Freshwater contact recreational water quality at Taranaki sites State of the Environment Monitoring Annual Report 2017-2018

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Executive summary

This survey of sixteen recognised freshwater contact recreational sites in the Taranaki region was the twenty-second of an on-going programme designed to annually monitor the bacteriological quality of lakes, rivers and streams at popular contact recreational sites during each bathing season. It forms a component of the State of the Environment bathing beaches trend monitoring programme, which commenced in the 1995-1996 summer period. Two sites (at Lakes Ratapiko and Opunake) were monitored in this programme during this 2017-2018 period for the twelfth time, partly as a component of the more recently instituted cyanobacteria programme (covering four lakes) instigated after consultation with Taranaki District Health Board. A site in the lower Waitara River was added in the 2010-2011 period at the joint request of Taranaki Healthcare and NPDC and two additional sites in the lower reaches of the Waiwhakaiho River and Te Henui Stream (both adjacent to the New Plymouth walkway) were included in the programme in the 2012-2013 period. The sixteen sites have been graded for recreational suitability (SFRG) according to MfE, 2003 guidelines, in part based upon the immediately preceding five seasons of monitoring data (where such data existed) although short-comings of this grading methodology are acknowledged. A re-assessed SFRG also has been provided by inclusion of the current season's data for comparative purposes and this showed minimal change of the microbiological water quality guideline over this latest five year period.

A further site (Lake Rotokare) has been monitored since 2007, principally for planktonic cyanobacteria. Additional comprehensive flowing water benthic cyanobacteria monitoring (at nine river/stream sites) was undertaken in the current period for the fifth time in this state of the environment programme.

Changes were made in 2016-2017 to follow protocols for reporting on the Land and Water Aotearoa (LAWA) website: sampling frequency at four of the most popular sites (Lake Rotomanu, Waiwhakaiho River at Merrilands Domain, and Kaupokonui and Waingongoro river mouths) was increased to weekly, mainly in dry weather, from December to February inclusive.

The results of the 2017-2018 survey have continued to illustrate variability in bacteriological water quality, with the highest quality achieved at the Urenui River estuary and lower Patea River sites where marked seawater intrusion is the norm (under high tide conditions), and Lakes Ratapiko and Rotomanu. Impacts on bacteriological water quality at some sites, particularly the lower reaches of the Waiwhakaiho River and Te Henui and Stream, were due principally to resident wild fowl populations in the vicinity of recreational usage sites (as confirmed previously by inspections and DNA marker surveys).

In terms of *E. coli*, bacteriological water quality in the latest survey period was lower than normal in comparison with historical surveys. The total number of samples falling within the "Alert" or "Action" categories (40% of samples) across the 16 recognised bathing sites was the highest recorded. However, it should be noted that the "Action" category is the only category for which swimming is not recommended. In the 2017-2018 season, 79% of all samples met the national bathing guideline. Of the 21% of samples that exceeded the guideline, 11% arose from just two sites- the two New Plymouth urban sites. Bird life was mainly responsible for the exceedances at these sites, where on occasions recreationalists have fed the birds.

One site recorded all single samples in either the 'Alert' or the 'Action' mode of the MfE, 2003 guidelines (Waiwhakaiho River opposite Lake Rotomanu), while one site (Te Henui Stream near East End beach) recorded twelve single samples in those modes. Twelve other sites from time to time exhibited single sample entries, mainly into the 'Alert' mode of the 2003 guidelines, at some time during the season. Nine of these sites had counts which entered the 'Action' mode, a slight increase in the number and frequency of guideline exceedances in comparison with many previous seasons' results.

To a certain extent these exceedances were probably a feature common to the mid and lower reaches of rivers and streams draining developed (particularly agricultural) catchments throughout New Zealand.

Notably, only two exceedances of the MfE 'Action' guideline were found in the Waiwhakaiho River at Merrilands Domain (mid urban New Plymouth and downstream of agricultural land), whereas 10 of 13 samples exceeded this guideline near this river's mouth.

Notable increase in frequency of exceedance of the MfE 'Action' guideline since 2016-2017 occurred at three monitoring sites (Patea River at King Edward Park, Stratford, Waingongoro River at Eltham camp, and Timaru Stream at mouth). Investigation through inspection of potential faecal sources upstream found all farm waste disposal systems to be operated in compliance with resource consents and no influences in riparian areas. Water quality surveys, including microbial DNA analysis, in each case, found no human contamination, but varying amounts of both ruminant (mainly in upper Patea and Waingongoro) and avian (mainly in Timaru) contribution.

At most sites, minimal follow-up sampling was performed when deemed necessary following exceedances of the 'Action' limit, as in most cases bacteriological quality was found to have returned to typical levels within short time frames or the causes were well established from historical data. Permanent health warning signage had been erected by the New Plymouth District Council (on the direction of Taranaki District Health Board) following past exceedances of 'Action' levels at the lower Waiwhakaiho River and Te Henui Stream sites, and of 'Alert' levels at Waitara. Temporary signage was required at the Lake Rotomanu, and at Timaru,Stream and Oakura, Kaupokonui, upper Patea and upper Waingongoro Rivers sites following single sample 'Action' levels, but single sample 'Alert' level exceedances at other sites were not necessarily signposted.

Temporal trends over the 1996-2018 period have been evaluated on the basis of seasonal median *E. coli* count for the sixteen sites that have ten years or more data (and will continue to be assessed annually). One site (lower Waiwhakaiho River) has shown a statistically significant increasing trend. No other sites have shown statistically significant trends (positive or negative) in seasonal median *E. coli* counts.

Additional sampling (in accordance with the MfE, 2003 guidelines for datasets for grading purposes) at four principal usage sites (Lake Rotomanu and Waiwhakaiho, Kaupokonui and Waingongoro Rivers) occurred largely in dry weather and resulted in little change in the overall median bacteriological numbers.

Cyanobacteria blooms were recorded at Lake Rotomanu on most fortnightly surveys until March 2018, and at Lake Rotokare in November and December 2017. These numbers necessitated warning notices to avoid contact recreation in these waters during most of the recreational period at Lake Rotomanu, and in early summer at Lake Rotokare. No planktonic cyanobacteria were found in Lake Ratapiko or Lake Opunake,

Benthic cyanobacteria were found occasionally in most of the nine rivers and streams monitored. Monitoring frequency was increased from fortnightly to weekly in response to 'Alert' levels found on several occasions. Two sites (Waingongoro and Kaupokonui Rivers at mouth) exceeded the 'Alert' level for bed coverage, both on two occasions. Exposed mats triggered the 'Alert' level at these two sites on a total of 15 individual site surveys, and detaching or detached mats accumulating on the river's edge triggered the 'Alert' level at the same four sites (Waingongoro River at Ohawe, Kaupokonui River at the mouth, and Waiwhakaiho River at the last riffle and at Merrilands Domain) on a total of 8 surveys. Levels of cyanobacteria were higher than in the previous season; and lower than the preceding three seasons, probably a reflection of the relative amounts of rainfall causing freshes that scour streambeds of periphyton.

Timely reporting of the results of bacteriological water quality and cyanobacteria numbers/cover was undertaken by use of the Taranaki Regional Council website (www.trc.govt.nz) and LAWA website (www.lawa.org.nz) as well as liaison with territorial local authorities and the Health Protection Unit of Taranaki District Health Board throughout the survey season of 2017-2018.

For the second time, this report also discusses the monitoring results in the light of the criteria for primary recreational use of water bodies ('swimmability') set out in the National Objectives Framework that is attached to the *National Policy Statement for Freshwater Management 2014*.

It is recommended that annual bacteriological monitoring of selected freshwater sites be continued (in conjunction with the coastal bathing water programme) by use of a similar sampling format over a five month (November to March inclusive) contact recreational period to provide information for trend detection purposes and for assessment of suitability for contact recreational usage. Cyanobacteria monitoring at the four lakes sites and nine stream/river sites at a lesser frequency is also recommended to continue. A further recommendation involves appropriate scheduling of the annual round of dairy wastes disposal systems and advice provided in relation to stock access to watercourses to attempt to reduce the frequency of exceedances of recreational limits particularly in catchments where historical problems from this source have been located.

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1 Introduction

1.1 General

The Resource Management Act 1991 (RMA) established new requirements for local authorities to undertake environmental monitoring. Section 35 of the RMA requires local authorities to monitor, among other things, the state of the environment of their region or district, to the extent that is appropriate to enable them to effectively carry out their functions under the Act.

To this effect, the Taranaki Regional Council ('the Council') has established a state of the environment monitoring (SEM) programme for the region. This programme is outlined in the Council's 'State of the Environment Monitoring Procedures Document', which was prepared in 1997. The monitoring programme is based on the significant resource management issues that were identified in the Council's Regional Policy Statement for Taranaki (1994).

The SEM programme is made up of a number of individual monitoring activities, many of which are undertaken and managed on an annual basis (from 1 July to 30 June). For these annual monitoring activities, summary reports are produced following the end of each monitoring year (i.e., after 30 June). Where possible, individual consent monitoring programmes have been integrated within the SEM programme to save duplication of effort and minimise costs. The purpose of annual SEM reports is to summarise regional environmental monitoring activity results for the year, and provide an interpretation of these results, together with an update of trends in the data.

Annual SEM reports act as 'building blocks' towards the preparation of the regional state of the environment report every five years. The Council's first, or baseline, state of the environment report was prepared in 1996 (TRC, 1996), summarising the region's progress in improving environmental quality in Taranaki over the past two decades. The second report (for the period 1995-2000) was published in 2003 (TRC, 2003). Data spanning the ten year period 1995 to 2005 have been used in the preparation of a trend report (TRC, 2006). The third State of the Environment report (for the period 1995 to 2007) was published (TRC, 2009) and included trend reporting and the fourth report (for the 1995 to 2014 period) has been published (TRC, 2015c). The provision of appropriate computer software statistical procedures allows regular reporting on trends in the environmental quality over time, in relation to Council's ongoing monitoring activities, now that there has been an accumulation of a comprehensive dataset of sufficient duration to permit a meaningful analysis of trends (i.e. minimum of 10 years).

This report summarises the results for the sites surveyed in the Freshwater contact recreational water quality SEM programme over the 2017-2018 monitoring year, the 22nd year of the programme.

1.2 Background

The microbiological water quality at bathing beaches along the Taranaki coast has been monitored by the Taranaki Regional Council (and its predecessors) since 1979, with systematic surveys undertaken since 1987. A more comprehensive annual bathing beach monitoring programme was first implemented during the 1995-1996 summer as an ongoing component of the state of the environment monitoring (SEM) programme for the Taranaki region.

Freshwater bathing and recreational sites were added during the 1996-1997 summer and integrated within the bathing beach bacteriological water quality monitoring programme in order to maximise the efficiency of field sampling procedures and protocols. This format has been continued in the summer periods since this date, with an additional component of cyanobacteria monitoring instituted at three lake sites since the 2006-2007 summer and an additional lake site in 2007-2008, and nine river and stream sites monitored for the benthic cyanobacteria component of the SEM periphyton programme. These results are also reported as appropriate in the current report.

The SEM freshwater contact recreational water quality programme has three objectives:

- to characterise the bacteriological and cyanobacterial quality of principal recreation waters in the Taranaki area, and more specifically to determine their suitability for contact recreation;
- to identify changes in contact recreational bacteriological water quality over time. Therefore the detection of trends is an important component in programme design; and
- to assess compliance with recreational water quality guidelines.

*[Note: Contact recreation concerns water-based activities involving a high probability of accidental water ingestion. This mainly applies to bathing, but may also include water- and jet-skiing, surfing, boardsailing, etc. Bathing, kayaking, and water skiing are the principal freshwater contact recreational usages identified. More recently, the term 'swimmability' has entered popular usage to denote waters used for primary contact recreation.]***.**

2 Standards and guidelines

Prior to 2003, the Council used guidelines for the management of recreational and marine shellfish-gathering waters (MfE, 1998), which replaced the provisional guidelines (DOH, 1992). These guidelines were developed (by MfE and MoH) to assist water managers to implement the Resource Management Act (1991) and the Health Act (1956) for the purposes of shellfish-gathering and contact recreation (refer to previous annual reports for more information on these historical guidelines). Guidelines issued in 2003 are now relevant to this programme. These guidelines are detailed below.

2.1 Microbiological water quality guidelines

Guidelines have been prepared by Ministry for the Environment in conjunction with the Ministry of Health (MfE, 2003). Changes to the *E. coli* freshwater recreational guideline values were made for the purpose of regularly assessing single samples against suitability for recreation, and thus providing information on current (ie, at time of sampling) suitability for recreational use. The current freshwater guidelines are now more reflective of New Zealand conditions. 'Alert' and 'Action' guideline levels are used for surveillance throughout the bathing season. They may be summarised as follows (Table 1), with the marine levels included within the table as some of the Taranaki sites monitored are in the lower, tidal reaches of rivers and streams).

Table 1 Surveillance, alert and Action levels for freshwaters (2003)

Mode	Acceptable (green)	Alert (amber)	Action (red)
Freshwater (*E. coli*/100ml)	≤260	261-550	>550
Marine (enterococci/100ml)	≤140	141-280	>280 (2 consecutive samples)
Procedure	• Continue routine monitoring	• Increase sampling to daily • Undertake sanitary survey • Identify sources of contamination • Consult CAC to assist in identifying possible source	• Increase sampling to daily • Undertake sanitary survey • Identify sources of contamination • Consult CAC to assist in identifying possible source • Erect warning signs • Inform the public through the media that a public health problem exists

CAC = Catchment Assessment Checklist

It is important to understand if bacteriological quality enters the 'Alert' status, it is still deemed suitable for swimming and other recreational uses. If bacteriological quality enters the 'red' (Action) level then the bathing area will be considered highly unsuitable for recreation, a public health problem is deemed to exist, and swimming is not recommended.

Sampling is generally conducted weekly, but with the proviso that it should be under conditions when the river is suitable and used for bathing. For example, this precludes sampling under conditions of river freshes

when high flows and turbid conditions would make bathing hazardous and in any case people would be less inclined to bathe. The Council endeavours to collect 13 samples per season under bathing conditions. In addition, at four of the most popular sites a further 7 samples are collected between November and March regardless of prevailing weather and river conditions, to facilitate the calculation of the Microbiological Assessment Category (see next section). Also, weekly sampling regardless of weather and river conditions was undertaken between mid-December 2017 and March 2018 at four of the most popular sites, to align with and assess the reporting protocols for the LAWA website and to enhance the provision of timely information to the public during holiday periods.

2.2 Suitability for recreation grade (SFRG)

Components of the guidelines include sanitary surveys/inspections together with assessments of historical microbiological data which, when combined, provide an overall suitability for recreation grade, which describes the general condition of a site based on both risk and indicator bacteria counts. The Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003) provide for the grading of recreational water bodies utilising Microbiological Assessment Categories (using historical data), and Sanitary Inspection Categories which generate a measure of the susceptibility of water bodies to faecal contamination (ranging from high to low risk). The SFRG therefore describes the general historical and perceived potential risk condition of a site based on both risk factors and indicator bacteria water quality (worst-case over the long term). A grade is established on the basis of the most recent five years' data and recalculation of a grade may be performed annually, although grades should be reassessed on a five-yearly basis.

SFRGs categories are very good, good, fair, poor, and very poor. Sites graded very good are those where it is believed they will almost always comply with the guideline values for recreation, and there are few sources of faecal contamination in the catchment. Consequently, there is a low risk of illness from bathing. Sites graded very poor are in catchments with significant sources of faecal contamination, and it is generically considered that they will rarely pass the guidelines. The risk of illness from bathing at these sites is deemed within the Guidelines to be high, and swimming is not recommended. For the remaining beaches (good, fair and poor) it is recommended that weekly monitoring be carried out during the bathing season to the extent that is practicable. The public is to be informed when guideline values are exceeded and swimming is not recommended (MfE, 2003).

All of the freshwater sites included in the bathing sites programme have been graded by the Council according to these criteria, using all historical SEM microbiological water quality data extending over the November 2012 to March 2017 period (i.e. the five years immediately preceding the current season as required by the Guidelines). The relevant information is provided in Appendix 1 and is summarised in Table 2. Recalculated gradings taking the results of the latest season into account are given in Table 57 of this report.

Table 2 Suitability for recreation grade for freshwater sites for the period November 2012 to March 2017

Site	Sanitary Inspection Category	Microbiological assessment E.coli (cfu/100ml)			SFR Grade	% of all samples not exceeding 'Action' level (ie: ≤ 550 E.coli)
		95 %ile	Number of samples	Category		
L Rotomanu: western beach	High	652	65	D	Very poor	93
Waiwhakaiho R: Merrilands domain	High	220	65	B	Poor	98

Site	Sanitary Inspection Category	Microbiological assessment E.coli (cfu/100ml)			SFR Grade	% of all samples not exceeding 'Action' level (ie: ≤ 550 E.coli)
		95 %ile	Number of samples	Category		
Waiwhakaiho R at L.Rotomanu	High	3075	65	D	Very poor	23
Te Henui S: mouth	High	4525	66	D	Very poor	12
Patea R: King Edward Park	High	572	65	D	Very poor	95
Patea R. boatramp, Patea	High	83	65	A	Poor	100
Waingongoro R: Eltham camp	High	472	65	C	Poor	98
Waingongoro R: Ohawe beach	High	518	65	C	Poor	95
Kaupokonui R: Beach domain	High	482	65	C	Poor	98
L Opunake: adjacent boat ramp	High	455	65	C	Poor	96
Timaru S: Lower Weld Road	High	690	65	D	Very poor	92
Oakura R: d.s SH45	High	3780	65	D	Very poor	90
Waitara R: Town wharf	High	1000	65	D	Very poor	93
Urenui R: estuary	High	59	65	A	Poor	100
Manganui R: Everett Park	High	432	65	C	Poor	96
L Ratapiko: boatramp	High	240	60	B	Poor	98
L Rotokare: adjacent boatramp	Low	255	44	B	Very good	100

Although all but one of the sites' SFRGs suggest possible high risks associated with contact recreational usage, the poor to very poor gradings have been very strongly influenced by the underlying agricultural nature of the catchments in question (within the Sanitary Investigation Category). The 5-year microbiological data, however, indicate that all but two sites (Te Henui Stream and lower Waiwhakaiho River) would not have entered the 'Action' guideline (ie would have exceeded guidelines) on more than 10% of all sampling occasions, that is, fourteen sites achieved the guideline on 90% or more of occasions. That is, the data shows the SFRG gradings to be highly precautionary.

The Urenui River estuary site and the Patea River estuary site have not reached the 'Action' mode during the previous five seasons, under the sampling protocols of the SEM programme; and the Waiwhakaiho River Merrilands domain site, the Everett Park site in the Manganui River, the Lake Ratapiko boat ramp site, the Patea River King Edward Park Stratford site, the Eltham camp site and the Ohawe Beach site in the mid- and lower reaches of the Waingongoro River, the Kaupokonui River beach domain site, and the Lake Opunake boat ramp site entered this 'Action' level on only one or two occasions during the same five-year period.

As explained above, in general, these data indicate shortcomings in the grading system set out within the Guidelines for these sites based upon landuse/perceived impacts and the use of extremes (95 % confidence levels) in bacteriological quality data (ie the 'worst case' data), rather than actual monitoring or representative data measured throughout the bathing seasons. Council's contact recreational water quality programme results confirm that the Guideline gradings do not reflect the recreational water quality experienced by recreational users. They show only susceptibility and predominantly reflect perceptions and suppositions about how some land uses might influence quality, as designated 'risk factors'. It is the view of the Council that when there is regular and systematic testing of the actual quality, those results reflect actual levels and are far more informative to recreational water users. Gradings should not be used to make

any statement about how safe water actually is for recreational purposes. Rather, the Council emphasises the importance of continued systematic and on-going testing and timely public notification in terms of the reporting of actual contact recreational water quality and assessments against guidelines.

2.3 Cyanobacteria

In 2009, the Ministry for the Environment released an interim guidance document entitled "New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters" (MfE, 2009). These guidelines provide a national alert–level framework for assessing the public health risk from cyanobacteria associated with contact recreation in lakes and rivers. Table 3 below shows the alert-level framework for benthic cyanobacteria.

Table 3 Alert level framework for benthic cyanobacteria

Alert level[a]	Actions
Surveillance (green mode) Up to 20% coverage of potentially toxigenic cyanobacteria attached to substrate.	• Undertake fortnightly surveys between spring and autumn at representative locations in the water body where known mat proliferations occur and where there is recreational use. • Take scrapings every second survey for microscopic identification, to compare with visual assessments in order to ensure cyanobacteria are being recorded accurately, and to provide an indication of the species present.
Alert (amber mode) 20–50% coverage of potentially toxigenic cyanobacteria attached to substrate.	• Notify the public health unit. • Increase sampling to weekly. • Recommend erecting an information sign that provides the public with information on the appearance of mats and the potential risks. • Consider increasing the number of survey sites to enable risks to recreational users to be more accurately assessed. • If toxigenic cyanobacteria dominate the samples, testing for cyanotoxins is advised. If cyanotoxins are detected in mats or water samples, consult the testing laboratory to determine if levels are hazardous.
Action (red mode) *Situation 1:* Greater than 50% coverage of potentially toxigenic cyanobacteria attached to substrate; or *Situation 2:* up to 50% where potentially toxigenic cyanobacteria are visibly detaching from the substrate, accumulating as scums along the river's edge or becoming exposed on the river's edge as the river level drops.	• Immediately notify the public health unit. • If potentially toxic taxa are present then consider testing samples for cyanotoxins.. • Notify the public of the potential risk to health.

a The alert-level framework is based on an assessment of the percentage of river bed that a cyanobacterial mat covers at each site. However, local knowledge of other factors that indicate an increased risk of toxic cyanobacteria (e.g., human health effects, animal illnesses, prolonged low flows) should be taken into account when assessing a site status and may, in some cases, lead to an elevation of site status (e.g., from surveillance to action), irrespective of mat coverage.

Over the period that planktonic cyanobacteria monitoring of lakes has been undertaken, the guidelines outlined in Table 3 have been utilised (TDHB, 2006), as agreed with all parties at the time of the inception of

this addition to the programme, until the 2014-2015 period when the volumetric guidelines were also included (Table 4).

Table 4 Planktonic cyanobacteria guidelines for lake monitoring

Mode	Cells (per ml)	Biovolume (mm^3/L)
Low risk	Less than 2,000	<0.5
Medium risk	2,000 and 15,000	0.5 -1.8
High risk	More than 15,000	>1.8

3 Monitoring methodology

3.1 Program design

The Council's Freshwater Recreational Water Quality programme consists of two primary components: State of the Environment monitoring and extended monitoring. The purpose of each component, and its respective sampling protocols, is discussed in sections 3.1.1 and 3.1.2.

It should be noted that the existing programme was designed and implemented prior to the release of the 1998 and 2003 guidelines. Therefore, for trend detection monitoring purposes, consistency in programme design is essential and will be maintained where possible. Results are interpreted in this report with reference to the 2003 guidelines for the purposes of comparative assessment with contact recreational guidelines.

3.1.1 State of the environment monitoring

The locations of the sixteen sites sampled by the various components of the 2017-2018 programme are shown in Figure 1 and summarised in Table 5.

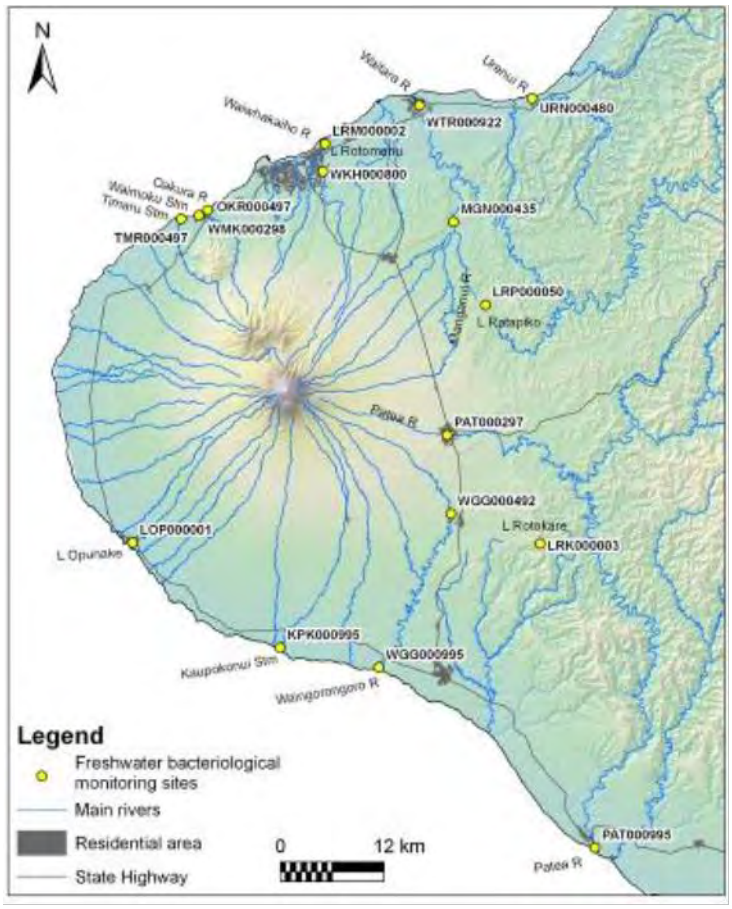


Figure 1 Location of freshwater contact recreation survey sites in 2017-2018

Having established its general state and the degree of influence on the nearby coastal waters of Oakura beach, sampling of the Waimoku Stream site at Oakura Beach was reduced in intensity from 2011 with sampling programmed for every third season thereafter (ie sampled in 2013-2014 and 2016-2017). Given the permanent warning signs at the Waimoku Stream, and its extremely shallow nature, the Waimoku Stream is not a designated bathing site in its own right. Two sites (Te Henui Stream at the mouth and lower

Waiwhakaiho River adjacent to Lake Rotomanu) were added to the 2011-2012 programme, in recognition of increased recreational usage of these areas.

For sampling convenience, all sites were included with the coastal bathing beaches runs undertaken over the same five month period from early November 2017 to mid April 2018. Ten sites, relatively close to stream mouths, were potentially affected by tidal influences (see conductivity data later in this report).

Table 5 Location of bathing water bacteriological and cyanobacteria sampling sites

Site	GPS Location		Site code	Bacteriological	Benthic Cyanobacteria	Planktonic Cyanobacteria
L Rotomanu: western beach	E 1696309	N 5678128	LRM000002	✓		✓
Waiwhakaiho R: Merrilands domain	E 1696059	N 5674931	WKH000800	✓	✓	
Waiwhakaiho R at L.Rotomanu	E 1696587	N 5678336	WKH000950	✓	✓	
Te Henui S: mouth, East End	E 1694213	N 5677047	THN000499	✓	✓	
Patea R: King Edward Park	E 1710433	N 5644464	PAT000297	✓	✓	
Patea R. boat ramp, Patea	E 1727517	N 5596784	PAT000995	✓		
Waingongoro R: Eltham camp	E 1710861	N 5635349	WGG000492	✓	✓	
Waingongoro R: Ohawe beach	E 1702531	N 5617624	WGG000995	✓	✓	
Kaupokonui R: Beach domain	E 1691110	N 5619893	KPK000995	✓	✓	
L Opunake: adjacent boatramp	E 1674029	N 5632022	LOP000001	✓		✓
Timaru S: Lower Weld Road	E 1697622	N 5669438	TMR000497	✓		
Oakura R: d/s SH45 bridge	E1682721	N 5670440	OKR000497	✓	✓	
Waitara R: Town wharf	E 1707203	N 5682572	WTR000922	✓		
Urenui R: estuary	E 1720245	N 5683370	URN000480	✓		
Manganui R: Everett Park	E 1711149	N 5669127	MGN000435	✓	✓	
L Ratapiko: boatramp	E 1714913	N 5659488	LRP000050	✓		✓
L Rotokare: adjacent boatramp	E 1721182	N 5631898	LRK000003	(✓)		✓

Sample collection, field measurements, and analyses were undertaken according to documented Taranaki Regional Council procedures. It was intended that, on average, three samples would be collected from each of the sites in each month when hydrological flow conditions permitted, within two hours of high tide (due to the format of the coastal programme). Sampling commenced in early November 2017 with three of the sampling surveys performed prior to January 2018. The majority of the surveys were performed over the latter half of the summer and early autumn period. Bathing water samples were taken between the hours of 0900 and 1600 hours (NZDT), with none collected within a three day period following significant river/stream fresh conditions. [NB: regional differences in rainfall patterns have caused difficulties at various sites in the past as localised rainfall may impact on bacteriological quality on isolated occasions]. Where necessary, a 2 metre sampling pole was used for bacteriological sample collection immediately beneath the water surface and at a minimum of calf depth at the sites. Thirteen samples were collected from all sites, except at Lake Ratapiko, where the water level was lowered for maintenance after the twelfth sampling.

Samples were analysed for *E. coli* bacteria, turbidity and conductivity. In addition, at each of the sites the following information was recorded: time, water temperature, weather, colour/appearance, estimation of algal cover on the streambed, number of bathers and other users, presence of wildfowl, etc., and flow characteristics. All sites' locations (map references and GPS) and descriptions are stored in the Council's Taradise and ESAM computer databases and all analytical results were stored in the Lab database following standard sample registration procedures.

Results were posted on the Taranaki Regional Council website (http://www.trc.govt.nz/#mapTab6), for both public and local health authority notification, as soon as data checking had been completed. The results were also included on the national Land, Air, Water Aotearoa (LAWA) website (http://www.lawa.org.nz/explore-data/taranaki-region/river-quality/). The Taranaki District Health Board no longer posted the results on its recreational water safety webpage after 2015-2016, instead introducing links to the regional and district councils' and national websites, and continuing to give general advice on water safety. In 2017-2018, the three district councils (New Plymouth, Stratford and South Taranaki) maintained sections on recreational water quality on their respective websites, using the data produced by the regional council.

In previous monitoring years, where results fell in the 'Action' mode, further investigations (e.g. sampling and inspections) were performed when considered necessary i.e. where historical databases and staff expertise indicated this was warranted. Since December 2016, health risk warning signs have been erected by District Councils as soon as practicable after receiving a single 'Action' level result, whether for freshwater or marine recreational sites. The signs were removed after a single result below 'Action' level.

Cyanobacteria information was included on the regional council website for all lake sites and river/stream sites.

3.1.2 Extended monitoring

The revised guidelines (MfE, 2003) require weekly surveillance monitoring during the 5-month recreational period, with a minimum of 20 data points collected, regardless of weather conditions or state of the tide, also facilitating the calculation of the Microbial Assessment Category. Following consultation with the three territorial local authorities and Taranaki District Health Board, TRC undertook to add seven sampling occasions to the SEM protocol (13 dry weather samples per season, representing conditions most conducive to bathing) at two of the most popular freshwater recreational sites (Lake Rotomanu and Waiwhakaiho River at Merrilands Domain) in the 2003-04 period and this additional monitoring has continued annually since. These seven sampling occasions were systematically selected (one per week), where possible in weeks not sampled by the SEM programme and were performed regardless of prior weather conditions or tides but adhering to all other SEM programme protocols and using documented sampling methods. Both sites were signposted advising the public of monitoring activity. Also, the additional data were included on the TRC website [Note: These additional data have not been used for trend detection purposes as they do not comply with the format of the originally established SEM programme].

In the 2016-2017 period, monitoring frequency was increased to at least weekly between December and February at four of the most popular freshwater recreational sites (Lake Rotomanu, Waiwhakaiho River at Merrilands Domain, Kaupokonui River at mouth, and Waingongoro River at Ohawe), to align fully with the MfE guidelines and the reporting protocols for the LAWA website. Monitoring over the Christmas to New Year period was specifically included to increase the provision of timely information on suitability for bathing to the public during holiday periods. When possible, the SEM protocol of dry weather monitoring (near high water for estuarine sites) was followed. In weeks when weather or tide did not meet the SEM protocol, sampling occurred no later in the week than Thursday to allow posting of results on local and national websites before the weekend.

In the 2017-2018 period, the duration at higher monitoring frequency was increased, to run from mid-December to the end of March. [Note: These additional data have not been used for trend detection purposes as they do not comply with the format of the originally established SEM programme].

3.1.3 Follow up monitoring

As recommended by the national guidelines (MfE, 2003), a follow up sample may be collected when a routine monitoring sample reaches 'Alert' or 'Action' mode (see Section 2.1). Follow up samples can be

useful in determining the source of a high *E. coli* count, the longevity of the event, and for updating the site's suitability for bathing. These samples are generally collected as soon as reasonably practicable in the days following the high result, though follow ups may be deemed inappropriate under certain circumstances. For example, if wet weather ensues, a follow up sample may not be collected due to contamination from run-off masking the source in question. In some instances, when routine surveys are scheduled within close succession, the subsequent survey may substitute a dedicated follow up survey.

3.1.4 Cyanobacteria

After consultation with Taranaki District Health Board, planktonic cyanobacteria monitoring commenced at each of the three lake sites in the 2006-2007 bathing season and has continued to date, including an additional lake site (Lake Rotokare). Cyanobacteria can produce toxicity in recreational waters which pose risks to humans and animals by contact or consumption during recreational activities. Lake samples were collected for microscopic analysis and enumeration which were performed in the TRC biological laboratory. A more comprehensive benthic cyanobacteria monitoring programme for the river and stream sites was instigated in the 2013-2014 period and continued over 2017-2018, the results of which are included in this report.

As part of the State of the Environment Freshwater Nuisance Periphyton monitoring programme, the Council undertakes a series of benthic cyanobacteria surveys during the recreational period each year. Monitoring is undertaken at nine sites within the Taranaki region that are established as popular for swimming and other fresh water-based activities.

The sampling period extends from 1 November to 31 March each year. Initially, the surveys are carried out in accordance with the sample frequencies listed in Table 6, which then may vary depending upon the percentage cover of benthic cyanobacteria detected previously at a site.

Table 6 Frequency of sampling for benthic cyanobacteria

Percentage of cyanobacterial mat cover per site	Level (MfE guidelines)	Frequency of sampling
Up to 20%	Surveillance [green mode]	Monthly
20-50%	Alert [amber mode]	Fortnightly
>50%	Action [red mode]	Weekly

At each site, measurements at four transects, using five evenly spaced viewing circles, were made across the streambed to a maximum depth of 0.6m. Two transects were established in riffle habitat and two transects in run habitat. Percentage cover of benthic cyanobacteria was estimated in each viewing circle for cyanobacteria mats greater than 1mm thick. Samples of benthic cyanobacteria were taken for laboratory analysis where species could not be identified on site. An average percentage cover per transect was calculated from which an average percentage cover for the site also was calculated. Average percentage cover results were then interpreted using the MfE level framework guidelines in Table 6. Monitoring was also extended to include information on exposed and detaching mats in accordance with relevant criteria.

Up until the 2016-2017 monitoring period the standard monitoring programme has consisted of seven sampling occasions spread over a five-month period from October to March. For the current monitoring period, bi-monthly sampling of lakes was to occur but due to low levels of cyanobacteria few samples were taken at Lakes Rotokare, Ratapiko and Opunake. Due to high cyanobacteria levels and interest from the public and other organisations an additional sample was collected at Lake Rotomanu.

3.2 Analysis

3.2.1 Sample analysis

Historically, samples were analysed for *E. coli*, faecal coliforms, enterococci, conductivity, and turbidity. *E. coli* and faecal coliform numbers were obtained using the mTEC agar method #9213-d, Standard Methods for the Examination of Waters and Wastewaters (APHA, 2005). Enterococci were quantified using the EPA modified method #1600 on mEI agar (EPA, 1986).

In the 2017-2018 summer period, it was decided to stop analysing for faecal coliforms and enterococci, in order to optimise the efficiency of the laboratory; given the increase in overall sampling intensity in recent years. Both routine and follow up samples were tested for *E. coli* using the faster, and technically easier, 18-hour Colilert (IDEXX) Quanti-Tray system (APHA Method 2223 B). See Section 3.1.3 for an explanation of when follow up samples are required. E. coli are the nationally designated indicator for assessing the bacteriological state of freshwaters.

At each of the sites the following additional information was recorded: time, water temperature, weather condition, wind condition, colour/appearance of water, and number of bathers and other users.

3.2.2 Long term trend analysis

Long term trend analysis is only carried out with the results from the SEM programme in order to determine the trends of recreational water quality around Taranaki under dry weather conditions. For sites with sufficient data (≥10 years), non-parametric trend analysis was performed using annual median *E. coli* data. For each site, a LOWESS (Logically Weighted Scatterplot) line (tension 0.4) was fitted to a temporal scatter plot of the *E. coli* median data. Statistical significance of the trend was tested using a Mann-Kendall test. The sign (+/-) of the Kendall tau value was used to assess whether the trend was positive or negative and the significance of the trend was determined using the p value ($p < 0.05$ = significant).

When multiple correlations are undertaken, there is a chance that some will be found to be significant purely by chance. In order to deal with this potential problem, the Benjamini-Hochberg False Discovery Rate (FDR) method was applied to the results of the Mann-Kendall test. Further justification for this statistical approach can be found in Stark and Fowles (2006).

4 Results

Sampling times in relation to tidal conditions (particularly for estuarine sites, see Appendix II), weather conditions and sites' usage information are contained in Appendices III and IV. Timing of sampling in relation to river flows is illustrated by Figure 7, Figure 20, Figure 28, Figure 33, Figure 38, Figure 47, Figure 55 and Figure 62. Those illustrate that the majority of the sampling occasions coincided with steady to low river recession flow conditions. In 2017-2018, sampling for trend monitoring was not known to be affected by localised rainfall, or by a prior increase in river flows, except at the lower Waitara River site where delayed effects of rainfall are known to occur. However, where possible, no sampling was undertaken within three days following significant river freshes. A total of 13 samples was collected at each site during the period from early November 2017 to mid-April 2018.

Sampling was confined to weekdays during the period, with one exception on a Saturday, and no public holidays were included due to sampling personnel and laboratory schedules' requirements. For these reasons, recreational usage of the waters was generally less intensive, often with no apparent usage at the time of sampling. However, all sites are known to be regularly utilised for bathing and other contact recreational activities, particularly at weekends, dependent on suitable weather conditions (see Appendix IV of TRC, 1999). The two additional sites included in the 2001-2002 programme (Patea River at Stratford and Waingongoro River at Eltham), and monitored annually since then, have been identified as used locally for bathing and other recreational purposes. The two lake sites (Ratapiko and Opunake) added to the 2006-2007 programme are also used for these purposes, while Lake Rotokare (added in the 2007-2008 season for cyanobacteria monitoring) is used extensively for recreational boating activities. The lower Patea River site (added in 2007-2008 year as a result of a Patea Wastewater Treatment Plant consent monitoring condition) is used principally for boating purposes. The lower Waitara River site (added in 2009-2010) is used for boating and bathing purposes, more so after the construction of a new wharf in the town. The Te Henui Stream and lower Waiwhakaiho River sites (added in 2011-2012) are both used for bathing (the latter more particularly) as the New Plymouth coastal walkway has provided improved access.

From time to time, public interest has focused on additional sites where sporadic sampling may be undertaken as a consequence after appropriate consideration (see Appendix VII).

All results (SEM, MfE and follow up monitoring) are presented and discussed on a site-by-site basis for the sampling period, which extended from 7 November 2017 to 7 April 2018 and totalled thirteen sampling occasions at each site for (SEM) trend monitoring, with eleven more sampling occasions at the four sites where additional (MfE) sampling was undertaken. The statistical analyses do not include follow-up sampling results, as they were collected in response to particular events (resulting in high *E. coli* counts) and are therefore not random, and potentially not representative of typical bathing conditions.

Supplementary data and observations are presented in the appendices.

4.1 Lake Rotomanu

A total of 25 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as 11 MfE samples and one follow up sample.

At the times of the surveys, conducted mostly in early to mid-morning, there was limited bathing usage of the lake recorded, with boating, jet-skiing, kayaking, and walking activities occurring on some occasions. Dog-walking and picnicking have been observed in previous seasons.

Ducks were present on the lake or in the vicinity of the lake edge throughout most the period. Public feeding of the ducks was observed. Gulls were present or common on the banks on several occasions. Lake levels were relatively consistent throughout the period. A wetland had been created several years ago at Peringa Park to improve the quality of stormwater runoff entering the lake.

A recreational water quality advisory sign was erected by NPDC on the access road to the lake in June 2017, in addition to the existing TRC sign at the monitoring site (Photo 1, the original sign on the right is in the far background on the left).

Photo 1 Signs at Lake Rotomanu, june 2017

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 2. The complete survey results are presented in Appendix I and summarised in Table 13.

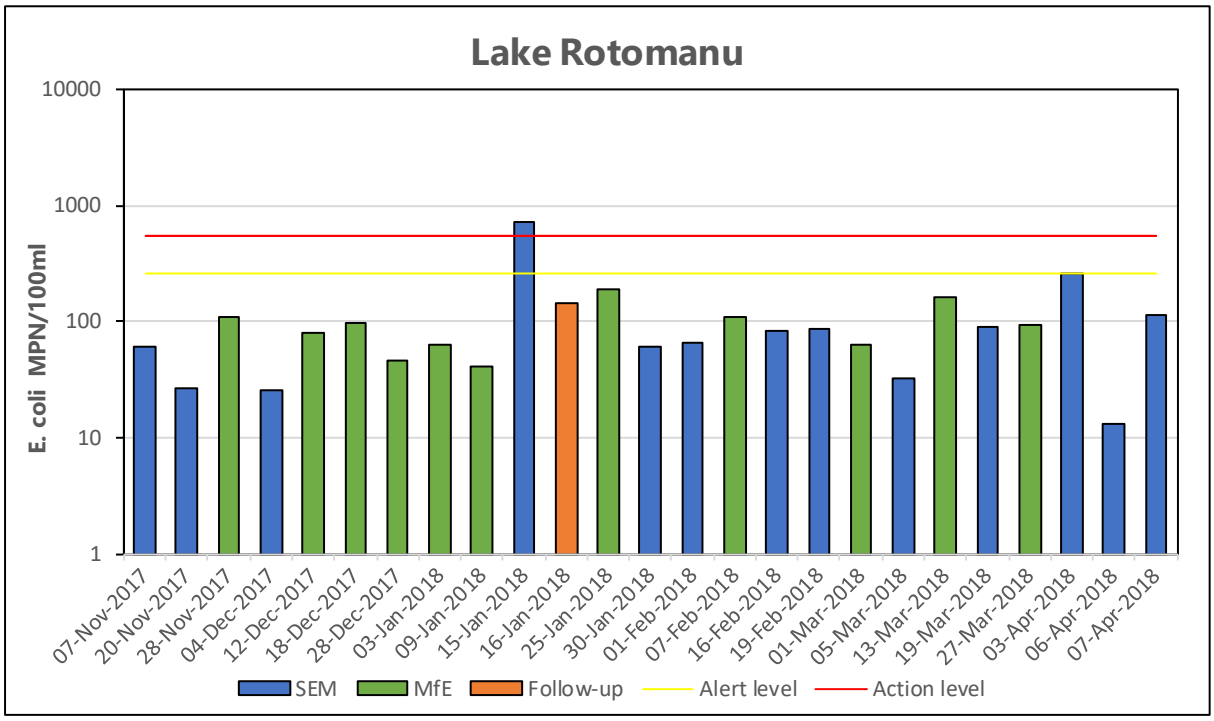


Figure 2 *E. coli* results for Lake Rotomanu

Table 7 Statistical summary for Lake Rotomanu

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	10.8	12.9	11.9
	E. coli	MPN/100ml	13	13	727	66.3
	Temperature	°C	13	18.7	28.6	24.9
	Turbidity	NTU	13	6.8	15	10
SEM + MfE samples	Conductivity	mS/m@20°C	24	10.8	13.0	11.9
	E. coli	MPN/100ml	24	13	727	81.6
	Temperature	°C	24	18.6	28.6	23.8
	Turbidity	NTU	24	1.05	16	9.95

The lake, which is close to the coast, is replenished from time to time by inflow from the nearby Waiwhakaiho River. Water quality was relatively good although it was generally noticeably turbid (median turbidity: 10; range: 7 NTU), possibly as a result of fluctuating concentrations of suspended algae and/or fine sediment. Water temperatures were relatively high (above 20°C) through most of the period with a maximum of 28.6°C (in late January 2018) and a range of 9.9°C. Conductivity had a narrow range through the season.

Generally, bacteriological quality was relatively good considering that the inflow to the lake is from the lower reaches of a river draining a developed catchment. From the trend monitoring, elevated numbers of *E. coli* (in the 'Action' mode) were found on one occasion, 15 January 2018. There was no apparent cause. NPDC adjusted the signage to reflect the increased health risk from recreational use of the lake. Resampling the next day returned an *E. coli* number back to 'Surveillance' level, and the sign was readjusted accordingly.

The additional (MfE) sampling resulted in a slight increase (from 66 to 82 *E.coli* per 100 ml, or 23%) in the overall seasonal median bacteria number, possibly due to the proximity of wet weather on some of the sampling survey occasions, though no further Action level was reached. The median turbidity with the additional samples was the same (10 NTU) and the turbidity range wider (1.0 to 16 NTU) than for the standard SEM sampling surveys.

4.1.1 Comparison with guidelines

E. coli counts from Lake Rotomanu over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 8.

Table 8 Performance against guidelines at Lake Rotomanu

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample>550/100 ml
SEM samples	0 [0%]	1 [8%]
SEM+MfE samples	0 [0%]	1 [4%]

One single sample exceeded the 'Action' mode during the period, during a SEM survey. All other samples, from both SEM and additional weekly sampling, were within 'Surveillance' mode.

4.1.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Lake Rotomanu over 22 summers are presented in Figure 3.

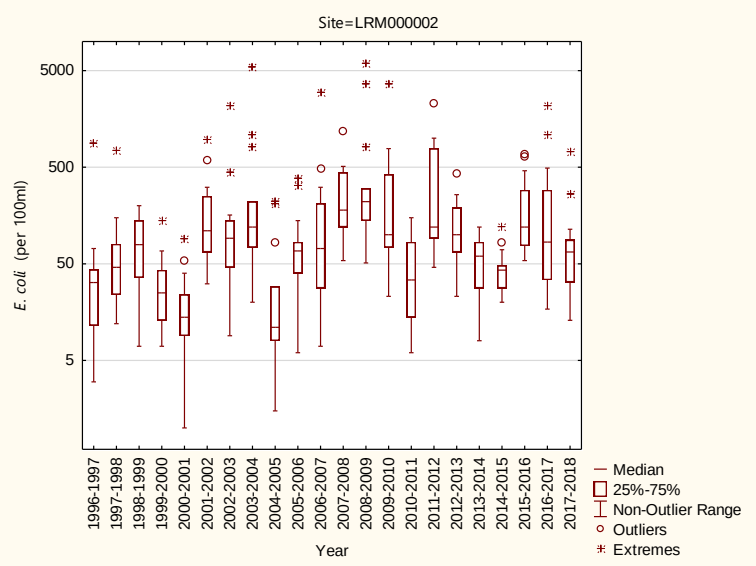


Figure 3 Box and whisker plots of *E. coli* for all summer SEM surveys at Lake Rotomanu

The median *E.* coli value and the maximum count (66 and 727 MPN/100 ml, respectively) obtained for the 2017-2018 summer were both near the middle of the range recorded for this site. The median value remained well below the 'Alert' level of the 2003 MfE guidelines.

4.1.3 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median *E. coli* data for 22 summer seasons (Figure 4) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

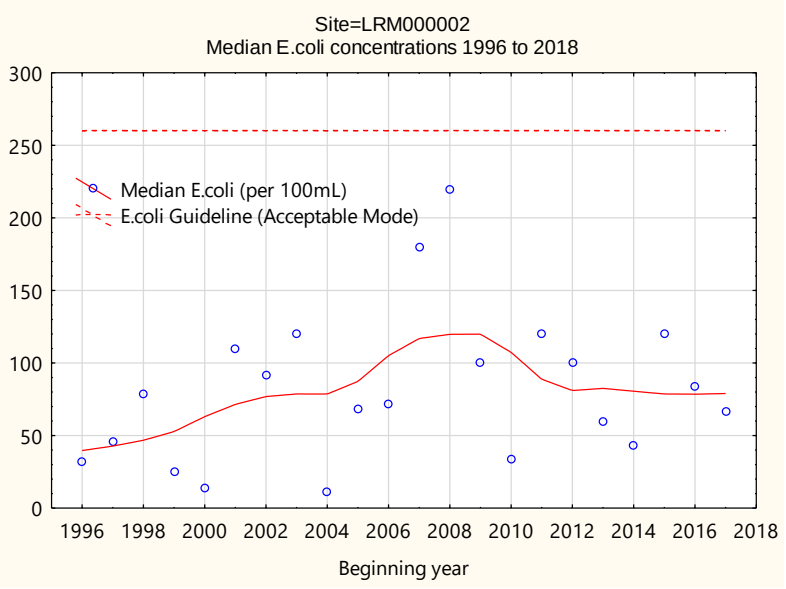


Figure 4 LOWESS trend analysis of median *E. coli* data at Lake Rotomanu

Overall, a positive trend, but not statistically significant or important increase in median *E. coli* numbers, has been found over the twenty-two seasons of monitoring. None of these seasonal medians has exceeded the 'Alert' or 'Action' modes.

4.1.4 Cyanobacteria

Planktonic cyanobacteria levels during the recreational monitoring year were high overall (median bio-volume 3.28 mm^3/L). There was a high degree of variability, with bio-volumes fluctuating between very low and very high levels (range 0.01-7.59 mm^3/L).

Planktonic cyanobacteria were monitored on eleven occasions throughout the season with results presented in Table 9 and Figure 5.

Table 9 Cyanobacteria counts and bio-volumes for Lake Rotomanu

Date	Cyanobacteria total cell count (cells/mL)	Bio-volume (mm^3/L)	Principal species by biovolume	Mode
07/11/2017	73856	3.32	*Limnococcus cf. limneticus*	Action
16/11/2017	10267	2.05	*Limnococcus cf. limneticus*	Action
28/11/2017	6389	1.28	*Limnococcus cf. limneticus*	Alert
12/12/2017	745278	3.35	Picocyanobacteria	Action
03/01/2018	7000910	3.12	Picocyanobacteria	Action
15/01/2018	8100000	3.32	Picocyanobacteria	Action
25/01/2018	10125000	4.15	Picocyanobacteria	Action
07/02/2018	18500000	7.59	Picocyanobacteria	Action
19/02/2018	8000000	3.28	Picocyanobacteria	Action
01/03/2018	4785000	1.96	Picocyanobacteria	Action
19/03/2018	64	0.01	*Limnococcus cf. limneticus*	Surveillance

* Additional samples

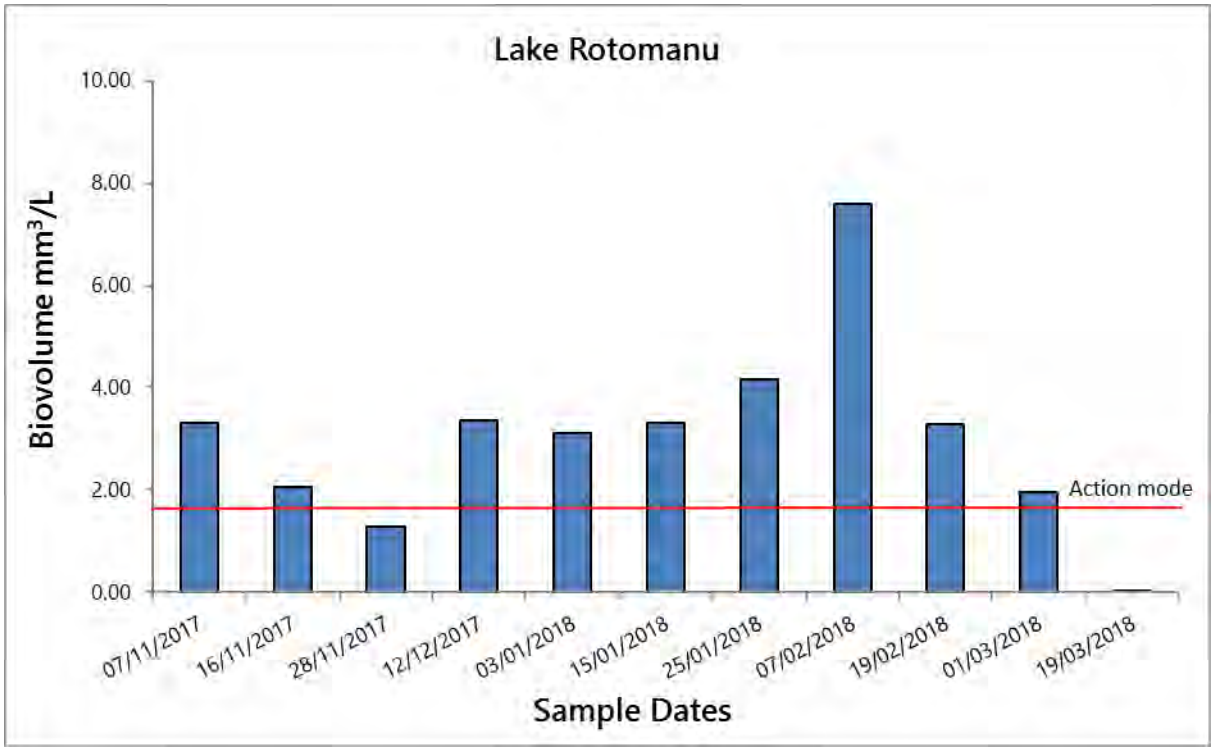


Figure 5 Cyanobacteria bio-volume at Lake Rotomanu

Following the high cyanobacteria bio-volume detected in early November 2017, NPDC changed the adjustable health warning sign at the main entrance to the lake accordingly, and erected a similar, temporary sign at the western beach. The signs were readjusted/removed when the cyanobacteria bio-volume reduced to below 'Action' level at the end of November 2017. From mid December 2017, for a period of three months, the signs were reset at 'no swimming' while cyanobacteria bio-volumes were continuously high.

4.2 Waiwhakaiho River at Merrilands Domain

A total of 26 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as 11 MfE samples and two follow up samples.

Some recreational usage was recorded at the time of the surveys, with bathing noted on four occasions. The dog-walking that was common in 2015-2016, but almost absent in 2016-2017, was recorded seven times in 2017-2018. No birdlife was noted on any but one occasion, when two ducks were observed downstream. The weather was overcast on nine occasions, six of them during the SEM surveys, and light rain immediately preceded three of the additional MfE surveys.

River flow information is illustrated in Figure 7. There was a long flow recession from early November 2017 over two months, followed by a series of evenly spaced freshes for the remainder of the monitoring period.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 6. The complete survey results are presented in Appendix I and summarised in Table 10.

