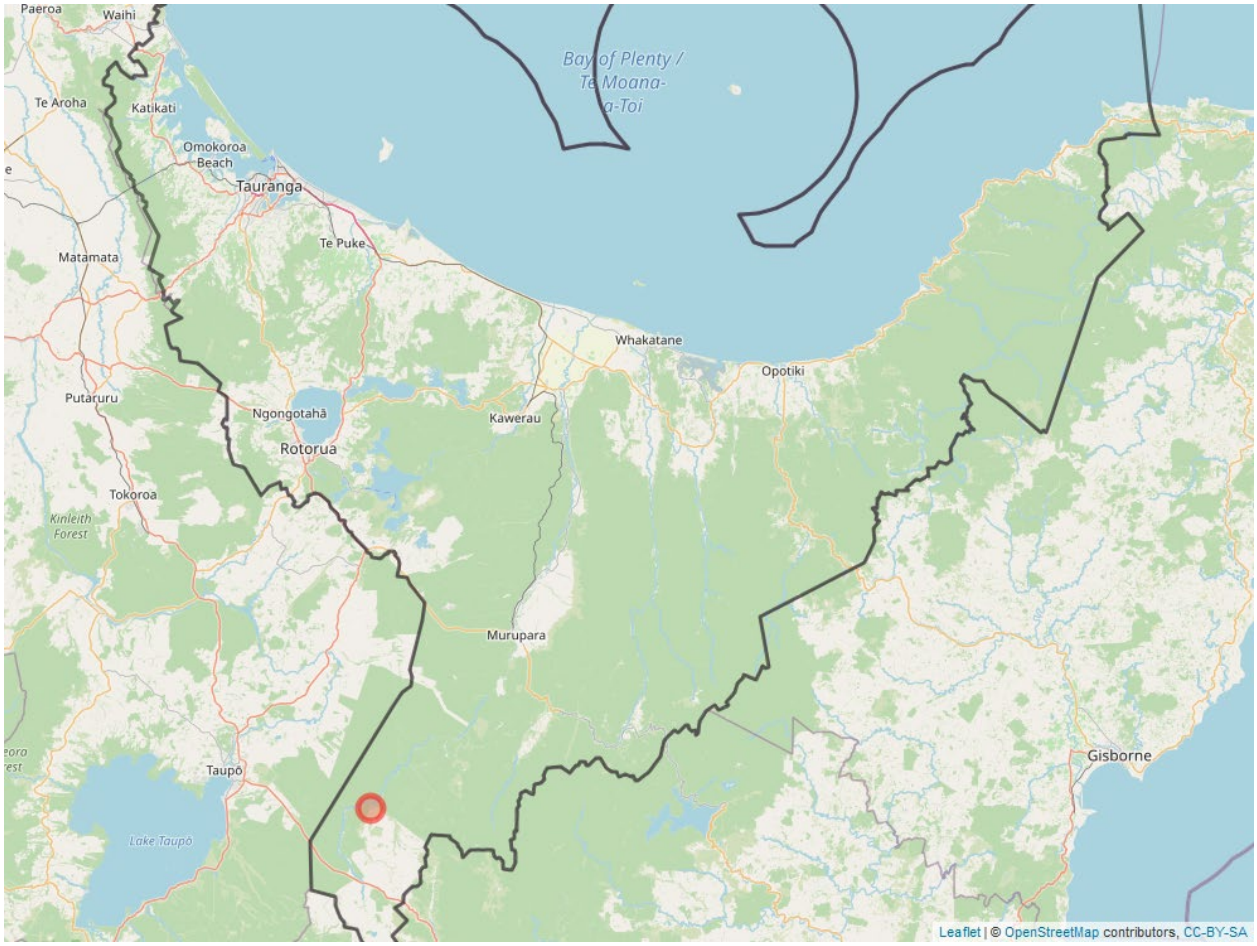


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	92	1.72	3.12	2.41	2.41	2.67	2.16	0.18	0.02
Nitrate Nitrite Nitrogen (g/m3)	90	1.49	2.69	2.33	2.32	2.65	2.11	0.18	0.02
Total Ammoniacal Nitrogen (g/m3)	91	<0.002	0.052	0.007	0.005	0.013	0.002	0.008	0.001
Total Phosphorus (g/m3)	92	0.004	0.094	0.038	0.036	0.064	0.016	0.015	0.002
Dissolved Reactive Phosphorus (g/m3)	92	<0.001	0.052	0.023	0.024	0.036	0.010	0.009	0.001
Dissolved Oxygen Sat (%)	81	92.5	112.3	104.6	104.6	110.3	98.7	3.6	0.4
Dissolved Oxygen (g/m3)	86	8.94	11.59	10.57	10.59	11.37	9.79	0.50	0.05
Escherichia coli (cfu/100ml)	88	<1	940	46	7	169	1	147	16
Total Suspended Solids (g/m3)	91	<1	24.00	6.00	4.67	15.90	1.72	4.60	0.48
Turbidity (NTU)	92	0.4	7.3	1.6	1.3	3.1	0.6	1.1	0.1
Water Clarity (m)	75	0.60	5.21	2.24	2.00	4.24	1.02	0.96	0.11
Conductivity (uS/cm)	87	64	126	110	111	118	88	9	1
pH (pH Units)	92	6.6	7.8	7.4	7.4	7.8	7.0	0.3	0.0
Water Temperature (degC)	88	7.7	15.0	11.7	11.6	14.5	9.0	1.7	0.2
Discharge (m3/s)	81	1.30	6.30	2.60	2.30	5.00	1.40	1.10	0.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

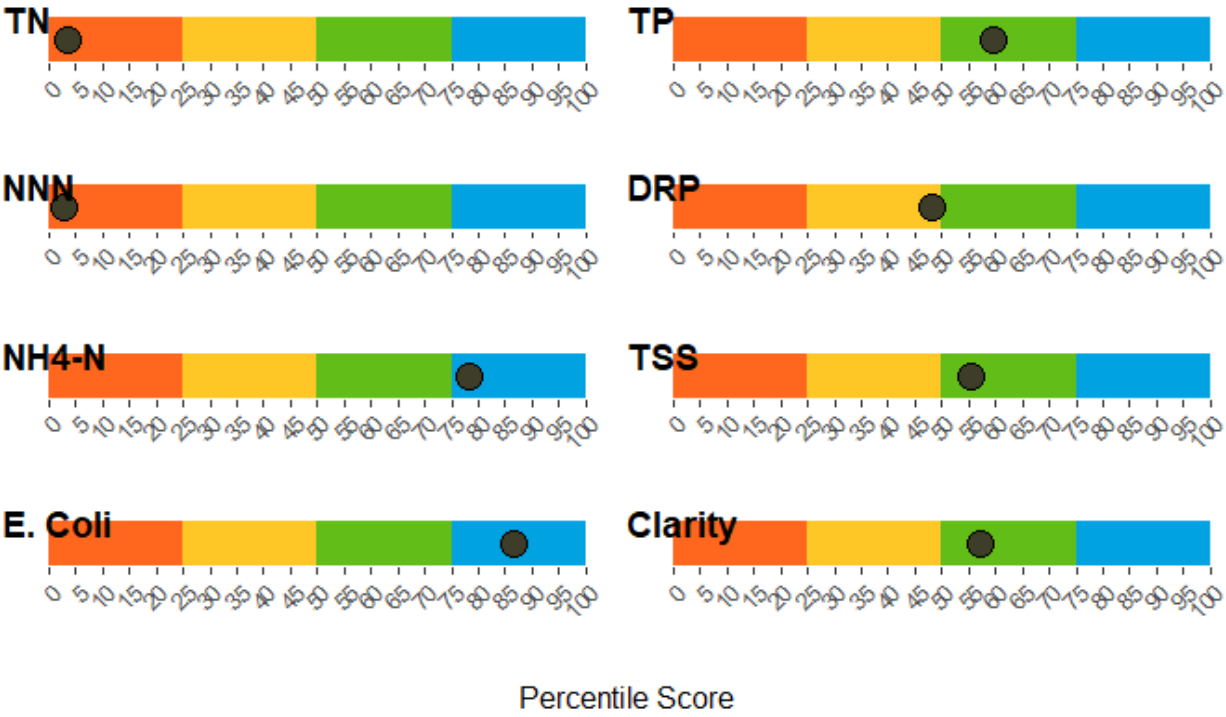


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

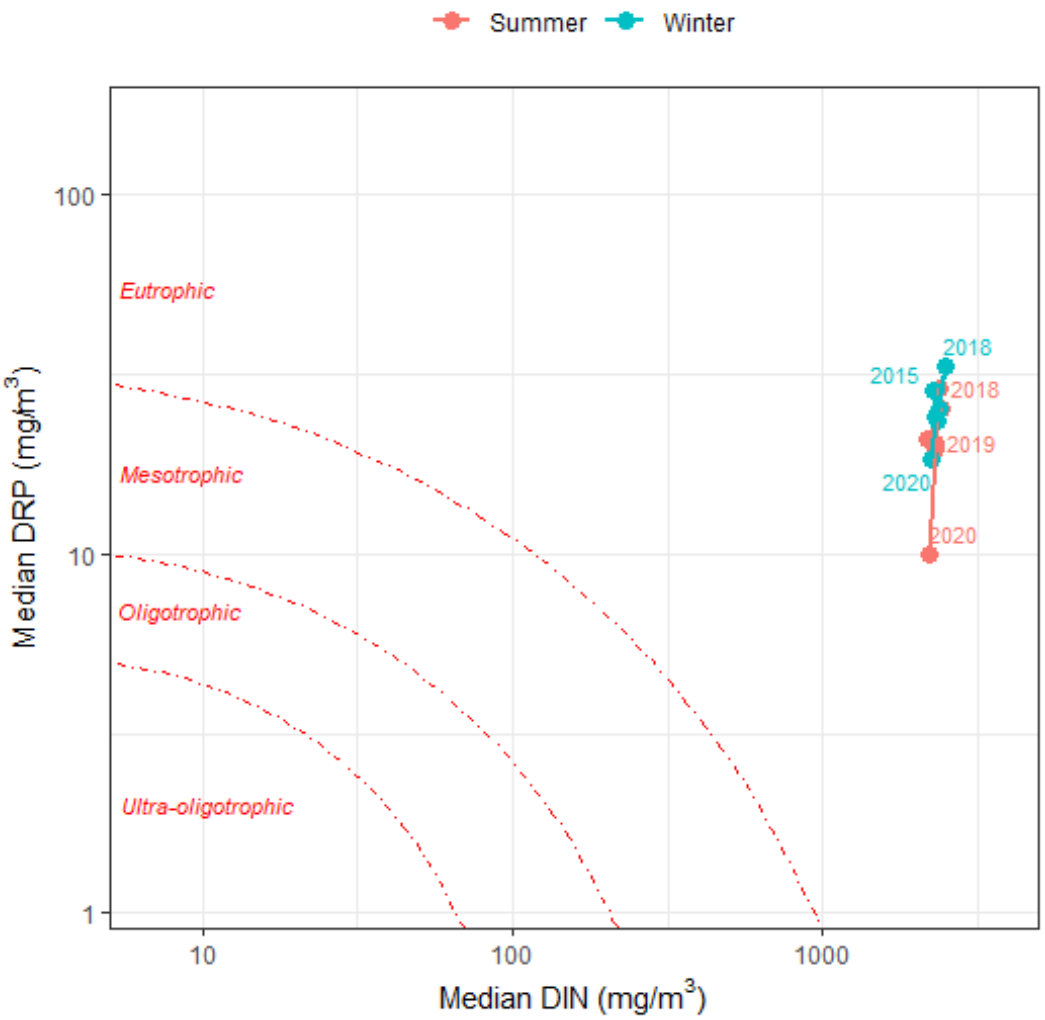


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-02	2020-12-01	16	0.0050	0.035	A
5 Years	2015-12-03	2020-12-01	63	0.0030	0.035	A
10 Years	2010-12-04	2020-12-01	86	0.0030	0.035	A
All	2010-01-21	2020-12-01	91	0.0029	0.035	A

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-02	2020-12-01	16	2.2	2.4	B
5 Years	2015-12-03	2020-12-01	62	2.3	2.5	B
10 Years	2010-12-04	2020-12-01	85	2.3	2.6	B
All	2010-01-21	2020-12-01	90	2.3	2.6	B

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-03	2020-12-01	56	1.94	A*
10 Years	2010-12-04	2020-12-01	72	2.00	A
All	2010-07-07	2020-12-01	73	2.00	A

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-03	2020-12-01	64	0.023	0.036	D
10 Years	2010-12-04	2020-12-01	87	0.024	0.037	D
All	2010-01-20	2020-12-01	91	0.024	0.036	D

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-03	2020-12-01	62	1.6	3.2	8	176	A	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-03	2020-12-01	62	8	200	96.8	1.6	1.6
10 Years	2010-12-04	2020-12-01	83	7	160	97.6	1.2	1.2
All	2010-01-21	2020-12-01	88	7	185	96.6	1.1	2.3

Time series plots

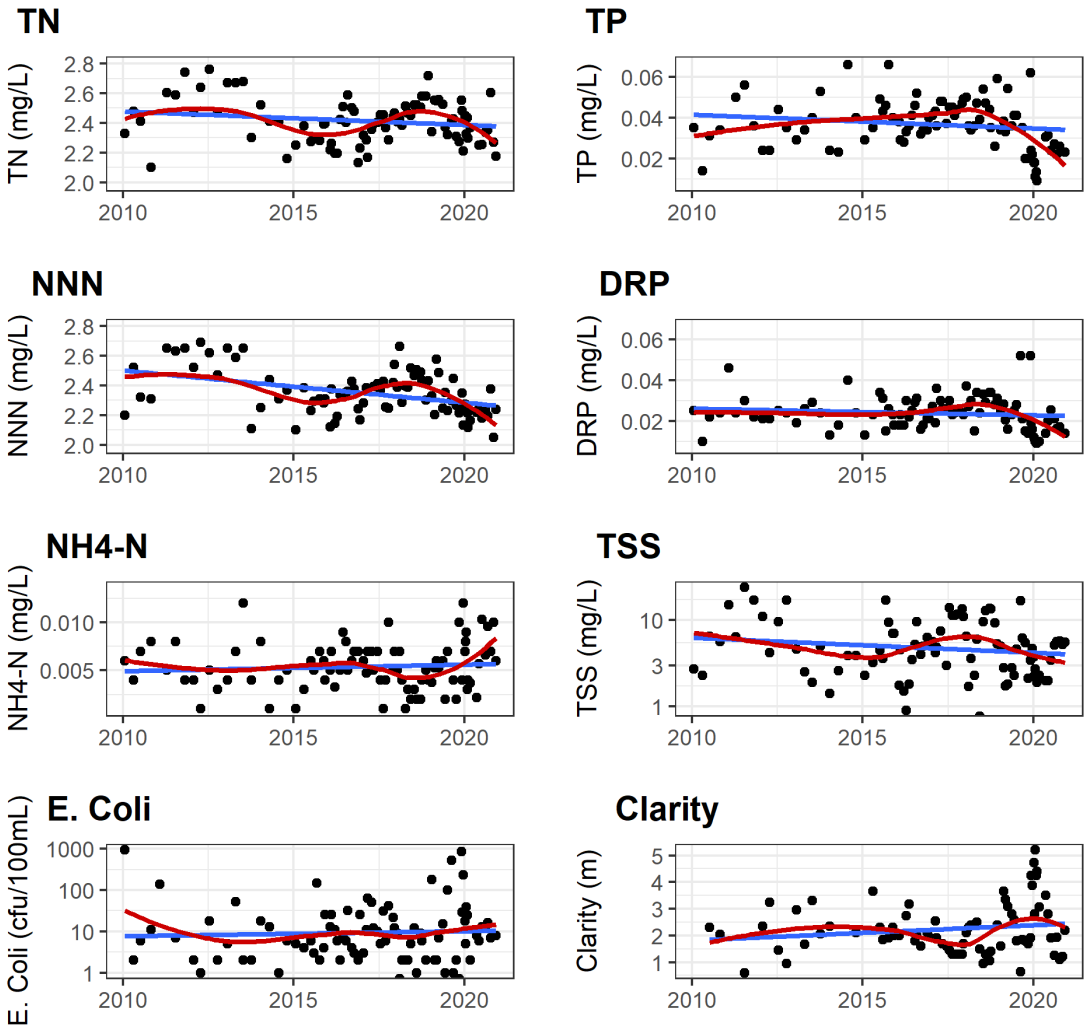


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-04	2020-12-01	0.0154	0.64	0.28	Indeterminant	NO	NO	Likely Degrading
TN	10 Years	2011-01-27	2020-12-01	-0.0032	-0.13	0.73	Indeterminant	NO	NO	Indeterminate/Uncertain
TN	All	2010-01-21	2020-12-01	-0.0001	-0.01	0.97	Indeterminant	NO	NO	Indeterminate/Uncertain
NNN	5 Years	2015-12-04	2020-12-01	-0.0139	-0.60	0.14	Indeterminant	YES	NO	Likely Improving
NNN	10 Years	2011-01-27	2020-12-01	-0.0223	-0.96	<0.01	Decreasing	YES	NO	Very Likely Improving
NNN	All	2010-01-21	2020-12-01	-0.0200	-0.86	<0.01	Decreasing	YES	NO	Very Likely Improving
NH4N	5 Years	2015-12-04	2020-12-01	-0.0002	-4.40	0.51	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-01-27	2020-12-01	0.0000	0.00	0.67	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	All	2010-01-21	2020-12-01	0.0000	0.00	0.99	Indeterminant	NO	NO	Indeterminate/Uncertain
TP	5 Years	2015-12-04	2020-12-01	-0.0019	-5.16	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-27	2020-12-01	-0.0011	-3.02	0.16	Indeterminant	YES	YES	Likely Improving
TP	All	2010-01-21	2020-12-01	-0.0002	-0.43	0.77	Indeterminant	YES	YES	Indeterminate/Uncertain
DRP	5 Years	2015-12-04	2020-12-01	-0.0006	-2.40	0.41	Indeterminant	YES	NO	Likely Improving
DRP	10 Years	2011-01-27	2020-12-01	-0.0003	-1.26	0.36	Indeterminant	YES	NO	Likely Improving
DRP	All	2010-01-21	2020-12-01	-0.0002	-0.72	0.59	Indeterminant	YES	NO	Likely Improving
ECOLI	5 Years	2015-12-04	2020-12-01	-0.0171	-1.80	0.52	Indeterminant	NO	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-27	2020-12-01	-0.0037	-0.44	0.90	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2010-01-21	2020-12-01	0.0014	0.17	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	5 Years	2015-12-04	2020-12-01	0.0014	0.18	0.88	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	10 Years	2011-01-27	2020-12-01	-0.0197	-2.61	<0.05	Decreasing	YES	YES	Very Likely Improving
TSS	All	2010-01-21	2020-12-01	-0.0162	-2.13	0.11	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years									Not Analysed
CLARITY	10 Years	2011-01-27	2020-12-01	0.0000	0.00	1.00	Indeterminant	Attempted	YES	Indeterminate/Uncertain
CLARITY	All	2010-01-21	2020-12-01	-0.0232	-1.16	0.69	Indeterminant	Attempted	YES	Indeterminate/Uncertain

Rangitaiki at Murupara

March 2021

Table 1 Site metadata.

Aquarius ID:	IG265664	**Labstar ID:**	BOP110015
LAWA ID:	EBOP-00048	**REC Reach:**	4022596
Easting:	1922660	**Northing:**	5736647
Longitude:	176.69769	**Latitude:**	-38.46015
Elevation:	183 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_VA		

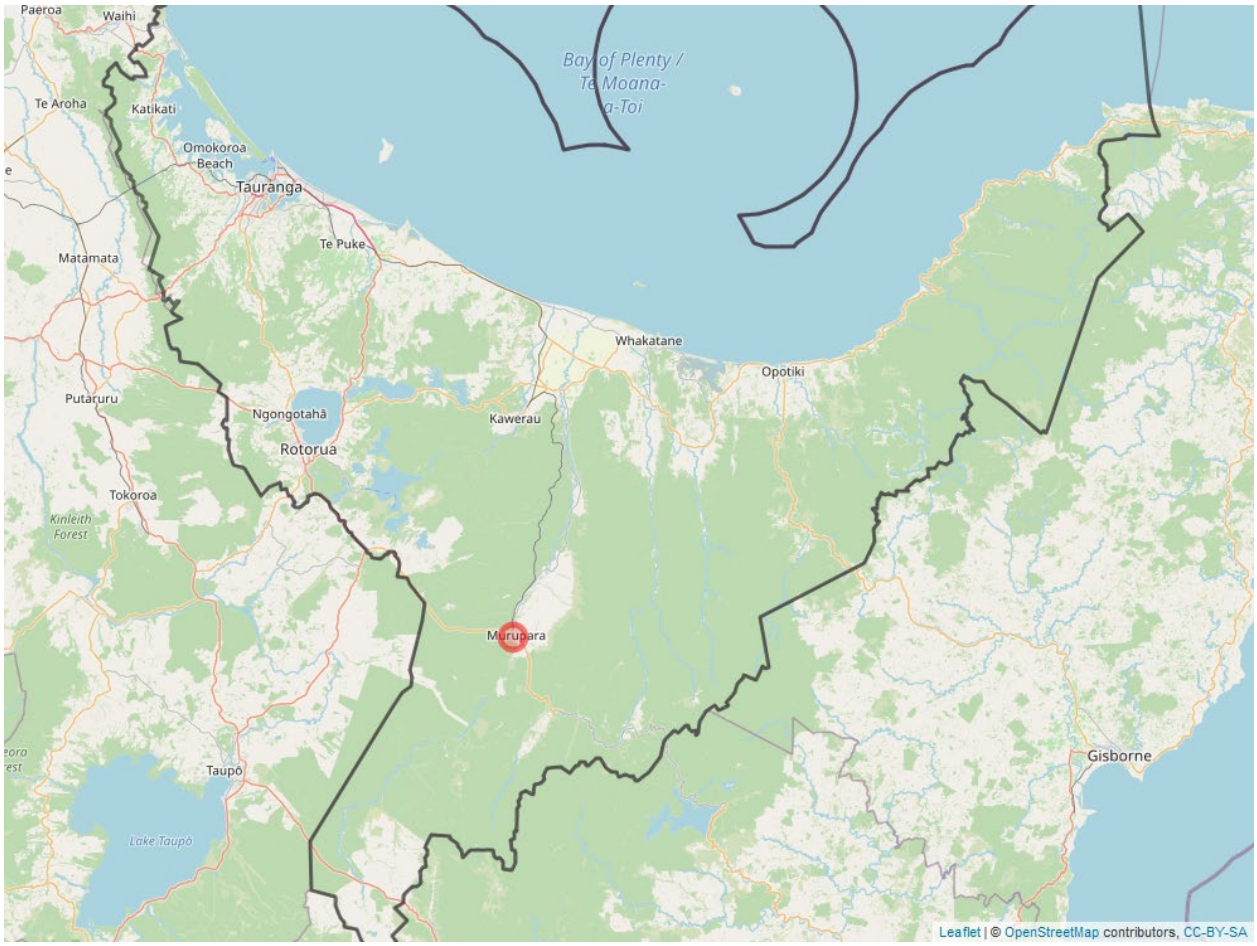


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	376	0.42	1.42	0.82	0.77	1.26	0.50	0.24	0.01
Nitrate Nitrite Nitrogen (g/m3)	378	0.30	1.32	0.73	0.69	1.15	0.41	0.23	0.01
Total Ammoniacal Nitrogen (g/m3)	387	<0.002	0.048	0.007	0.006	0.012	0.003	0.004	0.000
Total Phosphorus (g/m3)	398	0.021	0.092	0.032	0.030	0.043	0.025	0.008	0.000
Dissolved Reactive Phosphorus (g/m3)	397	0.012	0.056	0.021	0.021	0.027	0.016	0.005	0.000
Dissolved Oxygen Sat (%)	385	67.0	128.7	104.4	104.0	111.1	99.8	4.2	0.2
Dissolved Oxygen (g/m3)	388	6.00	13.30	10.73	10.70	11.80	9.84	0.66	0.03
Escherichia coli (cfu/100ml)	199	<1	1300	55	23	172	7	134	10
Total Suspended Solids (g/m3)	16	2.10	220.00	20.26	5.20	69.78	2.92	53.47	13.37
Turbidity (NTU)	380	0.4	15.0	1.7	1.3	4.0	0.6	1.4	0.1
Water Clarity (m)	381	0.23	6.33	2.02	1.94	3.55	0.71	0.91	0.05
Conductivity (uS/cm)	115	61	89	81	82	88	73	5	0
pH (pH Units)	397	6.3	8.6	7.8	7.7	8.1	7.5	0.2	0.0
Water Temperature (degC)	398	7.4	20.9	13.1	13.2	17.3	9.2	2.6	0.1
Discharge (m3/s)	231	9.50	51.40	21.50	20.80	33.50	10.90	7.30	0.50

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

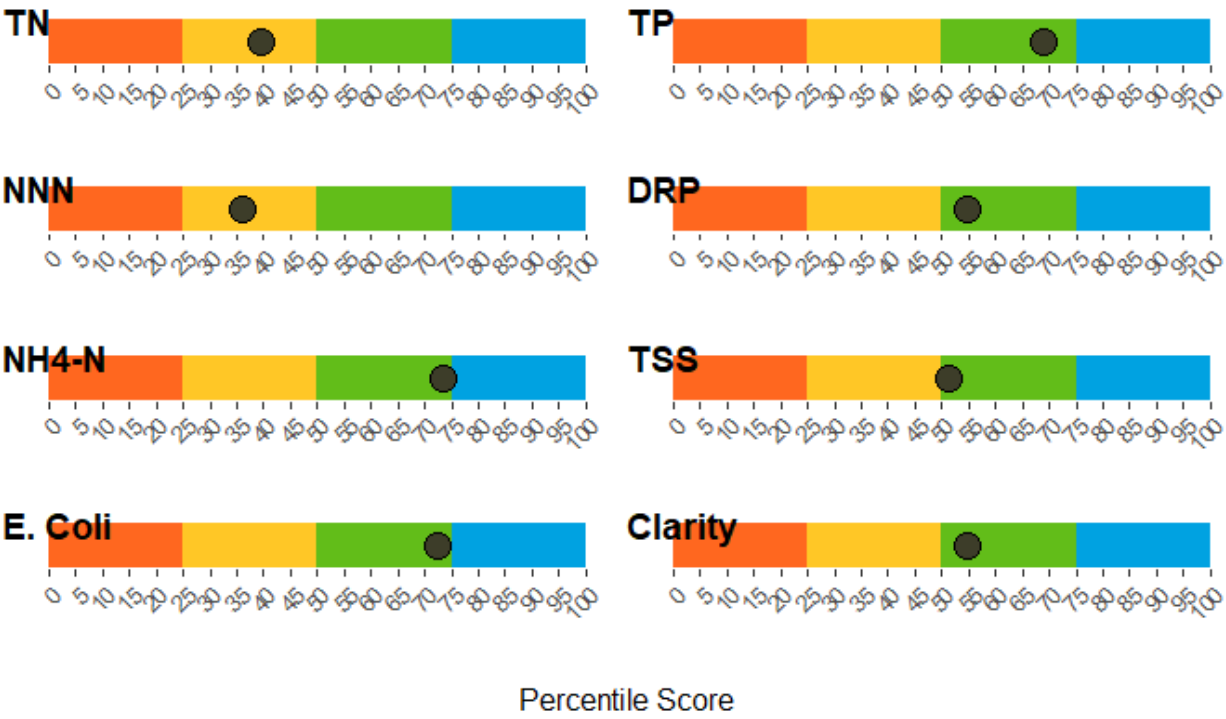


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

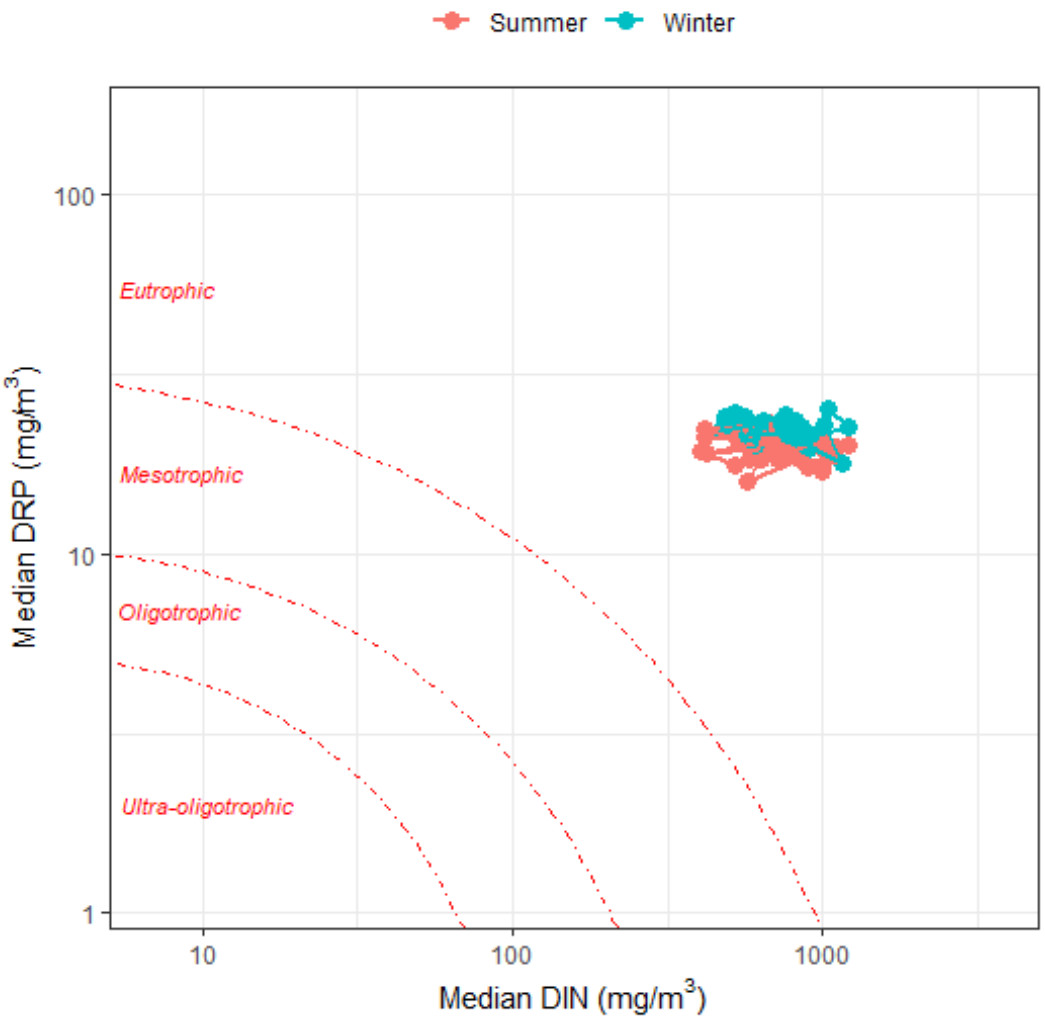


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-06-18	2020-06-17	9	0.0050	0.011	A
5 Years	2015-06-19	2020-06-17	57	0.0040	0.018	A
10 Years	2010-06-20	2020-06-17	116	0.0050	0.024	A
All	1989-02-16	2020-06-17	386	0.0046	0.024	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-06-18	2020-06-17	10	0.97	1.1	A
5 Years	2015-06-19	2020-06-17	58	0.96	1.3	A
10 Years	2010-06-20	2020-06-17	118	0.98	1.3	A
All	1989-02-16	2020-06-17	378	0.69	1.1	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-06-18	2020-06-17	58	1.49	C*
10 Years	2010-06-20	2020-06-17	117	1.86	A
All	1989-02-16	2020-06-17	379	1.94	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-06-18	2020-06-16	57	0.019	0.026	D
10 Years	2010-06-19	2020-06-16	117	0.020	0.026	D
All	1989-02-15	2020-06-16	396	0.021	0.027	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-06-19	2020-06-17	58	1.7	5.2	26	168	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-06-19	2020-06-17	58	26	233	94.8	3.4	1.7
10 Years	2010-06-20	2020-06-17	118	25	233	94.9	3.4	1.7
All	1991-01-29	2020-06-17	199	23	182	95.5	2.5	2

Time series plots

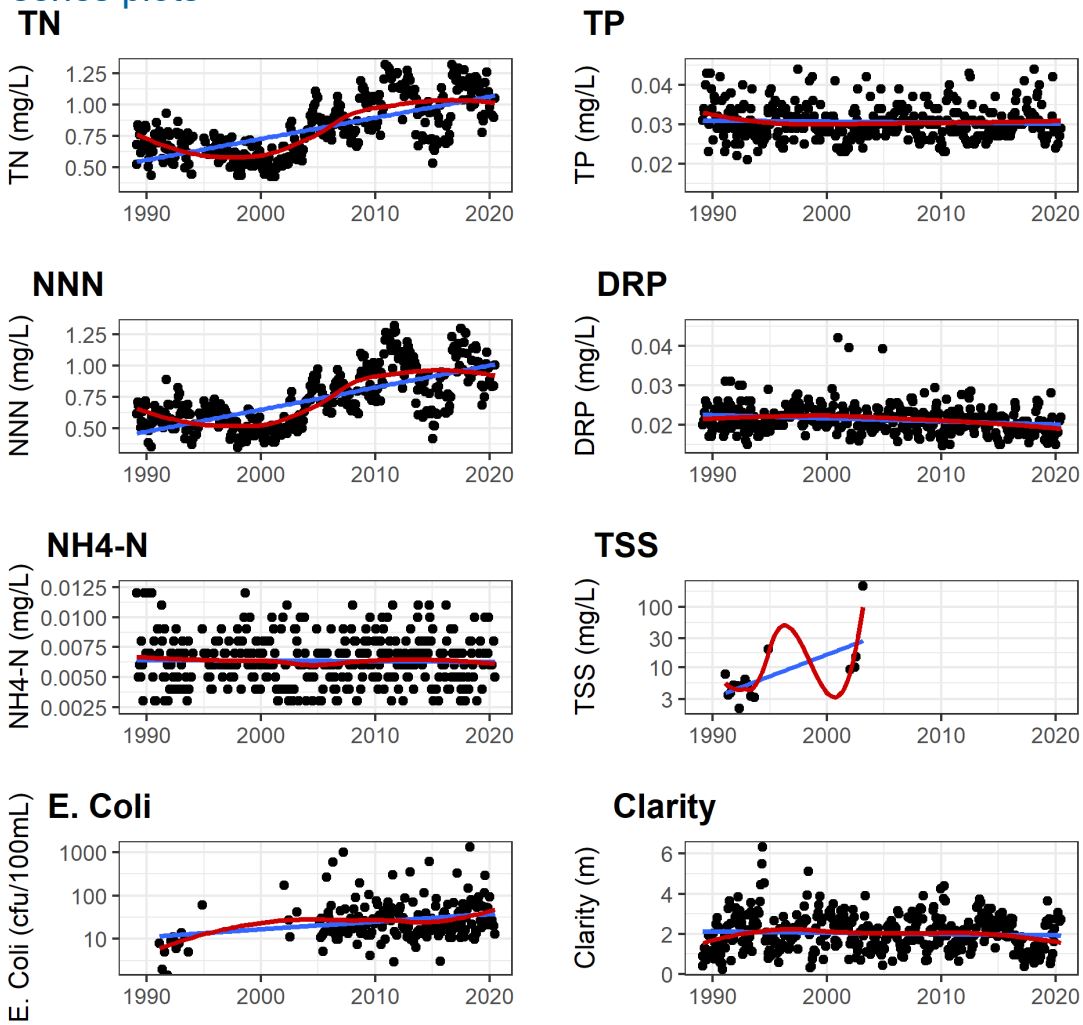


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-07-14	2020-06-17	0.0081	0.76	0.66	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2010-07-15	2020-06-17	-0.0129	-1.21	0.15	Indeterminant	YES	NO	Likely Improving
TN	All	1989-02-16	2020-06-17	0.0129	1.80	<0.001	Increasing	YES	NO	Very Likely Degrading
NNN	5 Years	2015-07-14	2020-06-17	0.0093	0.97	0.61	Indeterminant	YES	NO	Likely Degrading
NNN	10 Years	2010-07-15	2020-06-17	-0.0118	-1.23	0.15	Indeterminant	YES	NO	Likely Improving
NNN	All	1989-02-16	2020-06-17	0.0129	2.08	<0.001	Increasing	YES	NO	Very Likely Degrading
NH4N	5 Years	2015-07-14	2020-06-17	-0.0001	-2.67	0.71	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	10 Years	2010-07-15	2020-06-17	0.0000	-0.82	0.71	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	All	1989-02-16	2020-06-17	-0.0001	-0.90	<0.001	Decreasing	YES	YES	Very Likely Improving
TP	5 Years	2015-07-14	2020-06-17	-0.0003	-0.89	0.71	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	10 Years	2010-07-15	2020-06-17	0.0000	-0.06	0.87	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	1989-02-16	2020-06-17	0.0000	-0.02	0.95	Indeterminant	YES	YES	Indeterminate/Uncertain
DRP	5 Years	2015-07-14	2020-06-17	0.0001	0.67	0.68	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	10 Years	2010-07-15	2020-06-17	0.0000	-0.24	0.60	Indeterminant	YES	YES	Likely Improving
DRP	All	1989-02-16	2020-06-17	-0.0001	-0.29	<0.01	Decreasing	YES	YES	Very Likely Improving
ECOLI	5 Years	2015-07-14	2020-06-17	0.0297	1.98	0.63	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-07-15	2020-06-17	0.0178	1.23	0.50	Indeterminant	YES	YES	Likely Degrading
ECOLI	All	1989-02-16	2020-06-17	0.0146	1.03	<0.01	Increasing	YES	YES	Very Likely Degrading
TSS	5 Years									Not Analysed
TSS	10 Years									Not Analysed
TSS	All									Not Analysed
CLARITY	5 Years	2015-07-14	2020-06-17	0.0500	3.30	0.26	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2010-07-15	2020-06-17	-0.0165	-0.88	0.44	Indeterminant	YES	NO	Likely Degrading
CLARITY	All	1989-02-16	2020-06-17	-0.0159	-0.81	<0.001	Decreasing	YES	YES	Very Likely Degrading

Whirinaki at Galatea (BOPRC/NIWA)

March 2021

Table 1 Site metadata.

Aquarius ID:	IG691428	**Labstar ID:**	BOP110014
LAWA ID:	EBOP-00053	**REC Reach:**	4022892
Easting:	1926915	**Northing:**	5734286
Longitude:	176.74746	**Latitude:**	-38.47984
Elevation:	201 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	377	0.07	0.99	0.21	0.19	0.38	0.09	0.10	0.01
Nitrate Nitrite Nitrogen (g/m3)	379	<0.001	0.30	0.11	0.11	0.23	0.01	0.07	0.00
Total Ammoniacal Nitrogen (g/m3)	391	<0.002	0.080	0.005	0.005	0.010	0.002	0.006	0.000
Total Phosphorus (g/m3)	401	0.018	0.236	0.038	0.031	0.082	0.023	0.025	0.001
Dissolved Reactive Phosphorus (g/m3)	401	0.009	0.030	0.020	0.020	0.025	0.015	0.003	0.000
Dissolved Oxygen Sat (%)	378	93.9	118.4	103.4	102.4	110.0	99.7	3.4	0.2
Dissolved Oxygen (g/m3)	399	8.80	110.00	13.08	10.80	12.40	9.59	14.56	0.73
Escherichia coli (cfu/100ml)	200	2	1986	97	41	291	11	228	16
Total Suspended Solids (g/m3)	16	1.70	18.00	6.47	4.70	15.00	2.00	4.88	1.22
Turbidity (NTU)	383	0.6	187.0	5.2	1.7	23.0	0.8	13.4	0.7
Water Clarity (m)	384	0.06	4.08	1.70	1.85	2.96	0.23	0.87	0.04
Conductivity (uS/cm)	116	56	101	79	79	96	62	11	1
pH (pH Units)	400	6.3	8.7	7.9	7.8	8.4	7.5	0.3	0.0
Water Temperature (degC)	401	5.2	21.3	12.7	12.2	18.4	7.3	3.6	0.2
Discharge (m3/s)	224	3.30	99.90	15.10	11.10	39.00	4.40	12.70	0.80

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

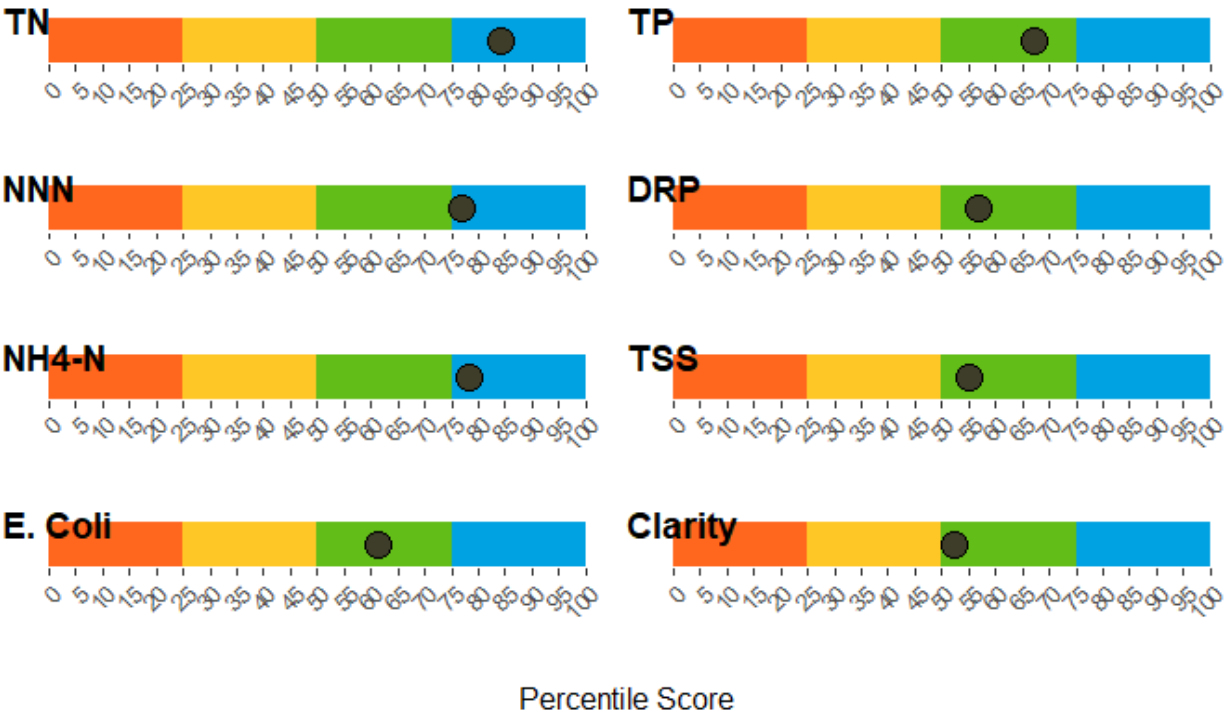


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

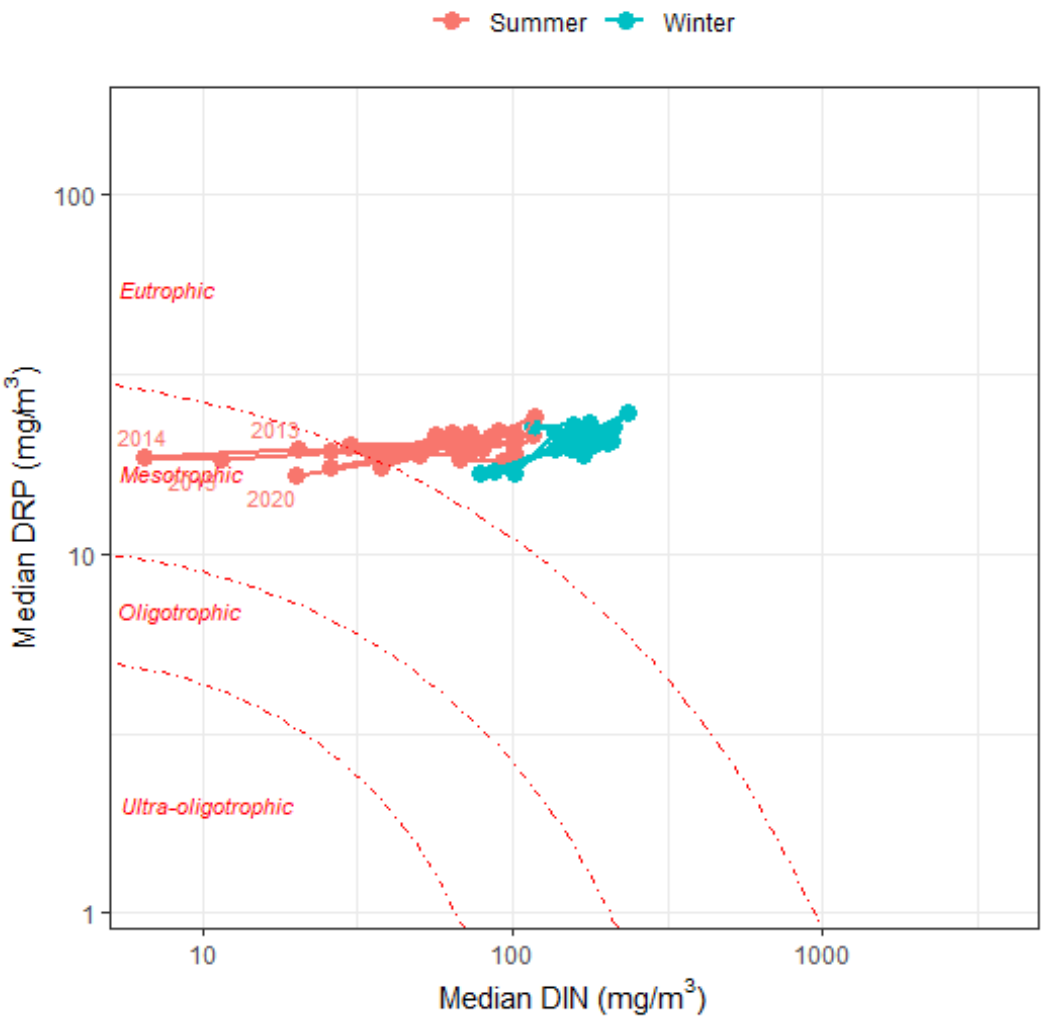


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-06-18	2020-06-17	10	0.0050	0.015	A
5 Years	2015-06-19	2020-06-17	58	0.0030	0.015	A
10 Years	2010-06-20	2020-06-17	118	0.0030	0.015	A
All	1989-02-16	2020-06-17	390	0.0038	0.042	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-06-18	2020-06-17	11	0.08	0.18	A
5 Years	2015-06-19	2020-06-17	59	0.12	0.23	A
10 Years	2010-06-20	2020-06-17	119	0.10	0.22	A
All	1989-02-16	2020-06-17	379	0.11	0.23	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-06-18	2020-06-17	59	1.49	C*
10 Years	2010-06-20	2020-06-17	119	1.83	A
All	1989-02-16	2020-06-17	383	1.85	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-06-18	2020-06-16	58	0.020	0.024	D
10 Years	2010-06-19	2020-06-16	118	0.020	0.025	D
All	1989-02-15	2020-06-16	400	0.020	0.025	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-06-19	2020-06-17	59	3.4	8.5	38	353	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-06-19	2020-06-17	59	38	407	91.5	5.1	3.4
10 Years	2010-06-20	2020-06-17	119	38	461	91.6	4.2	4.2
All	1991-01-29	2020-06-17	200	41	295	94	3	3

Time series plots

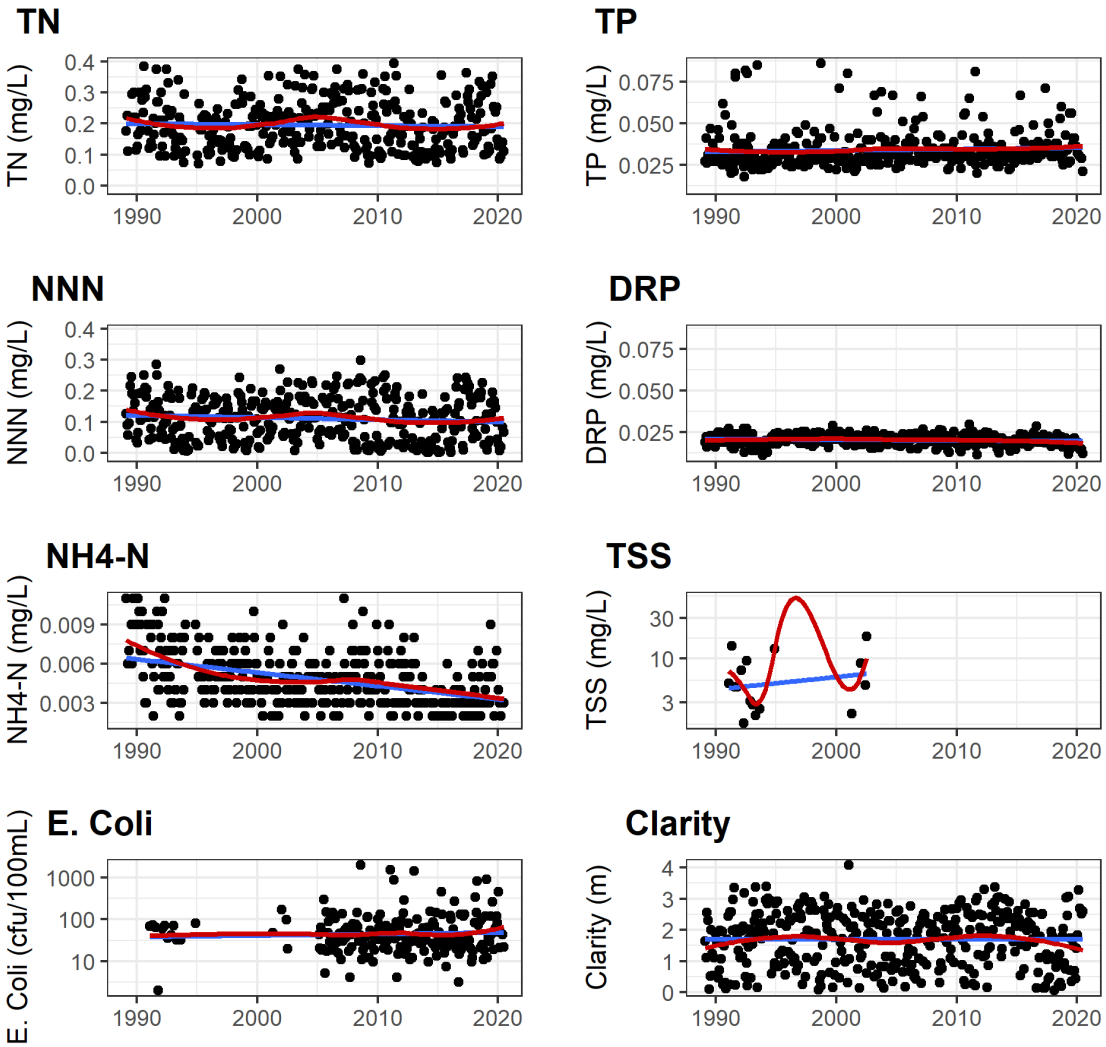


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-07-14	2020-06-17	0.0023	1.09	0.54	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2010-07-15	2020-06-17	0.0015	0.85	0.49	Indeterminant	YES	YES	Likely Degrading
TN	All	1989-02-16	2020-06-17	-0.0003	-0.14	0.49	Indeterminant	YES	YES	Likely Improving
NNN	5 Years	2015-07-14	2020-06-17	-0.0018	-1.49	0.56	Indeterminant	Attempted	YES	Likely Improving
NNN	10 Years	2010-07-15	2020-06-17	0.0008	0.80	0.77	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	All	1989-02-16	2020-06-17	-0.0007	-0.71	<0.001	Decreasing	YES	YES	Very Likely Improving
NH4N	5 Years	2015-07-14	2020-06-17	0.0001	4.60	0.15	Indeterminant	YES	NO	Very Likely Degrading
NH4N	10 Years	2010-07-15	2020-06-17	0.0000	-0.22	0.89	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	All	1989-02-16	2020-06-17	-0.0001	-2.22	<0.001	Decreasing	NO	YES	Very Likely Improving
TP	5 Years	2015-07-14	2020-06-17	0.0002	0.45	0.84	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	10 Years	2010-07-15	2020-06-17	0.0000	-0.05	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	1989-02-16	2020-06-17	0.0001	0.42	<0.001	Increasing	YES	YES	Very Likely Degrading
DRP	5 Years	2015-07-14	2020-06-17	-0.0006	-2.93	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2010-07-15	2020-06-17	-0.0003	-1.65	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	All	1989-02-16	2020-06-17	0.0000	-0.10	0.25	Indeterminant	YES	NO	Likely Improving
ECOLI	5 Years	2015-07-14	2020-06-17	0.0346	2.16	0.40	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-07-15	2020-06-17	-0.0060	-0.36	0.74	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	1989-02-16	2020-06-17	0.0063	0.37	0.52	Indeterminant	YES	YES	Likely Degrading
TSS	5 Years									Not Analysed
TSS	10 Years									Not Analysed
TSS	All									Not Analysed
CLARITY	5 Years	2015-07-14	2020-06-17	-0.0422	-3.13	0.20	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2010-07-15	2020-06-17	-0.0184	-0.95	0.36	Indeterminant	YES	NO	Likely Degrading
CLARITY	All	1989-02-16	2020-06-17	-0.0016	-0.09	0.65	Indeterminant	YES	YES	Likely Degrading

Rangitaiki at Inlet to Aniwhenua Canal

March 2021

Table 1 Site metadata.

