

Freshwater contact recreational
water quality at selected Taranaki sites
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Executive summary

This survey of sixteen freshwater contact recreational sites in the Taranaki region was the sixteenth 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 2011-2012 period for the sixth time, partly as a component of the recently instituted cyanobacteria programme (covering four lakes and one river site) instigated after consultation with Taranaki Healthcare. A site in the lower Waitara River was added in the previous period at the joint request of Taranaki Healthcare and NPDC. 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 current programme while the Waimoku Stream monitoring has been reduced to a three-yearly frequency. The sixteen sites have been graded for recreational suitability according to MfE, 2003 guidelines, based upon the immediately preceding five seasons of monitoring data (where such data existed) although short-comings of this grading methodology are acknowledged. A further site (Lake Rotokare) has been monitored since 2007, principally for cyanobacteria.

The results of this 2011-2012 survey have continued to illustrate variability in bacteriological water quality, with the highest water quality achieved at the Urenui River estuary and lower Patea River sites where marked seawater intrusion is the norm (under high tide conditions), Lake Ratapiko, and Waiwhakaiho River (at Merrilands Domain). Impacts on bacteriological water quality at some sites, particularly the lower reaches of the Waiwhakaiho River and Te Henui Stream and Lakes Opunake and Rotomanu, were due principally to resident wild fowl populations in the vicinity of recreational usage sites.

In terms of *E. coli*, bacteriological water quality showed some improvements in the latest survey period in comparison with historical surveys. Although only two sites had their lowest median counts on record, many other sites had lower seasonal median counts than usual. The total number of samples falling within the "Alert" or "Action" categories was 6% lower than the average of all the previous seasons, continuing the improvement shown by the previous season. Very few high counts were recorded during the 2011-2012 season.

One site (Te Henui Stream near East End beach) recorded all of its single samples in either the 'Alert' or the 'Action' mode of the MfE, 2003 guidelines. DNA marker tracking confirmed the principal contribution to be the wildfowl populations although there were background contributions from cattle and occasionally human sources. Previously this site had been monitored primarily to provide background information in relation to nearby East End Beach coastal water quality. Eleven other sites exhibited occasional single sample entries into the 'Alert' or 'Action' modes of the 2003 guidelines at some time during the season. However, only four sites had counts which entered the 'Action' mode, a decrease in the number and frequency of exceedances in comparison with most 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. Birdlife contributed to exceedances from time to time particularly at two sites where recreationalists often fed the birds. Limited 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. Permanent health warning signage had been erected at two sites by the New Plymouth District Council (on the direction of Taranaki District Health Board) following past exceedances of 'Alert' levels (at Oakura (for past Waimoku Stream issues)

and Waitara) and signage was required on occasions at the lower Waiwhakaiho River and Te Henui sites but single sample 'Alert' level exceedances were not necessarily signposted.

DNA marker tracking investigations in the lower Waiwhakaiho River found that the principal faecal contributions were sourced from wildfowl (gulls) with some contribution from ruminants. There were five exceedances of both the 'Alert' and of the 'Action' modes recorded during the season at this site. Cattle were found to be the principal source of faecal bacteria in the lower reaches of the Patea River although no exceedances of guidelines were recorded at the boatramp site in Patea township.

Temporal trends over the 1996-2012 period have been evaluated for the eleven sites that have with ten years or more data (and will continue to be assessed annually). One site (Oakura River) has shown a statistically significant increasing trend while another site (Waingongoro River at Ohawe Beach) has shown a significant decreasing trend in median *E. coli* counts, but no median counts have reached 'Alert' or 'Action' levels at either site. No other sites have shown significant trends (positive or negative) in seasonal median *E. coli* counts although these counts have trended upward in the Waimoku Stream at Oakura Beach, a site which will be monitored at three-yearly intervals.

Elevated enterococci to faecal coliform ratios typified ponded sites near the stream/river mouths possibly as a result of vegetative sources of enterococci and/or more prolonged survival in ponded freshwater environments, under high tidal conditions and often where saltwater penetration occurred.

Additional sampling (in accordance with the MfE, 2003 guidelines) at two principal usage sites (Lake Rotomanu and Waiwhakaiho River) coincided on two occasions with wet weather conditions and resulted in increases in the overall median bacteriological numbers at both sites. Three additional exceedances of limits occurred at both the river site and at the lake site where poorer bacteriological quality followed the wet weather events.

A moderate cyanobacteria bloom was recorded at Lake Rotokare from near mid-season with numbers peaking later in summer, but these numbers did not reach the level which had necessitated warning notices to avoid contact recreation on these waters in the past three seasons. Levels had fallen to very low numbers by the end of the survey period. Numbers were well below those found by previous summers. Unlike the situation in the previous three seasons, minimal cyanobacteria were found in Lake Rotomanu during the season.

Timely reporting of the results of bacteriological water quality and cyanobacteria presence/absence was undertaken by use of the Taranaki Regional Council website (www.trc.govt.nz) as well as liaison with territorial local authorities and the Health Protection Unit of Taranaki District Health Board (who also utilised its recently created website) throughout the survey season of 2011-2012.

It is recommended that bacteriological monitoring of selected freshwater sites be continued on an annual basis (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. Cyanobacteria monitoring at up to five selected sites (including the four lakes) 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

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 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 one river and three lake sites since the 2006-2007 summer and an additional lake site in 2007-2008.

The SEM bacteriological bathing water quality programme has three objectives:

- to characterise the bacteriological 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 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.]

2. Contact recreation water quality standards and guidelines

Prior to 2003, the Council has 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). Since 2003 new guidelines are now relevant to this programme. This guideline is detailed below.

2.1 Freshwater microbiological water quality guidelines (2003)

Guidelines have been prepared by Ministry for the Environment in conjunction with the Ministry of Health (MfE, 2003). Components of these 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. Changes to the *E. coli* freshwater recreational guideline values have been made for the purpose of regularly assessing single sample compliance with suitability for recreation. The new 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 (with the marine levels included as some of the Taranaki sites monitored are in the lower, tidal reaches of rivers and streams).

Mode	Acceptable (green)	Alert (amber)	Action (red)
Freshwater (<i>E. coli</i> /100mls)	≤260	261-550	>550
Marine (enterococci/100mls)	≤140	141-280	>280 (2 consecutive samples)

2.2 Suitability for recreation grading (SFRG) of sites

The 2003 Microbiological Water Quality Guidelines (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 condition of a site based on both risk and indicator bacteria water quality. 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 considered that they will rarely pass the guidelines.

The risk of illness from bathing at these sites is deemed 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. The public will 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 2006 to March 2011 period (i.e. the five years immediately preceding the current season as required by the Guidelines). The two new sites added to the programme in 2007-2008, the single site added in 2009-2010, and the two sites added in 2011-2012 have limited historical bacteriological data and only a maximum of four year's data have been collected in the recent five year period. The relevant information is provided in Appendix 1 and is summarised in Table 1.

Table 1 Suitability for recreation grade for freshwater sites for the period November 2006 to March 2011

Site	Sanitary Inspection Category	Microbiological assessment <i>E.coli</i> (nos/100ml)			SFR Grade	% of all samples in compliance (ie: <550 <i>E.coli</i>)
		95 %ile	Number of samples	Category		
L Rotomanu: western beach	High	3150	65	D	Very poor	87
Waiwhakaiho R: Merrilands domain	High	208	65	B	Poor	98
Waiwhakaiho River adjacent to L Rotomanu	High	2710	39	D	Very poor	48
Te Henui S: mouth, East End	High	4,000	65	D	Very poor	16
Patea R: King Edward Park	High	768	65	D	Very poor	86
Patea R. boatramp, Patea	High	80	52	A	Poor	100
Waingongoro R: Eltham camp	High	360	65	C	Poor	100
Waingongoro R: Ohawe beach	High	903	65	D	Very poor	92
Kaupokonui R: Beach domain	High	618	65	D	Very poor	95
L Opunake: adjacent boatramp	High	1350	65	D	Very poor	86
Timaru S: Lower Weld Road	High	565	65	D	Very poor	93
Oakura R: d/s SH45	High	428	65	C	Poor	96
Waitara R: Town wharf	High	1460	26	D	Very poor	84
Urenui R: estuary	High	30	65	A	Poor	100
Manganui R: Everett Park	High	390	65	C	Poor	98
L Ratapiko: boatramp	High	120	63	A	Poor	100
L Rotokare: adjacent boatramp	Low	82	39	A	Very good	100

Although most of the sites' SFRGs indicate possible high risks associated with contact recreational usage, the gradings have been strongly influenced by the agricultural nature of the catchments in question. The 5-year microbiological data however, indicate that all but one site (Te Henui Stream) would not have entered the 'Action' guideline (ie would have been out of compliance) on more than 16% of all sampling occasions, with eleven sites achieving compliance on 90% or more of occasions (ie less than 10% non-compliance).

The Eltham camp site in the mid reaches of the Waingongoro River, the Urenui River estuary site, the Patea River estuary site, and the Lake Ratapiko site have not reached the 'Action' mode during the previous five seasons, under the sampling protocols of the SEM programme, and the Merrilands Domain site in the lower reaches of the Waiwhakaiho River, and Everett Park site in the Manganui River entered this 'Action' level on only one occasion. In general, these data indicate shortcomings in the grading system for these sites based upon landuse/perceived impacts and the use of extremes (95 % confidence levels) in bacteriological quality data, rather than actual monitoring data measured throughout the bathing seasons. Council's contact recreational water quality programme results confirm that 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 results of systematic and on-going testing and public notification in terms of the reporting of actual contact recreational water quality.

to mid April 2012. Eight sites, relatively close to stream mouths, were potentially affected by tidal influences (see conductivity data later in this report).

Table 2 Location of bathing water bacteriological and cyanobacteria sampling sites

Site	Location	GPS Location		Site code
Te Henui Stream	Mouth, East End	E 1694213	N 5677047	THN000499
Lake Rotomanu	Western beach	E 1696309	N 5678128	LRM000002
Waiwhakaiho River	Merrilands Domain	E 1696059	N 5674931	WKH000800
Waiwhakaiho River	Adjacent to Lake Rotomanu	E 1696587	N 5678336	WKH000950
Patea River	King Edward Park, Stratford	E 1710433	N 5644464	PAT000297
Patea River	Boatrap, Patea	E 1727517	N 5596784	PAT000995
Waingongoro River	Eltham Presbyterian Camp	E 1710861	N 5635349	WGG000492
Waingongoro River	Ohawe Beach	E1702531	N 5617624	WGG000995
Kaupokonui River	Beach domain	E 1691110	N 5619893	KPK000995
Lake Opunake	adjacent to boatrap	E 1674029	N 5632022	LOP000001
Timaru Stream	end of Weld Road	E 1697622	N 5669438	TMR000497
Waimoku Stream	Oakura Beach	E 1681725	N 5669851	WMK000298
Oakura River	d/s SH45 bridge	E1682721	N 5670440	OKR000497
Waitara River	Town wharf	E 1707203	N 5682572	WTR000922
Urenui River	Urenui estuary	E 1720245	N 5683370	URN000480
Manganui River	Everett Park (d/s Kurapete S)	E1711149	N 5669127	MGN000435
Lake Ratapiko	Boatrap	E1714913	N 5659488	LRP000050
Lake Rotokare	Adjacent to boatrap	E 1721182	N5631898	LRK000003

Sample collection, field measurements, transport 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). However, spring wet weather affected the frequency of sample collection earlier in the period. Sampling commenced in mid November 2011 with only two of the sampling surveys performed prior to January 2012 due to a very wet late spring-early summer period. The majority of the surveys were performed over the latter half of the summer and early autumn period. Bathing water samples were normally taken between the hours of 0900 and 1800 hours (NZDST) 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 each site during the season.

Samples were analysed for enterococci, *E. coli* and faecal coliform bacteria, turbidity and conductivity. In addition, at each of the sites the following information was recorded time, water temperature, weather, colour/appearance, percentage estimation of algal cover on the streambed, and number of bathers and other users. All sites' locations (map references and GPS) and descriptions are stored in the Council Taradise and laboratory (Labsys) computer database and all analytical results were stored in Labsys following standard sample registration procedures.

After consultation with Taranaki District Healthboard, cyanobacteria monitoring commenced at each of the three lake sites and the lower Waiwhakaiho River site in

the 2006-2007 bathing season and continued in 2011-2012 and included an additional lake site. The Merrilands Domain site in the Waiwhakaiho River was considered to be representative of the more intensively used urban lower reaches of the river through New Plymouth to the mouth. Cyanobacteria can produce toxicity in recreational waters which pose risks to humans and animals by contact or consumption during recreational activities. Visual checks for surface scums were made on each sampling occasion and samples were collected for microscopic analysis which was performed in the TRC biological laboratory.

Results were posted on the Taranaki Regional Council website (www.trc.govt.nz) for public and local health authority notification in particular, as soon as checking had been completed. Mapping of the results was also included on the more recently established Taranaki District Health Board website (www.tdhb.org.nz) in the 2011-2012 season. 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. Cyanobacteria information was included on the websites where appropriate.