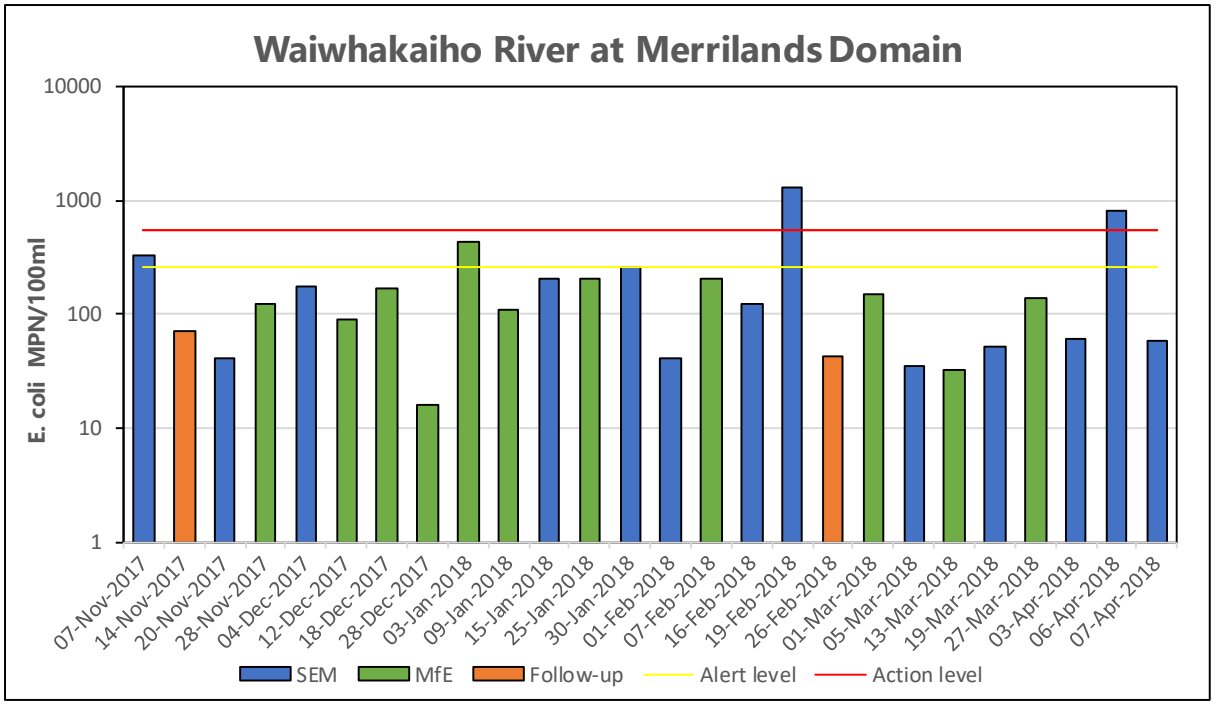


Figure 6 *E. coli* results for the Waiwhakaiho River at Merrilands Domain

Table 10 Statistical summary for the Waiwhakaiho River at Merrilands Domain

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	10.1	14.4	12.5
	E. coli	MPN/100ml	13	34.5	1300	124
	Temperature	°C	13	13.7	24.5	20.1
	Turbidity	NTU	13	0.31	1.6	0.5
SEM + MfE samples	Conductivity	mS/m@20°C	24	8.2	14.4	12.5
	E. coli	MPN/100ml	24	16	1300	131
	Temperature	°C	24	13.7	24.5	19.8
	Turbidity	NTU	24	0.29	2.1	0.5

This river drains an extensively developed farmland catchment prior to flowing through two kilometres of urban New Plymouth upstream of this popular domain and recreational area sited in the lower reaches of the river nearly 4 km from the sea.

Water temperatures varied over a moderate range of 10.8°C between early November and early April, with a record high maximum of 24.5°C in late morning in late January 2018. Conductivity and turbidity results, were generally indicative of very clean, clear, relatively high water quality, but moderate to widespread algal cover (up to 100% mats) was common throughout the period during flow recessions.

Considering the influence of agricultural activities, particularly dairying in the catchment, bacteriological water quality was relatively high. The additional MfE samples, mostly taken in fine weather, made little difference to the statistics.

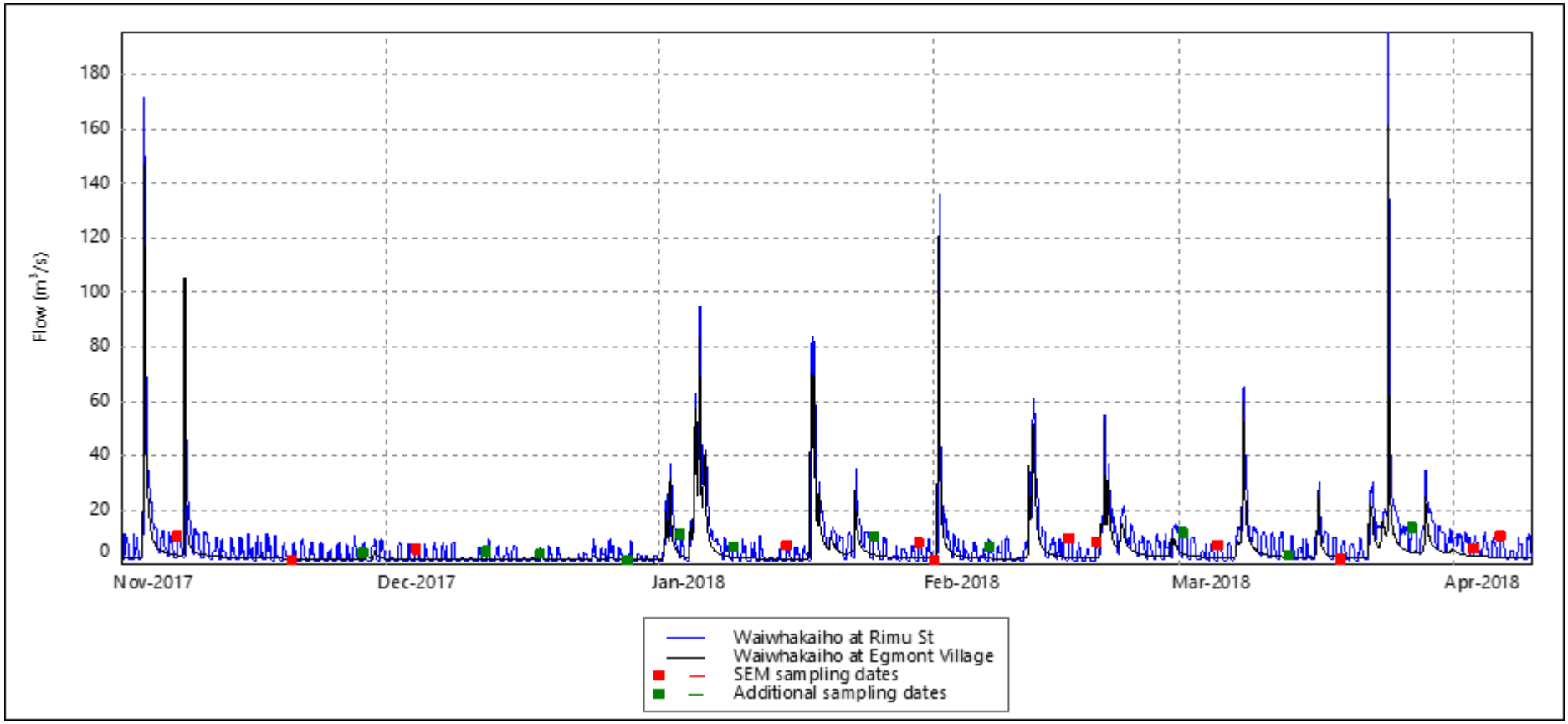


Figure 7 Flow in the Waiwhakaiho River during the survey period

4.2.1 Comparison with guidelines

E. coli counts from Waiwhakaiho River at Merrilands Domain over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 13.

Table 11 Performance against guidelines at Waiwhakaiho River Merrilands Domainn

Parameter	Number of exceedances of E. coli guidelines	
	ALERT **Single sample** 261-550/100ml	**ACTION** **Single sample** **>550/100 ml**
SEM samples	1 [8%]	2 [15%]
SEM + MfE samples	2 [8%]	2 [8%]

Action mode was triggered on two occasions, both during SEM surveys, in mid-February and early April. Alert mode level was exceeded on two occasions, one during the first SEM survey. Follow-up surveys were carried out after all three of the affected SEM surveys (the last follow up also being a routine survey), with results back at 'Surveillance' level on each occasion. Bacteriological water quality measured at this site was therefore within the acceptable standard for contact recreation usage for the majority of the survey period.

On the two occasions that Action mode was recorded, NPDC adjusted the permanent sign at the upper car park and erected a temporary sign at the lower car park to warn against swimming.

4.2.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected for Waiwhakaiho River at Merrilands Domain over 22 summers are presented in Figure 8.

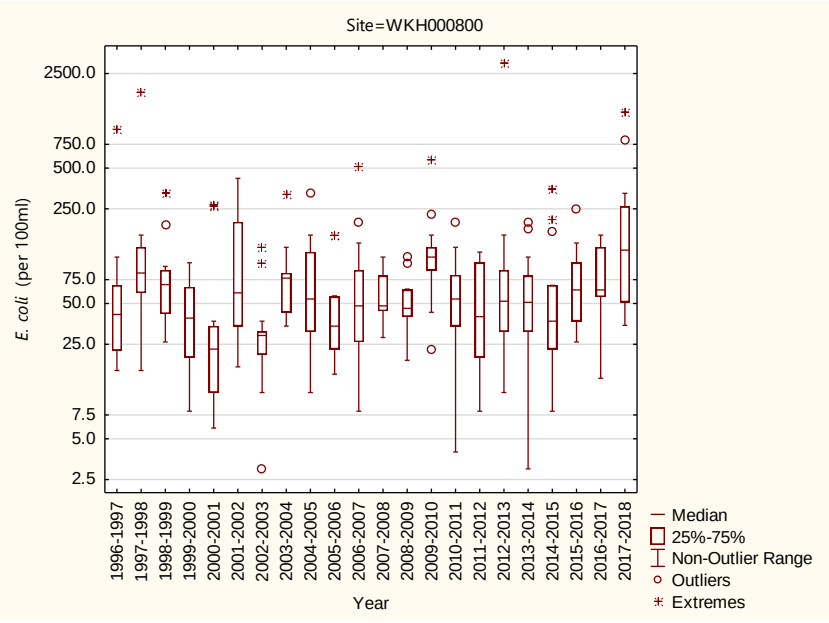
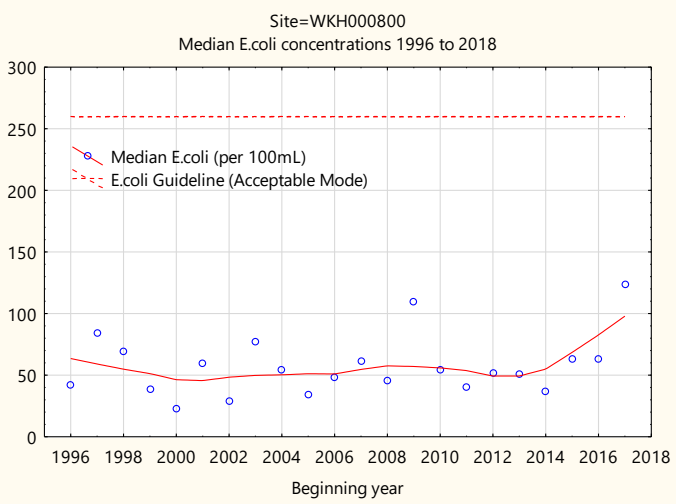


Figure 8 Box and whisker plots of *E. coli* for all summer SEM surveys of Waiwhakaiho River at Merrilands Domain

The median *E. coli* number in the 2017-2018 period was the highest recorded to date and 14 MPN/100 ml above the maximum of the range of historical medians, all of which have been much lower than the 'Alert' level of the 2003 MfE guidelines.

4.2.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the twenty-two seasons of data by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 9) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



Waiwhakaiho River at Merrilands
N = 22
Kendall Tau = 0135
p-value = 0.380
FDR, p-value = 0.652]

Figure 9 LOWESS trend analysis of median *E. coli* at the Waiwhakaiho River, Merrilands Domain

A slight, unimportant and statistically insignificant increase in median *E.coli* numbers has been found over the twenty-two seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

4.2.4 Cyanobacteria

Benthic cyanobacteria were monitored on 13 occasions during the 2017-2018 season. Results are presented in Table 12 and illustrated in Figure 10.

Table 12 Benthic cyanobacteria data for the Waiwhakaiho River at Merrilands Domain

Date	Average cyanobacteria % cover	Detached mats	Exposed mats	Mode
02/11/2017	19	No	No	Surveillance
14/11/2017	8	No	Minor	Alert
06/12/2017	6	Minor	Minor	Alert
12/12/2017	4	No	No	Surveillance
20/12/2017	0	No	Minor	Alert
03/01/2018	2	Minor	No	Alert
11/01/2018	6	No	Minor	Alert
24/01/2018	8	No	No	Surveillance
07/02/2018	8	No	Minor	Alert
14/02/2018	7	No	No	Surveillance
26/02/2018	5	No	Yes	Action
22/03/2018	4	No	Minor	Alert
27/03/2018	2	No	No	Surveillance

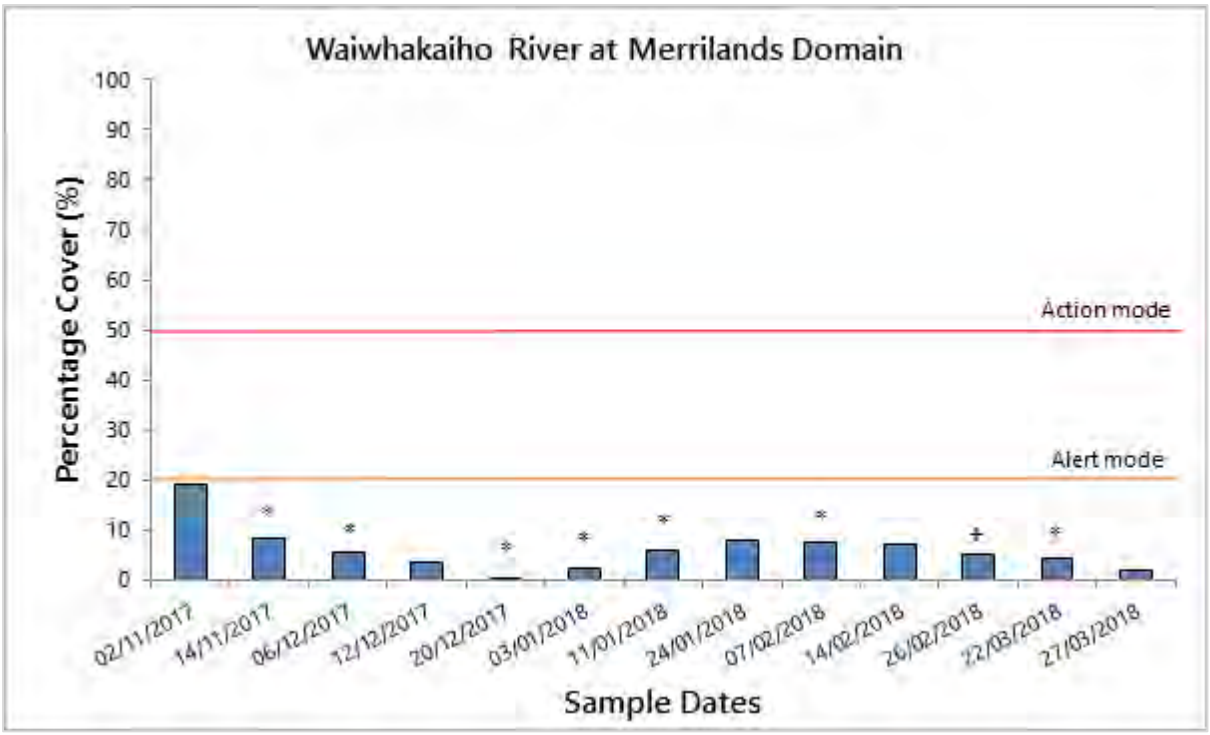


Figure 10 Percentage benthic cyanobacteria cover at the Waiwhakaiho River at Merrilands Domain site

Note that 'Action' and 'Alert' mode lines are for percentage cover only. The symbols * and + over a bar indicate where the status been raised to 'Alert' or 'Action' mode, respectively due to detaching or exposed mats.

Benthic cyanobacteria coverage was generally low throughout the season with a median value of only 6%. There was one occasion where it exceeded 10% coverage (range from 0 to 19%). The 'Action' or 'Alert' level was never exceeded for percentage cover. The benthic cyanobacteria found were *Phormidium* sp. Detaching mats reached minor levels on two occasions which triggered the 'Alert' level. Minor levels of exposed mats were visible on six occasions which triggered the 'Alert' level and significant exposed mats were visible on one occasion which triggered the 'Action' level. In total the 'Alert' level was triggered on seven occasions and the 'Action' level' was triggered on one occasion. Warning signs advising against swimming and dog access to the water were erected accordingly.

The cause of the high number of exposed mats when the cover percentage was low can be attributed to the daily fluctuations in flow caused by the release of water from the upstream Mangorei hydro-electric power scheme. When the hydro scheme was not releasing water (eg in early morning) river levels were low and mats were exposed. The mats were present on the top of boulders so that no cyanobacteria were immersed in water during these low flows. Higher flows would inundate the top of the boulders and thus stop the cyanobacteria from drying out. It appeared that other algae (green algae and diatoms) could not compete with *Phormidium* sp under this hydrological regime.

Photos 2 and 3 Exposed cyanobacteria mats, Waiwhakaiho River at Merrilands Domain

4.3 Waiwhakaiho River adjacent to Lake Rotomanu

A total of 13 samples were collected at this site over the summer, all scheduled SEM samples.

Minor usage of this site was recorded at the time of the sampling surveys, with some whitebaiting (in season) and dog-walking on the banks of the river. Seagulls (extremely abundant) were frequently present at this site with large numbers of gulls present along the lower reaches of the river upstream of this site (Photo 4). Ducks were present on three occasions.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 11. The complete survey results are presented in Appendix I and summarised in Table 13. River flow information is illustrated in Figure 7 as it is also applicable to this site.

Photo 4 A typical gull population immediately upstream of the Waiwhakaiho River, Lake Rotomanu site

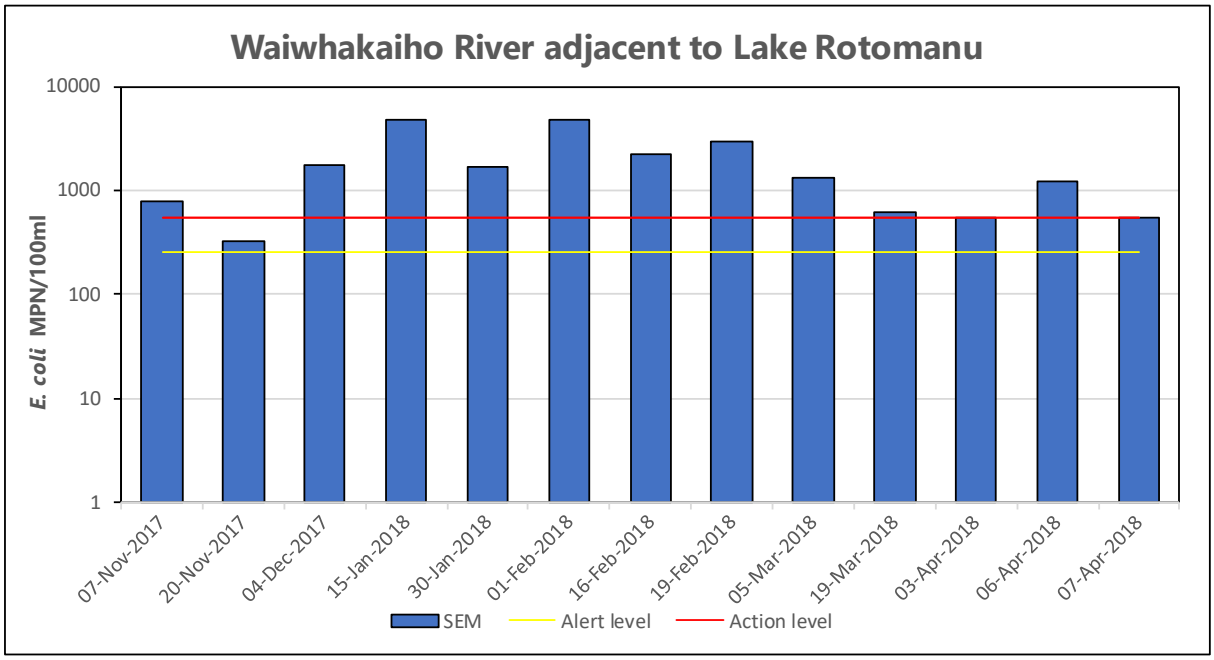


Figure 11 *E. coli* results for Waiwhakaiho River adjacent to Lake Rotomanu

Table 13 Statistical summary for Waiwhakaiho River adjacent to Lake Rotomanu

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	9.7	677	13.0
	E. coli	MPN/100ml	13	331	4880	1300
	Temperature	°C	13	16.9	26.1	21.7
	Turbidity	NTU	13	0.57	2.1	0.82

This river drains an extensively developed farmland catchment prior to flowing through six kilometres of urban New Plymouth upstream of this popular recreational area sited in the lower reaches of the river about 700m from the sea.

Large flocks of seagulls are known to roost on the river bed in the lower reaches between Merrilands and this site near the more recently constructed walkway bridge.

[Note: During the 2011-2012 period (TRC, 2012) faecal source DNA tracking marker analyses found that the Merrilands Domain samples contained bacteria only indicative of ruminants origin on one occasion and of ruminants and wildfowl origin on another occasion. However, samples from the lower river site (adjacent to Lake Rotomanu) were found to contain bacteria very specifically of gull origin on both occasions and a faint indication of ruminant origin on the latter sampling occasion. No bacteria of human origin were found at either site on either sampling occasion.]

In the current survey period, water temperatures varied over a moderate range of 9.2˚C between early November and early April, with a maximum of 26.1˚C in mid-morning in late January 2018. Conductivity and turbidity results were indicative of clean, clear, relatively high water quality, but significant algal cover (mainly moderate to widespread mats) was noted through the majority of the period. There were two instances of partial seawater ingress during the period.

Bacteriological water quality was poor with numbers varying over very wide ranges with a high median *E. coli* value of 1,300 per 100 ml, particularly in comparison with numbers found at the upstream Merrilands Domain site (median: 124 per 100 ml). Individual sample *E.coli* counts exceeded 530 per 100 ml on all but one occasion, coincident with the presence of large gull populations. The marked river flow fluctuations due to increased morning HEP generation could be expected to exacerbate wildfowl (gull) faecal contamination by inundation of river shingle areas where birds roost during lower flow periods. No follow-up surveys were deemed necessary as the cause of elevated counts (in the 'Action' mode) had been well documented, and permanent public warning signage was in place.

4.3.1 Comparison with guidelines

E. coli counts from Waiwhakaiho River opposite Lake Rotomanu over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 14.

Table 14 Performance against guidelines at Waiwhakaiho River adjacent to Lake Rotomanu

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT **Single sample** **261-550/100ml**	**ACTION** **Single sample** **>550/100 ml**
SEM samples	3 [23%]	10 [77%]

Ten single samples were recorded within the 'Action' mode and three samples in the 'Alert' mode during the season. Bacteriological water quality measured at this site was seldom within the acceptable standard for contact recreational usage through the survey period and therefore appropriate warning signage was required at this site adjacent to the walkway throughout the survey period (Photo 5). Appropriately worded signage should be retained on a permanent basis in future.

Photo 5 Health risk signage, lower Waiwhakaiho River

4.3.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected for Waiwhakaiho River opposite Lake Rotomanu over 22 summers are presented in Figure 12. [Note: These data had been collected prior to the current year from time to time for consent monitoring purposes].

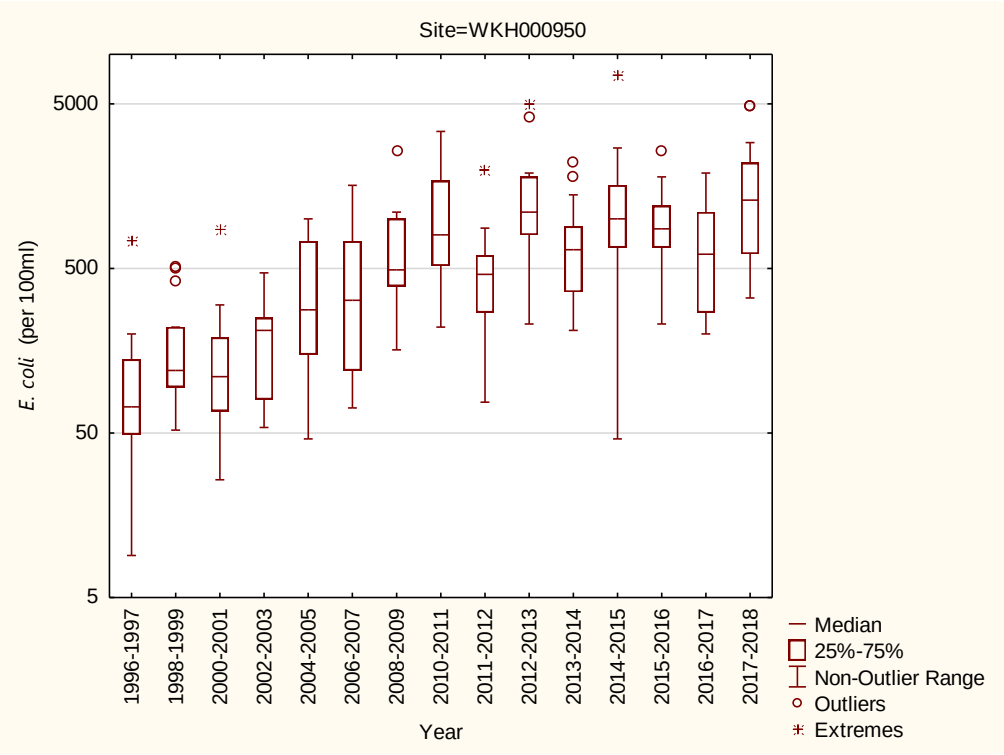
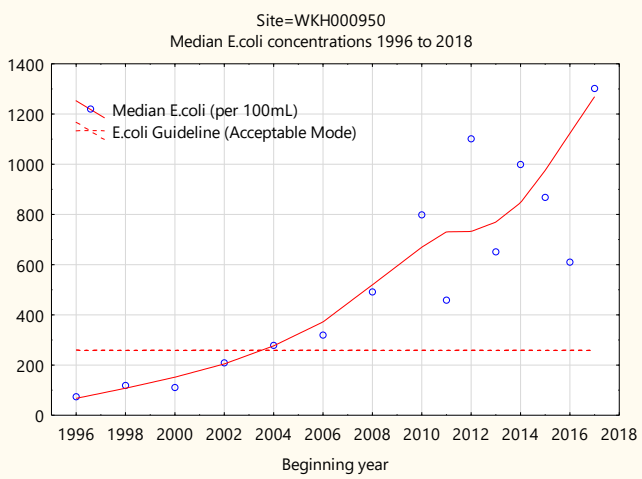


Figure 12 Box and whisker plots of *E. coli* for all summer SEM surveys in the Waiwhakaiho River adjacent to Lake Rotomanu

The median *E.coli* number in the 2017-2018 period was the highest recorded to date, maintaining a trend of high medians in more recent years (Figure 12). Most medians had been below the 'Action' level of the 2003 MfE guidelines, but since 2003-2004 all medians have been within, or exceeded the 'Alert' level, with the latest six medians in excess of the 'Action' guideline. The minimum *E. coli* number in 2017-2018 was the highest recorded, indicating a high baseline.

4.3.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the fifteen seasons of data by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 13). Testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discover Rate (FDR) analysis has been performed.



Waiwhakai River by Lake Rotomanu
N = 15
Kendall Tau = +0.7152
p-value = 0.0001
FDR p-value = 0.0015]

Figure 13 LOWESS trend plot of median E.coli data for the Waiwhakaiho River, adjacent to Lake Rotomanu

There has been a very significant trend ($p << 0.01$) of increasing median *E.coli* numbers over the fifteen seasons of monitoring, which is of importance given that five of these more recent seasonal medians have exceeded the 'Alert' mode and another seven are within the 'Action' mode.

4.3.4 Cyanobacteria

Benthic cyanobacteria were monitored on 13 occasions throughout the season. Results are presented in Table 15 and illustrated in Figure 14**.**

Table 15 Benthic cyanobacteria data for Waiwhakaiho River at last riffle below Lake Rotomanu

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	19	No	No	Alert
14/11/2017	8	No	Minor	Alert
06/12/2017	6	Minor	Minor	Surveillance
12/12/2017	4	No	No	Alert
20/12/2017	0	No	Minor	Alert
03/01/2018	2	Minor	No	Alert
11/01/2018	6	No	Minor	Alert
24/01/2018	8	No	No	Surveillance
07/02/2018	8	No	Minor	Alert
14/02/2018	7	No	No	Surveillance
26/02/2018	5	No	Yes	Alert
22/03/2018	4	No	Minor	Surveillance
27/03/2018	2	No	No	Surveillance

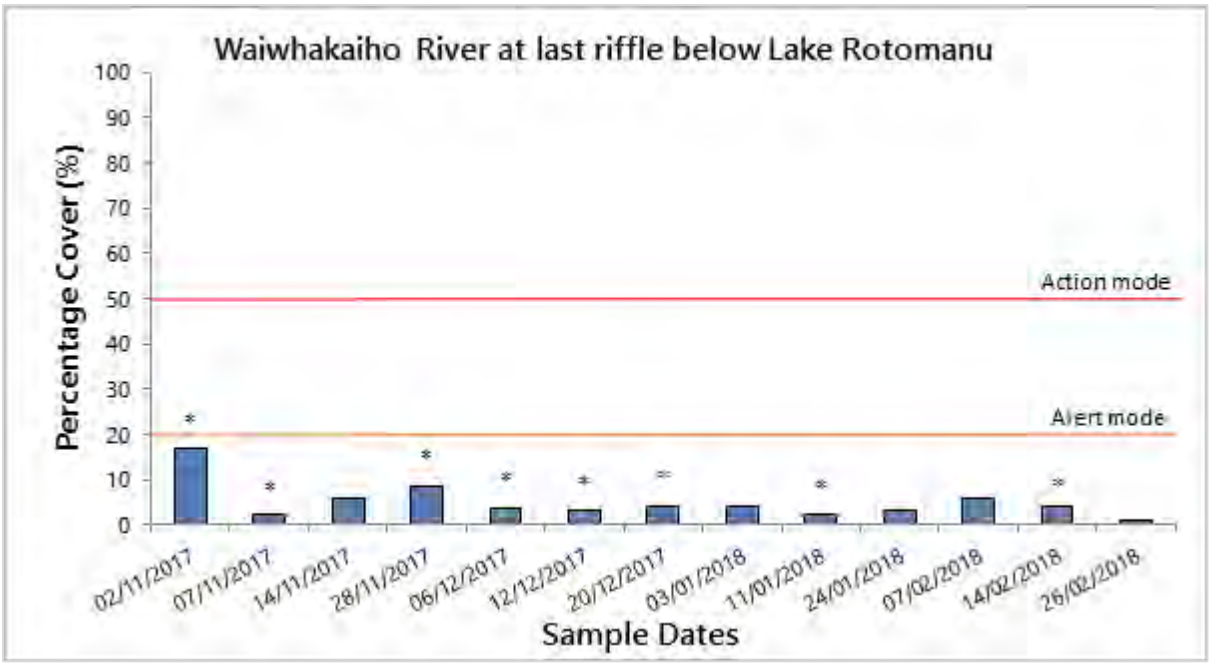


Figure 14 Percentage benthic cyanobacteria cover at Waiwhakaiho River at last riffle below Lake Rotomanu.

Note that 'Action' and 'Alert' mode lines are for percentage cover only. The symbols * and + over a bar indicate where the status been raised to 'Alert' or 'Action' mode, respectively due to detaching or exposed mats.

Benthic cyanobacteria coverage was generally low throughout the season with a median value of only 4%. There was one occasion where it exceeded 10% coverage (range from 0 to 17%). The 'Action' or 'Alert' level was never exceeded for percentage cover. The benthic cyanobacteria found were *Phormidium* sp. Detaching mats reached minor levels on two occasions which triggered the 'Alert' level. Minor levels of exposed mats were visible on six occasions which triggered the 'Alert' level. In total, the 'Alert' level was triggered on eight occasions.

4.4 Te Henui Stream at the mouth, East End

A total of 13 samples were collected at this site over the summer, all scheduled SEM samples.

Low usage of this site was recorded at the time of the sampling surveys, with no bathing noted. The adjacent playground was being used on one occasion, and one to five persons were on the banks or bridge on five occasions. Fishing off the bridge was noted on one occasion. This contrasted with walking, picnicking, or whitebaiting (in season) from the banks of the stream in many past seasons.

Ducks were common at this site on most survey occasions and gulls also were present, where they have been encouraged by people feeding the birdlife.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 15. The complete survey results are presented in Appendix I and summarised in Table 16.

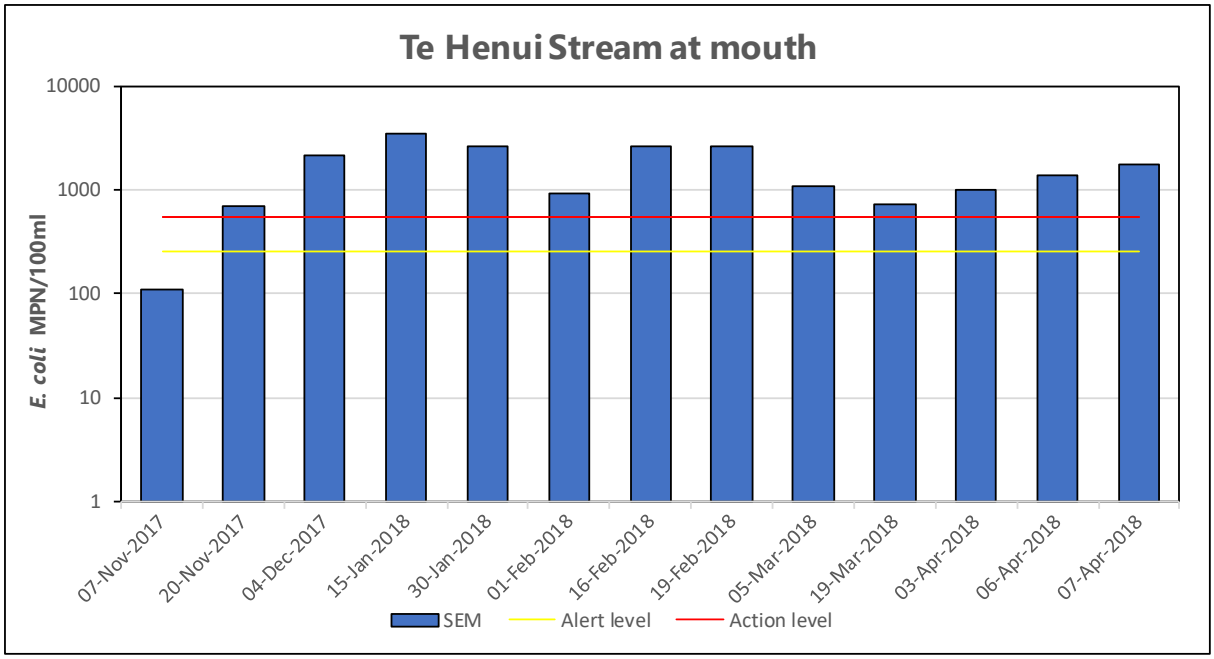


Figure 15 *E.coli* results for Te Henui Stream at mouth, East End

Table 16 Statistical summary for Te Henui Stream at mouth, East End

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	14.9	4570	714
	E. coli	MPN/100ml	13	108	3450	1400
	Temperature	°C	13	13.9	22.6	19.2
	Turbidity	NTU	13	0.51	30	0.86

The stream drains an extensively developed farmland catchment prior to flowing through urban New Plymouth upstream of this popular recreational area sited in the lower reaches of the stream at the coast adjacent to the walkway. Poor historical bacteriological quality, considered to be attributable mainly to wildfowl, resulted in two low tide and two high tide surveys' samples in the 2011-2012 season being forwarded to Cawthron Institute, Nelson for faecal source DNA tracking marker analyses. The initial low tide sample (which followed wet weather) contained bacteria of ruminant, gulls, and human origins while the second low tide, fine weather sample's bacteria were of ruminant, wildfowl, and human origins. The high tide, fine weather samples both contained bacteria with slight traces of ruminant origin, while only the second sample's bacteria were of wildfowl, and human origins. While wildfowl, gull, and ruminant derived bacteria might have been expected in the lower reaches of this stream, the presence of bacteria from human origin warranted further investigation (which was discussed and initiated with the Taranaki Area Health Board and New Plymouth District Council). No further incidents of human markers were found at this site near the mouth of the stream nor at several sites upstream and into the rural reaches.

In the current season water temperatures varied over a moderate range of 8.7˚C between early November and early April, with a high maximum of 22.6˚C in mid-morning in late January 2018. Conductivity and turbidity results were indicative of clean, clear, relatively high water quality, subject to tidal incursions of seawater from time to time. The water often appeared green, as a result of extensive algal cover.

Bacterial water quality in the 2017-2018 season was very poor with a wide range of counts and very high median *E. coli* count of 1,400 per 100 ml and an unusually low minimum count.

4.4.1 Comparison with guidelines

E. coli counts from Te Henui Stream at the mouth over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 17.

Table 17 Performance against guidelines at Te Henui Stream at mouth, East End

Parameter	Number of exceedances of E. coli guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	0 [0%]	12 [92%]

Only one single sample was recorded below the 'Action' mode during the season, which was at 'Surveillance' level. Bacteriological water quality measured at this site therefore was outside the acceptable standard for contact recreational usage on 92% of monitoring occasions. No additional sampling surveys were required as the source of these elevated counts was well established and documented. Appropriate signage therefore was required at this site adjacent to the New Plymouth walkway throughout the survey period and was the subject of periodic public enquiries. The coastal bathing waters monitored nearby at East End beach met the enterococci guidelines on all occasions during the season (that is, no occurrences within the 'Action' level).

4.4.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected for Te Henui Stream at the mouth over 16 summers are presented in Figure 16.

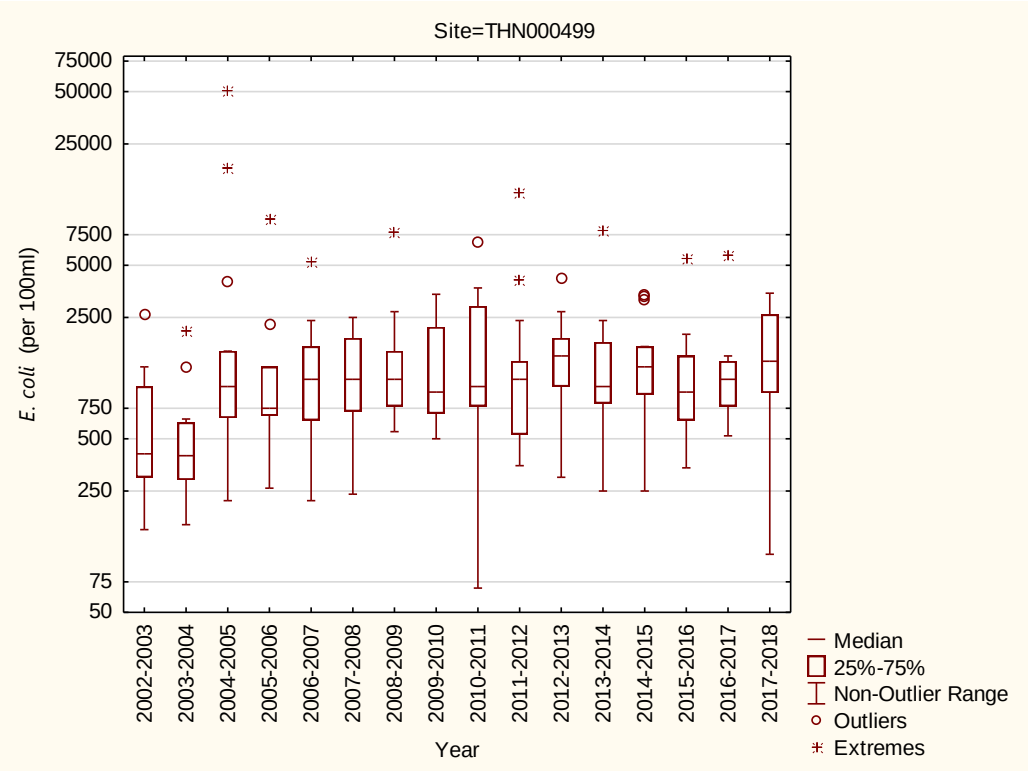


Figure 16 Box and whisker plots of *E. coli* for all summer SEM surveys of Te Henui Stream at mouth, East End

The median *E. coli* number in the 2017-2018 period was the second highest of the medians recorded over the last 15 seasons (Figure 16), and well above the 'Alert' level of the 2003 MfE guidelines. All but the first two of the 16 median numbers to date have also been in the 'Action' level. A wide range of numbers has also been typical for this site.

4.4.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the sixteen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 17) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

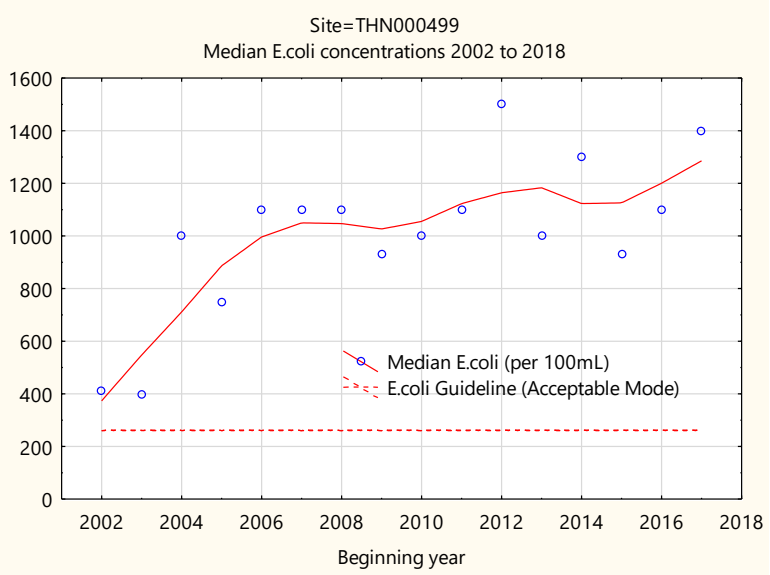


Figure 17 LOWESS trend analysis of median *E.coli* data at Te Henui Stream mouth, East End

A temporal trend of increasing median *E. coli* numbers has been found over the sixteen seasons of monitoring. (Note: This trend was statistically significant at $p < 0.05$ but not after FDR analysis, the p level being 0.013, increasing to 0.102 after FDR correction). Only two of these seasonal medians were within the 'Alert' mode with all others exceeding the 'Action' mode.

4.4.4 Cyanobacteria

Benthic cyanobacteria were monitored on ten occasions during the season. Results are presented in Table 18 and Figure 18.

Table 18 Benthic cyanobacteria data for Te Henui Stream near the mouth, East End

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	1	No	No	Surveillance
14/11/2017	1	No	No	Surveillance
06/12/2017	0	No	No	Surveillance
20/12/2017	0	No	No	Surveillance
11/01/2018	0	No	No	Surveillance
24/01/2018	0	No	No	Surveillance
07/02/2018	0	No	No	Surveillance

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
26/02/2018	0	No	No	Surveillance
08/03/2018	0	No	No	Surveillance
22/03/2018	0	No	No	Surveillance

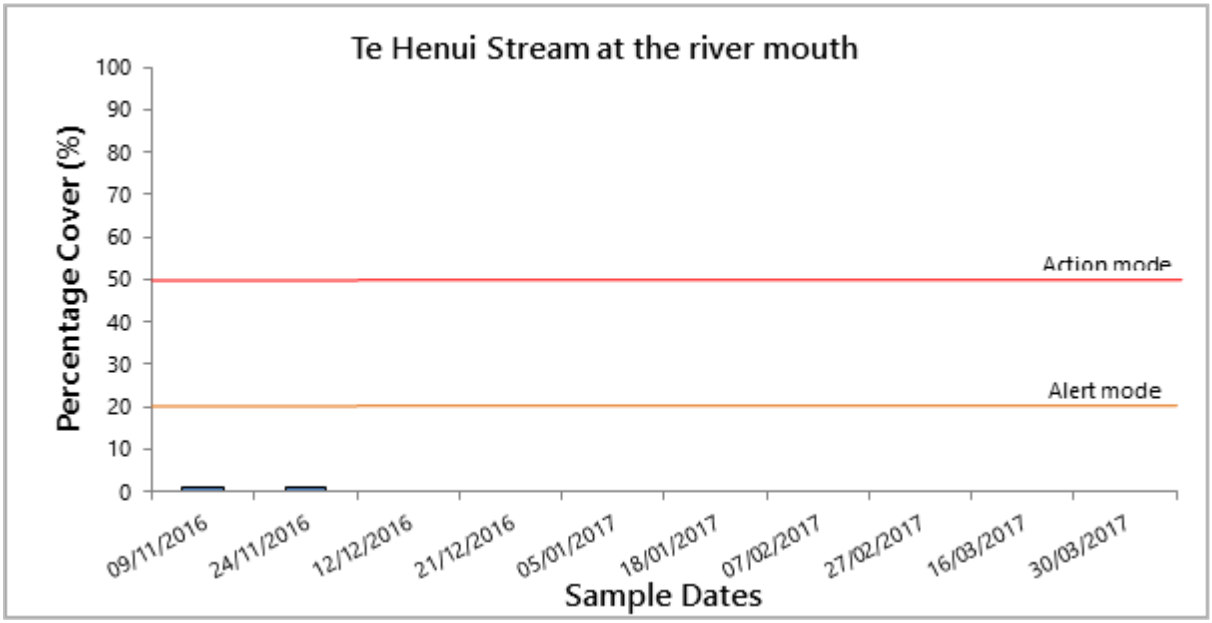


Figure 18 Percentage benthic cyanobacteria cover at Te Henui Stream at the mouth

Note that 'Action' and 'Alert' mode lines are for percentage cover only. * and + symbols over a bar indicate where the status has been risen to 'Alert' or 'Action' mode respectively due to detaching or exposed mats

Benthic cyanobacteria coverage was low throughout the season (ranging from 0 to 1%). The benthic cyanobacteria found were *Phormidium* sp. The 'Action' or 'Alert' level was never exceeded for percentage cover or for the presence of detaching or exposed mats and therefore no action at the site was required.

4.5 Patea River at King Edward Park, Stratford

A total of 19 samples were collected at this site over the summer as part of the monitoring programme. All 13 scheduled SEM samples were collected, as well as six follow up samples. Additional samples were taken, at the site and other locations in the catchment, as part of actions to investigate high *E. coli* levels.

Recreational usage of this river site was recorded at the time of eight of the sampling surveys (swimming in December 2017 and January 2018, and walking or resting on the banks throughout the summer, sometimes with dogs).

A few (2-15) ducks were observed on the water on five monitoring occasions over the monitoring period.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Table 19. The complete survey results are presented in Appendix I and summarised in Figure 19. River flow records are presented in Figure 20.

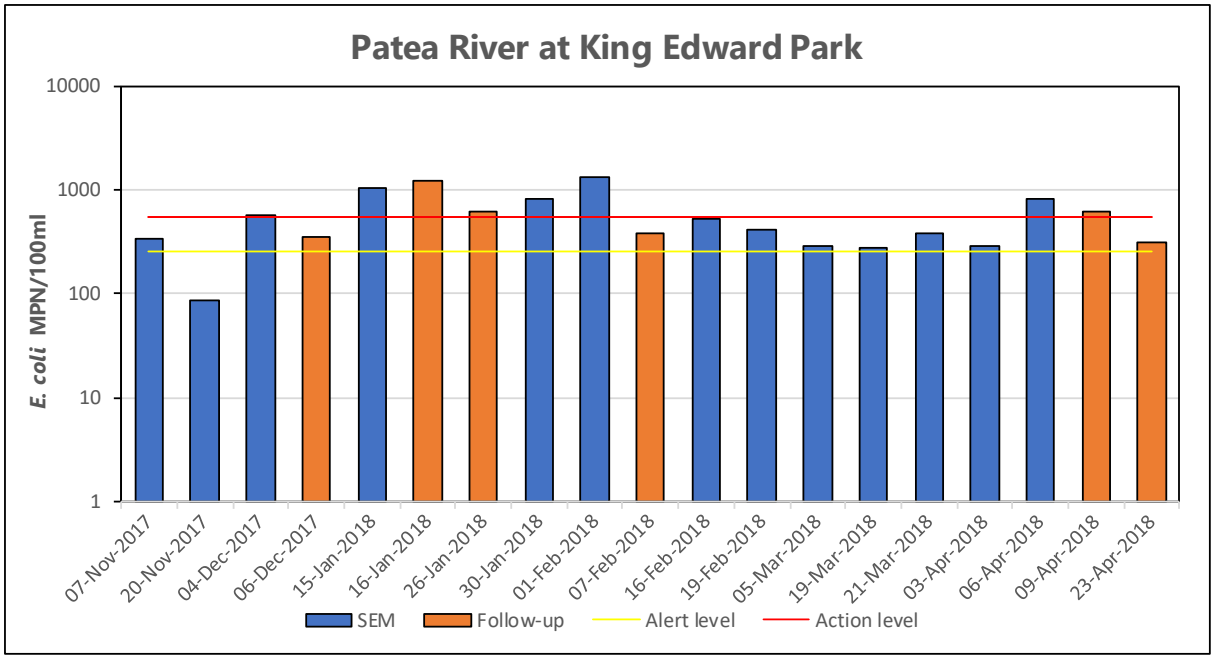


Figure 19 *E. coli* results for Patea River at King Edward Park, Stratford

Table 19 Statistical for Patea River at King Edward Park, Stratford

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	8.4	10.3	9.5
	E. coli	MPN/100ml	13	86.0	1300	411
	Temperature	°C	13	12.3	20.6	15.6
	Turbidity	NTU	13	0.49	1.5	0.72

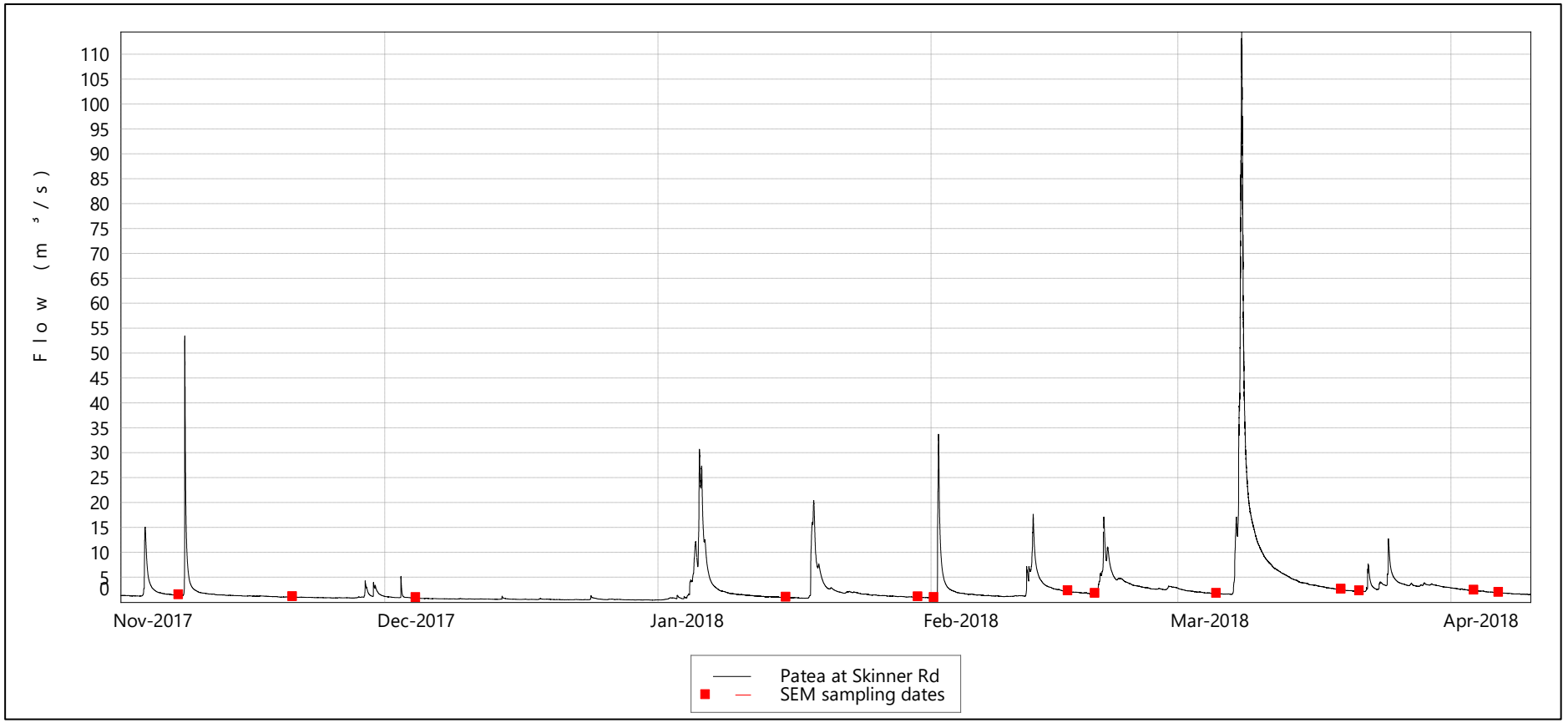


Figure 20 Flow in the Patea River at Skinner Rd during the survey period

This ring plain river drains a developed agricultural catchment. The survey site is situated within King Edward Park in Stratford township, approximately 11 km downstream of the National Park boundary, with several consented dairy ponds' treated wastes discharges in the catchment upstream of the site. River water was generally relatively clear (turbidity of ≤ 0.8 NTU on all occasions) and uncoloured or green or green-brown in appearance with a relatively low and narrow range of conductivity levels.

Water temperatures had a moderate range of 8.3°C for this site (at an elevation of 300 m asl), with a maximum of 20.6°C recorded in late January 2018 (at 1220 hrs).

Bacteriological water quality was poor for the mid reaches of this Taranaki ring plain river draining a predominantly agricultural catchment. Twelve of the thirteen surveys recorded *E. coli* counts above 'Alert' level under the Guidelines, five of them above 'Action' level.

Action was taken, by Stratford District Council (SDC) through the erection of health warning signs at local swimming areas, and by Taranaki Regional Council (TRC) through investigation of the source(s) of contamination. Additional samples were taken at the Park; several surveys of water quality in the catchment within and above Stratford were conducted; and inspections of farm dairy waste disposal systems upstream were undertaken. The water quality analysis included DNA testing of samples taken under both dry and wet weather conditions.

No human waste contamination was found. A small avian influence was apparent in dry weather conditions. The greatest source of faecal bacteria was of ruminant origin, most likely bovine given the predominance of dairy farming. The ruminant markers appeared to be aged, consistent with farm pond discharges. Significant *E. coli* loadings came from the Konini (Paetahi) and Mangarangi sub-catchments, both of which receive farm dairy pond discharges.

All farm waste disposal systems upstream had been inspected in September 2017: there was generally good compliance with resource consent conditions. Unscheduled re-inspections undertaken in February 2018 found no unauthorised discharge.

To address the potential effects of farm dairy wastes on surface water quality, TRC has sent out strong signals that discharge to land is the preferred disposal option throughout the region, and this will be pursued as a rule within the next regional water plan (in preparation). For the last four years, all consents issued to provide for farm dairy wastes only allow continued discharge to surface water for a short transition period, typically two years, while land disposal is instituted, or when conditions for land disposal (and recreational use of streams) are unsuitable.

Photo 6 Warning signage at King Edward Park site, 6 December 2017

The last results from monitoring at King Edward Park, on 23 April 2018, showed the water quality suitable for recreational use, and SDC removed the health risk warning signs, which often were ignored by the public (Photo 6).

4.5.1 Comparison with guidelines

E. coli counts for Patea River at King Edward Park, Stratford over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 20.

Table 20 Performance against guidelines at Patea River at King Edward Park, Stratford

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	7 [54%]	5 [38%]

Five single samples fell within the 'Action' mode, and another seven samples fell in the 'Alert' mode. These counts occurred between early December 2017 and early April 2018, in mid- morning to early afternoon. In terms of the guidelines for contact recreational usage, bacteriological water quality at this site was outside the acceptable level frequently during the period, with five incursions into the 'Action' level.

4.5.2 Comparison with previous summer surveys

Summary statistics for the SEM *E.coli* data collected at King Edward Park, Stratford over 17 summers are presented in Figure 21.