Aquarius ID:	JI148319	**Labstar ID:**	BOP110016
LAWA ID:	EBOP-00020	**REC Reach:**	4019035
Easting:	1931488	**Northing:**	5753195
Longitude:	176.79088	**Latitude:**	-38.30811
Elevation:	145 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	No
REC Class:	CW_Lake_VA		

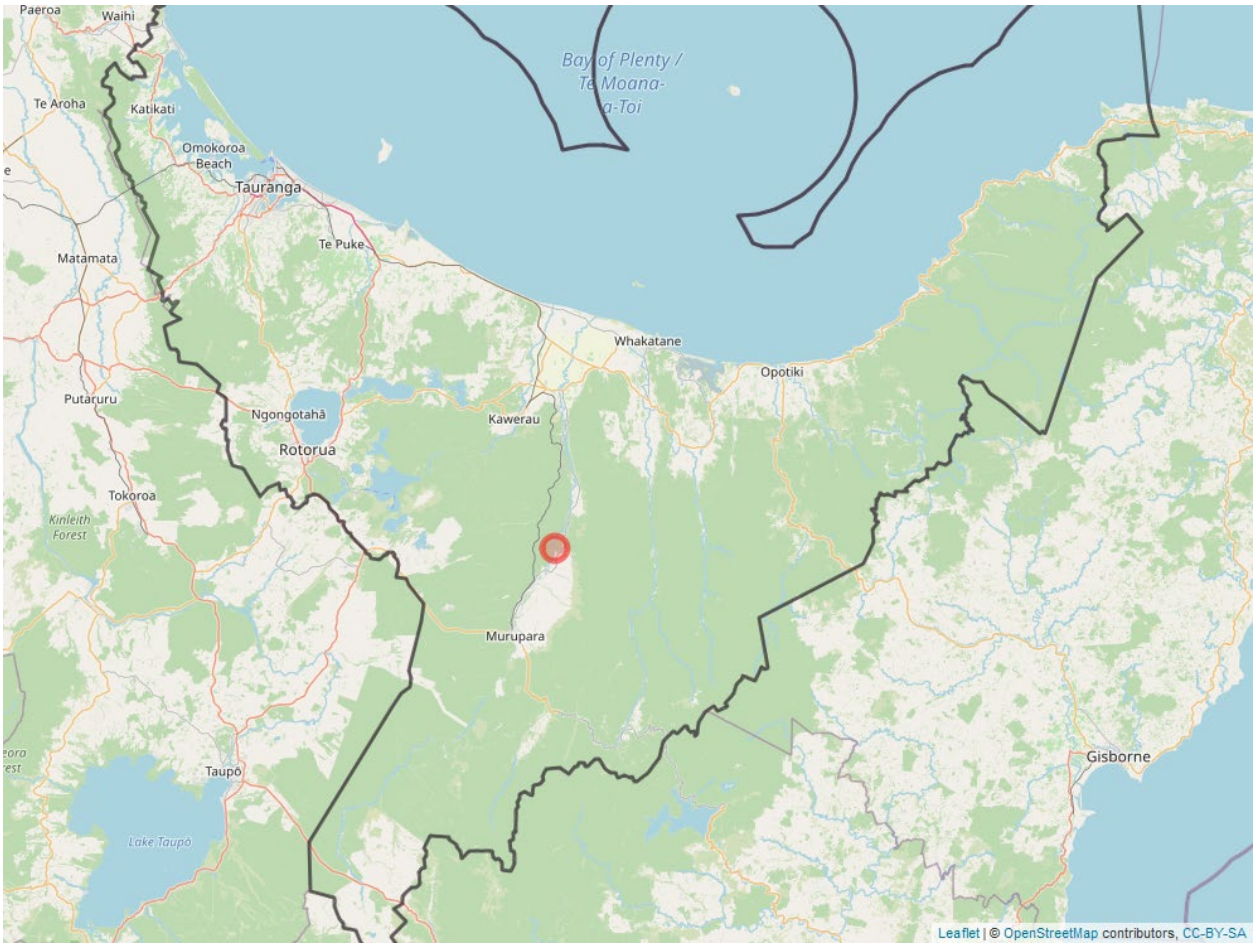


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	128	0.39	1.01	0.65	0.65	0.84	0.46	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	131	<0.001	0.96	0.53	0.51	0.82	0.26	0.17	0.01
Total Ammoniacal Nitrogen (g/m3)	153	<0.002	0.134	0.023	0.021	0.041	0.007	0.016	0.001
Total Phosphorus (g/m3)	151	0.018	0.329	0.050	0.047	0.076	0.030	0.027	0.002
Dissolved Reactive Phosphorus (g/m3)	152	0.011	0.096	0.032	0.031	0.047	0.019	0.011	0.001
Dissolved Oxygen Sat (%)	79	80.9	123.7	93.4	93.0	102.6	85.5	6.0	0.7
Dissolved Oxygen (g/m3)	149	6.00	13.80	9.70	9.80	11.10	8.12	1.00	0.08
Escherichia coli (cfu/100ml)	140	<1	2300	98	26	493	3	262	22
Total Suspended Solids (g/m3)	153	<1	66.80	4.78	2.30	17.50	0.80	8.54	0.69
Turbidity (NTU)	145	0.6	44.1	3.9	1.8	14.9	0.9	5.9	0.5
Water Clarity (m)	53	0.49	7.28	2.77	2.73	5.62	0.68	1.55	0.21
Conductivity (uS/cm)	151	19	403	95	94	104	78	27	2
pH (pH Units)	146	6.4	8.1	7.1	7.0	7.4	6.8	0.2	0.0
Water Temperature (degC)	148	8.4	21.0	14.2	13.9	19.3	9.4	3.3	0.3
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

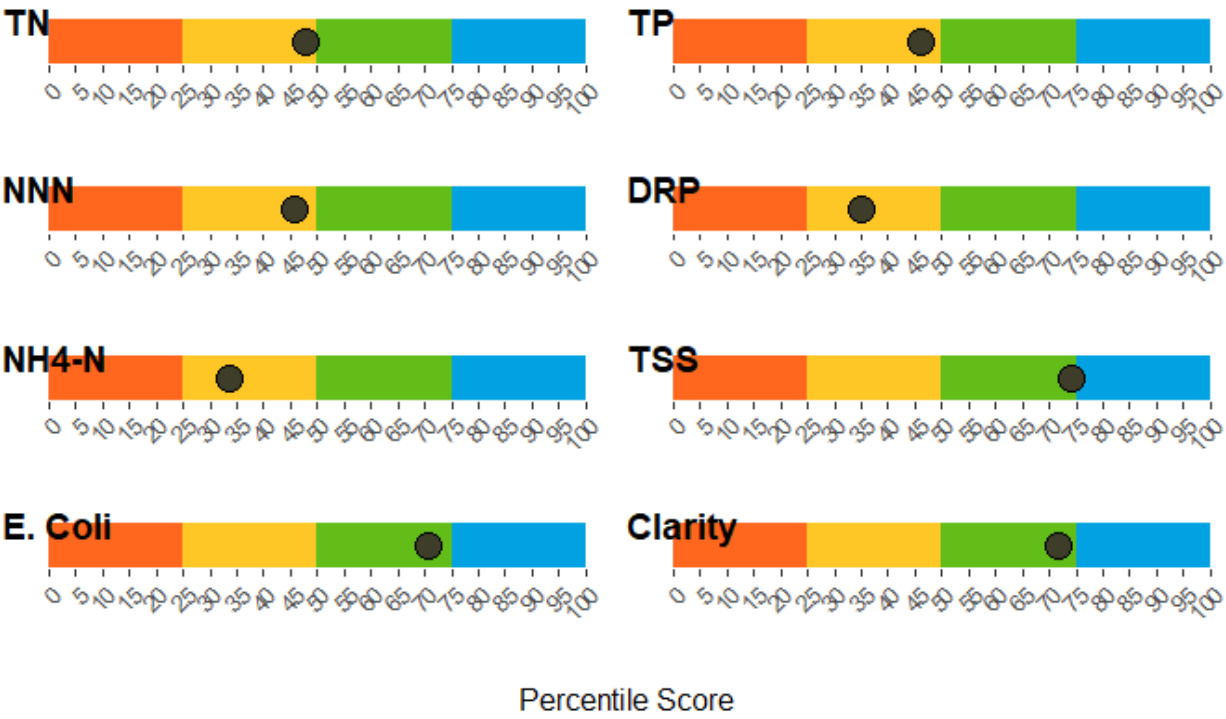


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

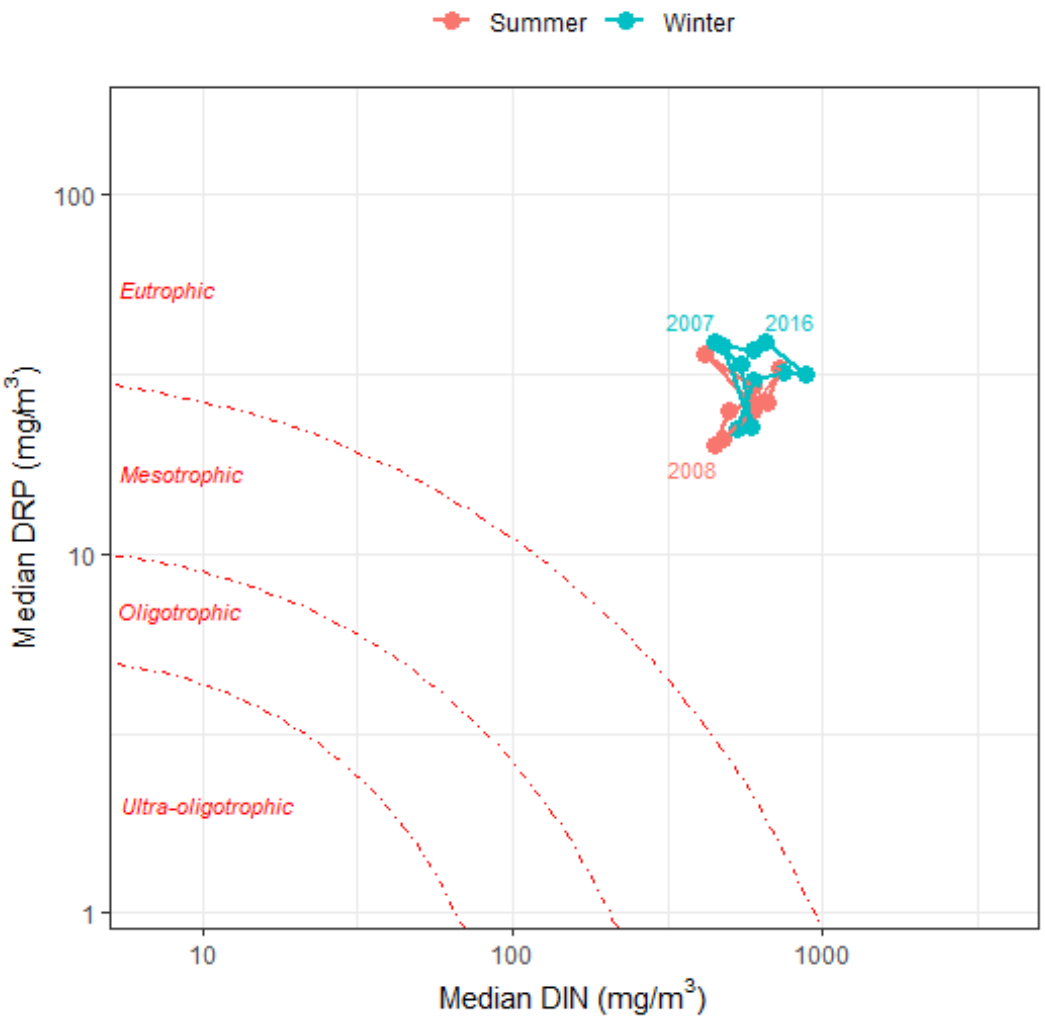


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-05	2020-12-04	10	0.0090	0.012	A
5 Years	2015-12-06	2020-12-04	56	0.0080	0.017	A
10 Years	2010-12-07	2020-12-04	81	0.0080	0.049	A
All	1991-01-29	2020-12-04	146	0.0091	0.052	B

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-05	2020-12-04	10	0.48	0.56	A
5 Years	2015-12-06	2020-12-04	56	0.63	0.89	A
10 Years	2010-12-07	2020-12-04	81	0.58	0.88	A
All	1993-08-19	2020-12-04	131	0.51	0.82	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-05	2020-12-04	12	3.22	A**
10 Years	2010-12-07	2020-12-04	27	3.41	A**
All	1992-07-29	2020-12-04	53	2.73	B*

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-05	2020-12-03	55	0.030	0.039	D
10 Years	2010-12-06	2020-12-03	80	0.030	0.047	D
All	1985-12-09	2020-12-03	151	0.031	0.047	D

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-06	2020-12-04	54	3.7	7.4	35	353	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-06	2020-12-04	54	35	448	92.6	3.7	3.7
10 Years	2010-12-07	2020-12-04	79	34	636	87.3	5.1	7.6
All	1991-01-29	2020-12-04	140	26	525	92.1	2.9	5

Time series plots

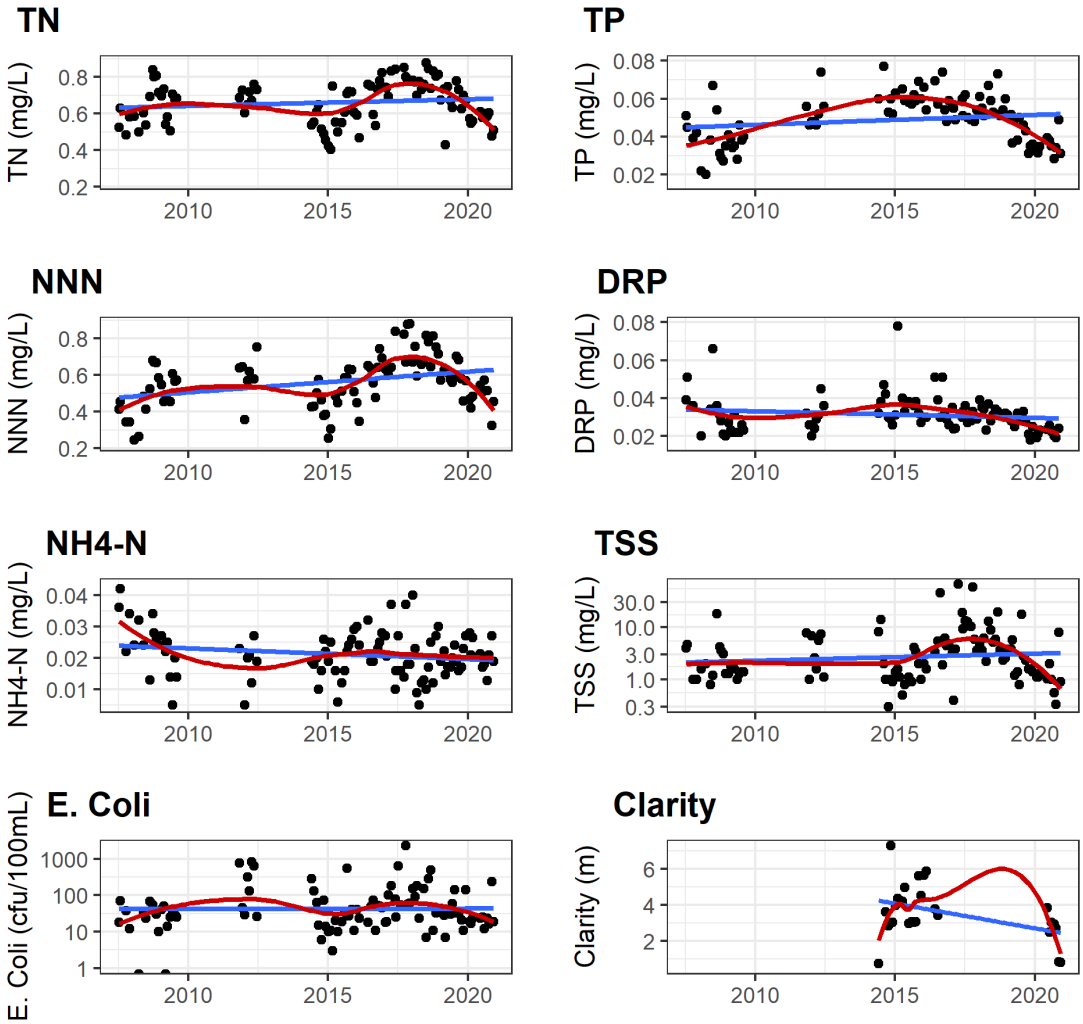


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-09	2020-12-04	-0.0454	-6.18	<0.01	Decreasing	NO	NO	Very Likely Improving
TN	10 Years	2011-11-04	2020-12-04	0.0037	0.53	0.47	Indeterminant	NO	NO	Likely Degrading
TN	All	2007-07-11	2020-12-04	0.0051	0.74	0.09	Increasing	NO	NO	Very Likely Degrading
NNN	5 Years	2015-12-09	2020-12-04	-0.0466	-7.37	<0.01	Decreasing	NO	NO	Very Likely Improving
NNN	10 Years	2011-11-04	2020-12-04	0.0048	0.83	0.49	Indeterminant	NO	NO	Likely Degrading
NNN	All	2007-07-11	2020-12-04	0.0101	1.75	<0.05	Increasing	NO	NO	Very Likely Degrading
NH4N	5 Years	2015-12-09	2020-12-04	0.0000	0.00	1.00	Indeterminant	NO	YES	Indeterminate/Uncertain
NH4N	10 Years	2011-11-04	2020-12-04	0.0001	0.57	0.79	Indeterminant	NO	YES	Indeterminate/Uncertain
NH4N	All	2007-07-11	2020-12-04	-0.0004	-1.99	<0.05	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2015-12-09	2020-12-04	-0.0066	-12.83	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2011-11-04	2020-12-04	-0.0038	-7.03	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	All	2007-07-11	2020-12-04	-0.0003	-0.60	0.48	Indeterminant	NO	NO	Likely Improving
DRP	5 Years	2015-12-09	2020-12-04	-0.0025	-8.54	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-11-04	2020-12-04	-0.0017	-5.54	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	All	2007-07-11	2020-12-04	-0.0006	-1.96	<0.05	Decreasing	NO	NO	Very Likely Improving
ECOLI	5 Years	2015-12-09	2020-12-04	-0.0594	-3.82	0.24	Indeterminant	NO	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-11-04	2020-12-04	-0.0290	-1.88	0.27	Indeterminant	NO	NO	Likely Improving
ECOLI	All	2007-07-11	2020-12-04	0.0017	0.11	0.81	Indeterminant	NO	NO	Indeterminate/Uncertain
TSS	5 Years	2015-12-09	2020-12-04	-0.1252	-18.90	<0.001	Decreasing	NO	NO	Very Likely Improving
TSS	10 Years	2011-11-04	2020-12-04	-0.0088	-1.59	0.57	Indeterminant	NO	NO	Likely Improving
TSS	All	2007-07-11	2020-12-04	0.0035	0.71	0.51	Indeterminant	NO	NO	Likely Degrading
CLARITY	5 Years									Not Analysed
CLARITY	10 Years	2011-11-04	2020-12-04	-0.1482	-4.35	0.17	Indeterminant	NO	NO	Very Likely Degrading
CLARITY	All	2007-07-11	2020-12-04	-0.1482	-4.35	0.17	Indeterminant	NO	NO	Very Likely Degrading

Rangitaiki at Matahina Dam

March 2021

Table 1 Site metadata.

Aquarius ID:	JK491452	**Labstar ID:**	BOP110082
LAWA ID:	EBOP-00021	**REC Reach:**	4012399
Easting:	1934919	**Northing:**	5774526
Longitude:	176.81998	**Latitude:**	-38.11502
Elevation:	77 m	**Biophysical Unit:**	VA/Steep
Flow:	No	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	110	0.17	1.30	0.58	0.56	0.85	0.33	0.17	0.02
Nitrate Nitrite Nitrogen (g/m3)	109	<0.001	0.88	0.39	0.38	0.73	0.04	0.20	0.02
Total Ammoniacal Nitrogen (g/m3)	118	<0.002	0.037	0.009	0.008	0.021	0.001	0.007	0.001
Total Phosphorus (g/m3)	118	0.015	0.229	0.046	0.046	0.071	0.023	0.026	0.002
Dissolved Reactive Phosphorus (g/m3)	117	0.002	0.047	0.020	0.019	0.036	0.004	0.011	0.001
Dissolved Oxygen Sat (%)	81	91.6	188.5	127.0	122.9	171.8	96.7	26.3	2.9
Dissolved Oxygen (g/m3)	114	8.70	17.87	11.96	11.58	15.11	9.73	1.87	0.17
Escherichia coli (cfu/100ml)	108	<1	1300	50	12	199	0	161	16
Total Suspended Solids (g/m3)	117	<1	41.00	5.35	3.30	15.28	0.80	6.34	0.59
Turbidity (NTU)	111	0.7	56.8	3.9	2.3	7.8	1.1	6.2	0.6
Water Clarity (m)	92	0.15	6.63	1.72	1.60	3.90	0.55	1.06	0.11
Conductivity (uS/cm)	117	66	130	90	90	99	76	8	1
pH (pH Units)	111	6.6	9.2	7.8	7.6	8.9	6.9	0.7	0.1
Water Temperature (degC)	115	9.2	24.4	16.0	15.9	21.9	10.6	3.9	0.4
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

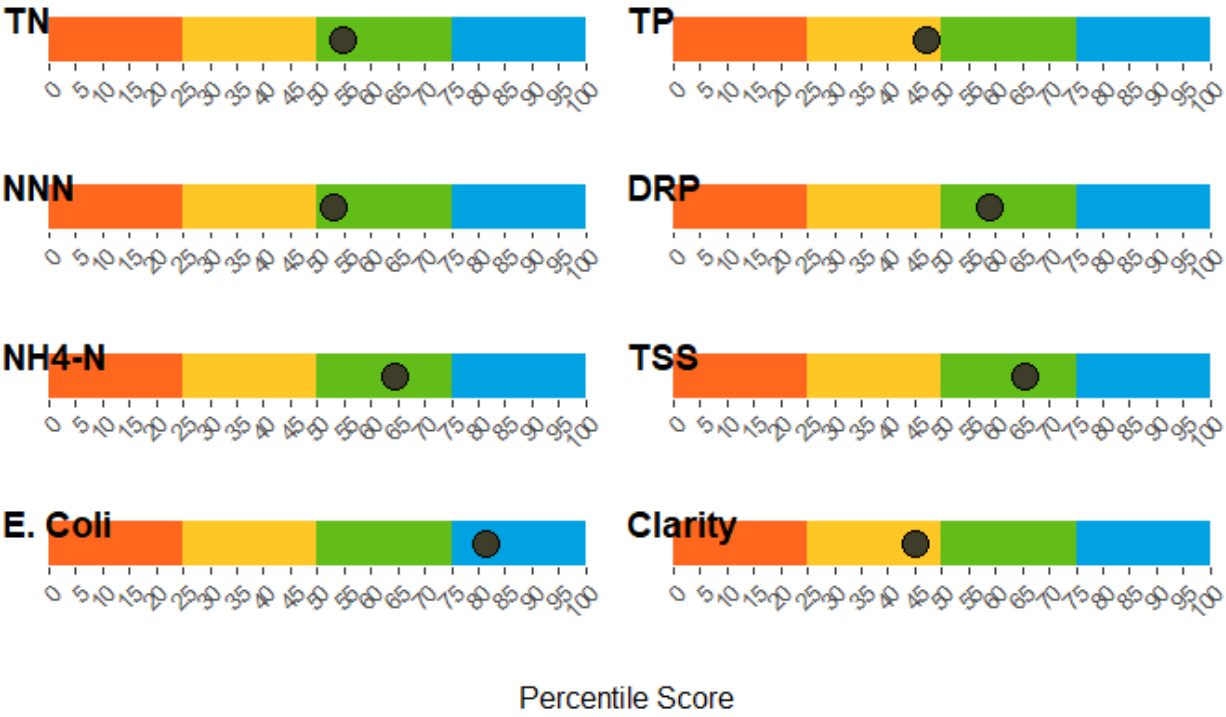


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

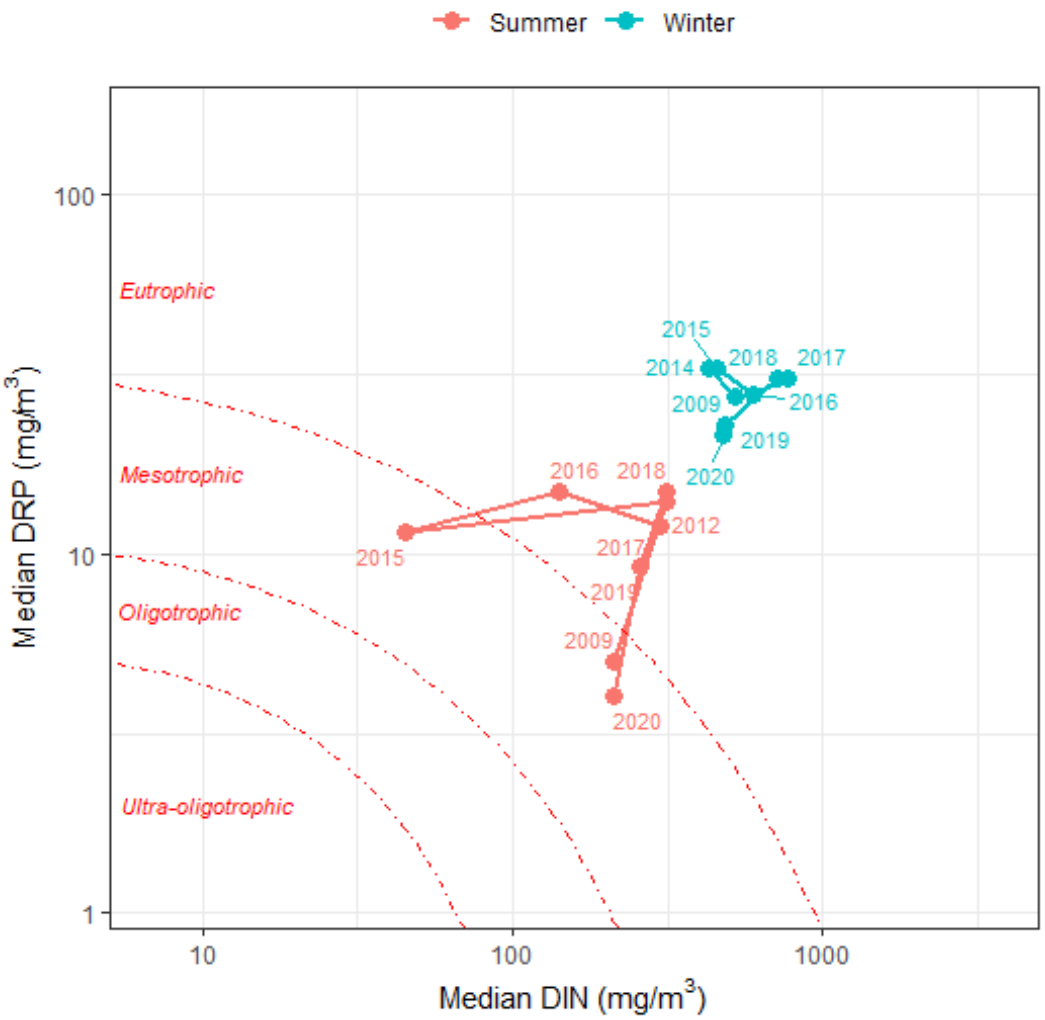


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-05	2020-12-04	11	0.0050	0.019	A
5 Years	2015-12-06	2020-12-04	59	0.0060	0.048	A
10 Years	2010-12-07	2020-12-04	84	0.0060	0.048	A
All	1995-08-23	2020-12-04	111	0.0054	0.066	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-05	2020-12-04	11	0.28	0.53	A
5 Years	2015-12-06	2020-12-04	59	0.41	0.76	A
10 Years	2010-12-07	2020-12-04	83	0.39	0.74	A
All	1995-08-23	2020-12-04	109	0.38	0.73	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-05	2020-12-04	55	1.30	D*
10 Years	2010-12-07	2020-12-04	78	1.63	B
All	1995-08-23	2020-12-04	91	1.61	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-05	2020-12-03	58	0.017	0.034	C
10 Years	2010-12-06	2020-12-03	83	0.018	0.036	C
All	1985-12-09	2020-12-03	116	0.019	0.036	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-06	2020-12-04	57	1.8	1.8	9	71	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-06	2020-12-04	57	9	72	98.2	0	0
10 Years	2010-12-07	2020-12-04	82	10	144	97.6	0	1.2
All	1995-08-23	2020-12-04	108	12	211	96.3	0.9	1.9

Time series plots

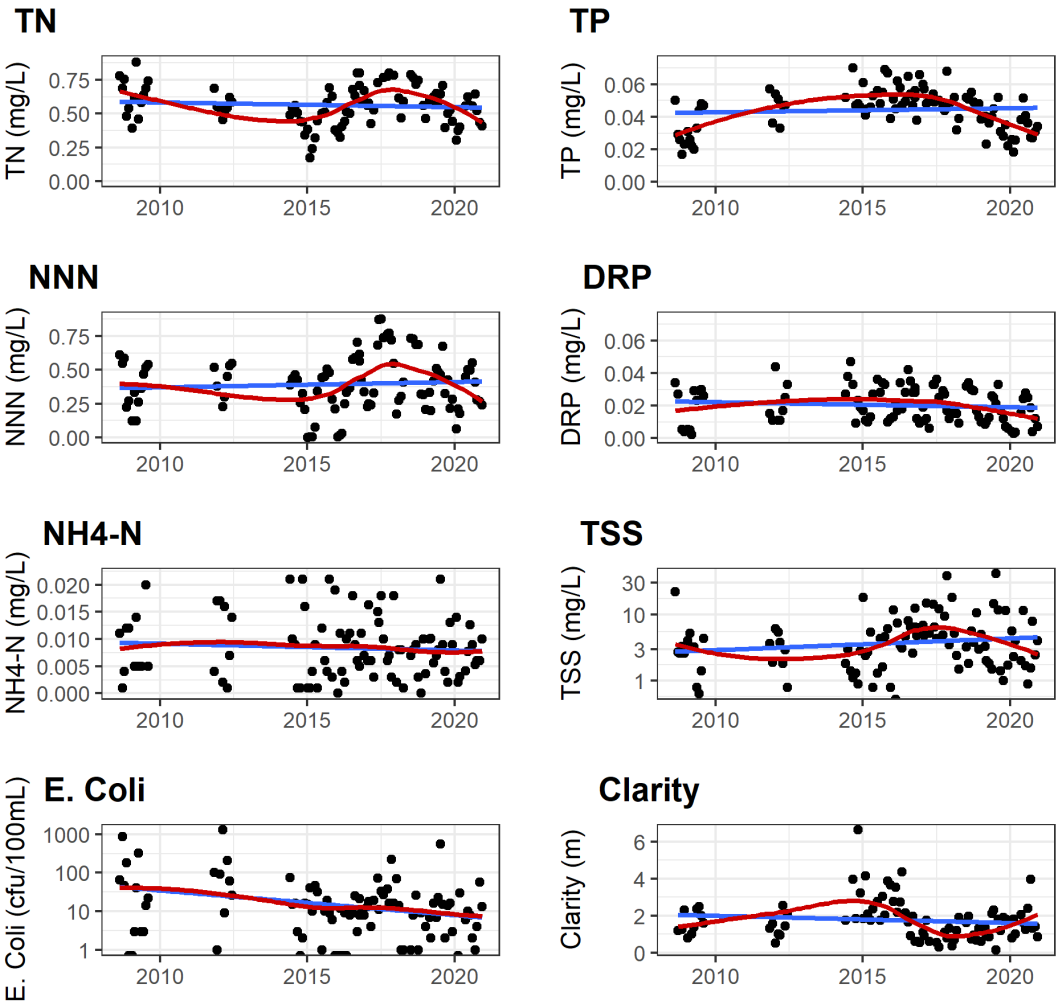


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-12-09	2020-12-04	-0.0163	-2.77	0.31	Indeterminant	NO	NO	Likely Improving
TN	10 Years	2011-11-04	2020-12-04	0.0114	2.03	0.19	Indeterminant	NO	YES	Very Likely Degrading
TN	All	2008-08-21	2020-12-04	0.0000	0.00	1.00	Indeterminant	NO	YES	Indeterminate/Uncertain
NNN	5 Years	2015-12-09	2020-12-04	-0.0201	-4.93	0.24	Indeterminant	NO	YES	Likely Improving
NNN	10 Years	2011-11-04	2020-12-04	0.0064	1.67	0.51	Indeterminant	NO	YES	Likely Degrading
NNN	All	2008-08-21	2020-12-04	0.0049	1.26	0.37	Indeterminant	NO	YES	Likely Degrading
NH4N	5 Years	2015-12-09	2020-12-04	-0.0003	-4.18	0.18	Indeterminant	NO	YES	Likely Improving
NH4N	10 Years	2011-11-04	2020-12-04	0.0000	0.00	0.79	Indeterminant	NO	YES	Indeterminate/Uncertain
NH4N	All	2008-08-21	2020-12-04	-0.0002	-2.09	0.36	Indeterminant	NO	YES	Likely Improving
TP	5 Years	2015-12-09	2020-12-04	-0.0051	-10.57	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2011-11-04	2020-12-04	-0.0028	-5.90	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	All	2008-08-21	2020-12-04	-0.0006	-1.37	0.23	Indeterminant	NO	NO	Likely Improving
DRP	5 Years	2015-12-09	2020-12-04	-0.0025	-14.78	<0.001	Decreasing	NO	YES	Very Likely Improving
DRP	10 Years	2011-11-04	2020-12-04	-0.0013	-7.60	<0.001	Decreasing	NO	YES	Very Likely Improving
DRP	All	2008-08-21	2020-12-04	-0.0006	-3.53	<0.01	Decreasing	NO	YES	Very Likely Improving
ECOLI	5 Years	2015-12-09	2020-12-04	0.0096	0.96	0.71	Indeterminant	NO	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-11-04	2020-12-04	-0.0424	-4.00	0.08	Decreasing	NO	NO	Very Likely Improving
ECOLI	All	2008-08-21	2020-12-04	-0.0381	-3.42	<0.05	Decreasing	NO	NO	Very Likely Improving
TSS	5 Years	2015-12-09	2020-12-04	-0.0537	-7.03	0.09	Decreasing	NO	NO	Very Likely Improving
TSS	10 Years	2011-11-04	2020-12-04	0.0157	2.30	0.31	Indeterminant	NO	NO	Likely Degrading
TSS	All	2008-08-21	2020-12-04	0.0126	1.93	0.16	Indeterminant	NO	NO	Very Likely Degrading
CLARITY	5 Years	2015-12-09	2020-12-04	-0.0078	-0.60	0.86	Indeterminant	NO	NO	Indeterminate/Uncertain
CLARITY	10 Years	2011-11-04	2020-12-04	-0.0947	-5.81	<0.05	Decreasing	NO	NO	Very Likely Degrading
CLARITY	All	2008-08-21	2020-12-04	-0.0501	-3.10	0.07	Decreasing	NO	NO	Very Likely Degrading

Rangitaiki at Te Teko

March 2021

Table 1 Site metadata.

Aquarius ID:	JL350292	**Labstar ID:**	BOP110018
LAWA ID:	EBOP-00070	**REC Reach:**	4009262
Easting:	1933508	**Northing:**	5782922
Longitude:	176.80000	**Latitude:**	-38.04004
Elevation:	12 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_VA		

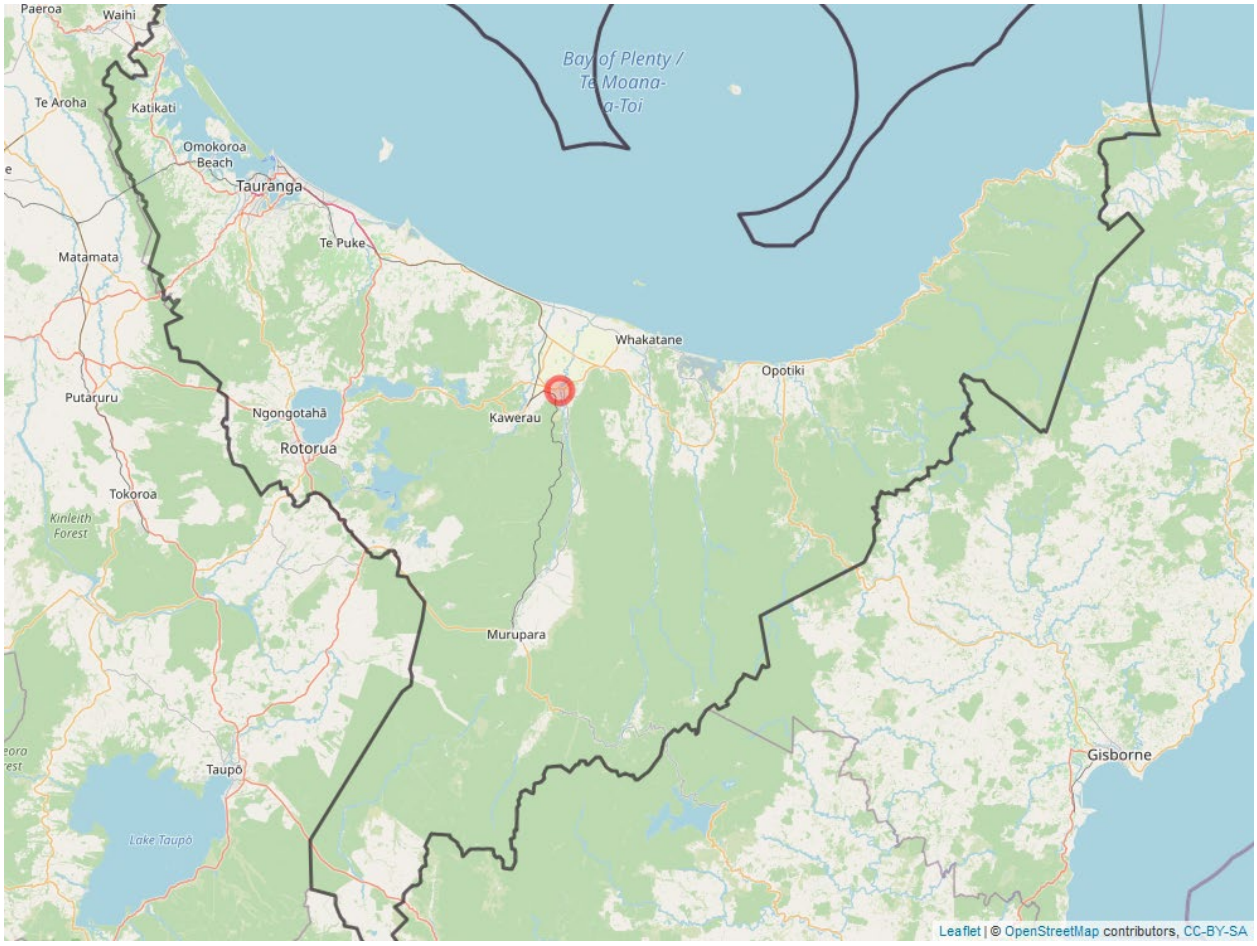


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	378	0.16	0.99	0.50	0.48	0.74	0.31	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	381	0.01	0.90	0.37	0.38	0.63	0.13	0.15	0.01
Total Ammoniacal Nitrogen (g/m3)	399	<0.002	0.050	0.012	0.011	0.023	0.003	0.007	0.000
Total Phosphorus (g/m3)	409	0.020	0.126	0.039	0.037	0.061	0.025	0.012	0.001
Dissolved Reactive Phosphorus (g/m3)	410	<0.001	0.044	0.017	0.020	0.030	0.003	0.009	0.000
Dissolved Oxygen Sat (%)	374	85.8	144.8	106.9	105.0	125.7	94.4	10.1	0.5
Dissolved Oxygen (g/m3)	407	8.70	115.00	13.47	10.70	12.20	9.53	15.87	0.79
Escherichia coli (cfu/100ml)	201	<1	1203	72	28	276	5	146	10
Total Suspended Solids (g/m3)	26	2.00	39.00	7.36	4.80	17.10	2.52	7.57	1.48
Turbidity (NTU)	386	0.6	84.9	4.4	2.0	16.2	0.9	8.0	0.4
Water Clarity (m)	372	0.05	3.93	1.45	1.29	3.01	0.28	0.80	0.04
Conductivity (uS/cm)	129	68	127	89	91	96	78	7	1
pH (pH Units)	402	6.5	7.8	7.1	7.1	7.4	6.9	0.2	0.0
Water Temperature (degC)	408	8.9	22.7	15.0	14.8	20.0	10.1	3.4	0.2
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

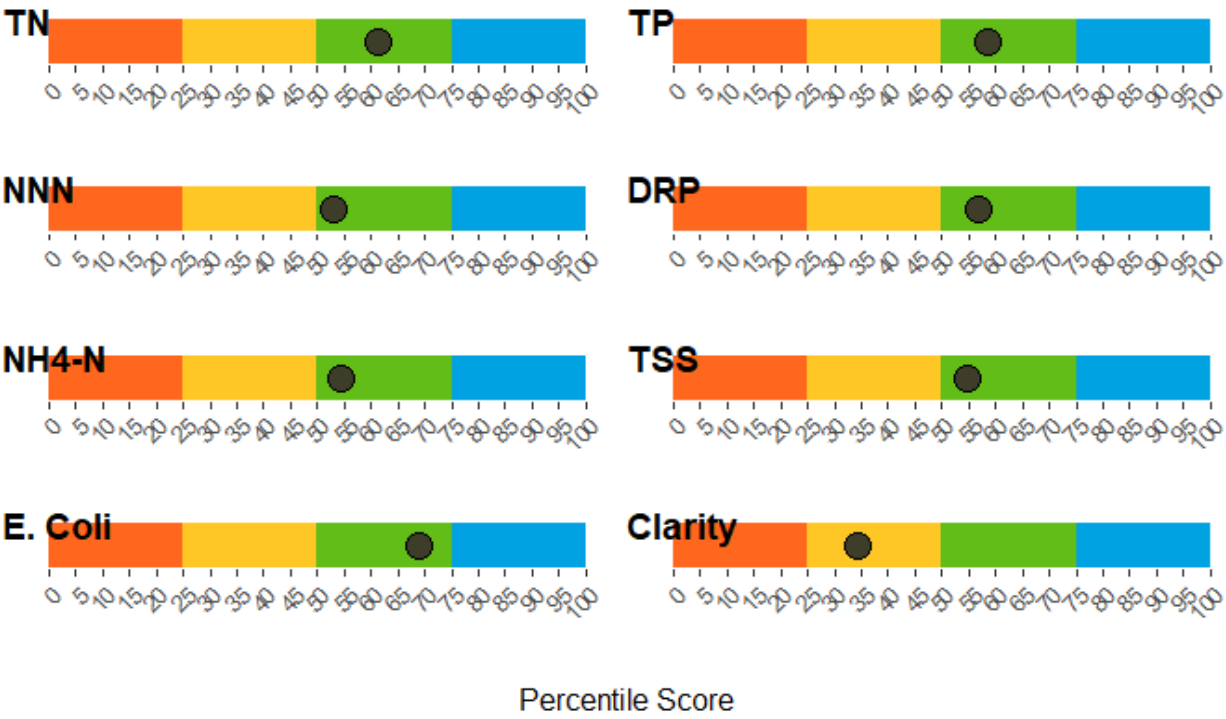


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

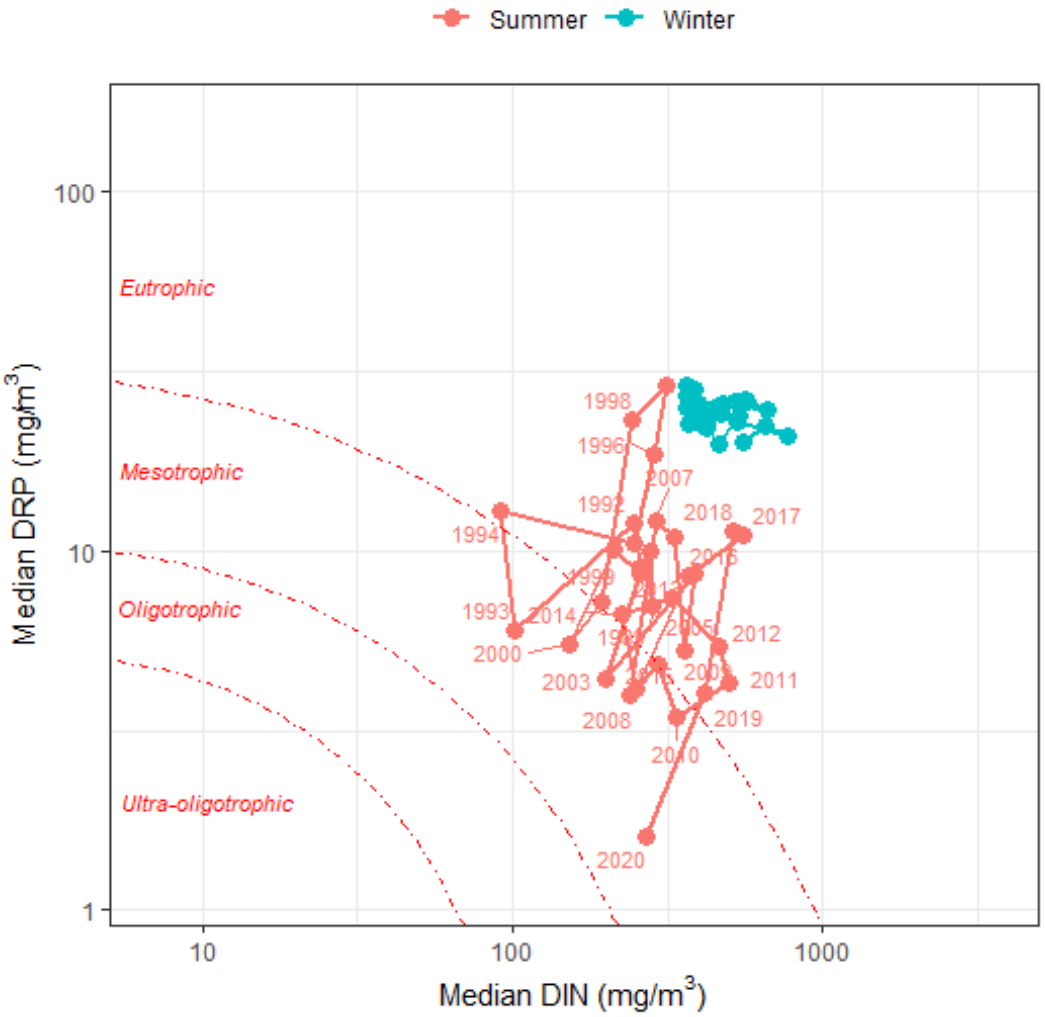


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-06-19	2020-06-18	11	0.0040	0.010	A
5 Years	2015-06-20	2020-06-18	59	0.0050	0.012	A
10 Years	2010-06-21	2020-06-18	118	0.0050	0.012	A
All	1989-02-16	2020-06-18	391	0.0045	0.021	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-06-19	2020-06-18	11	0.49	0.61	A
5 Years	2015-06-20	2020-06-18	59	0.50	0.76	A
10 Years	2010-06-21	2020-06-18	119	0.48	0.74	A
All	1989-02-16	2020-06-18	381	0.38	0.63	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-06-19	2020-06-18	59	1.16	D*
10 Years	2010-06-21	2020-06-18	119	1.43	C
All	1989-02-16	2020-06-18	371	1.29	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-06-19	2020-06-17	58	0.018	0.026	C
10 Years	2010-06-20	2020-06-17	118	0.018	0.027	C
All	1985-12-09	2020-06-17	409	0.020	0.030	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-06-20	2020-06-18	59	5.1	6.8	30	406	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-06-20	2020-06-18	59	30	527	93.2	1.7	5.1
10 Years	2010-06-21	2020-06-18	118	27	413	91.5	4.2	4.2
All	1991-01-30	2020-06-18	201	28	276	94.5	3	2.5

Time series plots

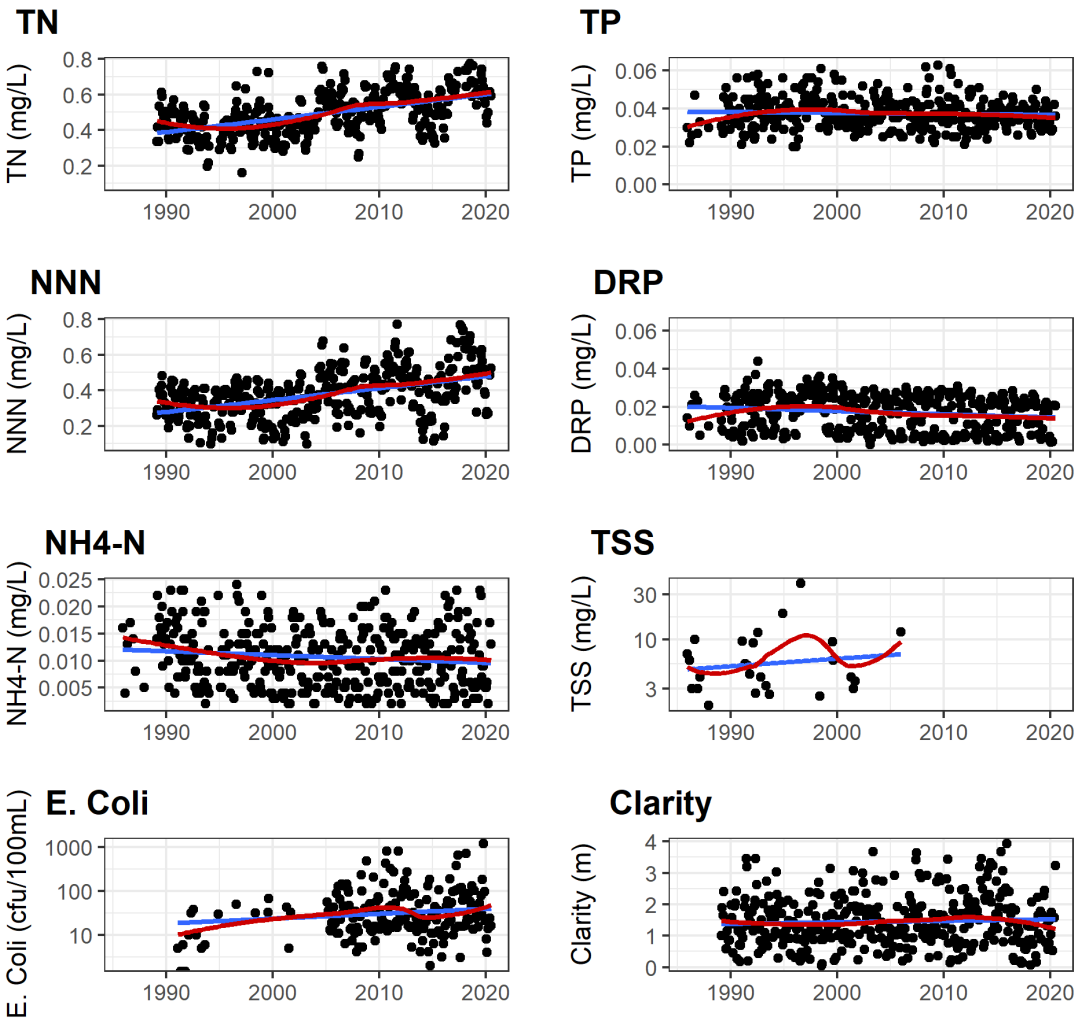


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-07-16	2020-06-18	0.0025	0.40	0.84	Indeterminant	NO	NO	Indeterminate/Uncertain
TN	10 Years	2010-07-14	2020-06-18	0.0040	0.65	0.45	Indeterminant	NO	YES	Likely Degrading
TN	All	1985-12-10	2020-06-18	0.0078	1.63	<0.001	Increasing	NO	YES	Very Likely Degrading
NNN	5 Years	2015-07-16	2020-06-18	0.0227	4.50	0.17	Indeterminant	NO	YES	Very Likely Degrading
NNN	10 Years	2010-07-14	2020-06-18	0.0037	0.78	0.42	Indeterminant	NO	YES	Likely Degrading
NNN	All	1985-12-10	2020-06-18	0.0067	1.79	<0.001	Increasing	NO	YES	Very Likely Degrading
NH4N	5 Years	2015-07-16	2020-06-18	-0.0007	-7.05	0.26	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2010-07-14	2020-06-18	0.0000	0.00	0.44	Indeterminant	NO	YES	Likely Degrading
NH4N	All	1985-12-10	2020-06-18	-0.0001	-0.69	<0.01	Decreasing	NO	YES	Very Likely Improving
TP	5 Years									Not Analysed
TP	10 Years	2010-07-14	2020-06-18	0.0000	0.00	0.87	Indeterminant	NO	YES	Indeterminate/Uncertain
TP	All	1985-12-10	2020-06-18	0.0000	-0.11	0.22	Indeterminant	NO	YES	Likely Improving
DRP	5 Years	2015-07-16	2020-06-18	-0.0008	-4.28	<0.05	Decreasing	NO	YES	Very Likely Improving
DRP	10 Years	2010-07-14	2020-06-18	-0.0002	-0.99	0.09	Decreasing	NO	YES	Very Likely Improving
DRP	All	1985-12-10	2020-06-18	-0.0001	-0.66	<0.001	Decreasing	NO	YES	Very Likely Improving
ECOLI	5 Years	2015-07-16	2020-06-18	0.0462	3.10	0.30	Indeterminant	NO	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-07-14	2020-06-18	-0.0062	-0.43	0.66	Indeterminant	NO	NO	Indeterminate/Uncertain
ECOLI	All	1985-12-10	2020-06-18	0.0085	0.59	0.12	Indeterminant	NO	NO	Very Likely Degrading
TSS	5 Years									Not Analysed
TSS	10 Years									Not Analysed
TSS	All	1985-12-10	2020-06-18	0.0000	0.00	0.98	Indeterminant	NO	NO	Indeterminate/Uncertain
CLARITY	5 Years	2015-07-16	2020-06-18	-0.0178	-1.53	0.74	Indeterminant	NO	NO	Indeterminate/Uncertain
CLARITY	10 Years	2010-07-14	2020-06-18	-0.0301	-2.11	0.22	Indeterminant	NO	NO	Likely Degrading
CLARITY	All	1985-12-10	2020-06-18	0.0046	0.35	0.24	Indeterminant	NO	YES	Likely Improving

Whakatāne and Tauranga WMA

The Whakatāne-Tauranga WMA is dominated by native forest in the upper catchment and includes 100 dairy farms and 36 kiwifruit orchards in the mid to lower reaches. The Whakatāne River originates within the Huiarau and Ikawhenua Ranges and flows 112 km along a graben that is the intersection between the volcanic zone and coast. The river catchment is relatively narrow and most tributaries are short and steep. The valley floor widens at the upper Rūātoki valley and agricultural land use becomes more common. It merges with the Tauranga River (Waimana River) at Taneatua and meanders over shingle bed and river flats to enter the sea at Whakatāne.