2.3.2 Additional monitoring (MfE guidelines)

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. Following consultation with the three territorial local authorities and Taranaki District Health Board, TRC undertook to add seven sampling occasions to the SEM protocol 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) 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 data will not be used for future trend detection purposes as they do not comply with the format of the originally established SEM programme].

3. Results

3.1 Introduction

Sampling times in relation to tidal conditions (particularly for estuarine sites, see Appendix II), weather conditions and sites' usage information are contained in Appendix III and IV. Timing of sampling in relation to river flows is illustrated by Figures 7, 13, 18, 20 and 25. Those illustrate that the majority of the sampling occasions coincided with steady to low river recession flow conditions. Very occasionally sampling was affected by localised rainfall and/or a prior increase in river flows. However, where possible no sampling was undertaken within three days following significant river freshes. A total of 13 samples were collected at each site during the period from mid November 2011 to mid April 2012 (with the exception of Lake Ratapiko where the very low lake level prevented sample collection on one occasion).

Sampling was confined almost entirely to weekdays during the period with no public holidays 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 recently with 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 particularly as the New Plymouth coastal walkway has provided improved access.

3.2 Presentation of results and discussion

All results are presented and discussed on a site-by-site basis for the sampling period, which extended from 15 November 2011 to 10 April 2012 and totalled thirteen sampling occasions at each site. The results for the sites with additional (seven) sampling occasions are also presented within the discussion for the two appropriate sites.

3.2.1 Lake Rotomanu

3.2.1.1 SEM programme

At the times of the surveys there was no bathing usage of the lake recorded although boating, water and jet-skiing, and/or picnicking activities were recorded at the time of several of the sampling surveys. Signage warning of health risks associated with lake water quality was required occasionally during the period. Ducks (and

occasionally gulls) were present on the lake or in the vicinity of the lake edge throughout the period and were often attracted to the immediate vicinity of the sampling site by public feeding of the ducks. Lake levels were relatively consistent throughout the period. A wetland had been created recently at Peringa Park to improve the quality of stormwater runoff entering the lake.

The data for this site are presented in Table 3 and illustrated in Figure 2, with a statistical summary provided in Table 4.

Table 3 Analytical results for Lake Rotomanu

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1230	15.3	2300	270	2300	21.6	4.6
28.11.11	1155	15.8	280	160	280	19.2	4.1
22.01.12	1000	13.5	1000	1700	1100	21.9	7.4
26.01.12	1145	13.8	870	810	870	22.5	11
7.02.12	1015	14.6	610	160	660	22.2	5.0
10.02.12	1135	15.0	780	320	840	24.2	4.8
13.02.12	1125	14.5	110	120	110	23.4	7.3
27.02.12	1325	14.3	92	17	92	22.5	7.7
8.03.12	1040	14.5	120	120	120	17.7	12
21.03.12	1045	14.9	120	120	120	17.8	8.9
28.03.12	1040	14.3	46	20	46	20.5	6.3
30.03.12	1140	14.4	54	68	57	20.3	6.5
10.04.12	0845	15.2	85	54	110	18.1	7.3

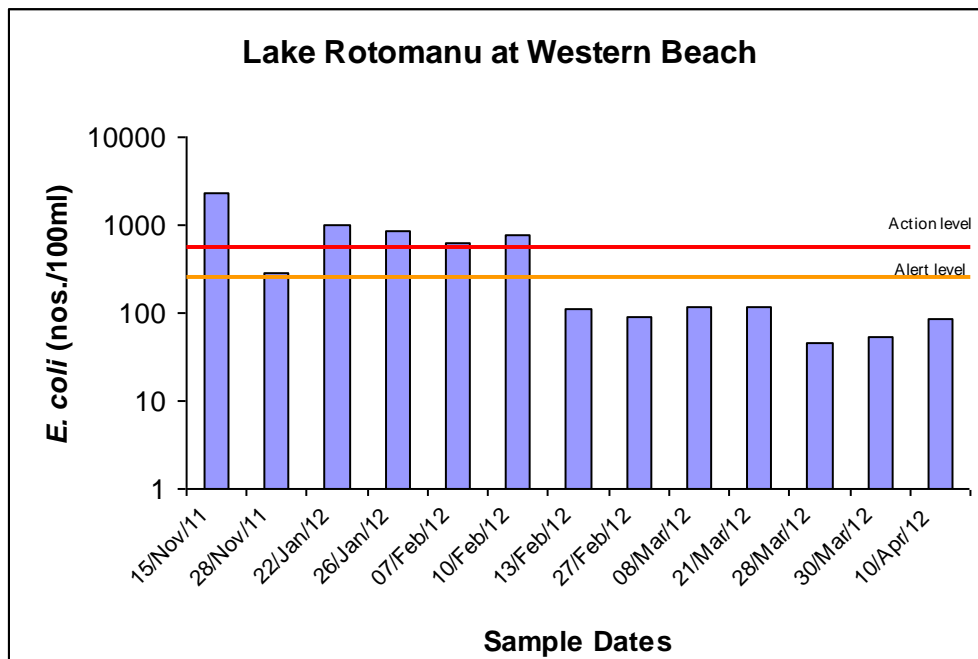


Figure 2

E. coli numbers for Lake Rotomanu during the regular season
(Note: Action limit >550/100 ml [single sample: Alert limit => 260 nos/100ml
[single sample]])

Table 4 Statistical results summary for Lake Rotomanu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	13.5	15.8	14.5
<i>E. coli</i>	nos/100ml	13	46	2300	120
Enterococci	nos/100ml	13	17	1700	120
Faecal coliforms	nos/100ml	13	46	2300	120
Temperature	°C	13	17.7	24.2	21.6
Turbidity	NTU	13	4.1	12	7.3

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 clarity was poorer than usual (median turbidity: 7.3; range: 7.9 NTU) possibly as a result of some sediment disturbance or fluctuating concentrations of suspended algae. Water temperatures were relatively high (above 20°C) through most of the period with a high maximum of 24.2°C (in mid January 2012) and a range of 6.5°C. Conductivity had a relatively 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. However, elevated numbers of *E. coli* (in the 'Action' mode) were found on five occasions coincident with the wildfowl population (mainly ducks) attracted to the main public recreational area. Four successive counts exceeded the 'Action' mode between late January and mid February 2012 but no subsequent bacterial counts approached the 'Alert' level. NPDC signage discouraging lake usage was required to be erected at the lake as had been the case in most previous seasons.

3.2.1.1.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 5.

Table 5 Bacterial guidelines performance at Lake Rotomanu [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	5 [38]

(Designation: freshwater contact recreational area)

Five single samples exceeded the 'Action' mode during the period, but no single sample was recorded within the 'Alert' mode.

3.2.1.1.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen seasons' *E. coli* surveys data is presented graphically in Appendix V for all sites. These summer data for the Lake Rotomanu site are summarised in Table 6 and illustrated in Figure 3.

Table 6 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys at Lake Rotomanu to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	3	12	7	7	1	31	9	20	<3	6	7	54	51	23	6	46
Maximum	899	740	200	140	90	980	2200	5500	220	380	3000	1200	6000	3600	150	2300
Median	32	46	79	25	14	110	92	120	11	68	72	180	220	100	34	120

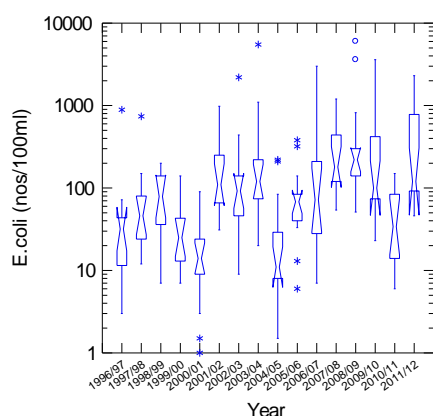
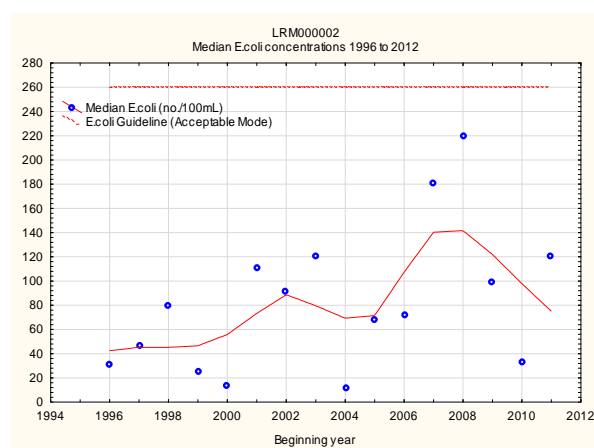


Figure 3

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

A more recent trend of relatively high median *E. coli* numbers in recent years re-occurred over the summer of 2011-2012 with a wide range of counts recorded by this survey and an elevated median value, the equal third highest to date. The maximum count was the fifth highest to date. However, the median value remained well below the 'Alert' level of the 2003 MfE guidelines.

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 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.



N = 16
Kendall tau = +0.326
p level = 0.078 [>FDR, p = 0.234]
N/S at p < 0.05

Figure 4 LOWESS trend plot of median *E. coli* numbers (per 100ml) at Lake Rotomanu for the 1996-2012 period

Overall, a positive, but not statistically significant increase in median *E. coli* numbers has been found over the sixteen seasons of monitoring although median numbers have trended downwards over the latest three seasons. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.1.2 MfE guidelines additional sampling

Seven additional samples were collected randomly under varying weather conditions during the survey season. No bathing, but some boating and picnicking were noted on these occasions. Ducks were present in moderate numbers on the lake on all occasions (and sometimes fed by picnickers) and gulls were recorded infrequently. Two surveys occurred by chance soon after significant rainfall events.

The data from these additional surveys are presented in Table 7, illustrated and statistically summarised (with the 13 SEM samples' data) in Figure 5 and Table 8 respectively.

Table 7 Lake Rotomanu additional seven water quality samples' results

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
22.11.11	1105	15.7	1300	180	1300	18.7	3.6
6.12.11	0920	14.4	1400	4400	1400	22.6	4.5
20.12.11	0950	13.4	15	14	15	19.5	3.2
5.01.12	1100	12.8	260	34	270	22.3	12
18.01.12	1035	13.1	200	71	220	23.0	9.7
31.01.12	0955	14.2	180	110	180	22.2	4.3
16.02.12	1020	14.3	330	68	330	23.3	8.6

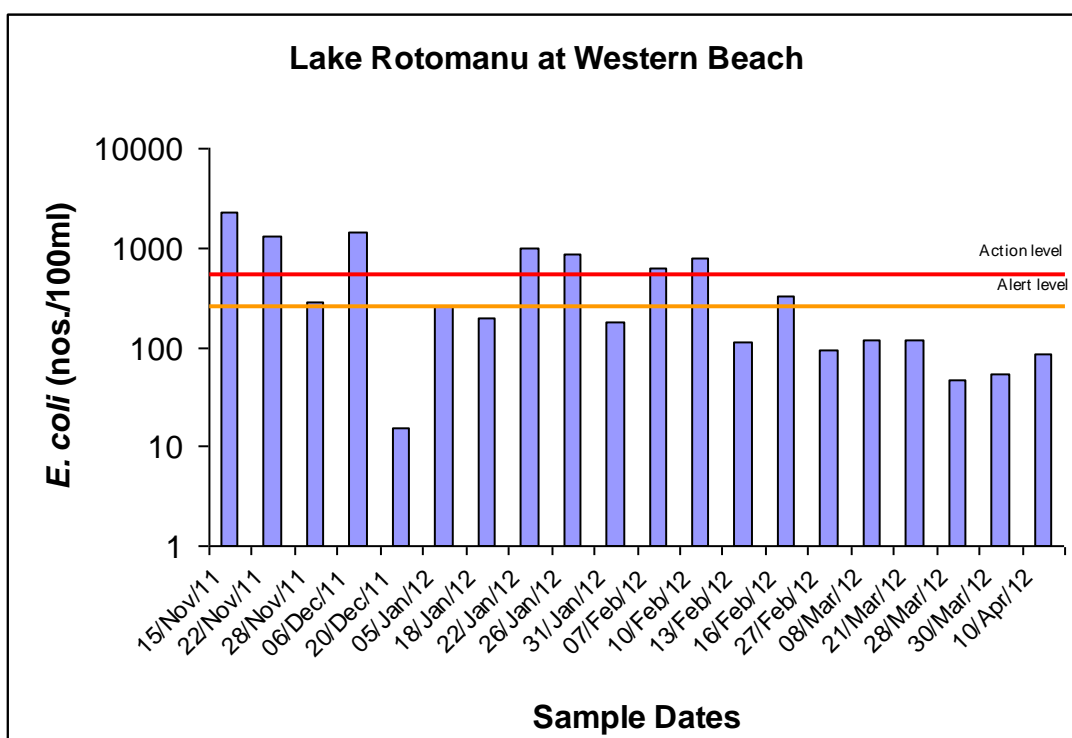


Figure 5 *E. coli* numbers for Lake Rotomanu for the 20 sample extended survey

Table 8 Summary statistics for SEM and additional samples at Lake Rotomanu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	12.8	15.8	14.4
<i>E. coli</i>	nos/100ml	20	15	2300	230
Enterococci	nos/100ml	20	14	4400	120
Faecal coliforms	nos/100ml	20	15	2300	245
Temperature	°C	20	17.7	24.4	22.2
Turbidity	NTU	20	3.2	12	6.9

The additional sampling resulted in a difference to the overall seasonal median bacteria numbers with a marked increase of 110 *E.coli* (per 100mls). These additional surveys' bacteria counts had a moderately wide range (6 to 1400 *E. coli* per 100mls), but a much higher median (260 *E.coli* per 100 mls) than the standard SEM sampling survey range, due to the proximity of wet weather to at least two of the sampling survey occasions.