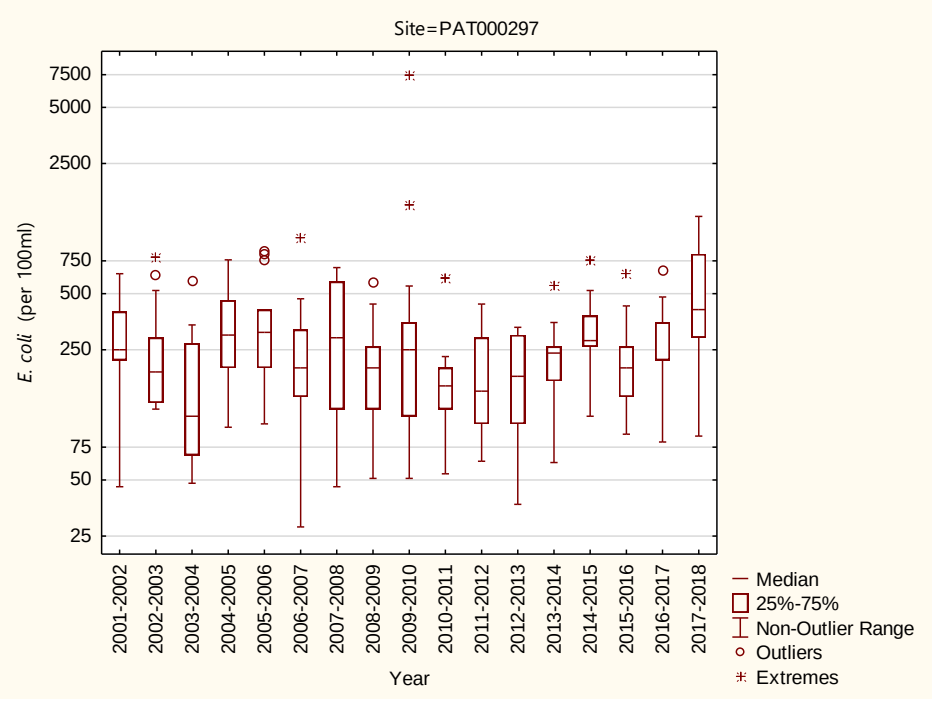


Figure 21 Box & whisker plots of *E. coli* for all summer surveys of Patea River at King Edward Park, Stratford

The median *E.* coli number in the 2017-2018 period was the highest recorded to date and 100 MPN/100 ml above the maximum of the range of historical medians recorded for this site. The range of counts was relatively wide, and the lower 25 percentile value was relatively high.

4.5.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the seventeen seasons of data by first applying LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 22) and testing

the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

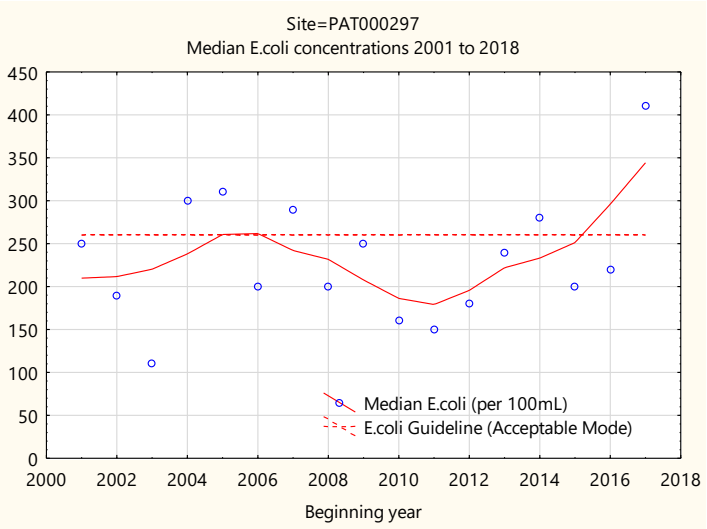


Figure 22 LOWESS trend plot of median E.coli data at the Patea River, King Edward Park, Stratford

A statistically insignificant temporal trend of increasing median *E.coli* numbers has been found over the seventeen monitoring seasons. Five of these seasonal medians exceeded the 'Alert' mode but none has exceeded the 'Action' mode.

4.5.4 Cyanobacteria

Benthic cyanobacteria were monitored on nine occasions during the season. Results are presented in Table 21 and Figure 23.

Table 21 Benthic cyanobacteria data for the Patea River, Edward Park site

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	1	No	No	Surveillance
14/11/2017	1	No	No	Surveillance
06/12/2017	0	No	No	Surveillance
20/12/2017	0	No	No	Surveillance
11/01/2018	0	No	No	Surveillance
24/01/2018	0	No	No	Surveillance
07/02/2018	0	No	No	Surveillance
26/02/2018	0	No	No	Surveillance
22/03/2018	0	No	No	Surveillance

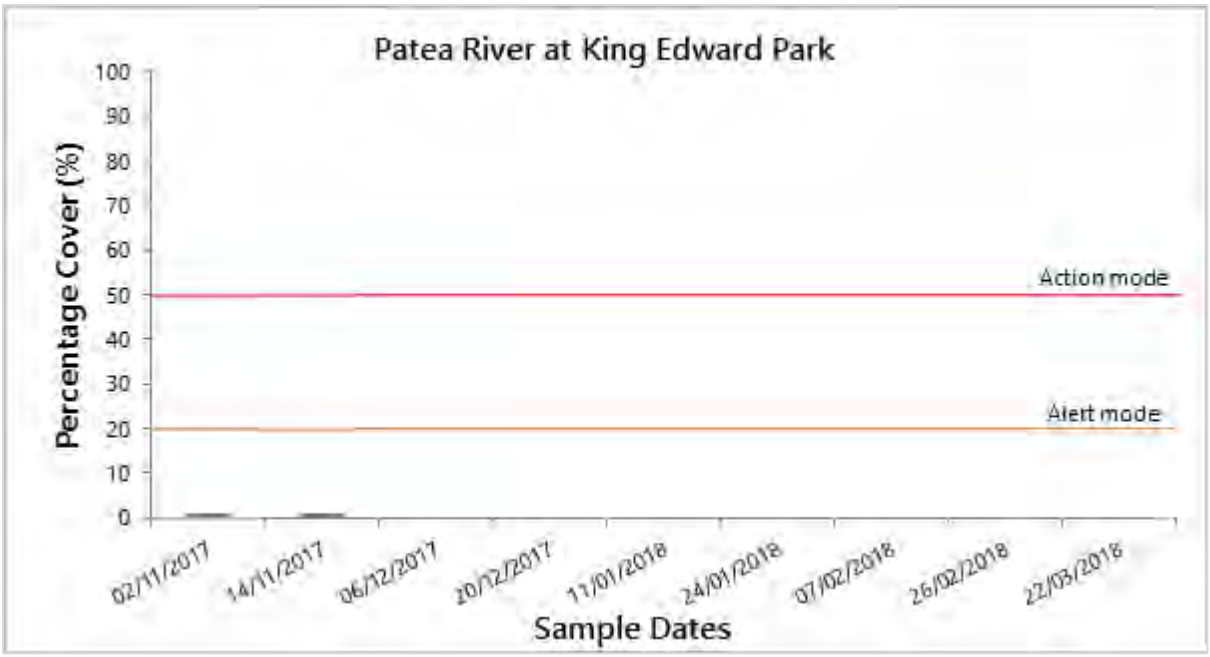


Figure 23 Percentage benthic cyanobacteria cover at the Patea River, Edward Park site.

Note that 'Action' and 'Alert' mode lines are for percentage cover only. * and + symbols over a bar indicate where the status has been risen to 'Alert' or 'Action' mode respectively due to detaching or exposed mats

Benthic cyanobacteria coverage was very low throughout the season (range from 0 to 1%). The benthic cyanobacteria found were *Phormidium* sp. The 'Action' or 'Alert' level was never exceeded for percentage cover or for the presence of exposed or detaching mats and therefore no action at the site was required.

4.6 Patea River at the boat ramp, Patea

A total of 13 samples were collected at this site over the summer, all scheduled SEM samples.

No bathing usage of this river site was recorded oat the time of sampling surveys, all of which were before or at midday. Boating and fishing were noted from time to time at this site with boating as the main activity as this is a popular launching site for fishermen, judging by the number of boat trailers often in the parking area.

During the 2011-2012 period Taranaki Regional Council undertook microbial source tracking (MST) using DNA marker techniques at this site and an upstream site at SH3 bridge on two occasions (high and low tides). Faecal coliform bacteria were found to have been sourced predominantly from cattle on both occasions at the two sites while gulls contributed to populations at the boat ramp site under both tidal conditions and a faint trace of human source derivation was found (downstream of the Patea WWTP treated discharge) at the boat ramp site, but only under low tidal flow conditions.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 24. The complete survey results are presented in Appendix I and summarised in Table 22.

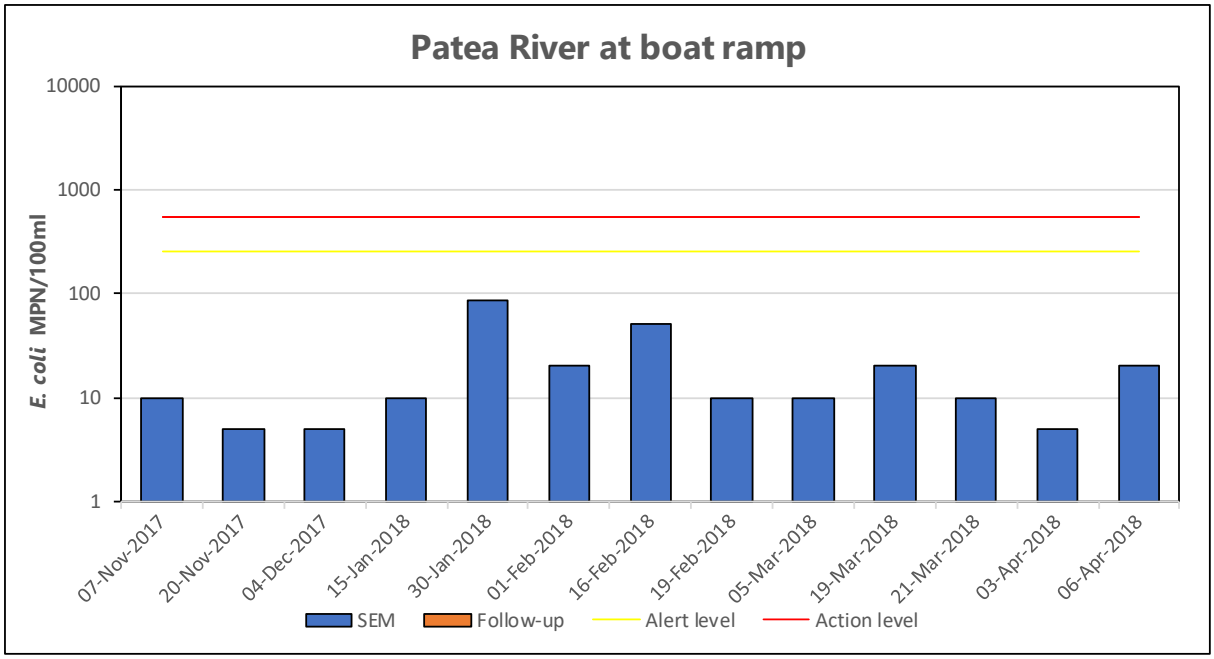


Figure 24 *E.coli* results for Patea River at boat ramp, Patea

Table 22 Statistical summary for Patea River at boat ramp, Patea

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	1510	4850	4750
	E. coli	MPN/100ml	13	<10	86.0	10
	Enterococci	cfu/100ml	13	<1	72	15
	Temperature	°C	13	15.7	23.5	19.6
	Turbidity	NTU	13	5.8	41	15

This ring plain river drains an extensively developed agricultural catchment. The survey site is situated some 45km downstream of the Patea HEP dam and 300 metres upstream of the river mouth. Flows in the lower river are regulated by operational requirements of the HEP station and associated consent conditions. There are consented dairy ponds' treated wastes discharges in the catchment upstream of the site and the consented upgraded Patea Wastewater Treatment Plant discharges upstream of the boat ramp (by about 0.7 km).

River water was usually turbid and milky pale green in appearance. High conductivity levels typical of seawater ingress at high tide occurred on most occasions, with lower conductivity levels at high river flows. Water temperatures had a moderate range of 7.8˚C, affected by the coastal seawater influence, with a high maximum of 23.3˚C recorded at midday in early February 2018 during a king tide.

Bacteriological water quality was good for the lower reaches of this Taranaki ring plain river (median: 10 *E.coli* per 100 ml and 15 enterococci per 100 ml) draining a predominantly agricultural catchment. This was due to the coastal seawater influence under high tide conditions and, to a lesser extent, the high bacteriological quality of the upstream lake waters released from the hydro dam. The existing recreational sampling programme was performed around higher tidal conditions for SEM trend purposes (due to its incorporation within the coastal sites programme) at times when aspects of public usage are likely to be more predominant at this site. Poorer bacteriological water quality could be expected under outflowing low tide conditions as emphasised by a consent monitoring programme undertaken at low tide at this site over the same recreational period (under similar sampling protocols) when a median *E. coli* bacterial number of

115 per 100 ml (with counts ranging from 30 to 435 per 100 ml) was found with numbers tending to be higher when seawater intrusion was less apparent.

4.6.1 Comparison with guidelines

E. coli counts for Patea River at the boat ramp, Patea over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 23.

Table 23 Performance against guidelines at Patea River at boat ramp, Patea

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT **Single sample** **261-550/100ml**	**ACTION** **Single sample** **>550/100 ml**
SEM samples	0 [0%]	0 [0%]

No single sample fell within the 'Alert' or 'Action' modes at any time during the monitoring period.

The bacteriological water quality at this site was within the acceptable guideline for contact recreational usage throughout the season recognising that all sampling occasions coincided with high tides and therefore a predominance of higher quality saline water mixing with poorer quality river water at this estuarine site. This was comparable with data for the nearby 'Mana' Bay coastal site adjacent to the river mouth monitored in the current season [median enterococci: 12 per 100 ml; range enterococci: <1-24 per 100 ml] for consent and SEM purposes.

4.6.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected for Patea River at Patea boat ramp over 11 summers are presented in Figure 7.

Ten previous SEM sampling seasons have been surveyed at this site. Otherwise prior sampling has been confined to consent monitoring surveys (TRC 2014a). A statistical comparison of all summers' survey data is presented graphically in Appendix VI for all sites. A much shorter data period exists for this Patea River site (at Patea boat ramp) which was added in 2007-2008. These data are illustrated in Figure 25.

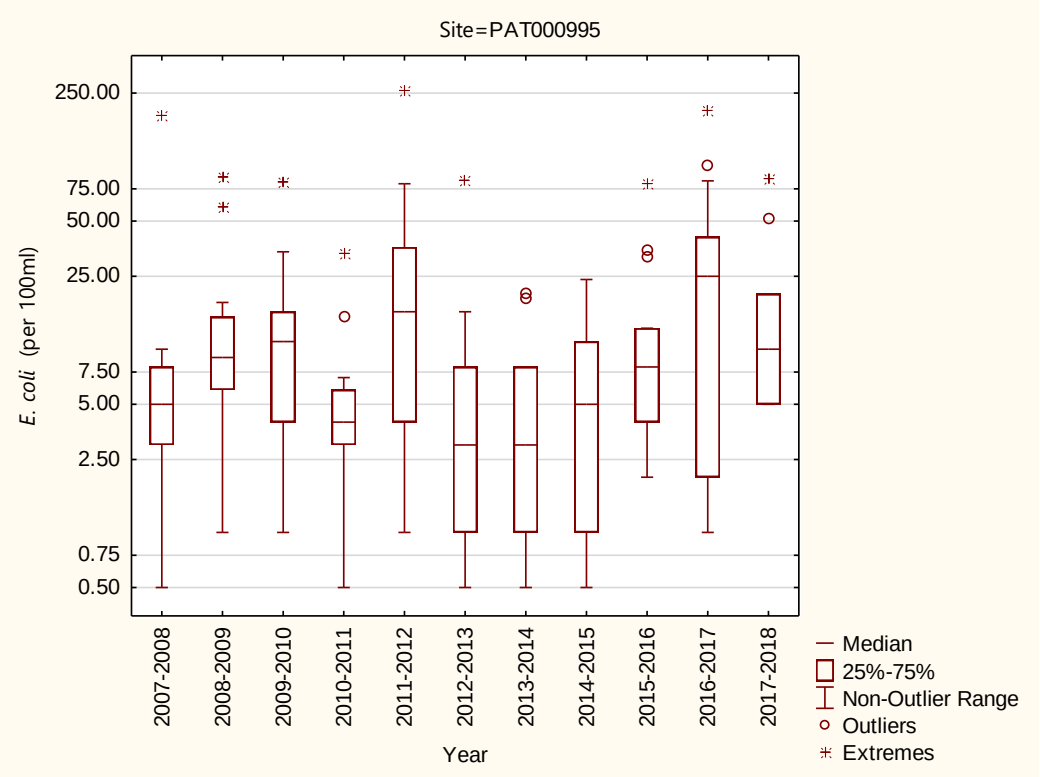


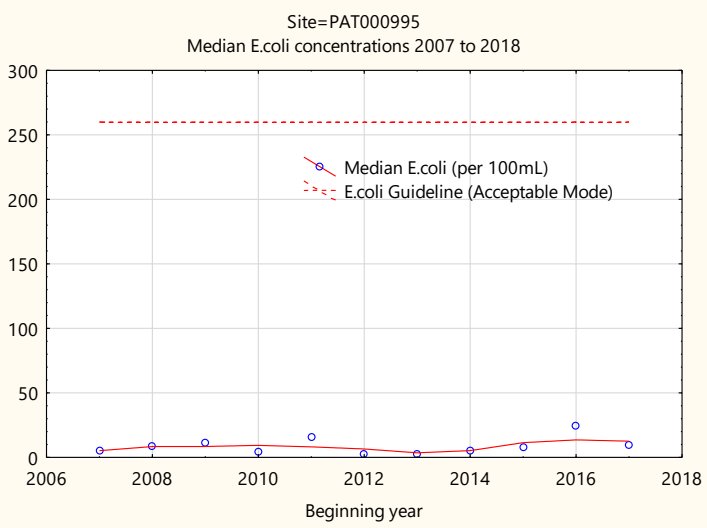
Figure 25 Box & whisker plots of *E. coli* for all summer SEM surveys of Patea River at boat ramp, Patea

Relatively similar (very low) median *E. coli* numbers have been found by these eleven seasons' surveys with a moderate range of counts with all the maximum values found to date having remained below the 'Alert' level. The recent season's range of counts was typical of the ranges found in the previous seasons. (Note that the higher detection limit of the Colilert test method in saline water, of 10 MPN/100 ml, in comparison to that of the previously used membrane filtration method, of 1 cfu/100 ml, affected the 25% quartile and lower values).

In terms of the guidelines for contact recreational usage, bacteriological water quality at this site was in compliance with the acceptable level for all of the period.

4.6.2.1 Long-term trend analysis

Trend analysis of these median *E. coli* numbers has been performed for the eleven seasons of data by first applying LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 26) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamin-Hochberg False Discovery Rate (FDR) analysis.



Patea River at boat ramp, Patea
N = 11
Kendall tau = 0.167
p-value = 0.475
FDR p-value = 0.673

Figure 26 LOWESS trend plot of median *E. coli* data for Patea River at boat ramp, Patea

A slight, unimportant, and statistically insignificant increase in median *E. coli* numbers has been found over the eleven seasons of monitoring. None of these medians has exceeded the 'Alert' or 'Action' modes.

4.7 Waingongoro River at Eltham Camp

A total of 16 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as three follow up samples.

Bathing usage of this river site was recorded once at the time of sampling surveys, and camp activities may have included other recreational usage as the camp was occupied on several occasions. The site is used as part of the camp's activities.

Sheep were present in the paddock adjacent to this unfenced site on six of the thirteen monitoring occasions, but no birdlife was recorded.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 27. The complete survey results are presented in Appendix I and summarised in Table 24. Flow records are illustrated in Figure 28.

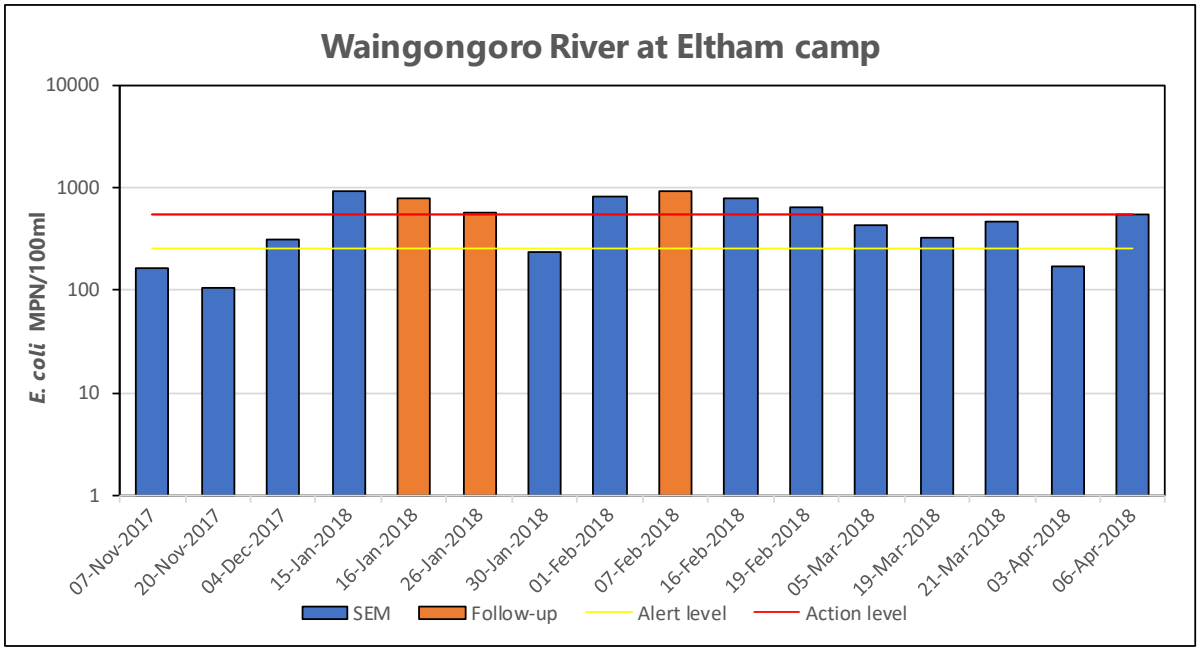


Figure 27 *E. coli* results for Waingongoro River at Eltham Camp

Table 24 Statistical summary for Waingongoro River at Eltham Camp

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	10.2	12.7	11.4
	E. coli	MPN/100ml	13	105	921	435
	Temperature	°C	13	14.1	23.7	17
	Turbidity	NTU	13	0.62	1.9	1

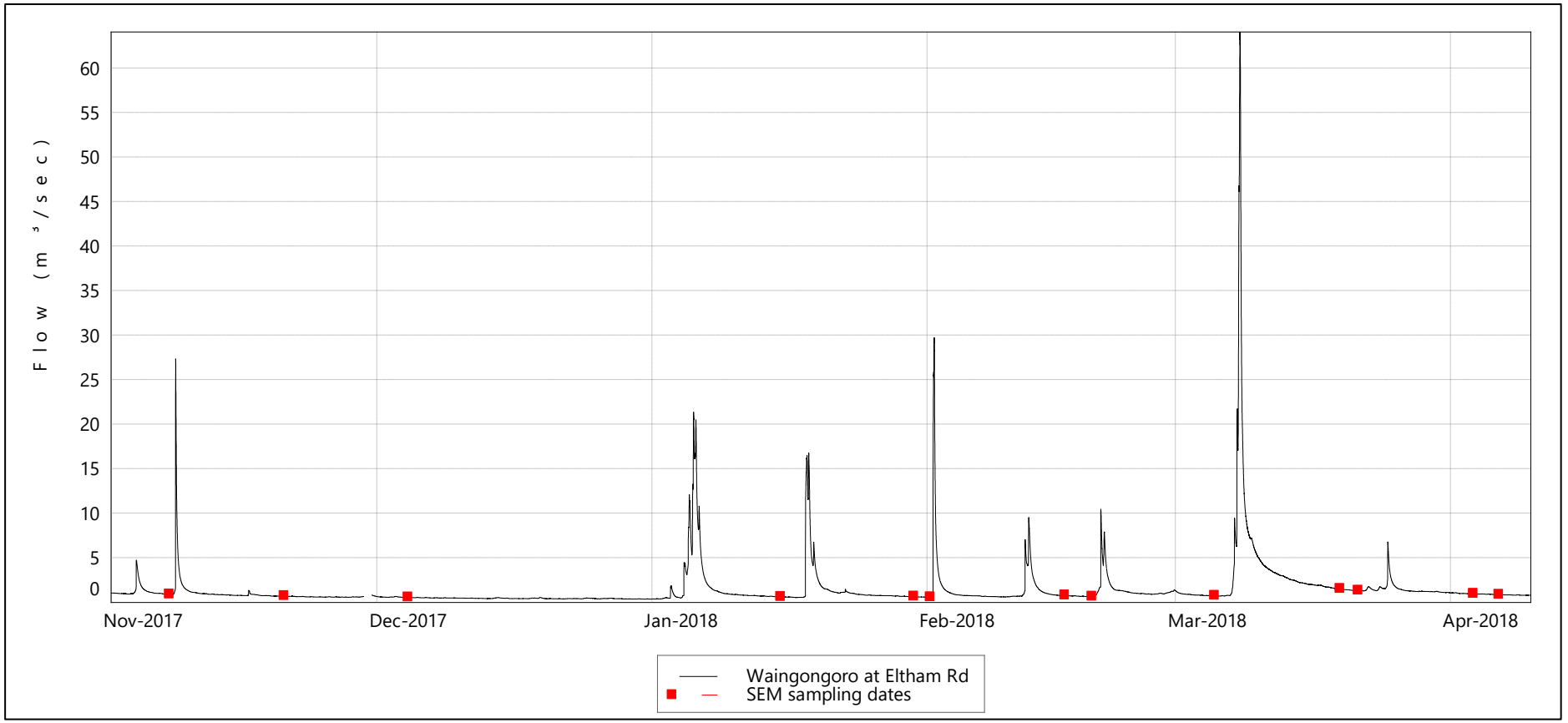


Figure 28 Flow in Waingongoro River at Eltham during the survey period

This ring plain river drains an extensively developed agricultural catchment, with the survey site situated in Eltham some 21 km below the National Park boundary. River water was generally relatively clear to slightly turbid (occasionally) in appearance with moderate conductivity levels. Water temperatures were within a relatively wide range (9.6 ˚C) with a record high maximum of 23.6 ˚C in late January 2018.

Bacteriological water quality was lower (median *E.*coli: 435 per 100 ml) than is typical of the mid reaches of a Taranaki ring plain river draining a predominantly agricultural catchment. This was also apparent in comparison with the nearby Eltham Road (state of the environment physicochemical monitoring) site where a median *E.coli* count of 175 per 100 ml (range: 6 to 59000 per 100 ml) has been recorded by monthly sampling since 1995.

4.7.1 Comparison with guidelines

E. coli counts for the Waingongoro River at Eltham Presbyterian camp over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 25.

Table 25 Performance against guidelines at the Waingongoro River, Eltham Camp site

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT **Single sample** **261-550/100ml**	**ACTION** **Single sample** **>550/100 ml**
SEM samples	5 [38%]	4 [31%]

Four single samples fell within the 'Action' mode, and another five samples in 'Alert' mode. The Action levels were all recorded between mid-January and mid-February 2018. A health warning sign was erected by STDC. Follow-up sampling was undertaken immediately after the first action level, but was hindered by rainfall after the second action level from routine monitoring. Further investigations indicated the possible influence of licensed dairy pond discharges via a tributary that joins about 900 m upstream. On 6 March 2018, after a week of fine weather, three samples were taken, at 0810, 1050 and 1400 NZST, which returned *E. coli* numbers of 770, 488 and 517 MPN/100 ml, respectively. One sample (the first) was subjected to DNA analysis, which did not show human contamination, but a small avian influence, and some ruminant material at a level consistent with aged farm dairy pond effluent.

4.7.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Waingongoro River at Eltham camp over 17 summers is presented in Figure 29.

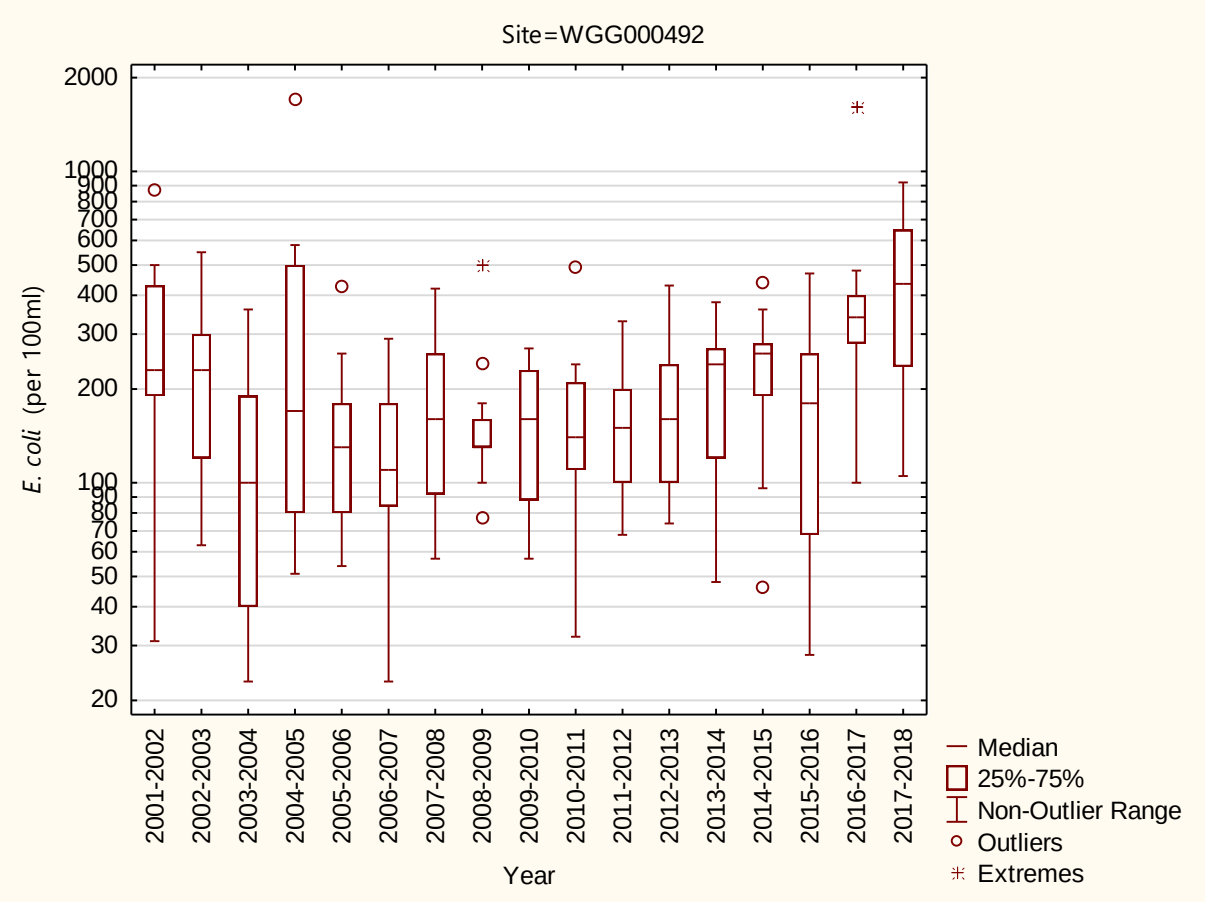
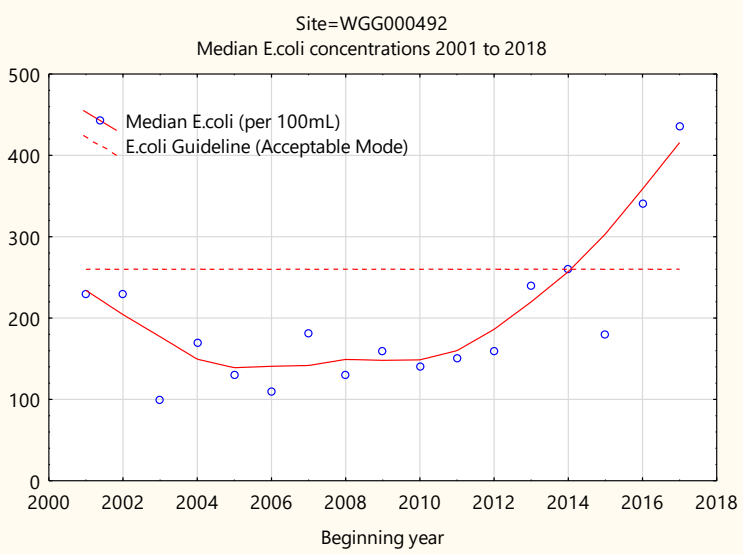


Figure 29 Box and whisker plots of *E. coli* for all summer surveys in Waingongoro River at Eltham Camp

A deterioration in *E.coli* bacterial water quality in the 2017-2018 season was indicated by a median count which was the highest recorded over the seventeen years of monitoring (Figure 29).

4.7.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the seventeen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 30) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



Waingongoro River at Eltham camp
N = 17
Kendall tau = 0.394
p-value = 0.027
FDR p-value = 0.145

Figure 30 LOWESS trend plot of median *E.coli* data for Waingongoro River at Eltham camp

A temporal trend of increasing median *E. coli* numbers has been found over the seventeen seasons of monitoring. (Note: This trend was statistically significant at $p < 0.05$ but not after FDR analysis, the p level being 0.027, increasing to 0.145 after FDR correction). None of these seasonal medians exceeded the 'Action' mode, although the 'Alert' mode was exceeded in the most recent season, for the second, consecutive time over the monitoring period.

4.7.4 Cyanobacteria

Benthic cyanobacteria were monitored on nine occasions throughout the season. Results are presented in Table 26 and Figure 31.

Table 26 Percentage benthic cyanobacteria cover, detached and exposed mats at the Waingongoro River at Eltham Presbyterian Camp

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	0	No	No	Surveillance
14/11/2017	0	No	No	Surveillance
06/12/2017	0	No	No	Surveillance
20/12/2017	0	No	No	Surveillance
11/01/2018	0	No	No	Surveillance
24/01/2018	2	No	No	Surveillance
07/02/2018	0	No	No	Surveillance
26/02/2018	1	No	No	Surveillance
22/03/2018	0	No	No	Surveillance

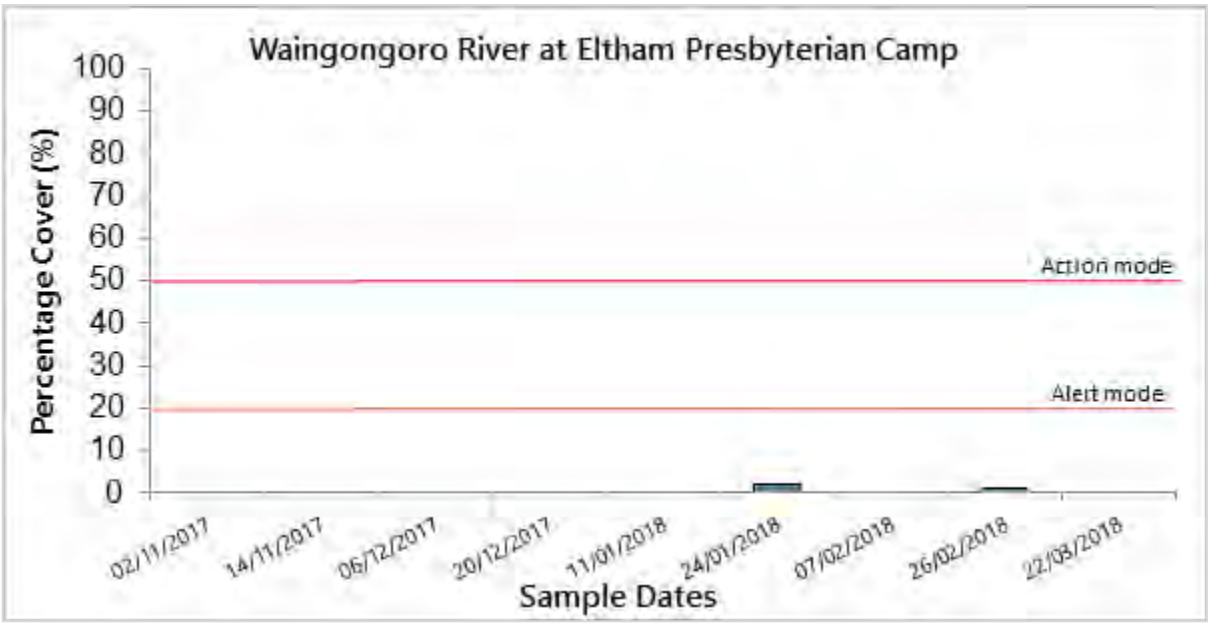


Figure 31 Percentage benthic cyanobacteria data for the Waingongoro River at Eltham Presbyterian Camp.

Note: 'Action' and 'Alert' mode lines are for percentage cover only. * and + symbols over a bar indicate where the status has been risen to 'Alert' or 'Action' mode respectively due to detaching or exposed mats

Benthic cyanobacteria coverage was low throughout the season (ranging from 0 to 2%). The benthic cyanobacteria found were *Phormidium* sp. The 'Action' or 'Alert' level was never exceeded for percentage cover or for the presence of exposed or detaching mats and therefore no action at the site was required.

4.8 Waingongoro River at Ohawe Beach

A total of 25 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as 11 MfE samples and one follow up sample. Rainfall immediately preceded sampling on two occasions.

Bathing usage of this site was recorded on four of the sampling occasions. Whitebaiting was recorded (in season), and fishing (once). Occasionally, livestock have been present in the paddock upstream of the site but during the 2017-2018 season none were noted at the river's edge or in the river as had been the case on occasions in the past (TRC, 2010). A few ducks were also noted on occasions.

In the 2012-2013 season, samples from two separate fine weather, low tide, very low flow conditions (mid to late summer) surveys at sites upstream of the township and near mouth were forwarded to Cawthron Institute, Nelson for faecal source DNA tracking marker analyses. Both surveys found low *E.coli* counts (ranging from 51 to 92 cfu/100 ml upstream and 43 to 60 cfu/100 ml downstream of the township) which comprised bacteria of only ruminant and wildfowl origins, typical for the lower reaches of ringplain streams and not indicative of septic tank waste disposal issues.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 32 and summarised in Table 27. The complete survey results are presented in Appendix I. River flow records are illustrated in Figure 33.

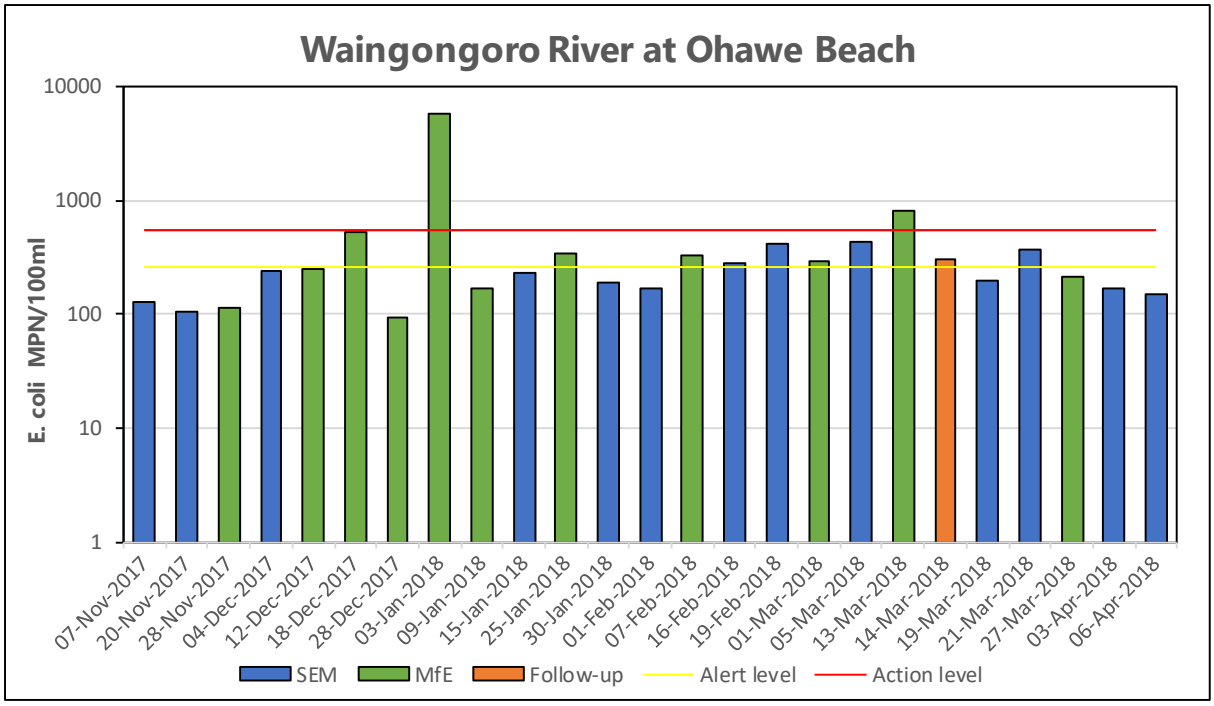


Figure 32 *E.coli* results for Waingongoro River at Ohawe Beach

Table 27 Statistical summary for Waingongoro River at Ohawe Beach

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	16.0	2300	17.5
	E. coli	MPN/100ml	13	105	435	201
	Temperature	°C	13	16.5	25.3	20.2
	Turbidity	NTU	13	1.0	7.6	1.8
SEM + MfE samples	Conductivity	mS/m@20°C	24	14.5	2300	17.5
	E. coli	MPN/100ml	24	93	5790	232
	Temperature	°C	24	15.8	25.3	20.6
	Turbidity	NTU	24	0.72	7.6	1.75

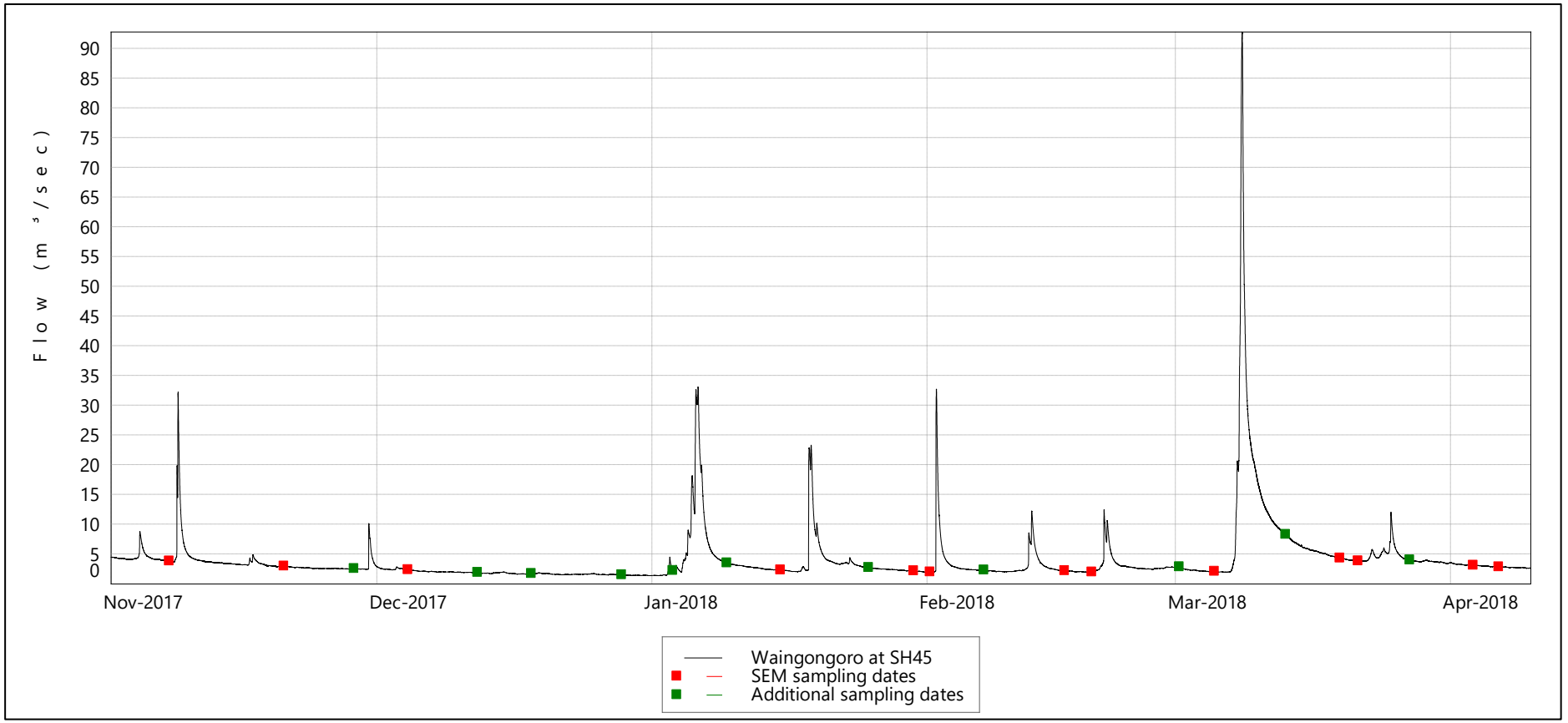


Figure 33 Flow in Waingongoro River at SH45 during the survey period

This river drains an extensively farmed catchment and receives point source industrial wastes (in its mid-reaches) and dairy pond wastes (more than 100 treatment systems) discharges. These industrial (meatworks) wastes are predominantly diverted out of the river (to land irrigation) during summer months, while the Eltham WWTP municipal and industrial wastes discharge was diverted permanently out of the catchment in winter 2010. The site is in the lower reaches of the river immediately upstream of the mouth, but is generally not tidal, although occasional upstream surging in the ponded area has been noted during low river flow and high tidal conditions during late summer.

The range of water temperatures was moderately wide (9.7°C) with a record maximum of 25.3˚ C recorded in late morning in late January 2018. However, as sampling was not performed after 1210 hrs during January and February, this maximum might be expected to have been exceeded later in the day from time-to-time during the period of the survey. Conductivity values were typical of the lower reaches of a Taranaki ring plain. Saltwater influence occurred on one occasion, on 1 February 2018, during a king tide coincident with surges caused by a tropical cyclone (Fehi). Turbidity values during trend monitoring were indicative of relatively clear water on most occasions, consistent with the presence of some fine colloidal material in suspension (ie: < 2 NTU on most occasions), typical of the lower reaches of a ring plain river.

Bacteriological water quality (Figure 32) was typical of the lower reaches of a Taranaki ring plain river receiving agricultural run-off and point source discharges in the catchment. This was also apparent in comparison with the nearby (state of the environment physicochemical monitoring) site at SH45 where monthly sampling since mid-1998 (under all weather conditions) has recorded a median *E. coli* count of 220 per 100 ml (and range from 3 to 41,000 per 100 ml). Uncontrolled livestock access to the river immediately upstream of this site near the mouth, particularly during low flow periods, was not recorded during the current season, which was an improvement on historical incidents.

4.8.1 Comparison with guidelines

E. coli counts for the Waingongoro River at Ohawe Beachover the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 28.

Table 28 Performance against guidelines at Waingongoro River at Ohawe Beach

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT **Single sample** **261-550/100ml**	**ACTION** **Single sample** **>550/100 ml**
SEM samples	4 [31%]	0 [0%]
All samples	4 [17%]	2 [8%]

Two single samples were recorded in the 'Action' category, both during additional MfE surveys, one in early January 2018 that was affected by rainfall, the other in mid-March in dry weather. The 'Alert' mode was exceeded on four occasions, all during SEM surveys in February and March 2018. Health risk warning signage was deployed by STDC after the 'Action' level *E. coli* count in dry weather. Immediate follow-up sampling returned results below Action level, and the sign was removed.

4.8.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Waingongoro River at Ohawe Beach over 22 summers is presented in Figure 34.

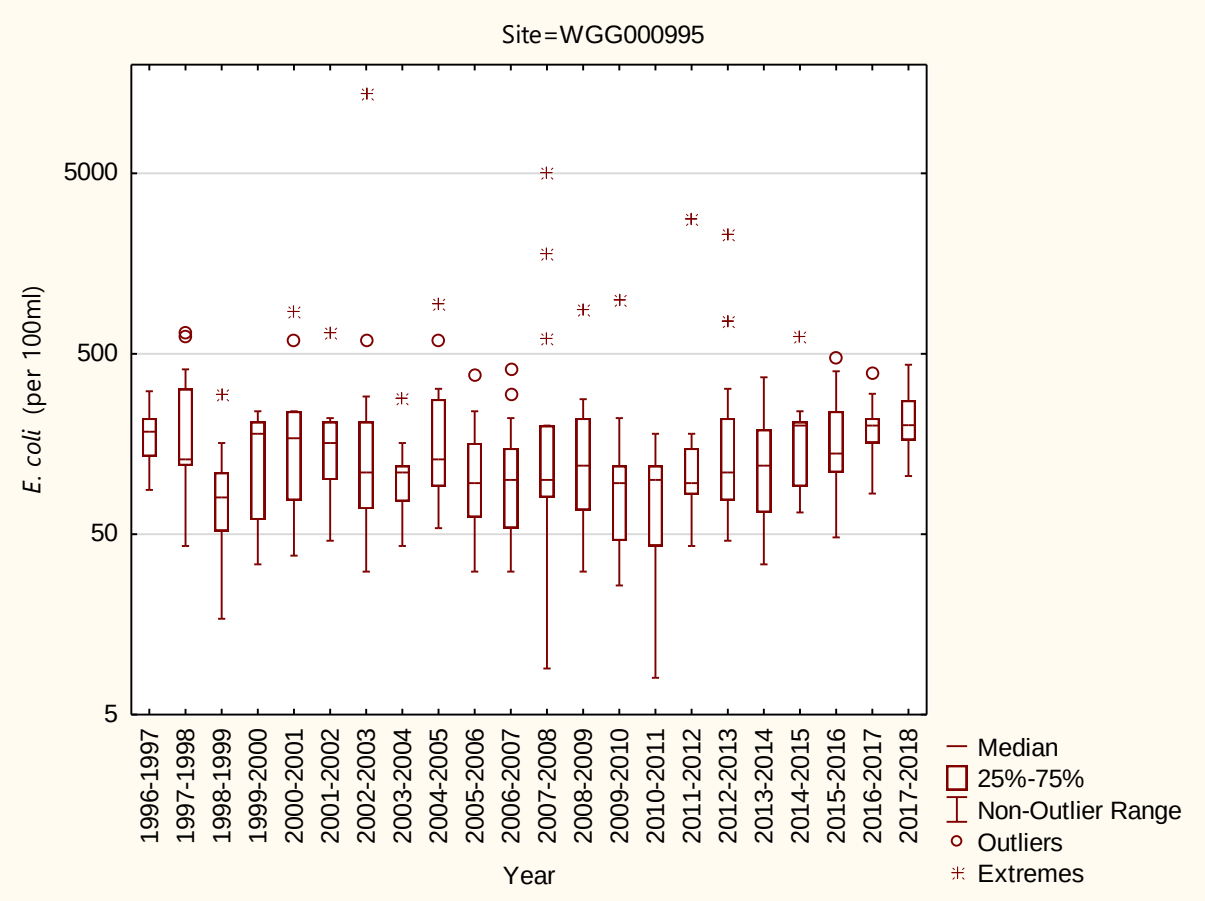


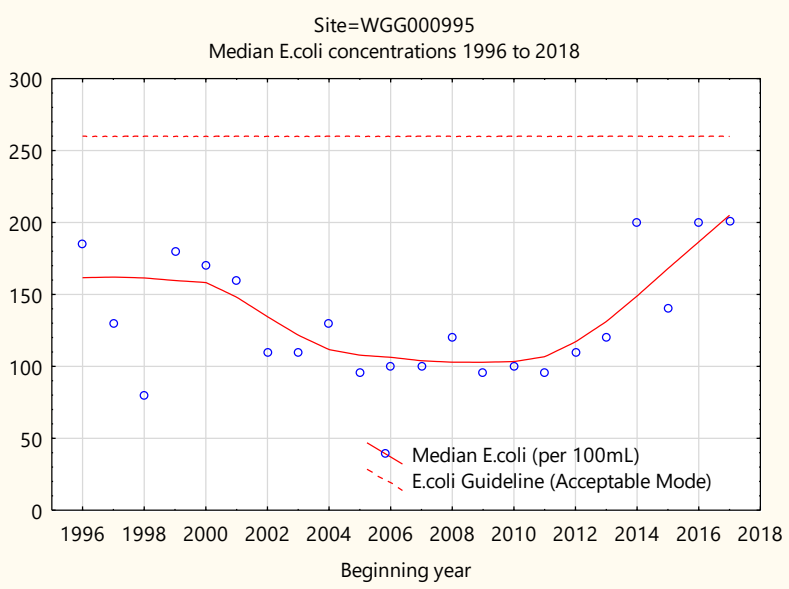
Figure 34 Box and whisker plots of *E. coli* for all summer surveys in Waingongoro River at Ohawe Beach

Median *E. coli* bacteria number for the 2017-2018 period was slightly more than the highest values found over the previous twenty-one seasons, in 2014-2015 and 2016-2017 (Figure 34).

A moderately narrow range of *E. coli* numbers was recorded in the recent 2017-2018 period in comparison with past seasons' ranges.

4.8.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the twenty-two seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 35) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.



Waingongoro river at Ohawe
N = 22
Kendall Tau = - 0.058
p value = 0.707
FDR p-value = 0.787

Figure 35 LOWESS trend plot of median *E.coli* numbers (per 100ml) for the 1996 to 2018 period at the Waingongoro River Ohawe beach site

Overall, a statistically insignificant increasing trend in median *E.coli* number was found over the twenty-two seasons of monitoring. The trend had been a statistically significant reduction at the p <0.05 level after the 2012-2013 season, but no longer significant due to the more recent increase in median number. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

4.8.4 Cyanobacteria

Benthic cyanobacteria were monitored on 11 occasions during the season. Results are presented in Table 29 and Figure 36.

Table 29 Benthic cyanobacteria data for the Waingongoro River at Ohawe Beach

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	1	No	No	Surveillance
14/11/2017	3	No	No	Surveillance
06/12/2017	2	No	No	Surveillance
20/12/2017	28	Minor	No	Alert
03/01/2018	6	No	No	Surveillance
11/01/2018	0	No	No	Surveillance
24/01/2018	0	No	No	Surveillance
07/02/2018	6	No	Minor	Alert
14/02/2018	20	Minor	Minor	Alert
26/02/2018	4	No	No	Surveillance
22/03/2018	6	No	No	Surveillance

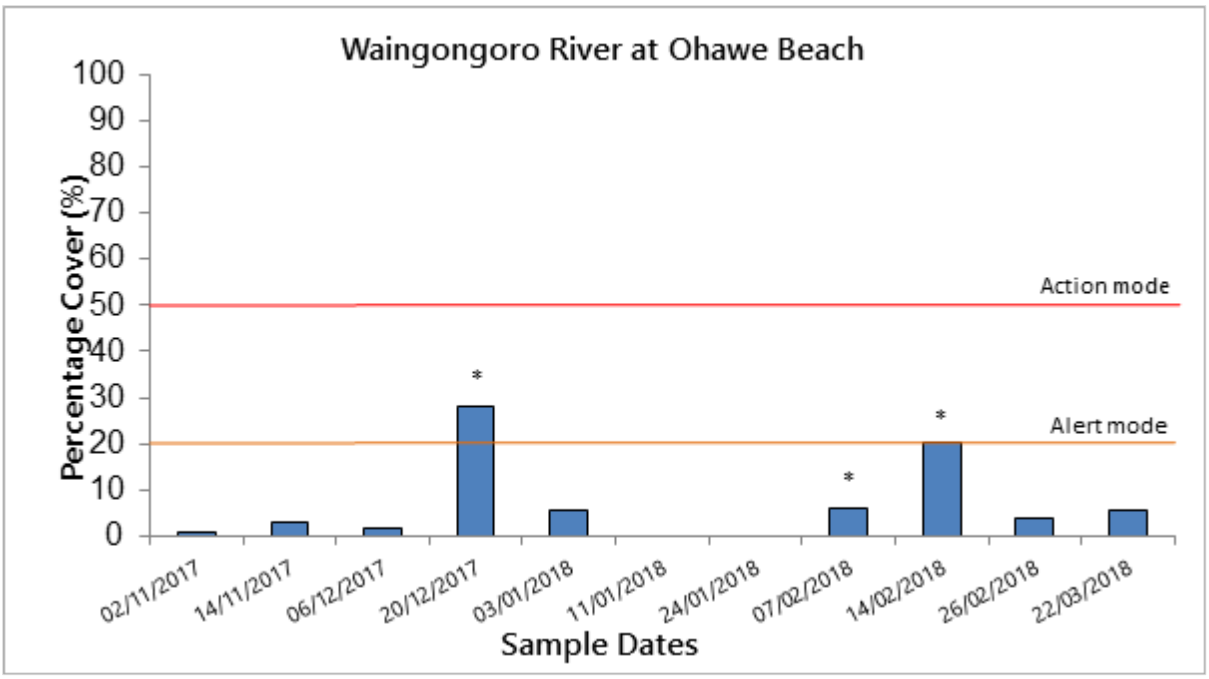


Figure 36 Percentage benthic cyanobacteria cover, for the Waingongoro River Ohawe beach site

Note that 'Action' and 'Alert' mode lines are for percentage cover only. The symbols * and ⁺ over a bar indicate where the status been raised to 'Alert' or 'Action' mode, respectively due to detaching or exposed mats.