The Tauranga River (Waimana River) originates in the Te Urewera National Park and flows about 77 km to enter the Whakatāne River downstream of Taneatua township. The catchment is relatively narrow and each tributary is short and steep. The underlying rock foundation over the whole of the area is greywacke. The final 13 km of the Waimana River is through the Waimana Gorge, here a stony bottomed river forms deep pools popular for swimming (Wardlaw Glade).

Table 8 NERMN sites in the Whakatāne and Tauranga WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Whakatāne and Tauranga								
KL919939	Whakatane opposite Trident	1949195	5789399	VA/Steep	CR	1495	6.4	Impact Q
KL998150	Whakatane at Pekatahi Bridge	1949980	5781507	VA/Steep	WS	1463	17	M
KM938159	Whakatane 300 m d/s SH 30	1949386	5791591	VA/Steep	CR	1738	1.3	Impact Q
LI953392	Tauranga at Ranger Station	1959534	5753920	VA/Steep	AE	211	49.7	M
LK082095	Whakatane at Ruatoki	1950830	5770958	VA/Steep	AE	896	31.2	M
LK149881	Tauranga at Taneatua Bridge	1951494	5778817	VA/Steep	WS	480	22.9	M

Whakatane opposite Trident

March 2021

Table 1 Site metadata.

Aquarius ID:	KL919939	**Labstar ID:**	BOP110168
LAWA ID:		**REC Reach:**	4007557
Easting:	1949195	**Northing:**	5789399
Longitude:	176.97520	**Latitude:**	-37.97589
Elevation:	1 m	**Biophysical Unit:**	VA/Gentle
Flow:	No	**Water Level:**	No
REC Class:	WW_Low_VA		

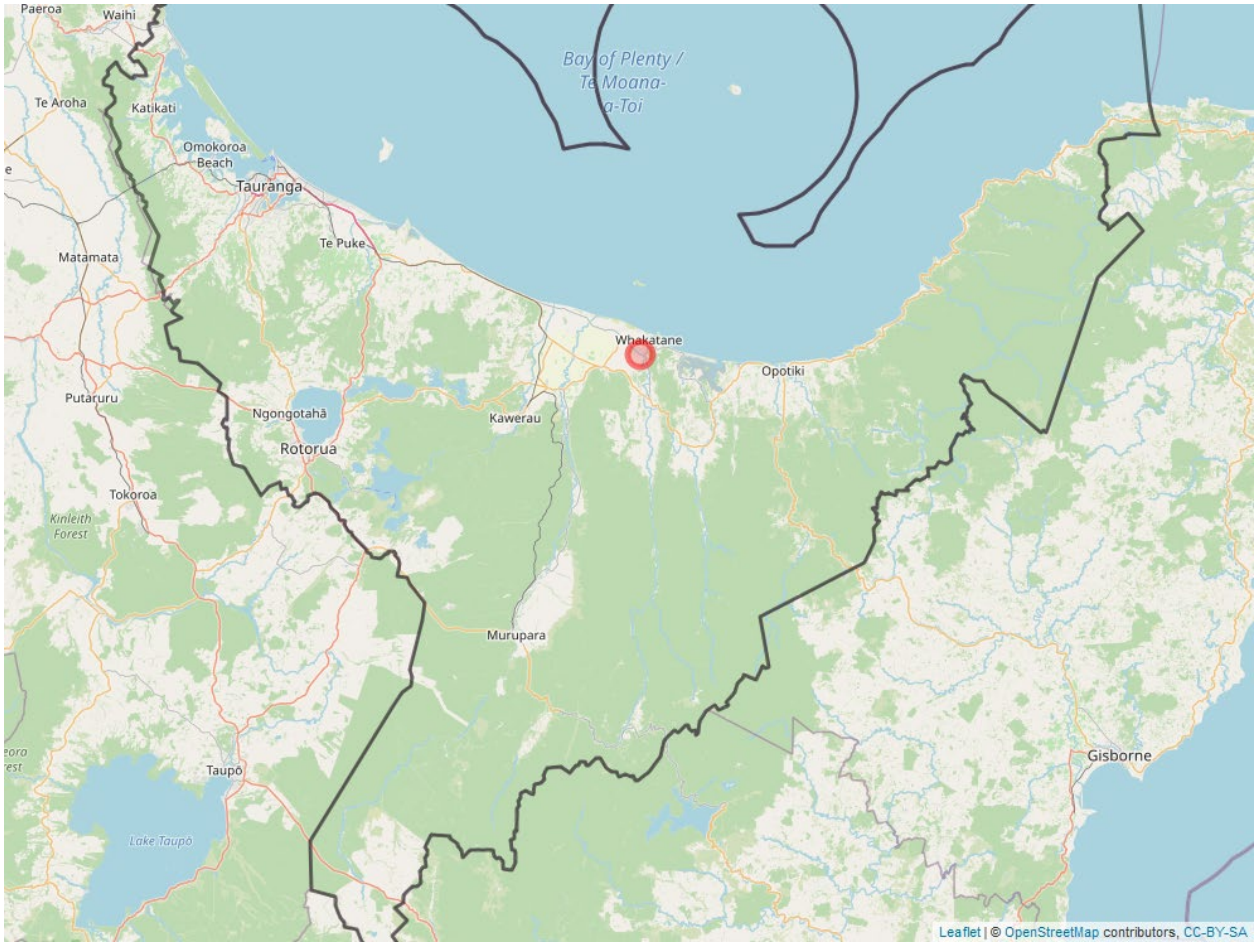


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	34	0.08	0.65	0.20	0.17	0.35	0.11	0.10	0.02
Nitrate Nitrite Nitrogen (g/m3)	34	<0.001	0.22	0.10	0.08	0.20	0.01	0.07	0.01
Total Ammoniacal Nitrogen (g/m3)	34	<0.002	0.037	0.012	0.009	0.030	0.003	0.008	0.001
Total Phosphorus (g/m3)	34	0.025	0.316	0.059	0.045	0.120	0.026	0.052	0.009
Dissolved Reactive Phosphorus (g/m3)	34	0.006	0.043	0.028	0.028	0.039	0.013	0.009	0.001
Dissolved Oxygen Sat (%)	35	81.2	119.0	98.0	96.9	115.5	87.6	8.5	1.4
Dissolved Oxygen (g/m3)	35	7.26	12.79	9.91	10.20	11.75	8.09	1.31	0.22
Escherichia coli (cfu/100ml)	35	8	3600	302	77	1112	14	658	111
Total Suspended Solids (g/m3)	35	1.80	235.00	24.49	7.04	95.99	1.87	50.71	8.57
Turbidity (NTU)	35	1.2	180.0	14.5	3.5	49.8	1.4	32.0	5.4
Water Clarity (m)	1	1.81	1.81	1.81	1.81	1.81	1.81	NA	NA
Conductivity (uS/cm)	34	66	6150	404	107	1536	73	1182	203
pH (pH Units)	34	6.5	7.6	7.1	7.2	7.5	6.7	0.2	0.0
Water Temperature (degC)	35	7.7	22.7	15.1	13.9	21.8	9.8	4.5	0.8
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

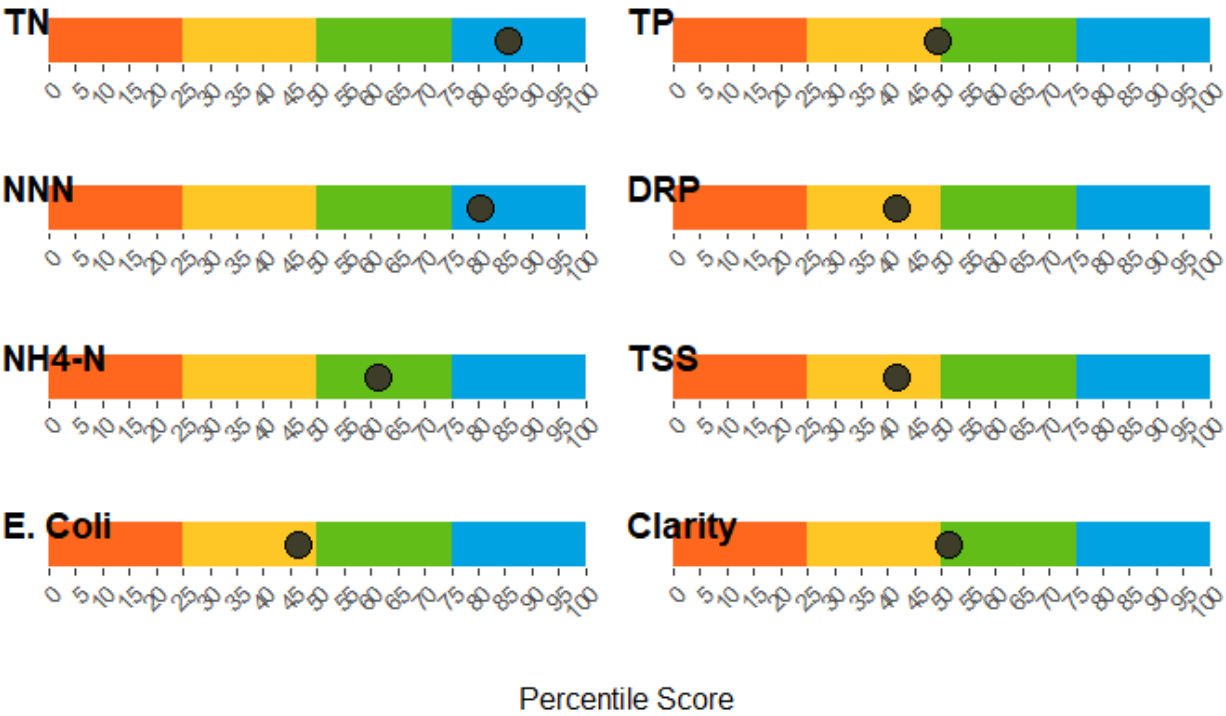


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

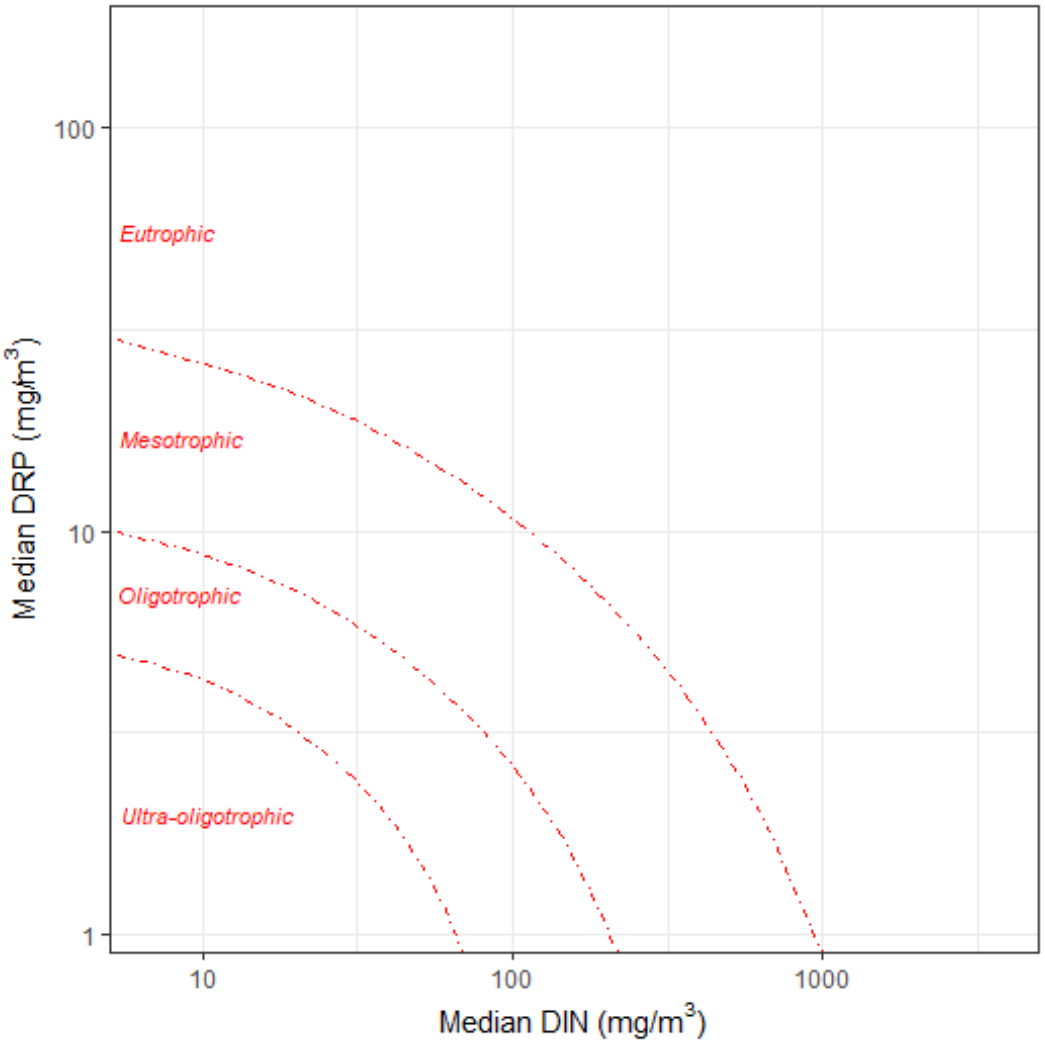


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	3	0.006	0.007	A
5 Years	2015-12-16	2020-12-14	17	0.004	0.01	A
10 Years	2010-12-17	2020-12-14	NA	NA	NA	NA
All	2012-03-23	2020-12-14	33	0.0041	0.0177	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	3	0.08	0.1	A
5 Years	2015-12-16	2020-12-14	17	0.08	0.2	A
10 Years	2010-12-17	2020-12-14	NA	NA	NA	NA
All	2012-03-23	2020-12-14	34	0.08	0.2	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	60	1.38	D
10 Years	2010-12-17	2020-12-14	63	1.41	D
All	1992-08-12	2020-12-14	88	1.31	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	17	0.028	0.037	D
10 Years	2010-12-17	2020-12-14	NA	NA	NA	
All	2012-03-22	2020-12-14	33	0.029	0.039	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-16	2020-12-14	18	5.6	11.1	100	384	B**	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-16	2020-12-14	18	100	488	88.9	5.6	5.6
10 Years	2010-12-17	2020-12-14	NA	NA	NA			
All	2012-03-23	2020-12-14	35	77	1490	80	5.7	14.3

Time series plots

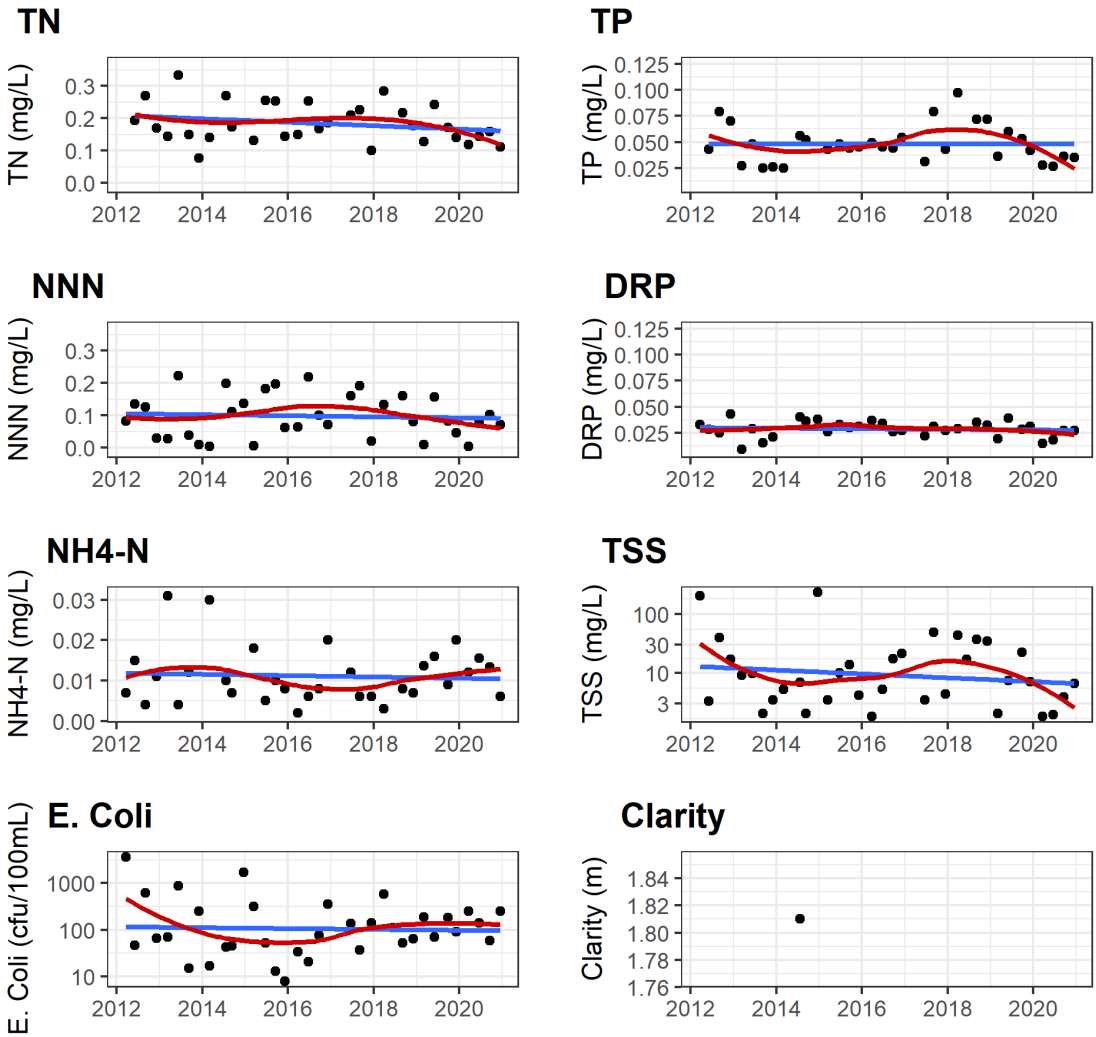


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years									Not Analysed
TN	10 Years	2012-03-23	2020-12-14	-0.0078	-4.55	<0.05	Decreasing	NO	NO	Very Likely Improving
TN	All	2012-03-23	2020-12-14	-0.0078	-4.55	<0.05	Decreasing	NO	NO	Very Likely Improving
NNN	5 Years									Not Analysed
NNN	10 Years	2012-03-23	2020-12-14				Not Analysed	NO	YES	Not Analysed
NNN	All	2012-03-23	2020-12-14				Not Analysed	NO	YES	Not Analysed
NH4N	5 Years									Not Analysed
NH4N	10 Years	2012-03-23	2020-12-14	0.0002	2.34	0.65	Indeterminant	NO	NO	Likely Degrading
NH4N	All	2012-03-23	2020-12-14	0.0002	2.34	0.65	Indeterminant	NO	NO	Likely Degrading
TP	5 Years									Not Analysed
TP	10 Years	2012-03-23	2020-12-14	-0.0013	-3.00	0.31	Indeterminant	NO	NO	Likely Improving
TP	All	2012-03-23	2020-12-14	-0.0013	-3.00	0.31	Indeterminant	NO	NO	Likely Improving
DRP	5 Years									Not Analysed
DRP	10 Years	2012-03-23	2020-12-14	-0.0004	-1.29	0.56	Indeterminant	NO	NO	Likely Improving
DRP	All	2012-03-23	2020-12-14	-0.0004	-1.29	0.56	Indeterminant	NO	NO	Likely Improving
ECOLI	5 Years									Not Analysed

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2012-03-23	2020-12-14	0.0224	1.19	0.57	Indeterminant	NO	NO	Likely Degrading
ECOLI	All	2012-03-23	2020-12-14	0.0224	1.19	0.57	Indeterminant	NO	NO	Likely Degrading
TSS	5 Years									Not Analysed
TSS	10 Years	2012-03-23	2020-12-14	-0.0161	-1.78	0.54	Indeterminant	NO	NO	Likely Improving
TSS	All	2012-03-23	2020-12-14	-0.0161	-1.78	0.54	Indeterminant	NO	NO	Likely Improving
CLARITY	5 Years									Not Analysed
CLARITY	10 Years									Not Analysed
CLARITY	All									Not Analysed

Whakatane at Pekatahi Bridge

March 2021

Table 1 Site metadata.

Aquarius ID:	KL998150	**Labstar ID:**	BOP110011
LAWA ID:	EBOP-00042	**REC Reach:**	4010027
Easting:	1949980	**Northing:**	5781507
Longitude:	176.98797	**Latitude:**	-38.04655
Elevation:	6 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Hill_VA		

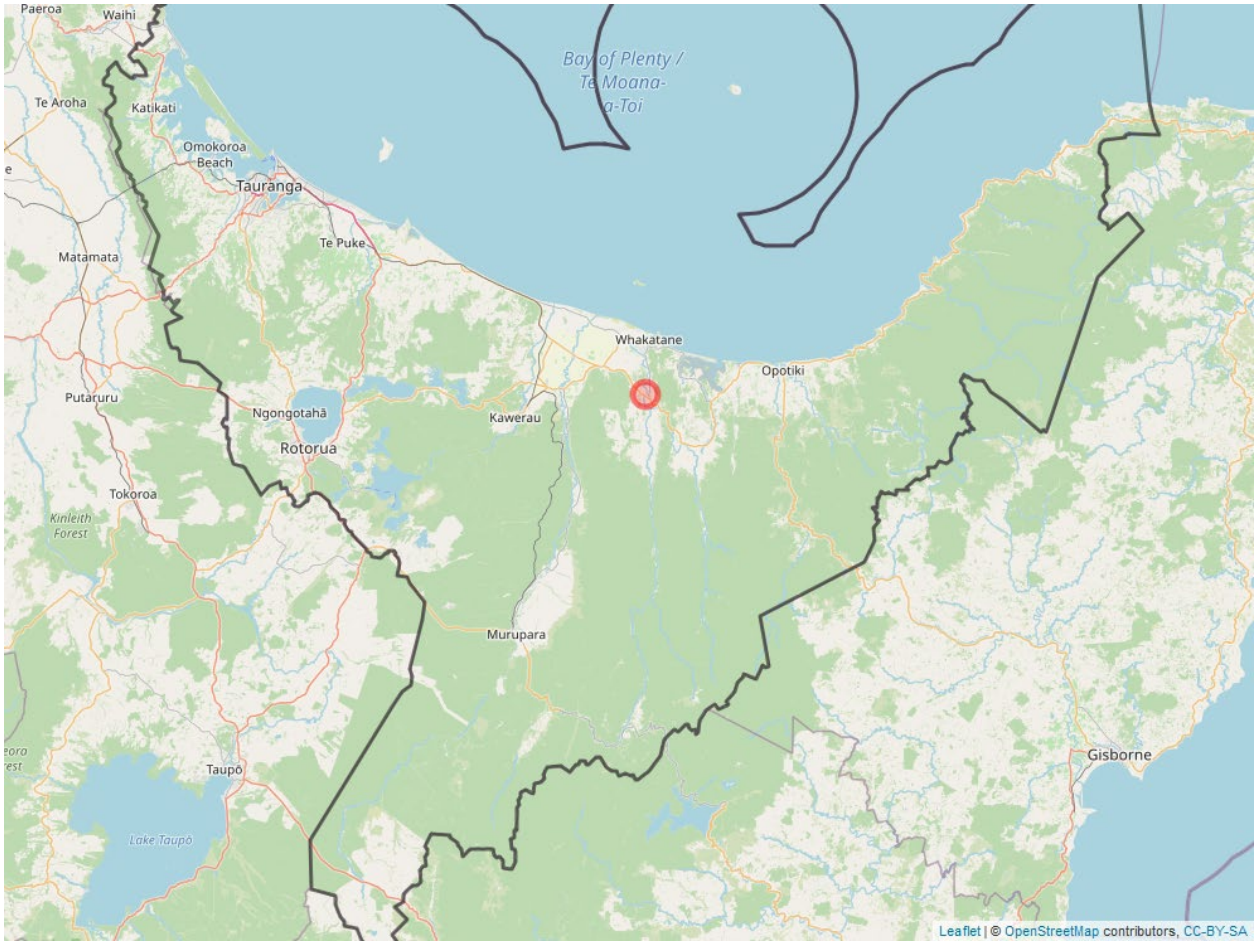


Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_ 95th	Perc_ 5th	StDev	SE
Total Nitrogen (g/m3)	347	0.06	1.08	0.22	0.20	0.41	0.07	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	352	<0.001	0.42	0.11	0.10	0.25	0.01	0.09	0.00
Total Ammoniacal Nitrogen (g/m3)	383	<0.002	0.060	0.009	0.007	0.022	0.001	0.008	0.000
Total Phosphorus (g/m3)	381	0.012	0.995	0.050	0.036	0.116	0.021	0.074	0.004
Dissolved Reactive Phosphorus (g/m3)	384	0.006	0.077	0.025	0.025	0.034	0.014	0.007	0.000
Dissolved Oxygen Sat (%)	160	15.4	160.5	104.3	102.4	130.0	89.8	14.7	1.2
Dissolved Oxygen (g/m3)	373	1.77	16.10	10.37	10.31	12.00	8.90	1.21	0.06
Escherichia coli (cfu/100ml)	364	<1	5200	217	63	925	9	552	29
Total Suspended Solids (g/m3)	384	<1	2940.00	30.17	5.20	89.64	1.10	168.69	8.61
Turbidity (NTU)	373	0.3	1696.0	19.2	3.0	50.0	0.8	110.6	5.7
Water Clarity (m)	309	0.00	6.18	2.07	1.90	4.77	0.24	1.40	0.08
Conductivity (uS/cm)	382	46	264	91	91	111	69	17	1
pH (pH Units)	378	6.2	8.8	7.4	7.4	7.8	7.0	0.3	0.0
Water Temperature (degC)	378	6.5	25.5	15.2	14.9	22.4	8.7	4.4	0.2
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

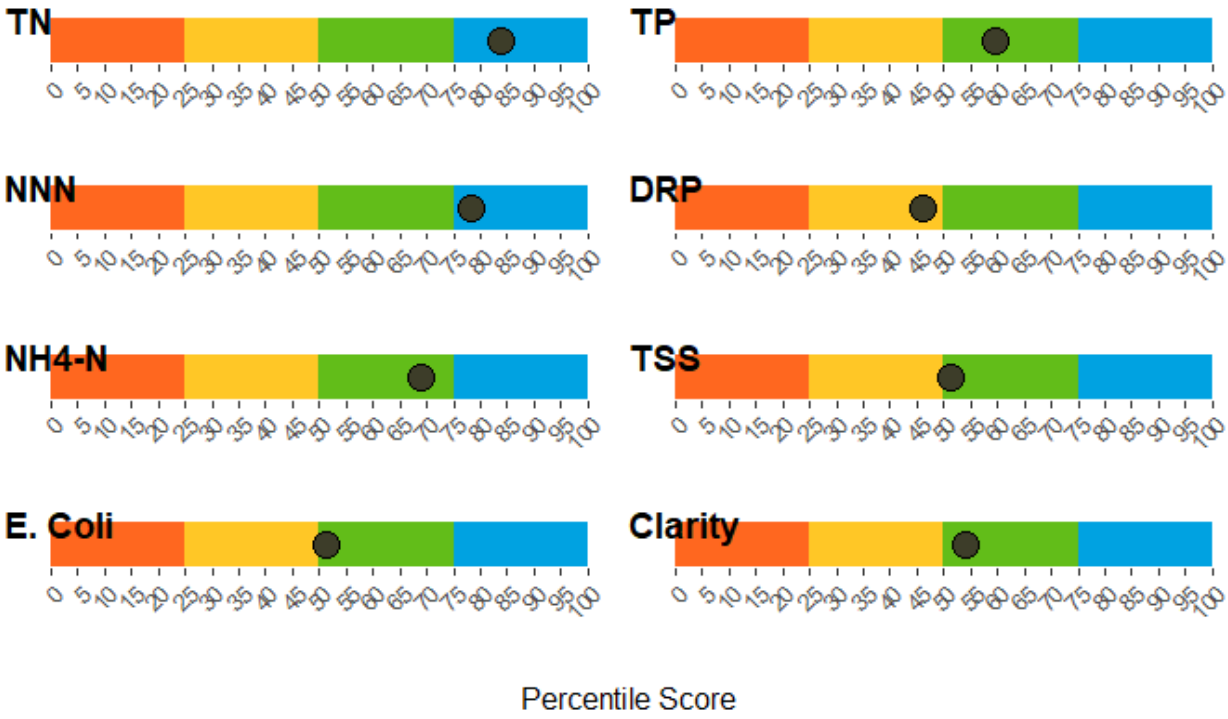


Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

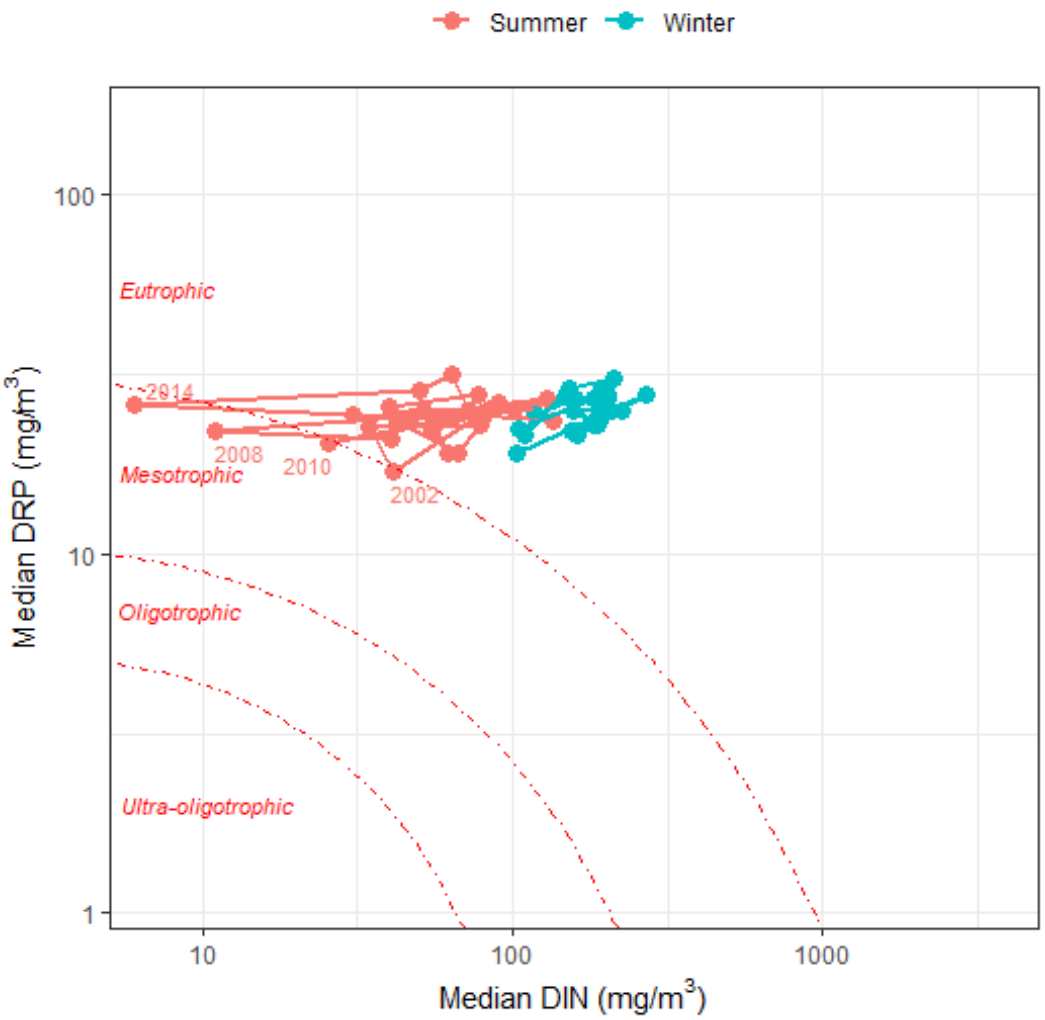


Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-16	2020-12-15	15	0.0030	0.012	A
5 Years	2015-12-17	2020-12-15	105	0.0030	0.024	A
10 Years	2010-12-18	2020-12-15	166	0.0030	0.024	A
All	1991-01-18	2020-12-15	375	0.0038	0.031	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-16	2020-12-15	15	0.07	0.17	A
5 Years	2015-12-17	2020-12-15	106	0.11	0.27	A
10 Years	2010-12-18	2020-12-15	167	0.10	0.27	A
All	1992-09-21	2020-12-15	352	0.10	0.25	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-15	94	1.63	B
10 Years	2010-12-18	2020-12-15	152	2.21	A
All	1992-08-06	2020-12-15	309	1.90	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	105	0.027	0.035	D
10 Years	2010-12-17	2020-12-14	166	0.027	0.035	D
All	1985-12-06	2020-12-14	383	0.025	0.034	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-17	2020-12-15	106	8.5	12.3	50	1355	D	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-17	2020-12-15	106	50	1480	87.7	3.8	8.5
10 Years	2010-12-18	2020-12-15	166	42	1480	90.4	2.4	7.2
All	1991-01-18	2020-12-15	364	63	939	87.4	4.7	8

Time series plots

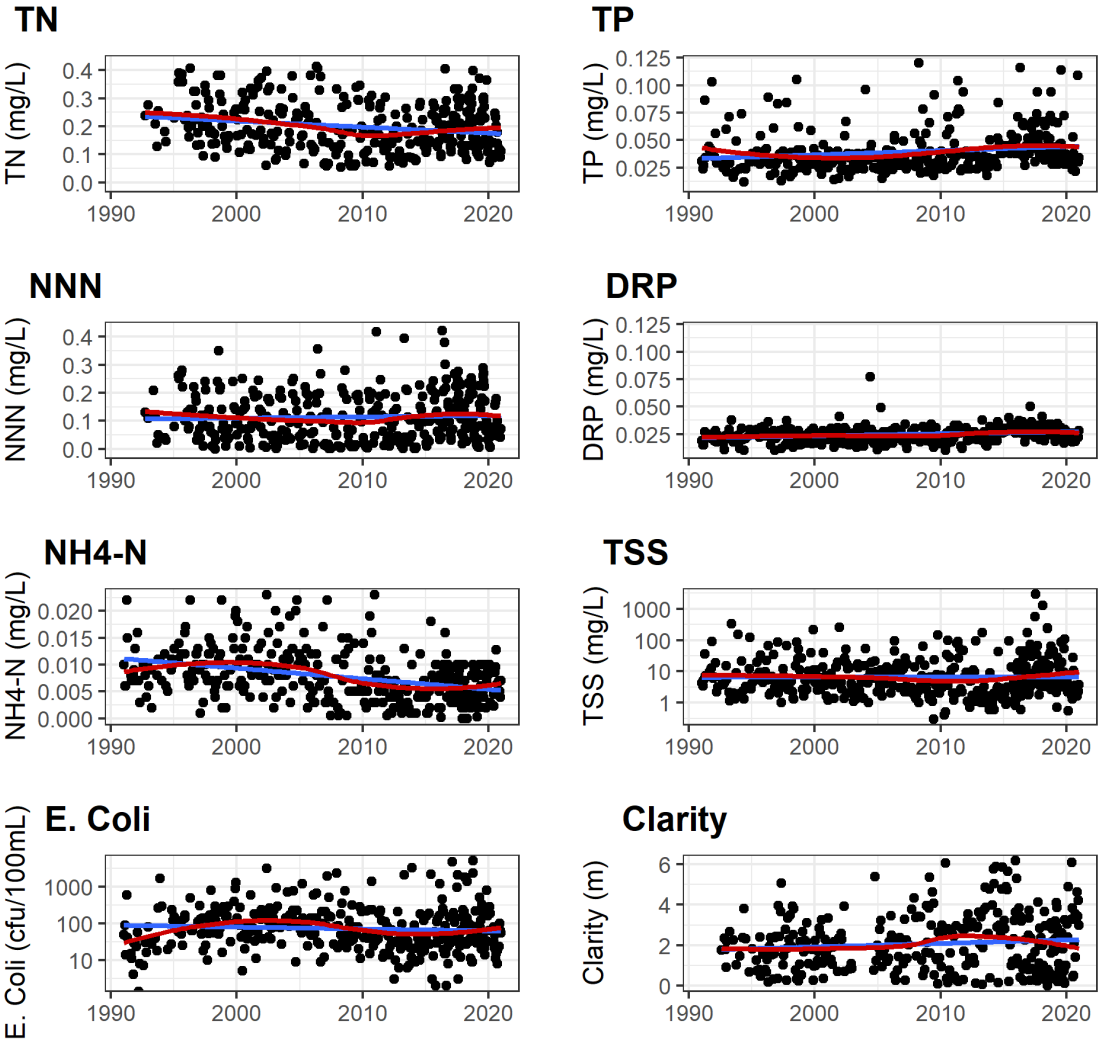


Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-16	2020-12-15	-0.0164	-8.29	<0.01	Decreasing	NO	YES	Very Likely Improving
TN	10 Years	2011-01-12	2020-12-15	0.0032	1.84	0.09	Increasing	NO	YES	Very Likely Degrading
TN	All	1991-01-18	2020-12-15	-0.0027	-1.36	<0.001	Decreasing	NO	YES	Very Likely Improving
NNN	5 Years	2016-01-16	2020-12-15	-0.0126	-11.42	<0.01	Decreasing	NO	YES	Very Likely Improving
NNN	10 Years	2011-01-12	2020-12-15	0.0023	2.23	0.15	Indeterminant	NO	YES	Very Likely Degrading
NNN	All	1991-01-18	2020-12-15	-0.0002	-0.19	0.59	Indeterminant	NO	YES	Likely Improving
NH4N	5 Years	2016-01-16	2020-12-15	-0.0003	-5.00	0.36	Indeterminant	NO	YES	Likely Improving
NH4N	10 Years	2011-01-12	2020-12-15	0.0001	1.99	0.16	Indeterminant	NO	YES	Very Likely Degrading
NH4N	All	1991-01-18	2020-12-15	-0.0002	-2.87	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2016-01-16	2020-12-15	-0.0044	-10.44	<0.01	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2011-01-12	2020-12-15	0.0012	2.99	<0.05	Increasing	NO	NO	Very Likely Degrading
TP	All	1991-01-18	2020-12-15	0.0004	1.18	<0.001	Increasing	NO	NO	Very Likely Degrading
DRP	5 Years	2016-01-16	2020-12-15	-0.0018	-6.50	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-01-12	2020-12-15	0.0000	0.00	0.70	Indeterminant	NO	NO	Indeterminate/Uncertain
DRP	All	1991-01-18	2020-12-15	0.0002	0.77	<0.001	Increasing	NO	NO	Very Likely Degrading
ECOLI	5 Years	2016-01-16	2020-12-15	-0.0263	-1.55	0.50	Indeterminant	NO	YES	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-12	2020-12-15	0.0283	1.73	<0.05	Increasing	NO	YES	Very Likely Degrading
ECOLI	All	1991-01-18	2020-12-15	-0.0075	-0.41	<0.05	Decreasing	NO	YES	Very Likely Improving
TSS	5 Years	2016-01-16	2020-12-15	-0.1125	-11.79	<0.05	Decreasing	NO	YES	Very Likely Improving
TSS	10 Years	2011-01-12	2020-12-15	0.0348	4.55	<0.05	Increasing	NO	YES	Very Likely Degrading
TSS	All	1991-01-18	2020-12-15	-0.0040	-0.50	0.10	Indeterminant	NO	YES	Likely Improving
CLARITY	5 Years	2016-01-16	2020-12-15	0.1590	9.75	0.25	Indeterminant	NO	YES	Likely Improving
CLARITY	10 Years	2011-01-12	2020-12-15	-0.0418	-1.89	0.54	Indeterminant	NO	YES	Likely Degrading
CLARITY	All	1991-01-18	2020-12-15	0.0249	1.31	<0.05	Increasing	NO	YES	Very Likely Improving

Whakatane 300 m d/s SH 30

March 2021

Table 1 Site metadata.

Aquarius ID:	KM938159	**Labstar ID:**	BOP110159
LAWA ID:		**REC Reach:**	4006872
Easting:	1949386	**Northing:**	5791591
Longitude:	176.97630	**Latitude:**	-37.95611
Elevation:	3 m	**Biophysical Unit:**	VA/Steep
Flow:	No	**Water Level:**	No
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

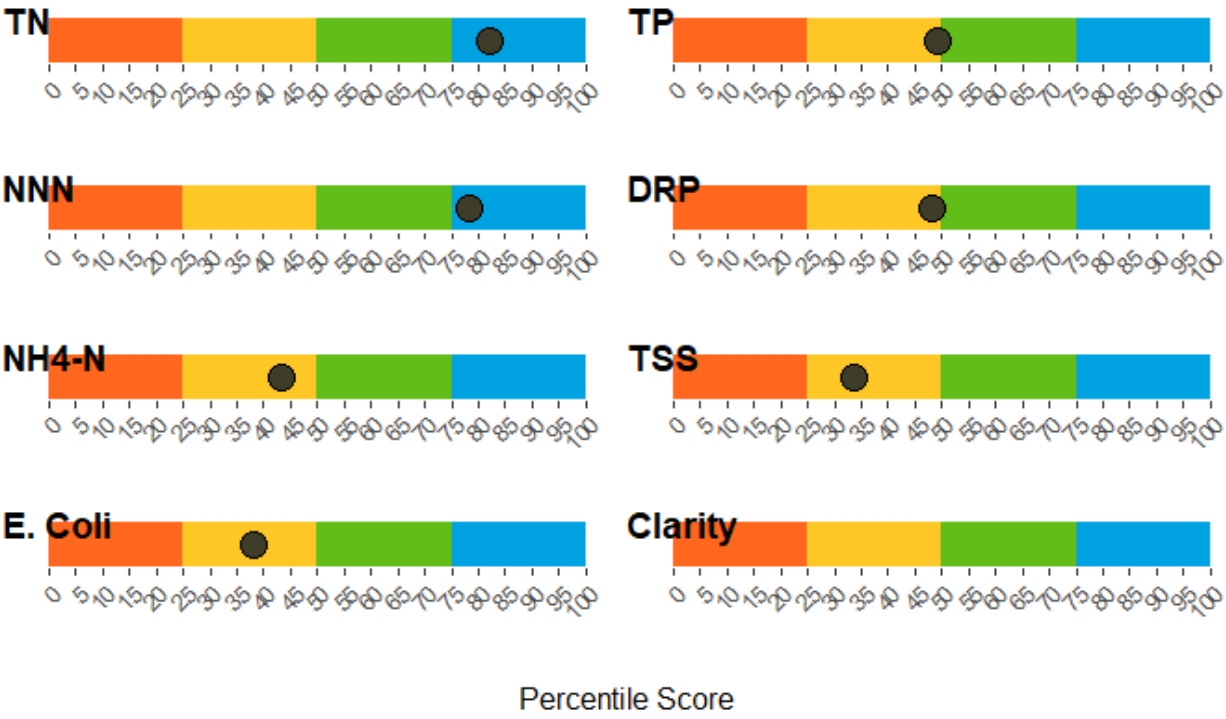
Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	46	0.11	0.79	0.25	0.22	0.37	0.13	0.12	0.02
Nitrate Nitrite Nitrogen (g/m3)	46	<0.001	0.60	0.11	0.10	0.24	0.01	0.10	0.02
Total Ammoniacal Nitrogen (g/m3)	46	<0.002	0.050	0.019	0.016	0.043	0.001	0.013	0.002
Total Phosphorus (g/m3)	46	0.023	0.279	0.055	0.044	0.109	0.027	0.041	0.006
Dissolved Reactive Phosphorus (g/m3)	46	0.004	0.046	0.023	0.024	0.035	0.011	0.008	0.001
Dissolved Oxygen Sat (%)	42	81.5	122.4	94.5	93.8	104.1	83.2	7.1	1.1
Dissolved Oxygen (g/m3)	47	7.23	13.05	9.31	9.25	11.10	7.49	1.29	0.19
Escherichia coli (cfu/100ml)	46	4	3300	392	115	2600	18	781	115
Total Suspended Solids (g/m3)	47	3.11	410.00	25.98	9.00	75.24	3.51	63.11	9.21
Turbidity (NTU)	47	1.8	250.0	17.0	4.8	52.1	2.3	41.1	6.0
Water Clarity (m)									
Conductivity (uS/cm)	47	49	16300	4940	3980	13354	101	4542	663
pH (pH Units)	47	6.8	8.8	7.2	7.3	7.4	6.9	0.3	0.0
Water Temperature (degC)	46	7.9	23.1	15.8	13.9	22.4	10.1	4.8	0.7
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).