3.2.1.2.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 9.

Table 9 Bacterial guidelines performance at Lake Rotomanu [% of 20 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100ml
<i>E. coli</i>	1[5]	7[35]

The number of exceedances of the single sample 'Alert' and 'Action' modes increased with the additional monitoring, as one additional exceedance of the 'Alert' level and two of the 'Action' level occurred; these exceedances following wet weather conditions and elevated river flows in the late November-early December 2011 period.

3.2.1.3 Cyanobacteria

No visual surface algal blooms were recorded during the season but slightly more turbid lake water quality, possibly due to suspended algae, was noted during the season. Microscopic scans of samples found no cyanobacteria present in all but one of the samples analysed during the season. There were a very low number of cyanobacteria detected in early December, 2011 after very wet weather and again in late January, 2012. On both occasions the only taxon present was *Anabaena*. The results of this sampling are presented in Table 10.

Table 10 Cyanobacteria counts (cells/ml) for Lake Rotomanu
[Health warning: >15,000 cells/ml]

Date	Cyanobacteria total cell count (cells/ml)	Principal species
22.11.11	nil	-
6.12.11	52	<i>Anabaena</i>
20.12.11	nil	-
5.01.12	nil	-
18.01.12	nil	-
31.01.12	67	<i>Anabaena</i>
16.02.12	nil	-

Therefore, no cyanobacteria related health warning signage was required at the lake as the density remained well below the health warning high alert level of 15,000 cells/ml (TDHB, 2006), unlike during the 2008-2009 season when *Microcystis* dominated the lake (TRC, 2009). No toxin testing of the lake waters (by the Cawthron Nelson laboratory) was therefore required by the Taranaki Health Board. *Microcystis* had also been found in the lake during the 2009-2010 season when cyanobacteria numbers ranged from nil to 7600 cells/ml (TRC, 2010), but no cyanobacteria were found during the 2010-2011 season (TRC, 2011).

3.2.2 Waiwhakaiho River at Merrilands Domain

3.2.2.1 SEM programme

Minimal usage of this site was recorded at the time of the sampling surveys, with minor bathing but none of the usual walking or picnicking on the banks of the river noted.

The data for this site are presented in Table 11 and illustrated in Figure 7, with a statistical summary provided in Table 12. River flow information is illustrated in Figure 6.

Table 11 Analytical results for the Waiwhakaiho River at Merrilands Domain

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1300	11.0	20	<1	20	17.2	0.5
28.11.11	1225	10.3	63	14	63	15.6	0.6
22.01.12	1030	11.3	40	19	40	18.1	0.4
26.01.12	1210	12.5	120	78	140	18.4	0.5
7.02.12	1045	10.2	100	31	100	17.2	0.7
10.02.12	1205	11.9	120	150	120	19.6	1.5
13.02.12	1110	12.8	20	16	20	20.0	1.2
27.02.12	1355	10.1	8	31	8	19.7	0.5
8.03.12	1110	11.6	28	48	28	16.7	0.6
21.03.12	1215	12.3	11	16	11	16.4	0.3
28.03.12	1025	9.8	110	70	110	14.8	1.0
30.03.12	1120	11.4	34	41	34	14.9	0.5
10.04.12	0830	13.0	71	24	71	14.6	0.5

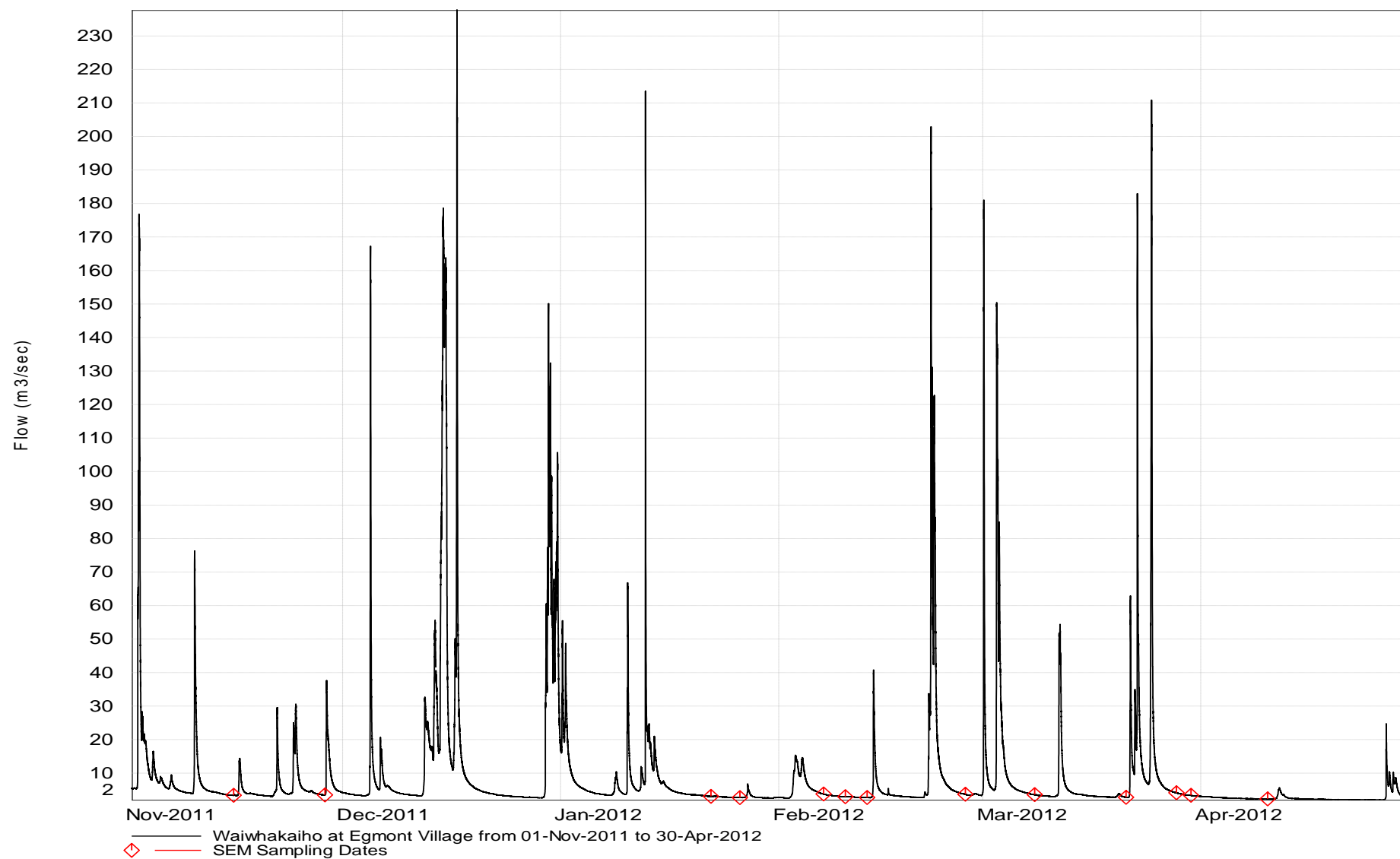


Figure 6 River flow in the Waiwhakaiho River during the survey period

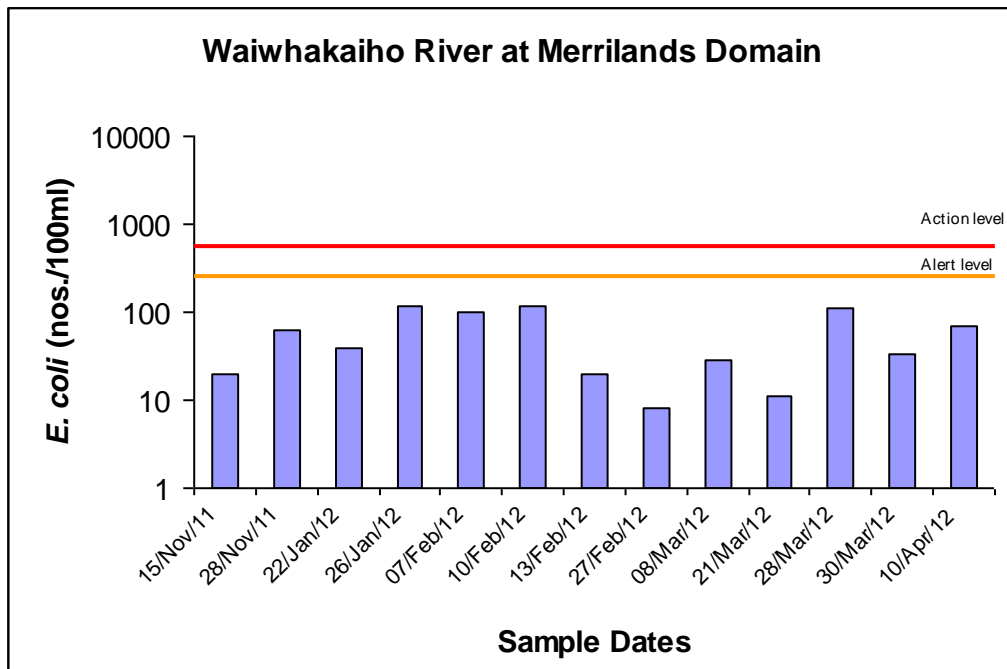


Figure 7 *E. coli* numbers for the Waiwhakaiho River at Merrilands Domain during the regular survey season

Table 12 Statistical results summary for the Waiwhakaiho River at Merrilands Domain

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	9.8	13.0	11.4
<i>E. coli</i>	nos/100ml	13	8	120	4.0
Enterococci	nos/100ml	13	1	150	31
Faecal coliforms	nos/100ml	13	8	140	40
Temperature	°C	13	14.6	20.0	17.2
Turbidity	NTU	13	03	1.5	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 relatively narrow range of 5.4°C between mid November and mid April, with a maximum of 20.0°C in mid February 2012. Conductivity and turbidity results were indicative of very clean, clear, relatively high water quality but moderate algal cover was relatively common through the period.

Considering the influence of agricultural activities, particularly dairying in the catchment, bacteriological water quality was relatively high. Bacterial numbers were not excessive remaining within a relatively narrow range on all occasions through the season and no high counts were recorded. A good standard of compliance with on-site dairy wastes disposal practices was recorded by the season's annual inspection round in this catchment.

3.2.2.1.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 13.

Table 13 Bacterial guidelines performance at the Waiwhakaiho River Merrilands Domain site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: freshwater contact recreational area)

No single sample was recorded within the 'Action' mode and none in the 'Alert' mode during the season. Bacteriological water quality measured at this site was therefore within the acceptable standard for contact recreational usage for the entire survey period.

3.2.2.1.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summer's surveys data is presented graphically in Appendix V for all sites. These data for the Waiwhakaiho River site are summarised in Table 14 and illustrated in Figure 8.

Table 14 Summary of *E. coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Waiwhakaiho River at Merrilands domain to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	16	16	26	8	6	17	3	34	11	15	8	28	19	23	4	8
Maximum	970	1800	330	100	270	420	130	320	330	160	510	110	110	570	200	120
Median	42	84	69	39	23	60	29	77	54	34	48	48	46	110	54	40

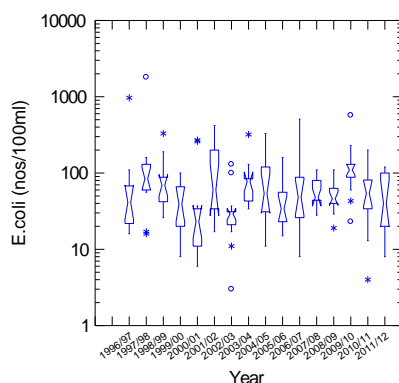


Figure 8 Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers in the Waiwhakaiho River at Merrilands Domain

The median *E. coli* number in the 2011-2012 period was typical of most recorded to date and 70 per 100 mls below the maximum of the range of historical medians (Table 13 and Figure 8), all of which have been well below the 'Alert' level of the 2003 MfE guidelines.

Trend analysis 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 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.