Benthic cyanobacteria coverage was very low for the majority of the monitoring period, with nine of the eleven surveys having under 10% streambed coverage. Two surveys had coverage at the 'Alert' level. The benthic cyanobacteria found were *Phormidium* sp. Minor levels of detaching mats were observed on two occasions, triggering the 'Alert' level, and minor levels of exposed mats were observed on two occasions, which triggered the 'Alert' response. In total there were three surveys that triggered the 'Alert' level.

4.9 Kaupokonui River at Beach Domain

A total of 26 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as 11 MfE samples and two follow up samples. Rainfall immediately preceded sampling on four occasions. Six of the additional surveys occurred within two hours of low tide.

Minor usage at this site by bathers was recorded at the time of the sampling surveys, and other recreational usage [mainly fishing and walking the banks] was occurring on several survey occasions at this popular site where the camping ground was consistently in use. The site was characterised by the tidal ponded nature of this reach of the river on the majority of occasions, particularly under high tide and low river flow conditions. No stock access was noted near the river's edge upstream of the domain during the current season. A few ducks were noted on a few occasions.

During the 2012-2013 season, additional fine weather samples were collected on two separate low tide, very low flow conditions (mid-summer and end of the season) at this site and analysed (by Cawthron Institute, Nelson) for faecal source DNA tracking markers. Low *E.coli* counts (26 and 17 cfu/100 ml) were found to be coincident with bacteria of only ruminant and wildfowl origin indicative of no septic tank wastes disposal issues at the beach, with numbers typical of the lower reaches of ring-plain streams.

River flow records for the current 2017-2018 season are provided in Figure 38.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 37 and summarised in Table 30. The complete survey results are presented in Appendix I.

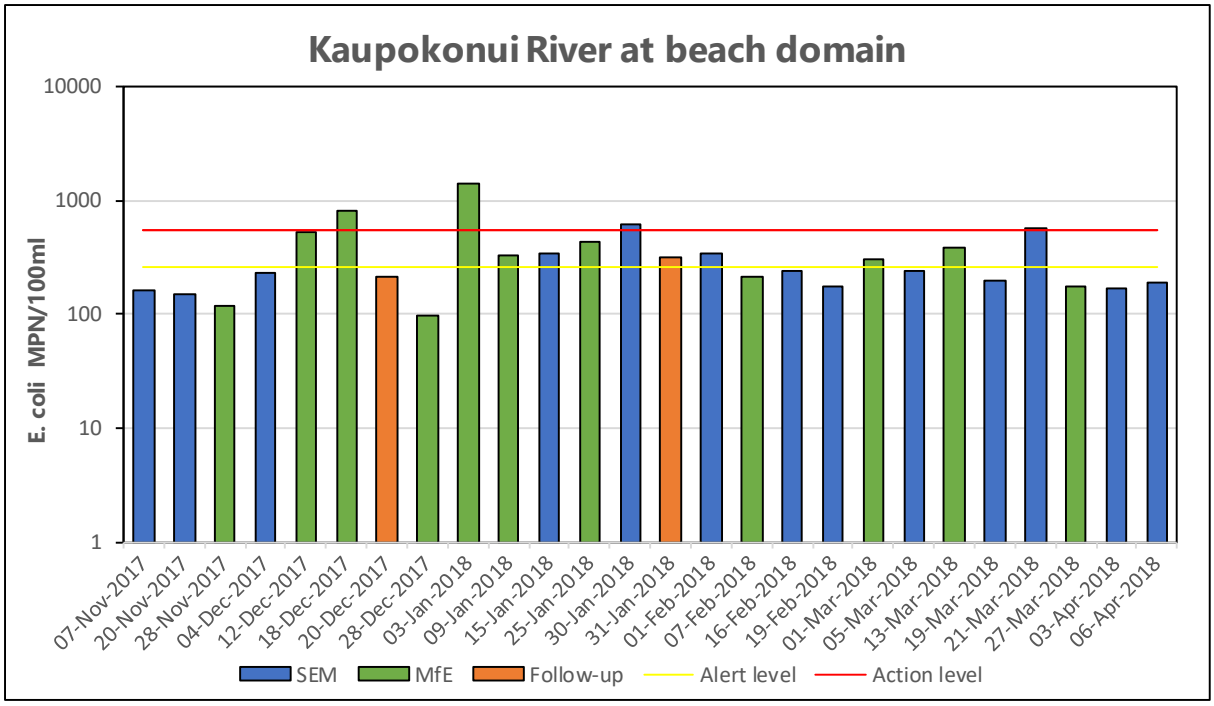


Figure 37 *E. coli* results for Kaupokonui River at the beach domain

Table 30 Statistical summary for Kaupokonui River at the beach domain

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	13.8	2150	103
	E. coli	MPN/100ml	13	152	613	228
	Temperature	°C	13	17.2	26.4	21.9
	Turbidity	NTU	13	0.84	29	1.3
SEM + MfE samples	Conductivity	mS/m@20°C	24	13.8	2150	20.1
	E. coli	MPN/100ml	24	99	1410	237
	Temperature	°C	24	16.0	26.4	20.9
	Turbidity	NTU	24	0.46	29	1.25

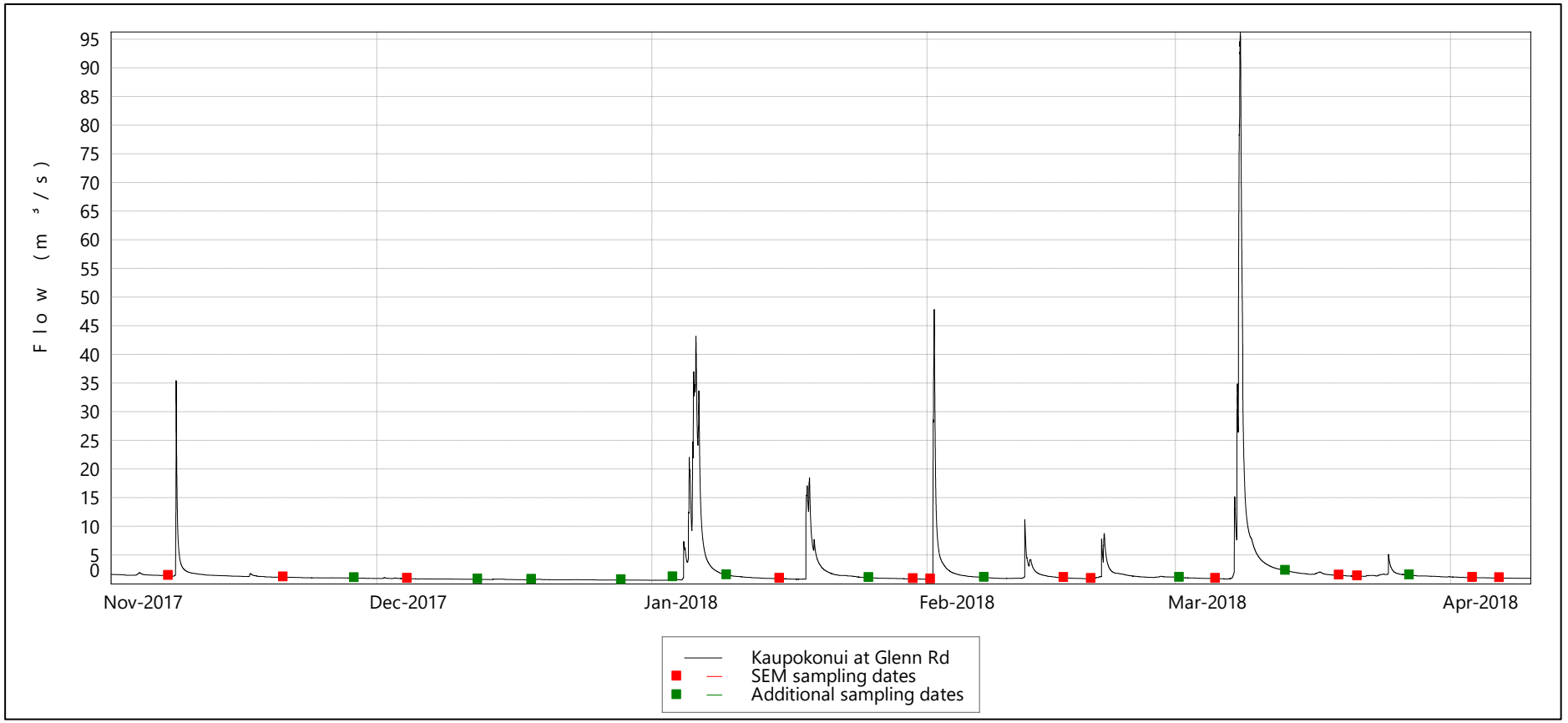


Figure 38 Flow in the Kaupokonui River at Glenn Rd during the survey period

This river also drains an extensively farmed catchment and receives point source wastes discharges from dairy pond wastes treatment systems, and in its mid-reaches from the Fonterra Kapuni lactose plant (cooling waters) and the Kaponga township municipal upgraded wastewater treatment system.

The site is located in the lower reach of the river near the mouth and on several occasions was noted as tidal (incoming surges, upstream or very slow flow) in terms of flow conditions. Elevated conductivity levels on nine occasions indicated some seawater influence near high tide under low flow conditions throughout the monitoring period. Otherwise, these conductivity levels were relatively stable (13.8 to 18.8 mS/m at 20°C) and typical of the lower reaches of a Taranaki ring plain river.

Turbidity levels were mostly typical of lower ring plain river reaches with minimal impacts of suspended algal matter though were increased markedly (to up to 29 NTU) by sediment suspended during larger tidal surges. Foaming was seldom noticeable in the ponded reach of the river and toward the edges, unlike in some previous periods when foaming and suspended algal matter reduced the aesthetic quality of this reach from time to time. Water temperatures varied over a moderately wide range of 10.4°C with a maximum of 26.4°C recorded in in late January 2018. This temperature was recorded at 1100 hrs and would be expected to have increased later in the day and on other occasions, particularly as most of the surveys were performed before 1325 hrs at this site.

Bacteriological water quality was moderately good and slightly less than that recorded in the lower reaches of the nearby Waingongoro River (see section 4.7), and better than found from time to time in the lower reaches of a Taranaki ring plain river draining a predominantly agricultural catchment.

Previous surveys have noted that bacteriological water quality deteriorated in this tidal pool reach of the river, probably as a result of the ponding of the flow and 'accumulation' of slugs of poorer quality downstream flow. This may have been as a result of upstream stock access, point source dairy effluent discharges and/or various other non-point source runoff, emphasising the importance of control and surveillance of dairy shed wastewater disposal practices, particularly in lower reaches of ring plain catchments utilised for bathing and recreational purposes. As well, many flocks of ducks have been recorded in reaches of the river upstream of this site.

During SEM surveys, two 'Alert' levels and two 'Action' levels were recorded, between mid-January and mid-March 2018. There was tidal surging, or saline influence was measured, on each occasion.

During MfE surveys, five 'Alert' levels and two 'Action' levels were recorded, between mid-December and mid-March 2018. One (and probably both) Action level results were affected by rainfall, and at least three of the Alert level results. A follow-up survey was conducted after the first Action level was reported, irrespect6ive of the likely rainfall influence, as it was immediately before the Christmas holiday period at a popular swimming site.

Relatively poor aesthetic water quality has been noted from time-to-time at this site, mainly in the form of surface froth (particularly toward the river margins) and fragments of periphyton suspended in the water column. These aspects of physical water quality were not as apparent during the 2017-2018 season.

4.9.1 Comparison with guidelines

E. coli counts for the Kaupokonui River at the beach domain over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 31.

Table 31 Performance against guidelines at Kaupokonui River at the Beach Domain

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	2 [15%]	2 [15%]
All samples	7 [29%]	4 [17%]

Four single samples were recorded in the 'Action' category, two during SEM trend surveys, and two during additional MfE surveys, one after wet weather. The 'Alert' mode was exceeded on seven occasions, two during SEM surveys, at least three of which (MfE) were affected by rainfall. Health risk warning signage was deployed by STDC after the 'Action' level *E. coli* counts in dry weather. Follow-up surveys were undertaken after the three Action level counts in dry weather (one as a routine MfE sampling, in late March), and all returned counts in the acceptable range. The signs were removed accordingly.

In summary, bacteriological water quality at this ponded lower river site was within guidelines for contact recreational usage for the majority of the survey period.

4.9.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Kaupokonui River at the beach domain over 22 summers is presented in Figure 39.

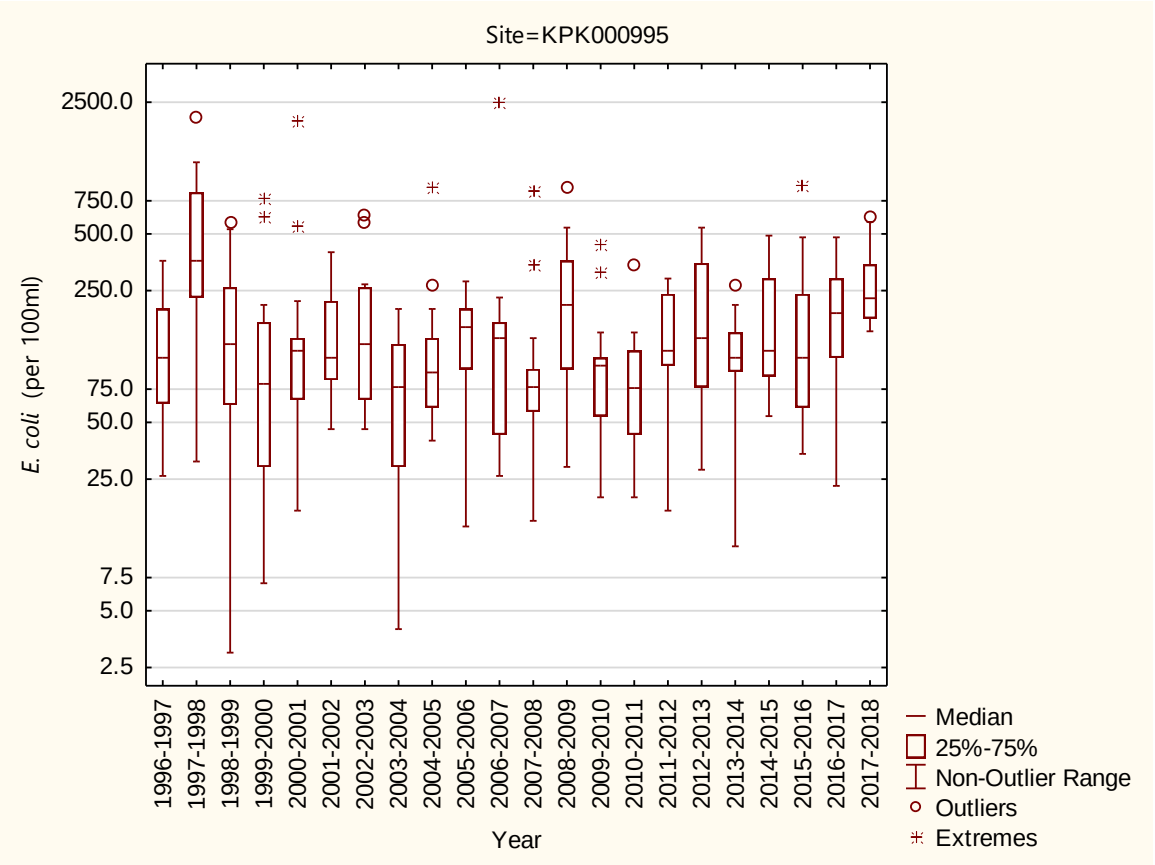


Figure 39 Box and whisker plots of *E. coli* for all summer surveys in the Kaupokonui River at the Beach Domain

Lower *E. coli* bacterial water quality in terms of median number, but a narrow range compared with many of the previous twenty-one survey seasons, was recorded over the 2017-2018 season (Figure 39). The median *E. coli* count was the second highest of all other seasons' medians to date and the seasonal maximum was in the mid-range of those for the twenty-two years of record.

4.9.2.1 Long-term trend analysis

Trend analysis of these median *E. coli* numbers has been performed for the twenty-two seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 40) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

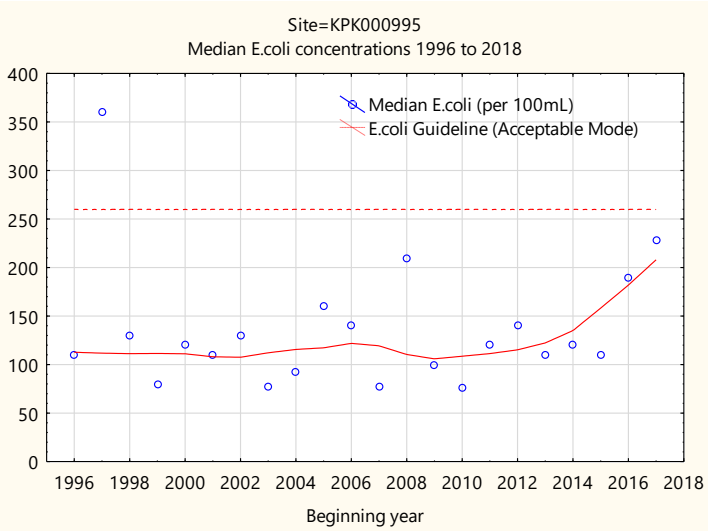


Figure 40 LOWESS trend plot of median *E. coli* data at the Kaupokonui River beach domain site

A slight, and statistically insignificant, increasing trend in median *E. coli* counts was found over the twenty-two seasons of monitoring. One of these seasonal medians (1997-1998 season) exceeded the 'Alert' mode but none has exceeded the 'Action' mode.

4.9.3 Cyanobacteria

Benthic cyanobacteria were monitored on 11 occasions during the season. Results are presented in Table 32 and Figure 41.

Table 32 Percentage benthic cyanobacteria cover, detached and exposed mats at the Kaupokonui River at Beach Domain

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	17	No	No	Surveillance
14/11/2017	8	No	No	Surveillance
06/12/2017	26	Minor	No	Alert
12/12/2017	15	Minor	No	Alert
20/12/2017	10	No	No	Surveillance
11/01/2018	10	No	No	Surveillance
24/01/2018	20	No	No	Surveillance
07/02/2018	16	No	No	Surveillance

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
26/02/2018	29	No	No	Alert
22/03/2018	4	No	No	Surveillance

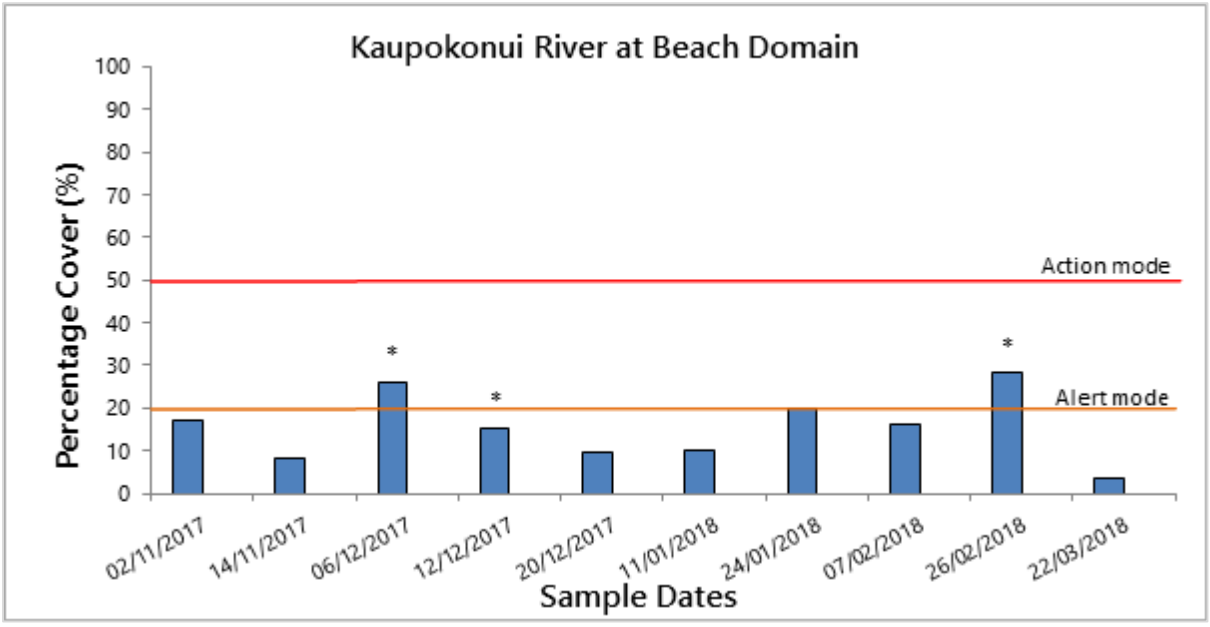


Figure 41 Benthic cyanobacteria data for Kaupokonui River at Beach Domain.

Note: 'Action' and 'Alert' mode lines are for percentage cover only. * and + symbols over a bar indicate where the status has been risen to 'Alert' or 'Action' mode respectively due to detaching or exposed mats

Benthic cyanobacteria coverage was moderately low with a median value of 16%. The benthic cyanobacteria found were *Phormidium* sp. The 'Action' level was never exceeded for percentage cover but the 'Alert' level was exceeded on three occasions. Minor detaching mats were observed on two occasions which triggered the 'Alert' level but exposed mats were never observed. In total the 'Alert' level was triggered on three occasions.

4.10 Lake Opunake

A total of 13 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, and no follow up samples were required

No bathing or boating usage of the lake was noted on any occasion, nor picnicking activities as has been recorded occasionally (sometimes with dogs present) at the time of sampling surveys in previous years. Ducks were noted regularly on the lake or in the vicinity of the lake edge and numbers were high on most occasions. A flock of Canadian geese was recorded separately, on one occasion. Large numbers of these wildfowl frequently have been present on the picnic area grass verge adjacent to the lake edge, attracted from time to time by food provided by picnickers. There was no repeat of the thick unsightly, algal scum prevalent on the lake surface for several weeks during mid to late summer in the 2010-2011 season (TRC, 2011) although some suspended algae and/or weed was noted in the middle and toward the end of the monitoring period.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 42 and summarised in Table 33.

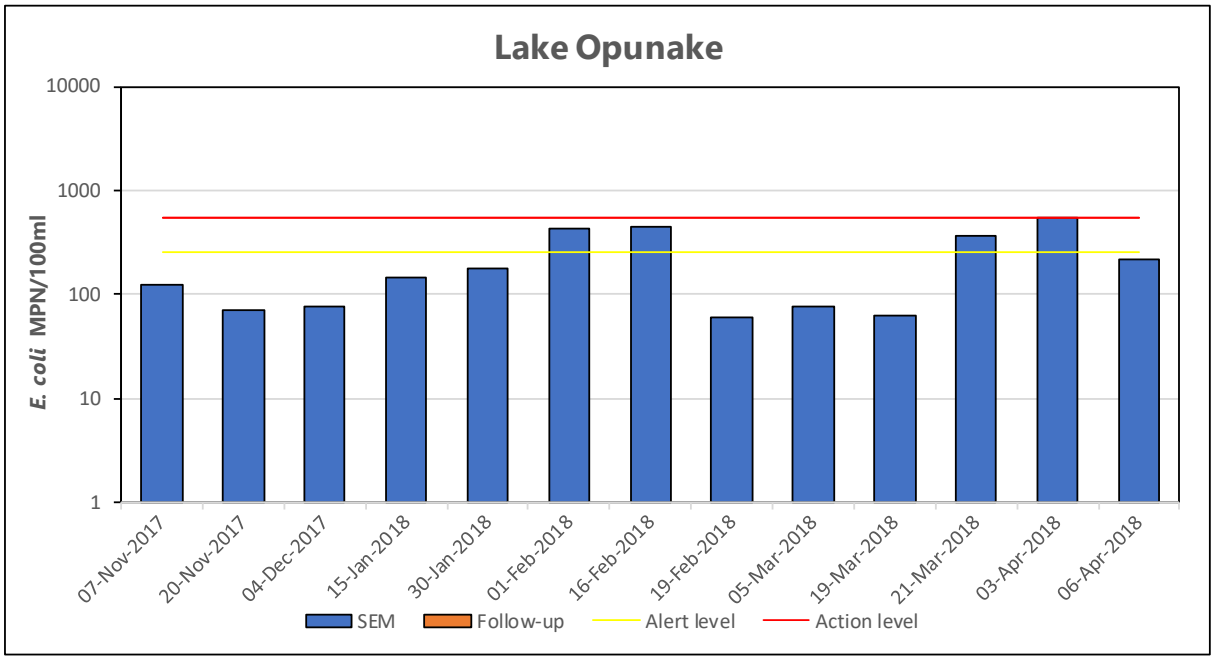


Figure 42 *E. coli* results for Lake Opunake

Table 33 Statistical summary for Lake Opunake

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	12.3	15.0	13.3
	E. coli	MPN/100ml	13	60.2	548	146
	Temperature	°C	13	16.7	26.5	22.0
	Turbidity	NTU	13	0.6	2.0	0.9

The lake is formed by the diversion of water from the nearby Waiaua River (as a component of the Waiaua HEP scheme) and is close to the coast.

Water clarity was good (median turbidity: 0.9 NTU; range of turbidity: 1.4 NTU) with a narrow range, as a result of minimal sediment disturbance and/or limited suspended algae in the water column. Good water quality was due, in part, to the lake's short residence time, with regular replenishment as a result of local hydroelectric power scheme usage. Median water temperature (22.0°C) was the third highest recorded, with a wider range (9.8°C) and higher maximum (26.5°C) value than usual. Conductivity varied over a very narrow range (1.0 mS/m @ 20˚C) reflecting river inflow conditions.

Generally, bacteriological quality was good, the median count (146 *E. coli* per 100 ml) being the fourth highest recorded, over a relatively narrow range, influenced in part by the inflow to the lake originating from the lower reaches of a river draining a developed catchment and also by the local wildfowl population., In previous seasons, marked fluctuations in counts have occurred which were most likely associated with this bird population, particularly in instances where ducks had been attracted to the immediate vicinity of the monitoring site by picnickers feeding the birds.

4.10.1 Comparison with guidelines

E. coli counts for Lake Opunake over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 34.

Table 34 Performance against guidelines at Lake Opunake

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	4 [31%]	0 [0%]

No single sample exceedance of the 'Action' mode occurred during the period, and four single samples were recorded within the 'Alert' mode.

In terms of the guidelines for contact recreational usage, bacteriological water quality at this site was in compliance with the acceptable level throughout the period.

4.10.2 Comparison with previous summer surveys

Summary statistics for the SEM *E.* coli data collected at Lake Opunake over 12 summers is presented in Figure 43.

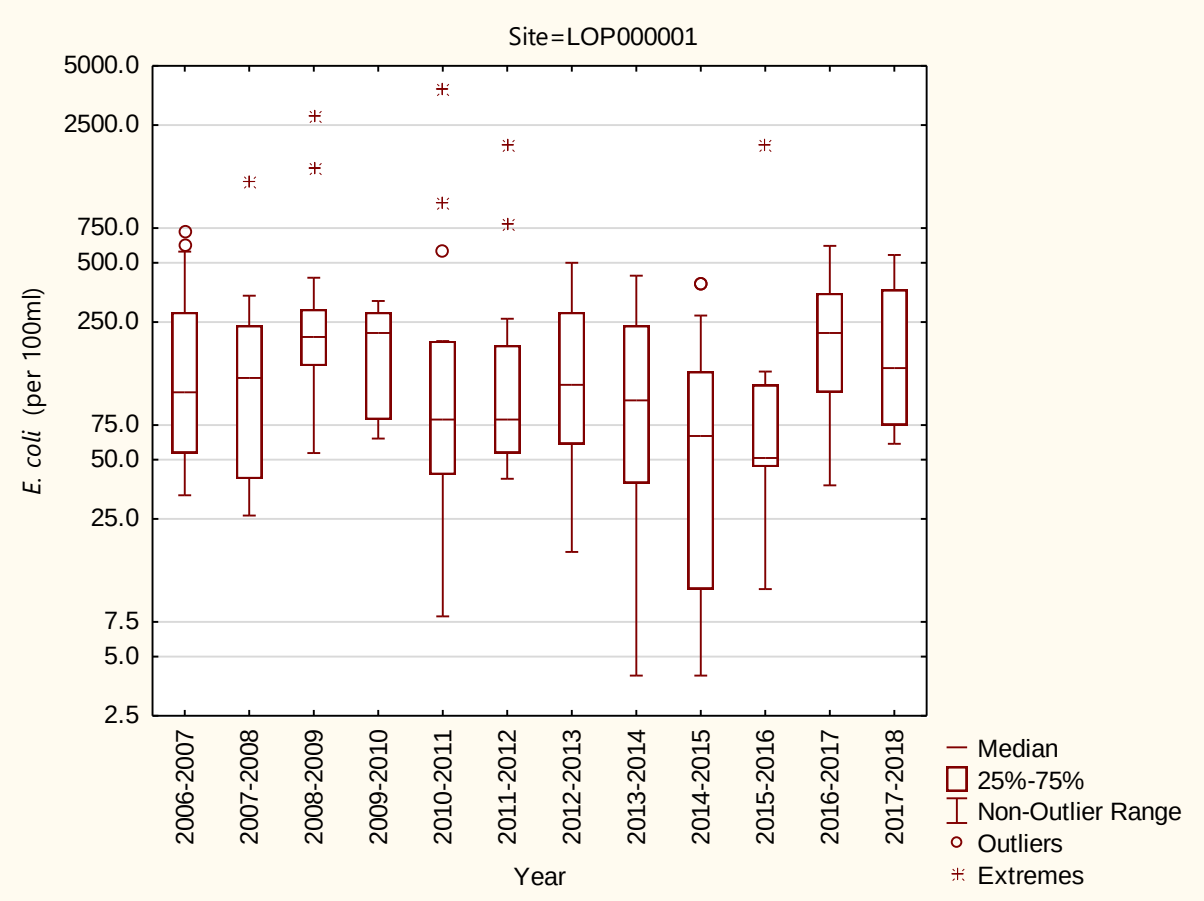


Figure 43 Box and whisker plots of *E. coli* for all summer SEM surveys at Lake Opunake

The median *E. coli* number in the 2017-2018 season was fourth to the highest for the twelve seasons' surveys to date, following the equal highest median *E. coli* number in 2016-2017 (Figure 43).

4.10.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the twelve seasons of data by first applying LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 44) and testing the

significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

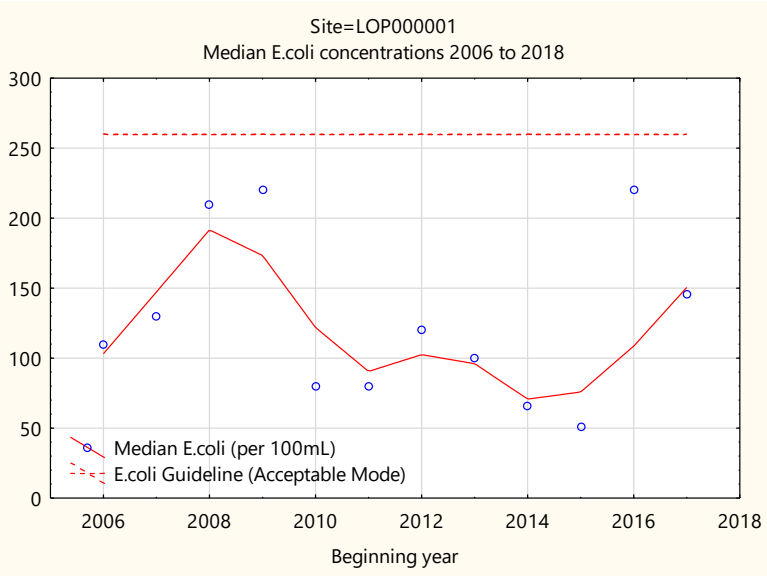


Figure 44 LOWESS trend plot of median *E. coli* data at the Lake Opunake site

Overall, a statistically insignificant decreasing trend in median *E. coli* counts was found over the twelve seasons of monitoring. None of these seasonal medians has exceeded the 'Alert' mode.

4.10.4 Cyanobacteria

Planktonic cyanobacteria were monitored on eight occasions throughout the season with results presented in Table 35 and Figure 45.

Table 35 Cyanobacteria counts (cells/mL) at Lake Opunake [Health warning: >1.8 mm^3/L]

Date	Cyanobacteria total cell count (cells/mL)	Biovolume (mm^3/L)	Principal species by biovolume	Mode
07/11/2017	0	0	No cyanobacteria present	Surveillance
28/11/2017	0	0	No cyanobacteria present	Surveillance
12/12/2017	0	0	No cyanobacteria present	Surveillance
03/01/2018	0	0	No cyanobacteria present	Surveillance
25/01/2018	0	0	No cyanobacteria present	Surveillance
07/02/2018	0	0	No cyanobacteria present	Surveillance
01/03/2018	0	0	No cyanobacteria present	Surveillance
19/03/2018	0	0	No cyanobacteria present	Surveillance

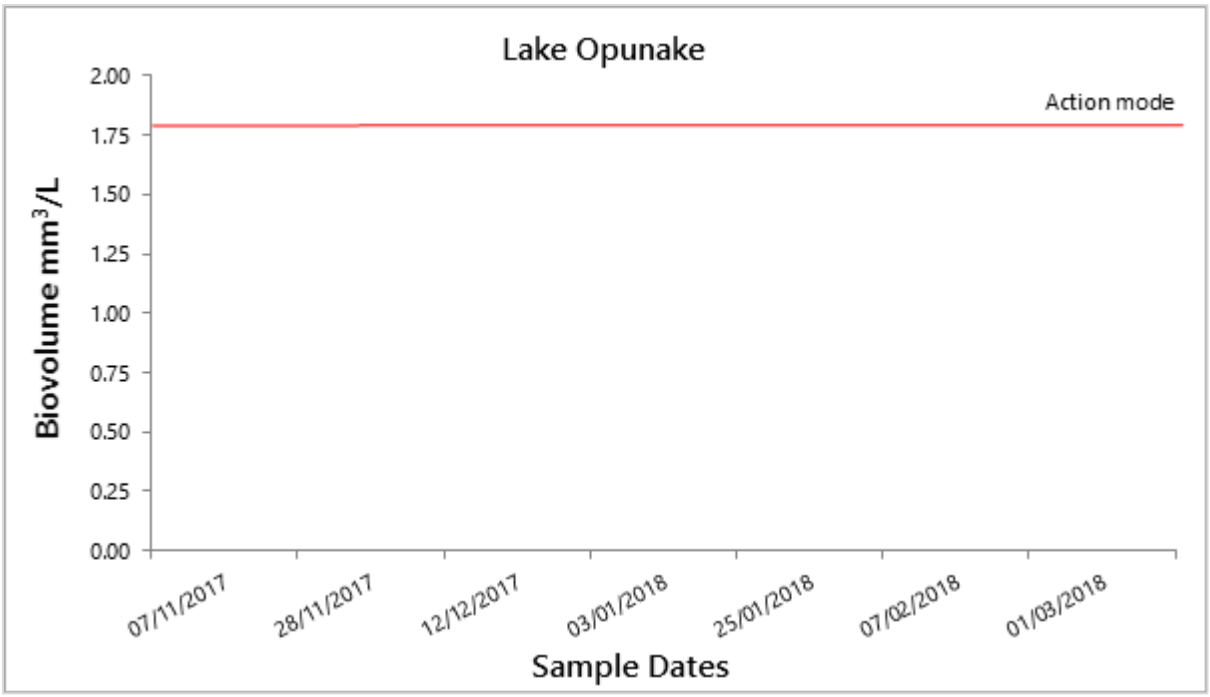


Figure 45 Cyanobacteria counts (cells/ml) at Lake Opunake [Health warning: >1.8 mm^3/L]

Planktonic cyanobacteria were not detected for the entire recreational monitoring period.

4.11 Timaru Stream at Weld Road (near mouth)

A total of 22 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as nine follow up samples.

Bathing usage was noted at this site on four sampling occasions between November and April, while fishing (whitebaiting in season, and rod fishing), walking, sometimes with dogs, and horse-riding along the stream banks was recorded on other occasions during the season. The site had been a popular camping area (until it was closed by NPDC during early 2005) and access point to the sea coast but camping had occurred from time to time across on the true left bank. The site, to a certain extent tidal, showed varying degrees of saltwater penetration, particularly under very low flow recession conditions toward late summer. The general direction of flow was upstream on three of the twenty two monitoring occasions with slack water or upstream surging noted on two other occasions. Gulls, sometimes in large numbers, and ducks were present on occasions, with dogs and horses in the water from time to time.

A recreational water quality advisory sign was erected by NPDC at the car park adjacent to the monitoring site in summer 2016-2017 (Photo 7).

The adjustable cursor was set to "no swimming or food gathering" (orange) between mid- October and late December 2017, in relation to an advisory from MBiE on paralytic shellfish poison. This sign was used to advise against swimming (also orange alert) for 10 days in late January and early February 2018.

Photo 7 Sign at Timaru Stream mouth, Weld Road car park, June 2017

Previously, analyses for faecal source DNA tracking markers (by Cawthron Institute, Nelson) were undertaken on two fine weather, low tide, samples collected under very low flow conditions in January and early April 2013. Low *E.coli* counts (80 and 40 per 100 ml) were found to be coincident with bacteria of ruminant and wildfowl origin, typical of sites in the lower reaches of streams and rivers elsewhere on the ringplain.

River flow records for the 2017-2018 season are provided in Figure 47.

All data for this site, from the 2017-2018 summer period, are presented in Table 36 and summarised in Figure 46. The complete survey results are presented in Appendix I.

All *E. coli* counts for the Timaru Stream at Weld Road over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 36.

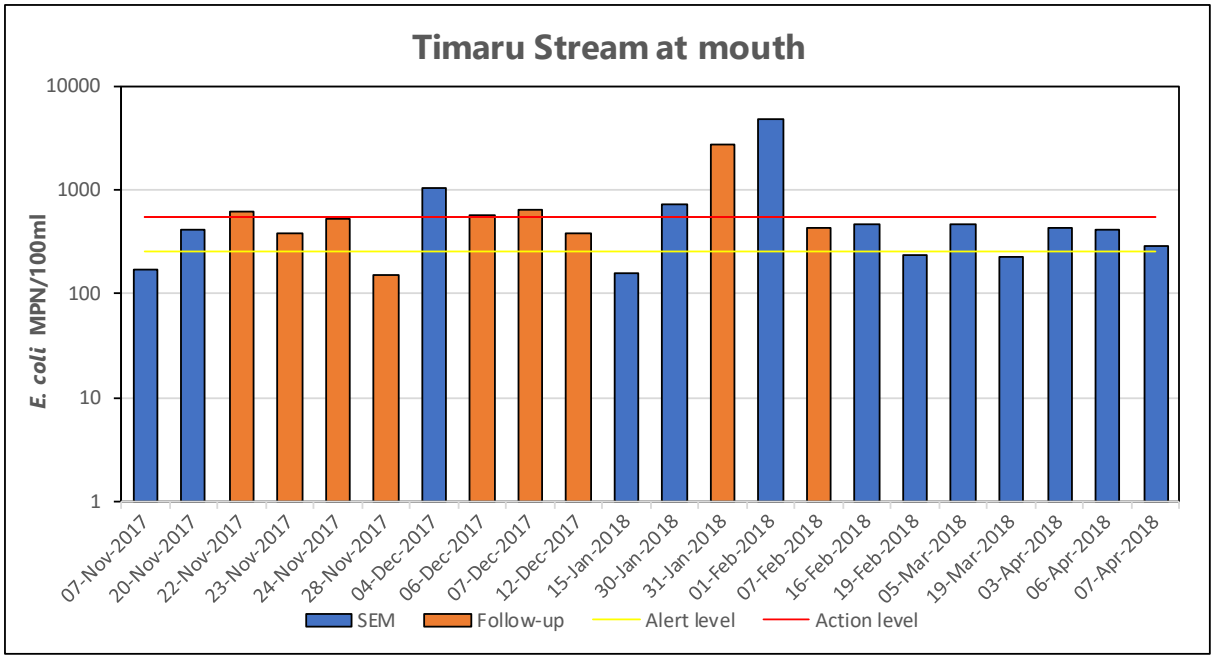


Figure 46 *E.*coli results for Timaru Stream at Weld Road

Table 36 Statistical summary for Timaru Stream at Weld Road

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	18.1	4640	54.5
	E. coli	MPN/100ml	13	158	4840	411
	Temperature	°C	13	15.3	23.0	19.1
	Turbidity	NTU	13	0.27	20	0.65

This river drains a moderately farmed catchment (five consented dairy farm discharges) receiving point and non-point source discharges from dairy farms, although it is relatively short in length, rising partly in the nearby Kaitake range and the north-western area of Egmont National Park. Conductivity levels varied markedly in response to saltwater penetration at this site and were elevated on all but four occasions during routine monitoring and particularly in mid to late summer-autumn under low stream flow conditions.

Turbidity levels were very low on all but one occasion through the season, consistent with the generally clear appearance of the river. Exceptionally high turbidity (20 NTU) occurred as the result of turbulence caused by surging during a king tide coincident with a tropical cyclone (Fehi) on 1 February 2018, when the water was almost entirely saline. Minimal algal cover was noted in association with the good aesthetic appearance of the river due to the sandy substrate at this deeper, ponded site. Water temperature varied over a moderate range of 7.7°C with a maximum water temperature of 23.0°C recorded in early morning in mid-January 2018. This maximum could have been expected to have been exceeded later in the day.

Bacteriological water quality at this site was generally below average and probably poorer than typical of the lower reaches of other Taranaki ring plain streams draining agricultural catchments. When the second sample of the season, taken on 20 November 2017, returned a relatively high *E. coli* count (411 MPN/100 ml), and considering the record high median for the previous season (330 cfu/100 mL), an investigation into the cause(s) was carried out, involving resampling on several occasions, re-inspection of the farm dairy waste disposal systems, and survey of riparian areas above the monitoring site. Water samples, taken on 7 December 2017 and 30 January 2018 (both at 'Action' level for *E. coli*), were subjected to PCR marker analysis to establish possible microbial sources, whether human, avian, ruminant or equine. No human or

horse marker was detected, and some (possibly aged) ruminant marker and avian marker were present. The farm waste disposal and riparian inspections found nothing amiss.

Stock access to the lower stream (which was crossed to reach adjacent farmland at times) during the prolonged dry period of the 2007-2008 season (requiring remedial action after incidents were reported by the general public) was not repeated or recorded in any subsequent seasons nor in the current season. Surveys in other rivers with tidal pool reaches have found that bacteriological water quality may deteriorate probably as a result of ponding of the flow and 'accumulation' of slugs of poorer quality downstream flow, and several high *E. coli* counts were coincidental with more ponded conditions (during elevated conductivity events).

4.11.1 Comparison with guidelines

E. coli counts for the Timaru Stream at Weld Road over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 37.

Table 37 Performance against guidelines at Timaru Stream at Weld Road

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT **Single sample** **261-550/100ml**	**ACTION** **Single sample** **>550/100 ml**
SEM samples	5 [38%]	3 [23%]

Five single samples were recorded in the 'Alert' mode, and three samples were recorded in the 'Action' mode during the period. Poorer bacteriological water quality tended to coincide with sampling earlier in the day.

In terms of the 2003 contact recreation guidelines, the bacteriological water quality at the site was relatively poor, although partly affected by the ponding caused by the site's proximity to the sea coast.

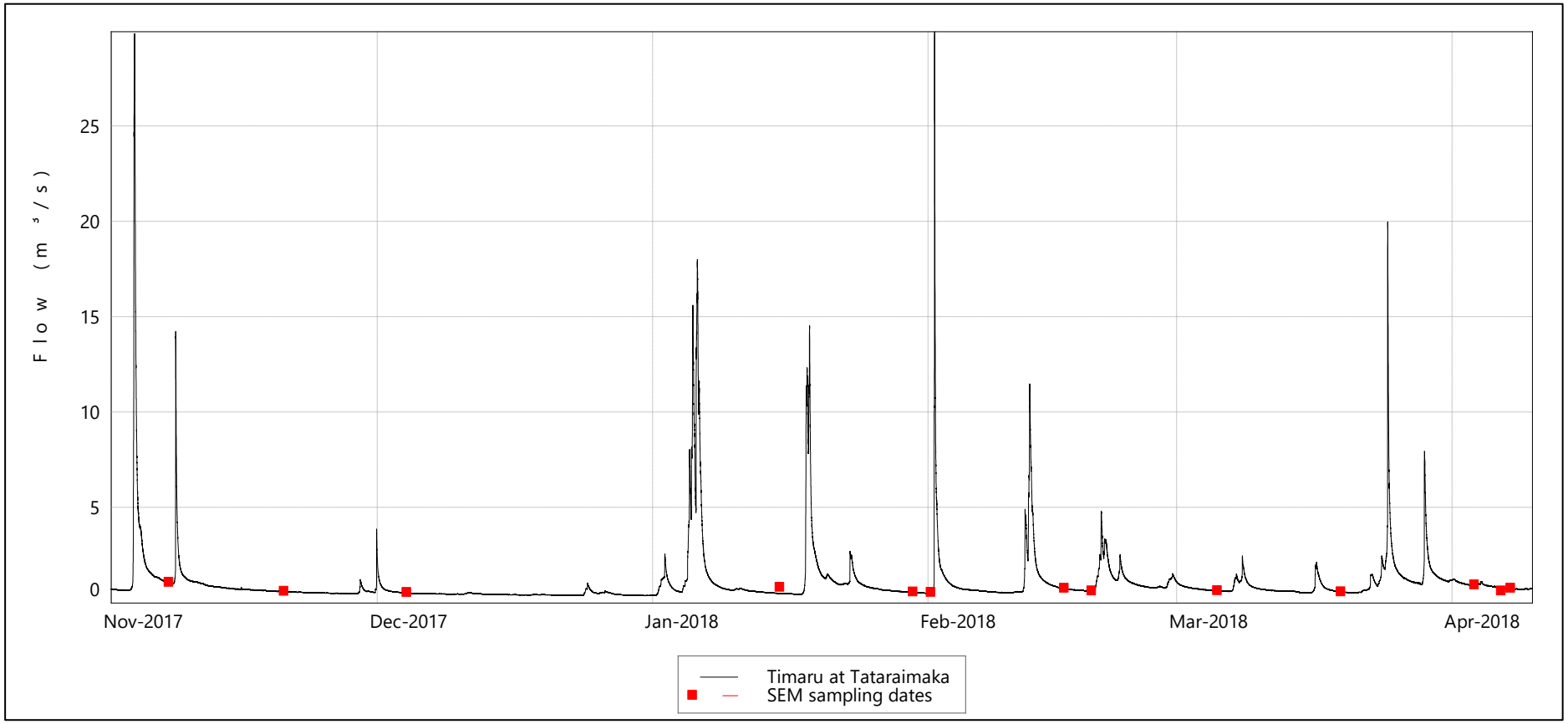


Figure 47 Flow in the Timaru Stream at Tataraimaka during the survey period

4.11.2 Comparison with previous summer surveys

Summary statistics for the SEM E. coli data collected at Timaru Stream mouth over 21 summers is presented in Figure 48.

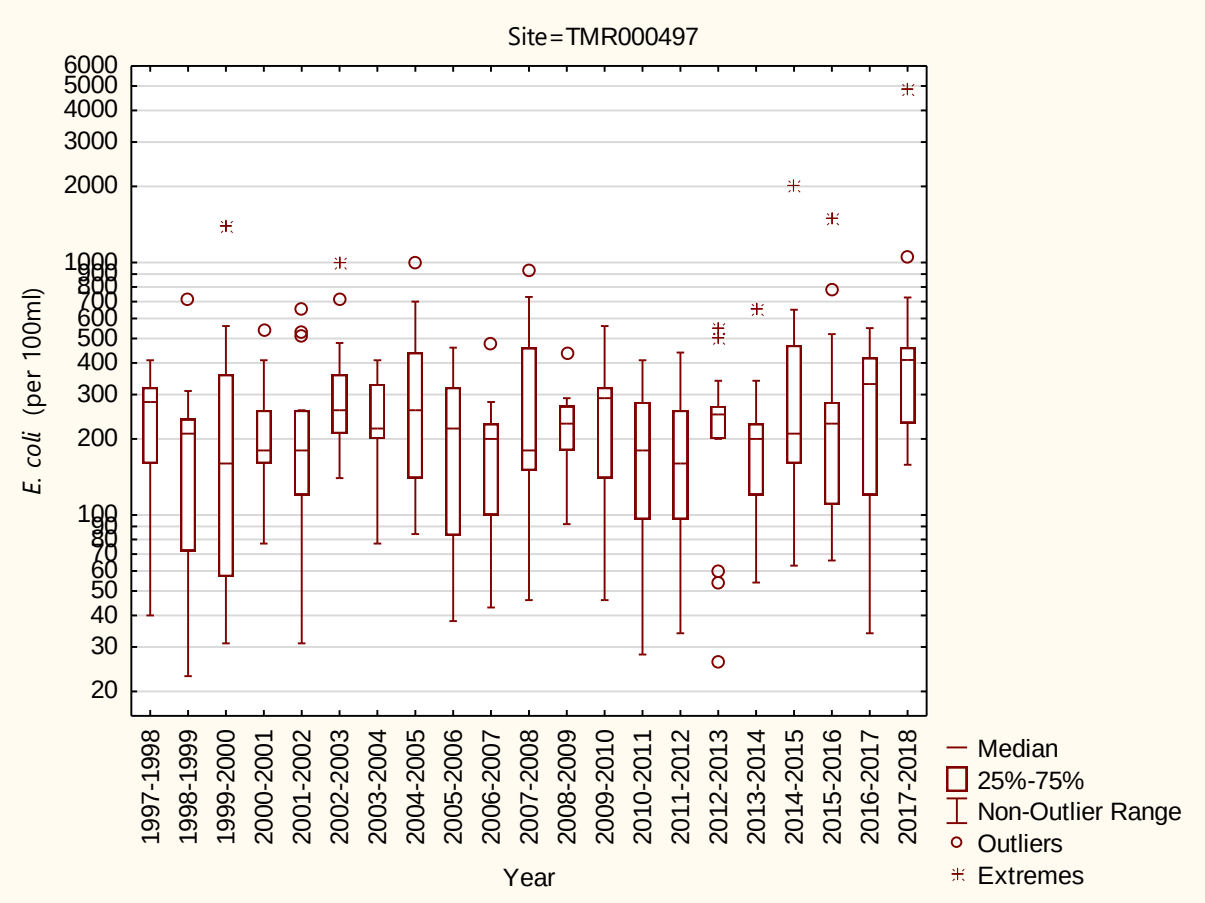
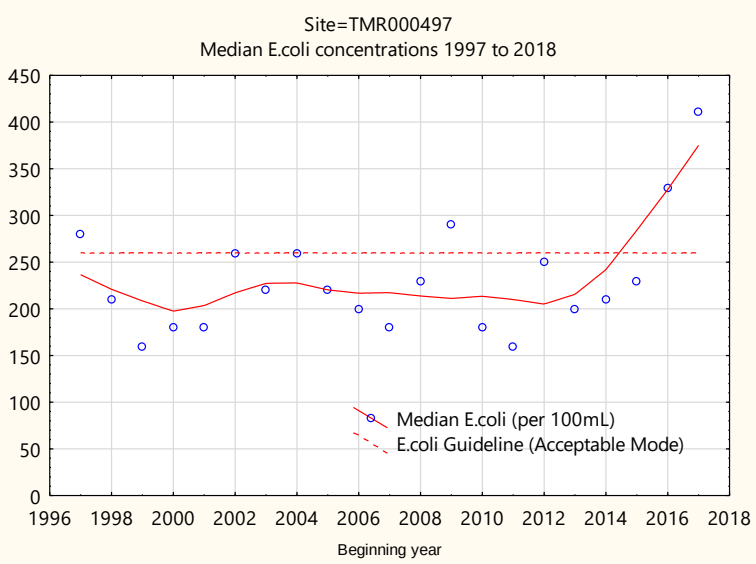


Figure 48 Box and whisker plots of *E.coli* for all summer surveys in the Timaru Stream at lower Weld Road

The median *E. coli* count for the 2017-2018 season was the highest recorded over twenty-one years of monitoring. Counts over the 2017-2018 season had a wide range (Figure 48) as the result of a record high maximum that occurred during highly turbid conditions brought about by the large tidal surges associated with Cyclone Fehi, likely causing resuspension of bacteria from the sediment.

4.11.3 Long-term trend analysis

Trend analysis of these median *E. coli* numbers has been performed for the twenty-one seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 49 and Figure 52) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.



Timaru Stream at mouth
N = 21
Kendall tau = 0.206
p-value = 0.192
FDR p-value = 0.438]

Figure 49 LOWESS trend plot of median *E. coli* data at Timaru Stream, lower Weld Road site

An overall slight, increasing trend in median *E. coli* numbers has been found over the twenty-one seasons of monitoring which has not been statistically significant. None of these seasonal medians exceeded the 'Action' mode, although the medians for the initial, 2008-2009 and the most recent two seasons entered the 'Alert' mode and three others have been very close to the 'Alert' mode from time to time at this site.

4.11.4 Cyanobacteria

No benthic cyanobacteria surveys were performed at this site as it is often ponded above a sandy substrate due to tidal influences.

4.12 Waimoku Stream at Oakura Beach

The easy access to this small stream which flows and often ponds across Oakura beach, the most popular recreational beach in north Taranaki, provides a convenient contact recreational area for children in particular. Bacteriological monitoring and various investigation surveys have been performed at this site from time-to-time, particularly in relation to septic tank wastes disposal in Oakura, the interpretation of coastal bathing beach water quality and for assessment of the effectiveness of Council's water policies. Such a survey at the mouth and upstream of Oakura township during the 1998-1999 bathing period, and two more recent catchment surveys in the 2004-2005 (TRC, 2005) and 2009-2010 periods (TRC, 2010a) indicated that the relatively high bacterial counts found in the stream at the coast were also apparent in the Waimoku Stream upstream of the township, where some stock access and extensive wildfowl populations contributed to high bacterial numbers. This was particularly apparent in certain tributaries upstream of the coastal township and therefore not attributable to domestic wastes disposal practices within Oakura township. Historical data have highlighted the poor bacteriological water quality regularly exhibited in this stream resulting in considerable publicity. More appropriate, permanent health warning signage was erected by NPDC in consultation with the Area Health Board early in the season in positions of public prominence. As a consequence, bacteriological samples collected during the first half of the 2009-2010 programme were also analysed by Cawthron Institute, Nelson using faecal source DNA tracking marker techniques in association with high *E.coli* counts at this site. All samples were found to contain bacteria indicative of wildfowl (principally ducks and other species) origin, with minimal ruminant (cattle) sources and no indications of human origin. (Note: Currently, there are no markers available for specific pukeko faecal identification). These results were consistent with the conclusions of the catchment survey reports referenced above.

Planting of streamside vegetation as a component of a riparian management scheme (in cooperation with landowners) although contributing to aspects of bacteriological water quality improvement in the lower reaches of the stream may also provide habitat for wildfowl species. Management of dairy farm wastes in the catchment will also continue to be monitored in conjunction with bathing water quality as a long-term component of the SEM programme. The recent completion of a newly reticulated sewerage system (by NPDC in 2010), with Oakura domestic wastewater collected and pumped to the New Plymouth WWTP, will also ensure that surface water bacteriological water quality will not be compromised by septic tank effluent seepages in the township.

The frequency of monitoring at this site was reduced to triennial surveys following the 2010-2011 survey, with the previous 2016-2017 survey being the second at this frequency. Therefore, no monitoring was performed over the 2017-2018 period.