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The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

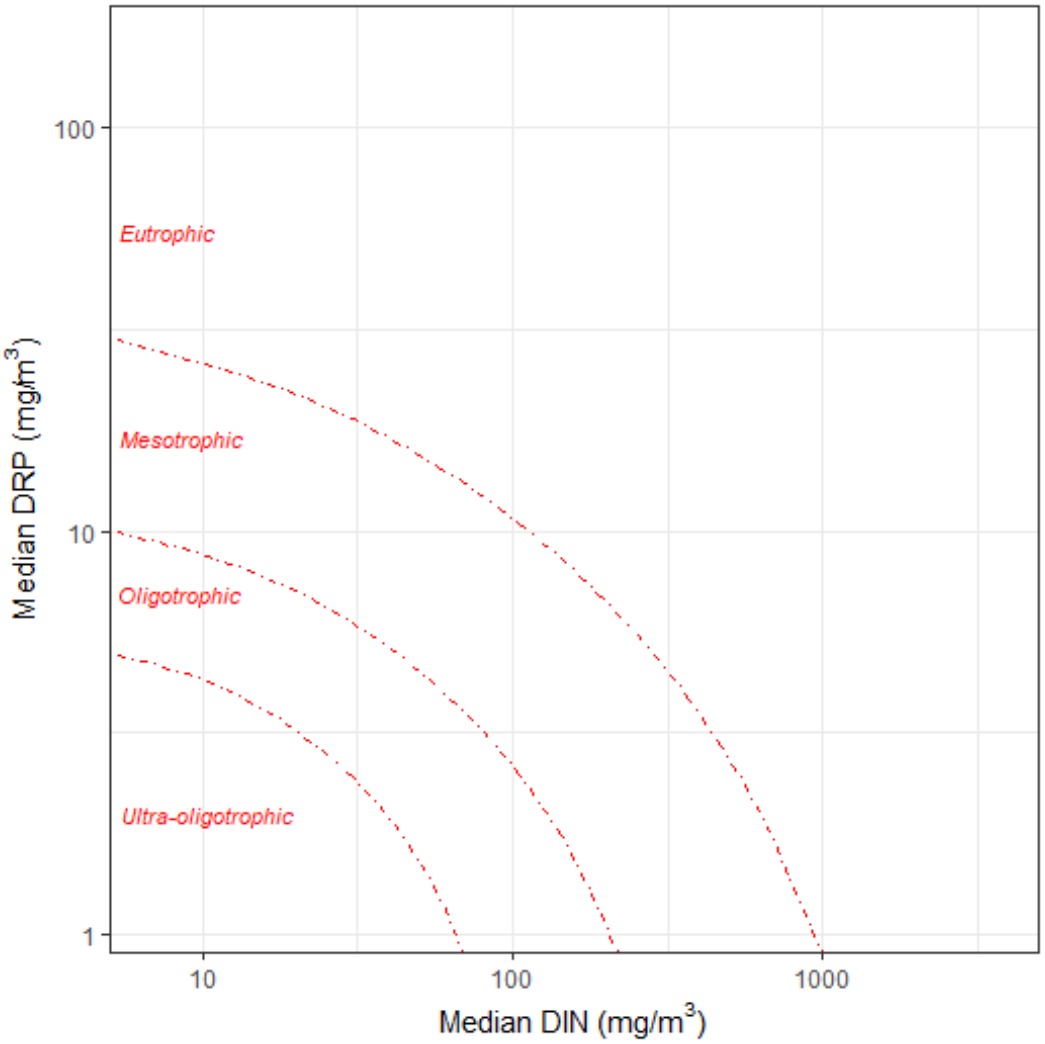

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	3	0.0150	0.018	A
5 Years	2015-12-16	2020-12-14	17	0.0070	0.018	A
10 Years	2010-12-17	2020-12-14	37	0.0080	0.020	A
All	2009-03-03	2020-12-14	46	0.0077	0.021	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	3	0.08	0.10	A
5 Years	2015-12-16	2020-12-14	17	0.11	0.21	A
10 Years	2010-12-17	2020-12-14	37	0.11	0.24	A
All	2009-03-03	2020-12-14	46	0.10	0.24	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-03	2020-12-01	58	2.49	C*
10 Years	2010-12-04	2020-12-01	NA	NA	
All	2013-12-03	2020-12-01	69	2.50	C

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	17	0.024	0.033	D
10 Years	2010-12-17	2020-12-14	37	0.024	0.035	D
All	2009-03-02	2020-12-14	45	0.024	0.035	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-16	2020-12-14	18	5.6	11.1	145	784	D**	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

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Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-16	2020-12-14	18	145	2116	88.9	5.6	5.6
10 Years	2010-12-17	2020-12-14	38	115	2600	76.3	13.2	10.5
All	2009-03-03	2020-12-14	46	115	2840	73.9	10.9	15.2

Time series plots

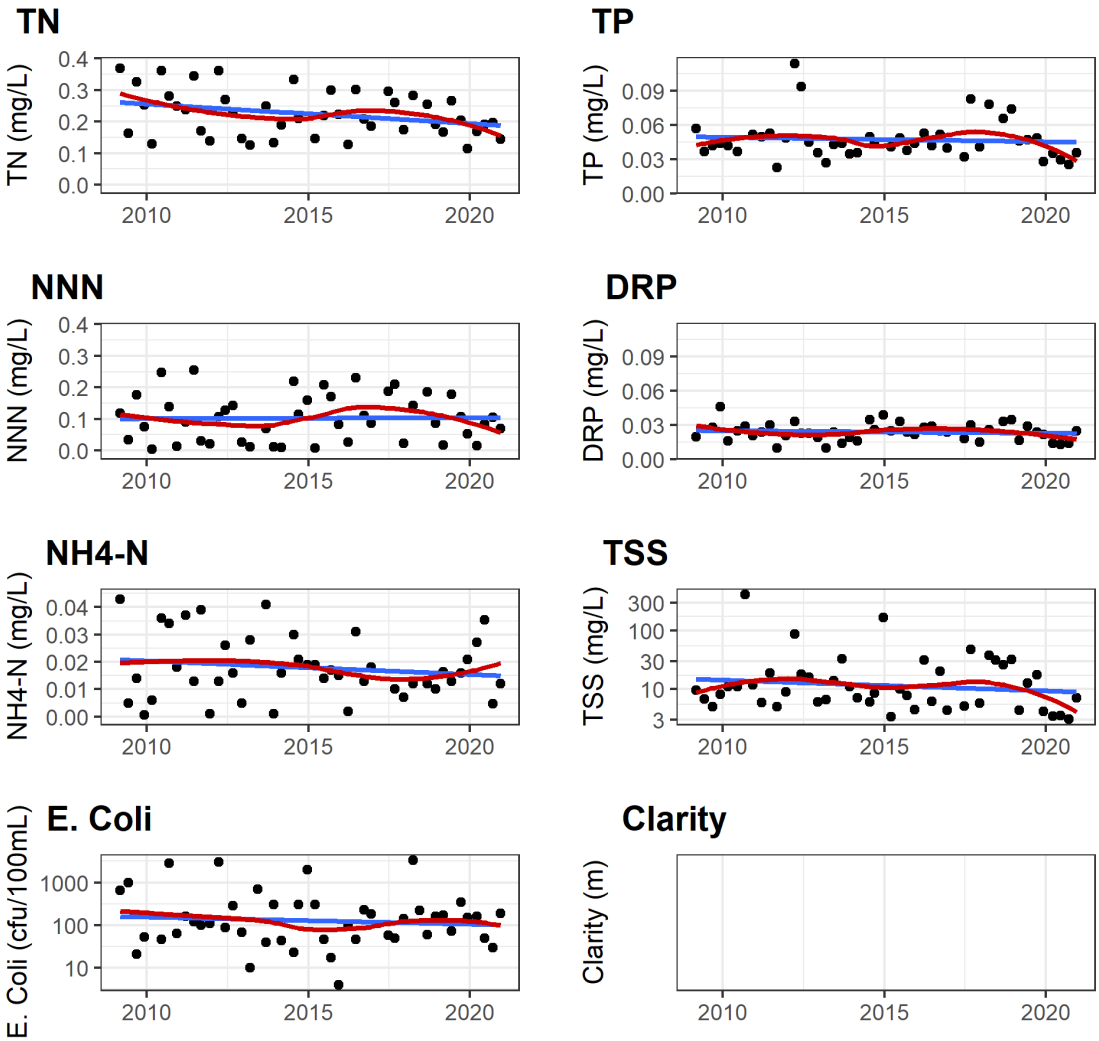

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

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Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years									Not Analysed
TN	10 Years	2011-03-17	2020-12-14	-0.0045	-2.13	0.25	Indeterminant	NO	YES	Likely Improving
TN	All	2009-03-03	2020-12-14	-0.0075	-3.38	<0.05	Decreasing	NO	YES	Very Likely Improving
NNN	5 Years									Not Analysed
NNN	10 Years	2011-03-17	2020-12-14	0.0005	0.51	0.96	Indeterminant	NO	YES	Indeterminate/Uncertain
NNN	All	2009-03-03	2020-12-14	0.0007	0.74	0.85	Indeterminant	NO	YES	Indeterminate/Uncertain
NH4N	5 Years									Not Analysed
NH4N	10 Years	2011-03-17	2020-12-14	-0.0006	-3.60	0.33	Indeterminant	NO	NO	Likely Improving
NH4N	All	2009-03-03	2020-12-14	-0.0003	-1.57	0.52	Indeterminant	NO	NO	Likely Improving
TP	5 Years									Not Analysed
TP	10 Years	2011-03-17	2020-12-14	-0.0010	-2.25	0.28	Indeterminant	NO	NO	Likely Improving
TP	All	2009-03-03	2020-12-14	-0.0007	-1.51	0.28	Indeterminant	NO	NO	Likely Improving
DRP	5 Years									Not Analysed
DRP	10 Years	2011-03-17	2020-12-14	0.0000	0.00	0.95	Indeterminant	NO	NO	Indeterminate/Uncertain
DRP	All	2009-03-03	2020-12-14	0.0000	0.00	0.98	Indeterminant	NO	NO	Indeterminate/Uncertain
ECOLI	5 Years									Not Analysed

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-03-17	2020-12-14	-0.0069	-0.33	0.91	Indeterminant	NO	NO	Indeterminate/Uncertain
ECOLI	All	2009-03-03	2020-12-14	-0.0045	-0.22	0.87	Indeterminant	NO	NO	Indeterminate/Uncertain
TSS	5 Years									Not Analysed
TSS	10 Years	2011-03-17	2020-12-14	-0.0258	-2.64	0.16	Indeterminant	NO	NO	Likely Improving
TSS	All	2009-03-03	2020-12-14	-0.0172	-1.72	0.24	Indeterminant	NO	NO	Likely Improving
CLARITY	5 Years									Not Analysed
CLARITY	10 Years									Not Analysed
CLARITY	All									Not Analysed

Tauranga at Ranger Station

March 2021

Table 1. Site metadata.

Aquarius ID:	LI953392	**Labstar ID:**	BOP160104
LAWA ID:	LAWA-100655	**REC Reach:**	4018693
Easting:	1959534	**Northing:**	5753920
Longitude:	177.11050	**Latitude:**	-38.29080
Elevation:	120 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_VA		

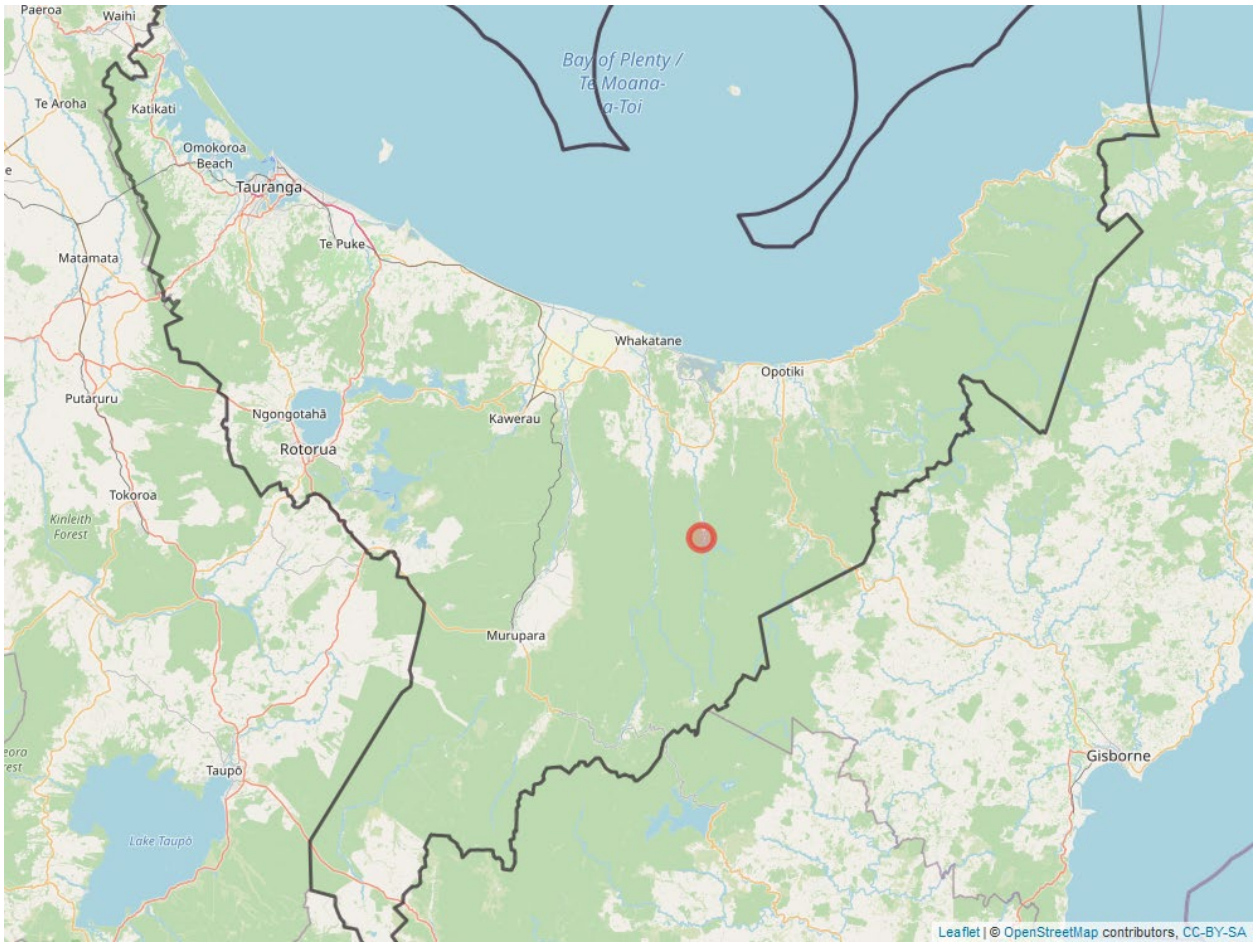

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	97	<0.01	0.47	0.07	0.06	0.18	0.03	0.07	0.01
Nitrate Nitrite Nitrogen (g/m3)	97	<0.001	0.23	0.03	0.02	0.09	0.00	0.04	0.00
Total Ammoniacal Nitrogen (g/m3)	95	<0.002	0.011	0.003	0.003	0.007	0.001	0.002	0.000
Total Phosphorus (g/m3)	97	0.021	0.217	0.035	0.030	0.065	0.022	0.024	0.002
Dissolved Reactive Phosphorus (g/m3)	97	0.016	0.033	0.025	0.025	0.030	0.020	0.003	0.000
Dissolved Oxygen Sat (%)	92	46.5	118.0	101.3	101.5	109.8	96.2	7.5	0.8
Dissolved Oxygen (g/m3)	93	4.01	78.63	11.00	10.52	11.91	8.65	7.18	0.74
Escherichia coli (cfu/100ml)	97	<1	5800	107	5	440	0	600	61
Total Suspended Solids (g/m3)	96	<1	210.00	8.90	1.40	43.29	0.12	25.77	2.63
Turbidity (NTU)	97	0.2	135.0	6.6	1.0	30.7	0.3	17.8	1.8
Water Clarity (m)	93	0.10	9.02	4.12	4.10	7.97	0.28	2.59	0.27
Conductivity (uS/cm)	97	59	150	82	82	101	66	12	1
pH (pH Units)	96	6.0	8.0	7.5	7.5	7.9	6.9	0.3	0.0
Water Temperature (degC)	96	5.9	24.6	14.6	13.9	22.0	8.3	4.5	0.5
Discharge (m3/s)									

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

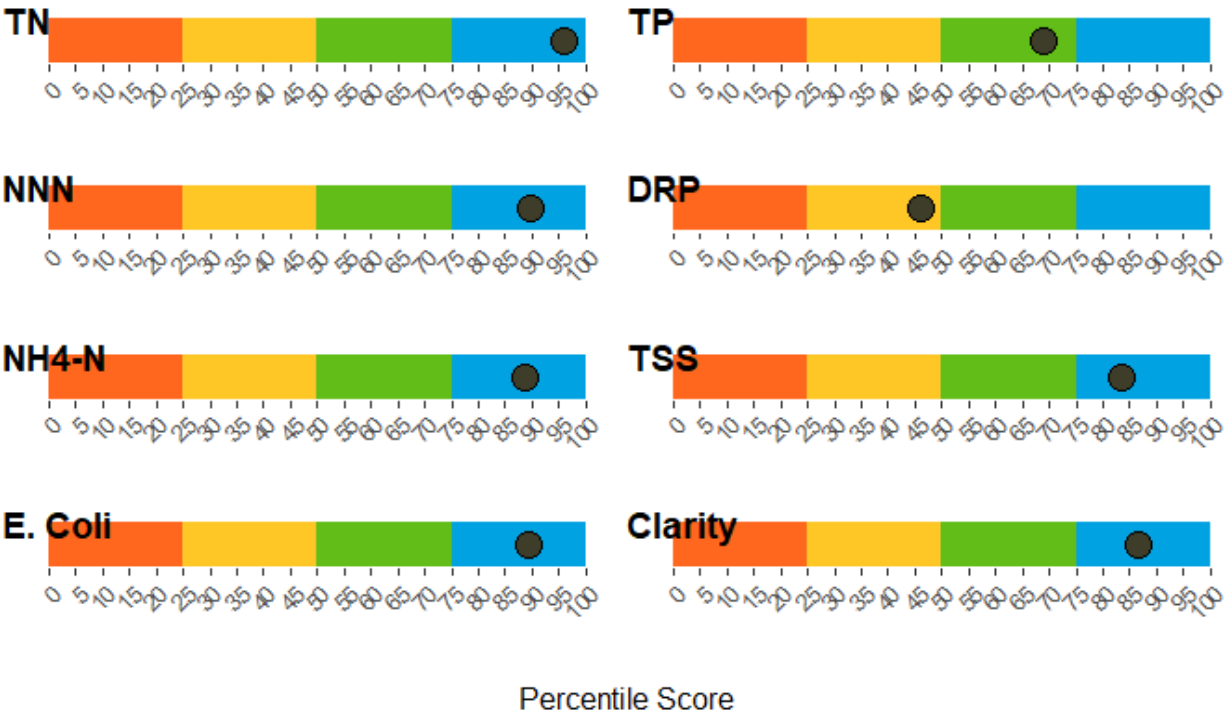

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

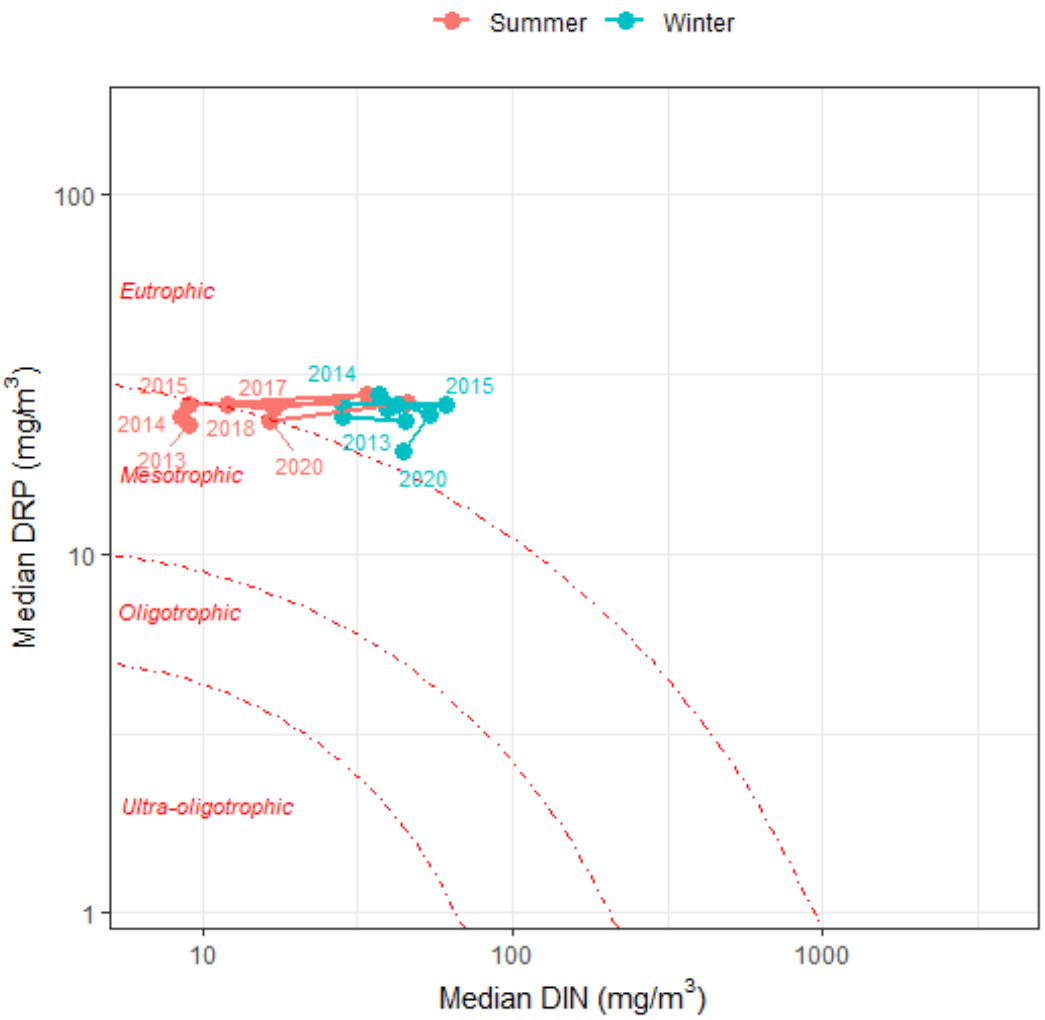

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-16	2020-12-15	10	0.003	0.005	A
5 Years	2015-12-17	2020-12-15	54	0.002	0.006	A
10 Years	2010-12-18	2020-12-15	NA	NA	NA	NA
All	2012-07-06	2020-12-15	94	0.0015	0.0061	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-16	2020-12-15	10	0.03	0.07	A
5 Years	2015-12-17	2020-12-15	55	0.03	0.09	A
10 Years	2010-12-18	2020-12-15	NA	NA	NA	NA
All	2012-07-06	2020-12-15	97	0.02	0.09	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-15	51	2.70	A*
10 Years	2010-12-18	2020-12-15	NA	NA	
All	2012-07-06	2020-12-15	92	4.13	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	54	0.025	0.029	D
10 Years	2010-12-17	2020-12-14	NA	NA	NA	
All	2012-07-05	2020-12-14	96	0.025	0.030	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-17	2020-12-15	55	1.8	9.1	5	339	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-17	2020-12-15	55	5	398	90.9	7.3	1.8
10 Years	2010-12-18	2020-12-15	NA	NA	NA			
All	2012-07-06	2020-12-15	97	5	462	91.8	5.2	3.1

Time series plots

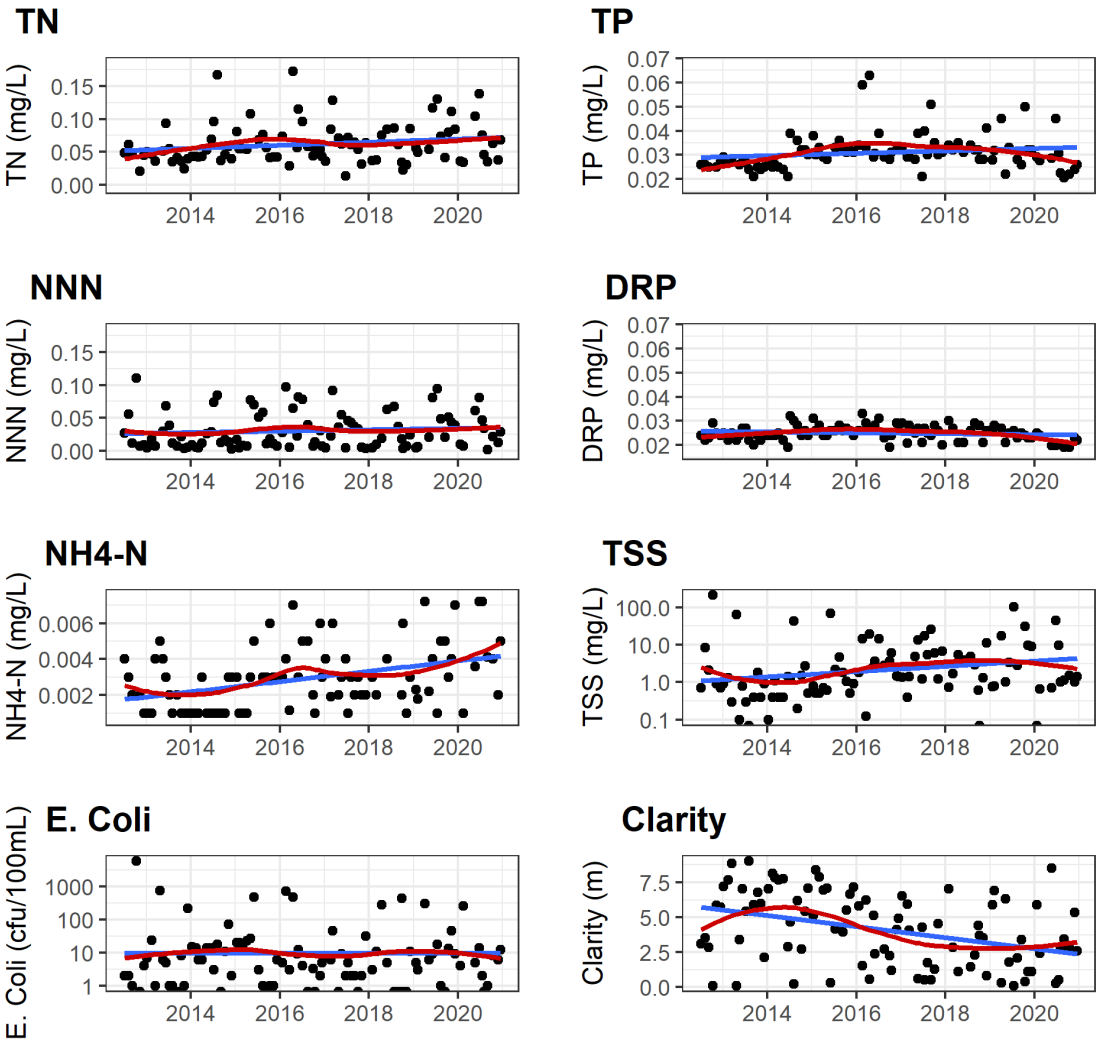

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-22	2020-12-15	-0.0010	-1.59	0.80	Indeterminant	NO	NO	Indeterminate/Uncertain
TN	10 Years	2012-07-06	2020-12-15	0.0020	3.57	0.08	Increasing	NO	YES	Very Likely Degrading
TN	All	2012-07-06	2020-12-15	0.0020	3.57	0.08	Increasing	NO	YES	Very Likely Degrading
NNN	5 Years	2016-01-22	2020-12-15	0.0002	0.66	0.94	Indeterminant	NO	YES	Indeterminate/Uncertain
NNN	10 Years	2012-07-06	2020-12-15	0.0006	2.88	0.15	Indeterminant	NO	YES	Very Likely Degrading
NNN	All	2012-07-06	2020-12-15	0.0006	2.88	0.15	Indeterminant	NO	YES	Very Likely Degrading
NH4N	5 Years	2016-01-22	2020-12-15	0.0000	0.00	0.66	Indeterminant	NO	NO	Likely Degrading
NH4N	10 Years	2012-07-06	2020-12-15	0.0001	4.84	<0.05	Increasing	NO	NO	Very Likely Degrading
NH4N	All	2012-07-06	2020-12-15	0.0001	4.84	<0.05	Increasing	NO	NO	Very Likely Degrading
TP	5 Years	2016-01-22	2020-12-15	-0.0013	-4.10	<0.05	Decreasing	NO	NO	Very Likely Improving
TP	10 Years	2012-07-06	2020-12-15	0.0003	1.11	0.21	Indeterminant	NO	NO	Likely Degrading
TP	All	2012-07-06	2020-12-15	0.0003	1.11	0.21	Indeterminant	NO	NO	Likely Degrading
DRP	5 Years	2016-01-22	2020-12-15	-0.0013	-5.31	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2012-07-06	2020-12-15	0.0000	-0.09	0.19	Indeterminant	NO	NO	Likely Improving
DRP	All	2012-07-06	2020-12-15	0.0000	-0.09	0.19	Indeterminant	NO	NO	Likely Improving
ECOLI	5 Years	2016-01-22	2020-12-15	0.0000	0.00	0.83	Indeterminant	NO	NO	Indeterminate/Uncertain

ECOLI	10 Years	2012-07-06	2020-12-15	0.0000	0.00	0.75	Indeterminant	NO	YES	Indeterminate/Uncertain
ECOLI	All	2012-07-06	2020-12-15	0.0000	0.00	0.75	Indeterminant	NO	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-22	2020-12-15	-0.0380	-6.56	0.15	Indeterminant	NO	YES	Likely Improving
TSS	10 Years	2012-07-06	2020-12-15	0.0263	6.91	<0.05	Increasing	NO	YES	Very Likely Degrading
TSS	All	2012-07-06	2020-12-15	0.0263	6.91	<0.05	Increasing	NO	YES	Very Likely Degrading
CLARITY	5 Years	2016-01-22	2020-12-15	0.0262	0.97	0.66	Indeterminant	NO	YES	Indeterminate/Uncertain
CLARITY	10 Years	2012-07-06	2020-12-15	-0.3525	-8.60	<0.001	Decreasing	NO	YES	Very Likely Degrading
CLARITY	All	2012-07-06	2020-12-15	-0.3525	-8.60	<0.001	Decreasing	NO	YES	Very Likely Degrading

Whakatane at Ruatoki

March 2021

Table 1 Site metadata.

Aquarius ID:	LK082095	**Labstar ID:**	BOP110010
LAWA ID:	EBOP-00041	**REC Reach:**	4013618
Easting:	1950830	**Northing:**	5770958
Longitude:	177.00281	**Latitude:**	-38.14106
Elevation:	25 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	127	0.03	0.64	0.13	0.11	0.27	0.06	0.10	0.01
Nitrate Nitrite Nitrogen (g/m3)	127	<0.001	0.20	0.06	0.04	0.14	0.01	0.04	0.00
Total Ammoniacal Nitrogen (g/m3)	141	<0.002	0.026	0.004	0.004	0.011	0.001	0.004	0.000
Total Phosphorus (g/m3)	141	0.014	0.804	0.050	0.035	0.088	0.019	0.077	0.006
Dissolved Reactive Phosphorus (g/m3)	139	0.005	0.064	0.027	0.028	0.037	0.016	0.007	0.001
Dissolved Oxygen Sat (%)	80	74.7	116.7	102.7	102.2	113.2	93.8	6.9	0.8
Dissolved Oxygen (g/m3)	136	6.79	13.40	10.31	10.38	11.96	8.82	1.08	0.09
Escherichia coli (cfu/100ml)	137	<1	2200	67	11	208	1	250	21
Total Suspended Solids (g/m3)	140	<1	1710.00	25.87	3.40	85.02	0.50	147.19	12.44
Turbidity (NTU)	139	0.4	1232.0	18.0	2.1	51.7	0.6	106.1	9.0
Water Clarity (m)	118	0.00	7.50	2.57	2.30	5.80	0.20	1.82	0.17
Conductivity (uS/cm)	140	41	168	95	94	118	73	15	1
pH (pH Units)	141	6.7	8.1	7.4	7.5	7.7	7.2	0.2	0.0
Water Temperature (degC)	140	6.2	25.6	15.1	14.5	23.2	8.5	4.6	0.4
Discharge (m3/s)	50	4.80	40.70	15.30	14.00	31.20	6.40	7.40	1.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

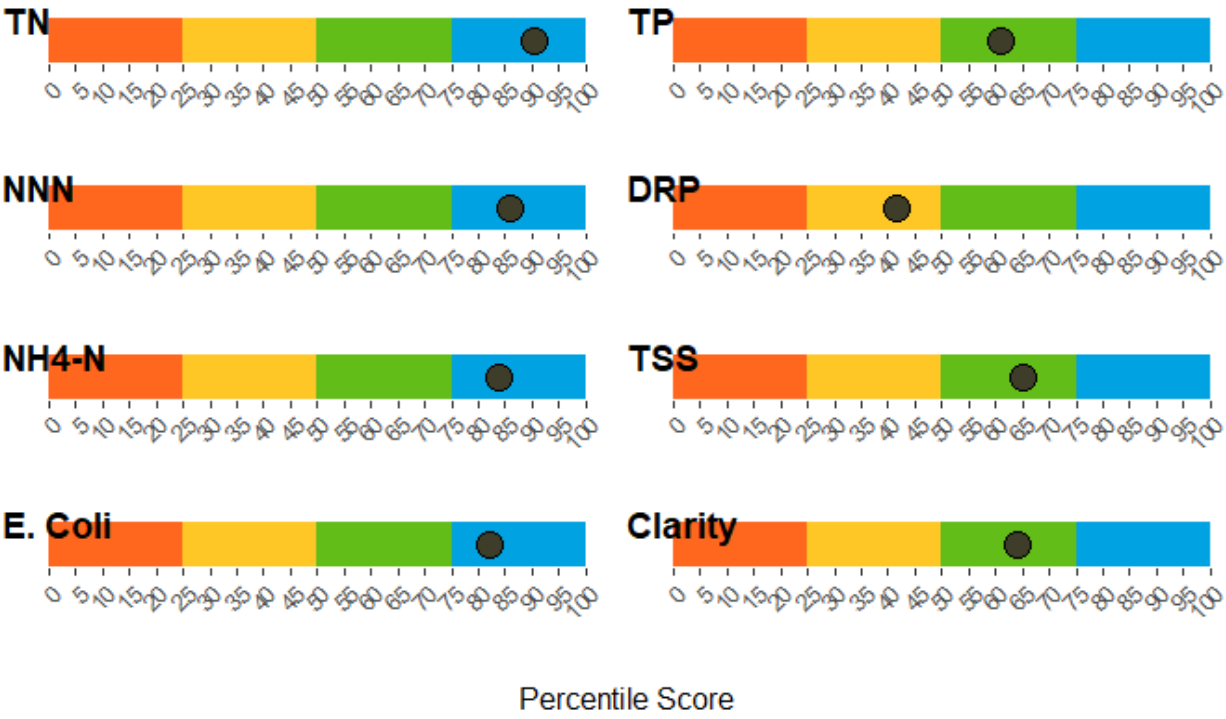

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

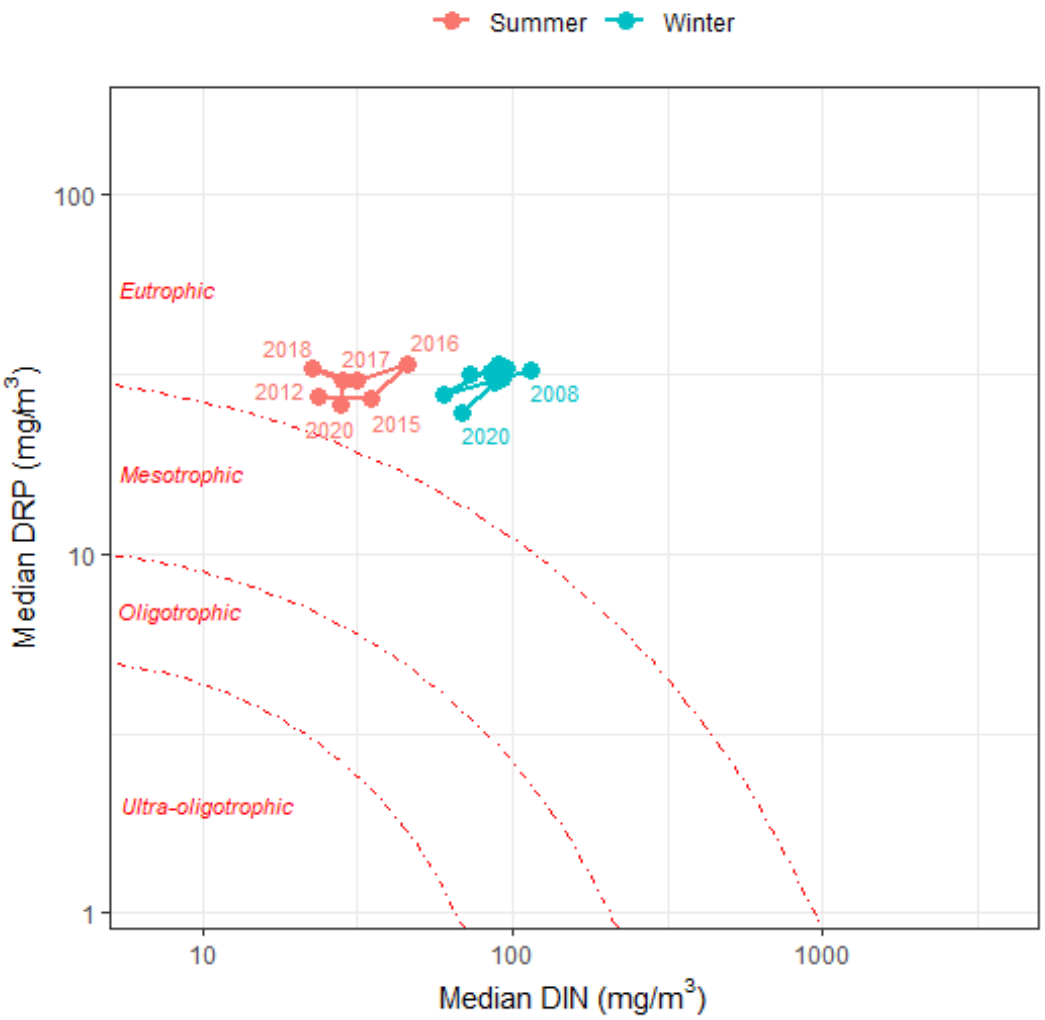

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-16	2020-12-15	10	0.0030	0.006	A
5 Years	2015-12-17	2020-12-15	57	0.0020	0.009	A
10 Years	2010-12-18	2020-12-15	86	0.0020	0.009	A
All	1991-01-18	2020-12-15	140	0.0019	0.018	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-16	2020-12-15	10	0.03	0.11	A
5 Years	2015-12-17	2020-12-15	58	0.05	0.14	A
10 Years	2010-12-18	2020-12-15	87	0.05	0.13	A
All	1993-05-17	2020-12-15	127	0.04	0.14	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-15	51	1.70	B*
10 Years	2010-12-18	2020-12-15	80	2.04	A
All	1992-08-06	2020-12-15	118	2.30	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	57	0.031	0.038	D
10 Years	2010-12-17	2020-12-14	86	0.030	0.038	D
All	1991-01-18	2020-12-14	138	0.028	0.037	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-17	2020-12-15	58	5.2	6.9	9	394	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-17	2020-12-15	58	9	556	93.1	1.7	5.2
10 Years	2010-12-18	2020-12-15	87	10	394	94.3	1.1	4.6
All	1991-01-18	2020-12-15	137	11	226	95.6	1.5	2.9

Time series plots

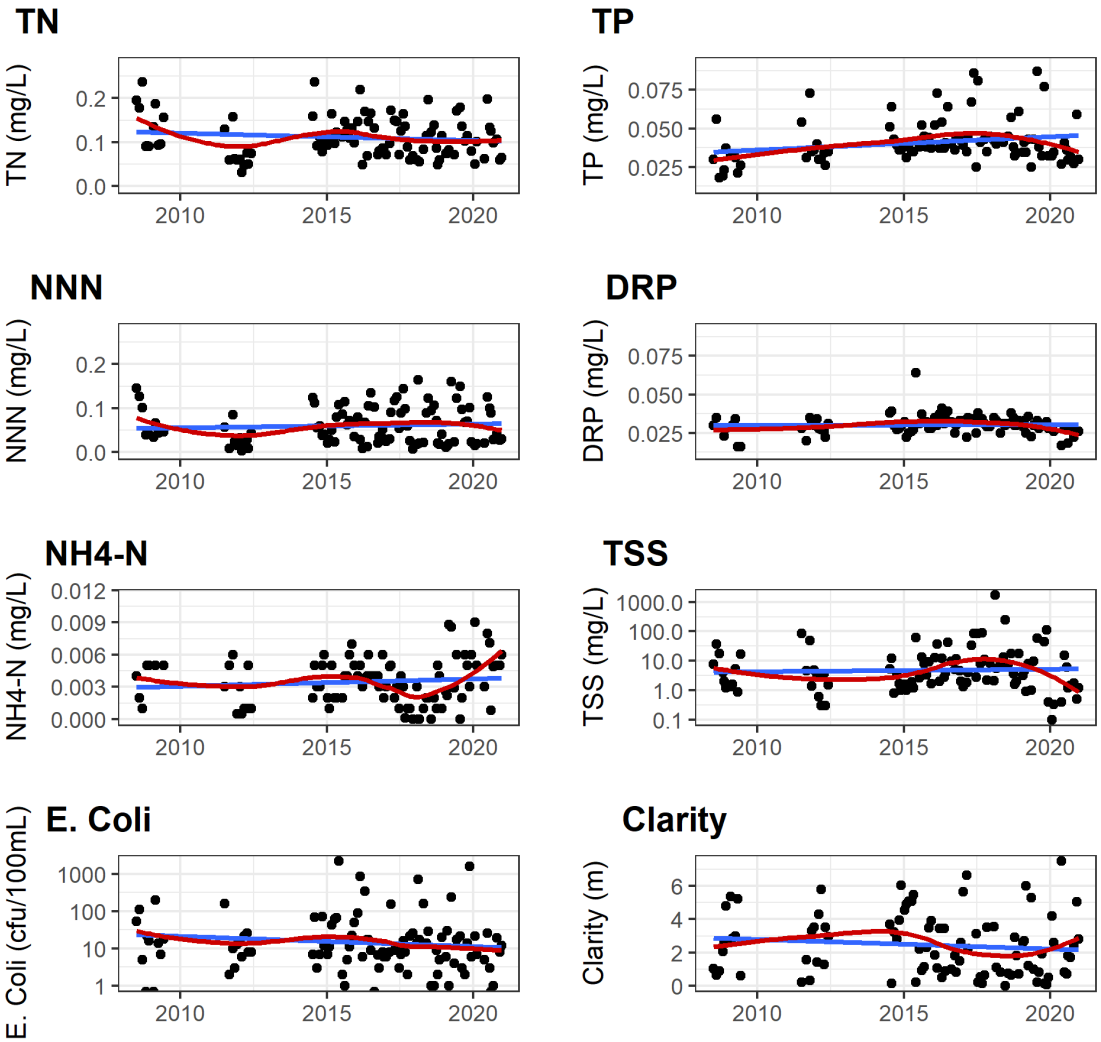

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-22	2020-12-15	0.0025	3.37	0.30	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2011-07-13	2020-12-15	0.0001	0.13	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
TN	All	2008-08-13	2020-12-15	0.0001	0.13	0.96	Indeterminant	YES	NO	Indeterminate/Uncertain
NNN	5 Years	2016-01-22	2020-12-15	0.0011	4.39	0.59	Indeterminant	YES	NO	Likely Degrading
NNN	10 Years	2011-07-13	2020-12-15	0.0008	2.84	0.56	Indeterminant	YES	NO	Likely Degrading
NNN	All	2008-08-13	2020-12-15	0.0008	2.84	0.56	Indeterminant	YES	NO	Likely Degrading
NH4N	5 Years	2016-01-22	2020-12-15	0.0004	10.69	0.10	Increasing	YES	NO	Very Likely Degrading
NH4N	10 Years	2011-07-13	2020-12-15	0.0001	4.53	0.23	Indeterminant	YES	NO	Likely Degrading
NH4N	All	2008-08-13	2020-12-15	0.0001	4.53	0.23	Indeterminant	YES	NO	Likely Degrading
TP	5 Years	2016-01-22	2020-12-15	-0.0013	-3.64	0.50	Indeterminant	YES	NO	Likely Improving
TP	10 Years	2011-07-13	2020-12-15	-0.0001	-0.38	0.81	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	2008-08-13	2020-12-15	-0.0001	-0.38	0.81	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	5 Years	2016-01-22	2020-12-15	-0.0014	-4.90	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-07-13	2020-12-15	-0.0002	-0.80	0.33	Indeterminant	YES	NO	Likely Improving
DRP	All	2008-08-13	2020-12-15	-0.0002	-0.80	0.33	Indeterminant	YES	NO	Likely Improving
ECOLI	5 Years	2016-01-22	2020-12-15	-0.0480	-4.80	0.33	Indeterminant	NO	YES	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-07-13	2020-12-15	-0.0049	-0.51	0.84	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	2008-08-13	2020-12-15	-0.0049	-0.51	0.84	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	5 Years	2016-01-22	2020-12-15	-0.0460	-9.64	<0.05	Decreasing	YES	NO	Very Likely Improving
TSS	10 Years	2011-07-13	2020-12-15	-0.0063	-1.42	0.73	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	2008-08-13	2020-12-15	-0.0063	-1.42	0.73	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	5 Years	2016-01-22	2020-12-15	-0.0233	-0.81	0.98	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2011-07-13	2020-12-15	-0.0961	-2.75	0.12	Indeterminant	YES	NO	Very Likely Degrading
CLARITY	All	2008-08-13	2020-12-15	-0.0961	-2.75	0.12	Indeterminant	YES	NO	Very Likely Degrading

Tauranga at Taneatua Bridge

March 2021

Table 1 Site metadata.