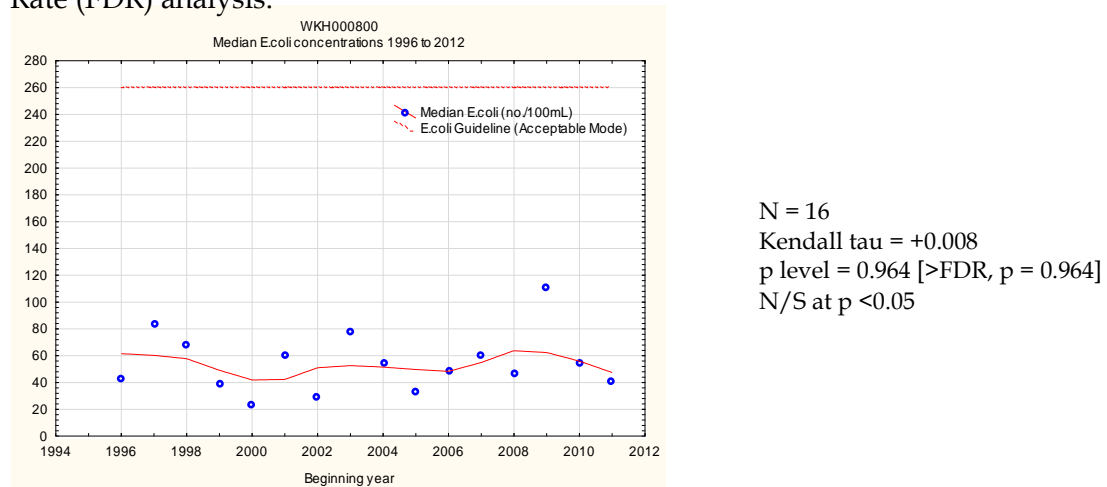


Figure 9 LOWESS trend plot of median *E.coli* numbers (per 100ml) at the Waiwhakaiho River, Merrilands Domain for the 1996 to 2012 period

A statistically insignificant temporal trend of minimal change in median *E.coli* numbers was found over the sixteen seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.2.2 MfE guidelines additional sampling

Seven additional samples were collected randomly at irregular intervals and under varying weather conditions (two of which by chance were wet weather events) during the survey season. Recreational activities on these occasions included walking (sometimes with dogs present at the river edge) and fishing.

The data from these additional surveys are presented in Table 15, illustrated in Figure 10, and statistically summarised (together with the 13 SEM samples' data) in Table 16.

Table 15 Waiwhakaiho River at Merrilands Domain additional seven water quality samples' results

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
22.11.11	1045	9.6	1800	180	1800	13.7	1.3
6.12.11	0955	7.8	7800	1000	8000	*	5.4
20.12.11	0935	9.3	190	23	200	14.5	1.1
5.01.12	1040	10.6	66	17	66	16.9	0.9
18.01.12	1015	10.3	28	20	28	18.6	0.6
31.01.12	0940	12.4	37	28	37	18.9	0.7
16.02.12	0945	10.4	380	80	380	17.9	2.0

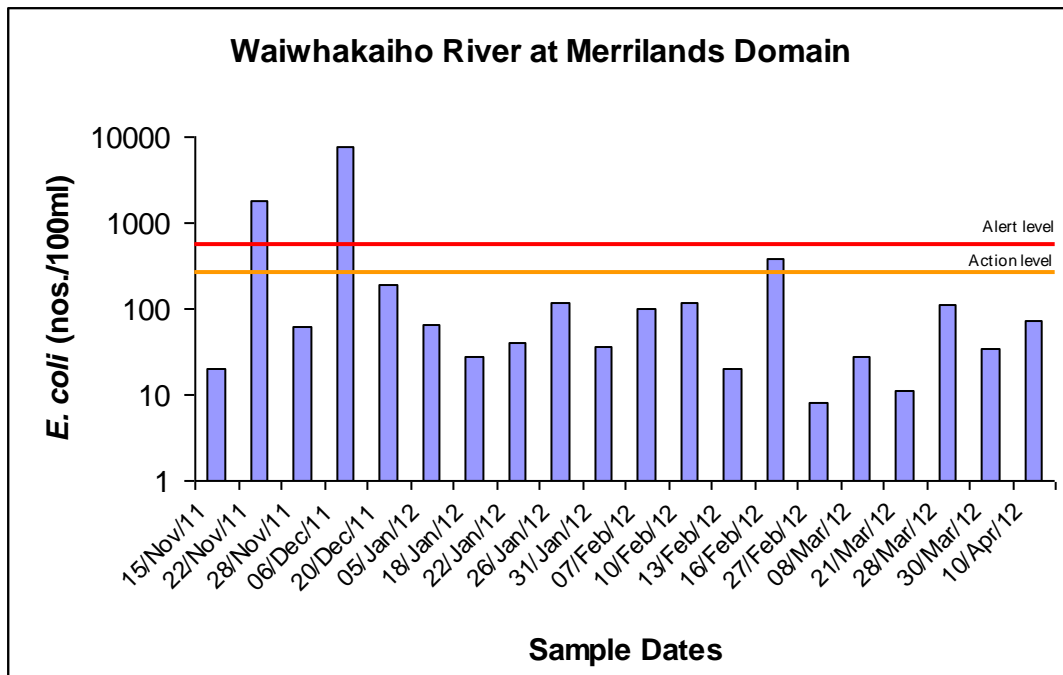


Figure 10 *E. coli* numbers for the Waiwhakaiho River at Merrilands Domain for the 20 sample extended survey

Table 16 Summary statistics for SEM and additional samples in the Waiwhakaiho River at Merrilands Domain

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	7.8	13.0	10.8
<i>E. coli</i>	nos/100ml	20	8	7800	65
Enterococci	nos/100ml	20	1	1000	30
Faecal coliforms	nos/100ml	20	8	8000	65
Temperature	°C	19	13.7	20.0	16.9
Turbidity	NTU	20	0.3	5.4	0.6

These seven additional samples resulted in increases in the seasonal median bacterial numbers in comparison with the regular SEM programme results (Table 12). The ranges for all three bacteria species were much wider due to elevated counts recorded in late November and early December 2011, the latter under high river flow conditions following a significant rainfall event, as also indicated by a marked decrease in conductivity level (Table 15).

3.2.2.2.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 17.

Table 17 Bacterial guidelines performance in the Waiwhakaiho River at Merrilands Domain [% of 20 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [5]	2 [10]

(Designation: freshwater contact recreational area)

One exceedance of the single sample 'Alert' mode occurred and two sample counts exceeded 550 *E. coli* per 100 mls ('Action' mode). An additional follow-up sample collected five days after the 'Alert' exceedance found a much lower count of 76 *E. coli* per 100 mls. No health warning signage was displayed as both exceedances were due to preceding heavy rainfall events and numbers fell markedly under dry weather conditions.

3.2.2.3 Cyanobacteria

No visual surface or river margin algal blooms were noted during the season. However, microscopic scans of samples found the cyanobacteria species *Phormidium* present in two of the samples in mid to late January 2012 but not in significant concentrations. There was no recurrence of cyanobacteria after January, 2012. The results of the sampling are presented in Table 18.

Table 18 Cyanobacteria counts (cells/ml) for the Waiwhakaiho River at Merrilands Domain [Health warning : >15,000 cells/ml]

Date	Cyanobacteria total cell count (cells/ml)
21.11.11	nil
06.12.11	nil
20.12.11	nil
05.01.12	<i>Phormidium</i> present
18.01.12	<i>Phormidium</i> present
31.01.12	Nil
16.02.12	nil

No health warning signage was required to be displayed at this site during the period.

3.2.3 Waiwhakaiho River adjacent to Lake Rotomanu

Minimal usage of this site was recorded at the time of the sampling surveys, with no bathing but some walking, or picnicking, and whitebaiting (in season) on the banks of the river noted. Seagulls, ducks and/or geese were frequently present at this site with large numbers of gulls known to be present along the lower reaches of the river.

The data for this site are presented in Table 9 and illustrated in Figure 11, with a statistical summary provided in Table 20. River flow information is illustrated in Figure 6 as that data is also applicable to this site.

Table 19 Analytical results for the Waiwhakaiho River adjacent to Lake Rotomanu

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1240	11.6	77	85	77	17.4	0.6
28.11.11	1205	10.7	440	280	460	15.3	0.6
22.01.12	1020	11.8	880	1000	1100	18.4	1.1
26.01.12	1155	12.8	600	590	690	19.9	1.0
7.02.12	1025	10.5	570	240	620	18.4	0.7
10.02.12	1145	12.2	2000	1400	2400	20.4	1.0
13.02.12	1135	13.2	260	340	300	22.3	0.7
27.02.12	1335	9.9	500	1100	540	19.7	1.0
8.03.12	1045	11.8	630	310	630	16.2	2.8
21.03.12	1055	12.5	280	750	300	17.0	0.5
28.03.12	1055	10.9	270	140	270	16.4	1.4
30.03.12	1150	11.5	260	270	260	16.1	0.5
10.04.12	0900	13.9	460	410	490	15.8	0.5

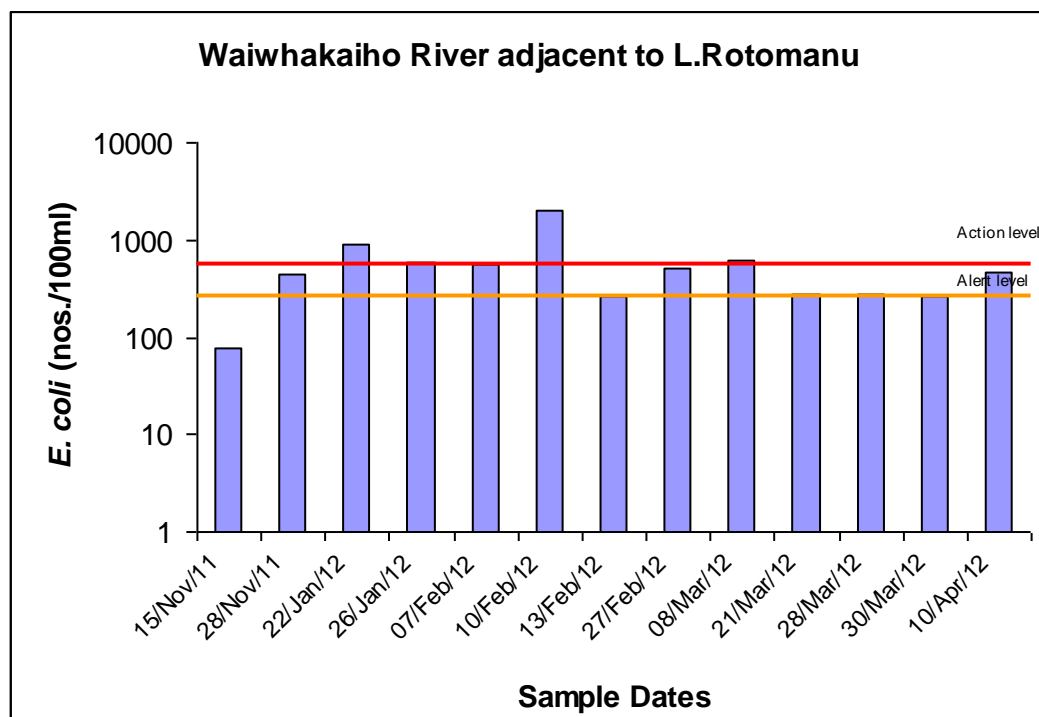


Figure 11 *E. coli* numbers for the Waiwhakaiho River adjacent to Lake Rotomanu during the regular survey season

Table 20 Statistical results summary for the Waiwhakaiho River adjacent to Lake Rotomanu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	9.9	13.9	11.8
	nos/100ml	13	77	2000	460
<i>E. coli</i>	nos/100ml	13	85	1400	340
Enterococci	nos/100ml	13	77	2400	490
Faecal coliforms	°C	13	15.3	22.3	17.4
Temperature	NTU	13	0.5	2.8	0.7
Turbidity					

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 new walkway bridge.

Water temperatures varied over a range of 7.0°C between mid November and mid April, with a maximum of 22.3°C in mid February 2012. Conductivity and turbidity results were indicative of clean, clear, relatively high water quality and minimal algal cover was noted through the period.

Bacteriological water quality was relatively poor despite a good standard of compliance with on-site dairy wastes disposal practices recorded by the season's annual inspection round in this catchment. Numbers had a very wide range with a high median *E. coli* value of 460 per 100 mls particularly in comparison with numbers found at the upstream Merrilands Domain site. As a consequence bacteriological samples collected on two occasions at both Waiwhakaiho River sites (28 November 2011 and 13 February 2012) were forwarded to Cawthron Institute, Nelson for faecal source DNA tracking marker analyses. The Merrilands Domain samples were found to contain bacteria only indicative of ruminants origin on the first occasion and ruminants and wildfowl origin on the latter occasion. Samples from the lower river site (adjacent to Lake Rotomanu) were found to contain bacteria very specifically of gulls origin on both occasions and a faint indication of ruminants origin on the latter sampling occasion. No bacteria of human origin were found at either site on either sampling occasion.

3.2.3.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 21.

Table 21 Bacterial guidelines performance at the Waiwhakaiho River adjacent to Lake Rotomanu site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	5 [38]	5[38]

(Designation: freshwater contact recreational area)

Five single samples were recorded within the 'Action' mode and five 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 almost throughout the survey period. Appropriately worded signage may be required on a permanent basis in future.

3.2.3.2 Comparison with previous summers' surveys

A statistical comparison of nine summer's surveys data is presented graphically in Appendix V for all sites [Note: These data had been collected prior to the current year from time to time for consent monitoring purposes]. These data for the site in the Waiwhakaiho River adjacent to Lake Rotomanu are summarised in Table 22 and illustrated in Figure 12.