4.13 Oakura River below SH45

A total of 15 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as two follow up sample.

Bathing usage was recorded on three occasions at this site where people were often present on the riverbank at this very accessible tidal site. (Fishing has been observed, including whitebaiting in season, in previous years). Ponding and upstream surging frequently occurred under high tide conditions, and gulls and dogs were recorded occasionally on or in the river. Stock access opposite the site has apparent in some previous seasons, but was not recorded during the current period.

A recreational water quality advisory sign was erected by NPDC at the car park adjacent to the monitoring site in summer 2016-2017 (Photo 8). The adjustable cursor was set to "no swimming or food gathering" (orange) between mid- October and late December 2017, in relation to an advisory from MBiE on paralytic shellfish poison. This sign was used to advise against swimming (also orange alert) for 10 days in late January and early February 2018.

Photo 8 Sign at Oakura River mouth, June 2017

Faecal source DNA tracking markers analyses (by Cawthron Institute, Nelson) had been performed on two low tide, fine weather samples collected in mid January 2013 and early April 2013 under very low flow conditions upstream of Oakura township as well as the usual site. *E. coli* counts were low (80 and 23 per 100 ml upstream and 100 and 20 per 100 ml downstream) and found to be coincident with bacteria of ruminant and wildfowl origin only, similar to the lower reaches of ring-plain rivers and streams elsewhere.

All data for this site, from the 2017-2018 summer period, are presented in Figure 50 and summarised in Table 38. The complete survey results are presented in Appendix I.

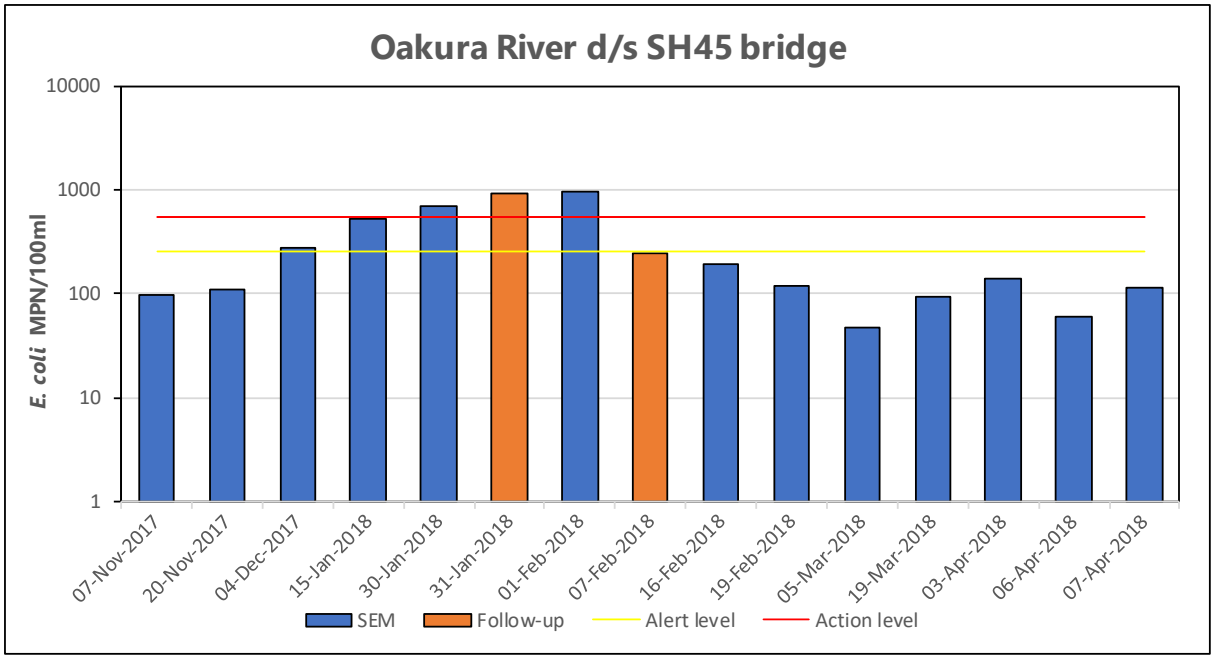


Figure 50 *E. coli* results for Oakura River below SH45

Table 38 Statistical summary for Oakura River below SH45

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	8.4	2880	59.5
	E. coli	MPN/100ml	13	47.3	977	119
	Temperature	°C	13	14.7	22.3	19.9
	Turbidity	NTU	13	0.34	9.6	0.57

This river drains a mainly agricultural catchment (three consented dairy farm discharges to surface water) with the survey site established in the popular short tidal reach between SH45 and the mouth of the river. The river was noted as tidal with ponding or inflowing obvious on four sampling occasions. Conductivity levels indicated a variable influence of saltwater intrusion on at least nine sampling occasions during the season. The most significant intrusion occurred during a king tide coincident with a tropical cyclone (Fehi) on 1 February 2018, when salinity was about 60%. On each occasion the river was clear in appearance, except during the cyclone. There was no algal substrate cover, due to the sandy nature of much of the substrate, except for a minor amount at the end of the season. Water temperatures varied over a moderate range (7.6°C) during the period reaching a maximum of 22.3°C in mid-morning in late January 2018, but below the maximum water temperature which might be anticipated later in the day as all sampling at this site occurred no later than 1350 hrs.

Bacteriological water quality was generally moderate, but with a wide range of *E. coli* counts that included two high counts, the one of which was explained: the release of microorganisms from sediment suspended during Cyclone Fehi, is a likely explanation for the second high count, which followed shortly after the first. The NPDC Follow-up sampling was carried out after both The E. coli level was elevated from early December 2017 through January 2018, but reduced after the flood associated with Cyclone Fehi. The other (nine) *E. coli* counts in November and from early February onwards were all below 200 cfu/100 ml. Bacteriological water quality was not dissimilar to that found elsewhere in ponded tidal reaches of ring-plain rivers and streams, probably as a result of the occasional 'accumulation' of slugs of poorer quality downstream flow. This may have resulted from upstream stock access, agricultural non-point source runoff and/or point source discharges.

4.13.1.1 Comparison with guidelines

E. coli counts for the Oakura River at the mouth over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 39.

Table 39 Performance against guidelines at Oakura River below SH45

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	2 [15%]	2 [15%]

Two single samples fell within the 'Alert' mode, and two samples entered the 'Action' mode. Health warning signage (Photo 8) was required to be displayed at this site by NPDC for the ten days from when the first action level was exceeded to when follow-up sampling showed return to acceptable level, and appropriate public advice was provided on the District and Regional Council and LAWA websites.

In terms of the 2003 contact recreation guidelines, the bacteriological water quality at the site was relatively poor, though it was within the acceptable single sample guidelines for contact recreational usage for the majority of the sampling season.

4.13.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Oakura River mouth over 22 summers is presented in Figure 51.

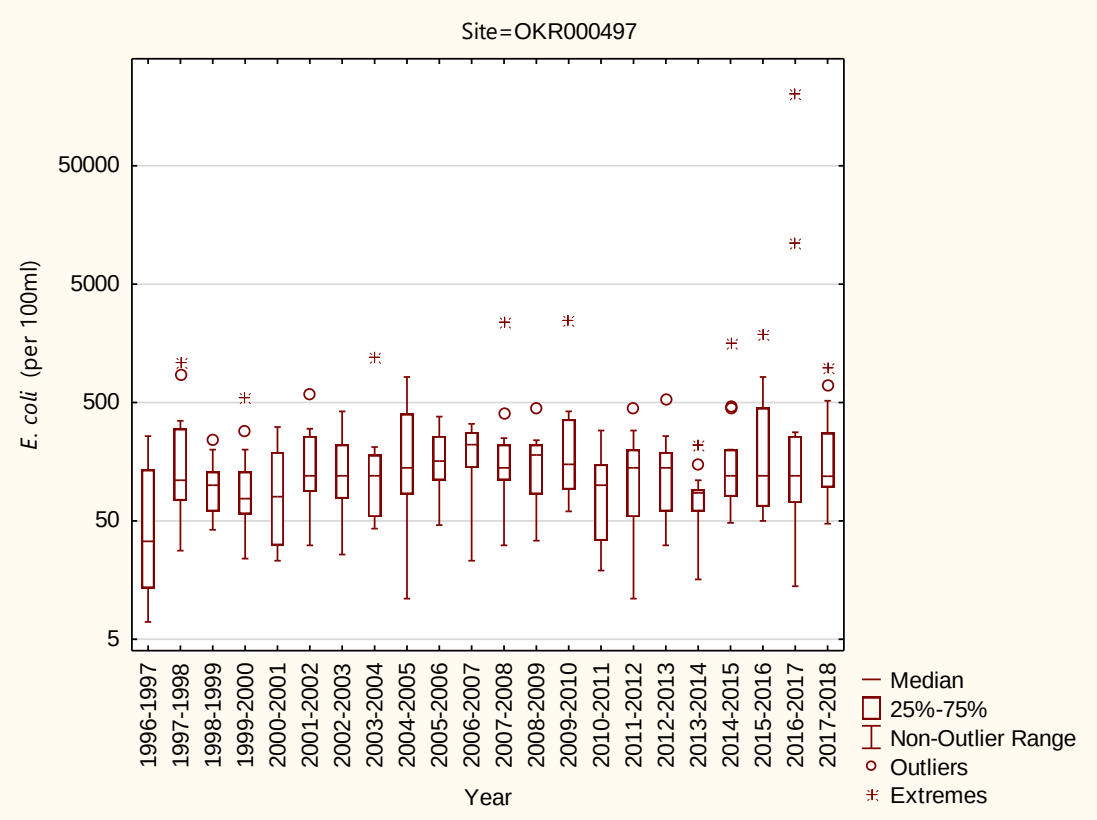
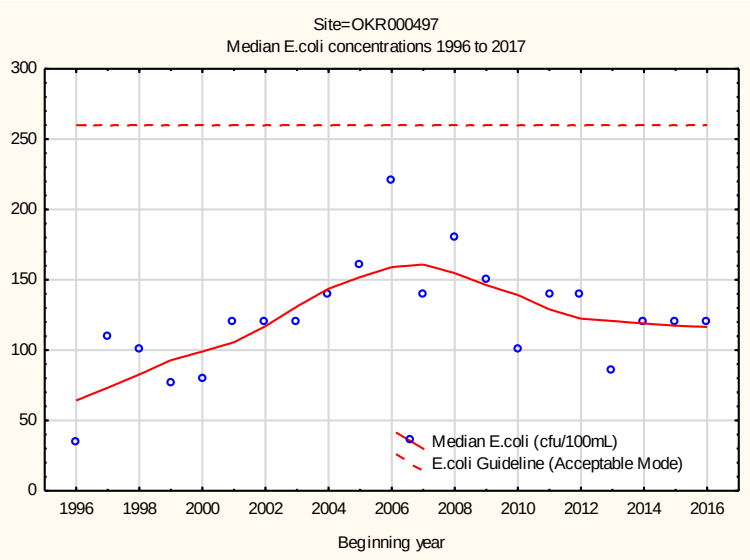


Figure 51 Box and whisker plots of *E. coli* for all summer surveys in the Oakura River below SH45

The median *E. coli* count was toward the middle of the range of past seasons' results (Figure 51). No median *E. coli* counts have exceeded the 2003 guidelines for contact recreational usage over the twenty-two seasons of monitoring.

4.13.3 Long-term trend analysis

Trend analysis of these median *E. coli* numbers has been performed for the twenty-two seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 52) and testing the significance of any trend using the Mann-Kendall test at 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.



Oakura River below SH45
N = 22
Kendall Tau = + 0.214
p-value = 0.164
FDR p-value = 0.436

Figure 52 LOWESS trend plot of median *E.coli* data at the Oakura River, SH 45 site

An increasing, but no longer significant, overall trend in median *E. coli* counts has been found over the twenty-two seasons of monitoring. However, none of these seasonal medians exceeded the 'Alert' or 'Action' modes.

4.13.4 Cyanobacteria

Benthic cyanobacteria were monitored on ten occasions during the season in a more appropriate reach, upstream of the SH45 bridge, with results presented in Table 40 and Figure 53.

Table 40 Percentage benthic cyanobacteria cover, detached and exposed mats at the Oakura River upstream of SH45 Bridge

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	2	No	No	Surveillance
14/11/2017	0	No	No	Surveillance
06/12/2017	0	No	No	Surveillance
20/12/2017	0	No	No	Surveillance
11/01/2018	0	No	No	Surveillance
24/01/2018	1	No	No	Surveillance
07/02/2018	0	No	No	Surveillance
26/02/2018	0	No	No	Surveillance

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
08/03/2018	0	No	No	Surveillance
22/03/2018	0	No	No	Surveillance

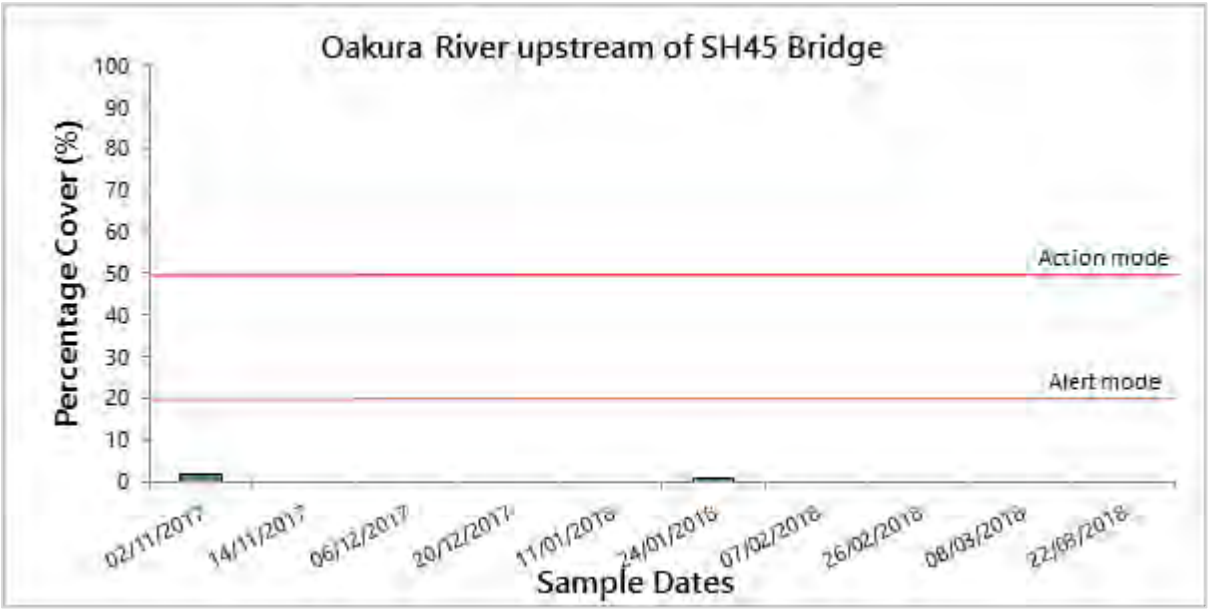


Figure 53 Percentage benthic cyanobacteria cover at the Oakura River upstream of SH45 Bridge.

Note: Action' and 'Alert' mode lines are for percentage cover only. * and + symbols over a bar indicate where the status has been risen to 'Alert' or 'Action' mode respectively due to detaching or exposed mats.

Benthic cyanobacteria coverage was very low throughout the season (ranging from 0 to 2%). The benthic cyanobacteria found were *Phormidium* sp. The 'Action' or 'Alert' level was never exceeded for percentage cover or for detaching and exposed mats.

4.14 Waitara River at the town wharf, Waitara

A total of 13 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, and no follow up samples were required

No bathing usage of this river site at the new town wharf was recorded at the time of sampling surveys, the majority of which were prior to midday. Both bathing and fishing (including whitebaiting in season) have been noted from time-to-time in previous seasons at this site with rowing and canoeing as additional activities. Ducks were often present in the second half of the period, sometimes common, and gulls were common sometimes in the later period.

Concerns relating to the source of faecal bacteria found at this site by past monitoring, led TRC to undertake additional microbial source tracing (MST) using DNA marker techniques at four sites in the lower Waitara River during the 2010-2011 season (TRC, 2011b). In summary, faecal bacteria found at this Town Wharf site were sourced predominantly from cattle (under all tidal and flow conditions) with some indication of bacteria of human origin under high tide and flood conditions. Upstream (Bertrand Road site) faecal bacteria were totally of cattle origin whilst downstream (on both sides of the river mouth), faecal bacteria of cattle (all occasions), wildfowl and human (occasional) derivation were found.

All *E.* coli data for this site, from the 2017-2018 summer period, are presented in Figure 54 and summarised in Table 41. The complete survey results are presented in Appendix I. River flow information is illustrated in Figure 55.

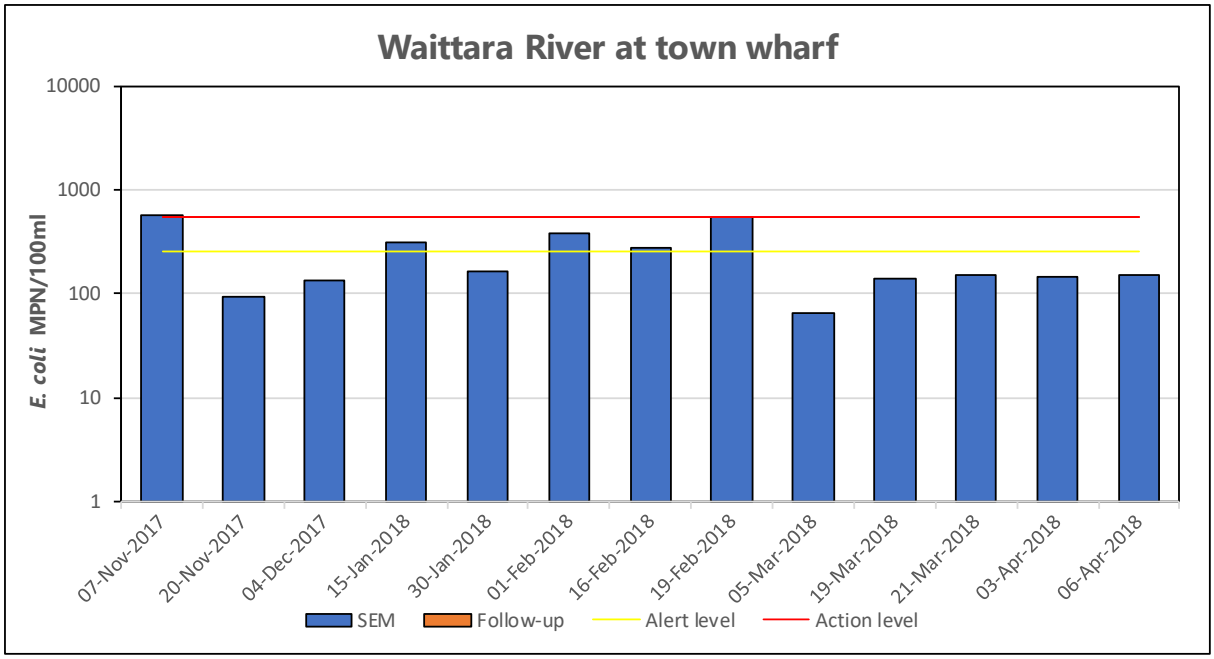


Figure 54 *E.coli* results for Waitara River at the town wharf, Waitara

Table 41 Statistical summary for Waitara River at the town wharf, Waitara

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	10.2	2350	756
	E. coli	MPN/100ml	13	64.6	579	152
	Temperature	°C	13	17.1	24.7	21.4
	Turbidity	NTU	13	2.3	24	3.6

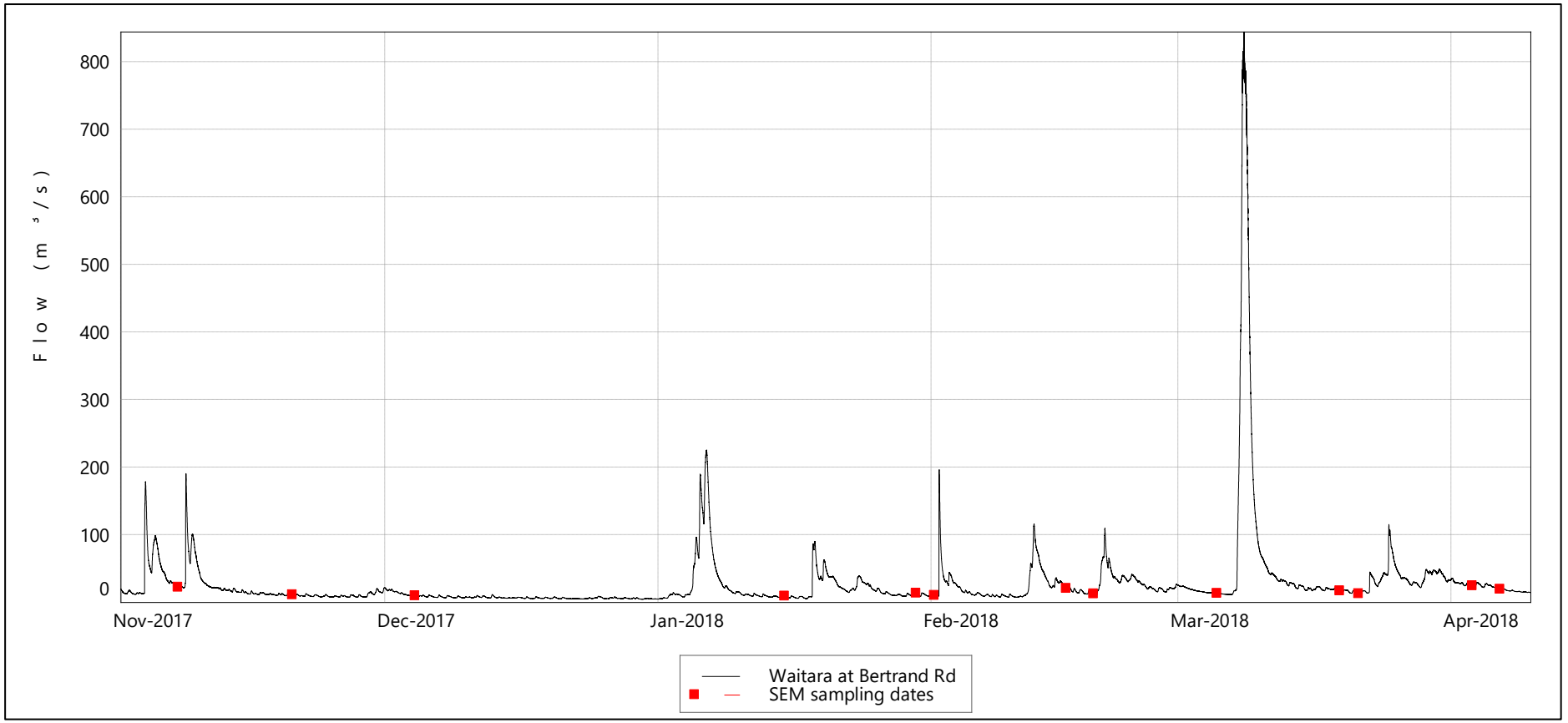


Figure 55 Flow in the Waitara River at Bertrand Road during the survey period

This ring plain and eastern hill country river drains an extensively developed agricultural catchment. The survey site is situated in the lower tidal reaches of this large river, some 1.5 km upstream of the river mouth. There are consented dairy ponds treated wastes discharges in the catchment upstream of the site particularly in the Manganui River sub catchment (see 4.16) River water was generally slightly turbid, green-brown to turbid brown in appearance. Elevated conductivity levels typical of seawater ingress near high tide occurred on all sampling occasions, and occasionally coincidental with ponded or very slow downstream flow conditions.

Water temperatures had a moderate range of 7.6˚C partly due to the coastal seawater influence, with a maximum of 24.7˚C recorded in early morning in late January 2018. All of the samples were collected before 1325 hrs and therefore maximum river temperatures (which tend to occur later in the afternoon) were not recorded.

Bacteriological water quality was moderate, and typical for the lower reaches of this large Taranaki eastern hill country and ring plain river draining a predominantly agricultural catchment subject to coastal seawater influence under high tide conditions (median 152 *E.coli* MPN/100 ml).The existing recreational sampling programme was performed around higher tidal conditions for SEM trend purposes (due to its incorporation within the coastal sites programme) at times when public usage is often more predominant at this site. Poorer bacteriological water quality might be expected under outflowing low tide conditions, although monitoring undertaken 6km further upstream (at the flow recorder site at Bertrand Road) over the recreational period 2009-2014 has found a lower median *E.coli* bacterial number of 67 cfu/100 ml but a wider range of *E. coli* numbers (6 to 5000 cfu/100 ml).

4.14.1.1 Comparison with guidelines

E. coli counts for the Waitara River at the town Wharf over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 42.

Table 42 Performance against guidelines at Waitara River at town wharf

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT **Single sample** **261-550/100ml**	**ACTION** **Single sample** **>550/100 ml**
SEM samples	4 [31%]	1 [8%]

Four single samples fell within the 'Alert' mode and one sample just within the 'Action' mode during the monitoring period. The 'Action' mode exceedance occurred on the first sampling, less than four days after a substantial rainfall event in the hinterland and coincided with the second highest turbidity (22 NTU) recorded during the survey period. It has been noted, during past survey periods, that the three-day post rainfall sampling protocols followed by the SEM programme for the other (ringplain) catchment sites are not necessarily appropriate for baseline assessments of bacteriological water quality at this site near the mouth of this predominantly eastern hill country catchment river as a result of the lag effects of rainfall run-off further upstream within this large catchment.

These issues were discussed with the Area Health Board and NPDC staff and appropriately worded health warning signage was permanently installed at the town wharf prior to the 2010-2011 season. However, the permanency of this signage was probematic due in part to vandalism. A new, recreational water quality advisory sign was erected by NPDC at the entrance to the town whart in summer 2016-2017 (Photo 9).

In summary, the bacteriological water quality at this estuarine site was within guidelines for contact recreation for the majority ot the survey period.

Photo 9 Sign at entrance to Waitara town wharf

4.14.1.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Waitara River Town Wharf site over 9 summers is presented in Figure 59.

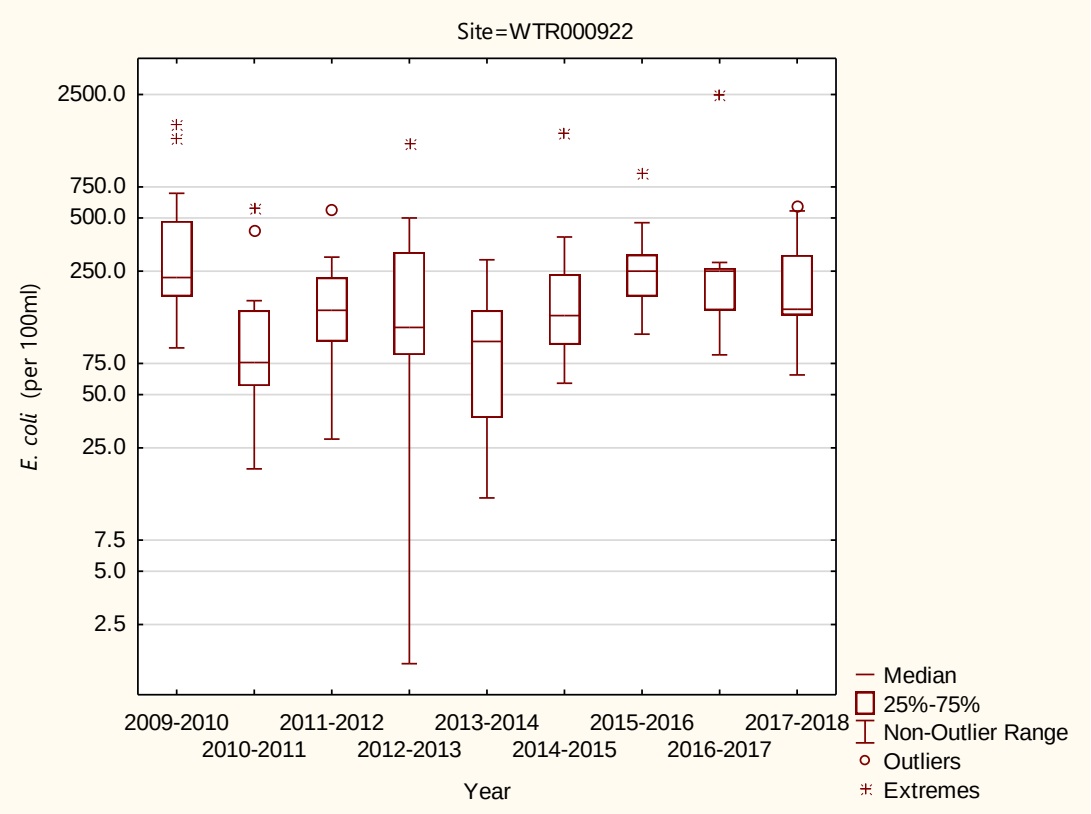


Figure 56 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers for the Waitara River at the town wharf, Waitara

The median *E. coli* number found by this ninth season's survey was the fourth highest recorded, and was well below the 'Alert' mode. A similar median value was recorded the previous year, and six years before. The narrowest range of counts to date was recorded. Trend analysis of median *E.coli* numbers will not be performed until the sampling period has encompassed ten seasons of data collection at this site.

4.15 Urenui River at the estuary

A total of 14 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, as well as one follow up sample.

Bathing usage was noted on four occasions and some fishing and boating during the 2017-2018 sampling surveys at this tidal site. This is a very popular site during weekends and holiday periods (see TRC, 1999 and TRC, 2008a), with these and boating, picnicking and other recreational activities taking place.

All *E.* colidata for this site, from the 2017-2018 summer period, are presented in Figure 57 and summarised in Table 43. The complete survey results are presented in Appendix I.

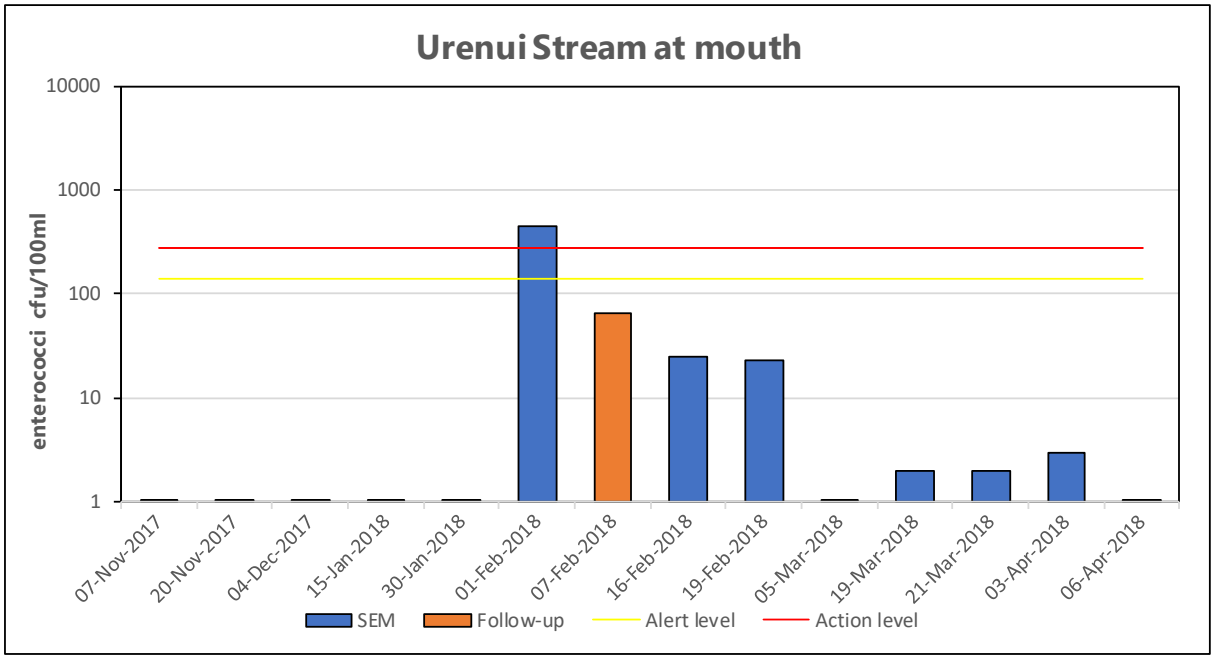


Figure 57 Enterococci numbers for the Urenui River at the estuary during the survey season

Table 43 Statistical summary for Urenui River at the estuary

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	4630	4830	4730
	E. coli	MPN/100ml	13	10	617	20
	Enterococci	cfu/100ml	13	<1	440	<2
	Temperature	°C	13	17.3	24.3	20.6
	Turbidity	NTU	13	1.7	51	7.2

This hill country catchment river typically is turbid under low tide conditions in the tidal lower reaches of the estuary where it is extensively used by visitors and the holiday population based at the Urenui Beach settlement. High tide conditions resulted in aesthetic improvements within the estuary. Under high tide sampling conditions, the minimum (1.7 NTU) and median turbidity (7.2 NTU) levels were indicative of moderately turbid conditions typical of mixing of the more discoloured river flow with inflowing, cleaner seawater. The river at this site was generally described as relatively uncoloured to blue-green to green-brown in appearance and varying between clearish to slightly turbid to turbid. Conductivity levels were characteristic of coastal saltwater on all occasions. Moderately high water temperatures (median of 20.6°C), more typical of coastal seawater temperatures, varied over a moderate range of 7.0°C during the sampling period with a maximum of 24.3°C recorded in late morning in mid-February 2018. All sampling however,

was undertaken prior to 1215 hrs when water temperatures could have been expected to have been cooler than later in the day, depending upon the state of the tide.

Bacteriological water quality was generally very good as a result of the seawater tidal intrusion into the estuary. Poorer bacteriological river water quality might be expected under low outflowing tidal conditions as comparative sampling at the semi-tidal upstream SH3 bridge site to date has identified significantly higher numbers of all three bacteriological species (e.g. medians for *E. coli* [390 per 100 ml] and enterococci [165 per 100 ml]). The existing sampling programme was designed around higher tidal conditions (for SEM trend purposes and due to its incorporation within the coastal sites sampling programme) at times when bathing is more predominant at this site. One unusually high pair of indicator bacteria levels was reported, for 1 February 2018, when a king tide coincided with large swells from a tropical cyclone (Fehi), likely causing suspension of sediment (turbidity 51 NTU) and release of the microorganisms (E. coli, 617 MPN/100ml; enterococci, 440 cfu/100ml).

4.15.1 Comparison with guidelines

Comparison with the 2003 guidelines for contact usage is summarised in Table 44 using the marine guidelines, which are considered to be more appropriate for this estuarine site.

Table 44 Performance against guidelines at Urenui River mouth

Parameter	Number of exceedances of enterococci guidelines	
	ALERT **Single sample** **141-280/100ml**	**ACTION** **Single sample** **>280/100 ml**
SEM samples	0 [0%]	1 [8%]

No single sample fell within the 'Alert' mode and one fell within the 'Action' mode for saline water during the monitoring period. The same results occurred in terms of the freshwater guidelines (for *E. coli*).

The bacteriological water quality at this site was within the acceptable guidelines for contact recreational usage throughout the season, with one exception (during cyclone Fehi), recognising that all sampling occasions coincided with mid to high tides and therefore a predominance of high quality saline water mixing with poorer quality river water at this estuarine site. This was consistent with data for the nearby Urenui Beach coastal site (median enterococci: 3 per 100ml) monitored over eight seasons to date.

4.15.2 Comparison with previous summer surveys

Summary statistics for the SEM enterococci data collected for Urenui River at the mouth over 22 summers is presented in Figure 58.

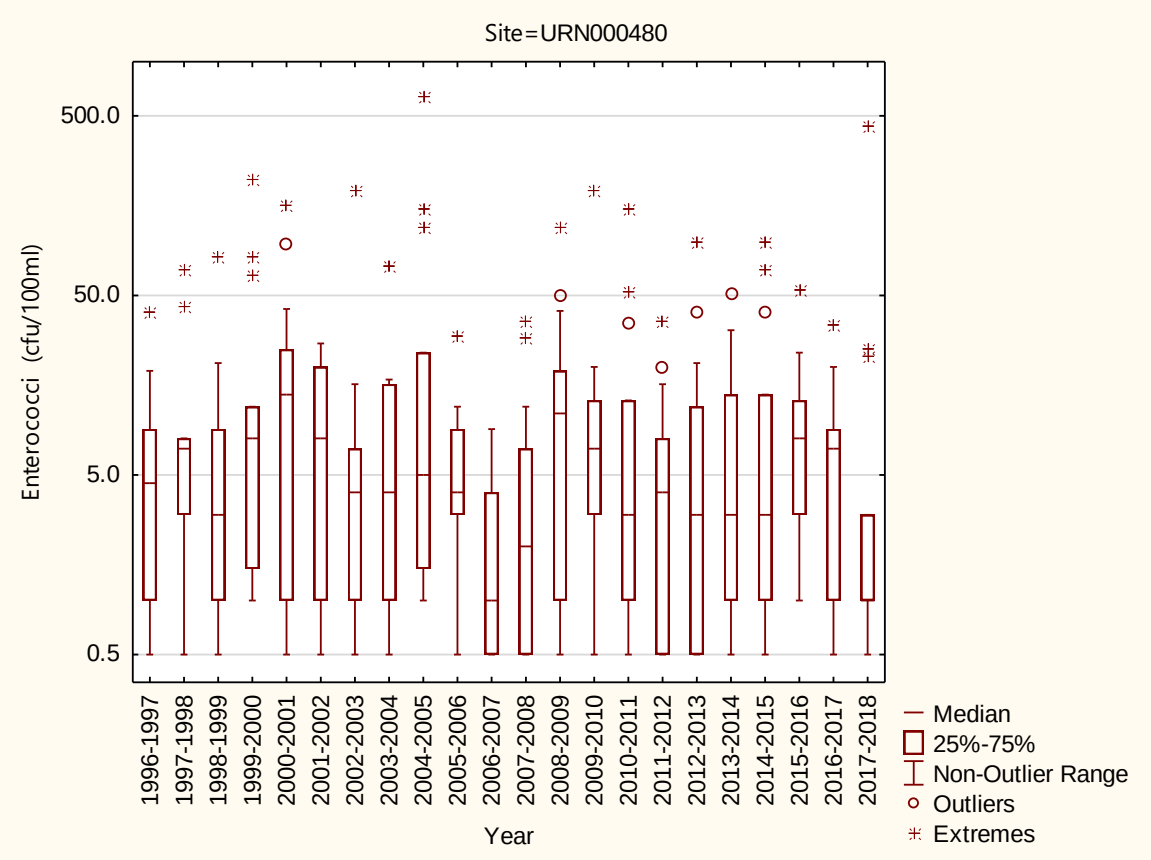


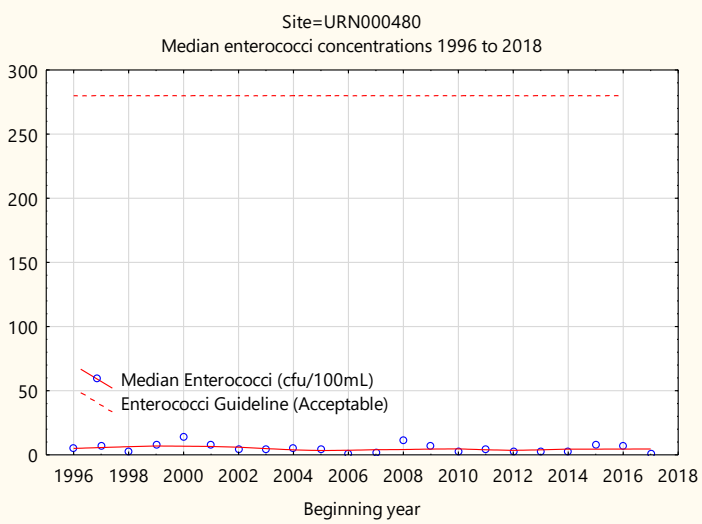
Figure 58 Box and whisker plots of enterococci for all summer surveys in the Urenui River at the estuary

The high bacteriological water quality of the Urenui River estuary, during high tide conditions, continued during the 2017-2018 season (Figure 58). This has been emphasised by all seasonal median enterococci counts being less than 15 enterococci (per 100 ml). The range was relatively wide for enterococci during the 2017-2018 season as a result of a single high sample count of 440 enterococci per 100 ml during the Cyclone Fehi event.

The high bacteriological quality of the coastal sea water intrusion was the major influence on the bacteriological water quality of the lower quality river water at this estuarine site during preferred recreational usage (i.e. higher tide) conditions.

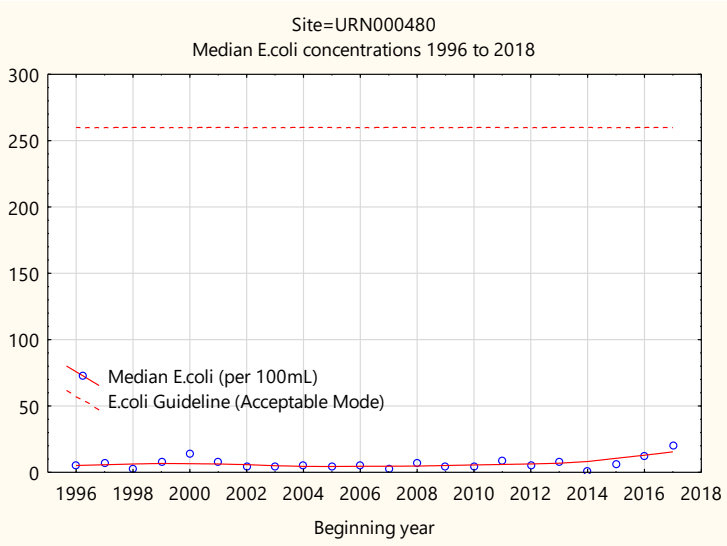
4.15.3 Long-term trend analysis

Trend analysis of median enterococci and *E. coli* numbers has been performed for the twenty-two seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 59 and Figure 60) and testing the significance of any trend using the Mann-Kendall test at 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.



Urenui River mouth - enterococci
N = 22
Kendall tau = - 0.242
p-value = 0.114
FDR p-value = 0.436]

Figure 59 LOWESS trend plot of median enterococci data at the Urenui River, estuary site



Urenui River mouth – *E. coli*
N = 22
Kendall tau = 0.127
p-value = 0.408
FDR p-value = 0.652

Figure 60 LOWESS trend plot of median *E. coli* data at the Urenui River, estuary site

No statistically significant trends in median enterococci or *E. coli* counts (after FDR applications) have been found over the twenty-two seasons of monitoring which have indicated an overall unimportant decrease in enterococci bacteria and a slight increase in *E.coli* bacteria numbers (both at very low median numbers) over this period. None of these medians exceeded the 'Alert' or 'Action' modes for either marine or freshwater contact recreational usage.

4.16 Manganui River at Everett Park (downstream of Kurapete Stream)

A total of 13 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, and no follow up samples were required.

No bathing or other usage of this river site was noted at the time of sampling occasions during the survey period despite the proximity of the site to a nearby outdoor adventure camp. Minimal birdlife was noted at this site during the season, on all but one occasion in mid-March, when ducks were common.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 61 and summarised in Table 45. The complete survey results are presented in Appendix I. River flow records are illustrated in Figure 62.

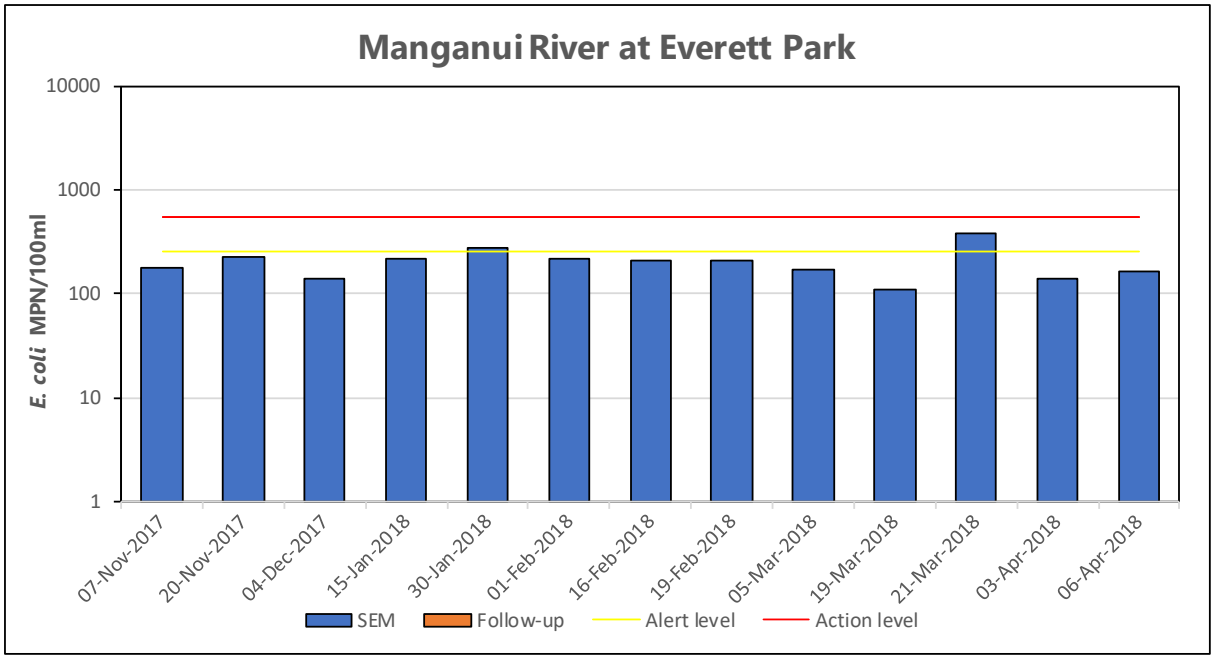


Figure 61 *E. coli* numbers for the Manganui River at Everett Park (downstream of the Kurapete Stream) during the survey season

Table 45 Statistical summary for Manganui River at Everett Park (downstream of the Kurapete Stream)

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	13	9.0	10.9	10.3
	E. coli	MPN/100ml	13	111	387	205
	Temperature	°C	13	14.4	23.2	18.4
	Turbidity	NTU	13	0.57	1.3	0.74

This ring plain river drains an extensively developed agricultural catchment, the site surveyed being situated at Everett Park approximately 300 m downstream of the Kurapete Stream confluence, and about 500 m below another (less utilised) Manganui River recreational site, upstream of the Kurapete Stream. Since the 1999-2000 season's survey, discharges from the Inglewood municipal oxidation ponds' system into the Kurapete Stream (approximately 8 km upstream of the survey site) have been diverted out of the stream to the New Plymouth wastewater treatment plant.

The river was clear and green-brown or colourless at the time of the majority of the sampling surveys, with relatively low conductivity levels. Water temperatures varied over a moderate range of 8.8°C with the maximum temperature (23.2°C) recorded in mid-morning in late January 2018. Higher temperatures could be expected later in the day as no sampling surveys were performed after 1415 hrs at this site.

Bacteriological water quality was moderate for this site during the 2017-2018 survey period with none of the counts recorded during the period below 111 *E. coli* per 100 ml (Figure 61). The elevated count in mid-March 2018 coincided with localised rainfall.

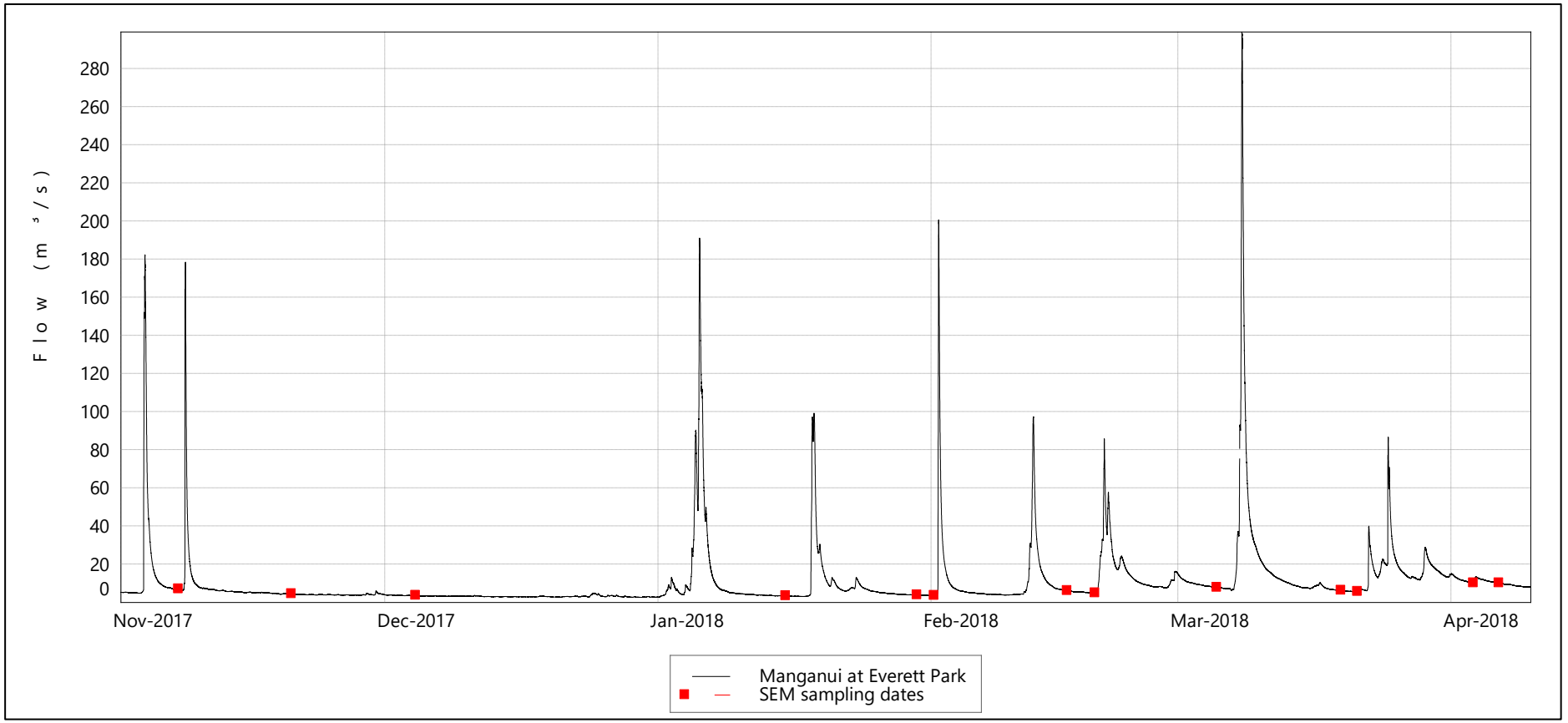


Figure 62 Flow in the Manganui River at Everett Park during the survey period

4.16.1 Comparison with guidelines

E. coli counts for the Manganui River at Everett Park over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 46.

Table 46 Performance against guidelines at Manganui River at Everett Park

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	2 [15%]	0 [0%]

Two single samples fell in the 'Alert' mode during the season, and none exceeded the 'Action' mode.

Bacteriological water quality at this site in terms of contact recreational usage was acceptable considering the impacts of farming activities, particularly in relation to the residual flow remaining in the river in mid-catchment downstream of the Motukawa HEP diversion (i.e., significant abstraction of upper catchment water for hydroelectric power production purposes).

4.16.2 Comparison with previous summer surveys

Summary statistics for the SEM *E. coli* data collected at Manganui River at Everett Park over 22 summers is presented in Figure 63.

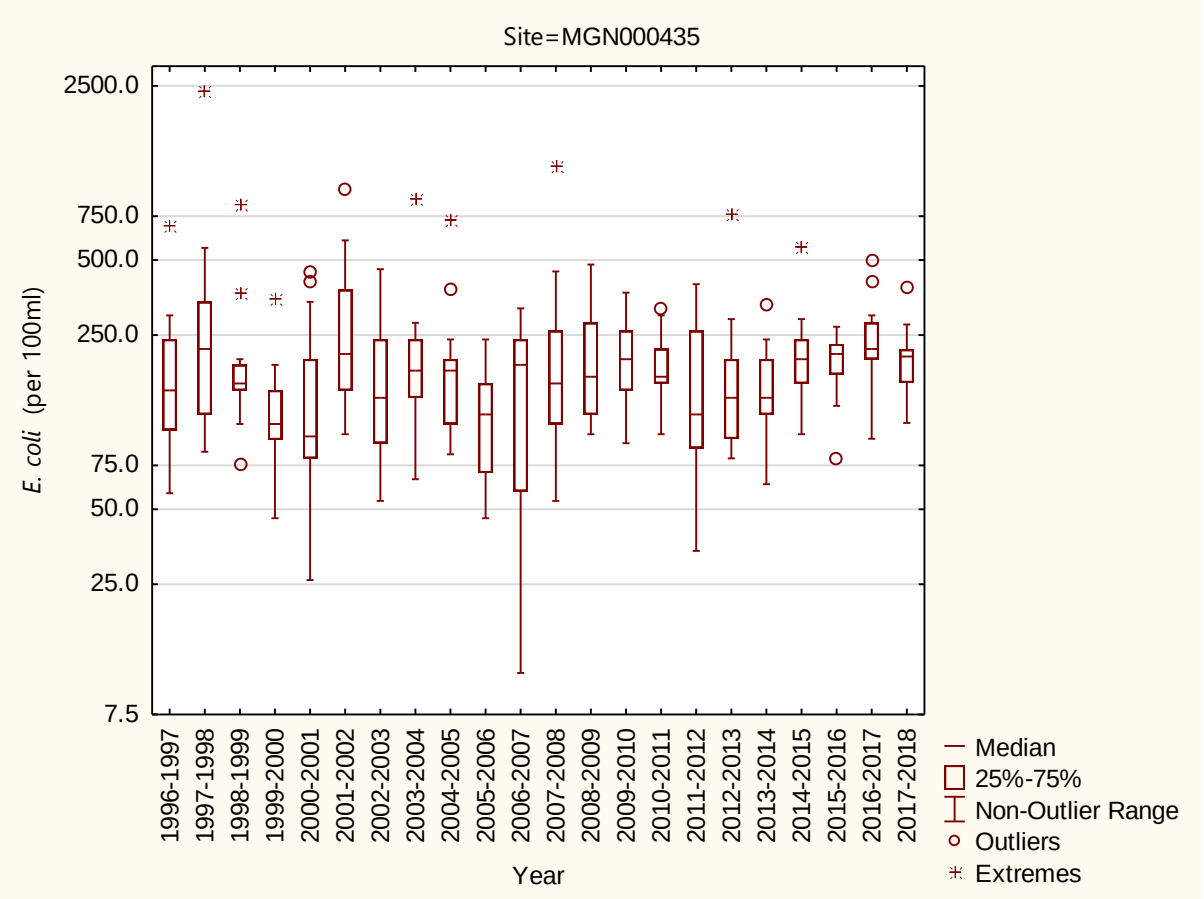


Figure 63 Box and whisker plots of *E. coli* for all summer surveys in the Manganui River at Everett Park

The median *E. coli* count for the 2017-2018 season was among the higher of the twenty-two seasons' medians recorded since the inception of the programme in 1996-97 (Figure 63). The number of single samples entering the alert mode, at two, was typical.. The range of *E. coli* numbers was typical of those recorded to date, mainly due to a moderate maximum count of 387 per 100 ml, in the mid-range of seasonal maxima recorded to date at this site.

4.16.3 Long-term trend analysis

Trend analysis of these median *E. coli* numbers has been performed for the twenty-two seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 64) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.