Aquarius ID:	LK149881	**Labstar ID:**	BOP110009
LAWA ID:	EBOP-00031	**REC Reach:**	4010825
Easting:	1951494	**Northing:**	5778817
Longitude:	177.00650	**Latitude:**	-38.07015
Elevation:	10 m	**Biophysical Unit:**	VA/Steep
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Hill_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	131	0.05	1.00	0.23	0.22	0.47	0.08	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	132	<0.001	0.40	0.14	0.13	0.31	0.01	0.09	0.01
Total Ammoniacal Nitrogen (g/m3)	144	<0.002	0.187	0.009	0.006	0.015	0.002	0.016	0.001
Total Phosphorus (g/m3)	145	0.009	0.875	0.044	0.033	0.082	0.013	0.074	0.006
Dissolved Reactive Phosphorus (g/m3)	143	0.006	0.049	0.023	0.023	0.034	0.008	0.008	0.001
Dissolved Oxygen Sat (%)	81	60.1	157.3	107.3	104.1	135.3	94.5	14.1	1.6
Dissolved Oxygen (g/m3)	142	0.50	14.70	10.68	10.70	12.66	9.07	1.50	0.13
Escherichia coli (cfu/100ml)	141	<1	3200	128	30	480	4	365	31
Total Suspended Solids (g/m3)	145	<1	1510.00	22.78	2.90	50.92	0.80	130.00	10.80
Turbidity (NTU)	143	0.2	1706.0	19.8	1.9	35.5	0.6	143.5	12.0
Water Clarity (m)	119	0.00	6.16	2.41	2.42	4.69	0.30	1.42	0.13
Conductivity (uS/cm)	143	47	168	83	82	96	66	12	1
pH (pH Units)	144	6.8	8.7	7.5	7.4	8.2	7.0	0.4	0.0
Water Temperature (degC)	145	6.9	25.8	15.4	14.6	23.5	8.8	4.5	0.4
Discharge (m3/s)	85	2.80	41.20	13.50	10.00	36.30	3.60	9.80	1.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

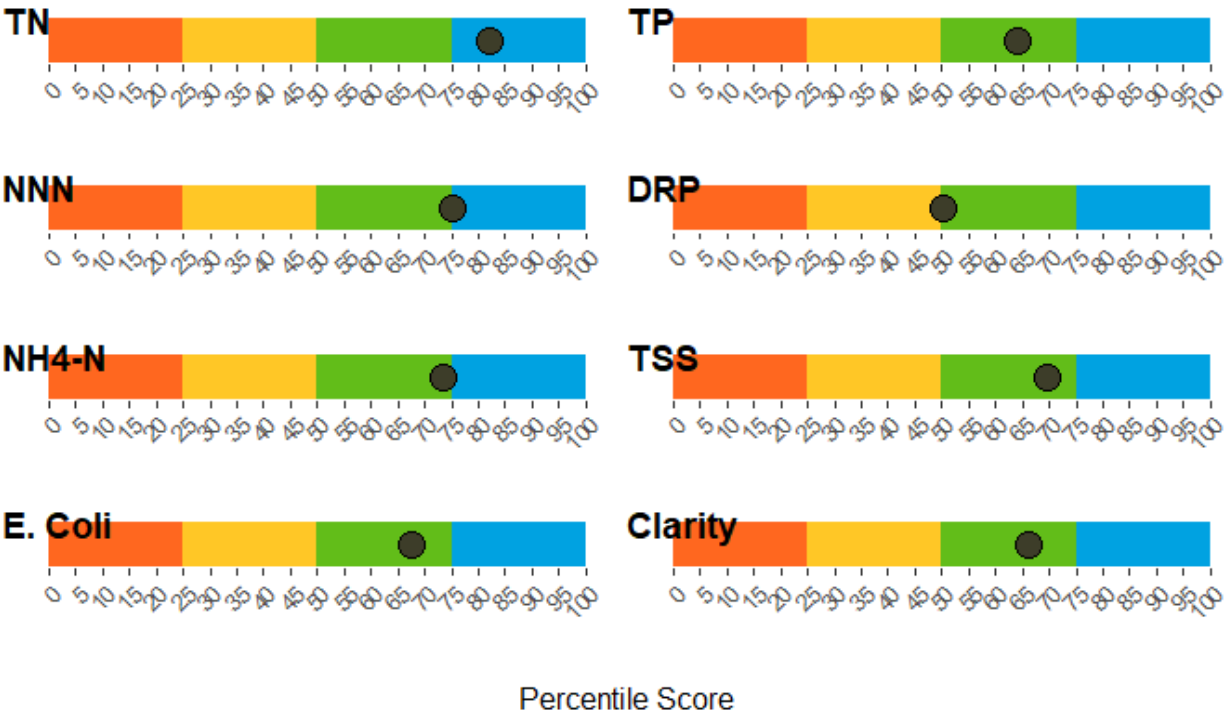

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

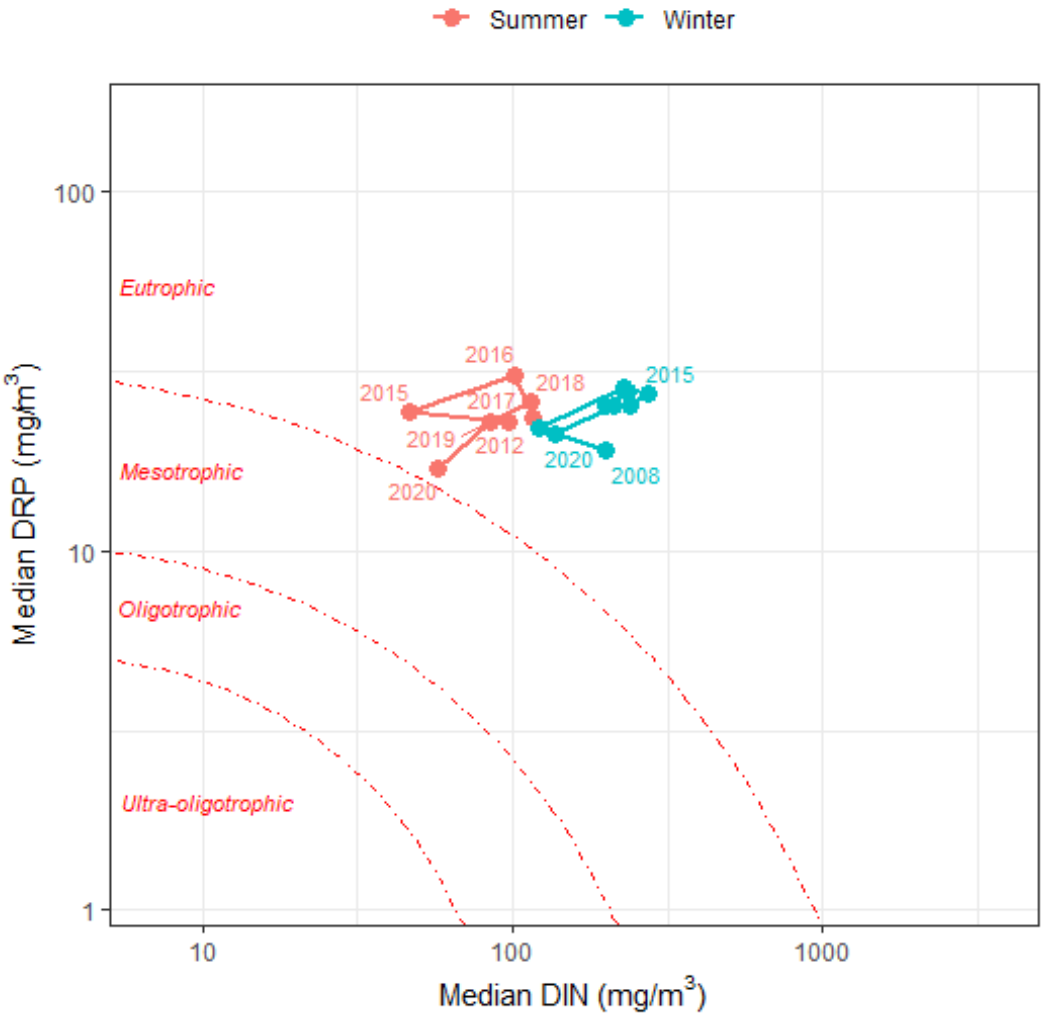

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-16	2020-12-15	10	0.0040	0.008	A
5 Years	2015-12-17	2020-12-15	57	0.0030	0.014	A
10 Years	2010-12-18	2020-12-15	86	0.0030	0.045	A
All	1991-01-18	2020-12-15	143	0.0034	0.074	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-16	2020-12-15	10	0.12	0.20	A
5 Years	2015-12-17	2020-12-15	58	0.14	0.29	A
10 Years	2010-12-18	2020-12-15	87	0.14	0.29	A
All	1993-05-17	2020-12-15	132	0.13	0.31	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-15	51	1.40	C*
10 Years	2010-12-18	2020-12-15	80	1.80	A
All	1992-08-06	2020-12-15	119	2.42	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	57	0.025	0.032	D
10 Years	2010-12-17	2020-12-14	86	0.025	0.034	D
All	1991-01-18	2020-12-14	142	0.023	0.034	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-17	2020-12-15	58	6.9	12.1	28	885	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-17	2020-12-15	58	28	1142	87.9	5.2	6.9
10 Years	2010-12-18	2020-12-15	87	28	885	90.8	3.4	5.7
All	1991-01-18	2020-12-15	141	30	624	92.2	2.8	5

Time series plots

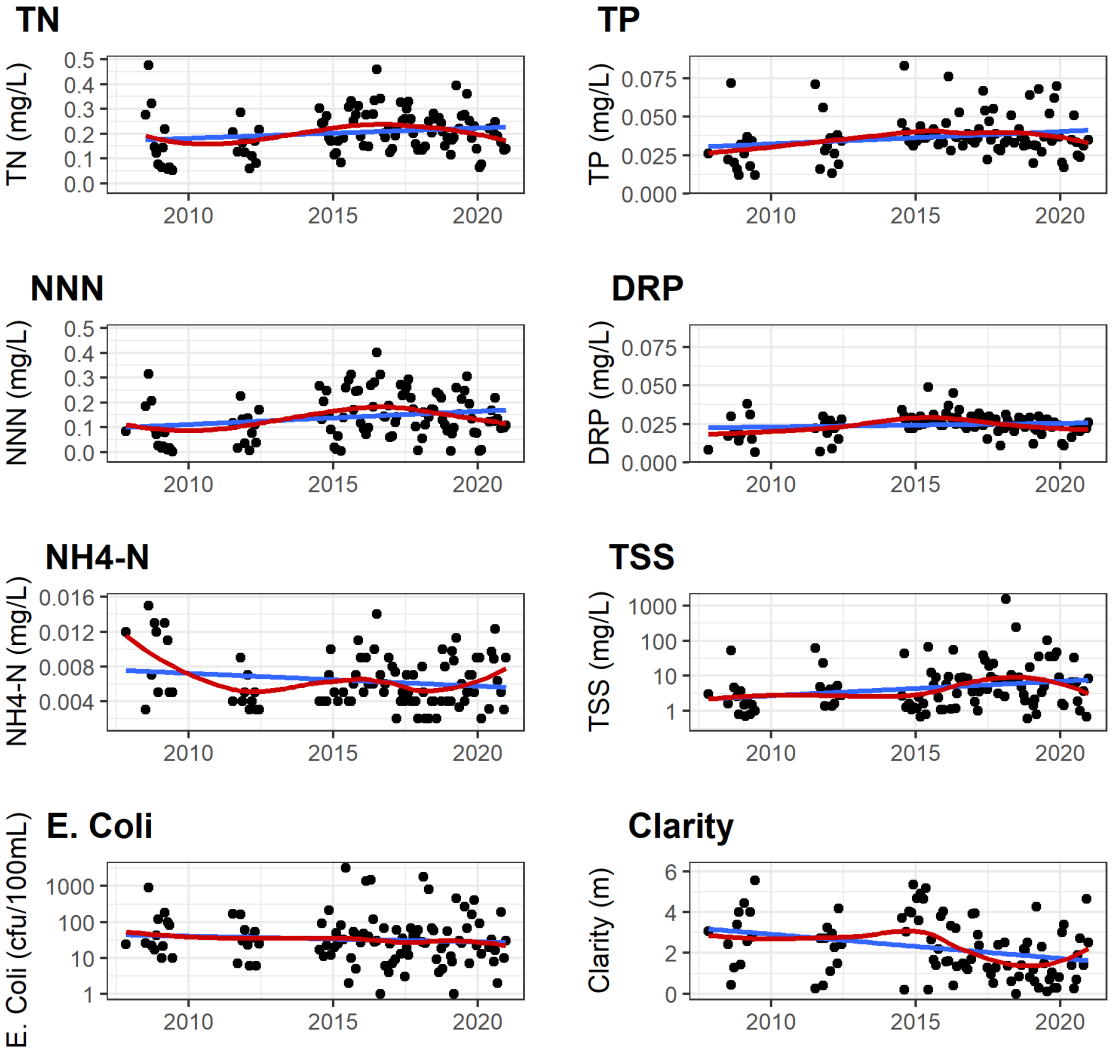

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-22	2020-12-15	-0.0140	-6.40	<0.01	Decreasing	Attempted	YES	Very Likely Improving
TN	10 Years	2011-07-13	2020-12-15	-0.0018	-0.93	0.48	Indeterminant	YES	YES	Likely Improving
TN	All	2007-11-01	2020-12-15	0.0015	0.83	0.59	Indeterminant	YES	YES	Likely Degrading
NNN	5 Years	2016-01-22	2020-12-15	-0.0193	-13.56	<0.001	Decreasing	Attempted	YES	Very Likely Improving
NNN	10 Years	2011-07-13	2020-12-15	-0.0015	-1.14	0.63	Indeterminant	YES	YES	Likely Improving
NNN	All	2007-11-01	2020-12-15	0.0002	0.21	0.93	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	5 Years	2016-01-22	2020-12-15	-0.0005	-7.76	0.26	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-07-13	2020-12-15	0.0001	2.85	0.35	Indeterminant	YES	NO	Likely Degrading
NH4N	All	2007-11-01	2020-12-15	0.0000	-0.16	0.94	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	5 Years	2016-01-22	2020-12-15	-0.0014	-4.02	0.14	Indeterminant	YES	NO	Likely Improving
TP	10 Years	2011-07-13	2020-12-15	-0.0004	-1.16	0.43	Indeterminant	YES	NO	Likely Improving
TP	All	2007-11-01	2020-12-15	0.0001	0.24	0.86	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	5 Years	2016-01-22	2020-12-15	-0.0018	-7.59	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-07-13	2020-12-15	-0.0007	-2.95	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	All	2007-11-01	2020-12-15	-0.0006	-2.21	0.07	Decreasing	YES	NO	Very Likely Improving
ECOLI	5 Years	2016-01-22	2020-12-15	-0.0225	-1.54	0.69	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-07-13	2020-12-15	-0.0107	-0.74	0.60	Indeterminant	YES	NO	Likely Improving
ECOLI	All	2007-11-01	2020-12-15	-0.0226	-1.55	0.21	Indeterminant	YES	NO	Likely Improving
TSS	5 Years	2016-01-22	2020-12-15	0.0092	1.29	0.62	Indeterminant	YES	NO	Likely Degrading
TSS	10 Years	2011-07-13	2020-12-15	0.0211	3.28	0.06	Increasing	YES	YES	Very Likely Degrading
TSS	All	2007-11-01	2020-12-15	0.0156	2.66	<0.05	Increasing	YES	YES	Very Likely Degrading
CLARITY	5 Years	2016-01-22	2020-12-15	0.0499	3.57	0.80	Indeterminant	Attempted	YES	Indeterminate/Uncertain
CLARITY	10 Years	2011-07-13	2020-12-15	-0.1283	-5.58	<0.05	Decreasing	YES	YES	Very Likely Degrading
CLARITY	All	2007-11-01	2020-12-15	-0.1109	-4.44	<0.001	Decreasing	YES	NO	Very Likely Degrading

Ōhiwa Harbour and Waiotahe WMA

Ohiwa Harbour and Waiotahi WMA is the smallest of the nine WMA's in the Bay of Plenty. Dairy farming is a prominent land-use on river flat areas. The Ōhiwa Harbour is a highly valued estuary in excellent conditions. It is home to a multitude of marsh and shore birds, shellfish and fish species. The Ōhiwa Harbour is fed by about 17 streams, the largest of which is the Nukuhou River. The Nukuhou River begins in the Matahi Forest and flows through 20 km of intensely farmed land comprised of volcanic acidic soil. It then narrows as it flows north through greywackle hills in the Kererutahi Forest, exiting to sea via Ōhiwa Harbour.

The Waiōtahe River enters the coast via a small river estuary. The area is used for shellfish harvesting.

Table 9 NERMN sites in the Ōhiwa Harbour and Waiōtahe WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Ōhiwa Harbour and Waiōtahe								
MK307635	Nukuhou at Glenholme Road	1963072	5776357	VA/Steep	AE	60	11.7	M
ML715056	Waiotahe at Toone Road	1967154	5780564	Non_VA/Steep	AE	111	9.7	M

Nukuhou at Glenholme Road

March 2021

Table 1 Site metadata.

Aquarius ID:	MK307635	**Labstar ID:**	BOP110007
LAWA ID:	EBOP-00062	**REC Reach:**	4011646
Easting:	1963072	**Northing:**	5776357
Longitude:	177.13940	**Latitude:**	-38.08769
Elevation:	19 m	**Biophysical Unit:**	VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	WW_Low_VA		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	275	0.19	5.13	0.88	0.84	1.40	0.41	0.42	0.03
Nitrate Nitrite Nitrogen (g/m3)	277	<0.001	1.42	0.51	0.47	0.97	0.15	0.26	0.02
Total Ammoniacal Nitrogen (g/m3)	298	<0.002	0.729	0.052	0.039	0.131	0.007	0.059	0.003
Total Phosphorus (g/m3)	297	0.015	0.506	0.080	0.067	0.149	0.039	0.053	0.003
Dissolved Reactive Phosphorus (g/m3)	296	0.006	0.229	0.033	0.028	0.069	0.013	0.021	0.001
Dissolved Oxygen Sat (%)	117	57.3	141.1	98.8	97.0	116.4	85.9	10.8	1.0
Dissolved Oxygen (g/m3)	294	5.80	12.02	9.62	9.70	11.28	7.67	1.14	0.07
Escherichia coli (cfu/100ml)	280	7	99000	1711	490	4205	70	7021	420
Total Suspended Solids (g/m3)	297	<1	335.00	19.70	10.00	76.80	1.56	32.33	1.88
Turbidity (NTU)	297	0.8	140.0	10.4	6.2	33.4	2.4	15.9	0.9
Water Clarity (m)	259	0.04	5.01	1.17	1.00	2.75	0.22	0.86	0.05
Conductivity (uS/cm)	295	63	188	101	100	117	84	11	1
pH (pH Units)	298	5.8	8.0	7.1	7.1	7.4	6.7	0.2	0.0
Water Temperature (degC)	298	5.3	25.4	15.0	15.0	21.8	8.5	4.3	0.2
Discharge (m3/s)	108	0.10	10.00	1.50	1.00	4.50	0.20	1.60	0.20

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

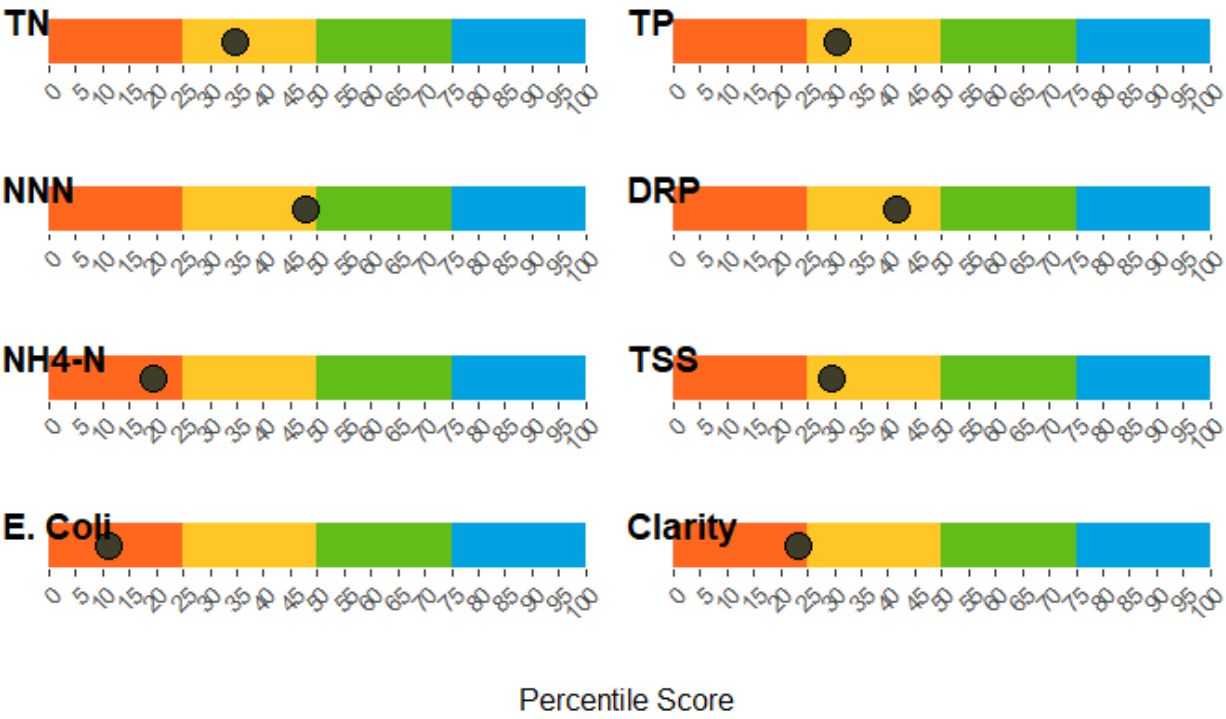

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

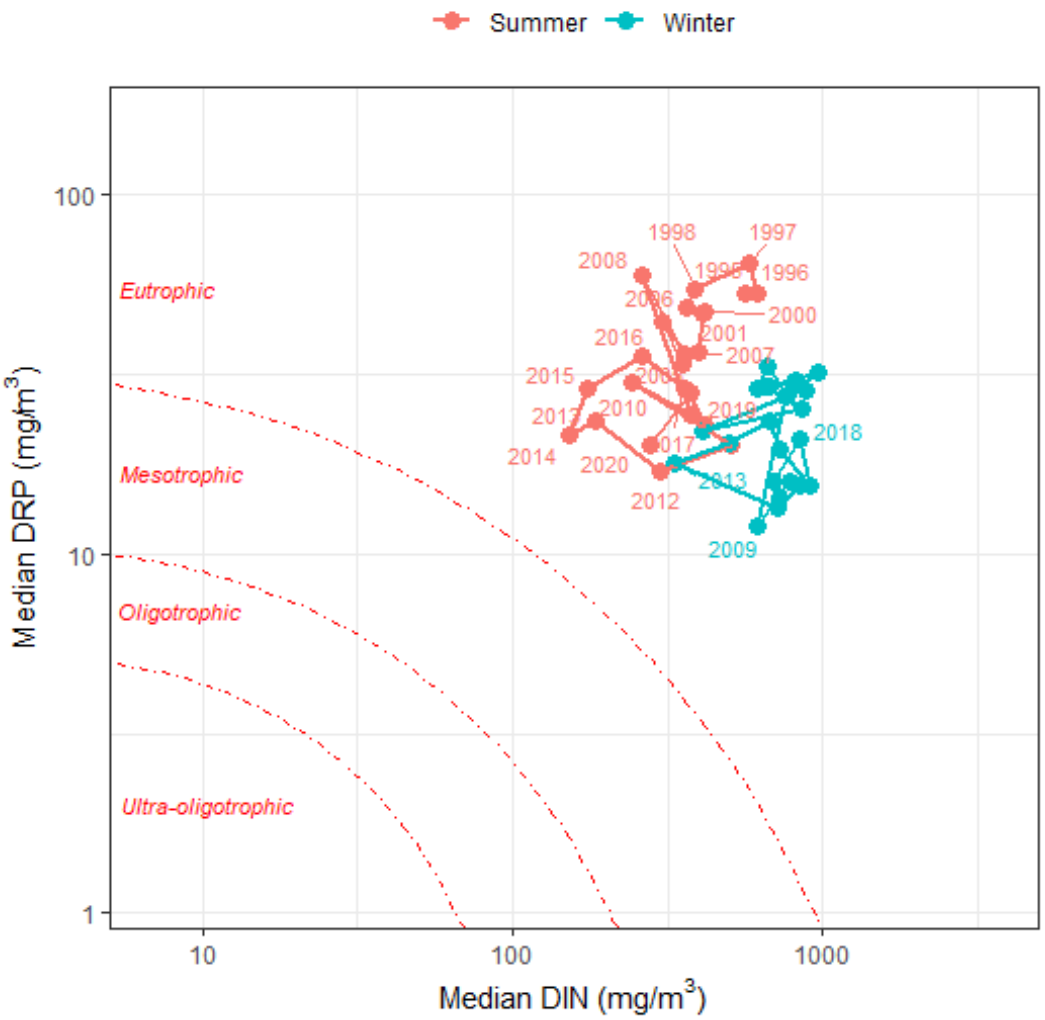

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 *Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.*

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-16	2020-12-15	10	0.011	0.042	A
5 Years	2015-12-17	2020-12-15	57	0.012	0.052	B
10 Years	2010-12-18	2020-12-15	116	0.011	0.183	B
All	1991-04-02	2020-12-15	297	0.017	0.270	B

Table 4 *Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-16	2020-12-15	10	0.31	0.77	A
5 Years	2015-12-17	2020-12-15	58	0.48	0.99	A
10 Years	2010-12-18	2020-12-15	117	0.43	0.92	A
All	1992-09-21	2020-12-15	277	0.47	0.97	A

Table 5 *Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-15	51	1.20	D*
10 Years	2010-12-18	2020-12-15	110	1.30	D
All	1992-08-04	2020-12-15	259	1.00	D

Table 6 *Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.*

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	57	0.020	0.042	D
10 Years	2010-12-17	2020-12-14	116	0.020	0.040	D
All	1991-04-02	2020-12-14	295	0.028	0.069	D

Table 7 *Assessment against the Escherichia coli (Human Contact) attribute.*

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-17	2020-12-15	58	34.5	58.6	315	3805	E*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-17	2020-12-15	58	315	5020	41.4	24.1	32.8
10 Years	2010-12-18	2020-12-15	116	295	3280	46.6	20.7	31
All	1991-04-02	2020-12-15	280	490	4250	31.4	22.5	45

Time series plots

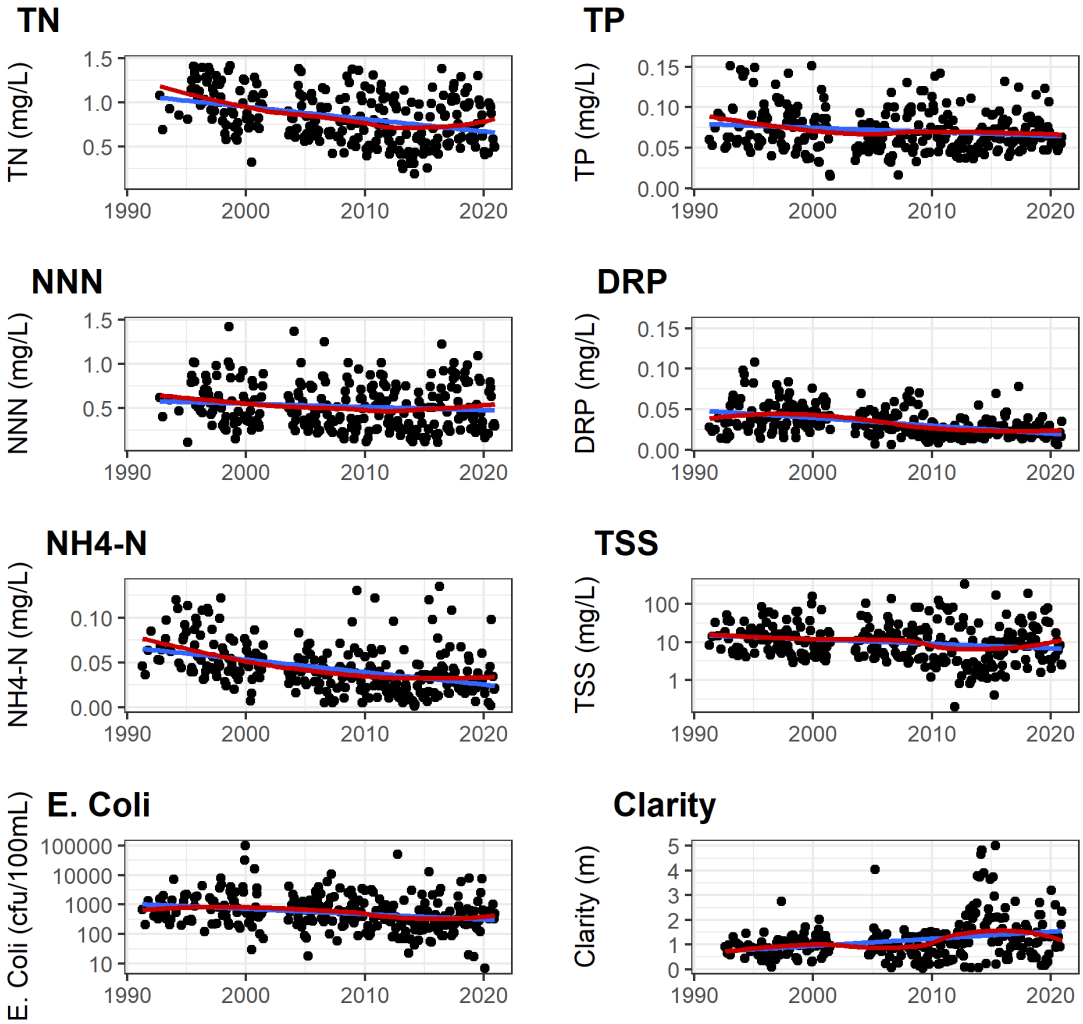

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-21	2020-12-15	0.0060	0.74	0.71	Indeterminant	YES	YES	Indeterminate/Uncertain
TN	10 Years	2011-01-12	2020-12-15	0.0124	1.91	<0.01	Increasing	YES	YES	Very Likely Degrading
TN	All	1991-07-03	2020-12-15	0.0124	1.91	<0.01	Increasing	YES	YES	Very Likely Degrading
NNN	5 Years	2016-01-21	2020-12-15	0.0026	0.54	0.94	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	10 Years	2011-01-12	2020-12-15	0.0146	3.49	<0.01	Increasing	YES	YES	Very Likely Degrading
NNN	All	1991-07-03	2020-12-15	0.0146	3.49	<0.01	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2016-01-21	2020-12-15	-0.0016	-5.76	0.24	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-01-12	2020-12-15	0.0004	1.60	0.45	Indeterminant	YES	NO	Likely Degrading
NH4N	All	1991-07-03	2020-12-15	0.0004	1.60	0.45	Indeterminant	YES	NO	Likely Degrading
TP	5 Years	2016-01-21	2020-12-15	-0.0016	-2.56	0.42	Indeterminant	YES	YES	Likely Improving
TP	10 Years	2011-01-12	2020-12-15	0.0011	1.67	0.11	Indeterminant	YES	YES	Very Likely Degrading
TP	All	1991-07-03	2020-12-15	0.0011	1.67	0.11	Indeterminant	YES	YES	Very Likely Degrading
DRP	5 Years	2016-01-21	2020-12-15	-0.0012	-6.01	0.09	Decreasing	YES	YES	Very Likely Improving
DRP	10 Years	2011-01-12	2020-12-15	0.0002	1.15	0.21	Indeterminant	YES	YES	Likely Degrading
DRP	All	1991-07-03	2020-12-15	0.0002	1.15	0.21	Indeterminant	YES	YES	Likely Degrading
ECOLI	5 Years	2016-01-21	2020-12-15	0.0713	2.85	0.06	Increasing	YES	NO	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-12	2020-12-15	0.0244	1.00	0.20	Indeterminant	YES	NO	Very Likely Degrading
ECOLI	All	1991-07-03	2020-12-15	0.0244	1.00	0.20	Indeterminant	YES	NO	Very Likely Degrading
TSS	5 Years	2016-01-21	2020-12-15	0.0193	1.85	0.41	Indeterminant	YES	YES	Likely Degrading
TSS	10 Years	2011-01-12	2020-12-15	0.0316	3.55	<0.001	Increasing	YES	YES	Very Likely Degrading
TSS	All	1991-07-03	2020-12-15	0.0316	3.55	<0.001	Increasing	YES	YES	Very Likely Degrading
CLARITY	5 Years	2016-01-21	2020-12-15	-0.0052	-0.43	0.93	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	10 Years	2011-01-12	2020-12-15	-0.0363	-2.79	0.10	Indeterminant	YES	YES	Very Likely Degrading
CLARITY	All	1991-07-03	2020-12-15	-0.0363	-2.79	0.10	Indeterminant	YES	YES	Very Likely Degrading

Waiotahe at Toone Road

March 2021

Table 1 Site metadata.

Aquarius ID:	ML715056	**Labstar ID:**	BOP110166
LAWA ID:	LAWA-100395	**REC Reach:**	4010281
Easting:	1967154	**Northing:**	5780564
Longitude:	177.18368	**Latitude:**	-38.04823
Elevation:	6 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_VA		

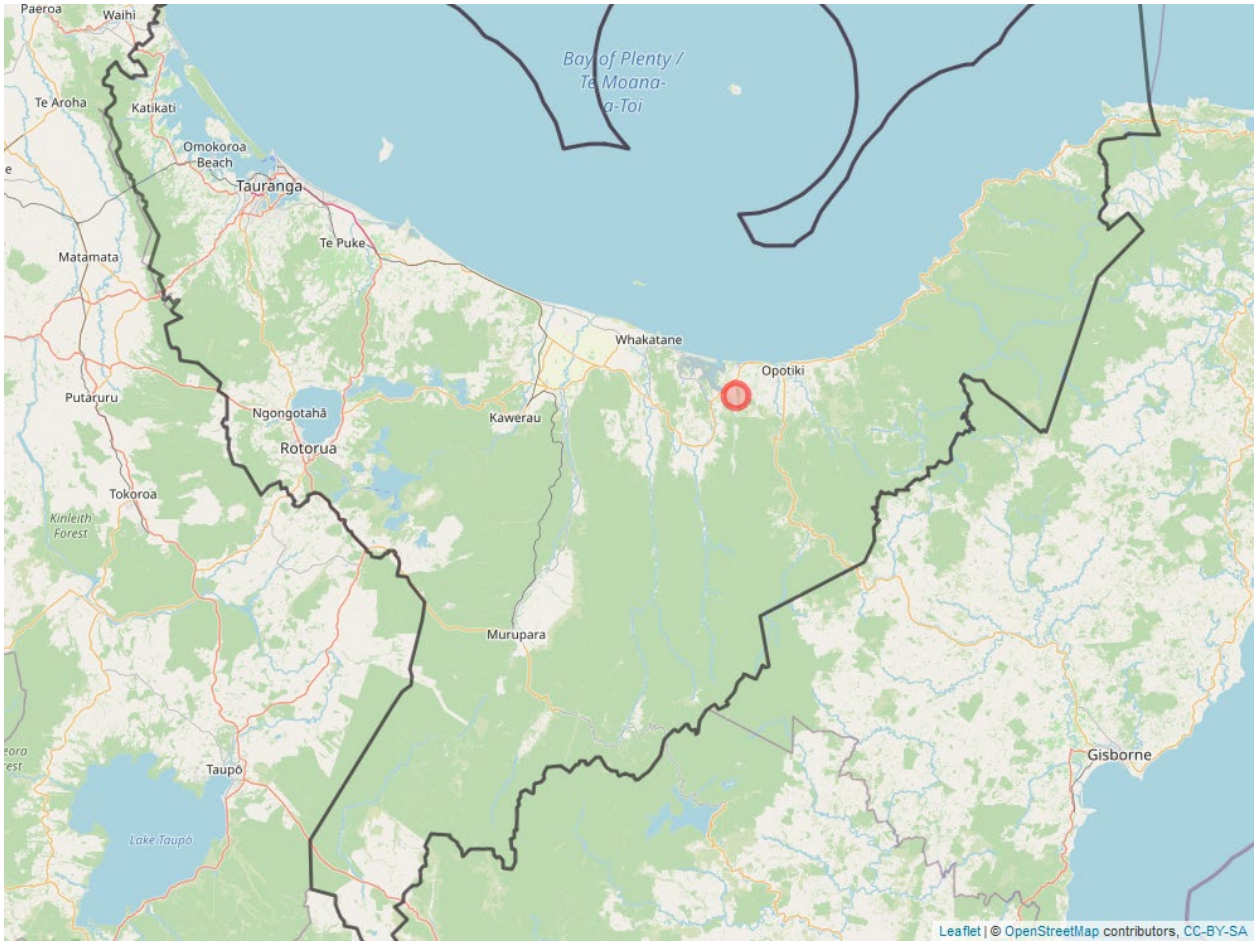

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	86	0.05	0.54	0.13	0.11	0.27	0.06	0.08	0.01
Nitrate Nitrite Nitrogen (g/m3)	86	<0.001	0.21	0.06	0.04	0.16	0.01	0.05	0.01
Total Ammoniacal Nitrogen (g/m3)	86	<0.002	0.023	0.007	0.007	0.013	0.001	0.004	0.000
Total Phosphorus (g/m3)	86	0.021	0.152	0.040	0.038	0.063	0.026	0.016	0.002
Dissolved Reactive Phosphorus (g/m3)	86	0.006	0.043	0.025	0.026	0.034	0.018	0.005	0.001
Dissolved Oxygen Sat (%)	80	45.4	112.2	98.1	98.2	106.8	92.1	7.8	0.9
Dissolved Oxygen (g/m3)	82	4.02	12.28	10.11	10.25	11.84	8.50	1.21	0.13
Escherichia coli (cfu/100ml)	86	<1	4800	274	78	855	10	746	80
Total Suspended Solids (g/m3)	85	<1	86.00	6.75	2.80	23.84	0.80	11.90	1.29
Turbidity (NTU)	86	0.4	70.0	3.5	1.5	9.7	0.6	8.0	0.9
Water Clarity (m)	82	0.20	6.15	2.89	2.95	5.04	0.50	1.44	0.16
Conductivity (uS/cm)	86	38	104	72	72	85	59	9	1
pH (pH Units)	85	6.2	7.8	7.2	7.2	7.4	6.9	0.2	0.0
Water Temperature (degC)	85	6.5	22.0	14.3	13.5	20.7	9.4	3.8	0.4
Discharge (m3/s)	69	0.50	18.00	3.50	2.80	8.40	0.70	2.90	0.40

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

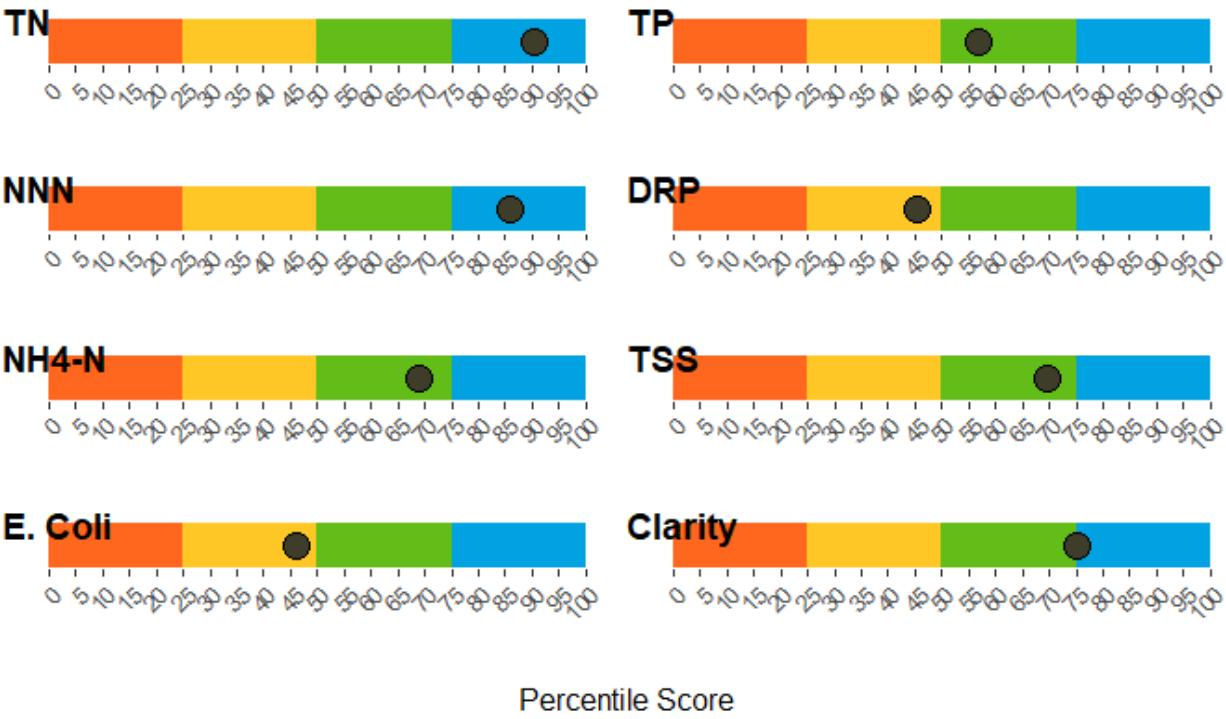

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

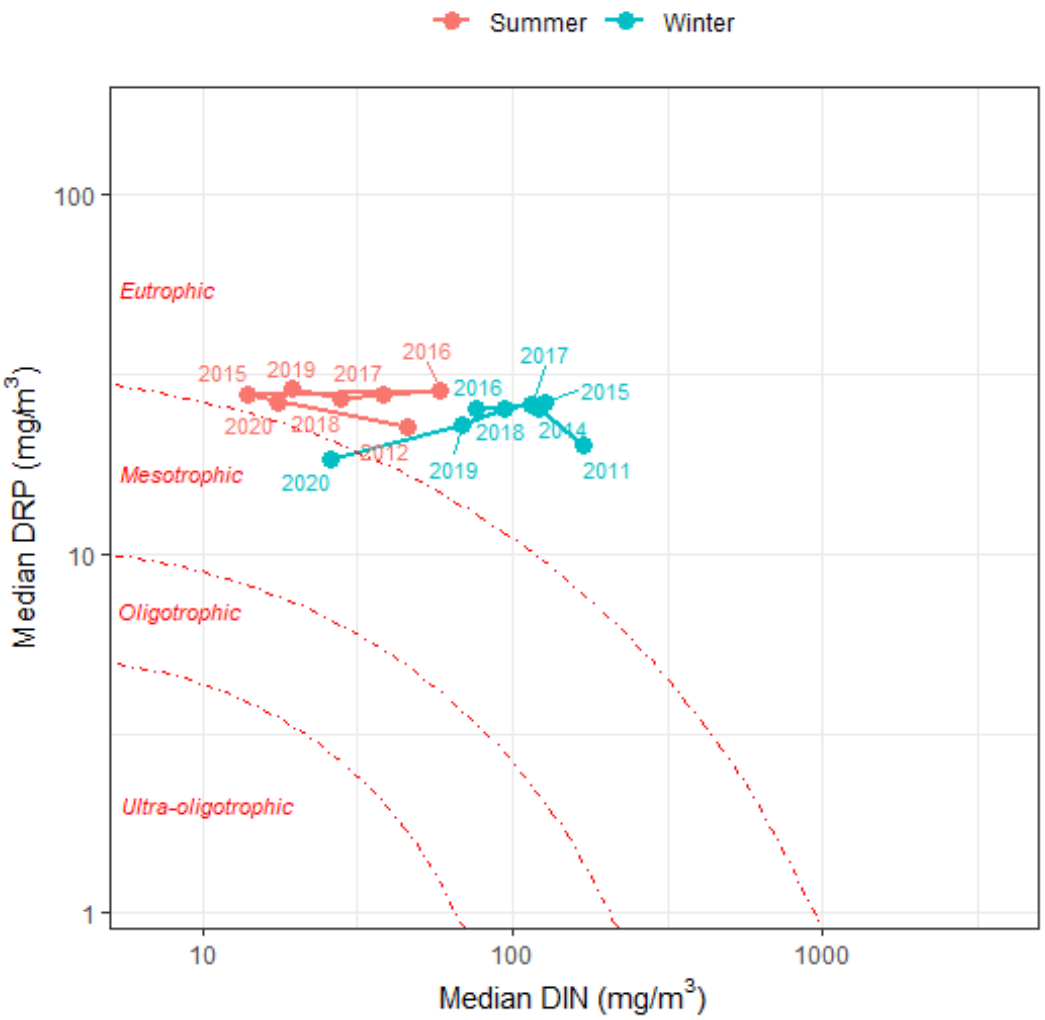

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	9	0.002	0.006	A
5 Years	2015-12-16	2020-12-14	55	0.003	0.008	A
10 Years	2010-12-17	2020-12-14	NA	NA	NA	NA
All	2011-07-12	2020-12-14	85	0.0032	0.0099	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	9	0.01	0.09	A
5 Years	2015-12-16	2020-12-14	56	0.05	0.13	A
10 Years	2010-12-17	2020-12-14	NA	NA	NA	NA
All	2011-07-12	2020-12-14	86	0.04	0.16	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	52	3.00	A*
10 Years	2010-12-17	2020-12-14	NA	NA	
All	2011-07-12	2020-12-14	81	3.00	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	56	0.026	0.033	D
10 Years	2010-12-17	2020-12-14	NA	NA	NA	
All	2011-07-12	2020-12-14	85	0.026	0.034	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-16	2020-12-14	56	8.9	16.1	60	938	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-16	2020-12-14	56	60	1041	83.9	7.1	8.9
10 Years	2010-12-17	2020-12-14	NA	NA	NA			
All	2011-07-12	2020-12-14	86	78	926	83.7	8.1	8.1

Time series plots

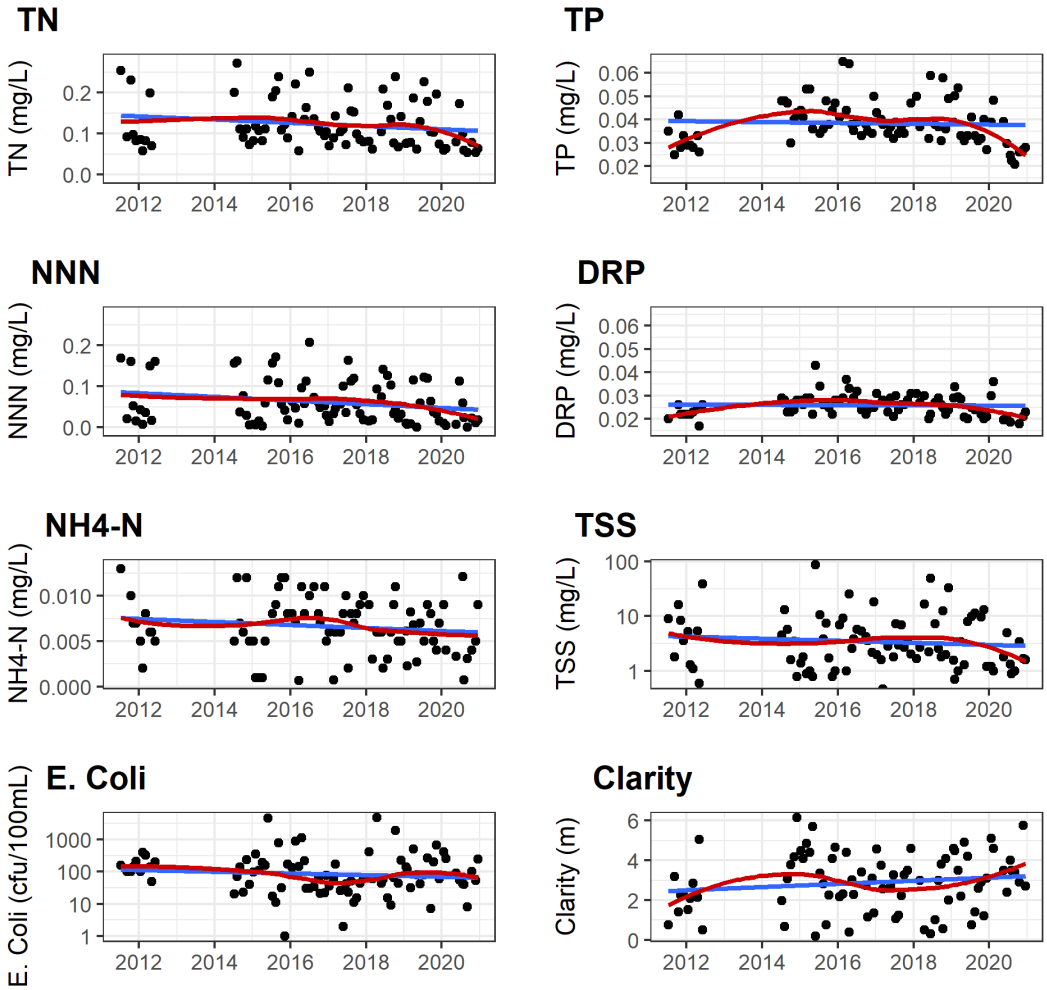

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-21	2020-12-14	-0.0123	-11.84	<0.05	Decreasing	YES	YES	Very Likely Improving
TN	10 Years	2011-07-12	2020-12-14	-0.0079	-7.53	<0.001	Decreasing	YES	YES	Very Likely Improving
TN	All	2011-09-07	2020-12-14	-0.0082	-7.82	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-21	2020-12-14	-0.0034	-7.30	0.15	Indeterminant	YES	YES	Likely Improving
NNN	10 Years	2011-07-12	2020-12-14	-0.0033	-7.08	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	All	2011-09-07	2020-12-14	-0.0039	-8.34	<0.05	Decreasing	YES	YES	Very Likely Improving
NH4N	5 Years	2016-01-21	2020-12-14	-0.0001	-2.38	0.65	Indeterminant	YES	NO	Likely Improving
NH4N	10 Years	2011-07-12	2020-12-14	-0.0001	-2.22	0.33	Indeterminant	YES	NO	Likely Improving
NH4N	All	2011-09-07	2020-12-14	-0.0001	-1.68	0.49	Indeterminant	YES	NO	Likely Improving
TP	5 Years	2016-01-21	2020-12-14	-0.0025	-6.81	<0.001	Decreasing	YES	YES	Very Likely Improving
TP	10 Years	2011-07-12	2020-12-14	-0.0010	-2.58	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	All	2011-09-07	2020-12-14	-0.0010	-2.79	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2016-01-21	2020-12-14	-0.0021	-7.91	<0.001	Decreasing	YES	YES	Very Likely Improving
DRP	10 Years	2011-07-12	2020-12-14	0.0000	-0.10	0.91	Indeterminant	YES	YES	Indeterminate/Uncertain
DRP	All	2011-09-07	2020-12-14	-0.0001	-0.55	0.69	Indeterminant	YES	YES	Indeterminate/Uncertain
ECOLI	5 Years	2016-01-21	2020-12-14	-0.0287	-1.63	0.67	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-07-12	2020-12-14	-0.0225	-1.22	0.58	Indeterminant	YES	YES	Likely Improving
ECOLI	All	2011-09-07	2020-12-14	-0.0135	-0.73	0.86	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-21	2020-12-14	-0.0204	-3.66	0.24	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-07-12	2020-12-14	-0.0099	-1.87	0.33	Indeterminant	YES	YES	Likely Improving
TSS	All	2011-09-07	2020-12-14	-0.0080	-1.57	0.35	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2016-01-21	2020-12-14	0.3370	11.23	<0.05	Increasing	Attempted	YES	Very Likely Improving
CLARITY	10 Years	2011-07-12	2020-12-14	0.0894	2.97	<0.05	Increasing	YES	NO	Very Likely Improving
CLARITY	All	2011-09-07	2020-12-14	0.0833	2.73	<0.05	Increasing	YES	NO	Very Likely Improving

Waioeka and Otara WMA

The Waioeka is a steam catchment with considerable indigenous bush cover. Over time farmland in the catchment has been retired and added to the Waioeka Scenic Reserve where native bush is regenerating. The upper reaches of the Waioeka River flow through a steep sided well cut gorge of brittle greywacke and volcanic ash. The river then begins to meander through the lower reaches across flood plains to Opotiki. Opotiki is where the Waioeka River meets with the Otara River forming a small river estuary.

The Otara River is fed by streams in the Raukūmara Ranges. The upper catchment is in native forest and the lower catchment in agriculture and horticultural landuse.

Table 10 NERMN sites in the Waioeka and Otara WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Waioeka and Otara								
NK608503	Waioeka at Mouth of Gorge	1976081	5775032	Non_VA/Steep	CR	780	13.0	M
OK300616	Otara at Browns Bridge	1983007	5776168	Non_VA/Steep	AE	240	19.7	M

Waioeka at Mouth of Gorge

March 2021

Table 1 Site metadata.