Table 22 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys in the Waiwhakaiho River adjacent to Lake Rotomanu

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	9	-	52	-	26	-	54	-	46	-	71	-	160	-	220	77
Maximum	740	-	51	-	870	-	470	-	1000	-	1600	-	2600	-	3400	2000
Median	72	-	120	-	110	-	210	-	270	-	320	-	490	-	885	460

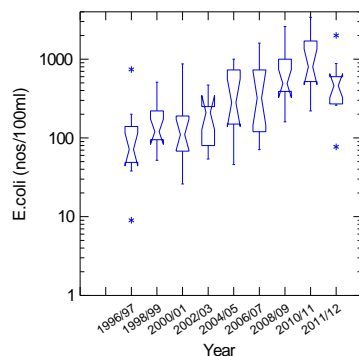


Figure 12 Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers in the Waiwhakaiho River adjacent to Lake Rotomanu

The median *E. coli* number in the 2011-2012 period was amongst the highest recorded to date but typical of more recent years' medians (Table 22 and Figure 12). Most medians have been below the 'Action' level of the 2003 MfE guidelines but since 2003-2004 all medians have been within, or exceeded the 'Alert' level.

Partial trend analysis of these median *E. coli* numbers has been performed for the nine 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 not been performed at this stage as there have not been ten seasons monitored to date.

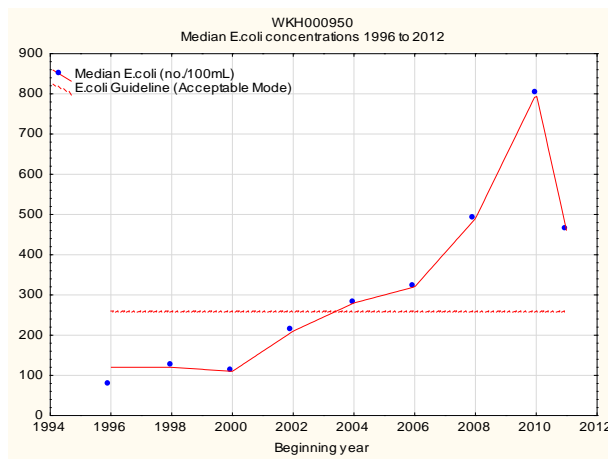


Figure 13 LOWESS trend plot of median *E. coli* numbers (per 100 ml) at the Waiwhakaiho River, adjacent to Lake Rotomanu for the 1996 to 2012 period

Increasing median *E. coli* numbers have been found over the nine seasons of monitoring with four of these seasonal medians exceeding the 'Alert' mode and one entering the 'Action' mode.

3.2.4 Te Henui Stream at the mouth, East End

Limited usage of this site was recorded at the time of the sampling surveys, with no bathing found. More frequently, walking, picnicking, or fishing on the banks of the stream was noted.

Ducks (and sometimes gulls) were common at this site on all survey occasions, where they were encouraged by people feeding the wildlife from time to time.

The data for this site are presented in Table 23 and illustrated in Figure 14, with a statistical summary provided in Table 24.

Table 23 Analytical results for the Te Henui Stream at the mouth, East End

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1200	11.0	820	200	820	15.0	1.3
28.11.11	1120	453	1100	380	1100	15.2	0.7
22.01.12	0920	193	13000	19000	14000	17.6	0.7
26.01.12	1110	165	1400	700	1600	18.0	0.6
7.02.12	0945	134	2400	1300	2500	16.3	1.0
10.02.12	1055	371	1300	1200	1300	18.5	0.6
13.02.12	1240	26.8	730	620	730	19.5	0.8
27.02.12	1240	10.1	510	800	510	16.2	1.4
8.03.12	1000	362	1300	1300	1400	16.0	0.8
21.03.12	1000	386	4100	3100	4100	15.4	1.1
28.03.12	1330	10.3	420	250	420	15.5	0.7
30.03.12	1405	12.5	350	280	360	15.3	0.5
10.04.12	1150	1210	530	350	550	16.4	1.9

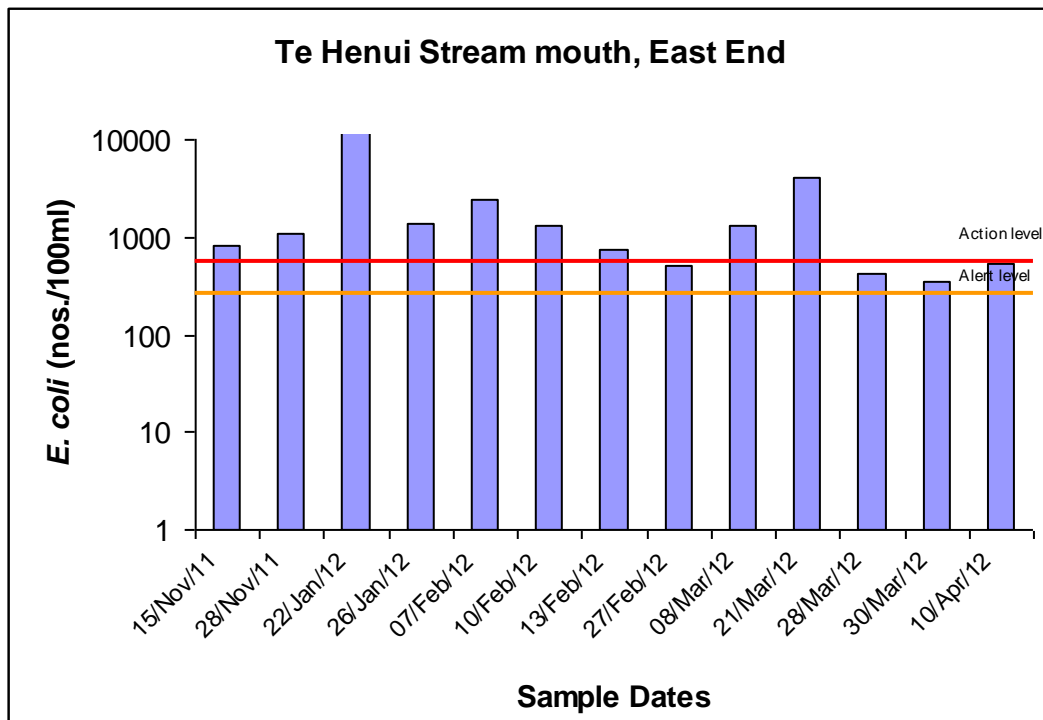


Figure 14 *E. coli* numbers for the Te Henui Stream at the mouth, East End during the regular survey season

Table 24 Statistical results summary for the Te Henui Stream at the mouth, East End

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	10.1	1210	165
<i>E. coli</i>	nos/100ml	13	350	13,000	1100
Enterococci	nos/100ml	13	200	19,000	700
Faecal coliforms	nos/100ml	13	360	14,000	1100
Temperature	°C	13	15.0	19.5	16.2
Turbidity	NTU	13	0.5	1.9	0.8

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.

Water temperatures varied over a relatively narrow range of 5°C between mid November and mid April, with a maximum of 19.5°C in mid February 2012. Conductivity and turbidity results were indicative of clean, clear, relatively high water quality subject to tidal incursions of seawater from time to time (e.g. late November 2011, mid February 2012, early and mid March 2012, and particularly in April 2012). Moderate to extensive algal cover was recorded through the period.

Bacterial water quality was very poor with a wide range of counts and very high median *E. coli* value of 1100 per 100 mls. Consequently, bacteriological samples collected on two low tide (6 December 2011 and 18 January 2012) and two high tide (28 November 2011 and 13 February 2012) occasions were 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 warrants further investigation (which has been discussed and initiated with the Taranaki Area Health Board and New Plymouth District Council).

3.2.4.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 25.

Table 25 Bacterial guidelines performance at the Te Henui Stream mouth East, End

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	4 [31]	9[69]

(Designation: freshwater contact recreational area)

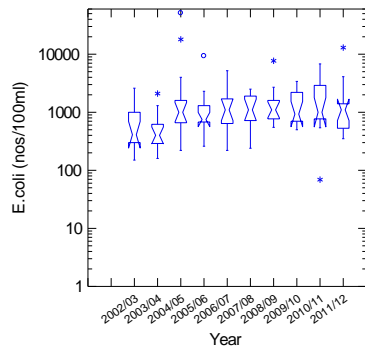
No single sample was recorded below the 'Alert' mode during the season. Bacteriological water quality measured at this site therefore was outside the acceptable standard for contact recreational usage for the entire survey period, and more frequently within the 'Action' mode. Additional sampling undertaken in early December 2011, mid January 2012, and mid February 2012, also found high bacterial levels, all within the 'Action' mode. Appropriate signage therefore was required at this site adjacent to the New Plymouth walkway throughout the survey period and was the subject of a number of public enquiries. The coastal bathing waters monitored nearby at East End beach met the enterococci guidelines on twenty of twenty-two occasions during the season with no occurrences within the 'Action' level. Minimal impact of the stream on the coastal East End beach water quality was indicated by the median *E.coli* number (24 per 100 mls) for the SEM season (TRC, 2012).

3.2.4.2 Comparison with previous summers' surveys

A statistical comparison of ten summer's surveys data is presented graphically in Appendix V for all sites. [Note: These data had been collected prior to the current year to provide interpretative information for nearby coastal beach monitoring data]. These data for the Te Henui Stream site are summarised in Table 26 and illustrated in Figure 15.

Table 26 Summary of *E.coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Te Henui Stream at the mouth, East End

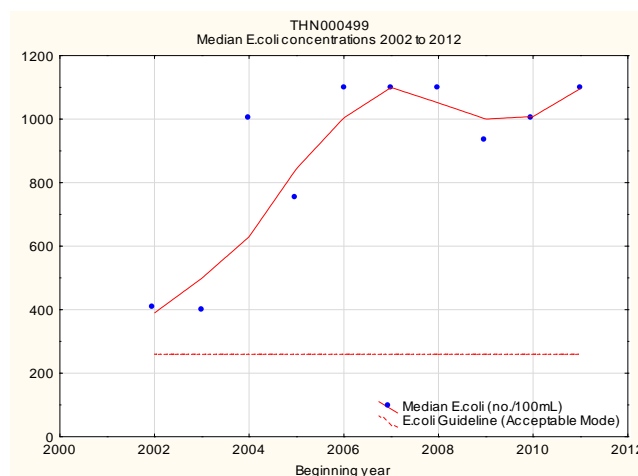
Summer	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	150	160	220	260	220	240	550	500	69	350
Maximum	2600	8700	51000	9300	5200	2500	7700	3400	6800	13000
Median	410	415	890	750	1100	1100	1100	930	985	1100

**Figure 15**

Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers in the Te Henui Stream at the mouth, East End

The median *E. coli* number in the 2011-2012 period was typical of the more recent medians recorded to date and equal with the maximum of the range of historical medians (Table 26 and Figure 15), each of which has been well above the 'Alert' level of the 2003 MfE guidelines. All but two of these median numbers have also been in the 'Action' level.

Trend analysis of these median *E. coli* numbers has been performed for the ten seasons of data by first applying a LOWESS fit (tension 0.45) to a time scatterplot of the median numbers (Figure 16) 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 16** LOWESS trend plot of median *E. coli* numbers (per 100 ml) at the Te Henui Stream mouth, East End for the 2002 to 2012 period

N = 10
Kendall tau = 0.484
P level = 0.052 [$>$ FDR, $p = 0.206$]
N/S at $p < 0.05$

An insignificant temporal trend of increasing median *E. coli* numbers was found over the ten seasons of monitoring. (Note: This trend was close to being statistically significant at $p < 0.05$ but not after FDR). Two of these seasonal medians entered the 'Alert' mode and all others exceeded the 'Action' mode.

3.2.5 Patea River at King Edward Park, Stratford

No bathing or picnicking usage of this river site was recorded at the time of sampling surveys, most of which were in the morning or early afternoon. Fishermen were noted on two occasions at this site, and following the release of trout into the river for the 'Take a Kid Fishing' promotion in late January 2012.

Data from the site are presented in Table 27 and illustrated in Figure 17, with a statistical summary provided in Table 28. River flow records are illustrated in Figure 18.