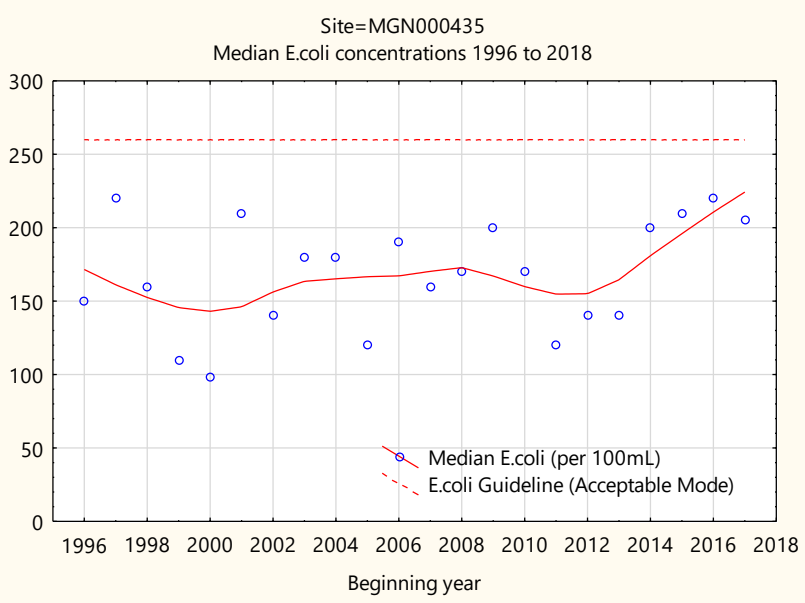


Figure 64 LOWESS trend plot of median *E.coli* data at the Manganui River, Everett Road site

A slight, unimportant, and statistically insignificant increase in median *E. coli* counts has been found over the twenty-two seasons of monitoring. None of these seasonal medians has exceeded the 'Alert' or 'Action' modes.

4.16.4 Cyanobacteria

Benthic cyanobacteria were monitored on nine occasions through the season with results presented in Table 47 and Figure 65.

Table 47 Percentage benthic cyanobacteria cover, detached and exposed mats at the Manganui River at Everett Park

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
02/11/2017	16	No	No	Surveillance
14/11/2017	1	No	No	Surveillance
06/12/2017	1	No	No	Surveillance
20/12/2017	4	No	No	Surveillance
11/01/2018	2	No	No	Surveillance

Date	Average cyanobacteria % cover	Detaching mats	Exposed mats	Mode
24/01/2018	4	No	No	Surveillance
07/02/2018	12	No	No	Surveillance
26/02/2018	11	No	No	Surveillance
22/03/2018	1	No	No	Surveillance

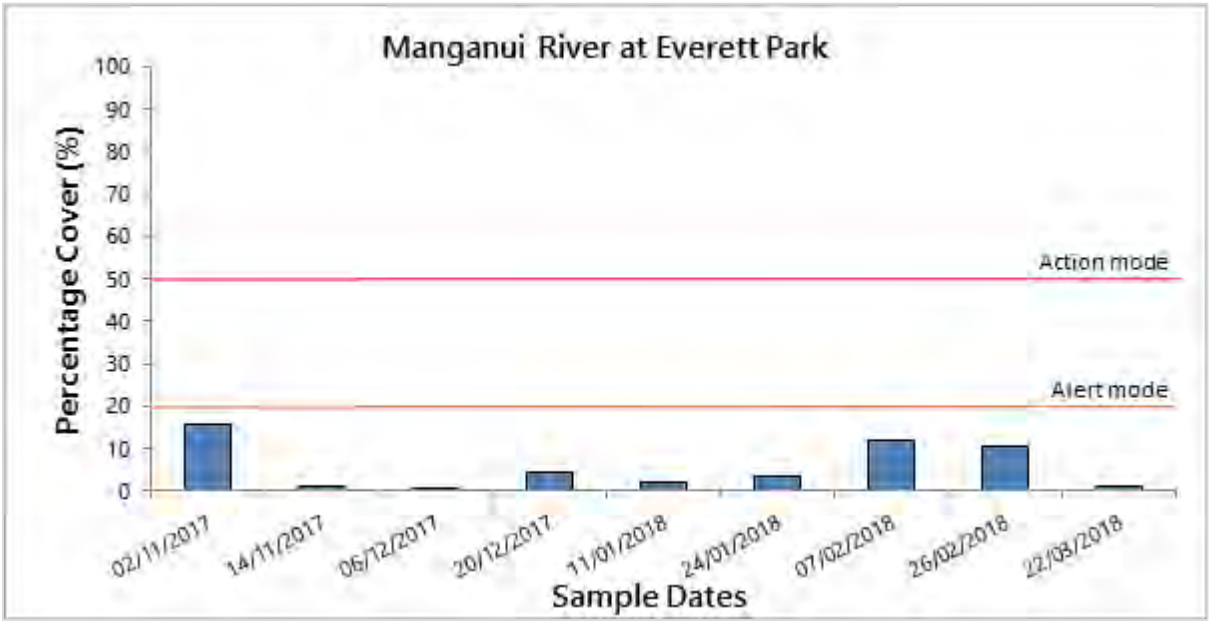


Figure 65 Percentage benthic cyanobacteria cover at the Manganui River at Everett Park. '

Note that 'Action' and 'Alert' mode lines are for percentage cover only. The symbols * and ⁺ over a bar indicate where the status been raised to 'Alert' or 'Action' mode, respectively due to detaching or exposed mats.

Benthic cyanobacteria coverage was low for the monitoring period with a median of 4% (range from 1 to 16%). The 'Action' and 'Alert' levels were never exceeded for percentage cover or for detaching and exposed mats. The benthic cyanobacteria found were *Phormidium* sp.

4.17 Lake Ratapiko

A total of 13 samples were collected at this site over the summer. All 13 scheduled SEM samples were collected, and no follow up samples were required

Bathing usage of the lake was not observed. Boating and jet-skiing were recorded on one occasion. However, the lake is commonly used for boating and fishing purposes, particularly at weekends and holidays. Ducks were present occasionally in low or common numbers. Minimal stock access to the lake margins was recorded, unlike on some past occasions (TRC, 2013). The lake was drawn down for maintenance purposes at the end of this season (early April 2017), and as a result sampling was unable to be performed on one occasion.

All *E. coli* data for this site, from the 2017-2018 summer period, are presented in Figure 66 and summarised in Table 48. The complete survey results are presented in Appendix I.

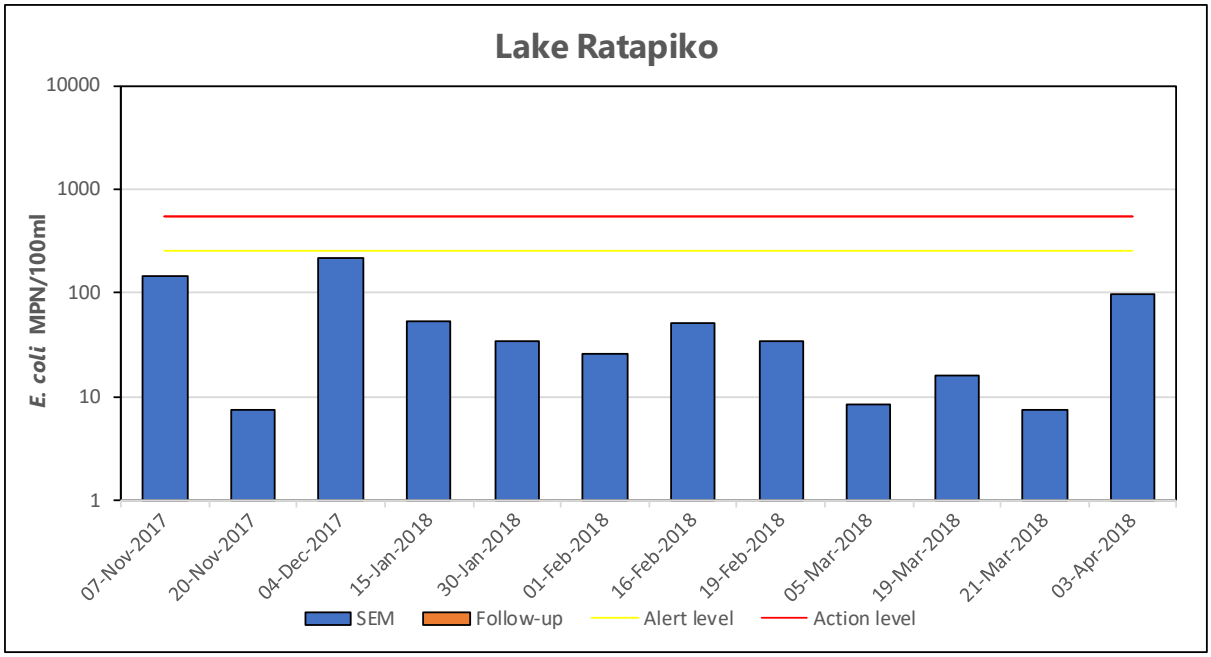


Figure 66 *E. coli* results for Lake Ratapiko

Table 48 Statistical summary for Lake Ratapiko

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM samples	Conductivity	mS/m@20°C	12	7.2	9.3	8.2
	E. coli	MPN/100ml	12	7.5	214	34
	Temperature	°C	12	16.6	26.6	21.1
	Turbidity	NTU	12	0.7	1.8	1.2

The lake is replenished by diversion water flow from the mid reaches of the Manganui River via the Motukawa HEP scheme. Water quality was generally very good with minimal variation in clarity (median turbidity: 1.2 NTU; range of turbidity: 1.1 NTU) as a result of low suspended algae populations possibly due to short retention times in the lake. Water temperatures were relatively high over a moderately wide range of 10.2˚C for the period with a low maximum of 26.6˚C (mid-morning in late January 2018) although all of the measurements were recorded prior to 1400 hrs. Conductivity showed low variation (up to 2.1 mS/m) during the period.

Generally, bacteriological quality was good considering that the inflow to the lake is from the mid reaches of a river draining a developed farmland catchment.

4.17.1 Comparison with guidelines

E. coli counts for Lake Ratapiko over the 2017-2018 summer are summarized against the guidelines for freshwater contact usage in Table 49.

Table 49 Performance against guidelines at Lake Ratapiko

Parameter	Number of exceedances of *E. coli* guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
SEM samples	0 [0%]	0 [0%]

No single sample exceedance of the 'Action' mode or was recorded within the 'Alert' mode during the review period.

Bacteriological water quality was good and within acceptable guidelines for contact recreational usage throughout the survey period.

4.17.2 Comparison with previous summer surveys

Summary statistics for the SEM *E.* coli data collected at Lake Ratapiko over 12 summers is presented in Figure 67.

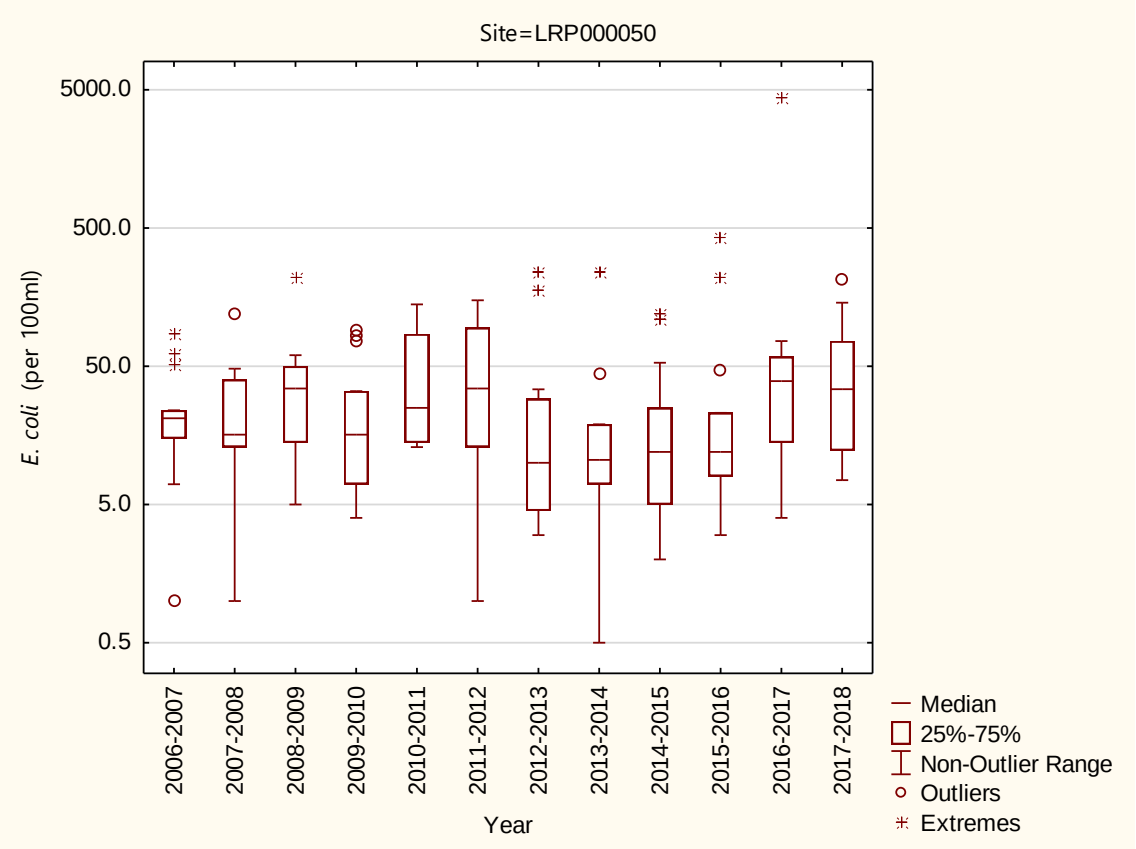


Figure 67 Box and whisker plots of *E.coli* for all summer SEM surveys at Lake Ratapiko

A low median *E. coli* number was found by the latest season's survey and a moderate range of counts was recorded. All seasonal medians have been low, with this season's being the fourth highest of the twelve seasons' medians to date.

4.17.3 Long-term trend analysis

Trend analysis of these median *E.coli* numbers has been performed for the twelve seasons of data by first applying LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 68) and testing the significance of any trend using the Mann-Kendall test at the 5% level followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

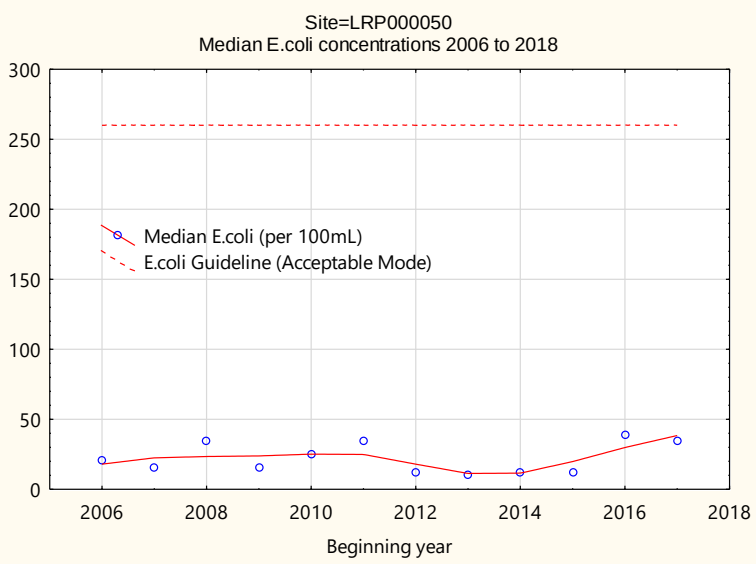


Figure 68 LOWESS trend plot of median *E. coli* data at the Lake Ratapiko site

No statistically significant trends in median *E.coli* counts have been found over the twelve seasons of monitoring, which have indicated an unimportant increase in *E.coli* numbers over this period. None of these medians exceeded the 'Alert' or 'Action' modes for freshwater contact recreational usage.

4.17.4 Cyanobacteria

Planktonic cyanobacteria were monitored on nine occasions throughout the season. The results of these analyses are presented in Table 50.

Table 50 Cyanobacteria counts (cells/mL) at Lake Ratapiko [Health warning: >1.8 mm3/L]

Date	Cyanobacteria total cell count (cells/mL)	Biovolume (mm^3/L)	Principal species by biovolume	Mode
07/11/2017	0	0	No cyanobacteria present	Surveillance
28/11/2017	0	0	No cyanobacteria present	Surveillance
12/12/2017	0	0	No cyanobacteria present	Surveillance
03/01/2018	0	0	No cyanobacteria present	Surveillance
25/01/2018	0	0	No cyanobacteria present	Surveillance
07/02/2018	0	0	No cyanobacteria present	Surveillance
01/03/2018	0	0	No cyanobacteria present	Surveillance
19/03/2018	0	0	No cyanobacteria present	Surveillance

Planktonic cyanobacteria were not detected throughout the entire recreational monitoring year.

Previously, no cyanobacteria had been found in this lake during any of the monitoring periods from 2006 to 2013 with the exception of low numbers of *Anabaena* present in the latter part of the 2007-2008 season following a lengthy, extremely low flow period. Also, moderate numbers of *Anabaena* were found during late January, 2014 during a dry period, but these numbers reduced rapidly by late February, 2014 and none were found by the survey of mid-March 2014. A similar event, with a near 'high risk' bloom of *Picocyanobacteria* occurred briefly in February 2016. The relatively short lake water residence time (due to hydroelectric power generation usage) may be a factor in the control of these bacteria populations.

4.18 Lake Rotokare

Cyanobacteria monitoring of this lake was instigated in the 2007-2008 season in recognition of this small lake's recreational usage, particularly for boating activities. A reduced bacteriological monitoring programme was also included, as considered appropriate. The boating season is restricted to the period from 1 December to 1 May by the STDC in recognition of the status of the Rotokare Scenic Reserve.

Some bacteriological water quality monitoring was also undertaken in conjunction with the cyanobacteria monitoring during the 2017-2018 season, with the lake sampled on eleven occasions between early November 2017 and late March 2018. [Note: bacteriological monitoring is not a component of the SEM programme at this lake].

No usage of the lake, other than two walkers, was recorded during the 2017-2018 surveys, all of which occurred on week days between mid-morning and mid-afternoon. In the 2016-2017 monitoring period, walkers (visitors) and camping were noted, and kayaking early in the season. The boat ramp was locked from late November for the remainder of the monitoring period. Birdlife, a few ducks, scaup and shags were observed at the lake margin on the majority of monitoring occasions. The lake appeared turbid, green or green-brownish throughout most of the period with a clearer appearance at the beginning and end of the period.

The bacteriological water quality data for this site are presented in Table 51 with a statistical summary provided in Appendix I.

Table 51 Statistical summary for Lake Rotokare

Parameter		Units	Number of samples	Minimum	Maximum	Median
SEM+MfE samples	Conductivity	mS/m@20°C	11	12.5	13.6	13.2
	E. coli	MPN/100ml	11	20.3	345	96.0
	Temperature	°C	11	18.8	25.9	21.9
	Turbidity	NTU	11	0.7	11	1.6

In general, bacteriological water quality was good, as might be expected for a small, bush clad lake with only small inflows and relatively low wildfowl numbers. Conductivity levels were very stable (range: 1.1 mS/m) through the period despite variations in inflow during the season. Water temperatures varied over a moderate range of 7.1˚C with a maximum of 25.9˚C recorded in late January 2018. Turbidity was relatively low (median: 1.6 NTU) with the range (10 NTU) reflecting the variability in abundances of suspended algae in the water column during the season. Highest turbidities (≥ 10 NTU) were coincidental with peaks in cyanobacteria concentrations in November and December 2017.

No bacterial counts from routine sampling entered the 'Action' level on any occasion during the season, and one count reached 'Alert' level. It should be noted that in past seasons the overriding health warnings on both the Regional Council website and on the sites at the lake and road access have related to cyanobacteria level exceedances of guidelines (see below), and not to bacterial counts. It has been noted in the past, that as cyanobacteria numbers decreased later in some seasons, coincidentally *E.coli* bacterial numbers increased.

4.18.1 Cyanobacteria

Planktonic cyanobacteria at Lake Rotokare were monitored on eight occasions throughout the season with results presented in Table 52 and Figure 69.

Table 52 Cyanobacteria counts (cells/mL) at Lake Rotokare [Health warning: >1.8 mm^3/L]

Date	Cyanobacteria total cell count (cells/mL)	Biovolume (mm3/L)	Principal species by biovolume	Mode
02/11/2017	31876	6.69	Anabaena circinalis	Action
28/11/2017	64042	13.45	Anabaena circinalis	Action
12/12/2017	15900	3.28	Anabaena circinalis	Action
03/01/2018	5913	0.92	Anabaena circinalis	Alert
15/01/2018	118	0.02	Anabaena circinalis	Surveillance
25/01/2018	0	0.00	No cyanobacteria	Surveillance
07/02/2018	1870	0.39	Anabaena circinalis	Surveillance
26/02/2018	1368	0.29	Anabaena circinalis	Surveillance

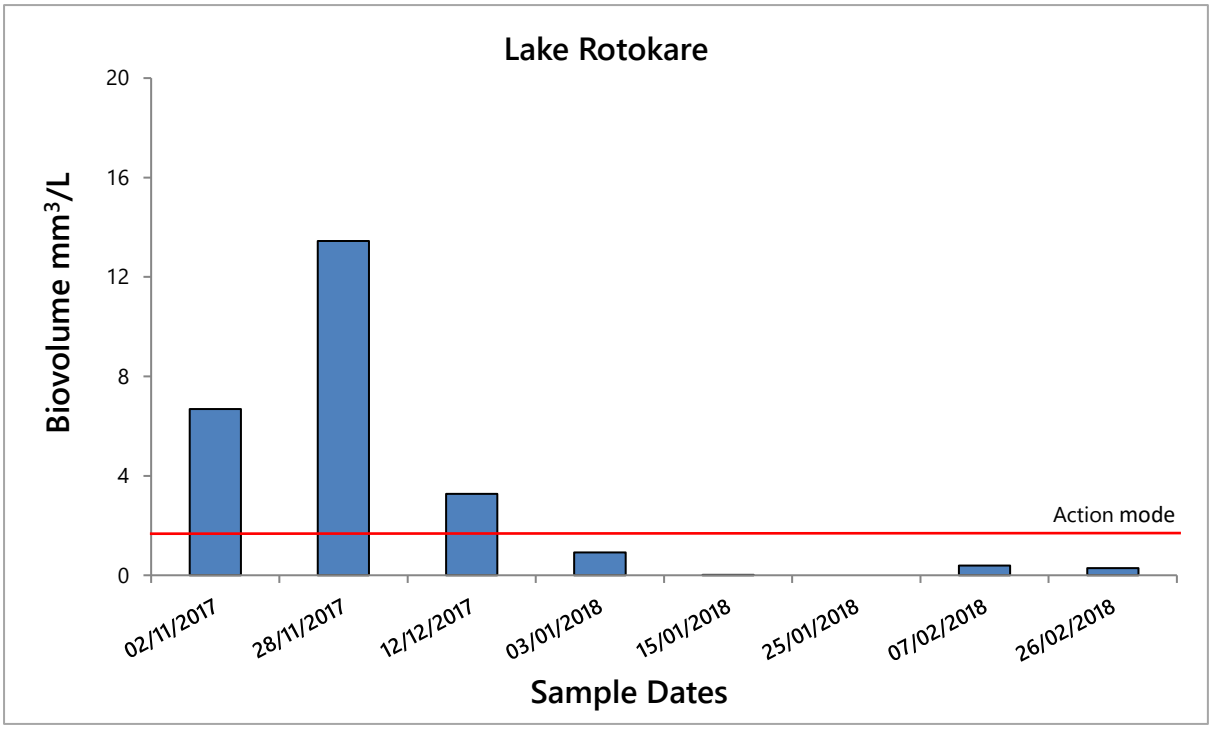


Figure 69 Cyanobacteria counts (cells/ml) at Lake Rotokare [Health warning: >1.8 mm^3/L]

There were high levels of planktonic cyanobacteria biovolumes recorded in late spring and early summer. Cyanobacteria biovolume levels then decreased to low levels from mid-summer onwards.

The installation of a blue-green algal hazard warning sign by the STDC upon advice from the Taranaki Area Health Board occurred once levels exceeded the health guideline (>1.8mm^3/L) from early November to mid-January. The District Health Board did not require algal toxin testing during the period.

5 Discussion

5.1 General data summary

A comparative summary of results of the twenty-first summer bacteriological quality freshwater survey involving seventeen contact recreational sites in the Taranaki region is provided in Table 53. Results are also illustrated in Figure 70 for each of the bacteriological species and a comparison of all sites' summer data is presented in Appendix VI in the form of statistical 'box and whisker' plots.

A comparative summary of results of the twenty-second summer bacteriological quality freshwater survey involving sixteen contact recreational sites in the Taranaki region is provided in Appendix X/Table 53. Results for *E.* coli are illustrated in Figure 70, and a comparison of all sites' summer data is presented in Appendix VI in the form of a statistical 'box and whisker' plot.

Table 53 Statistical summary of results for the sites sampled in the SEM freshwater contact recreational water quality survey, 2017-2018

Site		Temperature (°C)	Conductivity @ 20°C (mS/m)	E. coli (cfu/100 ml)	Enterococci (cfu/100 ml)	Turbidity (NTU)
Lake Rotomanu	Median	24.9	11.9	66		10
	Minimum	18.7	10.8	13		6.8
	Maximum	28.6	12.9	727		15
	No. of samples	13	13	13		13
Waiwhakaiho River at Merrilands Domain	Median	20.1	12.5	124		0.5
	Minimum	13.7	10.1	34		0.3
	Maximum	24.5	14.4	1300		1.6
	No. of samples	13	13	13		13
Waiwhakaiho River adjacent to L. Rotomanu	Median	21.7	13.0	1300		0.9
	Minimum	16.9	9.7	331		0.6
	Maximum	26.1	677	4880		2.1
	No. of samples	13	13	13		13
Te Henui Stream at mouth, East End	Median	19.2	714	1400		0.9
	Minimum	13.9	14.9	108		0.3
	Maximum	22.6	4570	3450		30
	No. of samples	13	13	13		13
Patea River at King Edward Park, Stratford	Median	15.6	9.5	411		0.7
	Minimum	12.3	8.4	86		0.5
	Maximum	20.6	10.2	1300		1.5
	No. of samples	13	13	13		13
Patea River at boatramp, Patea	Median	19.6	4750	10	15	15
	Minimum	15.7	1510	<10	<1	5.8
	Maximum	23.5	4850	86	72	41
	No. of samples	13	13	13	13	13
Waingongoro River at Eltham camp	Median	17.0	11.4	435		1.0
	Minimum	14.1	10.2	105		0.6
	Maximum	23.7	12.7	921		1.9
	No. of samples	13	13	13		13

Site		Temperature (°C)	Conductivity @ 20°C (mS/m)	E. coli (cfu/100 ml)	Enterococci (cfu/100 ml)	Turbidity (NTU)
Waingongoro River at Ohawe Beach	Median	20.2	17.5	201		1.8
	Minimum	16.5	16.0	105		1.0
	Maximum	25.3	2300	435		7.6
	No. of samples	13	13	13		13
Kaupokonui River at beach domain	Median	21.9	103	228		1.3
	Minimum	17.2	13.8	152		0.8
	Maximum	26.4	2150	613		29
	No. of samples	13	13	13		13
Lake Opunake adjacent to boat ramp	Median	22.0	13.3	146		0.9
	Minimum	16.7	12.3	60		0.6
	Maximum	26.5	15.0	548		2.0
	No. of samples	13	13	13		13
Timaru Stream at Weld Road (near mouth)	Median	19.1	34.5	411		0.6
	Minimum	15.3	18.1	158		0.3
	Maximum	23.0	4640	4840		20
	No. of samples	13	13	13		13
Oakura River d/s of SH45 bridge	Median	19.9	59.5	119		0.6
	Minimum	14.7	8.4	47		0.3
	Maximum	22.3	2880	977		9.6
	No. of samples	13	13	13		13
Waitara River at town wharf, Waitara	Median	21.4	756	152		3.6
	Minimum	17.1	10.2	65		2.3
	Maximum	24.7	2350	579		24
	No. of samples	13	13	13		13
Urenui River at estuary	Median	20.6	4730	20	1	7.2
	Minimum	17.3	4630	10	<1	1.7
	Maximum	24.3	4830	617	440	51
	No. of samples	13	13	13	13	13
Manganui River d.s of Kurapete S. (Everett Park)	Median	18.4	10.3	205		0.7
	Minimum	14.4	9.0	111		0.6
	Maximum	23.2	10.9	387		1.3
	No. of samples	13	13	13		13
Lake Ratapiko at boat ramp	Median	21.1	8.2	34		1.2
	Minimum	16.6	7.2	8		0.7
	Maximum	26.6	9.3	214		1.8
	No. of samples	12	12	12		12

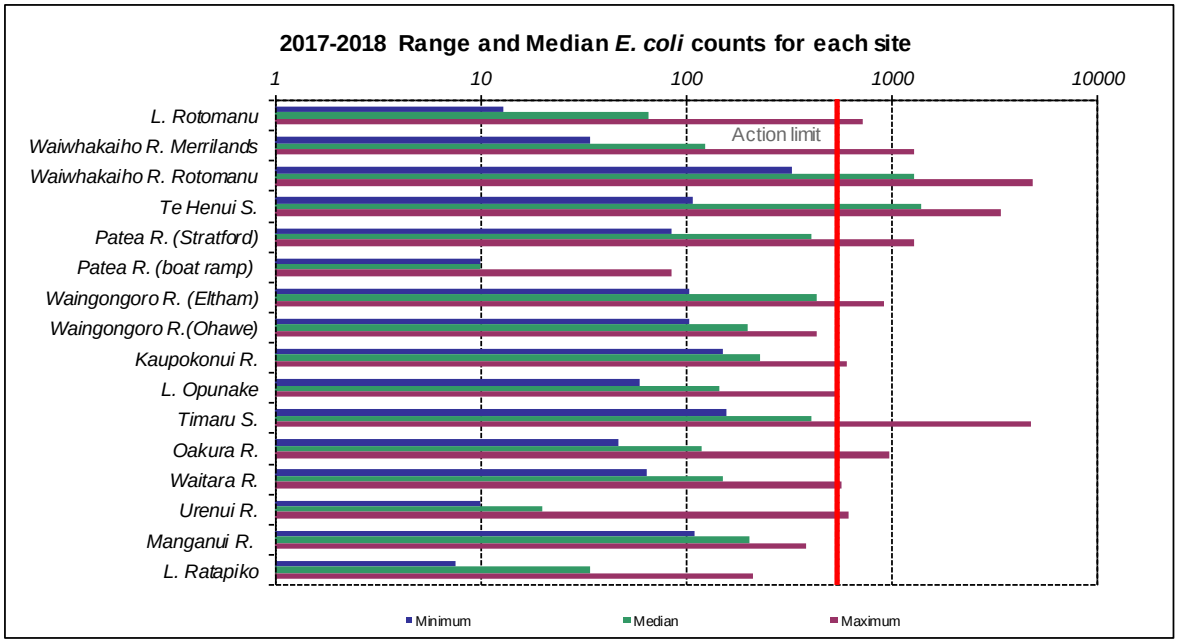


Figure 70 Ranges and medians *of E. coli* numbers recorded from all sites by the SEM programme over the 2017-2018 survey season

Non-exceedance of the 2003 guidelines has varied amongst the sixteen freshwater contact recreational sites sampled during the survey period (Figure 70 and Table 54), to the same degree as recorded in many of the previous seasons. In relation to the guidelines, two sites (Waiwhakaiho River at Lake Rotomanu and Te Henui Stream at East End beach), regularly failed to be below the *E. coli* 'Action' guideline suitable for contact recreation. In terms of median *E. coli* counts, these were also the only sites with the median count in the 'Action' (>550 *E. coli* per 100ml) mode. Three sites (Patea River at Stratford, Timaru Stream at mouth and Waingongoro River at Eltham camp) had median counts in the 'Alert' (>260 *E. coli* per 100 ml) mode. None of the other sites had a median count in the 'Action' or 'Alert' modes.

Table 54 Number of occasions single sample *E.coli* counts entered the 'Alert' and 'Action' modes and percentage [%] of samples which were below these modes, 2017-2018

Site	' Surveillance' mode	'Alert' mode	'Action' mode
Lake Rotomanu at western beach	[92%]	0	1
Waiwhakaiho River at Merrilands Domain	[77%]	1	2
Waiwhakaiho River adjacent to L Rotomanu	[0%]	3	10
Te Henui Stream at mouth, East End	[8%]	0	12
Patea River at King Edward Park, Stratford	[8%]	7	5
Patea River at boatramp, Patea	[100%]	0	0
Waingongoro River at Eltham Camp	[31%]	5	4
Waingongoro River at Ohawe beach [2]	[69%]	4	0
Kaupokonui River at beach domain	[69%]	2	2
Lake Opunake at boat ramp	[69%]	4	0
Timaru Stream at Weld Road	[38%]	5	3
Oakura River at SH45	[69%]	2	2
Waitara River at town wharf, Waitara	[62%]	4	1
Urenui River at estuary*	[92%]	0	1
Manganui River at Everett Park	[84%]	2	0
Lake Ratapiko at boat ramp[1]	[100%]	0	0

[Notes: N = 13 samples; * = enterococci count;] [2] Not a regional bathing site

Two sites maintained counts below the 'Alert' mode at all times throughout the season, while an additional three sites maintained counts below the 'Action' mode (Table 54 and Table 56) at all times, so, of the 16 recognised bathing sites, four (31%) never had a non-compliance during the 2017-2018 season, and another two (15%, giving 46% altogether) had only one non-compliance. In terms of the overall monitoring season, thirty-nine 'Alert' levels (19% of counts) and forty-three 'Action' levels (21% of counts) resulted over the period representing an overall 60% achievement of the 'Surveillance' contact recreational guideline (compared with 74%, 71%, 72% and 60% achievement in the 2013-2014, 2014-2015, 2015-2016 and 2016-2017 seasons, respectively). Reviewing only the 'Action' level samples (i.e. those which indicate swimming poses an unacceptable risk), 79 % of all samples met the bathing guideline in 2017-2018. Of these 21% of samples that were non-compliant, 11% were from just two urban sites – the lower Waiwhakaiho River and the Te Hēnui Stream. Both sites have high bird populations. Comparing levels of compliance for the same suite of sites over the past four years, the 79.2% compliance rate in 2017-2018 follows on from 86.% in 2016-2017, 84.1% in 2015-2016 and 85.6% in 2014-2015. Thus, while bacteriological levels generally were higher in the latest period, this did not lead to a noticeable increase in conditions when swimming would have involved an unacceptable risk.

In terms of guidelines attainment, the sites may be ranked in the following order for the 2017-2018 season:

1= Patea River at boat ramp, Patea

1= Lake Ratapiko

3= Lake Rotomanu

3= Urenui River at estuary

5 Manganui River at Everett Park

6 Waiwhakaiho River at Merrilands Domain

7= Waingongoro River at Ohawe Beach

7= Lake Opunake at boat ramp

7= Kaupokonui River at beach domain

7= Oakura River d/s SH45 bridge

11 Waitara River at town wharf

12 Timaru Stream at Weld Road (near mouth)

13 Waingongoro River at Eltham

14= Patea River at King Edward Park

14= Te Hēnui Stream at mouth, East End.

16 Waiwhakaiho River adjacent to Lake Rotomanu

Overall, a wide range from poor to very good bacteriological water quality was measured at the sixteen sites. In terms of results to date, this represented no overall change, with measured water quality improving at some sites and reducing at others. In terms of median *E. coli* counts, by far the best bacteriological quality was again found in the lower (estuarine) reach of the Patea River, and at the most estuarine site (Urenui River) which was strongly influenced by seawater penetration during high tide conditions, where both sites' median count were ≤10 *E.coli* per 100 ml. The programme focused on high tide periods due to its design and integration with the coastal bathing water quality monitoring programme. While future programmes' designs could give consideration to extending sampling to include low tide timing of sampling (at tidal sites), if this becomes necessary, it is essential that the high-tide format is retained for future trend monitoring purposes.

Based upon median *E. coli* bacterial numbers for the survey period, the following ranking of sites (in descending water quality) may be used to summarise results:

1 Patea River at boatramp, Patea

2 Urenui River at estuary

3 Lake Ratapiko

4 Lake Rotomanu

5 Oakura River d/s of SH 45 bridge

6 Waiwhakaiho River at Merrilands Domain

7 Lake Opunake at boat ramp

8 Waitara River at town wharf, Waitara

9 Waingongoro River at Ohawe Beach

10 Manganui River at Everett Park (d/s of Kurapete Stream)

11 Kaupokonui River at beach domain

12= Timaru Stream at Weld Road (near mouth)

12= Patea River at King Edward Park, Stratford

14 Waingongoro River at Eltham camp

15 Waiwhakaiho River adjacent to Lake Rotomanu

16 Te Henui Stream at mouth, East End

The three highest rankings remained at the three sites which were highest ranked for the last several seasons. The three lowest rankings also remained at the same three sites. The biggest improvement in ranking, in comparison with the 2016-2017 season, occurred in the Waitara Rver at the town wharf, although the median *E. coli* count was well within the previous range. Kaupokonui River at the beach domain slipped down in the rankings (four places to eleventh) in terms of seasonal median bacteriological water quality, where the median *E.coli* count was the highest since 1996-1997

5.2 Comparison with twenty-one previous summers' surveys

A statistical comparison of each summer's survey *E. coli* data is presented graphically in Appendix VI for all sites. Shorter data periods exist for the Patea River (at King Edward Park, Stratford) and Waingongoro River (at Eltham camp) which were added in 2001-2002, two lakes' sites (Lakes Ratapiko and Opunake) which were added in 2006-2007, the site in the lower reaches of the Patea River which was added in the 2007-2008 season, the site in the lower Waitara River which was added in the 2009-2010 season, and the sites in the lower reaches of the Waiwhakaiho River and Te Henui Stream which were added in the 2011-2012 season.

In general terms, *E. coli* bacteriological water quality was within ranges generally similar to those recorded over most previous summer bathing seasons. There was marked deterioration at six sites and improvement at four sites in terms of median counts, in comparison with the previous summer's results (as determined on the basis of >20% change where the median value was ≥10 per100 ml). Variability in quality between bathing seasons at each site may be related to a variety of reasons including hydrological conditions, stock access, wildlife presence, and dairy farm wastes disposal practices in particular.

All seasons' results have been summarised in terms of comparisons with the single sample modes of the MfE, 2003 guidelines for each site over the period since the state of the environment monitoring programme commenced (over the 1996-1997 season). This summary is presented in Table 56.

Noting that there is some variability in the numbers of sites included in each season's programme, conformity with the 'Surveillance' guidelines has occurred on 70% of sampling occasions over the combined twenty-two seasons to date with the worst season (2016-2017, by 1%) showing 60% guidelines conformity and the best seasons (1996-1997 and 1999-2000) 82% conformity with the guidelines. The previous season (2016-2017) was the historical minimum and the latest season showed no change. (Note that in any comparison between seasons, variability in monitored sites should be taken into account).

A ranking of sites based upon the historical average conformity with the surveillance mode guideline for the period 1996 to date can be summarised as follows:

1= Patea River at boat ramp, Patea

1= Urenui River at estuary

1= Lake Ratapiko

4 Waiwhakaiho River at Merrilands Domain

5= Oakura River at SH45

5= Waingongoro River at Ohawe Beach

5= Lake Rotomanu

8= Manganui River at Everett Park

8= Kaupokonui River at beach domain

10= Lake Opunake

10= Waitara River at town wharf, Waitara

10= Waingongoro River at Eltham Camp

13 Timaru Stream at Weld Road

14 Patea River at King Edward Park, Stratford

15 Waiwhakaiho River adjacent to Lake Rotomanu

16 Te Henui Stream at mouth, East End

One estuarine site (the Patea River) has never reached the 'Alert' *E.coli* level of the guidelines over the 22 seasons to date. All sites ranked above tenth have not exceeded guidelines on an average of at least 75% of seasonal sampling occasions. The poorest bacteriological water quality (less than 7% of seasonal sampling occasions within guidelines) has been recorded at the Te Henui Stream mouth where the resident wildfowl population has been the principal contributor to elevated *E.coli* counts. This has also been the case for the Waiwhakaiho River adjacent to Lake Rotomanu, the second worst site.

Temporal trending of season's median *E.coli* counts at each of the fifteen sites, with a minimum of ten years' data, was undertaken statistically for the period 1996 to 2018. One of these sites has shown a statistically significant ($p < 0.01$ after FDR application) trend in median *E.coli* counts:

- Waiwhakaiho River opposite Lake Rotomanu had a very strong trend of increasing median *E.coli* numbers over the 22 year period (15 seasons) to date which was significant at $p < 0.01$ after FDR application

Another two sites showed a significant ($p<0.05$, but not after FDR) application trend in median *E. coli* counts.

- Te Henui Stream at the mouth had a strong trend of increasing median *E. coli* numbers over the 16 year period which however was significant at $p<0.05$ but not after FDR application
- Waingongoro River at Eltham camp had a strong trend in increasing median *E. coli* number over the 17 year period which however was significant at $p<0.05$ but not after FDR application.

A ranking of the order of the significance of the temporal trends at those sites with a minimum of ten seasons' data (fifteen sites) is provided in Table 55.

Table 55 Ranking of sites in terms of significant temporal trends in median *E.coli* counts over the period 1996 to 2018

Site location	Valid N	p-level	FDR-corrected p value	Trend
Waiwhakaiho River at Lake Rotomanu	15	0.0001	0.0015	↑↑↑
Te Henui Stream mouth, East End	16	0.0127	0.1019	↑
Waingongoro River at Eltham camp	17	0.0273	0.1454	↑
Urenui River at estuary - enterococci	22	0.1144	0.4361	↓
Manganui River at Everett Park	22	0.1415	0.4361	↑
Oakura River d/s SH45 bridge	22	0.1635	0.4361	↑
Timaru Stream at end of Weld Road	21	0.1915	0.4377	↑
Lake Rotomanu western beach	22	0.2435	0.4870	↑
Waiwhakaiho River at Merrilands Domain	22	0.3800	0.6522	↑
Urenui River at estuary	22	0.4076	0.6522	↑
Patea River at boat ramp, Patea	11	0.4754	0.6738	↑
Kaupokonui River at Beach Domain	22	0.5054	0.6738	↑
Lake Opunake at boat ramp	12	0.5775	0.7107	↓
Waingongoro River at Ohawe Beach	22	0.7066	0.7872	↑
Patea River at King Edward Park	17	0.7380	0.7872	↑
Lake Ratapiko at boat ramp	12	0.9431	0.9431	↑

[NB: * = enterococci; ↑ = deteriorating: ↓= improving]

In summary, one site has shown a statistically significant increasing temporal trend and no sites significant decreasing temporal trends in seasonal median *E. coli* counts. The other less significant trends indicate gradual improvement (two sites) or deterioration (twelve sites) in seasonal median *E. coli* counts.

Table 56 Seasonal summaries of single sample *E.coli* counts in 'Surveillance'. 'Alert'. 'Action' modes for the period 1996 to date (13 samples per season)

Site Season	1996-1997		1997-1998		1998-1999		1999-2000		2000-2001		2001-2002		2002-2003		2003-2004		2004-2005		2005-2006		2006-2007		2007-2008		2008-2009		2009-2010		2010-2011		2011-2012		2012-2013		2013-2014		2014-2015		2015-2016		2016-2017		2017-2018		Average per season		
Lake Rotomanu at western beach	0	1	0	1	0	0	0	0	0	0	1	2	1	1	0	3	0	0	2	0	2	1	4	1	3	3	1	3	0	0	0	5	1	0	0	0	0	0	2	2	3	2	0	1	11	1	1
Waiwhakaiho River at Merrilands Domain	0	1	0	1	1	0	0	0	1	0	2	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	2	12.5	<0.5	<0.5
Waiwhakaiho River adj. to L. Rotomanu	0	1	*		3	0	*		2	1	*		3	0	*		2	5	*		1	6	*		7	5	*		1	9	5	5	0	12	5	7	1	11	0	12	2	8	3	10	4.5	2.5	6
Te Henui Stream at mouth, East End	*		*		*		*		*		*		7	5	7	4	1	10	1	11	2	10	2	10	1	12	2	11	1	11	4	9	1	12	1	11	0	12	3	10	1	12	0	12	1	2	10
Patea River at King Edward Park, Stratford	*		*		*		*		*		5	1	2	2	3	1	5	3	5	3	3	1	3	4	3	1	4	2	0	1	4	0	4	0	3	0	8	1	2	1	5	1	7	5	7.5	4	1.5
Patea River at boatramp, Patea	*		*		*		*		*		*		*		*		*		*		*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0
Waingongoro River at Eltham Camp	*		*		*		*		*		4	1	6	0	1	0	4	2	1	0	1	0	3	0	1	0	1	0	1	0	1	0	3	0	4	0	5	0	3	0	9	1	5	4	9.5	3	<0.5
Waingongoro River at Ohawe Beach	2	0	2	2	1	0	0	0	0	2	0	1	1	2	1	0	2	2	1	0	2	0	0	3	1	1	0	1	0	0	0	1	1	2	1	0	0	1	3	0	3	0	4	0	11	1	1
Kaupokonui River at beach domain	1	0	3	6	2	1	0	2	1	1	2	0	1	2	0	0	1	1	1	0	0	1	1	1	3	1	2	0	1	0	1	0	4	0	1	0	5	0	2	1	4	0	2	2	10.5	1.5	1
Lake Opunake at boat ramp	*		*		*		*		*		*		*		*		*		*		1	3	2	1	2	2	5	0	0	3	0	2	5	0	3	0	3	0	0	1	3	1	4	0	9.5	2.5	1
Timaru Stream at Weld Road	*		7	0	1	1	2	2	3	0	2	1	4	2	4	0	3	3	4	0	2	0	2	3	4	0	6	1	4	0	3	0	4	0	2	1	3	2	2	2	9	0	5	3	8.5	3.5	1
Waimoku Stream at Oakura Beach	2	9	2	11	3	10	8	3	5	5	3	9	1	12	1	12	2	11	0	13	2	11	0	13	0	13	0	13	0	13	*		*		2	11	*		*		0	13			0.5	2	10.5
Oakura River at SH45	0	0	2	2	0	0	2	0	2	0	1	1	1	0	0	1	3	2	3	0	4	0	1	1	1	0	4	1	1	0	2	0	1	0	0	0	2	1	1	3	1	2	2	2	11	1.5	0.5
Waitara River at town wharf, Waitara	*		*		*		*		*		*		*		*		*		*		*		*		*		2	3	1	1	2	0	3	1	3	0	2	1	5	1	2	1	4	1	9.5	2.5	1
Urenui River at estuary	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	<0.5	<0.5
Manganui River at Everett Park	1	1	3	1	1	1	1	0	3	0	3	2	2	0	1	1	1	1	0	0	2	0	2	1	4	0	3	0	2	0	3	0	1	1	1	0	1	1	1	0	5	0	2	0	10.5	2	0.5
Lake Ratapiko at boat ramp	*		*		*		*		*		*		*		*		*		*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	13	<0.5	<0.5
Average per site	0.7	1.4	2.1	2.7	1.2	1.3	1.4	0.9	1.7	0.9	2.1	1.6	2.2	2.0	1.6	1.8	2.0	3.1	1.5	2.3	1.5	2.2	1.3	2.5	1.9	2.4	1.9	2.3	0.7	2.2	1.6	1.4	1.8	1.8	1.5	1.8	1.9	1.9	1.6	2.1	2.8	2.5	2.4	2.7			
% overall non-exceedance of 2003 guidelines	82		63		80		82		80		71		67		74		61		71		71		70		67		68		77		78		72		74		71		72		60		60		70		

5.3 General

The Taranaki Regional Council will continue to ensure that attention is given to the appropriate timing of dairy shed wastes disposal inspections and repeat inspections when necessary in specific catchments, to ensure that river and stream bacteriological water quality is not compromised by inappropriate wastes disposal practices. However, initiatives proposed by the revision of the Regional Freshwater Plan (particularly the provisions for riparian fencing and interception planting, and the diversion of dairy ponds treated wastewaters to land irrigation) should result in further improvements in bacteriological surface water quality. There is also a need to encourage farmers to refrain from allowing direct stock access to natural surface waters and/or fording stock through streams particularly under summer-autumn low flow conditions.

It is intended that the improved liaison initiated over the 2000-2001 season with territorial local authorities and the Health Protection Unit of Taranaki Healthcare, and maintained to date, will continue with particular regard to the frequency and immediacy of reporting bathing water quality and cyanobacteria results during the survey period and in particular by usage of the District and Regional Councils' websites. All sites' results were displayed on these websites throughout the 2017-2018 survey period and all instances of exceedance of guidelines were advised to the appropriate authorities.

Few follow-up investigations were necessary over the 2017-2018 season and there were no obvious immediate issues with poor operation of dairy wastes disposal systems contributing to elevated counts in receiving waters. In most cases, occasionally at lakes and mainly in the lower reaches of three urban streams, wildfowl contamination was responsible for elevation in counts, particularly where public feeding of birds occurred at recreational sites. No isolated instances were related to localised rainfall during the regular, state of the environment monitoring surveys. On some occasions, particularly during lower flow periods, stock access problems, and/or cumulative impacts of consented wastewater discharges may have contributed.

In particular sub-catchments, appropriate publicity and timing of the annual round of dairy inspections has assisted with mitigation of these effects. Regular reviews of the sites' grading system will be performed and maintenance of the programme of increased sampling frequency (weekly from December to March) will continue at the four principal freshwater contact recreation usage sites. Planktonic cyanobacteria monitoring will also continue at lake sites (at a slightly lesser frequency to the bacteriological monitoring) and the benthic cyanobacteria periphyton monitoring will continue at the river/stream sites.

In 2017-2018, the number of scheduled sampling occasions was increased from seven to ten over the five month period from November to March, that is, to fortnightly. This was in response to high cyanobacteria levels found in Lakes Rotokare and Rotomanu in 2016-2017, and to increased public interest.

For planktonic cyanobacteria, of the four designated lake monitoring sites, two had bio-volumes exceeding contact recreational guidelines during the 2017-2018 season, requiring the erection of warning signs: Lake Rotokare in late spring until mid-summer and Lake Rotomanu for nearly all of the monitoring period until mid-March. Planktonic cyanobacteria were not detected in Lake Opunake or Lake Ratapiko at the times of sampling, which consequently were reduced in frequency to eight occasions at those sites.

Benthic cyanobacteria were found occasionally in most of the nine rivers and streams monitored. The benthic bacteria found were always *Phormidium* sp. No site reached over the 50% coverage that would trigger the 'Action' level for that criterion (MfE and MoH, 2009), and two sites on two occasions each had over 20% coverage, triggering the 'Alert' level that requires weekly monitoring. Exposed mats triggered the 'Alert' level at two sites on a total of 15 occasions, and on one occasion triggered the 'Action" level (Waiwhakaiho River at Merrilands Domain), requiring the erection of warning signs. Detaching mats or

detached mats accumulating on the rivers edge triggered the 'Alert' level at four sites on a total of eight occasions.

Monitoring before the 2014-2015 season was focussed on streambed percentage cover though information on exposed and detaching mats was collected. No sites had previously triggered the 'Action' or 'Alert' level before the 2014-15 sampling season based on the exposed or detaching mats criteria. Currently, the guidelines do not give any direction about how much exposed, detaching or detached mats is required to trigger the 'Action' level (MfE and MoH, 2009). The Council has adopted an approach based on best judgement practices to report minor and significant levels of exposed or detaching mats which trigger the 'Alert' and 'Action' level respectively as it better reflects the actual potential danger of benthic cyanobacteria. To date there have been no reported incidences of humans or animals in the Taranaki Region having been harmed by toxins produced by benthic cyanobacteria though there may have been unreported incidences.

Levels of cyanobacteria were higher than the 2016-2017 season, and lower than in the preceding three seasons, probably a reflection of the relative amounts of rainfall causing freshes that scour streambeds of periphyton.

The Suitability for Recreation Grading (SFRG) referenced earlier in this report (Section 2.2) may now be re-assessed to include the 2017-2018 microbiological data enabling a comparison of the five year 2012-2017 period (Table 2) with the latest SFRG for the 2013-2018 period (presented in Table 57.

Table 57 Suitability for recreation grade for freshwater sites for the period November 2013 to April 2018

Site	Sanitary Inspection Category	Microbiological assessment E.coli (cfu/100ml)			SFR Grade	% of all samples in compliance (ie: ≤550 *E.coli*)
		95 %ile	Number of samples	Category		
L Rotomanu: western beach	High	699	65	D	Very poor	92
Waiwhakaiho R: Merrilands domain	High	332	65	C	Poor	96
Waiwhakaiho R at L.Rotomanu	High	3392	65	D	Very poor	26
Te Henui S: mouth	High	3962	65	D	Very poor	12
Patea R: King Edward Park	High	816	65	D	Very Poor	87
Patea R. boat ramp, Patea	High	84	65	A	Poor	100
Waingongoro R: Eltham camp	High	782	65	D	Very Poor	92
Waingongoro R: Ohawe beach	High	417	65	C	Poor	95
Kaupokonui R: Beach domain	High	512	65	C	Poor	95
L Opunake: adjacent boat ramp	High	473	65	C	Poor	95
Timaru S: Lower Weld Road	High	1162	65	D	Very poor	87

Site	Sanitary Inspection Category	Microbiological assessment E.coli (cfu/100ml)			SFR Grade	% of all samples in compliance (ie: ≤550 *E.coli*)
		95 %ile	Number of samples	Category		
Oakura R: d/s SH45	High	1675	65	D	Very poor	87
Waitara R: Town wharf	High	659	65	D	Very poor	93
Urenui R: estuary	High	140	65	B	Poor	98
Manganui R: Everett Park	High	393	65	C	Poor	98
L Ratapiko: boat ramp	High	230	60	B	Poor	98
L Rotokare: adjacent boat ramp	Low	310	42	C	Very good	100

Few differences between the two five-year periods were apparent when comparing Table 2 and Table 57.

There were minimal changes in gradings at all sites, although in terms of the 95 percentile *E.coli* number: there was a moderate improvement at the Waingongoro River at Ohawe and Waitara town wharf sites and deterioration at the Waiwhakaiho River at Merrilands domain, Patea River at King Edward Park, Waingongoro River at Eltham camp, Timaru Stream and Urenui River sites.. There were slightly fewer samples in excess of the 'Action' level over the most recent five-year period at two of the monitored sites (Waiwhakaiho River at Lake Rotomanu, and Manganui River at Everett Park) while nine sites (Patea River at King Edward Park, Waingongoro River at Eltham, Timaru Stream, Kaupokonui Stream, Oakura River, Waiwhakaiho River at Merrilands Domain,, Urenui River, Lake Rotomanu and Lake Opunake) had more samples (8%, 6%, 5%, 3%, 3%, 2%, 2%, 1% and 1% more, respectively) in the 'Action' mode. Four sites deteriorated in terms of the MAC assessment (Waiwhakaiho River at Merrilands Domain, Waingongoro River at Eltham, Urenui River estuary and Lake Rotokare), which resulted in one change in SFR grading, to 'very poor' for the Waingongoro River at Eltham site. There were no other changes in MAC or SFR grades.

As outlined earlier in this report and also by the Ministry for the Environment, SFRG and MAC gradings do not represent actual water quality (and hence suitability for swimming) at any particular time. '*This indicator update* [of SFRG gradings] *cannot tell you whether it is safe to swim today at a particular spot and does not replace the site-specific information available on regional and district council websites which can help people understand the likely health risk when deciding whether to go swimming.. While beach grades provide information about the typical state of a beach, regional and district councils also use weekly monitoring to inform the public of more immediate health risks when measured bacteria concentration exceed 'action thresholds'. These action thresholds are based on levels of risk drawn from international guidelines confirmed by New Zealand studies.*' ('Recreational water quality in New Zealand indicator update' October 2012, INFO 653, Ministry for the Environment). [Suitability for recreation grading] '*reflects a precautionary approach to managing public health risks….it does not tell us whether a site is suitable for primary contact recreation on a particular day*'. ('Suitability for swimming update', August 2013, Ministry for the Environment website).

5.4 Water quality at bathing sites and the 2017 NOF 'Clean Water' Swimmability criteria

In February 2017 MfE released a suite of discussion documents which included proposals to further amend the National Objectives Framework (NOF). The proposals were given effect to later in the calendar year. The NOF specifies compulsory national criteria for various parameters used to categorise water quality in terms of suitability for various uses and values. Included in the NOF amendments were new criteria to be applied to water used for primary recreation (colloquially referred to as 'swimmability'). These requirements also included new protocols around sampling. The new criteria are presented in Table 58. The NOF does not include a national bottom line (compulsory minimum standard), but the government has announced its intention that 90% of the nation's rivers should be in the yellow, green, or blue categories by 2040.