Aquarius ID:	NK608503	**Labstar ID:**	BOP160102
LAWA ID:	EBOP-00044	**REC Reach:**	4012188
Easting:	1976081	**Northing:**	5775032
Longitude:	177.28805	**Latitude:**	-38.09429
Elevation:	41 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_HS		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_ 95th	Perc_ 5th	StDev	SE
Total Nitrogen (g/m3)	241	<0.01	1.42	0.14	0.10	0.33	0.04	0.13	0.01
Nitrate Nitrite Nitrogen (g/m3)	248	<0.001	0.72	0.06	0.02	0.18	0.00	0.08	0.00
Total Ammoniacal Nitrogen (g/m3)	246	<0.002	0.111	0.006	0.004	0.016	0.001	0.010	0.001
Total Phosphorus (g/m3)	247	0.008	0.847	0.034	0.022	0.103	0.012	0.061	0.004
Dissolved Reactive Phosphorus (g/m3)	239	<0.001	0.044	0.017	0.018	0.026	0.007	0.006	0.000
Dissolved Oxygen Sat (%)	118	52.6	123.3	101.3	99.8	113.9	88.8	8.5	0.8
Dissolved Oxygen (g/m3)	244	6.46	13.30	10.26	10.39	12.02	8.30	1.16	0.07
Escherichia coli (cfu/100ml)	245	<1	6900	138	20	548	2	536	34
Total Suspended Solids (g/m3)	250	<1	1640.00	20.71	1.51	77.50	0.40	117.60	7.44
Turbidity (NTU)	249	0.3	1259.0	17.1	1.3	63.0	0.4	92.8	5.9
Water Clarity (m)	214	0.00	9.07	3.47	3.34	6.83	0.20	2.16	0.15
Conductivity (uS/cm)	249	37	121	74	74	88	58	10	1
pH (pH Units)	250	6.1	8.4	7.3	7.4	7.7	6.9	0.3	0.0
Water Temperature (degC)	250	6.3	23.4	14.3	13.9	21.1	8.5	4.0	0.3
Discharge (m3/s)	103	3.10	114.80	14.80	12.00	28.30	4.30	13.20	1.30

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

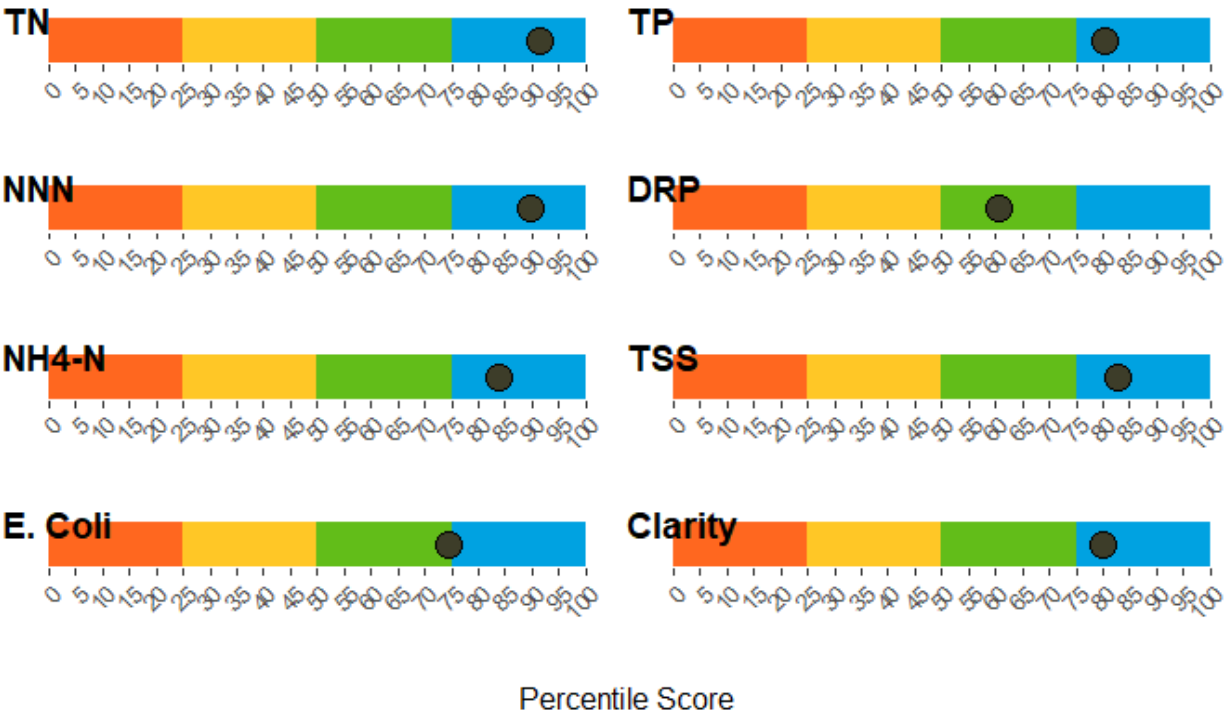

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

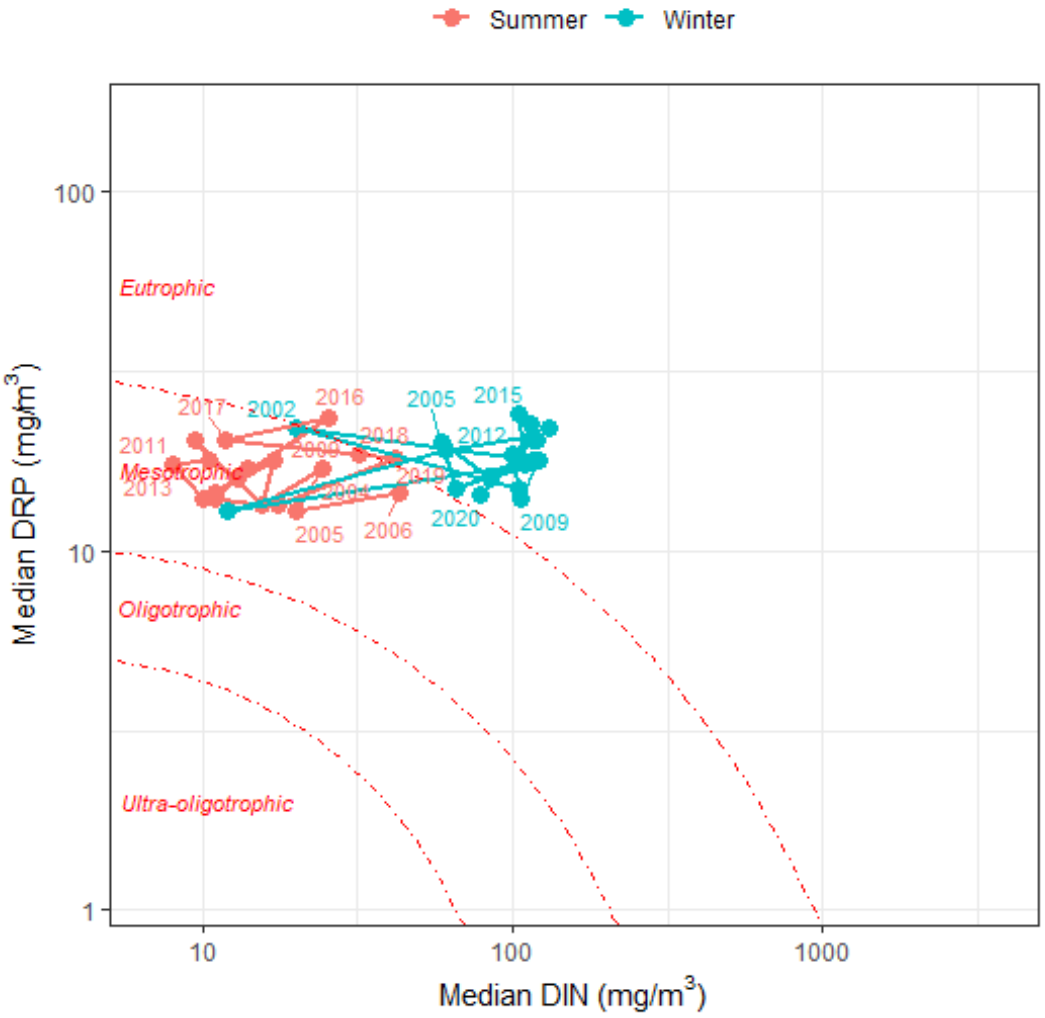

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	9	0.002	0.005	A
5 Years	2015-12-16	2020-12-14	56	0.002	0.005	A
10 Years	2010-12-17	2020-12-14	114	0.001	0.010	A
All	1995-07-31	2020-12-14	245	0.002	0.062	B

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	9	0.04	0.22	A
5 Years	2015-12-16	2020-12-14	57	0.06	0.20	A
10 Years	2010-12-17	2020-12-14	117	0.04	0.20	A
All	1995-07-31	2020-12-14	248	0.02	0.18	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	52	2.91	B*
10 Years	2010-12-17	2020-12-14	110	3.28	A
All	1995-07-31	2020-12-14	213	3.36	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	57	0.020	0.026	D
10 Years	2010-12-17	2020-12-14	117	0.019	0.027	D
All	1995-07-31	2020-12-14	238	0.018	0.026	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-16	2020-12-14	57	7.0	12.3	21	576	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-16	2020-12-14	57	21	634	87.7	5.3	5.3
10 Years	2010-12-17	2020-12-14	116	18	567	89.7	3.4	6
All	1995-07-31	2020-12-14	245	20	552	89.8	4.9	4.9

Time series plots

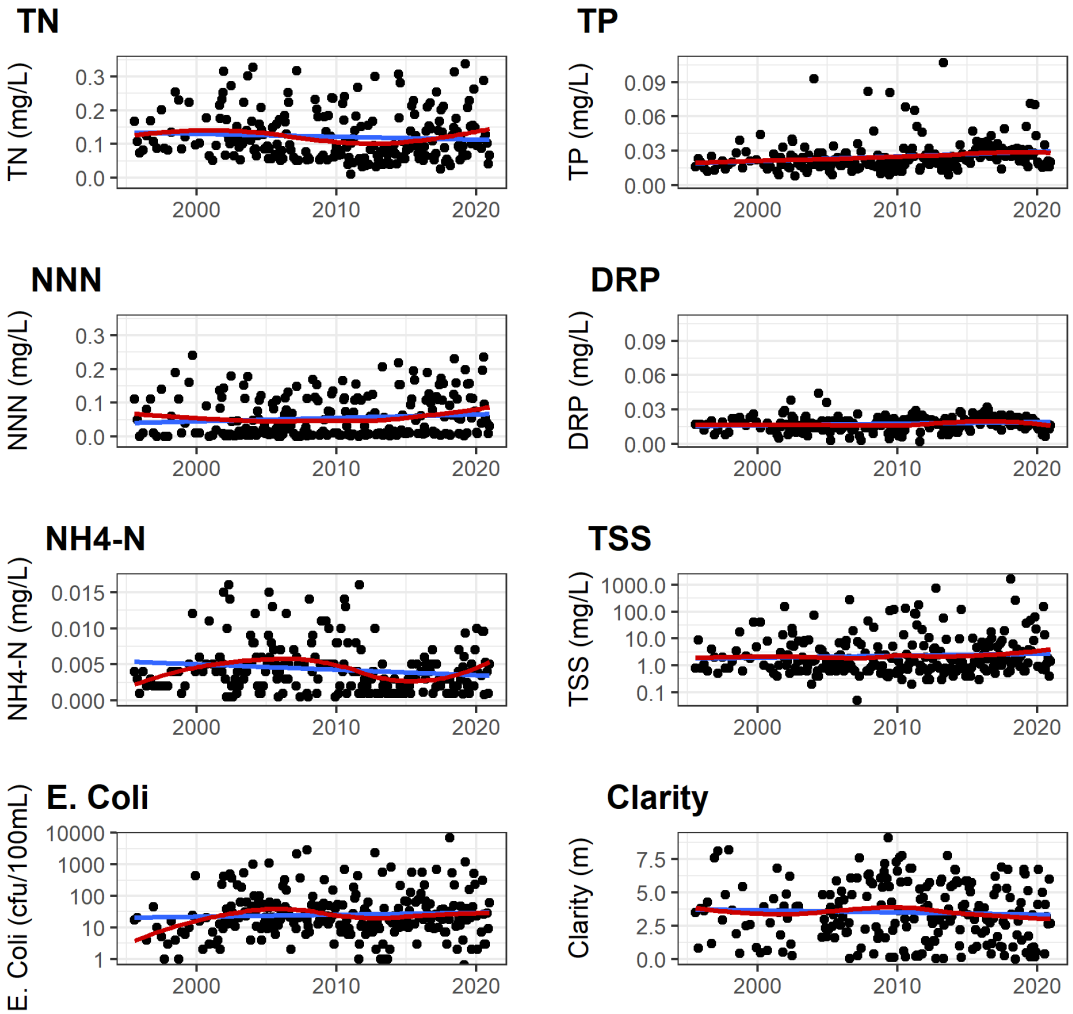

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-21	2020-12-14	0.0008	0.96	0.89	Indeterminant	YES	NO	Indeterminate/Uncertain
TN	10 Years	2011-01-11	2020-12-14	0.0024	3.47	0.09	Increasing	YES	NO	Very Likely Degrading
TN	All	1995-10-05	2020-12-14	-0.0003	-0.39	0.50	Indeterminant	YES	YES	Likely Improving
NNN	5 Years	2016-01-21	2020-12-14	-0.0023	-21.39	0.50	Indeterminant	YES	NO	Likely Improving
NNN	10 Years	2011-01-11	2020-12-14	0.0004	4.64	0.64	Indeterminant	YES	NO	Likely Degrading
NNN	All	1995-10-05	2020-12-14	0.0002	1.90	0.36	Indeterminant	YES	YES	Likely Degrading
NH4N	5 Years	2016-01-21	2020-12-14	0.0001	3.17	0.62	Indeterminant	YES	NO	Likely Degrading
NH4N	10 Years	2011-01-11	2020-12-14	0.0002	8.26	<0.05	Increasing	YES	NO	Very Likely Degrading
NH4N	All	1995-10-05	2020-12-14	-0.0002	-6.98	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-21	2020-12-14	-0.0024	-10.62	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-01-11	2020-12-14	0.0000	0.02	1.00	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	All	1995-10-05	2020-12-14	0.0002	0.91	0.12	Indeterminant	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-21	2020-12-14	-0.0021	-12.07	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-01-11	2020-12-14	-0.0003	-1.66	0.21	Indeterminant	YES	NO	Likely Improving
DRP	All	1995-10-05	2020-12-14	0.0001	0.72	0.24	Indeterminant	YES	NO	Likely Degrading
ECOLI	5 Years	2016-01-21	2020-12-14	-0.1095	-9.01	0.08	Decreasing	YES	NO	Very Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-01-11	2020-12-14	0.0244	2.10	0.42	Indeterminant	YES	YES	Likely Degrading
ECOLI	All	1995-10-05	2020-12-14	-0.0154	-1.28	0.11	Indeterminant	YES	YES	Likely Improving
TSS	5 Years	2016-01-21	2020-12-14	-0.0360	-12.26	0.10	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-01-11	2020-12-14	0.0055	2.15	0.41	Indeterminant	YES	NO	Likely Degrading
TSS	All	1995-10-05	2020-12-14	0.0004	0.16	0.85	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	5 Years	2016-01-21	2020-12-14	0.1309	3.19	0.24	Indeterminant	YES	NO	Likely Improving
CLARITY	10 Years	2011-01-11	2020-12-14	0.0216	0.47	0.66	Indeterminant	YES	NO	Likely Improving
CLARITY	All	1995-10-05	2020-12-14	0.0250	0.54	0.57	Indeterminant	YES	YES	Likely Improving

Otara at Browns Bridge

March 2021

Table 1 Site metadata.

Aquarius ID:	OK300616	**Labstar ID:**	BOP110005
LAWA ID:	EBOP-00014	**REC Reach:**	4011726
Easting:	1983007	**Northing:**	5776168
Longitude:	177.36620	**Latitude:**	-38.08117
Elevation:	32 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Low_HS		

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_ 95th	Perc_ 5th	StDev	SE
Total Nitrogen (g/m3)	147	0.03	4.55	0.14	0.10	0.23	0.04	0.37	0.03
Nitrate Nitrite Nitrogen (g/m3)	147	<0.001	0.23	0.06	0.05	0.14	0.01	0.05	0.00
Total Ammoniacal Nitrogen (g/m3)	158	<0.002	0.051	0.005	0.004	0.014	0.000	0.006	0.000
Total Phosphorus (g/m3)	162	0.013	2.112	0.053	0.036	0.062	0.024	0.165	0.013
Dissolved Reactive Phosphorus (g/m3)	156	0.015	0.155	0.031	0.030	0.037	0.020	0.011	0.001
Dissolved Oxygen Sat (%)	80	86.1	121.3	101.3	100.4	110.0	94.6	5.3	0.6
Dissolved Oxygen (g/m3)	154	8.40	13.97	10.53	10.59	12.06	9.00	0.99	0.08
Escherichia coli (cfu/100ml)	158	<1	8000	114	20	228	2	660	53
Total Suspended Solids (g/m3)	160	<1	3010.00	27.05	1.60	27.09	0.40	239.14	18.91
Turbidity (NTU)	161	<0.1	2832.0	25.2	1.6	27.0	0.5	224.1	17.7
Water Clarity (m)	132	0.00	9.80	3.48	3.40	7.57	0.35	2.27	0.20
Conductivity (uS/cm)	158	37	113	79	79	92	64	10	1
pH (pH Units)	160	6.1	8.3	7.4	7.4	7.8	6.9	0.3	0.0
Water Temperature (degC)	161	6.8	22.4	14.0	13.7	20.2	8.3	3.7	0.3
Discharge (m3/s)	159	1.50	651.50	13.10	6.60	24.30	2.00	51.50	4.10

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

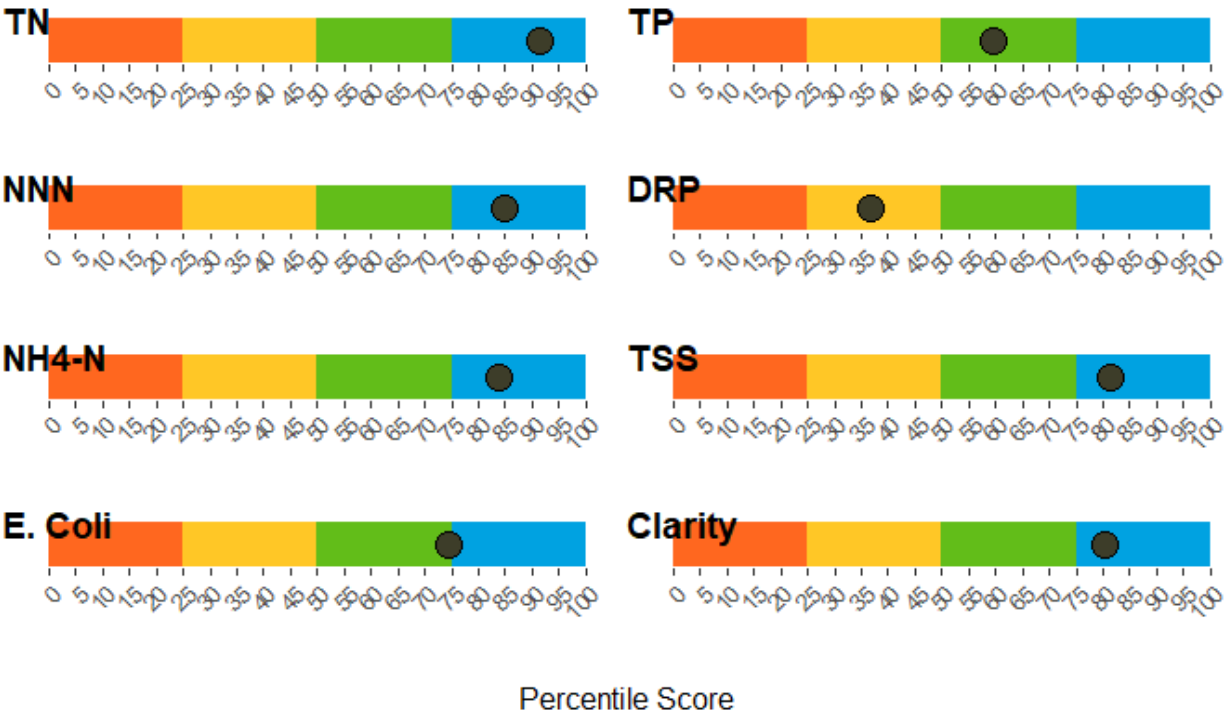

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

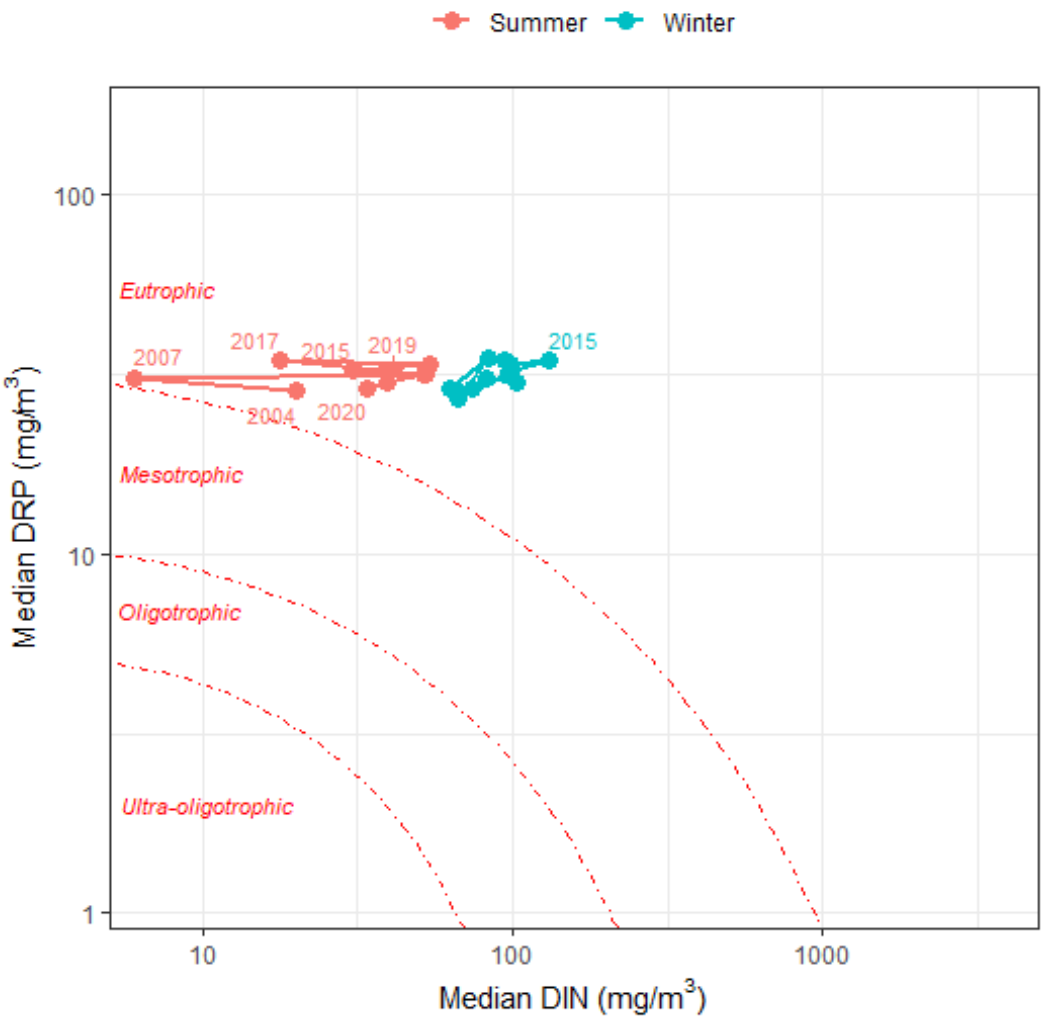

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-15	2020-12-14	9	0.0020	0.006	A
5 Years	2015-12-16	2020-12-14	56	0.0020	0.006	A
10 Years	2010-12-17	2020-12-14	83	0.0020	0.011	A
All	1991-04-02	2020-12-14	157	0.0021	0.024	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-15	2020-12-14	9	0.05	0.13	A
5 Years	2015-12-16	2020-12-14	57	0.06	0.14	A
10 Years	2010-12-17	2020-12-14	86	0.06	0.14	A
All	1993-07-29	2020-12-14	147	0.05	0.14	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-16	2020-12-14	53	2.80	B*
10 Years	2010-12-17	2020-12-14	82	3.05	A
All	1992-08-04	2020-12-14	131	3.50	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-16	2020-12-14	57	0.031	0.037	D
10 Years	2010-12-17	2020-12-14	86	0.032	0.037	D
All	1991-04-02	2020-12-14	155	0.030	0.037	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-16	2020-12-14	57	3.5	7.0	27	306	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-16	2020-12-14	57	27	387	93	3.5	3.5
10 Years	2010-12-17	2020-12-14	86	26	276	94.2	3.5	2.3
All	1991-04-02	2020-12-14	158	20	250	94.9	2.5	2.5

Time series plots

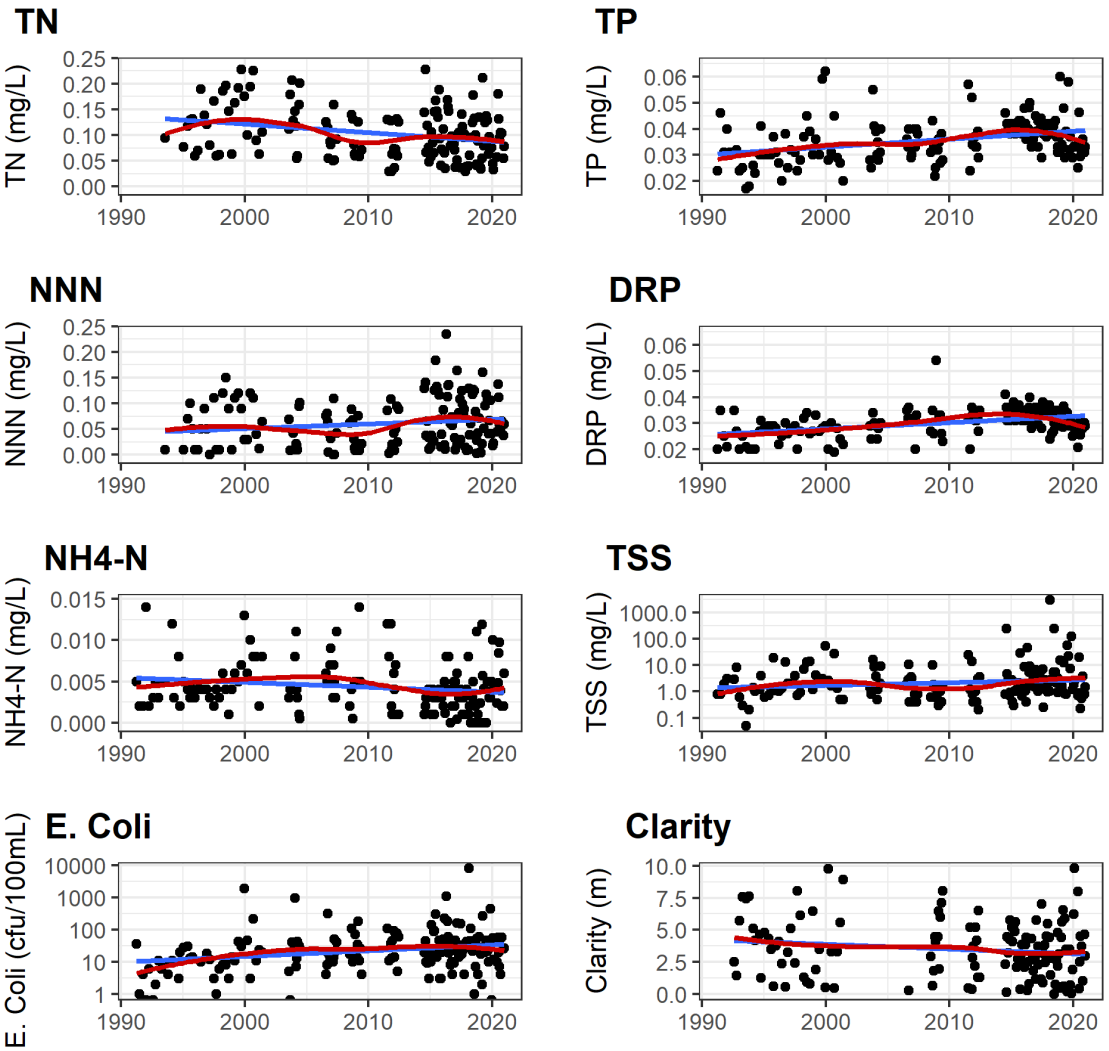

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-21	2020-12-14	0.0020	2.08	0.41	Indeterminant	YES	NO	Likely Degrading
TN	10 Years	2011-07-12	2020-12-14	0.0000	-0.01	1.00	Indeterminant	YES	YES	Indeterminate/Uncertain
TN	All	1991-07-03	2020-12-14	-0.0018	-1.82	<0.001	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-21	2020-12-14	0.0024	3.76	0.12	Indeterminant	YES	YES	Very Likely Degrading
NNN	10 Years	2011-07-12	2020-12-14	0.0005	0.77	0.57	Indeterminant	YES	YES	Likely Degrading
NNN	All	1991-07-03	2020-12-14	0.0003	0.68	0.19	Indeterminant	YES	YES	Very Likely Degrading
NH4N	5 Years	2016-01-21	2020-12-14	0.0000	0.00	0.64	Indeterminant	NO	NO	Likely Degrading
NH4N	10 Years	2011-07-12	2020-12-14	0.0000	0.00	0.75	Indeterminant	NO	NO	Indeterminate/Uncertain
NH4N	All	1991-07-03	2020-12-14	-0.0001	-1.82	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-21	2020-12-14	-0.0013	-3.54	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-07-12	2020-12-14	-0.0008	-1.99	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	All	1991-07-03	2020-12-14	0.0002	0.53	<0.01	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2016-01-21	2020-12-14	-0.0012	-3.89	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-07-12	2020-12-14	-0.0006	-1.88	<0.001	Decreasing	YES	NO	Very Likely Improving
DRP	All	1991-07-03	2020-12-14	0.0002	0.51	<0.01	Increasing	YES	NO	Very Likely Degrading
ECOLI	5 Years	2016-01-21	2020-12-14	-0.0591	-4.11	0.17	Indeterminant	YES	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-07-12	2020-12-14	-0.0189	-1.32	0.29	Indeterminant	YES	YES	Likely Improving
ECOLI	All	1991-07-03	2020-12-14	0.0104	0.79	<0.05	Increasing	YES	NO	Very Likely Degrading
TSS	5 Years	2016-01-21	2020-12-14	0.0120	2.26	0.41	Indeterminant	YES	NO	Likely Degrading
TSS	10 Years	2011-07-12	2020-12-14	0.0116	2.39	0.11	Indeterminant	YES	NO	Very Likely Degrading
TSS	All	1991-07-03	2020-12-14	-0.0020	-0.49	0.24	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-21	2020-12-14	-0.0648	-2.25	0.20	Indeterminant	YES	YES	Very Likely Degrading
CLARITY	10 Years	2011-07-12	2020-12-14	-0.0107	-0.36	0.73	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	1991-07-03	2020-12-14	-0.0061	-0.17	0.49	Indeterminant	YES	YES	Likely Degrading

East Coast WMA

The East Coast WMA is the second largest in the Bay of Plenty and has the highest proportion of its area in native forest cover. Most of the streams are short and steep with predominantly native forest landuse.

The Mōtū River is the largest river in the East Coast WMA. It is 115 km long, the upper reaches are in pasture with geology in brittle sandstone and siltstone. The river then continues into the Raukūmara Forest Park where a steep sided gorge has been cut through the hard sedimentary rock. The River then widens to form an alluvial fan where braiding becomes apparent along the coastal floodplains. Although the upper Motu catchment is in agricultural landuse, the mid and lower catchment is relatively undisturbed indigenous forest. Therefore, the Mōtū River water quality is considered high.

The Haparapara River originates in the Raukumara Ranges, joins with the Waikakariki River and enters the ocean at Omaio Bay, south of Te Kaha.

The Raukokore River has a steep catchment of predominantly indigenous forest landuse. The catchment is prone to high intensity rainfall which has contributed to landslides, slips and a braided alluvium river system.

Table 11 NERMN sites in the East Coast WMA

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
East Coast								
QJ471191	Motu at Waitangirua (NIWA)	2004713	5761919	Non_VA/Steep	NSR	294	95.7	NIWA M
QM756918	Motu at Houpoto SH 35 (NIWA)	2007565	5799183	Non_VA/Steep	NSR	1377	3.7	NIWA M
RN123610	Haparapara at SH 35	2011231	5806108	Non_VA/Steep	AE	167	1.5	M
RO629568	Kereu at SH 35	2016299	5815685	Non_VA/Steep	AE	141	0.6	M
SO991920	Raukokore at SH 35	2029919	5819206	Non_VA/Steep	AE	349	3.2	M

Motu at Waitangirua (NIWA)

March 2021

Table 1 Site metadata.

Aquarius ID:	QJ471191	**Labstar ID:**	BOP110093
LAWA ID:	NRWQN-00012	**REC Reach:**	4016696
Easting:	2004713	**Northing:**	5761919
Longitude:	177.62100	**Latitude:**	-38.19973
Elevation:	423 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_SS		

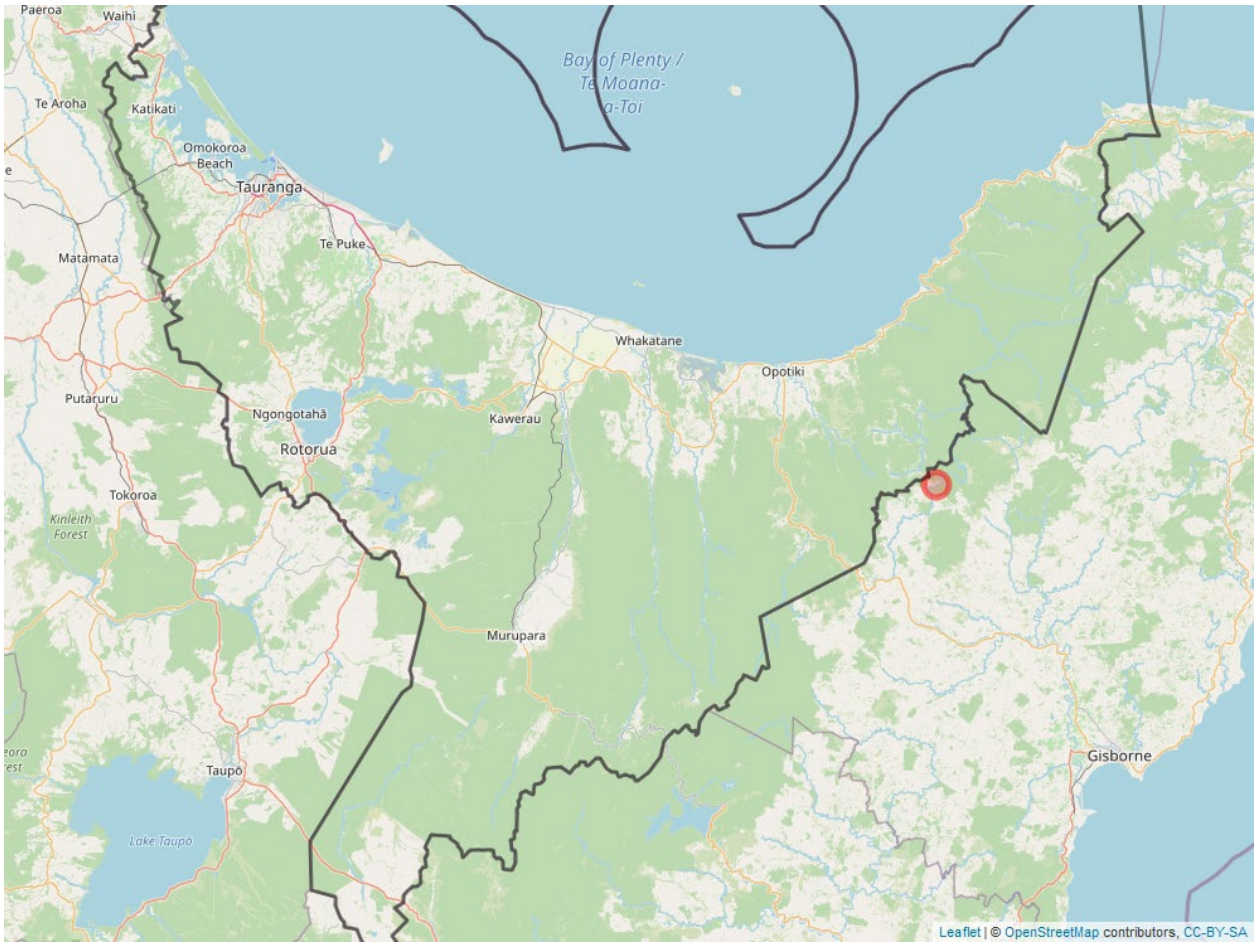

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	371	0.05	3.05	0.35	0.29	0.71	0.12	0.26	0.01
Nitrate Nitrite Nitrogen (g/m3)	384	<0.001	0.66	0.17	0.15	0.43	0.00	0.15	0.01
Total Ammoniacal Nitrogen (g/m3)	373	<0.002	0.052	0.008	0.007	0.018	0.002	0.006	0.000
Total Phosphorus (g/m3)	383	0.008	1.190	0.045	0.025	0.140	0.012	0.083	0.004
Dissolved Reactive Phosphorus (g/m3)	382	<0.001	0.034	0.009	0.009	0.018	0.004	0.004	0.000
Dissolved Oxygen Sat (%)	383	92.1	126.0	101.9	101.3	108.1	97.2	3.7	0.2
Dissolved Oxygen (g/m3)	382	7.90	13.30	10.24	10.30	11.80	8.60	1.05	0.05
Escherichia coli (cfu/100ml)	187	11	24192	817	172	2419	34	2695	197
Total Suspended Solids (g/m3)	5	<1	86.00	25.12	3.80	75.60	0.84	36.79	16.45
Turbidity (NTU)	367	0.6	650.0	12.7	2.2	52.2	0.8	43.1	2.3
Water Clarity (m)	382	0.02	5.07	1.75	1.70	3.69	0.11	1.20	0.06
Conductivity (uS/cm)	112	42	113	80	80	102	58	13	1
pH (pH Units)	384	6.6	8.9	7.7	7.7	8.1	7.3	0.3	0.0
Water Temperature (degC)	384	4.6	22.7	13.1	12.7	20.0	7.2	4.2	0.2
Discharge (m3/s)	186	0.60	262.50	14.00	6.90	49.70	1.10	26.30	1.90

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

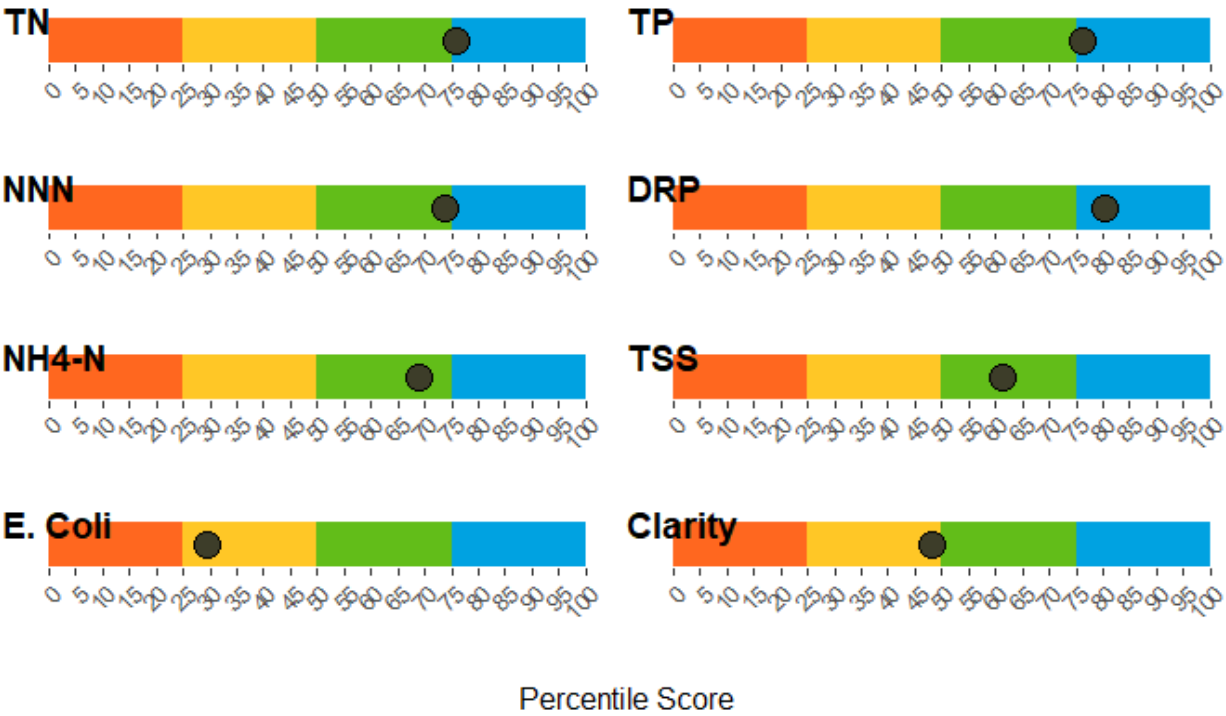

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

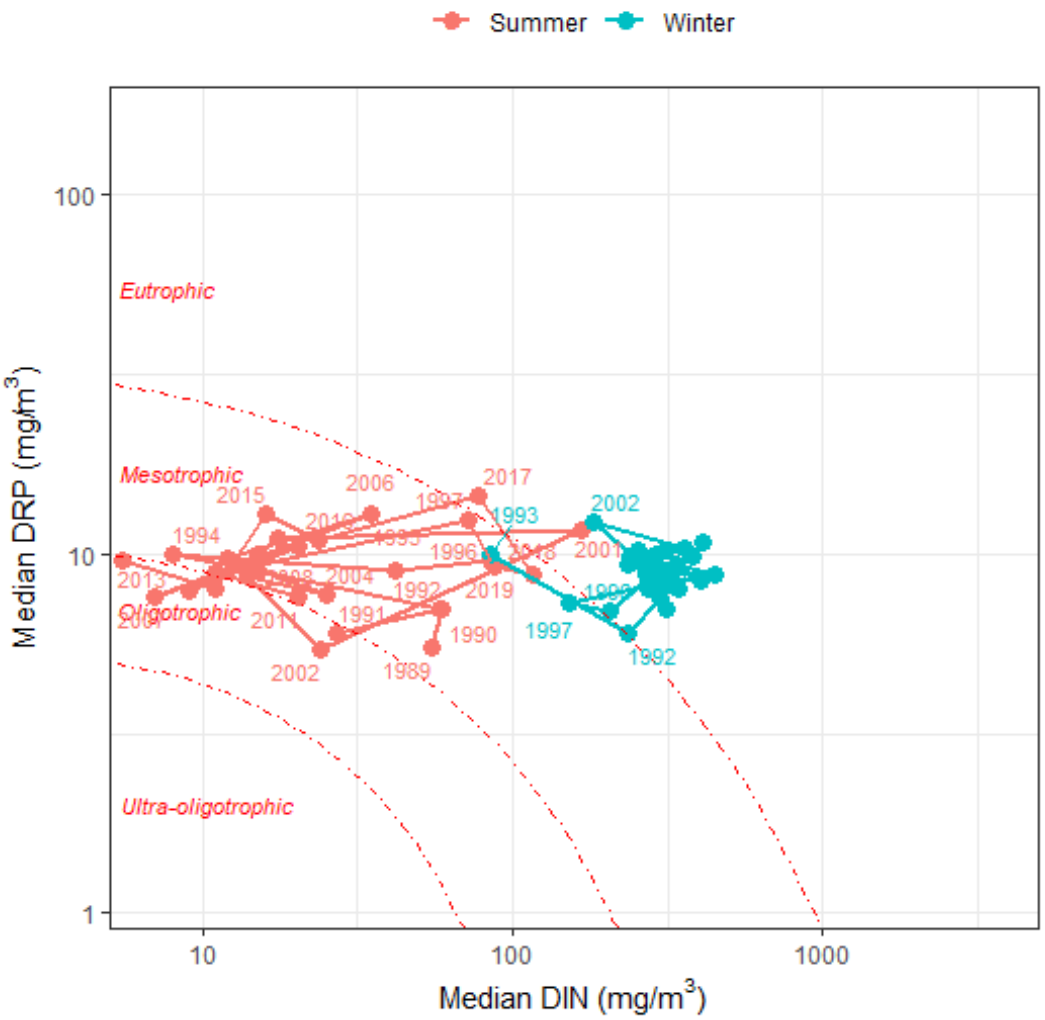

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-06-25	2020-06-24	10	0.008	0.013	A
5 Years	2015-06-26	2020-06-24	58	0.007	0.023	A
10 Years	2010-06-27	2020-06-24	118	0.006	0.023	A
All	1989-01-25	2020-06-24	373	0.005	0.023	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-06-25	2020-06-24	10	0.20	0.56	A
5 Years	2015-06-26	2020-06-24	58	0.22	0.49	A
10 Years	2010-06-27	2020-06-24	118	0.20	0.48	A
All	1989-01-25	2020-06-24	384	0.15	0.43	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-06-25	2020-06-24	57	1.49	C*
10 Years	2010-06-27	2020-06-24	117	1.33	D
All	1989-01-25	2020-06-24	382	1.71	B

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-06-25	2020-06-23	57	0.009	0.023	B
10 Years	2010-06-26	2020-06-23	116	0.009	0.019	B
All	1989-01-25	2020-06-23	381	0.009	0.018	B

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-06-26	2020-06-24	58	22.4	34.5	152	3438	D*	Not Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-06-26	2020-06-24	58	152	6492	65.5	13.8	20.7
10 Years	2010-06-27	2020-06-24	118	172	2419	59.3	16.9	23.7
All	2001-07-18	2020-06-24	187	172	2419	59.9	18.2	21.9

Time series plots

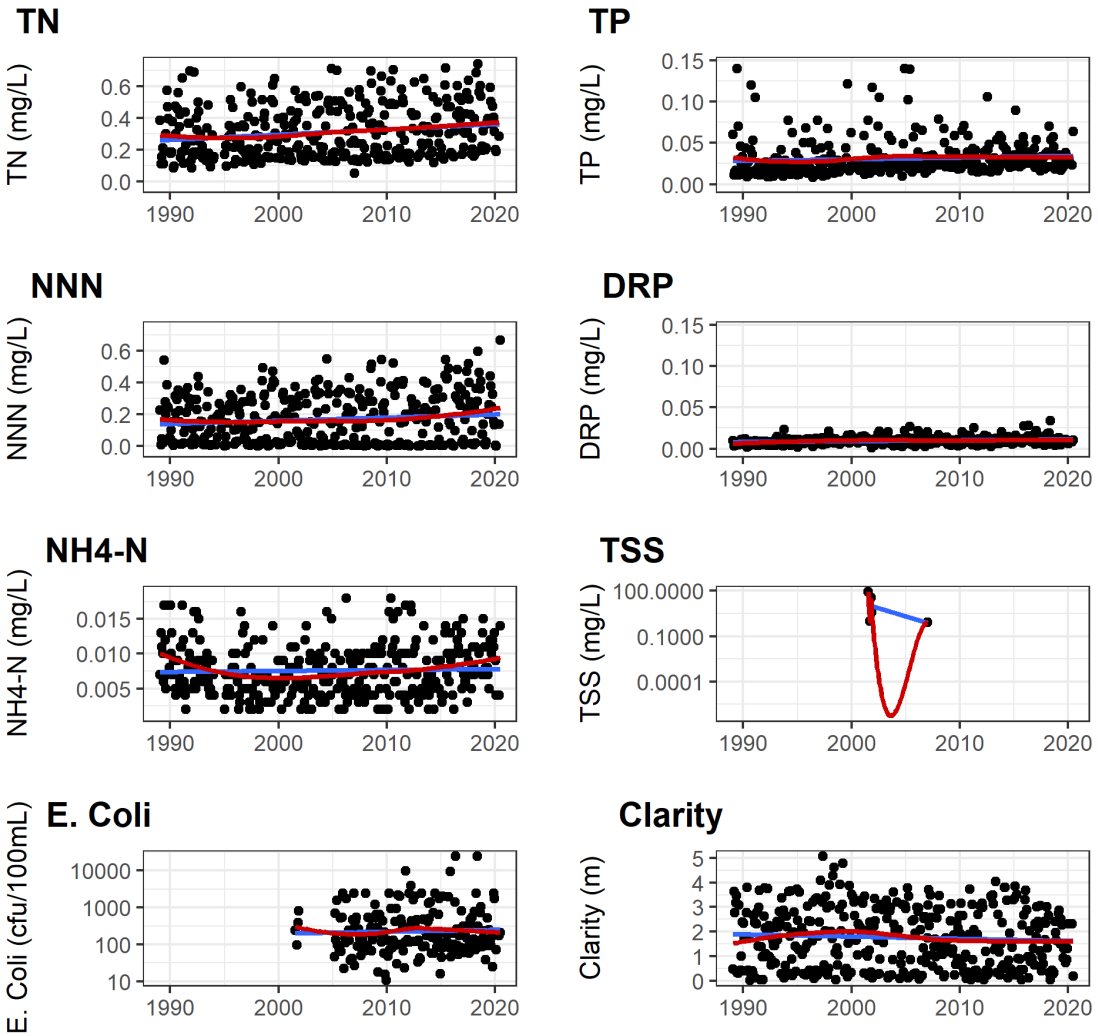

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-07-21	2020-06-24	0.0072	1.86	0.82	Indeterminant	Attempted	YES	Indeterminate/Uncertain
TN	10 Years	2010-07-20	2020-06-24	0.0070	2.05	<0.05	Increasing	Attempted	YES	Very Likely Degrading
TN	All	1989-02-28	2020-06-24	0.0036	1.39	<0.001	Increasing	YES	YES	Very Likely Degrading
NNN	5 Years	2015-07-21	2020-06-24	-0.0020	-0.90	0.51	Indeterminant	Attempted	YES	Likely Improving
NNN	10 Years	2010-07-20	2020-06-24	0.0024	1.23	<0.05	Increasing	Attempted	YES	Very Likely Degrading
NNN	All	1989-02-28	2020-06-24	0.0015	1.08	<0.01	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2015-07-21	2020-06-24	0.0014	15.09	0.15	Indeterminant	YES	NO	Very Likely Degrading
NH4N	10 Years	2010-07-20	2020-06-24	0.0008	8.83	<0.01	Increasing	YES	NO	Very Likely Degrading
NH4N	All	1989-02-28	2020-06-24	0.0000	0.39	0.45	Indeterminant	YES	NO	Likely Degrading
TP	5 Years	2015-07-21	2020-06-24	0.0028	8.75	0.26	Indeterminant	YES	NO	Likely Degrading
TP	10 Years	2010-07-20	2020-06-24	0.0015	4.84	<0.05	Increasing	YES	NO	Very Likely Degrading
TP	All	1989-02-28	2020-06-24	0.0004	1.76	<0.01	Increasing	YES	NO	Very Likely Degrading
DRP	5 Years	2015-07-21	2020-06-24	-0.0004	-3.73	0.49	Indeterminant	YES	NO	Likely Improving
DRP	10 Years	2010-07-20	2020-06-24	0.0005	4.55	<0.05	Increasing	YES	NO	Very Likely Degrading
DRP	All	1989-02-28	2020-06-24	0.0001	1.41	<0.001	Increasing	YES	NO	Very Likely Degrading
ECOLI	5 Years	2015-07-21	2020-06-24	0.1143	5.28	0.19	Indeterminant	YES	NO	Very Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-07-20	2020-06-24	0.0107	0.47	0.69	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	All	1989-02-28	2020-06-24	0.0035	0.16	0.59	Indeterminant	Attempted	YES	Likely Degrading
TSS	5 Years									Not Analysed
TSS	10 Years									Not Analysed
TSS	All									Not Analysed
CLARITY	5 Years	2015-07-21	2020-06-24	-0.0167	-1.12	0.94	Indeterminant	Attempted	YES	Indeterminate/Uncertain
CLARITY	10 Years	2010-07-20	2020-06-24	-0.0394	-2.37	0.07	Decreasing	YES	NO	Very Likely Degrading
CLARITY	All	1989-02-28	2020-06-24	0.0020	0.11	0.53	Indeterminant	YES	YES	Likely Improving

Motu at Houpoto (NIWA)

March 2021

Table 1 Site metadata.