Table 27 Analytical results for the Patea River at Kind Edward Park, Stratford

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	0800	9.0	440	120	440	11.0	0.7
28.11.11	1220	9.5	290	34	310	14.3	0.7
22.01.12	1135	8.8	150	35	150	14.6	0.7
26.01.12	0830	9.1	220	88	230	14.0	0.6
7.02.12	1210	9.3	130	100	140	15.3	2.2
10.02.12	1250	9.4	83	72	83	15.1	0.5
13.02.12	0955	9.6	320	110	320	15.6	0.5
21.02.12	1145	9.4	360	120	360	16.9	0.6
27.02.12	1410	8.5	140	110	160	15.6	1.0
8.03.12	1135	8.5	100	86	130	13.4	0.7
28.03.12	0900	8.7	190	100	190	11.7	0.7
30.03.12	1100	8.9	88	79	88	11.9	0.7
10.04.12	1340	9.2	63	62	66	13.0	2.1

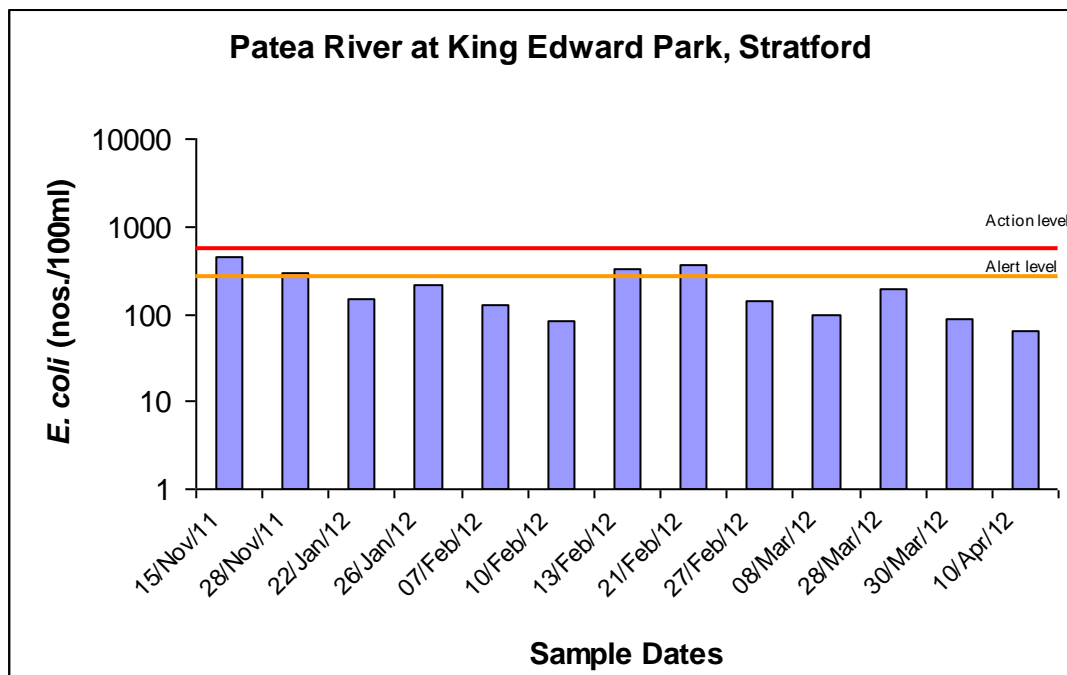


Figure 17 *E. coli* numbers for the Patea River at King Edward Park, Stratford during the survey season

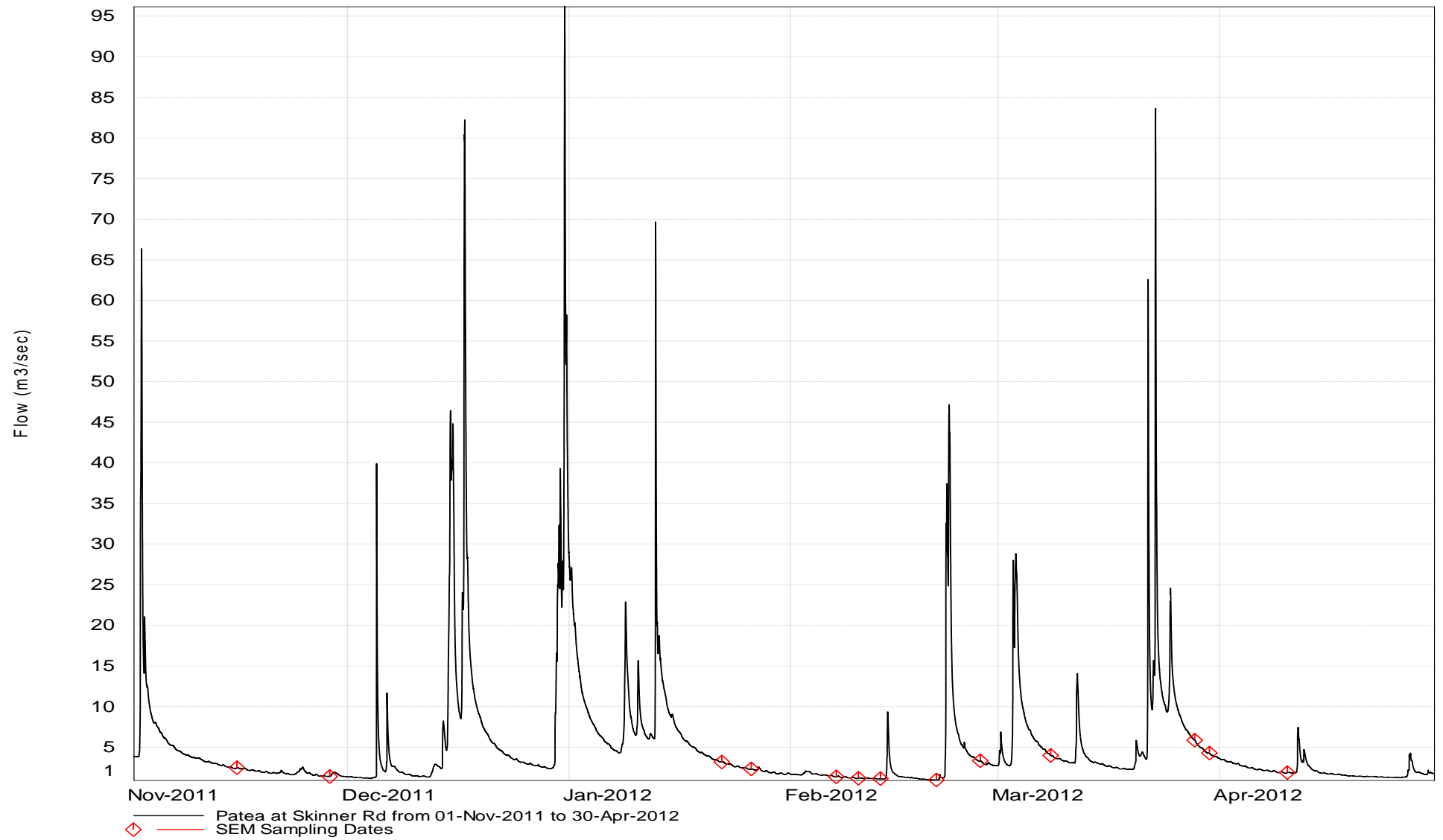


Figure 18 Flow in the Patea River at Skinner Rd during the survey period

Table 28 Statistical results summary for the Patea River at King Edward Park, Stratford

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	8.5	9.6	9.1
<i>E. coli</i>	nos/100ml	13	63	440	150
Enterococci	nos/100ml	13	34	120	88
Faecal coliforms	nos/100ml	13	66	440	160
Temperature	°C	13	11.0	16.9	14.3
Turbidity	NTU	13	0.5	2.2	0.7

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 and greenish in appearance with relatively low conductivity levels.

Water temperatures had a moderate range of 5.9°C for this site (at an elevation of 300 m asl), with a maximum of 16.9°C recorded at 1145 hrs in mid February 2012. All the samples were collected before 1410 hours and therefore the maximum river temperatures (which tend to occur later in the afternoon) which this site might experience over summer were not recorded.

Bacteriological water quality was moderate for the mid reaches of this Taranaki ring plain river draining a predominantly agricultural catchment. Four moderately high counts were recorded during the survey period. These did not necessitate further investigation as regular sampling which followed in February 2012, found lower counts. This was a considerable improvement over a number of previous seasons' surveys when it had been necessary to re-inspect a number of dairy farms' disposal systems in smaller upstream catchments and on several occasions issue abatement notices for non-compliance with consented disposal requirements. Four counts exceeded the 'Action' level (early in the season and in mid February 2012) but these short term incidents were not considered to warrant the placement of appropriate signage at the site by the Stratford District Council.

Annual dairy farms inspections in this area of the upper Patea catchment will continue to be timed to ensure compliance with consent conditions prior to the start at the contact recreation period.

3.2.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 29.

Table 29 Bacterial guidelines performance at the Patea River at King Edward Park, Stratford site [% of 13 samples]

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

(Designation: freshwater contact recreational area)

No single samples fell within the 'Action' mode, but four samples fell in the 'Alert' mode. These counts occurred early in the season and in mid February 2012 but no immediate follow-up sampling was possible due to very wet weather prior to January 2012. In terms of the guidelines for contact recreational usage, bacteriological water quality at this site was compliant with the acceptable level for almost the entire period, with no incursions into the 'Action' level.

3.2.5.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summers' survey data is presented graphically in Appendix V for all sites. A shorter data period (eleven years) exists for the Patea River (at King Edward Park, Stratford) site which was added in 2001-2002. These summer data for the Patea River at King Edward Park, Stratford site are summarised in Table 30 and illustrated in Figure 19.

Table 30 Summary *E. coli* bacteriological water quality data (nos/100 ml) all summer surveys in the Patea River at King Edward Park, Stratford

Summer	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	46	120	48	96	100	28	46	51	51	54	63
Maximum	640	780	580	760	840	1000	690	570	7400	610	440
Median	250	190	110	300	310	200	290	200	250	160	150

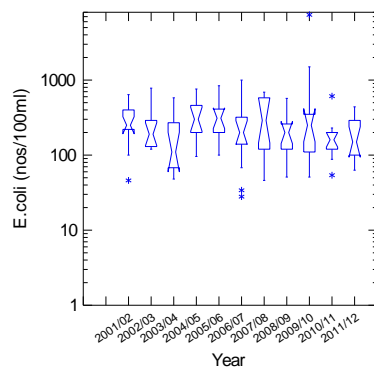
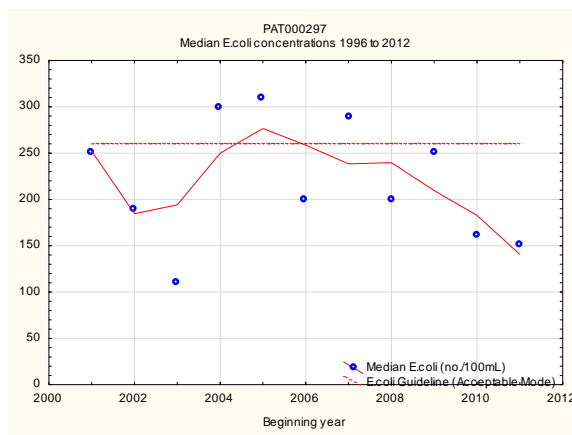


Figure 19 Box & whisker plots for all summer surveys of *E. coli* bacterial numbers for the Patea River at King Edward Park, Stratford

An improvement was indicated as the median *E. coli* bacterial count recorded for the 2011-2012 season was better than all but one of the historical median counts over the monitoring seasons. The 2011-2012 season recorded a narrower range of counts for this site due to the lowest maximum count compared with all of the eleven monitoring seasons to date.

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 20) 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.



N = 11
Kendall tau = -0.204
p level = 0.383 [$>$ FDR, $p = 0.713$]
N/S at $p < 0.05$

Figure 20 LOWESS trend plot of median *E.coli* numbers (per 100ml) at the Patea River, King Edward Park site, for the 2000-2012 period

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

3.2.6 Patea River at the boatramp, Patea

No bathing usage of this river site was recorded at the time of sampling surveys, all but one of which were in the morning. Boating, fishing, and walking were noted from time to time at this site with boating as the main activity as this was a popular launching site for fishermen, judging by the number of boat trailers often in the parking area and the recent provision of a boat jetty. Taranaki Regional Council also undertook microbial source tracking (MST) using DNA marker techniques (see Section 3.2.3) at this site and an upstream site at SH3 bridge on two occasions (high and low tides). Faecal coliform bacteria were 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 boatramp site only under low tidal flow conditions.

Data from the site are presented in Table 31 and illustrated in Figure 21, with a statistical summary provided in Table 32.