Table 58 *E. coli* swimming categories proposed in draft 'Clean Water' document, 2017

CATEGORY	PERCENTAGE OF EXCEEDANCES OVER 540: E. COLI PER 100 ML	MEDIAN: E. COLI PER 100ML	95TH PERCENTILE: E. COLI PER 100 ML	PERCENTAGE OF SAMPLES ABOVE 260: E. COLI PER 100 ML	NARRATIVE DESCRIPTION
Blue	< 5 per cent	≤ 130	≤ 540	< 20 per cent	Excellent for swimming
Green	5-10 per cent	≤ 130	≤ 1000	20-30 per cent	Good for swimming most of the time
Yellow	10-20 per cent	≤ 130	≤ 1200	20-34 per cent	Fair to swim in some of the time
Orange	20-30 per cent	>130	> 1200	> 34 per cent	Intermittently suitable to swim in
Red	> 30 per cent	>260	> 1200	> 50 per cent	Not safe to swim in.

The monitoring data from Taranaki's freshwater bathing sites for the past five seasons (Table 57) have been analysed against the proposed 2017 NOF criteria for 'swimmability'. Results are shown in Table 59. It should be noted that in some cases, a single criterion has been applied by MfE across several gradings. In this case, the categorisation in Table 58 has been based on the highest category in which a result applies.

What becomes apparent is that gradings denoting degrees of suitability for swimming vary immensely according to the particular criterion. For example, the quality of the Oakura River below SH45 can apparently be variously rated as 'excellent', 'good', or 'only intermittently suitable' for swimming. Likewise, the Patea River at King Edward Park is either good, intermittent or not safe to swim in, and the Waingongoro River at Oahwe Beach could be variously graded as 'excellent' through to only 'intermittently safe', depending on the choice of criterion. This lack of rationalisation between criteria is not helpful for conveying 'swimmability' to the public.

Table 59 *E.* coli swimming categories for freshwater sites for the period November 2013 to April 2018, according to MfE 2017

CATEGORY/SITE	N 'SEM' samples/All samples	PERCENTAGE OF EXCEEDANCES OVER 540: E. COLI PER 100 ML		MEDIAN: E. COLI PER 100ML		95TH PERCENTILE: E. COLI PER 100 ML		PERCENTAGE OF SAMPLES ABOVE 260: E. COLI PER 100 ML	
L Rotomanu: western beach	65/109	7.7	7.6	70	84	699	735	17	17
Waiwhakaiho R: Merrilands domain	65/108	3.1	7.7	60	69	332	1060	6.2	13
Waiwhakaiho R at L.Rotomanu	65	75		830		3392		91	
Te Henui S: mouth	65	88		1100		3962		95	
Patea R: King Edward Park	65	14		270		816		51	
Patea R. boat ramp, Patea	65	0		9		84		0	
Waingongoro R: Eltham camp	65	9.2		260		782		48	
Waingongoro R: Ohawe beach	65/87	1.5	3.4	180	200	417	489	18	22
Kaupokonui R: Beach domain	65/87	4.6	5.7	160	178	512	584	26	32
L Opunake: adjacent boat ramp	65	3.1		120		473		23	
Timaru S: Lower Weld Road	65	15		231		1162		46	
Oakura R: d/s SH45	65	12		110		1675		22	
Waitara R: Town wharf	65	6.2		180		659		29	
Urenui R: estuary	65	1.5		9		140		1.5	
Manganui R: Everett Park	65	1.5		200		393		17	
L Ratapiko: boat ramp	60	1.7		19.5		230		3.3	
L Rotokare: adjacent boat ramp	44	0		62		310		8.9	

6 Recommendations

As a result of the 2017-2018 summer freshwater contact recreation bacteriological survey it is recommended:

1. THAT the 2018-2019 survey be performed at sixteen regular sites continuing with the existing sampling protocols during the season extending from 1 November to 31 March (and into April, if necessary).
2. THAT the 2018-2019 survey includes additional samples collected at the four principal usage sites (Lake Rotomanu, Waiwhakaiho River at the Merrilands Domain, Waingongoro River at Ohawe and Kaupokonui River at the mouth) in accordance with MfE, 2003 guidelines.
3. THAT the 2018-2019 summer survey includes cyanobacteria monitoring at the three lake sites and an additional lake (Rotokare) site and benthic cyanobacteria monitoring at nine of the river and stream sites fortnightly on at least ten occasions.
4. THAT follow-up sampling (after guideline exceedances) be performed when deemed necessary by TRC staff.
5. THAT appropriate timing of the annual dairy farms inspection round be incorporated into the programme for catchments where issues relating to exceedances of contact recreational standards have been identified and advice and publicity be provided in relation to the prevention of stock access to natural water.
6. THAT reporting of results be performed as appropriate during the season, and in an Annual Report upon completion of the season's programme.
7. THAT the appropriate statistical trend detection procedures be applied to the data and reported in the Annual Report

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

'Action' mode	Single sample greater than 550 *E. coli* cfu/100 ml.
'Alert' mode	Single sample greater than 260 E. *coli* cfu/100 ml.
Bathers	Those who enter the water, and either partially or fully immerse themselves.
Bathing season	Generally the bathing season extends between 1 November and 31 March.
Catchment Assessment Checklist (CAC)	A checklist to identify potential catchment risk factors of faecal contamination for water recreational quality, used in establishing. the Sanitary Inspection Category of a monitoring site
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 ml sample.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Contact recreation	Recreation activities that bring people physically in contact with water, involving a risk of involuntary ingestion or inhalation of water.
Cyanobacteria	Also known as blue-green algae, are a phylum of bacteria that obtain their energy from photosynthesis. Typically, benthic cyanobacteria grow on stream beds, and planktonic cyanobacteria form floating colonies in lakes. Usually expressed as bio-volume per ml of sample.
E.coli	*Escherichia coli*, member of the Enterobacteriaceae, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample.
Enterococci	Members of the Streptococcus group of bacteria characterised as faecal in origin. Enterococci provide an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample.
Faecal coliform	An indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample.
Faecal Indicator Bacteria (FIB)	Micro-organisms selected as indicators of faecal contamination.
False Discovery Rate (FDR)	The expected proportion of true hypothesis rejected out of the total number of rejections.
Follow-up sample	Second sample taken to confirm an initial high result; usually within 24-72 hours depending on accessibility/sample turnaround time, etc.
Median	Central value when values are arranged in order of magnitude.
Microbiological Assessment Category (MAC)	A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D Category (MAC).

RMA	Resource Management Act 1991 and subsequent amendments.
Sanitary Inspection Category (SIC)	A measure of the susceptibility of a water body to faecal contamination – Very High, High, Moderate, Low or Very Low.
Suitability for Recreation Grade (SFRG)	A combination of Sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC), describes the general condition of a site at any given time, based on both risk and indicator bacteria counts.
Temp	Temperature, measured in °C (degrees Celsius).

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Appendix I

Bacteriological results for all sites
2017-2018 monitoring year

Lake Rotomanu (Site Code LRM000002)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	0935	19.6	10.8	11	60	SEM
20.11.17	0907	18.7	11.4	11	26	SEM
28.11.17	1145	23.9	11.4	5.9	108	MfE
4.12.17	1050	26.6	11.9	8.8	26	SEM
12.12.17	1100	26.8	11.9	16	79	MfE
18.12.17	1237	26.7	12.5	15	96	MfE
28.12.17	1030	22.4	12.8	14	47	MfE
3.01.18	1128	23.8	13.0	10	63	MfE
9.01.18	1010	23.8	12.1	9.9	41	MfE
15.01.18	1050	28.4	12.5	12	727	SEM
16.01.18	1410	27.3	12.7	9.2	144	FOLLOW-UP
25.01.18	1040	26.6	12.1	9.5	192	MfE
30.01.18	1018	28.6	12.2	9.1	61	SEM
1.02.18	1115	24.9	12.9	11	66	SEM
7.02.18	1245	24.1	12.3	10	110	MfE
16.02.18	1155	25.8	12.1	8.6	84	SEM
19.02.18	1325	27.0	12.0	8.2	86	SEM
1.03.18	1150	22.8	11.9	6.9	62	MfE
5.03.18	1005	25.8	11.9	6.8	32	SEM
13.03.18	1110	18.6	11.8	13	162	MfE
19.03.18	0915	20.2	11.8	8.2	88	SEM
27.03.18	1100	20.7	11.4	6.3	93	MfE
3.04.18	0940	20.1	11.2	12	261	SEM
6.04.18	1050	20.8	11.7	10	13	SEM
7.04.18	1205	21.2	11.5	15	114	SEM

Waiwhakaiho River at Merrilands (Site Code WKH000800)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	0910	13.7	10.1	0.4	326	SEM
14.11.17	0715	-	11.1	0.4	70.8	FOLLOW-UP
20.11.17	0840	15.3	12.5	0.3	40.4	SEM
28.11.17	1110	19.6	13.5	0.4	121	MfE
4.12.17	1135	22.0	14.4	0.8	172	SEM
12.12.17	1050	23.5	13.8	0.9	91	MfE
18.12.17	1302	22.9	14.4	1	166	MfE
28.12.17	1005	19.0	14.4	0.9	16	MfE
3.01.18	1043	19.1	8.2	2.1	435	MfE
9.01.18	0950	20.4	9.3	0.5	110	MfE
15.01.18	1125	23.2	13.8	0.5	205	SEM
25.01.18	1020	22.2	10.0	0.5	205	MfE
30.01.18	1055	24.5	13.0	0.8	260	SEM
1.02.18	0705	22.7	13.7	0.6	40	SEM
7.02.18	1310	20.6	11.8	0.5	205	MfE
16.02.18	1235	22.4	10.9	0.8	124	SEM
19.02.18	1340	21.9	12.5	0.5	1300	SEM
26.02.18	0645	17.9	11.6	1.5	42	FOLLOW-UP
1.03.18	1110	19.1	11.5	0.8	148	MfE
5.03.18	0940	20.1	12.7	0.1	34	SEM
13.03.18	1045	16.9	13.0	0.4	32	MfE
19.03.18	0830	16.4	10.9	0.4	51	SEM
27.03.18	1040	17.6	11.3	0.3	138	MfE
3.04.18	0920	16.0	11.8	1.6	61	SEM
6.04.18	1025	15.8	12.2	0.9	816	SEM

Waiwhakaiho River beside Lake Rotomanu (Site Code WKH000950)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	0950	17.2	9.7	0.7	771	SEM
20.11.17	0916	17.3	13.0	0.6	331	SEM
4.12.17	1105	23.1	72.7	0.9	1720	SEM
15.01.18	1100	25.0	13.6	0.8	4880	SEM
30.01.18	1030	26.1	14.2	0.7	1660	SEM
1.02.18	1120	21.7	677	2.1	4840	SEM
16.02.18	1205	22.2	10.6	0.6	2190	SEM
19.02.18	1310	23.0	12.6	0.8	2910	SEM
5.03.18	1020	23.4	13.5	0.6	1300	SEM
19.03.18	0900	16.9	11.6	0.6	613	SEM
3.04.18	0950	16.9	12.0	0.8	546	SEM
6.04.18	1100	17.1	12.8	1.1	1240	SEM
7.04.18	1215	17.5	13.1	1.0	537	SEM

Te Henui Stream

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1040	13.9	353	0.5	108	SEM
20.11.17	1013	15.7	714	0.6	697	SEM
4.12.17	0955	19.2	3050	1.2	2140	SEM
15.01.18	1000	22.0	121	0.8	3450	SEM
30.01.18	0932	22.6	1350	1.0	2610	SEM
1.02.18	1015	21.8	4570	30	922	SEM
16.02.18	1035	20.8	562	0.9	2600	SEM
19.02.18	1230	22.4	2140	3.9	2600	SEM
5.03.18	1155	21.6	1470	0.8	1100	SEM
19.03.18	1005	18.0	1710	1.0	733	SEM
3.04.18	1040	15.5	534	1.1	990	SEM
6.04.18	1120	16.8	14.9	0.9	1400	SEM
7.04.18	1300	16.5	22.9	0.8	1720	SEM

Patea River, King Edward Park, Stratford (Site Code PAT000297)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1440	12.3	8.4	0.5	344	SEM
20.11.17	1255	14.7	8.9	0.7	86	SEM
4.12.17	1230	17.2	9.5	0.9	579	SEM
6.12.17	0740	16.2	9.6	1.0	345	FOLLOW-UP
	1200	16.4	9.4	1.0	411	FOLLOW-UP
	1520	19.0	9.8	1.1	299	FOLLOW-UP
18.12.17	1300	18.0	9.8	1.0	921	INVEST
9.01.18	1300	17.6	7.9	1.2	393	FOLLOW-UP
15.01.18	1250	19.3	9.1	1.2	1050	SEM
16.01.18	1045	18.5	9.6	0.9	1200	FOLLOW-UP
	1340	19.1	9.5	0.9	613	INVEST
18.01.18	1120	15.5	3.7	8.7	14100	INVEST
26.01.18	1215	19.5	8.9	0.9	624	FOLLOW-UP
30.01.18	1220	20.6	9.4	0.8	816	SEM
1.02.18	0800	17.9	9.6	0.7	1300	SEM
7.02.18	1245	15.4	8.8	0.4	387	FOLLOW-UP
16.02.18	1250	17.9	8.7	1.5	517	SEM
19.02.18	1420	18.3	9.3	0.7	411	SEM
5.03.18	0900	15.6	9.8	0.6	291	SEM
19.03.18	1305	15.4	9.9	0.5	276	SEM
21.03.18	1440	14.8	10.3	0.6	387	SEM
3.04.18	1430	15.0	9.5	0.7	291	SEM
6.04.18	1000	13.7	9.7	1.1	816	SEM
9.04.18	0910	11.7	10.5	0.8	613	FOLLOW-UP
23.04.18	1130	11.5	9.4	0.8	309	FOLLOW-UP

Patea River, boatramp, Patea (Site Code PAT000995)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Enterococci	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	cfu/100ml	
7.11.17	1000	16.5	4720	5.8	10	<1	SEM
20.11.17	0920	15.7	4580	15	<10	<1	SEM
4.12.17	0834	19.6	4750	20	<10	15	SEM
15.01.18	0830	21.1	4790	7.9	10	<2	SEM
30.01.18	0825	23.0	4790	11	86	15	SEM
1.02.18	1150	23.5	4850	11	20	72	SEM
16.02.18	0830	21.9	4740	30	52	22	SEM
19.02.18	1025	23.0	4830	17	10	27	SEM
5.03.18	1030	21.7	4790	10	<10	1	SEM
19.03.18	0900	18.4	4670	15	20	18	SEM
21.03.18	1010	19.3	4750	29	10	12	SEM
3.04.18	1000	18.9	4750	41	<10	8	SEM
6.04.18	1135	19.4	1510	17	20	46	SEM

Waingongoro River, Eltham Camp (Site Code WGG000492)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1405	15.9	11.4	1.0	167	SEM
20.11.17	1245	17.0	11.4	1.0	105	SEM
4.12.17	1210	18.6	12.7	1.9	313	SEM
15.01.18	1140	21.4	11.4	1.4	921	SEM
16.01.18	1011	20.4	11.3	1.1	770	FOLLOW-UP
26.01.18	1150	22.3	10.3	1.0	579	FOLLOW-UP
30.01.18	1200	23.7	10.9	1.0	236	SEM
31.01.18	1130	21.6	10.9	1.0	820	INVEST
1.02.18	0810	19.7	11.2	0.9	816	SEM
7.02.18	0945	16.7	10.3	0.6	921	FOLLOW-UP
16.02.18	1225	20.7	10.2	1.2	770	SEM
19.02.18	1350	20.3	10.5	1.0	649	SEM
5.03.18	0935	17.0	10.9	0.6	435	SEM
6.03.18	0815	17.5	10.7	0.8	770	INVEST
	1050	18.2	10.6	0.8	488	INVEST
	1400	18.3	10.7	0.8	517	INVEST
14.03.18	1311	16.8	12.0	2.0	260	FOLLOW-UP
19.03.18	1240	16.4	12.4	1.1	326	SEM
21.03.18	1410	16.0	12.2	1.0	461	SEM
3.04.18	1330	15.8	12.0	1.2	172	SEM
6.04.18	1025	14.1	12.2	1.7	548	SEM

Waingongoro River, near mouth – (Site Code WGG000995)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1125	16.7	19.8	1.8	126	SEM
20.11.17	1015	16.5	21.0	2.7	105	SEM
28.11.17	1010	19.7	20.4	1.6	112	MfE
4.12.17	0940	20.2	20.9	2.9	236	SEM
12.12.17	0830	21.6	21.9	3.2	248	MfE
18.12.17	0950	21.2	21.1	4.7	517	MfE
28.12.17	1355	20.6	20.7	1.5	93	MfE
3.01.18	0835	22.0	22.6	7.1	5790	MfE
9.01.18	1055	20.6	15.0	2.4	171	MfE
15.01.18	0930	23.5	17.5	2.6	228	SEM
25.01.18	1010	24.1	16.7	1.2	345	MfE
30.01.18	1130	25.3	17.4	1.2	192	SEM
1.02.18	1045	22.3	2300	6.5	167	SEM
7.02.18	1015	20.5	16.9	0.7	326	MfE
16.02.18	0945	20.8	16.0	1.4	276	SEM
19.02.18	1140	23.2	18.9	1.2	411	SEM
1.03.18	1030	19.5	16.8	1.1	288	MfE
5.03.18	1210	22.8	16.9	1.0	435	SEM
13.03.18	1015	15.8	14.5	2.0	816	MfE
14.03.18	1220	17.3	14.7	1.3	299	FOLLOW-UP
19.03.18	1010	17.3	16.2	1.2	201	SEM
21.03.18	1130	18.2	17.7	7.6	365	SEM
27.03.18	0955	18.6	17.0	1.7	214	MfE
3.04.18	1110	18.0	17.5	1.3	166	SEM
6.04.18	1335	17.5	17.3	1.8	148	SEM

Kaupokonui River at beach (Site Code: KPK000995)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	0935	19.6	10.8	11	60	SEM
20.11.17	0907	18.7	11.4	11	26	SEM
28.11.17	1145	23.9	11.4	5.9	108	MfE
4.12.17	1050	26.6	11.9	8.8	26	SEM
12.12.17	1100	26.8	11.9	16	79	MfE
18.12.17	1237	26.7	12.5	15	96	MfE
28.12.17	1030	22.4	12.8	14	47	MfE
3.01.18	1128	23.8	13.0	10	63	MfE
9.01.18	1010	23.8	12.1	9.9	41	MfE
15.01.18	1050	28.4	12.5	12	727	SEM
16.01.18	1410	27.3	12.7	9.2	144	FOLLOW-UP
25.01.18	1040	26.6	12.1	9.5	192	MfE
30.01.18	1018	28.6	12.2	9.1	61	SEM
1.02.18	1115	24.9	12.9	11	66	SEM
7.02.18	1245	24.1	12.3	10	110	MfE
16.02.18	1155	25.8	12.1	8.6	84	SEM
19.02.18	1325	27.0	12.0	8.2	86	SEM
1.03.18	1150	22.8	11.9	6.9	62	MfE
5.03.18	1005	25.8	11.9	6.8	32	SEM
13.03.18	1110	18.6	11.8	13	162	MfE
19.03.18	0915	20.2	11.8	8.2	88	SEM
27.03.18	1100	20.7	11.4	6.3	93	MfE
3.04.18	0940	20.1	11.2	12	261	SEM
6.04.18	1050	20.8	11.7	10	13	SEM
7.04.18	1205	21.2	11.5	15	114	SEM

Lake Opunake (Site Code LOP000001)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1315	16.7	13.0	1.1	124	SEM
20.11.17	1230	17.7	13.0	1.9	71	SEM
4.12.17	1110	24.1	13.2	1.4	77	SEM
15.01.18	1100	24.3	13.1	1.7	146	SEM
30.01.18	1030	26.5	14.1	0.9	179	SEM
1.02.18	0930	24.3	13.8	2.0	435	SEM
7.02.18	1200	20.5	14.4	0.8	122	FOLLOW-UP
16.02.18	1115	22.0	13.3	1.2	448	SEM
19.02.18	1315	24.2	13.8	0.8	60	SEM
5.03.18	1400	23.9	14.4	0.6	75	SEM
19.03.18	1120	19.7	12.3	0.8	63	SEM
21.03.18	1330	21.3	13.1	0.7	365	SEM
3.04.18	1250	17.6	14.8	0.8	548	SEM
6.04.18	1330	17.6	15.0	0.8	219	SEM

Timaru Stream, near mouth (Site Code: TMR0000497)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1255	15.3	246	0.6	173	SEM
20.11.17	1219	19.1	40.2	0.5	411	SEM
22.11.17	0725	16.9	28.8	3.5	613	FOLLOW-UP
23.11.17	1130	19.5	24.2	1.2	387	FOLLOW-UP
	1227	19.4	-	-	214	FOLLOW-UP
24.11.17	1230	22.4	0.0	0.7	517	FOLLOW-UP
28.11.17	1320	21.4	13.4	0.4	150	FOLLOW-UP
4.12.17	0755	18.4	61.2	0.7	1050	SEM
6.12.17	0625	20.0	191	1.0	579	FOLLOW-UP
7.12.17	1324	24.1	136	1.3	649	FOLLOW-UP
12.12.17	1250	23.0	34.3	0.8	387	FOLLOW-UP
15.01.18	0800	23.0	18.1	0.8	158	SEM
30.01.18	0757	22.2	230	0.7	727	SEM
31.01.18	1055	22.8	629	0.8	2720	FOLLOW-UP
1.02.18	0800	21.7	4640	20.0	4840	SEM
7.02.18	0915	18.3	18.3	0.3	435	FOLLOW-UP
16.02.18	0820	19.7	32.8	0.6	457	SEM
19.02.18	1027	22.6	54.5	0.4	231	SEM
5.03.18	1400	22.9	172	1.0	461	SEM
19.03.18	1205	17.1	20.5	0.3	228	SEM
3.04.18	1245	17.8	207	0.6	435	SEM
6.04.18	1255	17.1	20.2	0.7	411	SEM
7.04.18	1445	17.5	22.2	0.8	285	SEM

Oakura River, near mouth (Site Code: OKR000497)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1145	14.7	39.3	0.3	96	SEM
20.11.17	1109	18.2	78.8	0.4	108	SEM
4.12.17	0835	19.9	344	0.8	276	SEM
15.01.18	0840	21.7	9.2	0.6	517	SEM
30.01.18	0850	22.3	146	0.4	687	SEM
31.01.18	1130	23.0	297	0.4	933	FOLLOW-UP
1.02.18	0830	21.5	2880	9.6	977	SEM
7.02.18	1100	19.0	10.2	0.2	249	FOLLOW-UP
16.02.18	0930	19.9	59.5	0.3	194	SEM
19.02.18	1120	21.5	274	0.4	119	SEM
5.03.18	1255	21.8	14.4	2.2	47	SEM
19.03.18	1110	17.1	154	0.4	93	SEM
3.04.18	1140	17.0	55.1	0.6	142	SEM
6.04.18	1345	17.0	8.4	0.6	60	SEM
7.04.18	1350	16.9	8.8	0.8	116	SEM

Waitara River at town wharf, Waitara (Site Code WKH000922)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1220	17.1	324	22	579	SEM
20.11.17	1200	18.1	1430	2.7	93	SEM
4.12.17	1000	22.3	1082	3.4	135	SEM
15.01.18	0842	23.3	756	8.7	308	SEM
30.01.18	0646	24.7	10.2	5.2	167	SEM
1.02.18	0815	22.9	2350	9.6	387	SEM
16.02.18	0745	21.4	356	24	276	SEM
19.02.18	1021	23.9	1000	6.4	548	SEM
5.03.18	1030	22.2	2180	3.2	65	SEM
19.03.18	0845	18.0	728	2.9	141	SEM
21.03.18	1200	18.8	1280	2.3	152	SEM
3.04.18	0950	17.2	246	3.6	148	SEM
6.04.18	1325	17.8	255	3.0	150	SEM

Urenui River at estuary (Site Code: URN000480)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Enterococci	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	cfu/100ml	
7.11.17	1100	17.3	4650	6.7	20	<1	SEM
20.11.17	1030	18.7	4790	1.7	<10	1	SEM
4.12.17	0830	19.9	4770	3.3	10	1	SEM
15.01.18	1000	23.8	4790	7.2	10	<2	SEM
30.01.18	0800!	23.7	4800	2.5	166	<2	SEM
1.02.18	0900	22.7	4730	51	617	440	SEM
7.02.18	1025	22.8	3120	6.2	246	66	FOLLOW-UP
16.02.18	0900	22.3	4670	13	63	25	SEM
19.02.18	1140	24.3	4630	6.8	10	23	SEM
5.03.18	1215	23.4	4720	6.5	20	1	SEM
19.03.18	1020	20.2	4720	42	72	2	SEM
21.03.18	1030	20.1	4790	7.2	89	2	SEM
3.04.18	1105	20.4	4730	12	10	3	SEM
6.04.18	1155	20.6	4830	14	<10	<1	SEM

Manganui River d/s of Kurapete Stream (Site Code: MGN000435)

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1335	14.7	9.0	0.8	178	SEM
20.11.17	0920	14.9	9.7	0.7	225	SEM
4.12.17	1150	20.1	9.6	1.0	141	SEM
15.01.18	1150	22.0	9.9	0.7	214	SEM
30.01.18	0926	23.2	10.1	0.6	276	SEM
1.02.18	0749	21.5	10.2	0.6	219	SEM
16.02.18	1015	18.8	10.3	0.8	205	SEM
19.02.18	1415	21.3	10.6	0.8	210	SEM
5.03.18	0945	18.4	10.5	0.7	172	SEM
19.03.18	1220	17.1	10.8	0.6	111	SEM
21.03.18	0910	16.6	10.9	0.6	387	SEM
3.04.18	1255	15.3	10.9	0.9	138	SEM
6.04.18	1025	14.4	10.6	1.3	161	SEM

Lake Ratapiko

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
7.11.17	1405	16.9	7.2	1.6	144	SEM
20.11.17	0900	17.1	7.6	1.5	8	SEM
4.12.17	1225	24.9	8.2	1.8	214	SEM
15.01.18	1220	25.2	7.6	1.4	53	SEM
30.01.18	1009	26.6	8.1	1.2	35	SEM
1.02.18	0730	24.5	8.2	1.3	25	SEM
16.02.18	1104	21.6	8.1	1.1	52	SEM
19.02.18	1440	22.6	8.8	1.3	34	SEM
5.03.18	0910	20.6	9.3	0.8	9	SEM
19.03.18	1245	19.4	9.2	0.7	16	SEM
21.03.18	1400	18.2	9.1	0.7	8	SEM
3.04.18	1320	16.6	9.3	0.9	99	SEM

Lake Rotokare

Date	Time	Temperature	Conductivity	Turbidity	E. coli	Programme
	NZST	°C	mS/m@20°C	NTU	MPN/100ml	
2.11.17	0835	19.4	12.8	9.1	57	SEM
14.11.17	1445	18.8	12.7	7.5	64	SEM
28.11.17	1300	21.9	12.5	11	29	SEM
12.12.17	1130	23.9	12.6	9.7	101	SEM
3.01.18	1130	24.0	13.2	1.6	201	MfE
15.01.18	1230	25.6	13.3	1.6	96	SEM
25.01.18	1230	25.9	13.3	0.7	162	MfE
7.02.18	1300	23.5	13.6	0.7	124	MfE
26.02.18	1405	21.1	13.3	1.6	345	SEM
13.03.18	1300	19.6	13.3	1.4	20	SEM
27.03.18	1240	20.5	12.9	2.0	62	SEM

Appendix II

High tide times

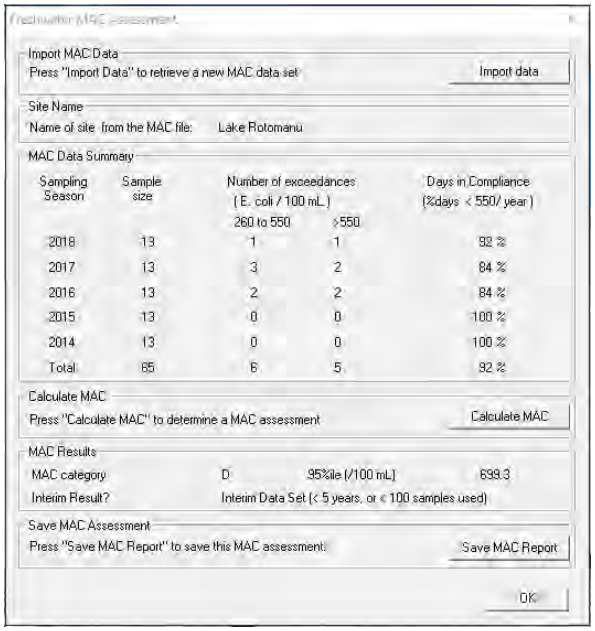
Appendix II High tide times

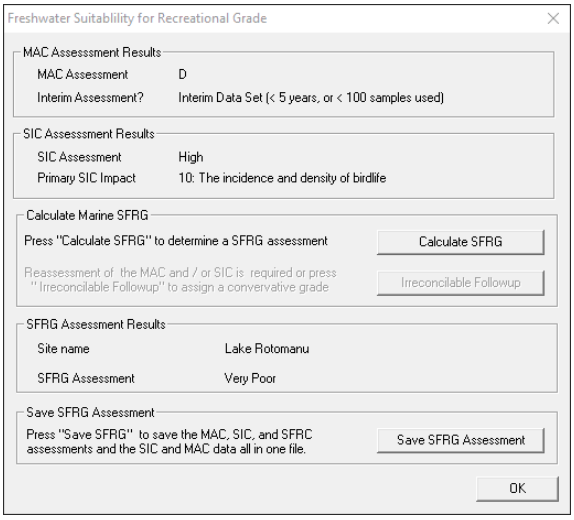
Date	Programme	Day	Time (NZST)	Height (m)
07 Nov 2017	SEM	Tuesday	1141	3.7
20 Nov 2017	SEM	Monday	1039	3.4
28 Nov 2017	MFE	Tuesday	1656	2.9
04 Dec 2017	SEM	Monday	0953	3.8
12 Dec 2017	MFE	Tuesday	1725	3.0
18 Dec 2017	MFE	Monday	0946	3.3
28 Dec 2017	MFE	Thursday	1709	3.0
03 Jan 2018	MFE	Wednesday	1030	3.8
09 Jan 2018	MFE	Tuesday	1538	3.0
15 Jan 2018	SEM	Monday	0850	3.1
25 Jan 2018	MFE	Thursday	1427	3.0
30 Jan 2018	SEM	Tuesday	0836	3.5
01 Feb 2018	SEM	Thursday	1017	3.8
07 Feb 2018	MFE	Wednesday	1453	3.0
16 Feb 2018	SEM	Friday	1015	3.4
19 Feb 2018	SEM	Monday	1155	3.5
01 Mar 2018	MFE	Thursday	0914	3.6
05 Mar 2018	SEM	Monday	1206	3.6
13 Mar 2018	MFE	Tuesday	0705	2.8
19 Mar 2018	SEM	Monday	1154	3.5
21 Mar 2018	SEM	Wednesday	1210	3.5
27 Mar 2018	MFE	Tuesday	0602	3.0
03 Apr 2018	SEM	Tuesday	1137	3.5
06 Apr 2018	SEM	Friday	1334	2.9

Appendix III

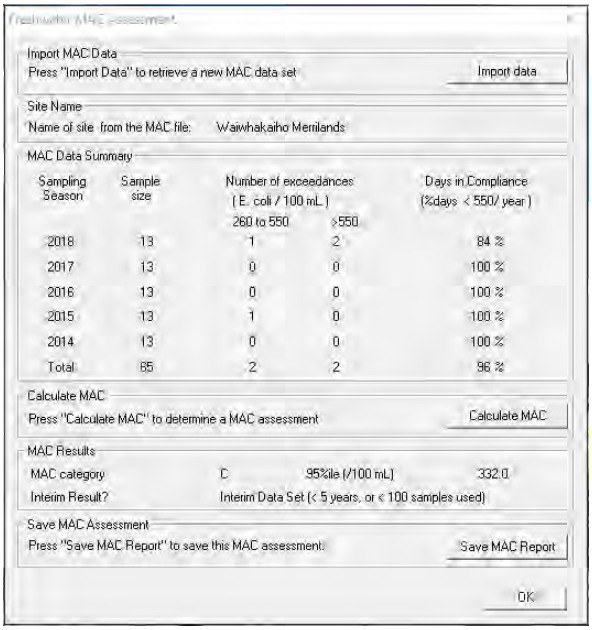
MAC Assessments 2013-2018

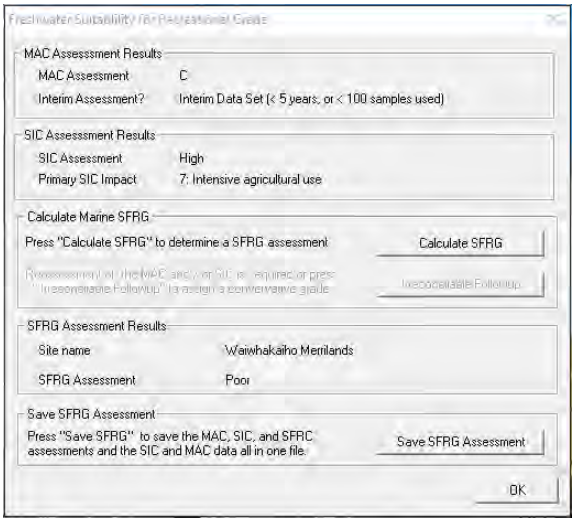
Lake Rotomanu



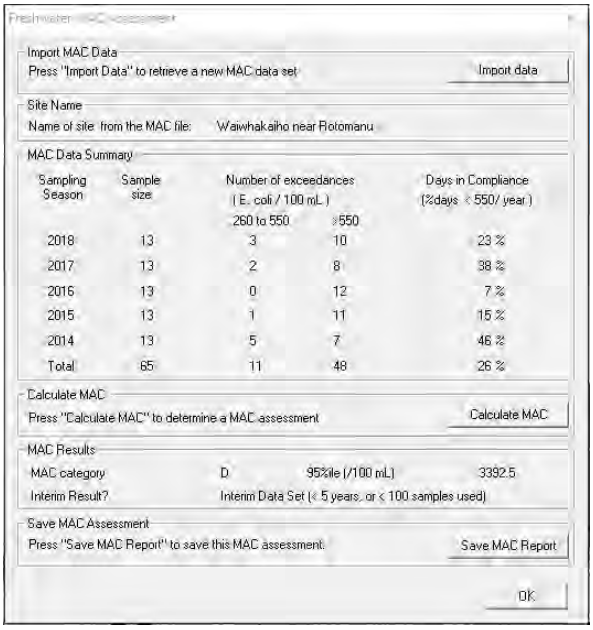


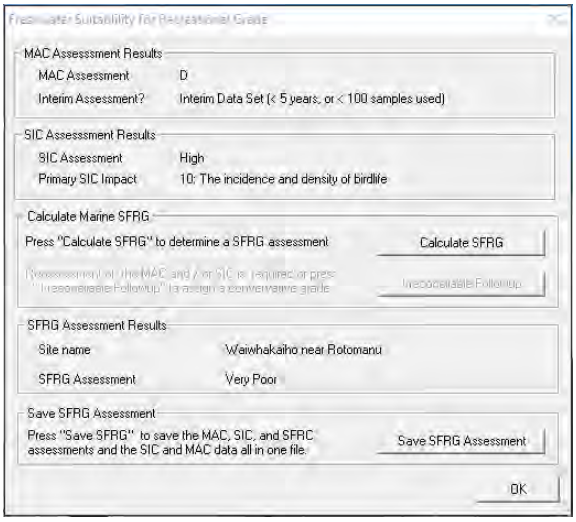
Waiwhakaiho River at Merrilands Domain



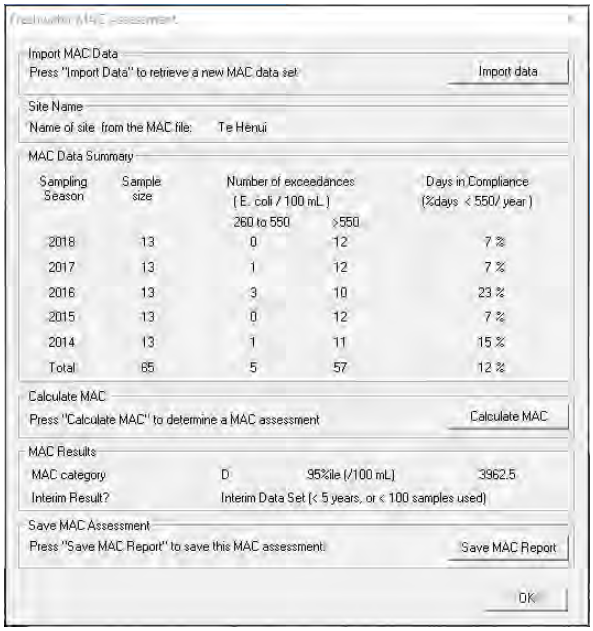


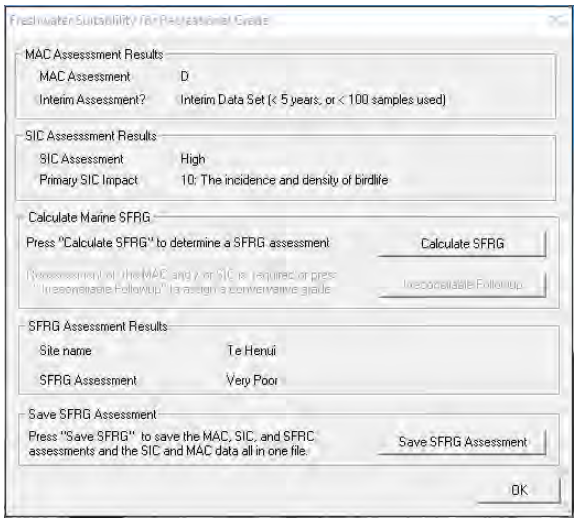
Waiwhakaiho near Lake Rotomanu



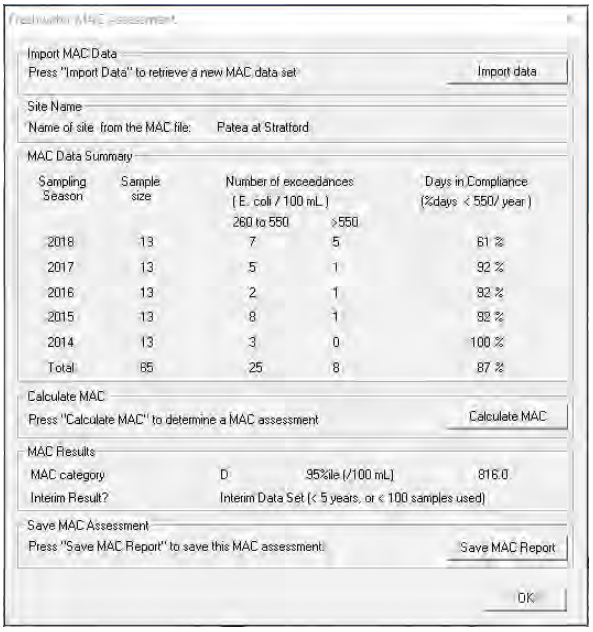


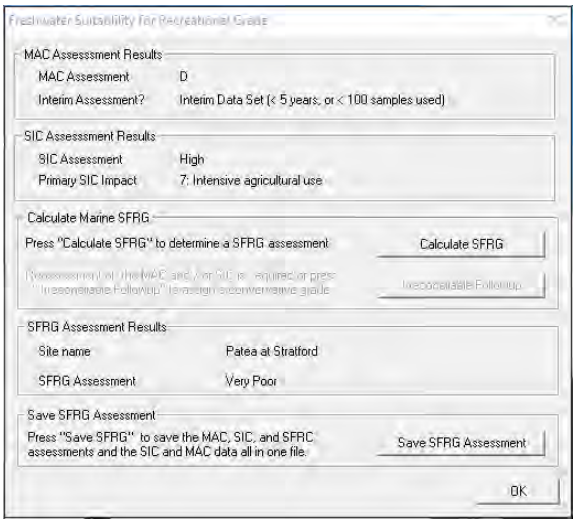
Te Henui Stream: mouth



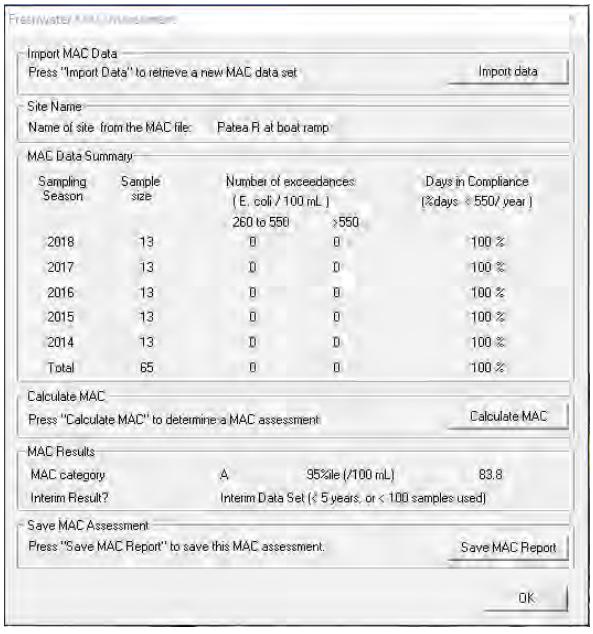


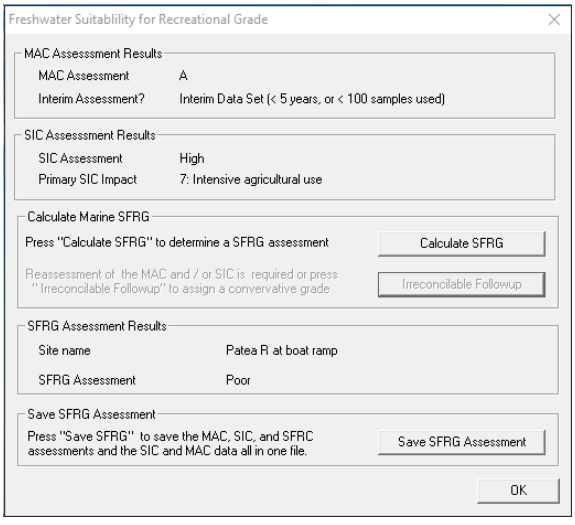
Patea River at Stratford





Patea River at boat ramp, Patea



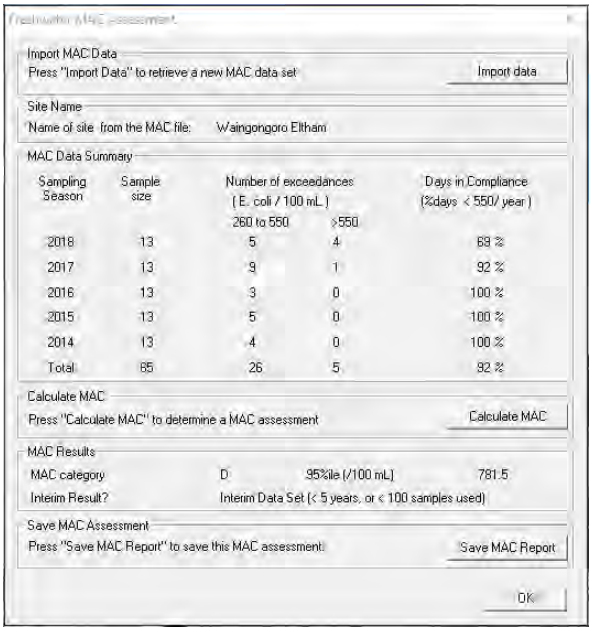


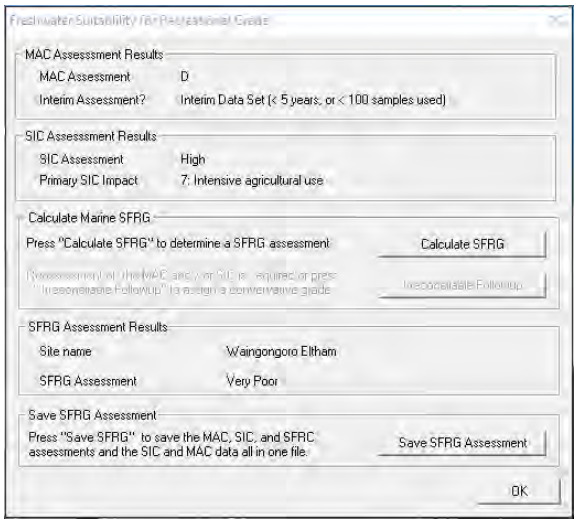
Patea River at boat ramp was Follow up, irreconcilable flow-up and SFRG Assessment resulted in Poor.

Document Number: 2152846

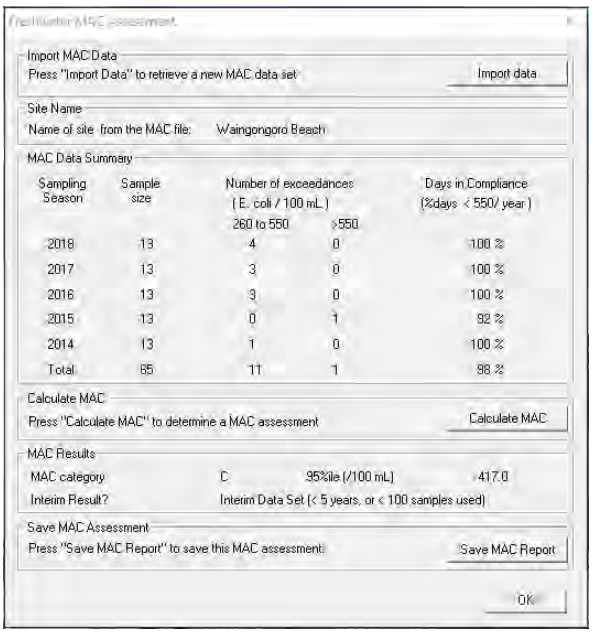
Document Name: Bathewatch Freshwater SFRG assessments 2017-2018

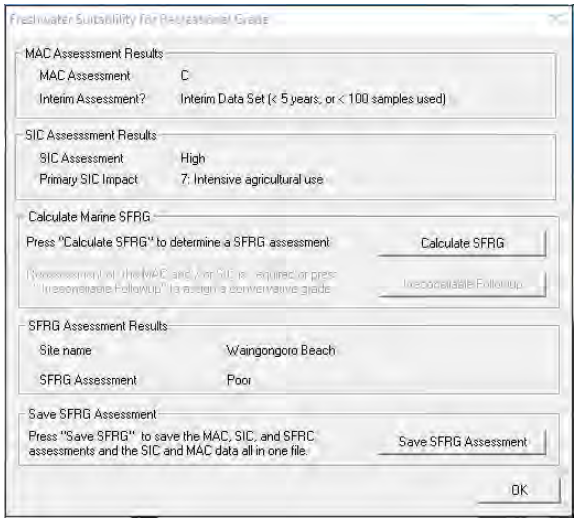
Waingongoro River at Eltham camp



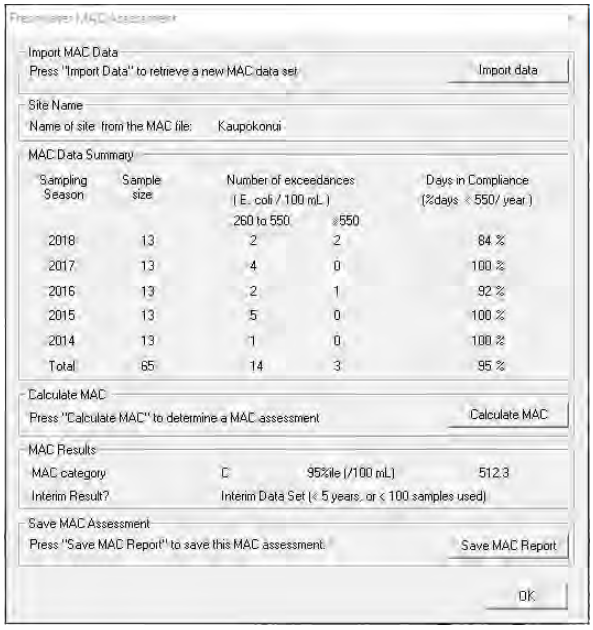


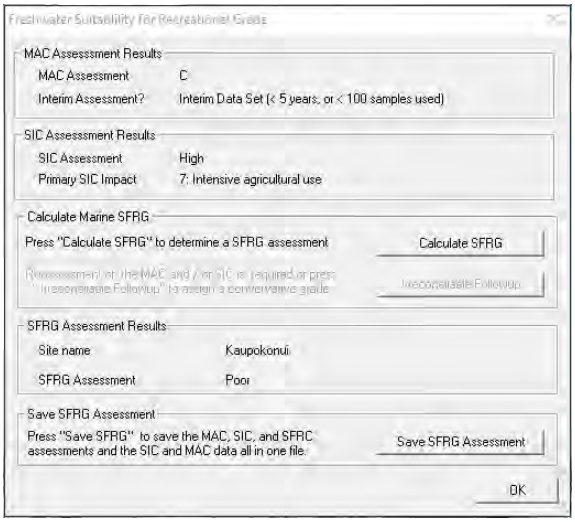
Waingongoro River at Ohawe beach



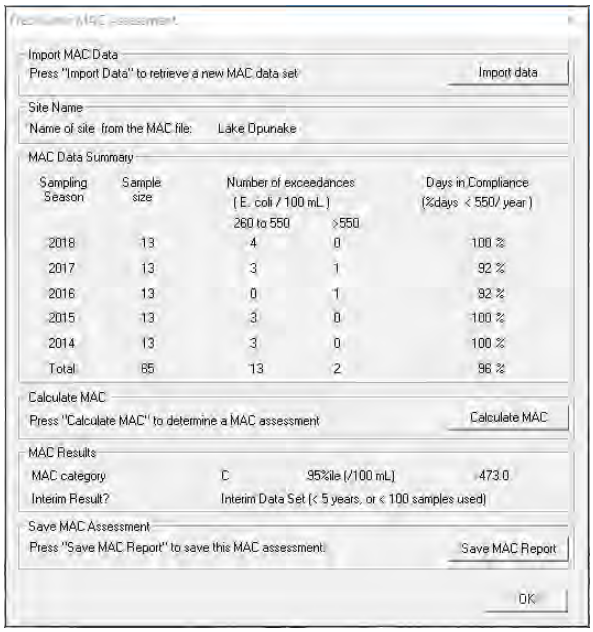


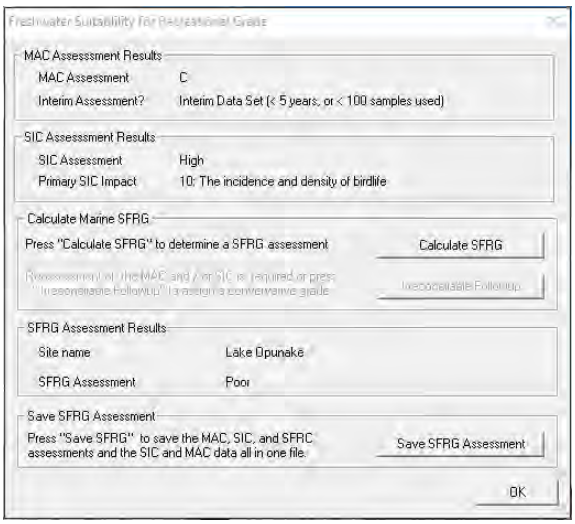
Kaupokonui River at beach domain



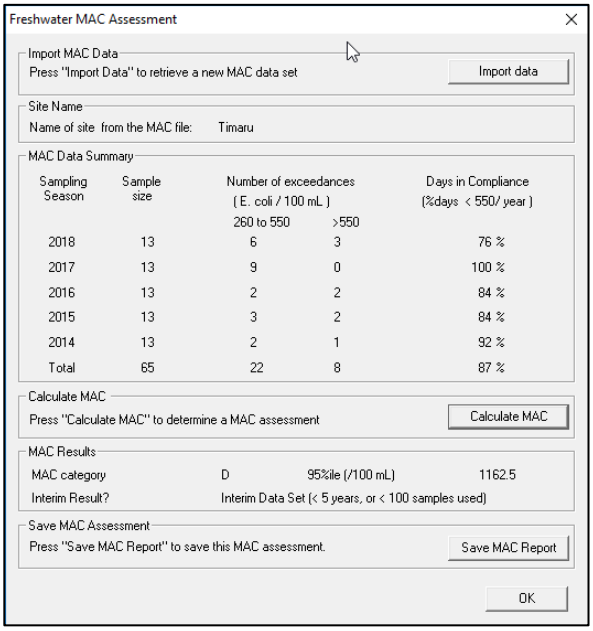


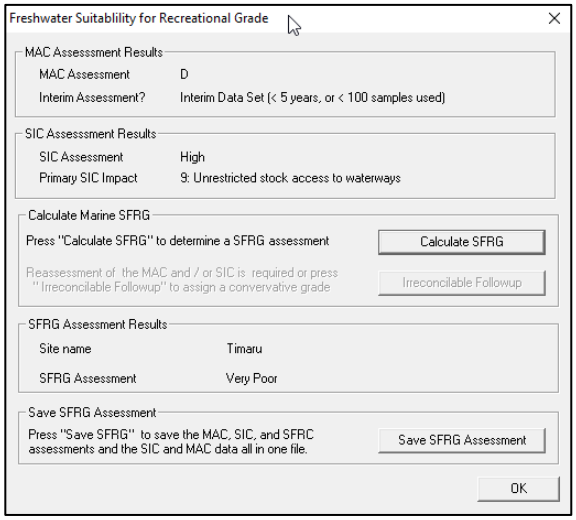
Lake Opunake



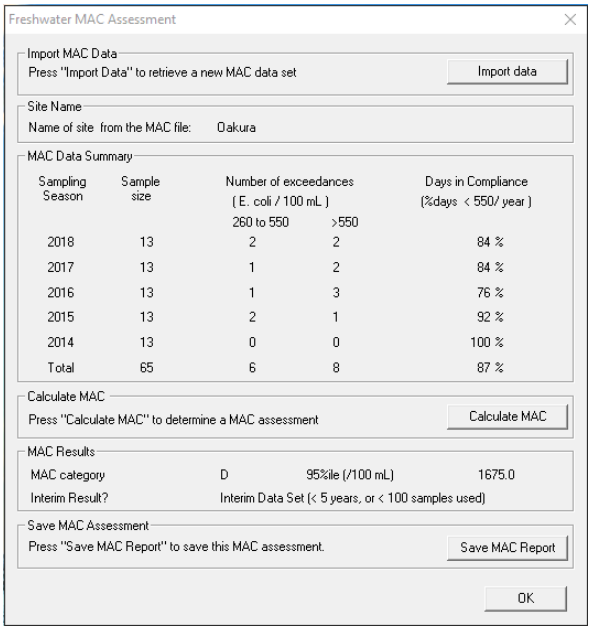


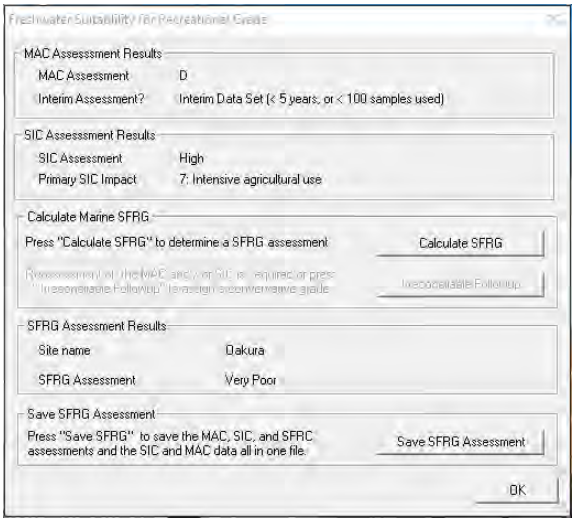
Timaru Stream at Weld Road



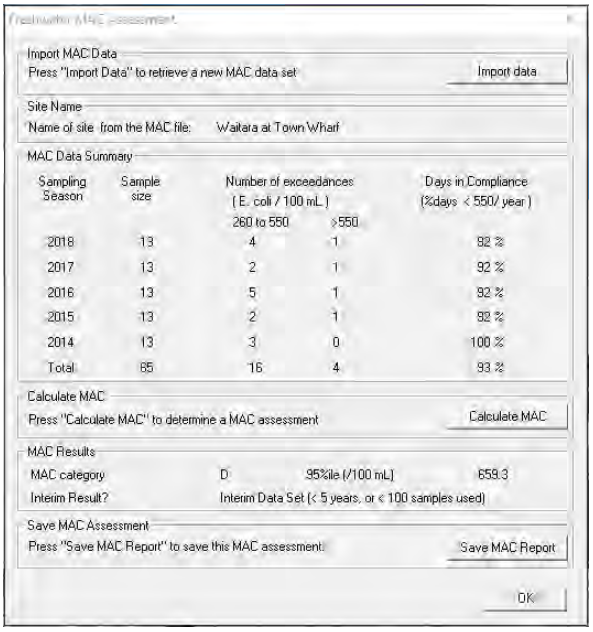


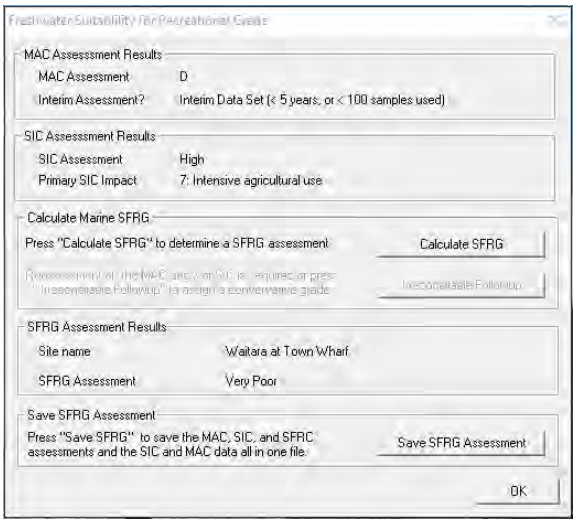
Oakura River d/s SH45



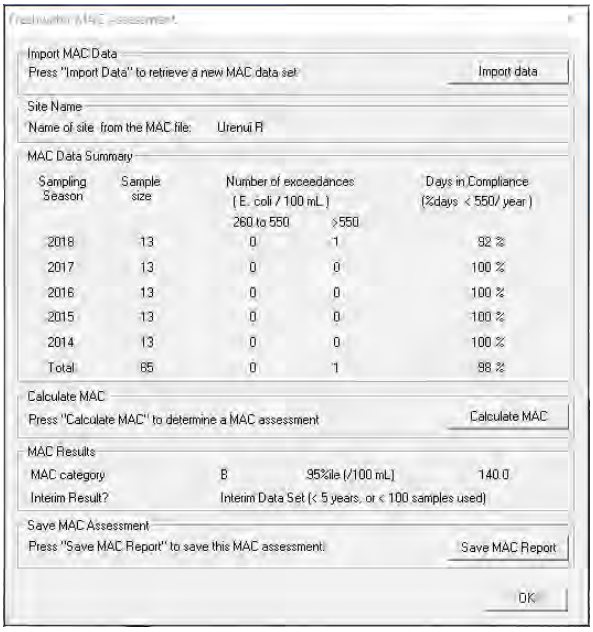


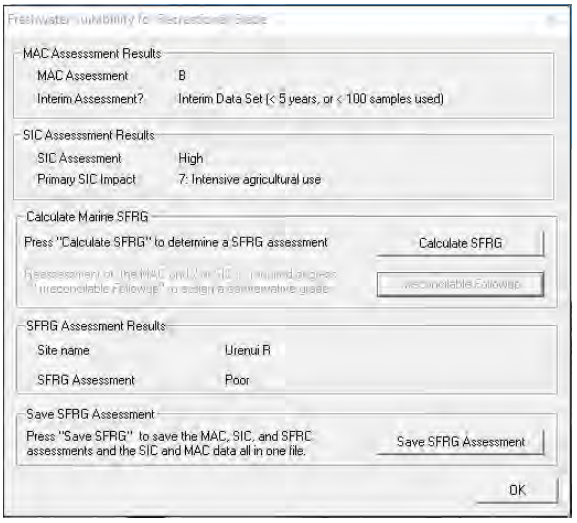
Waitara River





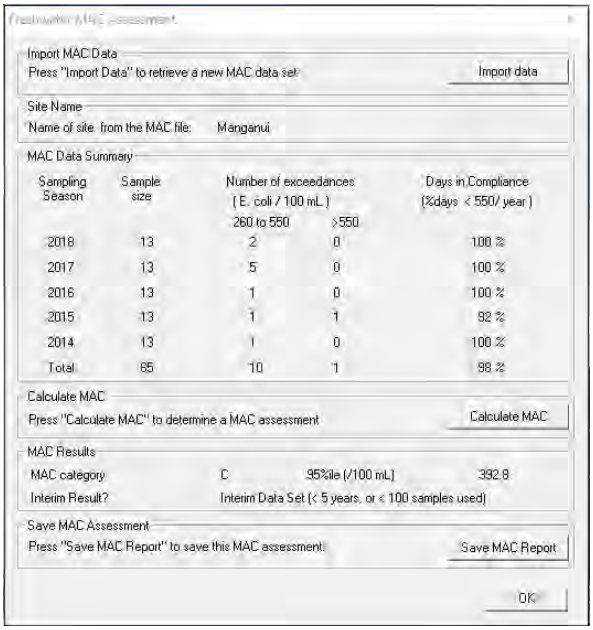
Urenui River at estuary

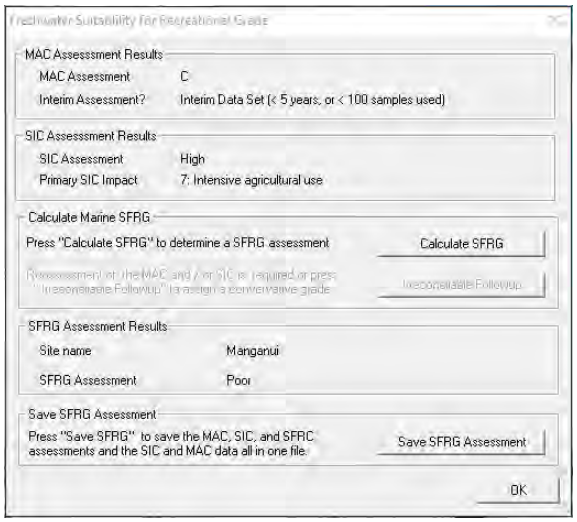




Urenui River was Follow up, irreconcilable follow-up and SFRG Assessment resulted in Poor