Aquarius ID:	QM756918	**Labstar ID:**	BOP110003
LAWA ID:	EBOP-00045	**REC Reach:**	4005222
Easting:	2007565	**Northing:**	5799183
Longitude:	177.63229	**Latitude:**	-37.86370
Elevation:	12 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	Yes
REC Class:	CW_Hill_HS		

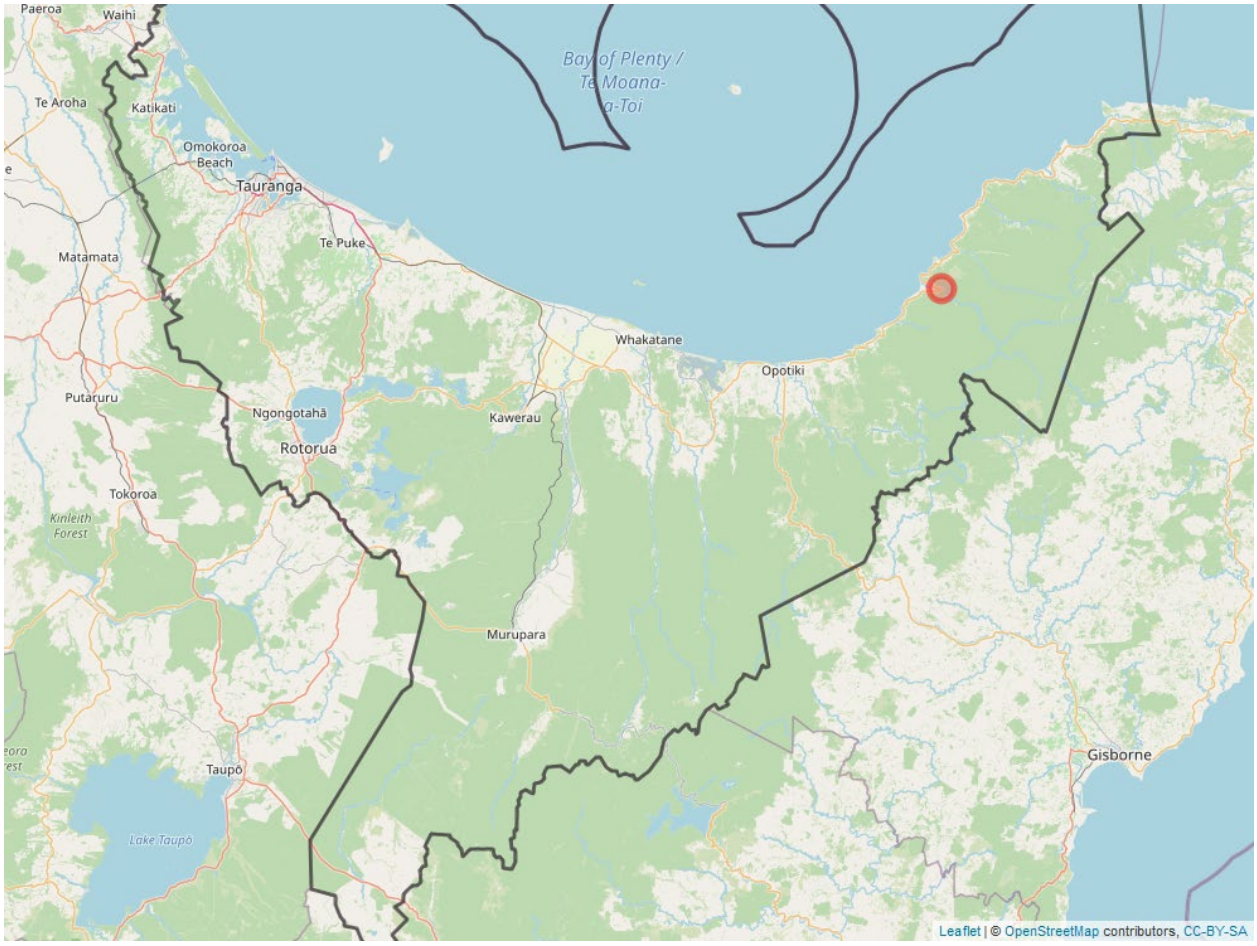

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_ 95th	Perc_ 5th	StDev	SE
Total Nitrogen (g/m3)	380	<0.01	0.66	0.14	0.12	0.33	0.04	0.10	0.01
Nitrate Nitrite Nitrogen (g/m3)	380	<0.001	0.21	0.06	0.06	0.17	0.00	0.05	0.00
Total Ammoniacal Nitrogen (g/m3)	387	<0.002	0.046	0.004	0.003	0.010	0.000	0.005	0.000
Total Phosphorus (g/m3)	398	0.006	1.085	0.083	0.022	0.451	0.010	0.170	0.009
Dissolved Reactive Phosphorus (g/m3)	399	0.002	0.031	0.011	0.011	0.017	0.005	0.004	0.000
Dissolved Oxygen Sat (%)	391	89.9	113.2	100.2	99.7	105.2	97.0	2.7	0.1
Dissolved Oxygen (g/m3)	382	8.20	13.70	10.39	10.40	11.80	8.90	0.93	0.05
Escherichia coli (cfu/100ml)	190	<1	2282	120	21	733	1	297	22
Total Suspended Solids (g/m3)	10	<1	900.00	101.12	9.10	513.90	0.87	281.00	88.86
Turbidity (NTU)	382	0.3	640.0	47.4	6.3	300.0	0.6	103.6	5.3
Water Clarity (m)	381	0.02	11.90	1.92	0.80	7.42	0.04	2.40	0.12
Conductivity (uS/cm)	116	54	127	92	93	116	64	16	1
pH (pH Units)	397	7.0	8.9	7.8	7.8	8.1	7.5	0.2	0.0
Water Temperature (degC)	399	5.8	25.5	13.9	13.6	20.4	8.5	3.9	0.2
Discharge (m3/s)	204	9.60	578.90	86.10	51.00	319.90	15.10	99.10	6.90

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

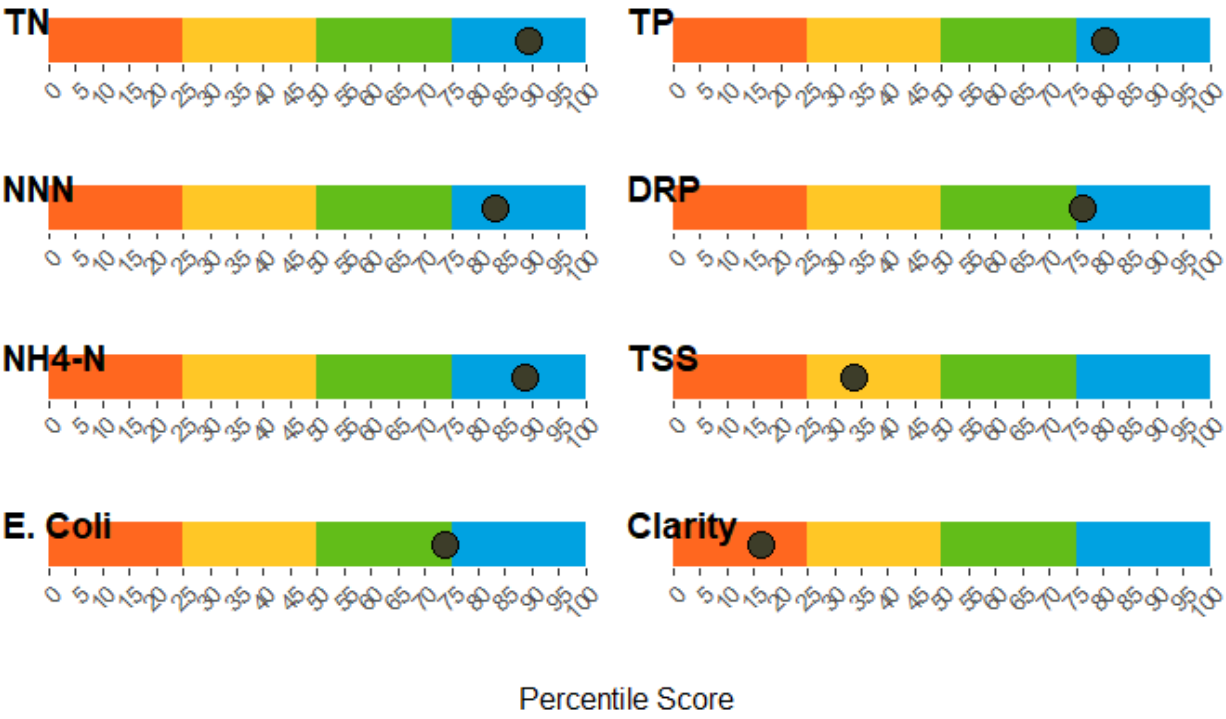

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

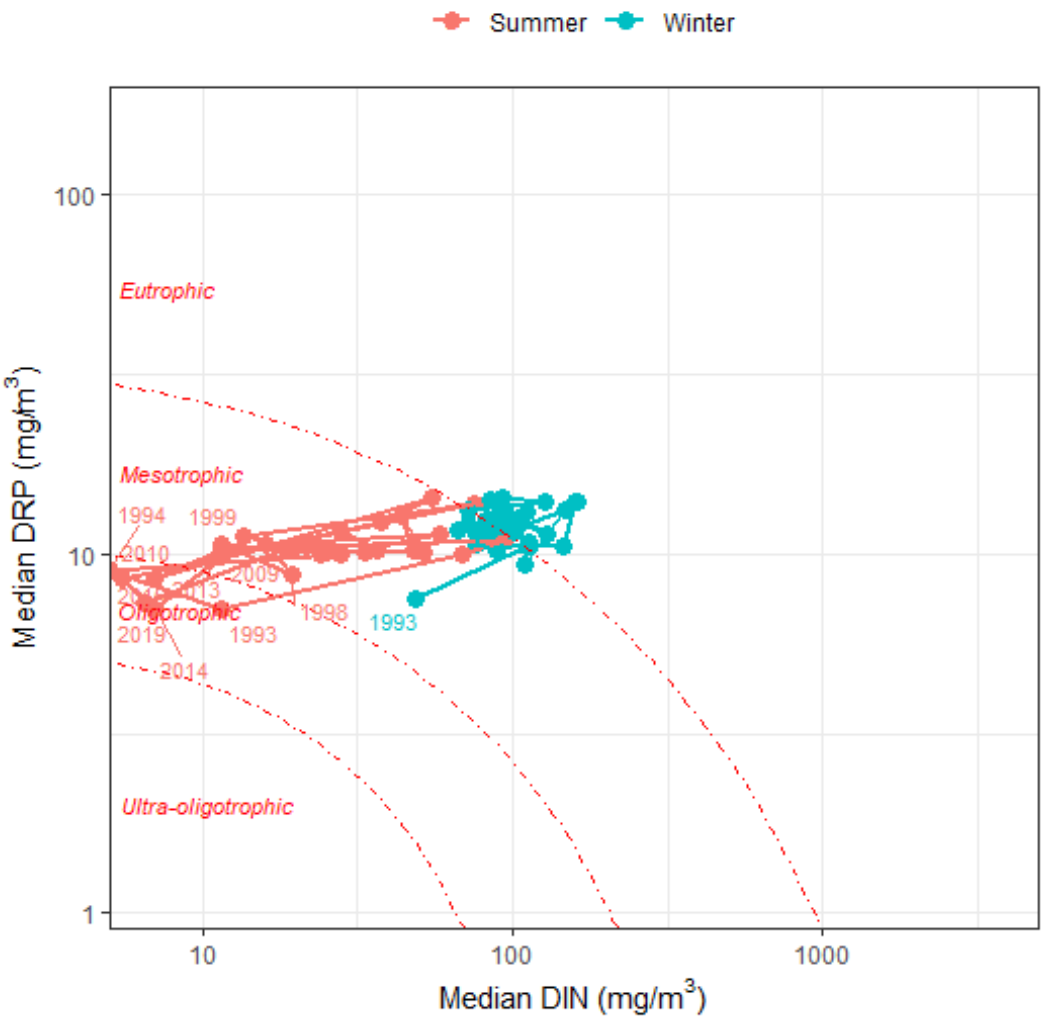

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-06-10	2020-06-09	9	0.003	0.007	A
5 Years	2015-06-11	2020-06-09	55	0.003	0.026	A
10 Years	2010-06-12	2020-06-09	115	0.002	0.026	A
All	1989-02-10	2020-06-09	385	0.002	0.034	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-06-10	2020-06-09	9	0.04	0.18	A
5 Years	2015-06-11	2020-06-09	57	0.06	0.18	A
10 Years	2010-06-12	2020-06-09	117	0.05	0.17	A
All	1989-02-10	2020-06-09	380	0.06	0.17	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-06-11	2020-06-09	57	1.19	D*
10 Years	2010-06-12	2020-06-09	117	1.25	D
All	1989-02-10	2020-06-09	379	0.81	D

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-06-11	2020-06-09	57	0.011	0.016	C
10 Years	2010-06-12	2020-06-09	117	0.011	0.017	C
All	1989-02-09	2020-06-09	398	0.011	0.017	C

Table 7. Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-06-11	2020-06-09	55	7.3	10.9	21	847	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-06-11	2020-06-09	55	21	895	89.1	3.6	7.3
10 Years	2010-06-12	2020-06-09	115	24	803	87	5.2	7.8
All	1991-04-03	2020-06-09	190	21	738	89.5	4.2	6.3

Time series plots

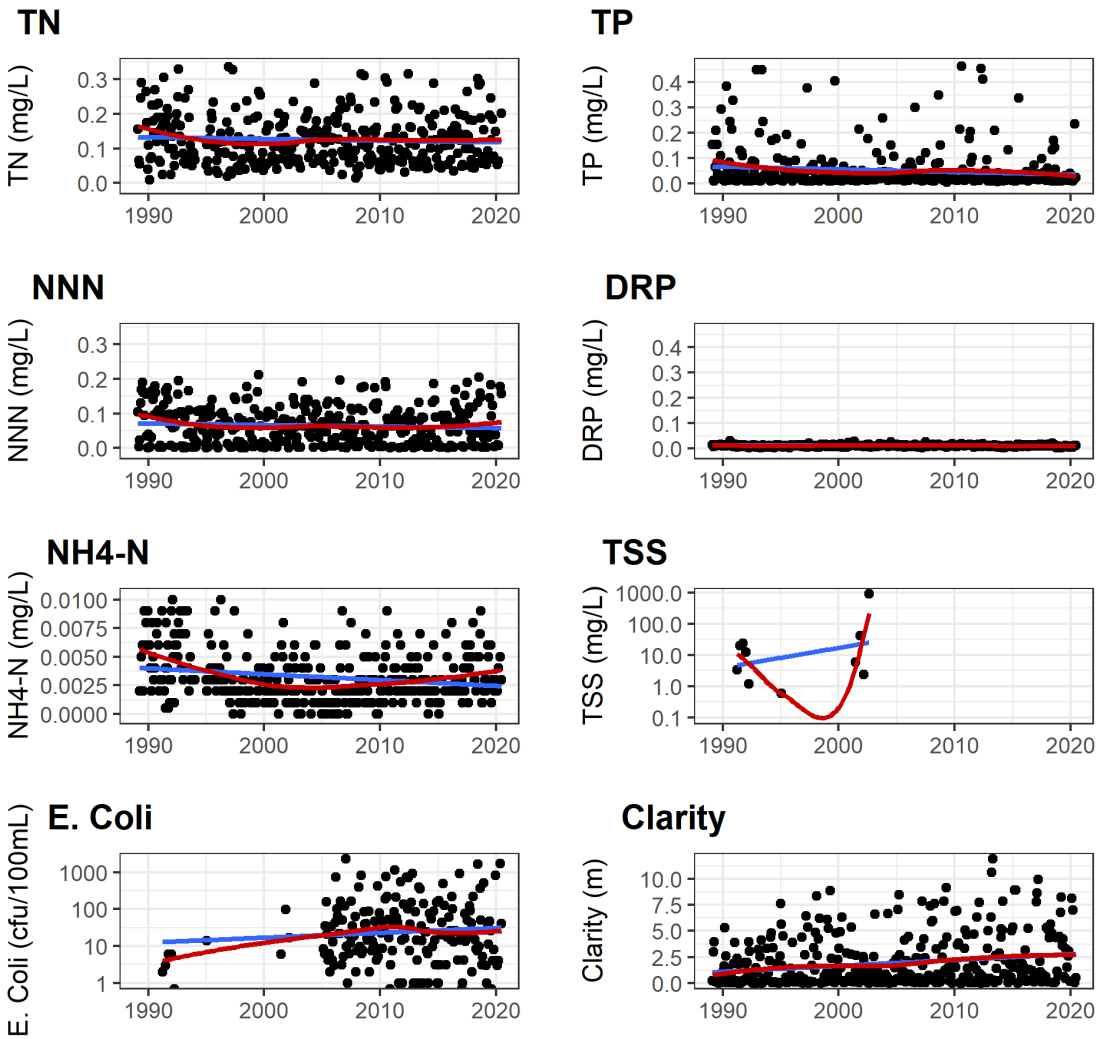

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2015-07-08	2020-06-09	0.0085	6.76	<0.05	Increasing	YES	NO	Very Likely Degrading
TN	10 Years	2010-07-07	2020-06-09	0.0039	3.60	<0.05	Increasing	YES	NO	Very Likely Degrading
TN	All	1989-02-10	2020-06-09	-0.0001	-0.05	0.81	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	5 Years									Not Analysed
NNN	10 Years	2010-07-07	2020-06-09	0.0008	1.54	0.11	Indeterminant	Attempted	YES	Very Likely Degrading
NNN	All	1989-02-10	2020-06-09	0.0000	-0.05	0.85	Indeterminant	YES	YES	Indeterminate/Uncertain
NH4N	5 Years									Not Analysed
NH4N	10 Years	2010-07-07	2020-06-09	0.0000	0.00	0.21	Indeterminant	Attempted	YES	Likely Degrading
NH4N	All	1989-02-10	2020-06-09	-0.0001	-2.02	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2015-07-08	2020-06-09	0.0008	4.32	0.12	Indeterminant	YES	NO	Very Likely Degrading
TP	10 Years	2010-07-07	2020-06-09	-0.0001	-0.82	0.61	Indeterminant	YES	NO	Likely Improving
TP	All	1989-02-10	2020-06-09	-0.0005	-1.80	<0.01	Decreasing	YES	YES	Very Likely Improving
DRP	5 Years	2015-07-08	2020-06-09	-0.0007	-6.06	<0.01	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2010-07-07	2020-06-09	-0.0003	-2.50	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	All	1989-02-10	2020-06-09	0.0000	0.17	0.47	Indeterminant	YES	YES	Likely Degrading
ECOLI	5 Years	2015-07-08	2020-06-09	0.0064	0.51	0.92	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2010-07-07	2020-06-09	-0.0675	-4.92	<0.05	Decreasing	YES	NO	Very Likely Improving
ECOLI	All	1989-02-10	2020-06-09	-0.0046	-0.37	0.66	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	5 Years									Not Analysed
TSS	10 Years									Not Analysed
TSS	All									Not Analysed
CLARITY	5 Years	2015-07-08	2020-06-09	-0.0192	-1.61	0.55	Indeterminant	YES	NO	Likely Degrading
CLARITY	10 Years	2010-07-07	2020-06-09	-0.0382	-2.83	0.25	Indeterminant	YES	NO	Likely Degrading
CLARITY	All	1989-02-10	2020-06-09	0.0206	2.93	<0.001	Increasing	YES	YES	Very Likely Improving

Haparapara at SH 35

March 2021

Table 1 Site metadata.

Aquarius ID:	RN123610	**Labstar ID:**	BOP160100
LAWA ID:	EBOP-00002	**REC Reach:**	4003934
Easting:	2011231	**Northing:**	5806108
Longitude:	177.66991	**Latitude:**	-37.79984
Elevation:	3 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	CW_Hill_HS		

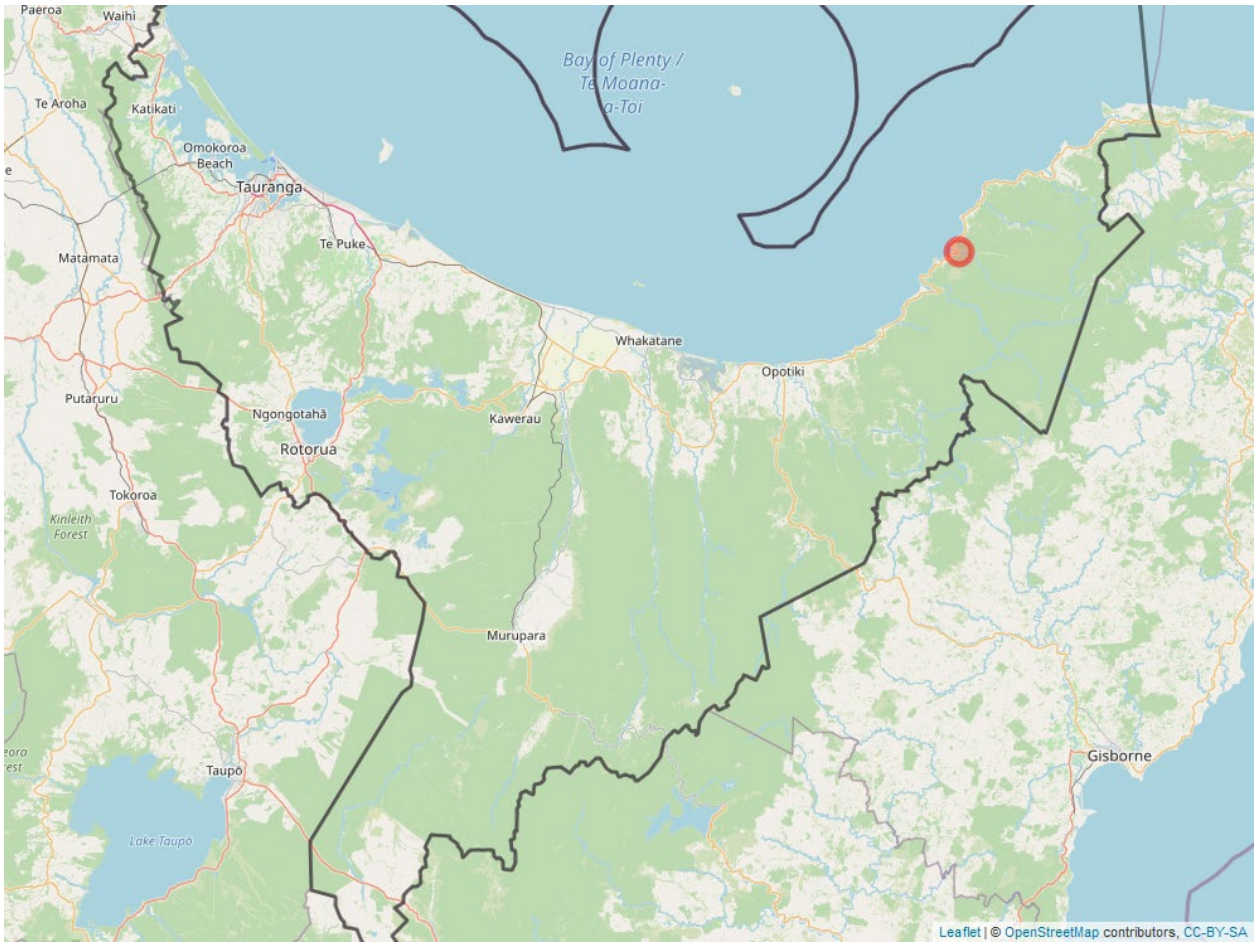

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	117	0.02	0.61	0.08	0.06	0.18	0.02	0.09	0.01
Nitrate Nitrite Nitrogen (g/m3)	118	<0.001	0.18	0.03	0.02	0.09	0.00	0.03	0.00
Total Ammoniacal Nitrogen (g/m3)	115	<0.002	1.410	0.017	0.003	0.015	0.000	0.131	0.012
Total Phosphorus (g/m3)	120	0.005	0.762	0.031	0.020	0.057	0.012	0.073	0.007
Dissolved Reactive Phosphorus (g/m3)	118	0.002	0.072	0.016	0.016	0.021	0.012	0.006	0.001
Dissolved Oxygen Sat (%)	82	43.2	111.7	100.4	100.9	107.7	96.2	7.3	0.8
Dissolved Oxygen (g/m3)	116	4.68	12.66	10.14	10.16	11.59	8.93	0.96	0.09
Escherichia coli (cfu/100ml)	120	<1	1700	46	6	170	0	195	18
Total Suspended Solids (g/m3)	121	<1	1000.00	15.22	0.90	48.00	0.00	93.96	8.54
Turbidity (NTU)	121	0.2	370.0	8.0	0.9	36.1	0.3	36.7	3.3
Water Clarity (m)	103	0.02	14.20	5.84	5.80	11.29	0.26	3.46	0.34
Conductivity (uS/cm)	119	46	85	69	70	79	54	8	1
pH (pH Units)	121	6.7	8.1	7.4	7.4	7.7	7.1	0.2	0.0
Water Temperature (degC)	119	9.4	24.5	15.4	15.4	21.4	10.6	3.7	0.3
Discharge (m3/s)	103	1.10	114.80	8.70	5.40	18.20	1.80	13.30	1.30

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

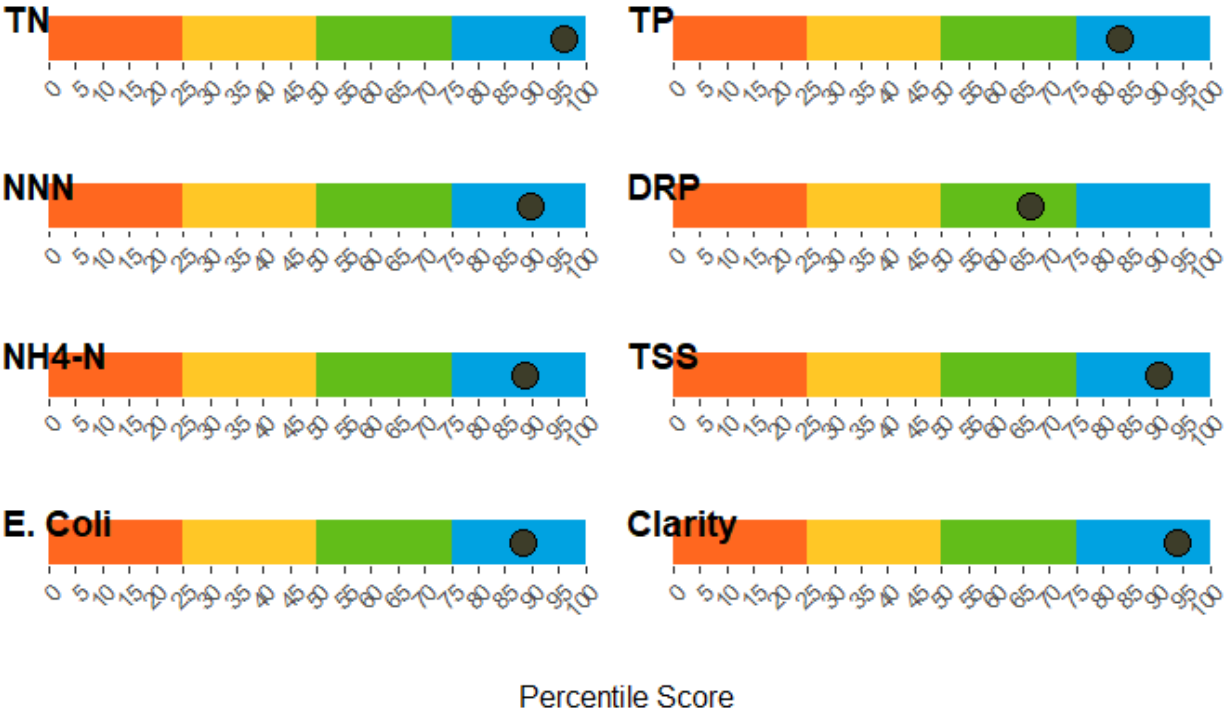

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

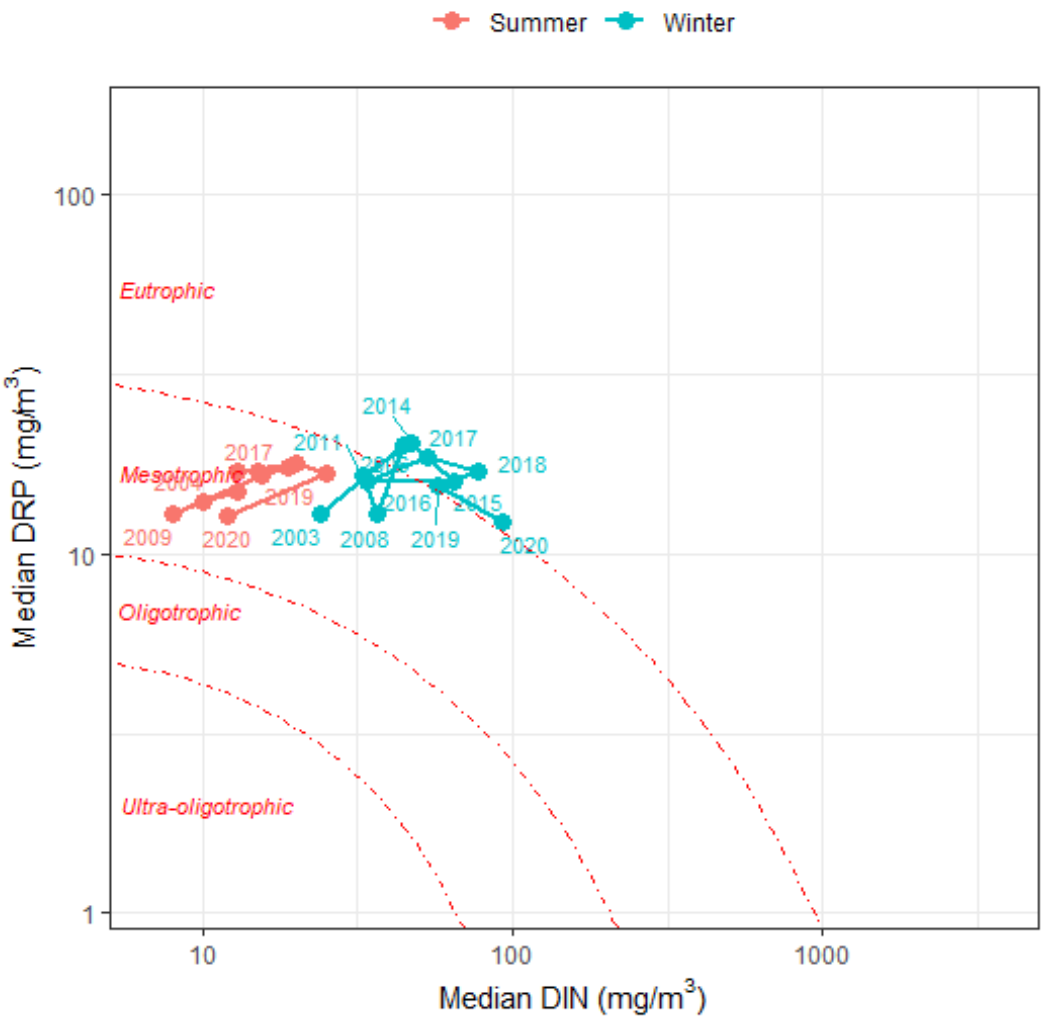

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-04	2020-12-03	12	0.0010	0.003	A
5 Years	2015-12-05	2020-12-03	54	0.0010	0.004	A
10 Years	2010-12-06	2020-12-03	82	0.0010	0.025	A
All	2003-04-06	2020-12-03	115	0.0015	0.788	C

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-04	2020-12-03	12	0.02	0.15	A
5 Years	2015-12-05	2020-12-03	57	0.03	0.12	A
10 Years	2010-12-06	2020-12-03	87	0.03	0.11	A
All	2003-04-06	2020-12-03	118	0.02	0.09	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-03	53	6.30	A*
10 Years	2010-12-06	2020-12-03	81	5.65	A
All	2006-07-27	2020-12-03	102	5.92	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	56	0.016	0.021	C
10 Years	2010-12-05	2020-12-02	86	0.017	0.021	C
All	2003-04-06	2020-12-02	117	0.016	0.021	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-05	2020-12-03	57	3.5	5.3	6	220	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

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Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-05	2020-12-03	57	6	310	94.7	1.8	3.5
10 Years	2010-12-06	2020-12-03	87	6	210	95.4	2.3	2.3
All	2003-04-06	2020-12-03	120	6	175	95.8	2.5	1.7

Time series plots

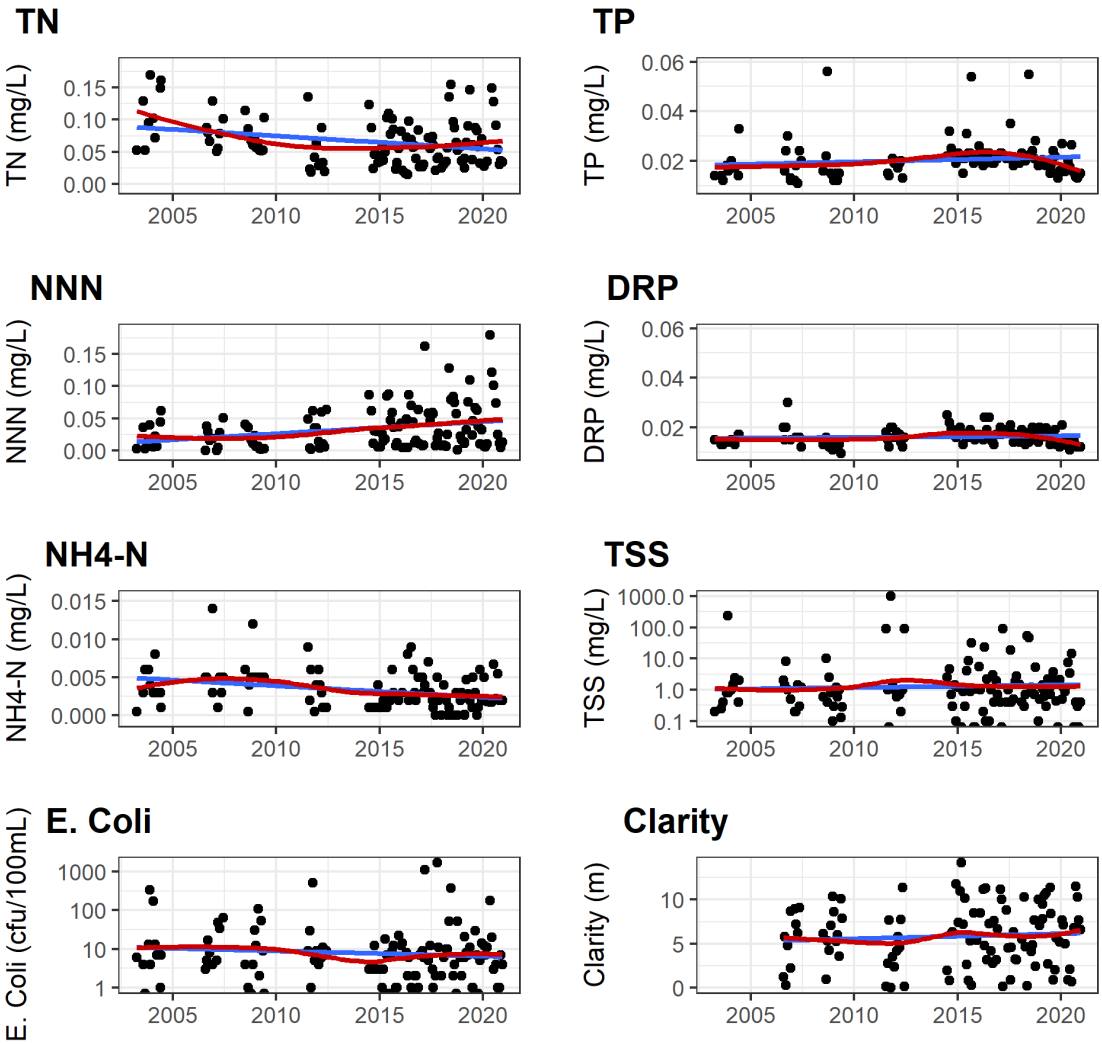

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-14	2020-12-03	0.0044	7.77	<0.05	Increasing	Attempted	YES	Very Likely Degrading
TN	10 Years	2011-07-16	2020-12-03	0.0016	3.17	0.10	Increasing	YES	YES	Very Likely Degrading
TN	All	2003-07-29	2020-12-03	-0.0017	-3.02	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-14	2020-12-03	0.0020	7.29	0.26	Indeterminant	Attempted	YES	Likely Degrading
NNN	10 Years	2011-07-16	2020-12-03	0.0008	3.11	0.19	Indeterminant	YES	YES	Very Likely Degrading
NNN	All	2003-07-29	2020-12-03	0.0008	4.59	<0.05	Increasing	YES	YES	Very Likely Degrading
NH4N	5 Years	2016-01-14	2020-12-03	-0.0005	-24.55	<0.05	Decreasing	YES	NO	Very Likely Improving
NH4N	10 Years	2011-07-16	2020-12-03	-0.0001	-5.48	0.26	Indeterminant	YES	NO	Likely Improving
NH4N	All	2003-07-29	2020-12-03	-0.0002	-6.25	<0.001	Decreasing	NO	NO	Very Likely Improving
TP	5 Years	2016-01-14	2020-12-03	-0.0012	-5.97	<0.001	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-07-16	2020-12-03	-0.0004	-1.88	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	All	2003-07-29	2020-12-03	0.0001	0.62	0.22	Indeterminant	YES	NO	Likely Degrading
DRP	5 Years	2016-01-14	2020-12-03	-0.0010	-6.19	<0.001	Decreasing	NO	NO	Very Likely Improving
DRP	10 Years	2011-07-16	2020-12-03	-0.0003	-1.47	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	All	2003-07-29	2020-12-03	0.0001	0.38	0.37	Indeterminant	YES	NO	Likely Degrading

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	5 Years	2016-01-14	2020-12-03	-0.0031	-0.36	0.91	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	10 Years	2011-07-16	2020-12-03	0.0118	1.39	0.43	Indeterminant	YES	NO	Likely Degrading
ECOLI	All	2003-07-29	2020-12-03	0.0014	0.18	0.85	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	5 Years	2016-01-14	2020-12-03	-0.0005	-0.20	0.99	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	10 Years	2011-07-16	2020-12-03	0.0017	0.64	0.81	Indeterminant	YES	NO	Indeterminate/Uncertain
TSS	All	2003-07-29	2020-12-03	-0.0017	-0.66	0.54	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-14	2020-12-03	-0.2634	-3.87	0.11	Indeterminant	YES	NO	Very Likely Degrading
CLARITY	10 Years	2011-07-16	2020-12-03	0.0391	0.62	0.77	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	2003-07-29	2020-12-03	0.1056	1.72	0.08	Increasing	YES	YES	Very Likely Improving

Kereu at SH 35

March 2021

Table 1 Site metadata.

Aquarius ID:	RO629568	**Labstar ID:**	BOP110165
LAWA ID:	EBOP-00101	**REC Reach:**	4002237
Easting:	2016299	**Northing:**	5815685
Longitude:	177.72180	**Latitude:**	-37.71152
Elevation:	0 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Low_HS		

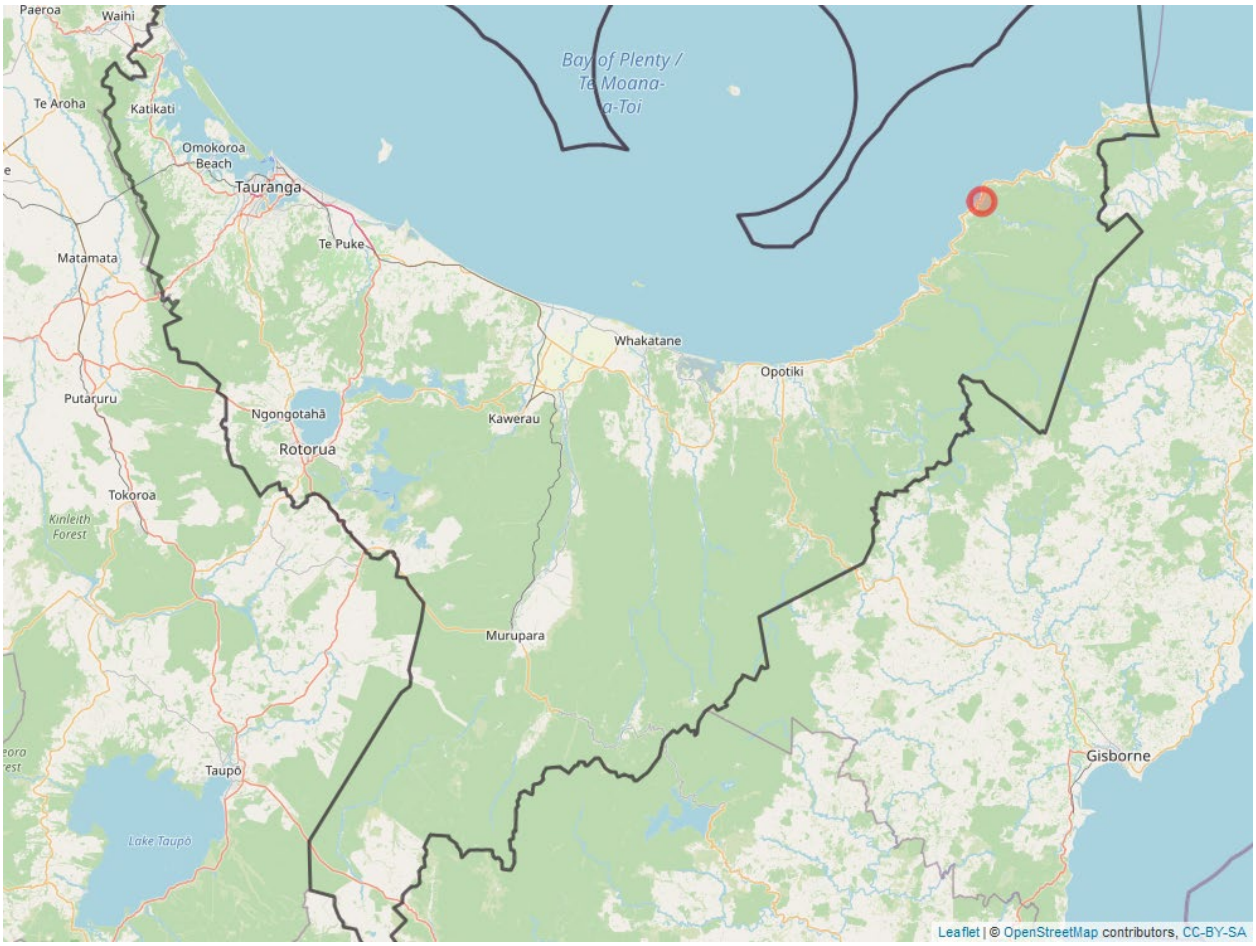

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	88	0.02	1.67	0.08	0.05	0.18	0.02	0.18	0.02
Nitrate Nitrite Nitrogen (g/m3)	88	<0.001	0.17	0.04	0.03	0.12	0.00	0.04	0.00
Total Ammoniacal Nitrogen (g/m3)	83	<0.002	0.015	0.004	0.003	0.010	0.000	0.003	0.000
Total Phosphorus (g/m3)	88	0.010	2.830	0.062	0.026	0.087	0.018	0.299	0.032
Dissolved Reactive Phosphorus (g/m3)	88	0.006	0.027	0.021	0.021	0.026	0.017	0.003	0.000
Dissolved Oxygen Sat (%)	82	64.7	110.7	100.9	101.0	108.9	94.8	5.8	0.6
Dissolved Oxygen (g/m3)	84	6.71	11.66	9.89	9.83	11.04	8.67	0.80	0.09
Escherichia coli (cfu/100ml)	88	<1	2900	57	5	77	0	322	34
Total Suspended Solids (g/m3)	88	<1	2700.00	40.52	1.15	82.79	0.24	288.02	30.70
Turbidity (NTU)	88	0.3	2100.0	30.7	1.2	53.5	0.4	223.8	23.9
Water Clarity (m)	83	0.00	10.80	4.63	4.50	9.26	0.16	2.94	0.32
Conductivity (uS/cm)	87	37	346	75	70	94	58	33	3
pH (pH Units)	88	6.6	8.0	7.2	7.3	7.6	6.7	0.3	0.0
Water Temperature (degC)	87	11.0	24.5	16.6	16.5	22.9	11.5	3.7	0.4
Discharge (m3/s)	81	0.70	150.00	8.50	4.40	18.60	1.20	17.60	2.00

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

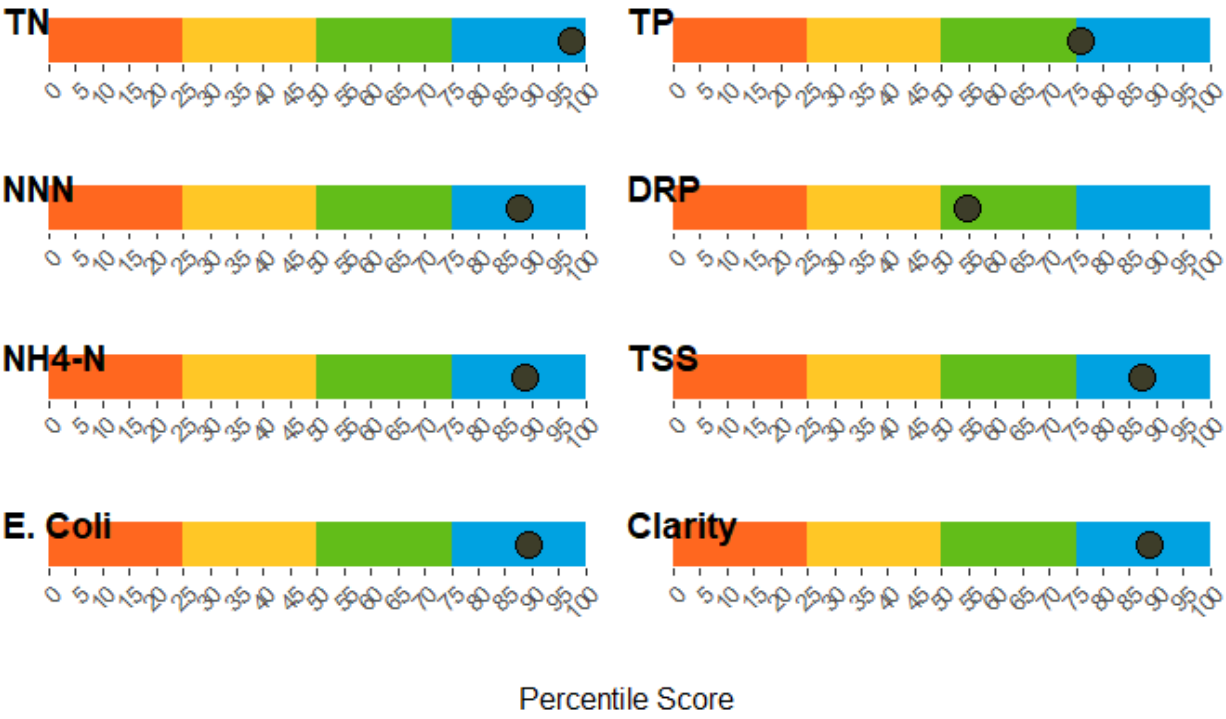

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

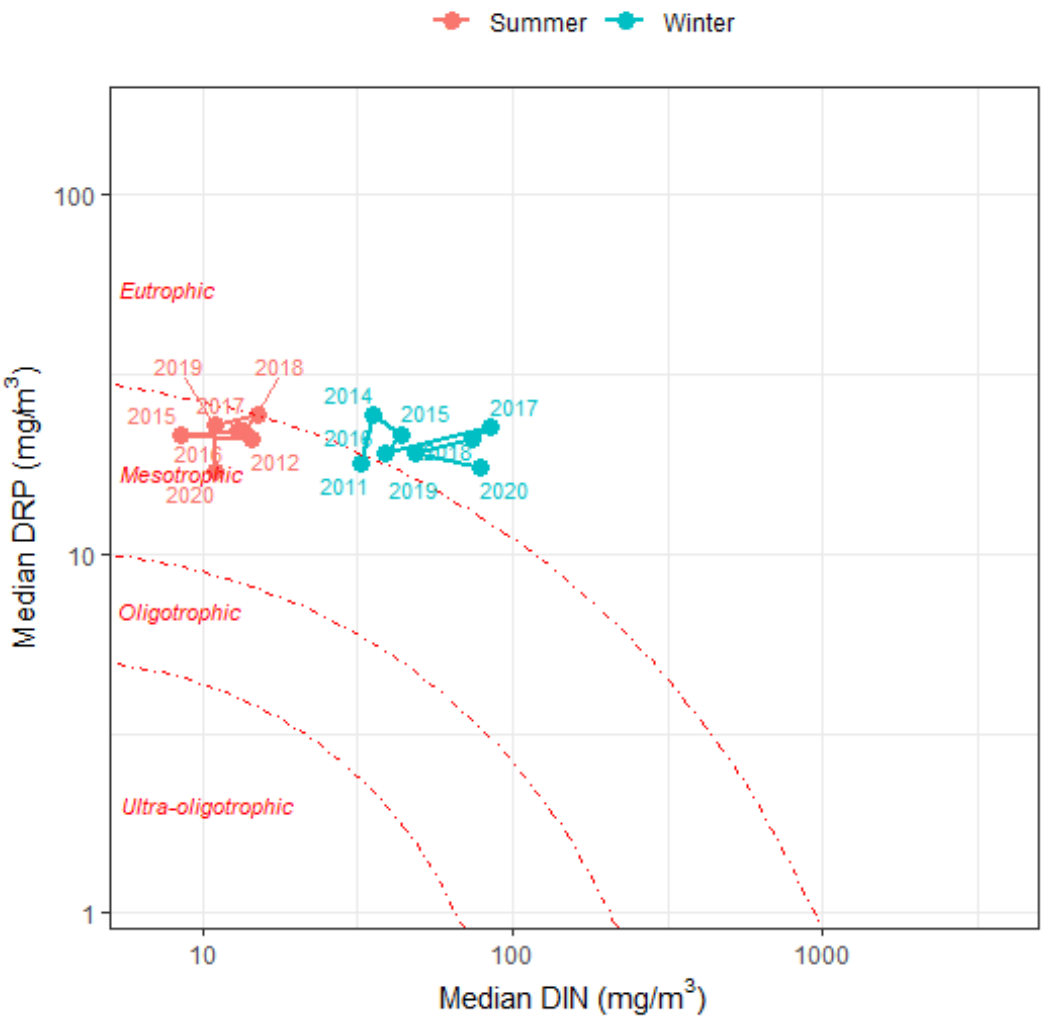

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.002	0.005	A
5 Years	2015-12-04	2020-12-02	55	0.001	0.005	A
10 Years	2010-12-05	2020-12-02	NA	NA	NA	NA
All	2011-07-16	2020-12-02	83	0.0014	0.0062	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	0.01	0.14	A
5 Years	2015-12-04	2020-12-02	57	0.03	0.13	A
10 Years	2010-12-05	2020-12-02	NA	NA	NA	NA
All	2011-07-16	2020-12-02	88	0.03	0.12	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	53	4.74	A*
10 Years	2010-12-05	2020-12-02	NA	NA	
All	2011-07-16	2020-12-02	81	4.50	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	57	0.021	0.026	D
10 Years	2010-12-05	2020-12-02	NA	NA	NA	
All	2011-07-15	2020-12-02	87	0.021	0.026	D

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	57	1.8	3.5	4	74	A*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	57	4	77	96.5	1.8	1.8
10 Years	2010-12-05	2020-12-02	NA	NA	NA			
All	2011-07-16	2020-12-02	88	5	86	96.6	1.1	2.3

Time series plots

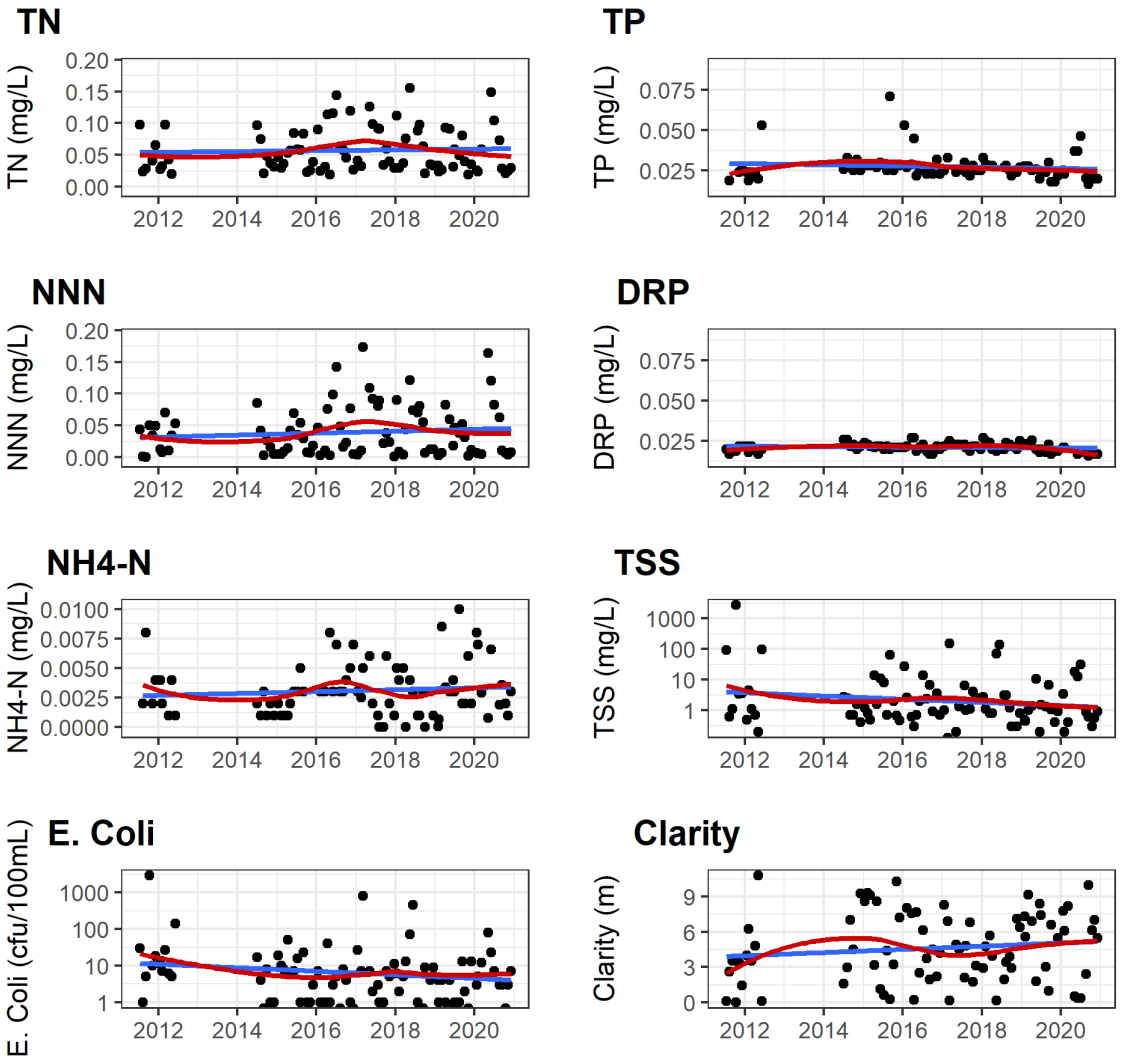

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-14	2020-12-02	-0.0023	-5.81	0.31	Indeterminant	YES	YES	Likely Improving
TN	10 Years	2011-07-16	2020-12-02	-0.0003	-0.67	0.63	Indeterminant	YES	YES	Likely Improving
TN	All	2011-07-16	2020-12-02	-0.0003	-0.67	0.63	Indeterminant	YES	YES	Likely Improving
NNN	5 Years	2016-01-14	2020-12-02	0.0004	2.30	1.00	Indeterminant	YES	YES	Indeterminate/Uncertain
NNN	10 Years	2011-07-16	2020-12-02	0.0006	3.41	0.57	Indeterminant	YES	YES	Likely Degrading
NNN	All	2011-07-16	2020-12-02	0.0006	3.41	0.57	Indeterminant	YES	YES	Likely Degrading
NH4N	5 Years	2016-01-14	2020-12-02	0.0000	0.00	0.55	Indeterminant	NO	NO	Likely Improving
NH4N	10 Years	2011-07-16	2020-12-02	0.0000	0.02	0.98	Indeterminant	YES	NO	Indeterminate/Uncertain
NH4N	All	2011-07-16	2020-12-02	0.0000	0.02	0.98	Indeterminant	YES	NO	Indeterminate/Uncertain
TP	5 Years	2016-01-14	2020-12-02	-0.0011	-4.52	<0.01	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-07-16	2020-12-02	-0.0004	-1.54	0.07	Decreasing	YES	NO	Very Likely Improving
TP	All	2011-07-16	2020-12-02	-0.0004	-1.54	0.07	Decreasing	YES	NO	Very Likely Improving
DRP	5 Years	2016-01-14	2020-12-02	-0.0007	-3.33	0.05	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-07-16	2020-12-02	-0.0002	-0.85	0.19	Indeterminant	YES	NO	Likely Improving
DRP	All	2011-07-16	2020-12-02	-0.0002	-0.85	0.19	Indeterminant	YES	NO	Likely Improving
ECOLI	5 Years	2016-01-14	2020-12-02	0.0021	0.36	0.94	Indeterminant	YES	NO	Indeterminate/Uncertain

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-07-16	2020-12-02	-0.0284	-4.06	0.10	Indeterminant	YES	NO	Likely Improving
ECOLI	All	2011-07-16	2020-12-02	-0.0284	-4.06	0.10	Indeterminant	YES	NO	Likely Improving
TSS	5 Years	2016-01-14	2020-12-02	-0.0162	-5.37	0.32	Indeterminant	YES	NO	Likely Improving
TSS	10 Years	2011-07-16	2020-12-02	-0.0093	-2.88	0.17	Indeterminant	YES	NO	Likely Improving
TSS	All	2011-07-16	2020-12-02	-0.0093	-2.88	0.17	Indeterminant	YES	NO	Likely Improving
CLARITY	5 Years	2016-01-14	2020-12-02	0.0289	0.53	0.82	Indeterminant	YES	NO	Indeterminate/Uncertain
CLARITY	10 Years	2011-07-16	2020-12-02	0.0183	0.39	0.96	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	2011-07-16	2020-12-02	0.0183	0.39	0.96	Indeterminant	YES	YES	Indeterminate/Uncertain

Raukokore at SH 35

March 2021

Table 1 Site metadata.