Table 31 Analytical results for the Patea River at the boatramp, Patea

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1000	4660	1	<1	1	16.6	21
28.11.11	0940	4700	7	1	7	16.4	36
22.01.12	0810	4490	28	8	28	18.9	8.3
26.01.12	1000	4620	19	1	19	19.4	18
7.02.12	0900	4640	1	1	1	19.1	12
10.02.12	0920	4630	16	8	16	19.5	11
13.02.12	1140	4610	4	3	4	19.7	9.0
21.02.12	0815	4230	80	160	80	19.6	7.0
27.02.12	1055	4660	8	20	8	19.5	22
8.03.12	0805	4400	260	54	260	16.6	91
28.03.12	1100	166	66	28	66	18.7	12
30.03.12	1240	492	36	8	36	19.1	7.6
10.04.12	1015	4630	4	4	4	17.0	54

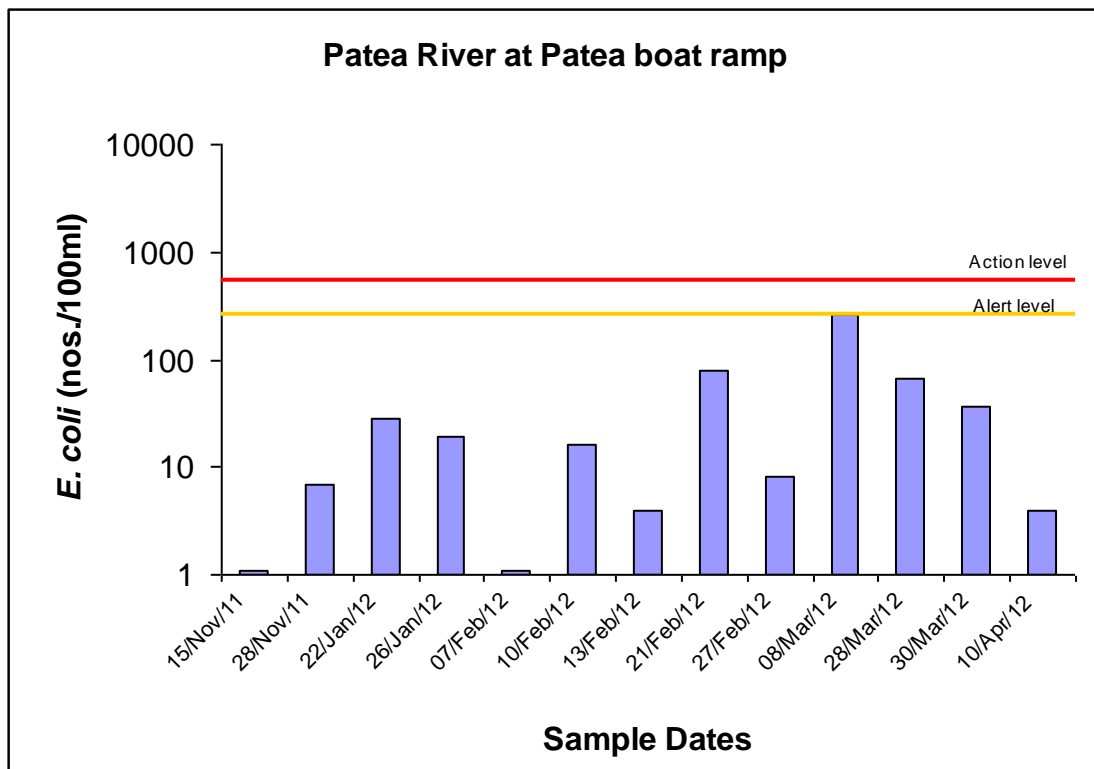
**Figure 21** *E. coli* numbers for the Patea River at the boatramp, Patea during the survey season

Table 32 Statistical results summary for the Patea River at the boatramp, Patea

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	166	4700	4620
<i>E. coli</i>	nos/100ml	13	1	260	16
Enterococci	nos/100ml	13	<1	160	8
Faecal coliforms	nos/100ml	13	1	260	16
Temperature	°C	13	16.4	19.7	19.1
Turbidity	NTU	13	7.0	91	12

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 discharge 0.7km upstream of the boatramp.

River water was usually slightly turbid in appearance with high conductivity levels typical of seawater ingress at high tide on most occasions. Water temperatures had a narrow range of 3.3°C, a narrower than expected range despite the coastal seawater influence, with a maximum of 19.7°C recorded in late morning in mid February 2012 when the river was in very low flow. All of the samples were collected before 1245 hours and therefore maximum river temperatures (which could be anticipated to occur later in the afternoon) were not sampled.

Bacteriological water quality was very good for the lower reaches of this Taranaki ring plain river (median: 16 *E.coli* per 100mls and 8 enterococci per 100mls) draining a predominantly agricultural catchment principally as a result of the coastal seawater influence under high tide conditions and the high bacteriological quality of the 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 public usage is 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 when a median *E. coli* bacterial number of 103 per 100mls (with counts ranging from 54 to 340 per 100mls) was found with numbers tending to be higher when seawater intrusion was minimal.

3.2.6.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 33.

Table 33 Bacterial guidelines performance at the Patea River at the boatramp, Patea site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: freshwater contact recreational area)

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 consistent with data for the nearby 'Mana' Bay coastal site adjacent to the river mouth monitored in the current season [median *E.coli*: 14 per 100 mls] for consent and SEM purposes.

3.2.6.2 Comparison with previous summers' surveys

Four previous SEM sampling seasons have been surveyed at this site. Otherwise prior sampling has been confined to consent monitoring surveys (TRC 2011b). A statistical comparison of each of the five summers' survey data is presented graphically in Appendix V for all sites. A much shorter data period exists for the Patea River (at Patea boat ramp) site which was added in 2007-2008. These data are summarised in Table 34 and illustrated in Figure 22.

Table 34 Summary *E. coli* bacteriological water quality data (nos/100ml) all summer surveys in the Patea River at the boat ramp, Patea

Summer	07/08	08/09	09/10	10/11	11/12
Minimum	1	1	1	<1	1
Maximum	190	87	82	33	260
Median	5	9	11	4	16

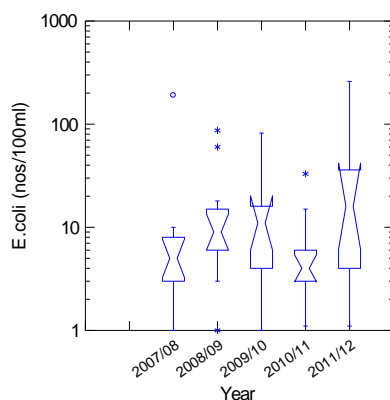


Figure 22 Box & whisker plots for all summer surveys of *E. coli* bacterial numbers for the Patea River at the boat ramp, Patea

Relatively similar (very low) median *E. coli* numbers have been found by these five seasons' surveys with a wider range of counts due to the highest maximum value found to date, recorded in the most recent season. 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.

3.2.7 Waingongoro River at Eltham camp

No bathing usage of this river site was recorded at the time of sampling surveys but camp activities were recorded 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 occasions.

Data from the site are presented in Table 35 and illustrated in Figure 23 with a statistical summary provided in Table 36. River flow records are illustrated in Figure 24.

Table 35 Analytical results for the Waingongoro River at Eltham camp

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	0835	11.8	330	33	330	12.2	2.3
28.11.11	1205	12.1	150	46	150	14.5	1.4
22.01.12	1125	11.8	100	40	100	15.5	1.7
26.01.12	0850	12.1	160	83	170	15.0	2.6
7.02.12	0805	12.4	200	80	200	14.2	1.5
10.02.12	1230	12.3	100	42	100	16.3	1.4
13.02.12	1015	12.4	240	62	240	16.5	1.9
21.02.12	1125	12.4	200	62	200	17.3	1.5
27.02.12	1350	10.7	84	60	88	17.1	1.2
8.03.12	1115	11.0	140	110	140	14.0	1.8
28.03.12	0920	11.5	220	90	220	13.7	2.4
30.03.12	1120	11.6	100	36	100	12.9	2.2
10.04.12	1320	12.1	68	44	74	14.3	1.6

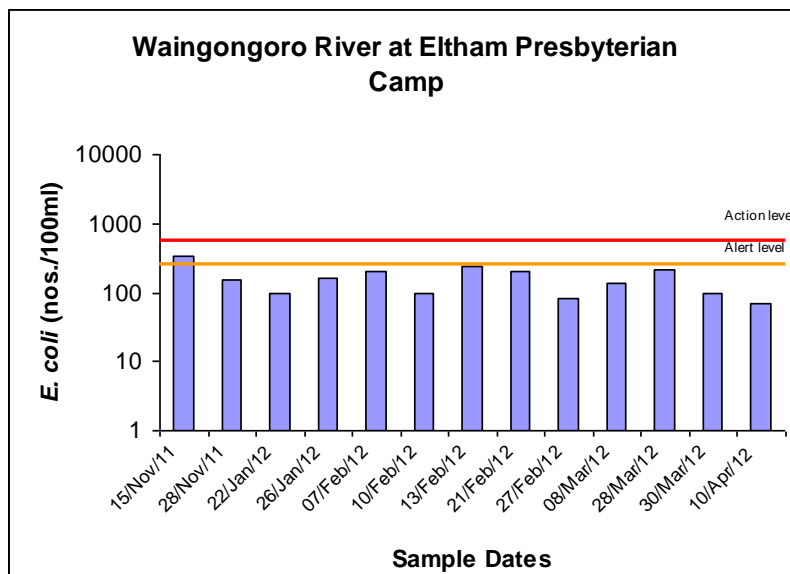


Figure 23 *E. coli* numbers for the Waingongoro River at Eltham Camp during the survey season

Table 36 Statistical results summary for the Waingongoro River at Eltham camp

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	10.7	12.4	12.1
<i>E. coli</i>	nos/100ml	13	68	330	150
Enterococci	nos/100ml	13	33	110	60
Faecal coliforms	nos/100ml	13	74	330	150
Temperature	°C	13	12.2	17.3	14.5
Turbidity	NTU	13	1.2	2.6	1.7

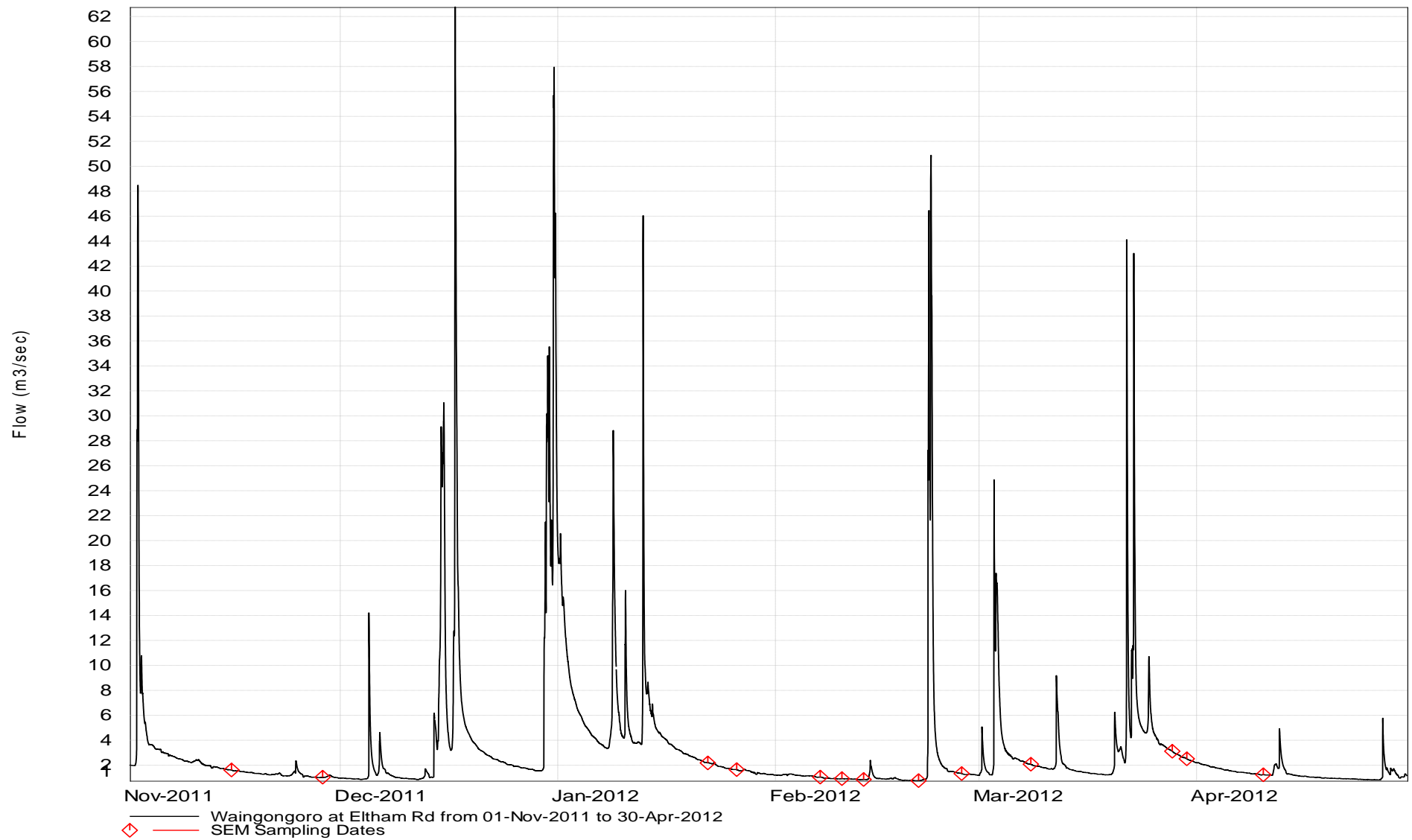


Figure 24 Flow in the Waingongoro River at Eltham during the survey period

This ring plain river drains an extensively developed agricultural catchment, with the survey site situated in Eltham some 21km below the National Park boundary. River water was relatively clear to slightly turbid in appearance with moderate conductivity levels. Water temperatures were within a moderate range of 5.1 °C and with a slightly lower than typical maximum of 17.3 °C recorded at 1125 hours in mid February 2012. All samples were collected before 1355 hours and therefore higher river temperatures (which tend to occur later in the afternoon) were not recorded.

Bacteriological water quality was in the range typical of the mid reaches of the 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 160 per 100mls (range: 6 to 59000 per 100mls) has been recorded by monthly sampling since 1995. The highest count in the current survey occurred early in the period under higher (median) flow conditions (Figures 23 and 24). A relatively good standard of compliance with dairy wastes disposal practices was found by the annual inspection round.

3.2.7.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 37.