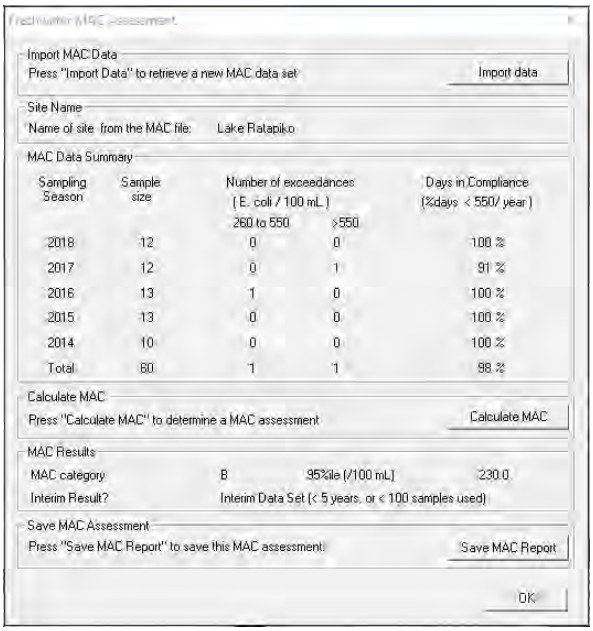
Manganui River at Everett Park

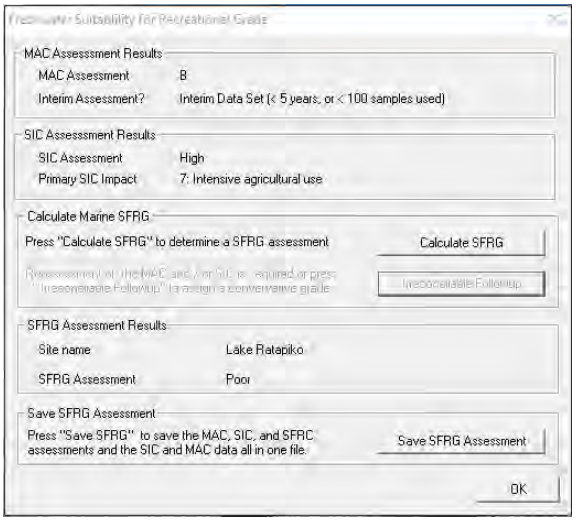




Lake Ratapiko was Follow up, irreconcilable follow-up and SFRG assessment resulted in Fair

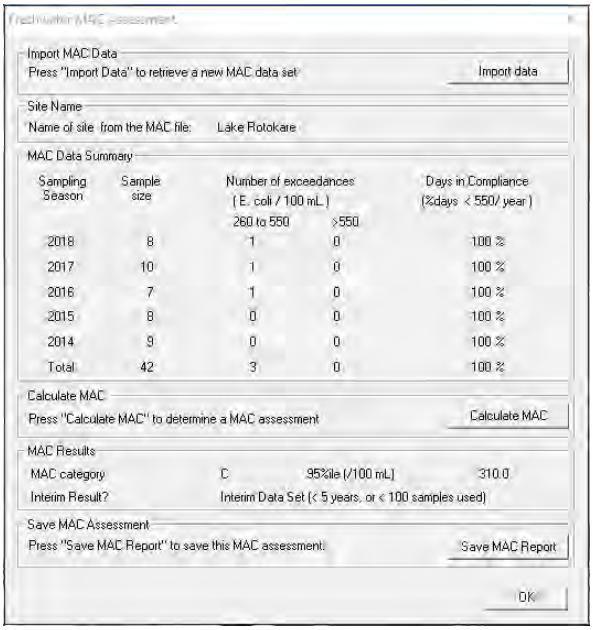
Lake Ratapiko





Lake Ratapiko was Follow up, irreconcilable follow-up and SFRG assessment resulted in Poor

Lake Rotokare



There is no SIC or SFRG assessment as no relevant sic file to import.

Appendix IV

Sampling conditions and public usage recorded at each site

Site Lake Rotomanu (Site Code: LRM000002)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	3/8	N/A	Turbid, brown-green	Rippled	0/6 (walkers)	Ducks common, 2 gulls; TRC signage, NPDC sign green	0	0.5
20 November 2017	SEM	Fine, windy	0/8	N/A	Turbid, brown, some foaming	Rippled	0/0	Ducks common; NPDC signs red (entrance), orange (temporary at W beach, for cyanobacteria)	0	0
28 November 2017	MfE	Fine	4/8	N/A	Sl. turbid, brown	Rippled	0/0	Ducks common; NPDC signs red and yellow	0	0
4 December 2017	SEM	Fine	2/8	N/A	Sl. turbid, brown	Rippled	1/2 (kayaker, shore)	Ducks v. common , 5 gulls; NPDC sign green, temporary sign gone	0	0
12 December 2017	MfE	Fine	0/8	N/A	Sl. turbid, brown	Rippled	0/0	Ducks common; NPDC sign green	0	21
18 December 2017	MfE	Fine, overcast	6/8	N/A	Turbid, brown	Rippled	4/20 (2 swimmers, jet-ski, boat; 20 onshore)	No birdlife; 2 NPDC signs, red (entrance) and yellow (W)	9	10
28 December 2017	MfE	Fine	1/8	N/A	Turbid, dark brown	Choppy	2/25 (jet-ski, skier; ~25 onshore)	No birdlife, 2 NPDC signs against swimming/dogs	0	8.5
3 January 2018	MfE	Fine	2/8	70-80%, brown mat	Turbid, brown	Rippled	6/15	No birdlife; NPDC sign red	0	27
9 January 2018	MfE	Fine	4/8	70% brown mat	Turbid, brown	Rippled	3/3 (boating, onshore)	No birdlife; NPDC signs red/yellow	0	0
15 January 2018	SEM	Fine	1/8	N/A	Turbid, brown	Rippled	4/0 (boat, 4 on board)	No birdlife;	0	0
25 January 2018	MfE	Fine	3/8	40% brown mat	Turbid brown	Rippled	6/2	Ducks common	0	15.8
30 January 2018	SEM	Fine	3/8	N/A	Turbid, brown	Flat	4/0 (3 on jet-ski, 1 kayak)	Ducks common; NPDC signs red/yellow	0	0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 February 2018	SEM	Showers, strong wind	8/8	N/A	Turbid, brown	Choppy	0/0	No birdlife, New TRC sign. NPDC signs red/yellow	0	0
7 February 2018	MfE	Fine	7/8	N/A	Turbid, brown	Rippled	0/0	Few ducks; NPDC signs red/yellow	0	0.2
16 February 2018	SEM	Fine	1/8	N/A	Turbid, brown	Flat	0/0	No birdlife; NPDC signs red/yellow	0	0
19 February 2018	SEM	Fine, overcast	8/8	N/A	Turbid, brown	Flat	0/0	2 ducks; NPDC signs red/yellow	0	0
1 March 2018	MfE	Fine	5/8	N/A	Turbid, brown	Rippled	0/0	No birdlife; NPDC signs red/yellow	0	0
5 March 2018	SEM	Fine, warm	3/8	N/A	Turbid, brown	Rippled	0/0	No birdlife; NPDC sing red/orange	0	0
13 March 2018	MfE	Fine	7/8	N/A	Turbid, brown	Rippled	0/0	4 ducks; NPDC sign at red	0	0
19 March 2018	SEM	Fine, overcast	7/8	N/A	Turbid, brown	Rippled	0/2 (on bank feeding birds)	9 ducks, 20+ gulls fed on shore; NPDC sign yellow	0	0
27 March 2018	MfE	Fine, overcast	8/8	N/A	Turbid, brown	Rippled	0/0	No birdlife; NPDC sign green	0	3.4
3 April 2018	SEM	Fine, overcast	8/8	N/A	Turbid, brown	Flat	0/0	Gulls v common on bank; NPDC sign green	0	4.4
6 April 2018	SEM	Fine	5/8	N/A	Turbid, brown	Flat	0/0	1 gull, 1 swan; NPDC sign green	0	0.6
7 April 2018	SEM	Fine	3/8	N/A	Turbid, brown	Rippled	0/6 (bank)	5 gulls on bank; NPDC sign green	0	0.2

Site Waiwhakaiho River at Merrilands (Site Code: WKH000800)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	3/8	70% thin brown mat	Clear, yellow-brown	D/S	0/1 (fisher)	TRC signage present, no birdlife	0.5	1.0
14 November 2017	FOLLOW UP	Fine			Clear, uncoloured	D/S			0	0
20 November 2017	SEM	Fine	0/8	70% brown mat, 10% green filam.	Sl. turbid, uncoloured	D/S	0/1 (walker)	Signage present; no birdlife, 3 dogs, 1 in water	0	0
28 November 2017	MfE	Fine	6/8	80% brown	Clear, dark green	D/S	3/0 (swimmers u/s)	TRC sign, NPDC traffic light green; 2 ducks	0	0
4 December 2017	SEM	Fine	0/8	60% brown	Clear, dark green	D/S	20+ u/s	NPDC sign green, no birdlife, 2 dogs	0	0.5
12 December 2017	MfE	Fine	0/8	60% brown, 15% green	Clear, uncoloured	D/S	0/3 (banks)	NPDC sign green	0	8.0
18 December 2017	MfE	Fine, overcast	7/8	85% brown, 5% green, 10% sand	Clear, green-grey	D/S	10 (swimmers)	NPDC sign green	9.5	12.0
28 December 2017	MfE	Fine	2/8	70% green mat	Clear, green-brown	D/S	0/2 (banks)	NPDC sign green; 1 dog in water, no birdlife	0.5	9.5
3 January 2018	MfE	Fine, rainfall preceding	2/8	60% brown mat	Clear, brown	D/S	5/4	Signage present; no birdlife	0.5	40.5
9 January 2018	MfE	Fine, overcast	5/8	40% thick brown	Clear, dark green	D/S	0/0	NPDC sign green; no birdlife	0	0
15 January 2018	SEM	Fine	0/8	60% mats	Clear, colourless	D/S	5 (swimming)	No birdlife; 1 dog in water	0	0
25 January 2018	MfE	Fine, windy, rainfall preceding	4/8	10% brown	Clear, green	D/S	0/4	NPDC sign green, no birdlife	0	14
30 January 2018	SEM	Fine	7/8	100% brown	Clear, yellow/brown	D/S	9/5 (including 3 in water u/s)	2 new TRC signs, NPDC green, no birdlife, 1 dog in water	0	0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 February 2018	SEM	Fine, overcast	8/8	100% brown	Clear, brown	D/S	0/0	Signage present; no birdlife	0.5	1.0
7 February 2018	MfE	Fine	7/8	60% brown	Clear, green	D/S	0/0	NPDC sign green; no birdlife	0	1.0
16 February 2018	SEM	Fine, warm	4/8	10%	Clear, yellow-green	D/S	0/0	Signage present; no birdlife	0	0.5
19 February 2018	SEM	Fine, overcast	8/8	40% hard substrate brown	Clear, colourless	D/S	0/0	NPDC sign green; no birdlife, 1 dog	0.5	1.0
26 February 2018	FOLLOW UP	Fine, overcast	6/8	100% green-brown mat	Clear, uncoloured	D/S	0/0	NPDC sign red;	0	0
1 March 2018	MfE	Fine, rainfall preceding	5/8	80%	Clear, dark green	D/S	0/0	NPDC sign yellow	0	0
5 March 2018	SEM	Fine, warm	1/8	70% brown	Clear, yellow-green	D/S	0/1 (dog walker)	NPDC yellow; no birdlife, 1 dog	0	0
13 March 2018	MfE	Fine	7/8	60% brown	Clear, green	D/S	0/0	NPDC signs yellow (temp.) and red, no birdlife	0	0
19 March 2018	SEM	Fine, overcast	7/8	40% brown, 5% green, 5% black	Clear, yellow	D/S	0/0	NPDC signs yellow/red; no birdlife	0	0
27 March 2018	MfE	Fine, overcast	8/8	60% brown	Clear, green	D/S	0/0	NPDC sign green, no birdlife	0	15
3 April 2018	SEM	Fine, overcast	8/8	100% brown	Clear, uncoloured	D/S	0/0	NPDC sign green, no birdlife	0	5
6 April 2018	SEM	Fine	6/8	90%, 5% black, 85% brown	Clear, uncoloured	D/S	0/0	NPDC green, no birdlife	0	6
7 April 2018	SEM + FOLLUP	Fine	6/8	100% brown	Clear, uncoloured	D/S	0/0	NPDC green, no birdlife	2	2

Site Waiwhakaiho River adjacent to Lake Rotomanu (Site Code: WKH000950)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	Fine	4/8	60-70% brown	Clear, green-brown	D/S	0/14 (whitebaiters)	TDHB permanent health warning; Gulls colony u/s	0	0.5
20 November 2017	Fine, windy	0/8		Clear, colorless	D/S	2/7 (swimmers, whitebaiters)	No birdlife	0	0
4 December 2017	Fine	1/8	30% brown	Clear, green-blue	D/S	0/0	No birdlife	0	0
15 January 2018	Fine	1/8	30% green-brown	Clear, colourless	D/S	0/0	Gulls colony u/s	0	0
30 January 2018	Fine	5/8		Clear, colourless	D/S	0/0	New TRC sign, gull colony and ducks common u/s	0	0
1 February 2018	Showers	8/8		Clear, colourless	D/S	0/0	Gulls colony u/s	0	0
16 February 2018	Fine	1/8	10%	Clear, colourless	D/S	0/0	NPDC sign orange, gulls colony u/s	0	0
19 February 2018	Fine, overcast	8/8	<5% brown	Clear, colourless	D/S	0/0	Gull colony u/s	0	0
5 March 2018	Fine, warm	3/8	10%	Clear, colourless	D/S	0/0	NPDC sign orange, gull colony u/s	0	0
19 March 2018	Fine, overcast	7/8	10% brown	Clear, yellow	D/S	0/0	NPDC orange, 10 ducks u/s	0	0
3 April 2018	Fine, overcast	8/8		Clear, green	D/S	0/0	9 ducks	0	4.4
6 April 2018	Fine	6/8	70%	Clear, colourless	D/S	0/0	NPDC sign orange, gull colony u/s	0	0.6
7 April 2018	Fine	2/8	60% brown	Clear, colourless	D/S	0/0	NPDC sign orange, gulls flocking u/s	0	0.2

Site Te Henui Stream at mouth, East End (Site Code: THN000499)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	Fine	5/8	N/A	Turbid, dark green	U/S	0/0	Permanent TDHB warning sign, ducks common	0	0.5
20 November 2017	Fine	0/8	N/A	Sl. turbid, green	U/S	0/0	Shellfish warning sign, ducks v common	0	0
4 December 2017	Fine	0/8	N/A	Clear, green	U/S	0/0	Ducks common u/s	0	0
15 January 2018	Fine	1/8	N/A	Clear, green-yellow	D/S	0/1 (bank)	No birds	0	0
30 January 2018	Fine	3/8	N/A	Clear, green	D/S	0/4 (3 fishing off bridge, 1 shore)	New TRC sign, few seagulls, 1 dog	0	0
1 February 2018	Showers, strong onshore wind	8/8	N/A	Turbid, grey-green	U/S	0/0	No birdlife	0	0
16 February 2018	Fine	4/8	N/A	Sl. turbid, green	D/S	0/5 (bank)	Ducks common u/s, few gulls d/s & 2 dogs	0	0
19 February 2018	Fine, overcast	8/8	N/A	Turbid, dull green	U/S	0/0	Seagulls u/s, ducks d/s	0	0
5 March 2018	Fine, warm	1/8	N/A	Turbid, green	D/S	0/3 (bank)	Ducks common u/s, seagulls common d/s	0	0
19 March 2018	Fine	4/8	N/A	Sl. turbid, green	Slack	0/0	Ducks common, 1 dog	0	0
3 April 2018	Fine, overcast	8/8	N/A	Clear, green	D/S	0/0	Ducks common u/s	0	0.6
6 April 2018	Fine, overcast	7/8	70% brown	Clear, colourless	D/S	0/0	Sewage spill warning, ducks common	0	0.2
7 April 2018	Fine	2/6	25% green	Clear, colourless	U/S	0/3 (bank)	Sewage spill warning, ducks common	0	0.5

Site Patea River, King Edward Park, Stratford (Site Code: PAT000297)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine, overcast	8/8	Nil	Clear, colourles	D/S	0/0	No signage, no birdlife	0	2.0
20 November 2017	SEM	Fine	0/8	Widespread green	Clear, brown tinge	D/S	0/0		0	0.5
4 December 2017	SEM	Fine	4/8	Green slim	Clear, brown tinge	D/S	0/2 (bank)	1 dog	0	33.5
6 December 2017	FOLLOW UP/INV	Fine	0/8	Widespread green	Clear, green tinge	D/S	5/3 (swimming, bank)	SDC warning sign, ignored by bathers, 2 ducks	0	0
9 January 2018	INVEST	Fine	0/8	Slight	Clear, colourless	D/S	15/5 (swimming, fishing)	2 dogs	0	0
15 January 2018	SEM	Fine	5/8		Sl. turbid, brown	D/S	1/0 (swimming, bank)	Ducks common	0	0.5
16 January 2018	FOLLOW UP	Fine	3/8	Brown mats	Sl. turbid, grown	D/S	3/1 (swimming, bank)	1 dog, DNA sampling	0	0.5
18 January 2018	INVEST	Heavy rain	8/8	Brown	Turbid brown	D/S	0/0	No birdlife, DNA sampling	32.5	32.5
26 January 2018	FOLLOW UP	Fine	4/8	Patchy green mats	Clear, colourless	D/S	0/0	Warning sign	0	0
30 January 2018	SEM	Fine	6/8	Widespread brown	Clear, colourless	D/S	0/2 (bank)	SDC warning sign, no birdlife	0	0
1 February 2018	SEM	Starting to rain	8/8		Clear, green	D/S	0/0	SDC sign pushed over	0	0
7 February 2018	FOLLOW UP	Fine	5/8		Clear uncoloured	D/S	0/0	Signage present	0	0
16 February 2018	SEM	Fine	1/8	Widespread green/brown	Clear, colourless	D/S	0/0	No birdlife	0	2.0
19 February 2018	SEM	Spitting	8/8	Widespread brown/green	Clear, uncoloured	D/S	0/0	No birds	0	0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
5 March 2018	SEM	Fine	0/8	Widespread brown	Clear, green tinge	D/S	0/0	No birdlife	0	0.5
19 March 2018	SEM	Fine	6/8	30% brown	Clear, green-brown	D/S	0/0	Few ducks	0.5	0.5
21 March 2018	SEM	Fine, overcast	8/8	Patchy brown	Clear, brown	D/S	0/0	No birdlife	0	0.5
3 April 2018	SEM	Fine, overcast	8/8	Brown mats	Clear, colourless	D/S	0/0	Few ducks	0	0
6 April 2018	SEM	Fine	3/8	Brown	Clear, colourless	D/S	0/3 (bank)	No birdlife	0	0.5
9 April 2018	FOLLOW UP	Fine	3/8		Clear, brown	D/S	0/0	Health risk sign, no birdlife	1.0	1.0
23 April 2018	FOLLOW UP	Fine	8/8		Clear, colourless	D/S	0/2 (bank)	Health risk sign, few ducks u/s	0	1.0

Site Patea River, boat ramp, Patea (Site Code: PAT000995)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	Fine	3/8	N/A	Turbid, light green	D/S	0/1 (fishing)	No birdlife	0	2.8
20 November 2017	Fine	0/8	N/A	Turbid, green	U/S	0/0	No birdlife. Didymo sign needs repair	0	0
4 December 2017	Fine	0/8	N/A	Turbid, green	U/S	0/1 (dog-walker)	No birdlife, 1 dog	0	0
15 January 2018	Fine	3/8	N/A	Turbid, blue-green	D/S	0/3 (launching boat)	No birdlife	0	0
30 January 2018	Fine	3/8	N/A	Turbid, light green	U/S	0/20 (shore)	No birdlife, TRC monitoring sign erected	0	0
1 February 2018	Fine, windy	6/8	N/A	Turbid, grey-green	D/S	0/0	No birdlife	0	0
16 February 2018	Fine	3/8	N/A	Turbid, light green-brown	D/S	0/0	No birdlife	0	0.2
19 February 2018	Fine	2/8	N/A	Turbid, light green	U/S	0/1 (shore)	No birdlife, dog swimming	0	0
5 March 2018	Fine	0/8	N/A	Sl. turbid, green-brown	U/S	0/0	No birdlife	0	0
19 March 2018	Fine	1/8	N/A	Turbid, grey	U/S	0/0	No birdlife	0	0
21 March 2018	Fine	8/8	N/A	Turbid, green-brown	D/S	0/0	No birdlife	0	0
3 April 2018	Fine, overcast	6/8	N/A	Turbid, light green	D/S	0/0	No birdlife	0	0
6 April 2018	Fine	2/8	N/A	Turbid, green-brown	D/S	0/0	No birdlife	0	0

Site Waingongoro River, Eltham camp (Site Code: WGG000492)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine, overcast	7/8	Patchy brown mat	Clear, brown, sweet smell, brown scum at pool edge u/s	D/S	0/0	No birdlife, sheep in adjacent paddock	0	2.0
20 November 2017	SEM	Fine, gusty wind	0/8	Patchy brown mat	Clear, green tinge	D/S	0/0	No birdlife	0	0.5
4 December 2017	SEM	Fine	0/8	Brown mats	Sl. turbid, brown tinge	D/S	0/0	No birdlife, 2 sheep d/s on bank	0	33.5
15 January 2018	SEM	Fine	5/8	Brown mats	Sl. turbid, brown	D/S	0/0	No birdlife	0	0.5
16 January 2018	FOLLOW UP	Fine	5/8	Brown mats	Sl. turbid, brown	D/S	0/0	No birdlife	0	0.5
26 January 2018	FOLLOW UP	Fine	3/8	70% brown	Clear, colourless	D/S	0/0	No birdlife	0	0
30 January 2018	SEM	Fine	6/8	Widespread brown	Clear, colourless	D/S	0/0	TRC sign erected, no birdlife	0	0
31 January 2018	INVEST	Fine	0/8	Thick brown mats	Clear, colourless	D/S	0/0	No birdlife	0	0
1 February 2018	SEM	Drizzle	8/8	Brown	Clear	D/S	0/0	No birdlife	0	0
7 February 2018	FOLLOW UP	Fine	0/8		Clear, colourless	D/S	0/0	No birdlife	0	0
16 February 2018	SEM/ FOLLUP	Fine	1/8	Widespread brown	Clear, brown tinge	D/S	4/0 (swimming) u/s	Warning sign, no birdlife	0	2.0
19 February 2018	SEM/ FOLLUP	Spitting	8/8	Widespread brown	Clear, brown	D/S	0/0	Warning sign, no birdlife. Sheep in adjacent paddock	0	0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
5 March 2018	SEM	Fine	0/8	Widespread brown, patchy greem	Clear, colourless	D/S	0/0	TRC sign, no warning sign, no birdlife. Sheep present.	0	0.5
6 March 2018	INVEST	Fine, overcast	8/8		Clear, uncoloured	D/S	0/0	No birdlife, DNA sample taken	0	0
14 March 2018	FOLLOW UP	Fine	4/8	10% brown mat		D/S	0/3	No birdlife	0	0
19 March 2018	SEM	Fine	6/8	60% brown	Clear, green	D/S	0/0	No birdlife	0	0.5
21 March 2018	SEM	Fine, overcast	8/8	Widespread brown	Clear, brown tinge	D/S	0/30 (camping)	No birdlife	0.5	0.5
3 April 2018	SEM	Fine	4/8	Widespread brown	Clear, green	D/S	0/0	No birdlife. Sheep in adjacent paddock	0	0
6 April 2018	SEM	Fine	4/8	Widespread brown	Clear, uncoloured	D/S	0/0	No birdlife. Sheep in adjacent paddock	0	0.5

Site Waingongoro River, near mouth (Site Code: WGG000995)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	3/8	Nil	Sl. turbid, green-brown	D/S, u/s surging	0/3 (whitebaiting)	No birdlife	0	1.0
20 November 2017	SEM	Fine, gusty wind	0/8	Patchy brown mats	Sl. turbid, green	D/S	0/8	No birdlife	0	0
28 November 2017	MfE	Fine	0/8		Sl. turbid	D/S	0/4	No birdlife	0	0
4 December 2017	SEM	Fine	2/8		Sl. turbid, brown tinge	D/S	0/0	No birdlife	0	6.0
12 December 2017	MfE	Fine, windy	2/8	Widespread brown	S. turbid, brown tinge	D/S	0/0	No birdlife, gate locked	0	0
18 December 2017	MfE	Fine, overcast, windy	6/8		Clear, brown tinge	U/S	0/0	No birdlife	2.0	2.0
28 December 2017	MfE	Fine	1/8	30% brown mat	Clear, green-brown	D/S	4/4 (swimming/fishing)	No birdlife	1.0	6.5
3 January 2018	MfE	Fine, rainfall preceding	4/8	Brown	Murky brown, susp. material	D/S	0/0	No wildlife	2.5	2.5
9 January 2018	MfE	Fine	2/8	Widespread brown	Clear, brown	D/S	0/0	1 black shag, gate locked	0	0
15 January 2018	SEM	Fine	2/8	Brown	Clear, brown tinge	D/S	0/0	No birdlife	0	0
25 January 2018	MfE	Fine	5/8	Widespread brown	Clear, colourless	D/S	2/0 (swimming d/s)	No birdlife	0	5.5
30 January 2018	SEM	Fine	0/8	Widespread brown	Clear, brown	D/S	4/0 (swimming)	1 duck u/s	0	0
1 February 2018	SEM	Rain	8/8	Brown mats	Clear, grey	U/S	0/0	No birdlife	0	0
7 February 2018	MfE	Fine	2/8	Brown mats	Sl. turbid, green	D/S	0/0	No birdlife	0	3.0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
16 February 2018	SEM	Fine, overcast	8/8	Patchy brown	Clear, green	D/S	0/0	No birdlife	0	0.5
19 February 2018	SEM	Fine, overcast	8/8	Patchy brown	Clear, brown tinge	D/S, u/s surging	0/0	2 ducks d/s	0	0
1 March 2018	MfE	Fine	3/8	Widespread brown	Clear, brown	D/S, u/s surging	3/2 (swimming)	No birdlife	0	0
5 March 2018	SEM	Fine	5/8	Widespread brown	Clear, brown	Slack, u/s surges	0/0	1 duck u/s	0	0.5
13 March 2018	MfE	Fine, overcast	8/8	Nil	Clear, green tinge	D/S	0/0	No birdlife	0	0
14 March 2018	FOLLOW UP	Fine	0/8	10-20% brown			0/0	No birdlife	2.5	2.5
19 March 2018	SEM	Fine	0/8	80% brown	Clear, green	D/S	0/0	STDC warning sign, No birdlife	0	0.5
21 March 2018	SEM	Fine, overcast	8/8	Nil	Sl. turbid, brown	D/S	0/0	STDC warning sign, few ducks, 1 shag	0	0
27 March 2018	MfE	Fine	0/8	Widespread brown	Clear, green tinge	D/S	0/0	No birdlife	0	3.0
3 April 2018	SEM	Fine	4/8	Nil	Clear, green	D/S, u/s surge	0/3 (banks)	No birdlife	0	5.0
6 April 2018	SEM	Fine	2/8	Widespread brown	Clear, colourless	D/S	0/0	No birdlife, mullet shoals	0	0

Site Kaupokonui River, beach domain (Site Code: KPK000995)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	2/8	N/A	Clear, dark green	D/S, u/s surging	0/4 (banks)	No birdlife	0	3.0
20 November 2017	SEM	Fine	2/8	N/A	Clear, blue-green	U/S	0/4 (banks)	No birdlife	0	0
28 November 2017	MfE	Fine	0/8	Widespread brown mats	Clear, brown tinge	D/S	0/2 (banks)	No birdlife	0	0
4 December 2017	SEM	Fine	0/8	None visible	Turbid, green	U/S	1/8 (fishing)	No birdlife	0	0.5
12 December 2017	MfE	Fine	4/8	Brown mats	Sl. turbid, brown-green	D/S	0/1 (dog-walker)	No birdlife, 1 dog	0	0.5
18 December 2017	MfE	Fine,, windy, rainfall preceding	6/8	Too turbid	Turbid, brown	U/S	0/0	No birdlife	0	0
20 December 2017	FOLLOW UP	Fine	8/8	Widespread brown	Turbid. brpwn tinge	U/S	0/0	STDC warning sign, no birdlife	0.5	0.5
28 December 2017	MfE	Fine	1/8	30% green mat	Clear, brown	D/S	8/10 (swimming, banks)	No birdlife	1.0	4.0
3 January 2018	MfE	Fine, rainfall preceding	5/8	Brown	Turbid, brown, large suspended sediment	U/S	0/6 (fishing)	No birdlife	0	0
9 January 2018	MfE	Fine	4/8	Widespread green/brown	Clear, brown	D/S	0/2 (banks)	No birdlife	0	0
15 January 2018	SEM	Fine	2/8	Brown mats	Clear, brown	D/S	2/6 (kayaking, walking)	No birdlife	0	0
25 January 2018	MfE	Fine, rain preceding	6/8	Brown mats	Sl. turbid, brown	D/S	4/10 (swimming, walking)	No birdlife	0	2.5
30 January 2018	SEM	Fine	0/8	Brown mats detaching	Clear, brown	D/S	0/0	2 ducks u/s	0	0
31 January 2018	FOLLOW UP	Fine	0/8		Clear, yellow	U/S	0/0	New TRC sign, No birdlife	0	0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
1 February 2018	SEM	Fine, windy	4/8	N/A	Turbid, green-brown	U/S	0/0	No birdlife	0	0
7 February 2018	MfE	Fine	3/8	Brown mats	Clear, colourless	D/S	0/0	No birdlife	0	1.5
16 February 2018	SEM	Fine	3/8	Nil	Sl. turbid, dark green-brown	D/S	0/10 (banks)	3 ducks & 1 shag u/s	0	0
19 February 2018	SEM	Fine, overcast	8/8	Brown suspended	Sl. turbid, brown	U/S	0/0	No birdlife	0	0
1 March 2018	MfE	Fine, rainfall preceding	4/8	Nil	Clear, green	D/S	0/0	No birdlife	0	0
5 March 2018	SEM	Fine	1/8	Nil	Sl. turbid, dark green	D/S	0/0	No birdlife	0	1.5
13 March 2018	MfE	Fine	7/8	Nil	Clear, green	D/S	0/2 (banks)	2 ducks, 1 blue heron	0	0
19 March 2018	SEM	Fine	2/8		Sl. turbid, green	D/S	0/3 (fishing at mouth)	No birdlife	0	1.5
21 March 2018	SEM	Fine	5/8	Nil	V. turbid, brown, sediment suspended	D/S,strong surging	0/0	No birdlife	0	0
27 March 2018	MfE	Fine	0/8	Patchy brown mats	Clear, green	D/S	0/0	2 ducks	0	1.0
3 April 2018	SEM	Fine	3/8	Nil	Sl. turbid, green	D/S	0/0	No birdlife	0	7.0
6 April 2018	SEM	Fine	6/8	Nil	Clear, dark green	D/S	0/0	1 black shag u/s	0	0

Site Lake Opunake (Site Code: LOP000001)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine, overcast	8/8	N/A	Sl. turbid, brown	Rippled	0/0	4 ducks on water, 3 on shore	0	3.5
20 November 2017	SEM	Fine	0/8	N/A	Clear, green	Flat	0/0	Ducks common	0	0
4 December 2017	SEM	Fine	2/8	N/A	Clear, green	Flat	0/1 (banks)	Ducks common	0	0
15 January 2018	SEM	Fine	2/8	Oxygen weed on bottom	Clear, green	Flat	0/0	Ducks common	0	0
30 January 2018	SEM	Fine	0/8	Abundant weed	Clear, green	Flat	0/0	Ducks common	0	0
1 February 2018	SEM	Fine, windy	7/8	N/A	Clear, blue-green	Rippled	0/0	Ducks common	0	0
7 February 2018	FOLLOW UP	Fine	7/8	N/A	Clear, dark green	Rippled	0/0	Ducks common	0.5	3.5
16 February 2018	SEM	Fine	6/8	N/A	Clear, dark green	Rippled	0/0	Few ducks	0	0.5
19 February 2018	SEM	Fine, overcast	8/8	N/A	Clear, dark green	rippled	0/0	Ducks common	0	0
5 March 2018	SEM	Fine	1/8	N/A	Clear, dark green	Rippled	0/0	Ducks common	0	0
19 March 2018	SEM	Fine	7/8	N/A	Clear, green	Flat	0/0	Ducks & geese v common	0	0
21 March 2018	SEM	Fine	3/8	Abundant surface weed	Clear, green	Flat	0/2 (banks)	Ducks common	0	0
3 April 2018	SEM	Fine, overcast	7/8	N/A	Clear, green	Rippled	0/0	Ducks common	0	0
6 April 2018	SEM	Fine	3/8	N/A	Clear, dark green	Flat	0/0	Few ducks	0	0.5

Site Timaru Stream, near mouth (Site Code: TMR000497)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	5/8	N/A	Sl. turbid, green-blue	D/S, u/s surging	0/0	New NPDC sign, on shellfish alert (orange), few gulls	0	3.0
20 November 2017	SEM	Fine	0/8	N/A	Clear, green	D/S	0/0	NPDC sign orange, few gulls	0	0
22 November 2017	FOLLOW UP	Fine	0/8	N/A	Turbid, murky dark green	D/S	0/4 (walkers)	NPDC sign orange, no birdlife	0	0
23 November 2017	FOLLOW UP	Fine	0/8	N/A	Clear, colourless	D/S	2/1 (swimming/ whitebaiting)	NPDC sign orange, gulls at mouth	0	0
24 November 2017	FOLLOW UP	Fine	3/8	N/A	Sl. turbid, green	D/S	0/1 (whitebaiter)	NPDC sign orange, no birdlife	0	0
28 November 2017	FOLLOW UP	Fine	2/8	N/A	Clear, light green	D/S	8/2 (swimmers/banks)	NPDC sign orange, no birdlife	0.5	0.5
4 December 2017	SEM	Fine	2/8	40% on sand	Cloudy yellow-green	D/S	0/0	NPDC sign orange, no birdlife –abundant fpptprints	0	0
6 December 2017	FOLLOW UP	Fine	1/8	Nil	Clear, colourless	D/S	0/0	NPDC sign orange, few ducks	0	0
7 December 2017	FOLLOW UP	Fine	4/8	N/A				DNA sample at bridge u/s	0	0
12 December 2017	FOLLOW UP	Fine	2/8	N/A	Sl. turbid, green-brown	D/S	0/0	NPDC sign orange	0.5	8.5

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 January 2018	SEM	Fine	0/8	50% brown-green filam.	Clear, colourless	D/S	0/0	NPDC sign green, sparrows	0	0
30 January 2018	SEM	Fine	4/8		Clear, colourless	U/S	0/0	NPDC sign green, no birdlife, DNA sample taken	0	0
31 January 2018	FOLLOW UP	Fine	4/8		Clear, blue-green	D/S	0/3 (horseriders)3	New TRC sign, NPDC green, 3 horses, 1 dog	0	0
1 February 2018	SEM	Fine, strong winds	8/8		Sl. turbid, grey-blue	U/S	0/0	NPDC sign orange, seagulls common on far bank	0.5	0.5
7 February 2018	FOLLOW UP	Fine, overcast	7/8		Clear, colourless	D/S	0/0	NPDC sign orange, no birdlife	0.5	1.5
16 February 2018	SEM	Fine, overcast	8/8	Nil	Clear, colourless	D/S	0/0	NPDC sign green, horse defecating in stream	0	3.0
19 February 2018	SEM	Fine, overcast	7/8	Nil	Clear, colourless	U/S	10 (swimming, more in sea)	NPDC sign green, 1 dog	0.5	0.5
5 March 2018	SEM	Fine	4/8	Nil, sandy	Clear, colourless	D/S	0/5 (bank)	NPDC sign green, 1 dog swimming	0	0
19 March 2018	SEM	Fine, overcast	7/8	Nil	Clear, colourless	Slack	0/2 (fishing)	NPDC sign green, few gulls	0	0
3 April 2018	SEM	Fine, overcast	8/8	Nil	Clear, green	D/S	0/0	NPDC sign green, a shag, 1 dog	1.0	3.0
6 April 2018	SEM	Fine	6/8	Nil	Clear, colourless	D/S	0/2 (bank)	No birdlife	0	1.0
7 April 2018	SEM	Fine, overcast, windy	7/8	Nil	Clear, colourless	D/S	3/5 (swimming/bank)	No birdlife, 2 dogs	0	0

Site Oakura River, near mouth (Site Code: OKR000497)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	5/8	Nil	Sl. turbid, dark green	D/S	0/3 (bank)	NPDC sign orange (shellfish), no birdlife	0	5.5
20 November 2017	SEM	Fine	0/8		Clear, green tinge	D/S	0/2 (beach)	NPDC sign orange, 2 gulls	0	0
4 December 2017	SEM	Fine	1/8	N/A	Sl. turbid, green	U/S	0/0	NPDC sign orange, no birdlife	0	0.5
15 January 2018	SEM	Fine	2/8	Nil, sandy	Clear, sl. yellow-green	D/S	2/8 (swimming/banks)	2 gulls, 2 dogs in water	0	0
30 January 2018	SEM	Fine	2/8	Nil	Clear, colourless	D/S	1/0 (swimmer)	NPDC sign green, no birdlife, 1 dog	0	0
31 January 2018	FOLLOW UP	Fine	4/8		Clear, green	D/S	12/8	Sign green, no birdlife, 1 dog	0.5	0.5
1 February 2018	SEM	Showers, strong wind	8/8		Turbid, grey-green	Swirling	0/0	New TRC sign, NPDC orange, no birdlife	0	1.0
7 February 2018	FOLLOW UP	Fine	6/8		Clear, green	D/S	0/0	NPDC orange, no birdlife	0	2.0
16 February 2018	SEM	Fine	4/8	Nil	Clear, green	D/S	0/4 (bank)	NPDC green	0	4.5
19 February 2018	SEM	Fine, overcast,	8/8	Nil	Clear, colourless	U/S	1/ 2 (swimming/beach)	NPDC green, few gulls	0	0.5
5 March 2018	SEM	Fine	0/8	Nil	Clear, green	D/S	1/1 (paddleboarder)	NPDC green, few gulls d/s	0	0
19 March 2018	SEM	Fine, overcast	7/8	Nil	Clear, green-brown	D/S	2	NPDC green, no birdlife, 2 dogs	0	0
3 April 2018	SEM	Fine, overcast	8/8		Clear, green	D/S	0/0	NPDC green, no birdlife	1.0	11.0
6 April 2018	SEM	Fine	5/8	Nil	Clear, colourless	U/S	0/1 (dog-walker)	NPDC green, no birdlife, 1 dog	0	6.0

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 April 2018	SEM	Fine	2/8	5% had substrate	Clear, colourless	D/S	0/0	NPDC green, few gulls d/s	1.5	1.5

Site Waitara River at town wharf, Waitara (Site Code: WTR000922)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	3/8	N/A	Turbid, brown	Slack	0/1 (whitebaiter)	No health warning, no birdlife	0	1.0
20 November 2017	SEM	Fine	0/8	N/A	Sl. turbid, green-brown	D/S	0/0	No birdlife	0	0
4 December 2017	SEM	Fine	0/8	N/A	Clear, green	D/S	0/0	No birdlife	0	0
15 January 2018	SEM	Fine	2/8	N/A	Turbid, green, hint brown	D/S	0/0	NPDC sign green	0	0
30 January 2018	SEM	Fine	3/8	N/A	Turbid, green	D/S	0/0	Sign green, ducks common	0	0
1 February 2018	SEM	Showers, windy	8/8	N/A	Turbid, grey-brown	U/S	0/0	TRC sign, NPDC sign green, few ducks	2.0	6.5
16 February 2018	SEM	Fine, overcast	7/8	20% green mat	Turbid, brown	D/S	0/0	Sign green, no birdlife. Sampled 2.5 h before HT.	0	0.5
19 February 2018	SEM	Fine, overcast	8/8	N/A	Turbid, browny-yellow	D/S	0/0	Ducks and gulls common	0	0
5 March 2018	SEM	Fine	2/8	N/A	Sl. turbid, green	D/S	0/1 (fishing right bank)	2 ducks, gulls common	0	0
19 March 2018	SEM	Fine, overcast	8/8	N/A	Turbid, green-brown	D/S	0/0	2 ducks, gulls common	0	0
21 March 2018	SEM	Drizzle	8/8	N/A	Turbid, green	D/S	0/0	No birdlife	2.5	2.5
3 April 2018	SEM	Fine, overcast	8/8	N/A	Turbid brown	D/S	0/7 (walkers)	Ducks common, few gulls and pigeons, 2 dogs	0	5.5
6 April 2018	SEM	Fine	2/8	N/A	Turbid, green	D/S	0/0	2 ducks	0	0

Site Urenui River at estuary (Site Code: URN000480)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	2/8	N/A	Turbid, green-brown	U/S	0/2 (fishing)	No birdlife	0	1.0
20 November 2017	SEM	Fine	0/8	N/A	Clear, green-blue	U/S	0/0	No birdlife	0	0
4 December 2017	SEM	Fine	0/8	N/A	Clear, turquoise-green	U/S	1/20 (boating/students)	2 oystercatchers	0	0
15 January 2018	SEM	Fine	1/8	N/A	Clear, green	D/S	20/40 (swimming/shore)	No birdlife	0	0
30 January 2018	SEM	Fine	2/8	N/A	Clear, green	D/S	8/1 (swimming)	No birdlife	0	0
1 February 2018	SEM	Heavy rain	8/8	N/A	Turbid, green	U/S	0/0	Few gulls, oystercatchers	2.0	6.5
7 February 2018	FOLLOW UP	Fine	7/8	N/A	Clear, brown	D/S	0/5	Few gulls	0	0.5
16 February 2018	SEM	Fine, overcast	7/8	N/A	Clear, green	U/S	0/0	No birdlife	0	0.5
19 February 2018	SEM	Fine, overcast	8/8	N/A	Sl. turbid, green	U/S	1/0 (swimmer)	2 oystercatchers	0	0
5 March 2018	SEM	Fine	3/8	N/A	Turbid, brown-green	D/S	5/0 (1 boat, 4 swimmers)	2 oystercatchers	0	0
19 March 2018	SEM	Fine	5/8	N/A	Turbid, brown-green	D/S	0/0	No birdlife	0	0
21 March 2018	SEM	Fine, overcast	8/8	N/A	Turbid, turquoise-blue	U/S	0/0	No birdlife	2.5	2.5
3 April 2018	SEM	Fine, overcast	8/8	N/A	Turbid, milky green	U/S	0/2 (fishing)	2 gulls	0	5.5
6 April 2018	SEM	Fine	4/8	N/A	Turbid, grey-blue	U/S	0/0	No birdlife	0	0

Site Manganui River d/s of Kurapete Stream (Site Code: MGN000435)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine	4/8	Abundant	Clear, light brown	D/S	0/0	No birdlife	0	1.0
20 November 2017	SEM	Fine	0/8	80%	Clear, colourless	D/S	0/0	No birdlife	0	0
4 December 2017	SEM	Fine	0/8	100% green-brown	Clear, colourless	D/S	0/0	No birdlife	0	0
15 January 2018	SEM	Fine	4/8	80% thick green & brown	Clear, colourless	D/S	0/0	No birdlife	0	0
30 January 2018	SEM	Fine	3/8	40% brown, 30% green mat	Clear, colourless	D/S	0/0	No birdlife	0	0
1 February 2018	SEM	Fine, overcast, windy	8/8	50% brown, 20% green mat	Clear, colourless	D/S	0/0	TRC sign, no birdlife	0.5	4.5
16 February 2018	SEM	Fine, overcast	6/8	50% brown, 50% green	Clear, colourless	D/S	0/0	1 duck	0	1.0
19 February 2018	SEM	Light rain	8/8	50% green, 50% brown	Clear, green-brown tinge	D/S	0/0	No birdlife	0.5	4.5
5 March 2018	SEM	Fine	0/8	100% brown mats	Clear, grey-yellow tinge	D/S	0/0	No birdlife	0	0
19 March 2018	SEM	Fine	8/8	75% green fil, brown mats	Clear, green tinge	D/S	0/0	Ducks common u/s	0	0
21 March 2018	SEM	Drizzle	8/8	100% brown	Clear, dark green	D/S	0/0	Few ducks u/s	4.5	4.5
3 April 2018	SEM	Raining	8/8	100% sh green & med brown	Clear, brown tinge	D/S	0/0	No birdlife	0	5.5
6 April 2018	SEM	Fine, overcast	5/8	40% green, 60% brown	Clear, colourless	D/S	0/0	No birdlife	0	4.5

Site Lake Ratapiko (Site Code: LRP000050)

Sampling Date	Pro-gramme	Weather		Conditions			Site usage		Rainfall (mm)	
		General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	SEM	Fine, overcast	7/8	Nil	Clear, brackish brown	Rippled	0/0	2 shags, freshwater pest signage	0	1.0
20 November 2017	SEM	Fine	0/8		Clear, light brown	Rippled	0/0	No birdlife	0	0
4 December 2017	SEM	Fine	0/8	N/A	Sl. turbid, brown	Flat	0/0	2 ducks	0	0
15 January 2018	SEM	Fine	7/8	60% brown mat	Clear, brown	Rippled	0?0	Ducks common	0	0
30 January 2018	SEM	Fine	3/8	50% brown mat	Clear, brown	Rippled	0/0	Ducks common	0	0
1 February 2018	SEM	Fine, overcast, windy	8/8	30% brown mat	Clear, brown	Choppy	0/0	New TRC sign, few ducks	0.5	4.5
16 February 2018	SEM	Fine	5/8	60% brown mat	Clear, brown	Rippled	0/0	Ducks common	0	1.0
19 February 2018	SEM	Light rain	8/8		Turbid, brown	Flat	2/0 (boat, jet-ski)	No birdlife	0.5	4.5
5 March 2018	SEM	Fine	0/8	100% brown mats	Clear, brown	Rippled	0/0	No birdlife	0	0
19 March 2018	SEM	Fine	7/8	100% cover	Clear, colourless	Flat	0/0	No birdlife	0	0
21 March 2018	SEM	Drizzle	8/8		Clear, dark green	Rippled	0/0	2 ducks	4.5	4.5
3 April 2018	SEM	Spitting	8/8	805	Clear, brown	Rippled	0/0	Few ducks	0	5.5
6 April 2018	SEM							Lake level lowered for maintenance. No sampling.		

Appendix V

Sampling conditions and public usage recorded at three sites during the cyanobacteria programme

Site Lake Opunake (Site Code: LOP000001)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Direction of flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	Fine, overcast	8/8	N/A	Sl. turbid, brown	Rippled	0/0	4 ducks on water, 3 on shore	0	3.5
28 November 2017	Fine	0/8	N/A	Clear, green	Flat	0/0	Ducks common	0	0
12 December 2017	Fine	2/8	N/A	Sl. turbid, green	Flat	0/0	Ducks common	0	3.5
3 January 2018	Fine	5/8	N/A	Sl. turbid, green	Flat	0/0	Few ducks	0.5	1.5
25 January 2018	Fine	5/8	Oxy. weed on bottom	Clear, green	Rippled	0/0	Few ducks	0	2.0
7 February 2018	Fine	7/8	N/A	Clear, green	Rippled	0/0	Few ducks	0.5	3.5
1 March 2018	Fine	6/8	N/A	Clear, dark green	Flat	0/0	Ducks common, swan	0	0
27 March 2018	Fine	0/8	N/A	Clear, dark green	Rippled	0/2 (banks)	Few ducks	0	1.0

Site Lake Ratapiko (Site Code: LRP000050)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
7 November 2017	Fine, overcast	7/8	Nil	Clear, brackish brown	Rippled	0/0	2 shags, freshwater pest signage	0	1.0
28 November 2017	Fine	6/8		Clear, brown	Rippled	0/0	4 ducks	0.5	0.5
12 December 2017	Fine	1/8		Sl. turbid, brown	Flat	0/0	Few ducks	0	10.5
3 January 2018	Fine, overcast	7/8	70-80% brown mat	Sl. turbid, green-brown	Rippled	0/0	Few ducks	0	17.5
25 January 2018	Fine, windy	5/8	60% brown mat	Sl. turbid	Rippled	5/3 (swimmers)	Few duclks	0	11.0
7 February 2018	Fine	5/8	80% brown mat	Clear, brown	Rippled	0/0	Ducks common	0	3.0
1 March 2018	Fine	3/8		Clear, green-brown	Rippled	0/0	Few ducks	0	0
27 March 2018	Drizzle	8/8		Clear, dark green	Rippled	0/0	2 ducks	0	4.5

Site Lake Rotokare (Site Code: LRK000003)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
2 November 2017	Fine	6/8		Turbid, green-brown	Rippled	0/0	Few ducks	0	3.5
14 November 2017	Fine	0/8	Colonies visible	Turbid, green-brown	Rippled	0/0	STDC warning sign, ducks0 common, 2 black shags	0	0
28 November 2017	Showe4	6/8		Turbid, brown	Rippled	0/0	Few ducks	0.5	0.5
12 December 2017	Fine, windy	4/8		Turbid, brown	Rippled	0/0	Few ducks and pukeko	0	0.5
3 January 2018	Fine, overcast	6/8		Turbid brown	Rippled	0/0	Few ducks and pukeko	0	7.0
15 January 2015	Fine	5/8		Turbid, brown	Rippled	0/0	Few ducks and pukeko	0	0
25 January 2018	Fine	4/8		Clear, brown	Rippled	0/0	2 ducks	0	6.5
7 February 2018	Fine	4/8		Clear, brown	Rippled	0/0	Few ducks	0.5	0.5
26 February 2018	Light rain	8/8		Clear, brown-green	Rippled	0/0	Boat ramp open, few pukeko, shag	0	0
13 March 2018	Fine	3/8		Clear, brown	Choppy	0/2 (ashore)	No birdlife	4.0	65.5
27 March 2018	Fine	2/8		Sl. turbid, brown	Choppy	0/0	2 pukeko	0	6.5

Appendix VI

Comparative annual box and whiskers plots of SEM data for *E.coli* for the period 1996-2018

All sites individually, 2017-2018