Aquarius ID:	SO991920	**Labstar ID:**	BOP110002
LAWA ID:	EBOP-00022	**REC Reach:**	4001560
Easting:	2029919	**Northing:**	5819206
Longitude:	177.87370	**Latitude:**	-37.67362
Elevation:	4 m	**Biophysical Unit:**	Non_VA/Gentle
Flow:	Yes	**Water Level:**	No
REC Class:	WW_Hill_HS		

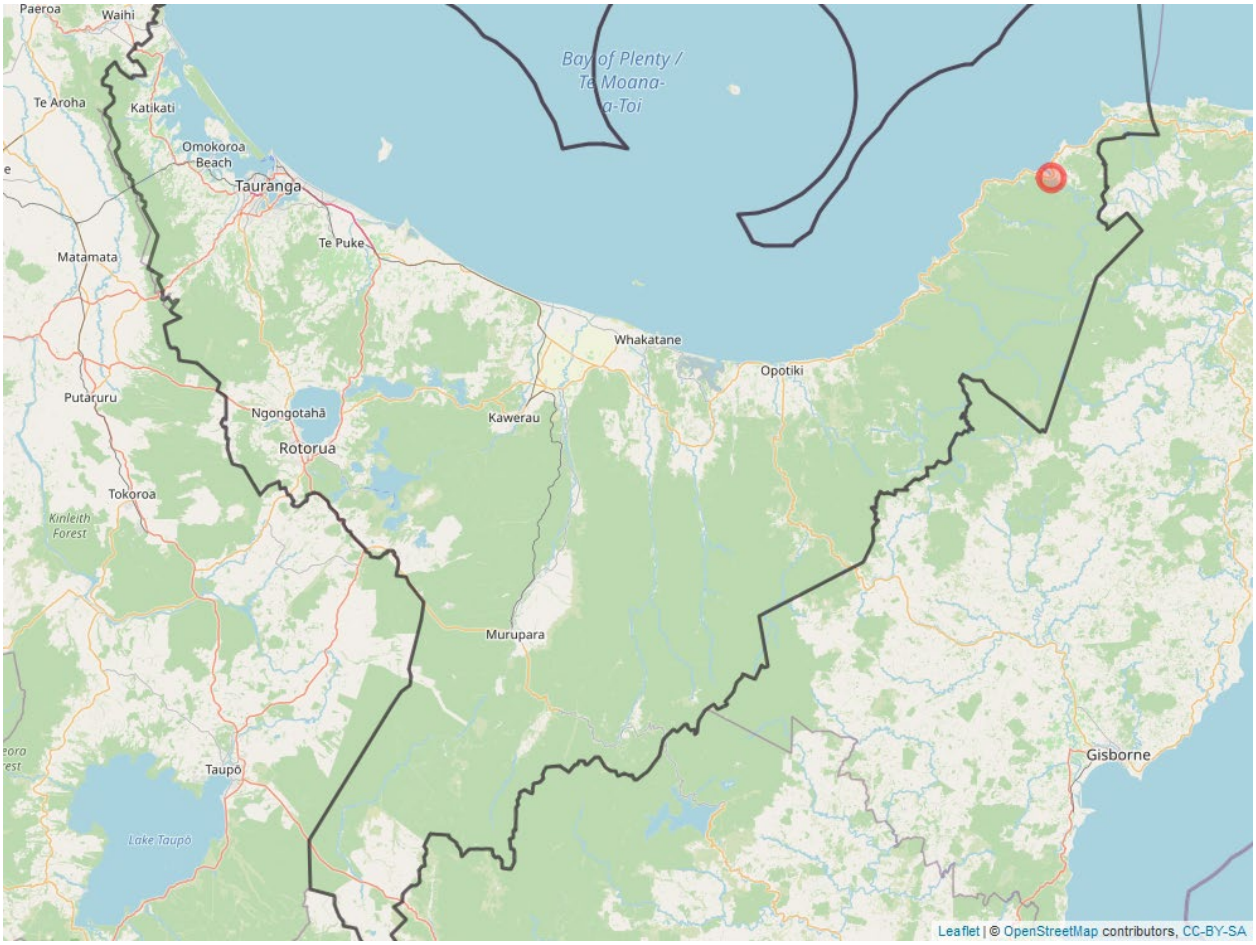

Figure 1 The location of the site within the Bay of Plenty region.

Summary statistics

Table 2 Summary statistics calculated from all available data.

Variable	n	Min	Max	Mean	Median	Perc_95th	Perc_5th	StDev	SE
Total Nitrogen (g/m3)	139	<0.01	0.80	0.10	0.08	0.23	0.02	0.10	0.01
Nitrate Nitrite Nitrogen (g/m3)	139	<0.001	0.27	0.04	0.03	0.11	0.00	0.04	0.00
Total Ammoniacal Nitrogen (g/m3)	150	<0.002	0.085	0.005	0.003	0.016	0.001	0.010	0.001
Total Phosphorus (g/m3)	154	0.006	5.630	0.083	0.019	0.240	0.010	0.460	0.037
Dissolved Reactive Phosphorus (g/m3)	153	<0.001	0.032	0.013	0.012	0.020	0.007	0.004	0.000
Dissolved Oxygen Sat (%)	84	11.0	112.3	100.2	100.8	107.0	97.2	10.4	1.1
Dissolved Oxygen (g/m3)	148	8.47	12.40	10.30	10.21	11.52	9.05	0.82	0.07
Escherichia coli (cfu/100ml)	150	<1	6700	146	12	556	0	655	53
Total Suspended Solids (g/m3)	155	<1	6000.00	112.05	4.60	363.56	0.37	571.29	45.89
Turbidity (NTU)	155	0.3	3300.0	67.7	4.3	279.3	0.5	327.1	26.3
Water Clarity (m)	132	0.00	9.87	2.48	1.55	7.53	0.10	2.57	0.22
Conductivity (uS/cm)	153	52	464	114	113	144	75	36	3
pH (pH Units)	155	6.7	8.2	7.5	7.6	7.9	7.0	0.3	0.0
Water Temperature (degC)	154	8.1	23.6	15.2	15.5	21.9	9.5	4.0	0.3
Discharge (m3/s)	123	2.30	530.00	22.30	11.40	59.60	3.80	50.20	4.50

Comparison plots

This figure compares median values for eight different measurements collected at the site, against the distribution of data from all sites in the Bay of Plenty region. The grey dot represents the site's percentile score (0% = worst, 100% = best), with each coloured segment representing 25% of the overall distribution. The segment colour scheme ranges from (worst 25% of sites) to blue (best 25% of sites).

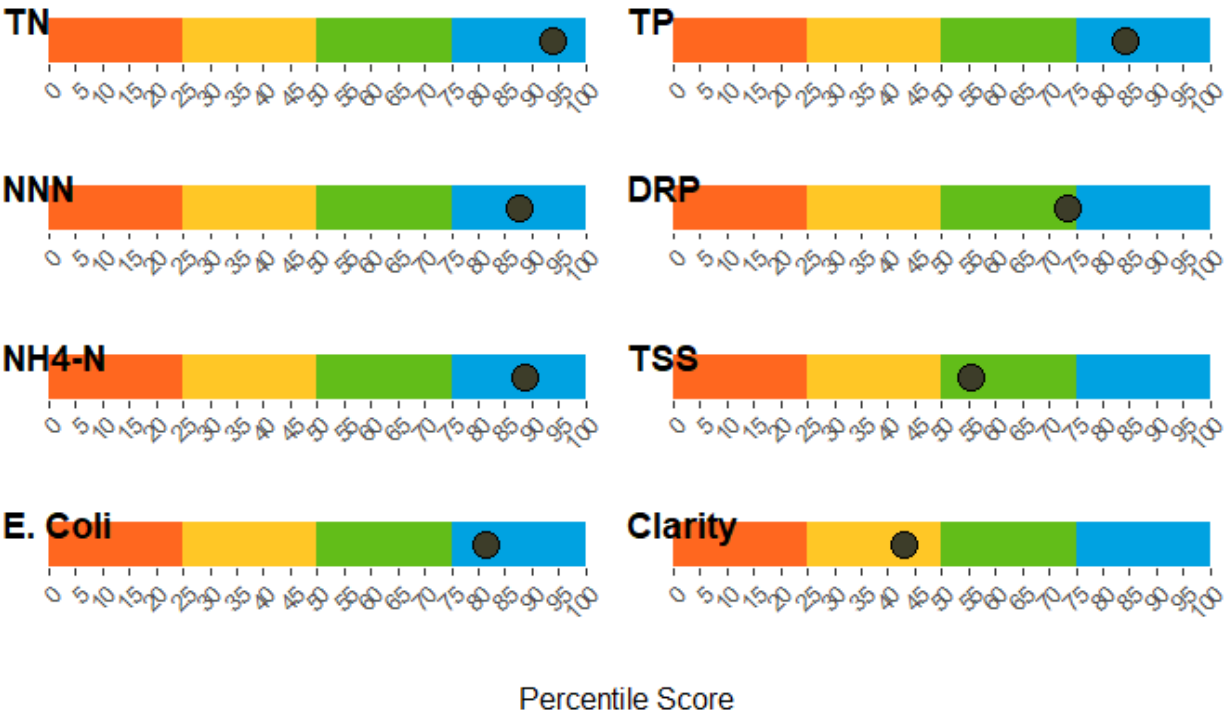

Figure 2 *Comparison of the subject site against other monitoring sites in the Bay of Plenty.*

Nutrient ratios for in-stream productivity

The figure below shows the relationship between bioavailable N and P over time. Data is split into summer and winter seasons to provide seasonal context. Points are only displayed if three or more DIN and DRP values are available for that year-season combination. DIN is the sum of NNN and NH4-N.

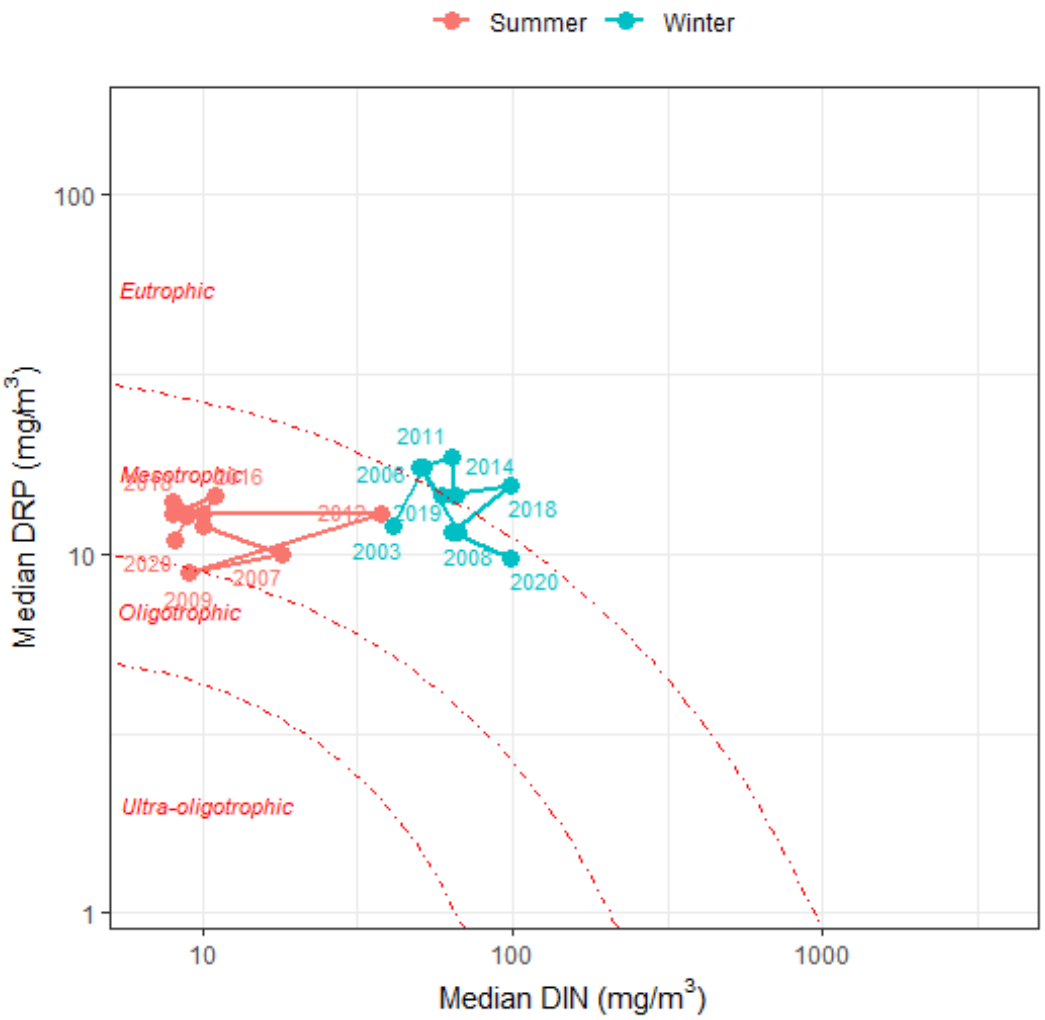

Figure 3 *Median DRP: DIN ratios at the subject site, over time. Data is split into 'summer' and 'winter' seasons, which represent November-April, and May-October, respectively.*

NPS-FM assessment

The tables below compare the site to relevant attributes in Appendix 2 of the National Policy Statement for Freshwater Management (NPS-FM) (2020). Analysis has been split into numerous analysis periods of interest, but only one period is officially applicable under the NPS-FM. Refer to the NPS-FM (2020) for more information about attributes, attribute statistics, and analysis periods.

Table 3 Assessment against the Ammonia (Toxicity) attribute. Values adjusted to a pH of 8 and temperature of 20°C.

Timeframe	Start	End	n	Median	Maximum	Band
1 Year	2019-12-03	2020-12-02	11	0.0020	0.007	A
5 Years	2015-12-04	2020-12-02	56	0.0020	0.007	A
10 Years	2010-12-05	2020-12-02	84	0.0020	0.041	A
All	1991-04-03	2020-12-02	150	0.0018	0.041	A

Table 4 Assessment against Nitrate Toxicity (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
1 Year	2019-12-03	2020-12-02	11	0.02	0.13	A
5 Years	2015-12-04	2020-12-02	57	0.03	0.13	A
10 Years	2010-12-05	2020-12-02	87	0.03	0.12	A
All	1993-07-30	2020-12-02	139	0.03	0.11	A

Table 5 Assessment against the Suspended Fine Sediment (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Band
5 Years	2015-12-04	2020-12-02	53	1.60	A*
10 Years	2010-12-05	2020-12-02	82	1.60	A
All	1992-08-05	2020-12-02	130	1.55	A

Table 6 Assessment against the Dissolved Reactive Phosphorus (Ecosystem Health: Water Quality) attribute.

Timeframe	Start	End	n	Median	Perc95	Band
5 Years	2015-12-04	2020-12-02	57	0.013	0.019	C
10 Years	2010-12-05	2020-12-02	87	0.014	0.020	C
All	1991-04-02	2020-12-02	152	0.012	0.020	C

Table 7 Assessment against the Escherichia coli (Human Contact) attribute.

Timeframe	Start	End	n	Exc540	Exc260	Median	Perc95th	Band	Swimmable
5 Years	2015-12-04	2020-12-02	57	5.3	7.0	10	556	B*	Swimmable

** Attribute requires 60 samples over five years but only 40-60 samples were available. Bands should be treated with caution.*

*** Attribute requires 60 samples over five years but less than 40 samples were available. Bands should be treated as unreliable.*

Microbiological guideline assessment

Table 8 contains an assessment of Escherichia coli data against the 'Surveillance, alert, and action level' framework for freshwater, part of the Microbiological Guidelines for Marine and Freshwater Recreational Areas (2002). This framework is designed to inform the public of the bathing risk at a particular site, based on the results of a single water quality sample. Although many of BOPRC's water quality monitoring sites are not specifically monitored for swimming purposes, this framework can provide a useful indicator of the extent of faecal contamination that may pose a risk to human health.

Data is summarised into three periods: Five years, 10 years, and all available data. The overall percentage of samples that fit into each category, for each period, are calculated on the right of the table. You can gain an understanding of the prevalence of faecal contamination by comparing the percentage of samples that fall into each category, across time periods.

Table 8 Surveillance, alert, and action levels for freshwater.

Timeframe	Start	End	n	Median	Perc95	Green	Amber	Red
5 Years	2015-12-04	2020-12-02	57	10	592	93	1.8	5.3
10 Years	2010-12-05	2020-12-02	87	12	819	92	1.1	6.9
All	1991-04-03	2020-12-02	150	12	570	93.3	1.3	5.3

Time series plots

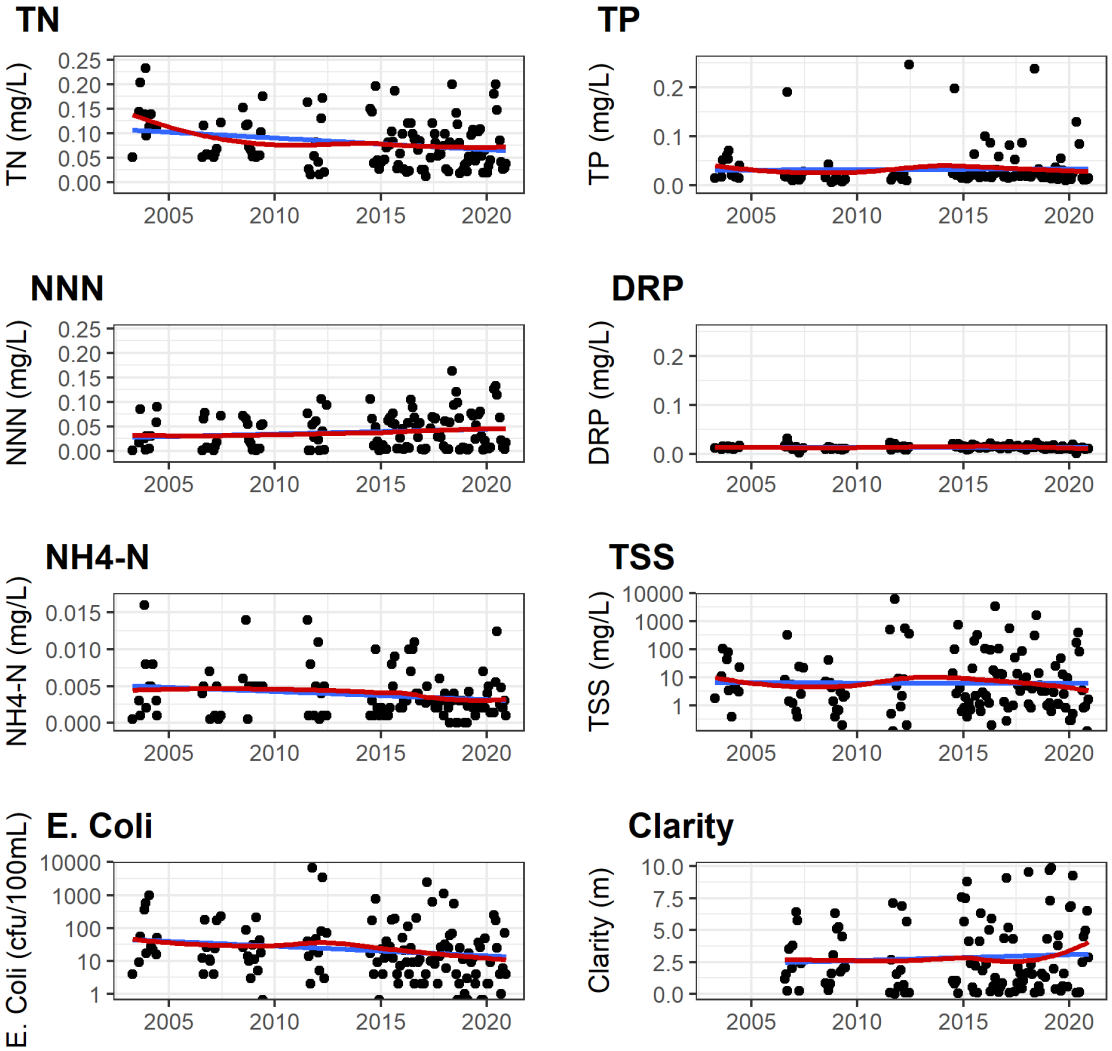

Figure 4 Time series of data for eight different parameters. The blue line represents a linear regression model and the red line represents a loess fit.

Trend analysis

Table 9 shows trend analysis results for each parameter presented in the time series plots in Figure 4. This trend analysis follows the method outlined in Snelder and Fraser (2018). This trend method assumes that there is always a trend, no matter how small, but the ability to confidently infer its direction depends on the power of the statistical analysis. If a confidence interval around the trend result does not contain zero, then the trend direction (either positive of negative) is established with confidence, labelled by an 'Increasing' or 'Decreasing' result in the Trend column. If it does contain zero, then the trend has insufficient data to confidently determine direction and is 'Indeterminate'.

Rather than just accept a p-value to define statistical significance (e.g. p-value <0.05), the likelihood that the trend has a given direction has been expressed using categorical levels of confidence, consistent with methods used by LAWA. These rank trends from 'Very Likely Improving' to 'Very Likely Degrading', as determined by the Kendall test 'S' statistic and p-value.

Table 9 Trend statistics for the subject site

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
TN	5 Years	2016-01-13	2020-12-02	0.0000	0.00	1.00	Indeterminant	Attempted	YES	Indeterminate/Uncertain
TN	10 Years	2011-07-15	2020-12-02	0.0000	0.06	1.00	Indeterminant	YES	YES	Indeterminate/Uncertain
TN	All	2003-07-28	2020-12-02	-0.0016	-2.83	<0.05	Decreasing	YES	YES	Very Likely Improving
NNN	5 Years	2016-01-13	2020-12-02	0.0002	0.79	0.88	Indeterminant	Attempted	YES	Indeterminate/Uncertain
NNN	10 Years	2011-07-15	2020-12-02	0.0006	2.04	0.58	Indeterminant	YES	YES	Likely Degrading
NNN	All	2003-07-28	2020-12-02	0.0002	1.10	0.63	Indeterminant	YES	YES	Likely Degrading
NH4N	5 Years	2016-01-13	2020-12-02	-0.0003	-10.82	<0.05	Decreasing	YES	NO	Very Likely Improving
NH4N	10 Years	2011-07-15	2020-12-02	-0.0002	-6.28	0.16	Indeterminant	YES	NO	Likely Improving
NH4N	All	2003-07-28	2020-12-02	-0.0002	-6.66	<0.05	Decreasing	YES	NO	Very Likely Improving
TP	5 Years	2016-01-13	2020-12-02	-0.0008	-4.48	0.05	Decreasing	YES	NO	Very Likely Improving
TP	10 Years	2011-07-15	2020-12-02	-0.0003	-1.35	0.52	Indeterminant	YES	NO	Likely Improving
TP	All	2003-07-28	2020-12-02	0.0000	0.04	0.98	Indeterminant	YES	NO	Indeterminate/Uncertain
DRP	5 Years	2016-01-13	2020-12-02	-0.0006	-4.41	<0.05	Decreasing	YES	NO	Very Likely Improving
DRP	10 Years	2011-07-15	2020-12-02	-0.0002	-1.42	0.17	Indeterminant	YES	NO	Likely Improving
DRP	All	2003-07-28	2020-12-02	0.0000	0.09	0.88	Indeterminant	YES	NO	Indeterminate/Uncertain
ECOLI	5 Years	2016-01-13	2020-12-02	-0.0445	-4.45	0.38	Indeterminant	YES	NO	Likely Improving

Parameter	Timeframe	Start	End	SenSlope	PAC	p	Trend	Flow_Aj	Season_Aj	PIT
ECOLI	10 Years	2011-07-15	2020-12-02	-0.0328	-3.04	0.19	Indeterminant	YES	NO	Likely Improving
ECOLI	All	2003-07-28	2020-12-02	-0.0309	-2.86	<0.05	Decreasing	YES	NO	Very Likely Improving
TSS	5 Years	2016-01-13	2020-12-02	-0.0422	-6.77	0.05	Decreasing	YES	NO	Very Likely Improving
TSS	10 Years	2011-07-15	2020-12-02	-0.0042	-0.69	0.71	Indeterminant	YES	YES	Indeterminate/Uncertain
TSS	All	2003-07-28	2020-12-02	-0.0061	-1.03	0.27	Indeterminant	YES	YES	Likely Improving
CLARITY	5 Years	2016-01-13	2020-12-02	0.2403	14.97	0.20	Indeterminant	Attempted	YES	Likely Improving
CLARITY	10 Years	2011-07-15	2020-12-02	0.0219	1.16	0.73	Indeterminant	YES	YES	Indeterminate/Uncertain
CLARITY	All	2003-07-28	2020-12-02	0.0549	2.71	<0.01	Increasing	YES	YES	Very Likely Improving

Part 4: **References**

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Appendices

Appendix A:

River Water Quality Reporting Framework

The Bay of Plenty Regional Council monitors water quality, ecology, flow (and other variables) in rivers through the region as part of the Natural Environment Regional Monitoring Network (NERMN) programme. The current report is part of river water quality reporting framework that aims to make NERMN river water quality data easier to access, as well as increasing the frequency of assessment against national frameworks and expert, region-wide interpretation.

The reporting framework is split into three time-based components: real time, every year, and every five years. An overview of these components is depicted in Figure A-1 and explained in more detail in the subsequent section.

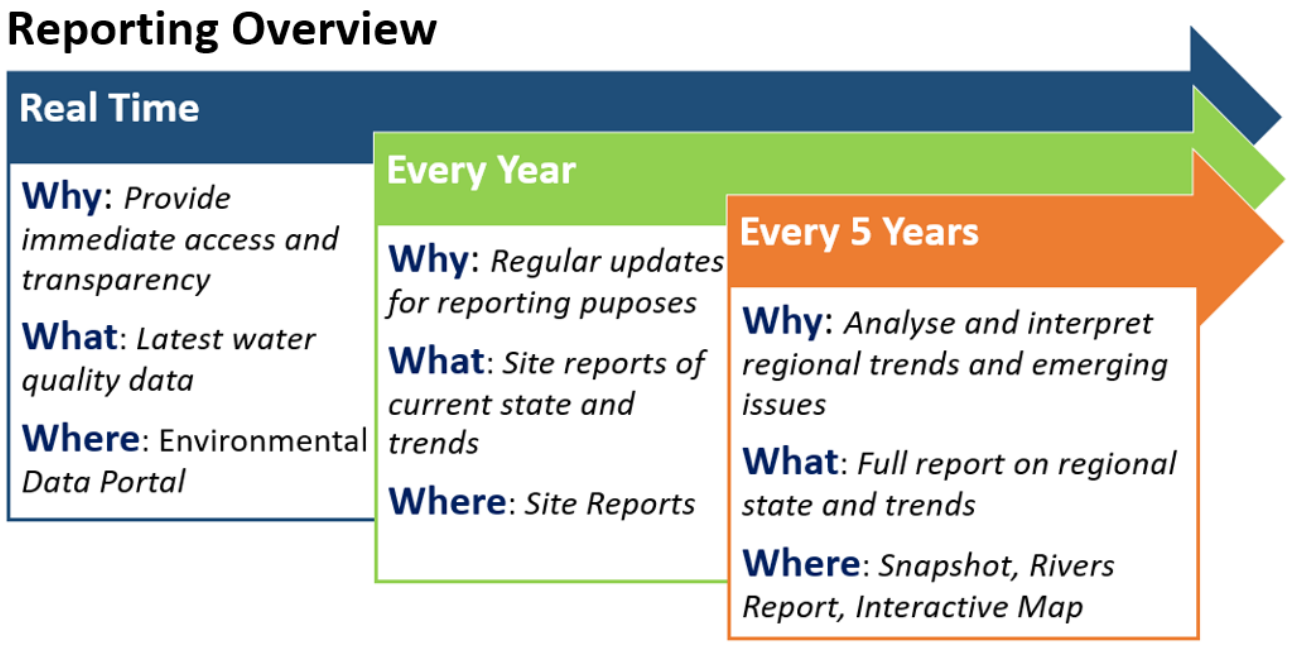

Figure A-1 Overview of the NERMN reporting framework.

Real Time

Real time data availability provides immediate access to NERMN water quality results and allows users to download datasets of interest. This is achieved through the BOPRC Environmental Data portal, which acts as an interface to all environmental monitoring data collected by BOPRC. Monitoring data for sites of interest can be viewed using the link below, where '[SITE ID]' is replaced with the Site ID (see Appendix 3 for a full list).

"https://envdata.boprc.govt.nz/Data/DataSet/Chart/Location/" + "[SITE ID]"

For example, data from 'Ngongotahā at SH36' can be accessed using the link:

https://envdata.boprc.govt.nz/Data/DataSet/Chart/Location/EL174017

The site, dataset, and timeframe can be adjusted using the drop-down menus located above the chart display (**Error! Reference source not found.**), providing access to all approved water quality data.

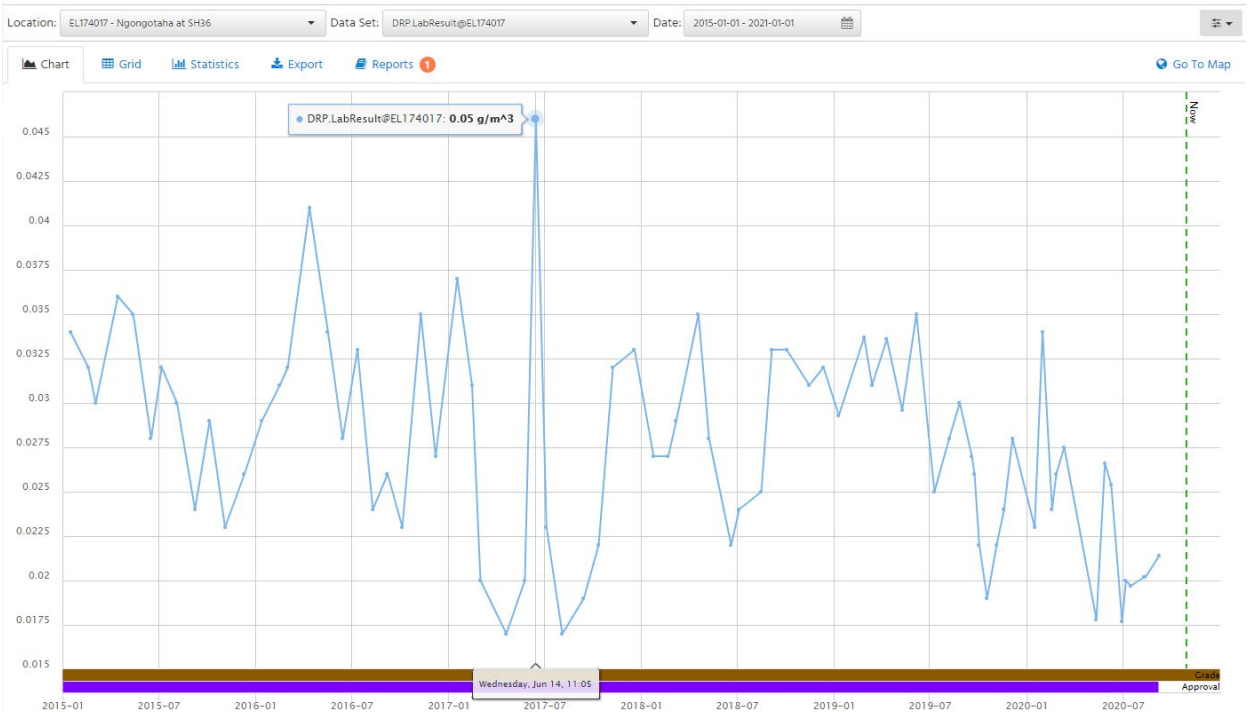

Figure A-2 *An example of the dissolved reactive phosphorus record at Ngongotahā at SH 36, from January 2015 to September 2020. The sites, dataset, and timeframe can be changed using the drop-down boxes at the top of the page. Accessed from BOPRC's Environmental Data Portal.*

Every Year

Open access to raw data is useful, however not every user has the time or skills necessary to run statistical analysis (e.g. trend analysis) or apply assessments using national frameworks or guidelines (e.g. National Policy Statement for Freshwater Management). Most of these analyses are routine and can be automated through analysis scripts, greatly improving reporting efficiency.

The annual component of the NERMN river water quality reporting framework provides an automated site analysis for all water quality sites within the NERMN network, using the most up-to-date datasets. This provides interested parties with an annual update of the state of each NERMN site using contextual frameworks, as well as updated analysis of water quality parameter trends. This information can help internal staff, or the wider community better understand site dynamics and water quality parameter trajectory, allowing informed conversations to take place.

Bay of Plenty Regional Council make every effort to ensure that extreme outliers are investigated and that errors are removed from the database. However due to the automated nature of this analysis, occasionally undetected error values can end up being processed when they would otherwise be removed if the analyses were completed by hand. For this reason, these reports should be used for indicative purposes only, with the understanding that the analysis in the five yearly report holds more analytical weight.

Every five years

The five yearly river water quality report describes the state and trends in the water quality of rivers monitored throughout the NERMN programme. It consists of two parts; the first describes the methods and presents the overall results of state and trends in river water quality across the Bay of Plenty, while the second part consists of an annual site report for each NERMN monitoring site (i.e. the annual report update).

The most recent five yearly regional analysis can be found by clicking on 'River Water Quality' and 'State and Trends' via the following link:

https://envdata.boprc.govt.nz/Data/Report

There is also a dashboard interface based on the most recent five yearly report, allowing users to explore trends, NPSFM grades, and current state:

https://envdata.boprc.govt.nz/Data/Dashboard/112

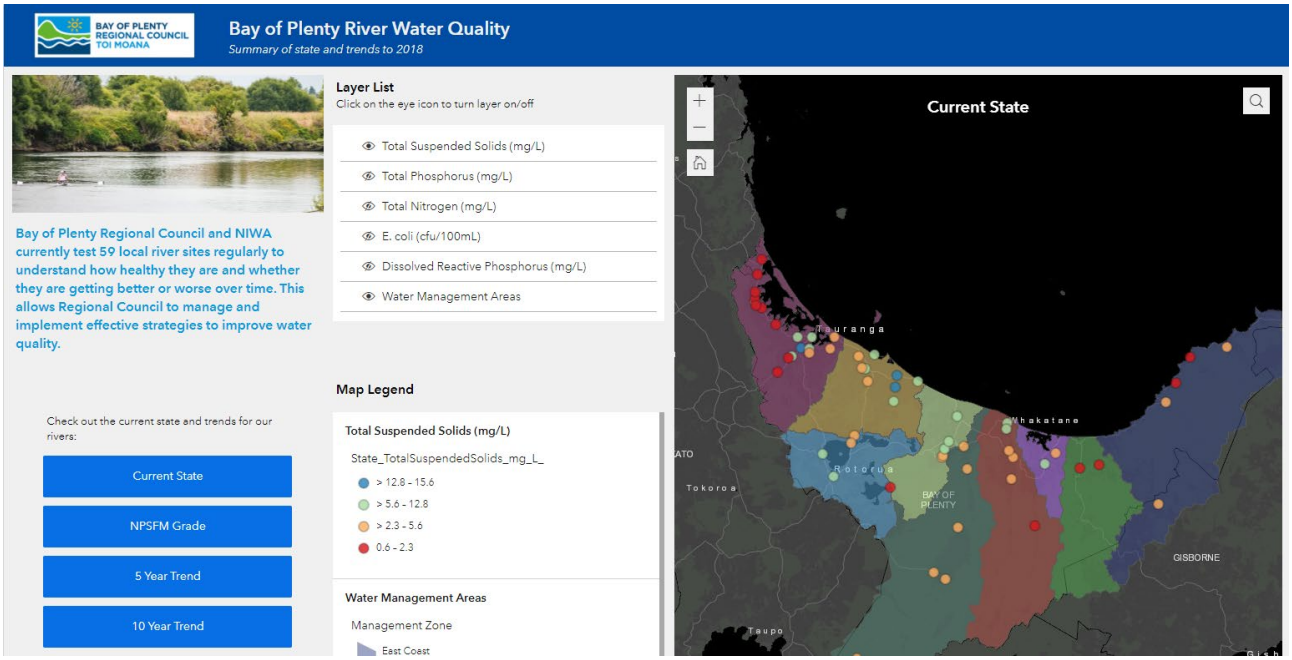

Figure 1 *The water quality dashboard for the five yearly rivers report. This is based on data collected prior to 2019.*

Appendix B:

Glossary of Water Quality Parameters

Table B-1 *Glossary of water quality parameters used for site reports. This list has been modified from the glossary found on LAWA (https://www.lawa.org.nz/).*

Parameter	Name	Description
DIN	Dissolved Inorganic Nitrogen	**Dissolved Inorganic Nitrogen** is the sum of nitrate, nitrite and ammonia.
TN	Total Nitrogen	**Total Nitrogen** is the sum of all organic and inorganic forms of nitrogen that are found in a water sample (i.e., nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), ammoniacal-nitrogen (NH_4-N) and organic nitrogen such as amino acids or plant tissue. High total nitrogen can be a cause of eutrophication in lakes, estuaries and coastal waters and can cause algal blooms.
TP	Total Phosphorus	**Total Phosphorus** is a measure of all forms of phosphorus that are found in a sample, including dissolved and particulate, organic and inorganic. High levels of total phosphorus in water can come from either wastewater or run-off from agricultural land. Too much phosphorus can encourage the growth of nuisance plants such as algal blooms.
NNN	Nitrate Nitrite Nitrogen	**Nitrate Nitrite Nitrogen** is a combination of nitrate nitrogen (NO3-) and nitrite nitrogen (NO2-). Nitrite and nitrate are water soluble molecules that can be toxic in high concentrations. Nitrite nitrogen is typically low in riverine systems due to oxidation to nitrate, so NNN is usually an accurate measurement of nitrate nitrogen.
DRP	Dissolved Reactive Phosphorus	**Dissolved Reactive Phosphorus** is a measure of the dissolved phosphorus compounds that are readily available for use by plants and algae. Phosphorus enters waterways attached to soil particles that are transported from the land, usually via runoff. As the sediments remain in waterways, the phosphate dissolves and becomes DRP. Dissolved reactive phosphorus concentrations are an indication of a waterbody's ability to support nuisance algal or plant growths (algal blooms).
NH4-N	Total Ammoniacal Nitrogen	**Ammoniacal Nitrogen** covers two forms of nitrogen: ammonia (NH_3) and ammonium (NH_4). Animal waste (particularly from humans and farmed animals such as sheep and cows) is the major source of ammoniacal nitrogen in New Zealand waterways. In concentrations higher than 2.2 mg/L, it can become toxic to aquatic life under certain temperature and pH conditions.
TSS	Total Suspended Solids	**Total Suspended Solids** are particles of silt, clay, or organic matter suspended in a water. They affect invertebrate food quality and cause sedimentation of streams and estuaries.
E. coli	*Escherichia coli*	***E. coli*** is a bacteria commonly found in the guts and faeces of warm-blooded mammals (including people) and birds. People can get sick if they drink, gather

		shellfish from, or swim in water that has high levels of E. coli. Common sources of E. coli bacteria are animal waste from farm stock and water fowl, storm water run-off and sewerage leaks.
Clarity	Water Clarity (measured via Black Disc)	**Black Disc** is a type of water clarity observation that measures how far away a black target (“black disc”) be seen horizontally through the water. Murky water can harm aquatic life by clogging their gills which reduces their ability to take up oxygen.

Appendix C:

NERMN Sites

Table C-1 NERMN river water quality monitoring sites in each water management area (WMA). Location, bio-physical units, RLWP Class, upstream catchment area, distance to the sea and type of water quality monitoring programme. WMAs and sites are ordered from west to east and upstream to downstream where multiple sites on the same river. Refer to Hamill et al. (2020) for more information on biophysical units.

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Tauranga Harbour								
BS961133	Waiau at Waiau Road Ford	1859615	5851333	VA/Steep	AE	23	3.2	M**
BR809582	Tuapiro at Hikurangi Road	1858127	5845878	VA/Steep	AE	44	2.5	M**
BQ723939	Uretara at Henry Road Ford	1857235	5839394	VA/Gentle	AE	24	3.4	M**
BQ708712	Te Rereatukahia at SH 2	1857084	5837121	VA/Steep	AE	18	1.5	M**
BQ711622	Te Mania at SH 2	1857111	5836225	VA/Gentle	AE	12	1.7	M
BQ739463	Waitekohe at SH 2	1857397	5834637	VA/Steep	AE	11	3.9	M
BQ966369	Aongatete at SH 2	1859660	5833690	VA/Steep	AE	43	3.7	M**
CP466747	Waipapa at Old Highway	1864663	5827478	VA/Gentle	CR	30	2.9	M**
CO543022	Ngamuwahine at Old Bridge	1865432	5810228	VA/Gentle	AE	41	22.4	M**
CO938527	Wairoa d/s Ruahihi Power Station	1869387	5815277	VA/Gentle	AE	308	11.8	M**
DO047598	Omanawa at SH 29	1870477	5815980	VA/Gentle	AE	83	10.5	M
DP281304	Wairoa at SH 2	1872819	5823049	VA/Gentle	AE	449	2.4	M
DO406909	Kopurererua at SH 29	1874065	5819093	VA/Gentle	AE	60	6.4	M
DP784306	Kopurererua at SH 2	1877840	5823064	VA/Gentle	AE	73	0.6	M
DO712717	Waimapu at Pukemapu Road	1877129	5817176	VA/Gentle	AE	60	6.7	M**
DO686858	Waimapu 100m d/s SH 29	1876865	5818584	VA/Gentle	CR	102	2.8	M
EO451883	Waitao at Waitao Road	1884514	5818831	VA/Steep	AE	30	2.6	M**
EP623312	Rocky at Mangatawa Lane	1886234	5823121	Non_VA/Gentle	RBL	16	1.0	M**

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
Kaituna, Maketū and Pongakawa								
FN834668	Kaituna at Maungarangi Road	1898345	5806689	VA/Gentle	AE	712	22.2	M
FO761142	Kaituna at AFFCO Intake	1897610	5811421	VA/Gentle	AE	937	15.4	Impact M
FO620177	Kaituna at Te Matai	1896202	5811773	VA/Gentle	CR	971	13.0	M
FO497605	Kaituna at Clarkes	1894979	5816054	VA/Gentle	CR	1138	7.8	Impact M
GO089653	Kaituna at Te Tumu	1900764	5816420	VA/Gentle	CR	1198	1.6	
GM781934	Pongakawa at Pumphouse	1907814	5799349	VA/Gentle	AE	55	19.2	M
GN849464	Pongakawa at Old Coach Road	1908494	5804645	VA/Gentle	AE	102	12.3	M
GN922883	Pongakawa at SH 2	1909225	5808837	VA/Gentle	DEV	120	6.5	M
HN674689	Waitahanui at Otamarakau Marae	1916743	5806891	VA/Steep	AE	118	1.4	M
Rotorua Lakes								
EL174017	Ngongotaha at SH 36	1881743	5780173	VA/Gentle	AE	77	67.1	M
EK598179	Puarenga at FRI	1885980	5771792	VA/Gentle	AE	73	69.6	M
FL230406	Ohau Channel at SH 33	1892304	5784064	VA/Gentle	AE	500	53.8	M
FL356693	Kaituna at Rotoiti Outlet	1893562	5786935	VA/Gentle	AE	624	49.6	M
GJ662805	Tarawera at Lake Outlet (NIWA)	1906622	5768057	VA/Gentle	FSP	187	58.0	NIWA M
Tarawera								
IK564876	Tarawera at Boyce Park	1925589	5778832	VA/Steep	FSP	550	30.5	M
IK604969	Tarawera at Caxton Foot Bridge	1926048	5779695	VA/Steep	FP	550	30.5	Impact M
IL663193	Tarawera at Onepū Springs Road	1926636	5781936	VA/Steep	FP	598	2.4	Impact M
IL818464	Tarawera at SH 30	1928182	5784643	VA/Steep	FP	620	18.2	Impact M
JM102399	Tarawera at Awakaponga	1931027	5793990	VA/Steep	FP	701	9.2	M
Rangitāiki								
FC231176	Rangitaiki at SH 5	1892311	5691766	VA/Gentle	AE	104	181.8	M *
FD445529	Otamatea at Wairere Road	1894459	5705298	VA/Gentle	AE	120	155.9	M *

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
IG265664	Rangitaiki at Murupara (NIWA)	1922660	5736647	VA/Gentle	AE	1149	94.1	NIWA M
IG691428	Whirinaki at Galatea (NIWA)	1926915	5734286	VA/Steep	AE	507	98.3	NIWA M
JI148319	Rangitaiki at Inlet to Aniwhenua	1931488	5753195	VA/Gentle	AE	2423	64.9	M
JK491452	Rangitaiki at Matahina Dam	1934919	5774526	VA/Steep	AE	2817	37.4	M
JL350292	Rangitaiki at Te Teko (NIWA)	1933508	5782922	VA/Gentle	AE	2883	26.0	NIWA M
Whakatāne and Tauranga								
LK082095	Whakatane at Ruatoki	1950830	5770958	VA/Steep	AE	896	31.2	M
KL998150	Whakatane at Pekatahi Bridge	1949980	5781507	VA/Steep	WS	1463	17.0	M
KL919939	Whakatane opposite Trident	1949195	5789399	VA/Steep	CR	1495	6.4	Impact Q
KM938159	Whakatane 300m d/s SH 30	1949386	5791591	VA/Steep	CR	1738	1.3	Impact Q
LI953392	Tauranga at Ranger Station	1959534	5753920	VA/Steep	AE	211	49.7	M
LK149881	Tauranga at Taneatua Bridge	1951494	5778817	VA/Steep	WS	480	22.9	M
Ōhiwa Harbour and Waiōtahe								
MK307635	Nukuhou at Glenholme Road	1963072	5776357	VA/Steep	AE	60	11.7	M
ML715056	Waiotahe at Toone Road	1967154	5780564	Non_VA/Steep	AE	111	9.7	M
Waioeka and Otara								
NK608503	Waioeka at Mouth of Gorge	1976081	5775032	Non_VA/Steep	CR	780	13.0	M
OK300616	Otara at Browns Bridge	1983007	5776168	Non_VA/Steep	AE	240	19.7	M
East Coast								
QJ471191	Motu at Waitangirua (NIWA)	2004713	5761919	Non_VA/Steep	NSR	294	95.7	NIWA M
QM756918	Motu at Houpoto SH 35 (NIWA)	2007565	5799183	Non_VA/Steep	NSR	1377	3.7	NIWA M
RN123610	Haparapara at SH 35	2011231	5806108	Non_VA/Steep	AE	167	1.5	M
RO629568	Kereu at SH 35	2016299	5815685	Non_VA/Steep	AE	141	0.6	M

Site ID	Site Name	Easting	Northing	Bio-Physical Unit	Class	Catchment area (km^2)	Km to sea	Programme / Frequency
SO991920	Raukokore at SH 35	2029919	5819206	Non_VA/Steep	AE	349	3.2	M