Table 37 Bacterial guidelines performance at the Waingongoro River, Eltham Camp [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	0 [0]

(Designation: freshwater contact recreational area)

Only one single sample fell within the 'Alert' mode and no samples reached the 'Action' mode. The highest sample count (in the 'Alert' mode) occurred toward the start of the season in November 2011 about twelve days after the most recent river fresh. The count was below the 'Alert' mode some thirteen days later. In general these results were a small improvement on typical bacteriological counts obtained at the site just downstream at Eltham Road (by the longer term physicochemical SEM programme), although the latter programme samples throughout the year under more variable river flows and climatological conditions.

In terms of contact recreational usage guidelines, bacteriological water quality at this site was within the acceptable level for almost the entire period and no warning signage was required during the period.

3.2.7.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summer's survey data is presented graphically in Appendix V for all sites. A shorter data period exists for the Waingongoro River (at Eltham camp) site which was added to the programme in 2001-2002. These data for the Waingongoro River site at Eltham camp are summarised in Table 38 and illustrated in Figure 25.

Table 38 Summary of *E. coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Waingongoro River at Eltham camp to date

Summer	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	31	63	23	51	54	23	57	77	57	32	68
Maximum	870	550	360	1700	430	290	420	500	270	490	330
Median	230	230	100	170	130	110	160	130	160	140	150

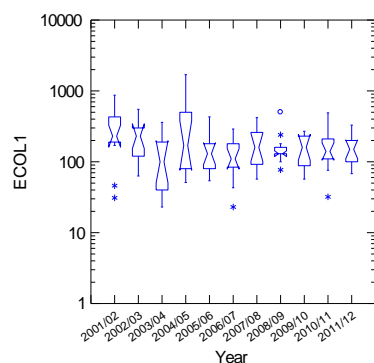
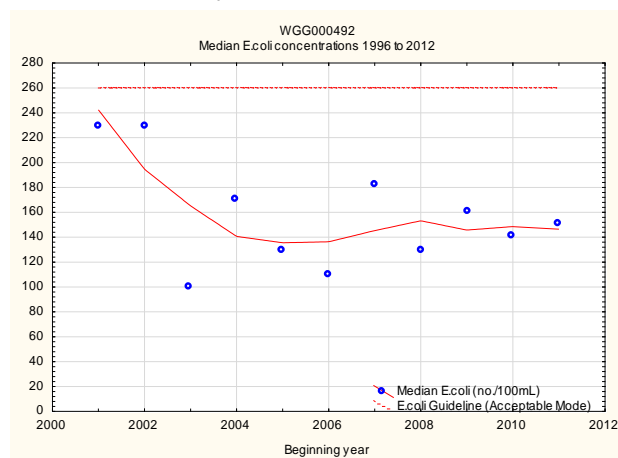


Figure 25 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers of the Waingongoro River at Eltham Camp

Similar *E. coli* bacterial water quality was indicated by a median count within the mid range of those recorded by the ten preceding seasons (Figure 25). There was a relatively narrow range of counts over the 2011-2012 season in comparison with the ten other seasons monitored previously.

Trend analysis of these median *E. coli* numbers has been performed for the eleven seasons of data by first applying a 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 Benjamini-Hochberg False Discovery Rate (FDR) analysis.



N = 11
Kendall tau = - 0.167
p level = 0.475 [$>$ FDR, p = 0.713]
N/S at p < 0.05

Figure 26 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Waingongoro River, Eltham camp for the 2000 to 2012 period

A statistically insignificant temporal trend of decreasing median *E. coli* numbers was found over the eleven seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes although those of the first two seasons were relatively high.

3.2.8 Waingongoro River at Ohawe Beach

No bathing usage of this site was recorded with the site used more frequently for whitebaiting (in season), fishing, and picnicking. Occasionally stock were present in the paddock upstream of the site but were not noted at the river's edge or in the river as had been the case on occasions in the past (TRC, 2010). The data for this site are presented in Table 39 and illustrated in Figure 27, with a statistical summary provided in Table 40. River flow records are illustrated in Figure 28.

Table 39 Analytical results for the Waingongoro River at Ohawe Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1055	17.4	83	9	83	16.2	3.4
28.11.11	1025	18.8	66	17	74	17.0	2.3
22.01.12	0900	17.2	2800	250	2800	17.7	4.6
26.01.12	1105	18.2	72	83	88	17.0	3.4
7.02.12	1005	19.7	84	76	100	17.1	3.0
10.02.12	1020	22.1	180	1200	-	18.1	2.4
13.02.12	1240	19.7	43	36	46	19.0	2.6
21.02.12	0915	20.5	150	220	160	18.5	2.5
27.02.12	1145	16.2	120	180	120	17.3	2.6
8.03.12	0905	15.5	120	300	140	15.5	5.9
28.03.12	1155	14.8	160	200	160	15.7	2.6
30.03.12	1330	15.2	96	140	96	15.5	2.7
10.04.12	1110	17.2	88	130	92	15.5	2.8

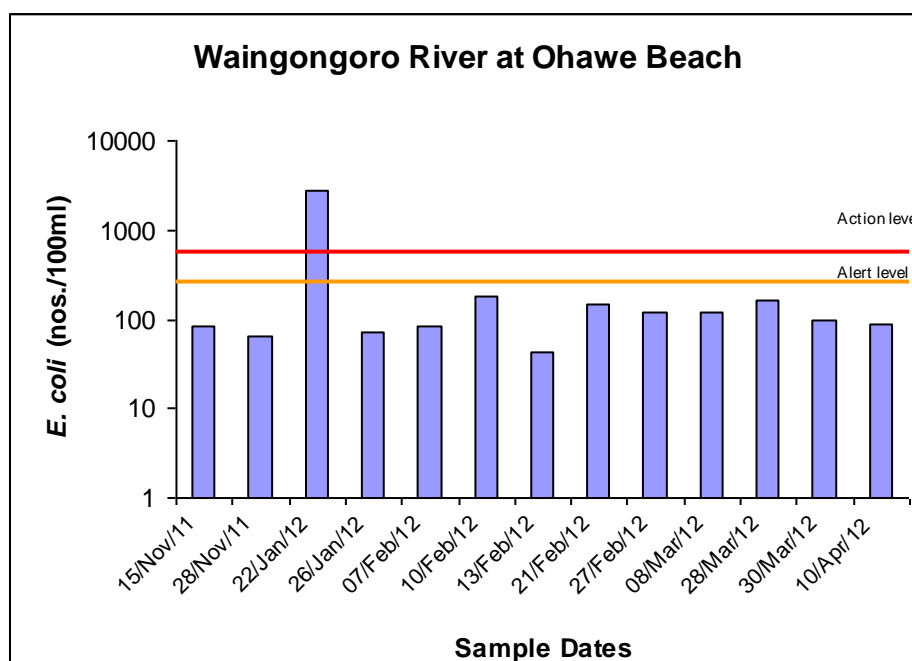


Figure 27 *E. coli* numbers for the Waingongoro River at Ohawe Beach during the survey season

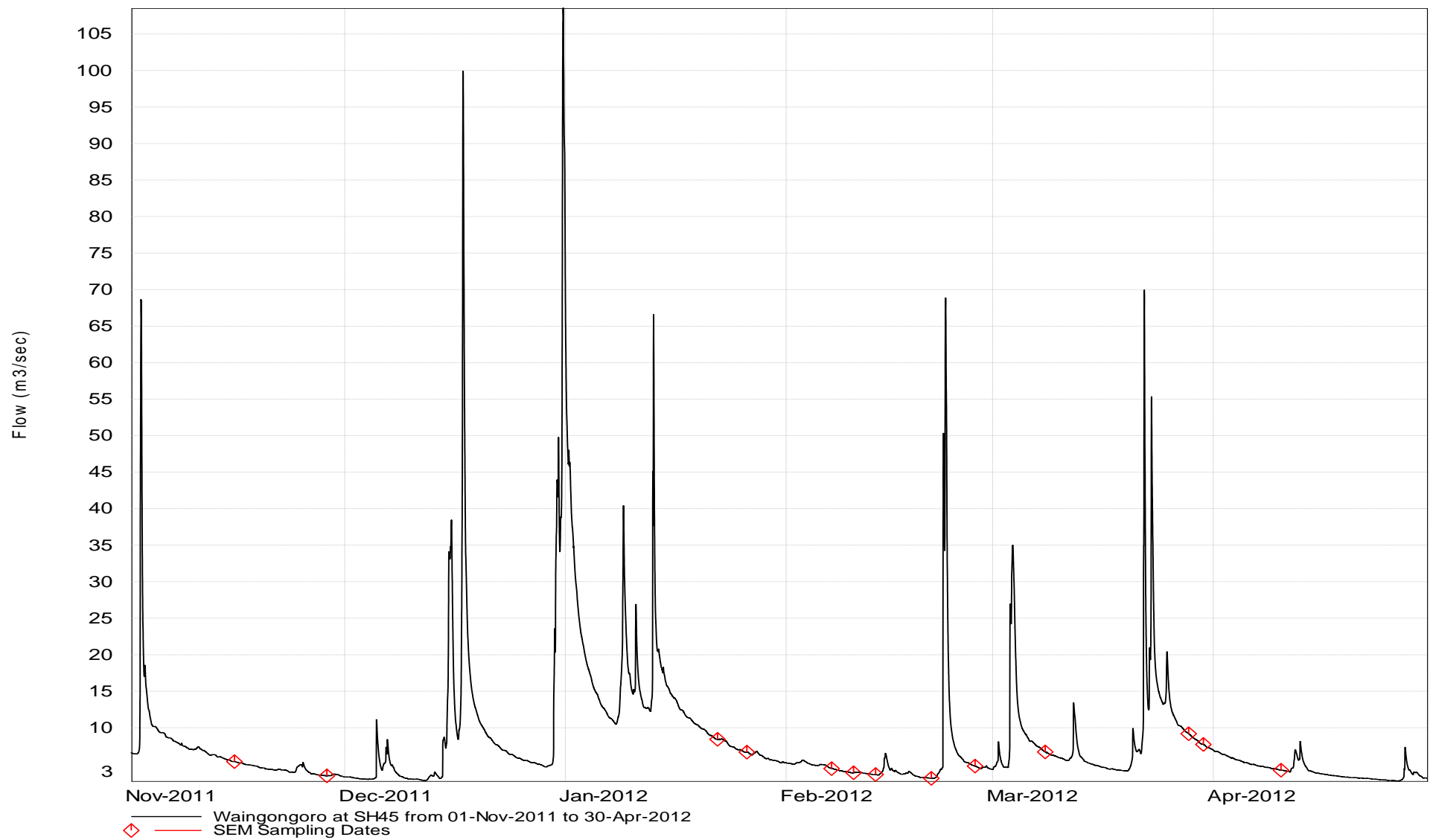


Figure 28 River flow in the Waingongoro River at SH45 during the survey period

Table 40 Statistical results summary for the Waingongoro River at Ohawe Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	14.8	22.1	17.4
<i>E. coli</i>	nos/100ml	13	43	2800	96
Enterococci	nos/100ml	13	9	1200	140
Faecal coliforms	nos/100ml	12	46	2800	98
Temperature	°C	13	15.5	19.0	17.0
Turbidity	NTU	13	2.3	5.9	2.7

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. These conditions were much less prevalent during the 2011-2012 season.

The range of water temperatures was relatively narrow (4.5°C) with a lower maximum than usual (19.0°C) recorded in early afternoon in mid February 2012. However, as no sampling was performed after 1330 hrs at this site, this maximum could 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 and showed minimal salt water influence on any occasion despite sampling low flow conditions coincident with higher tides. Turbidity values were indicative of slightly turbid water on most occasions, consistent with the presence of some fine colloidal material in suspension (ie: 2 to 3 NTU on most occasions), typical of the lower reaches of a ring plain river.

Bacteriological water quality (Figure 27) was relatively good for 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 has recorded a median *E. coli* count of 220 per 100 mls. On-site monitoring of dairy farm wastes disposal systems indicated a generally good standard of compliance in the catchment during the survey period. Uncontrolled stock access to the river, particularly during low flow periods, was not as apparent during the current season as it had been historically.

3.2.8.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 41.

Table 41 Bacterial guidelines performance at the Waingongoro River, Ohawe Beach [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	1 [8]

(Designation: freshwater contact recreational area)

No single sample was recorded in the 'Alert' category but one sample was found in the 'Action' mode in mid January 2012. No reason was found for this isolated exceedance of the guidelines and follow-up investigations upstream found normal bacteriological numbers at an upstream site (SH45) and this site a few days later. Counts were consistently between 80 and 180 *E.coli* per 100 mls under late summer-autumn lower flow conditions.

Bacteriological water quality at this site was within the acceptable guidelines for contact recreational usage for almost the entire survey period coincident with the diversion of the Eltham WWTP discharge out of the catchment and land irrigation of Riverlands meatworks wastes for most of the season, and consistent with on-site monitoring of dairy wastes disposal systems having a relatively good compliance standard for this large catchment at the time of the summer contact recreation survey period.

3.2.8.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summer's survey data is presented graphically in Appendix V for all sites. These summer data for the Waingongoro River site at Ohawe Beach are summarised in Table 42 and illustrated in Figure 29.

Table 42 Summary of *E. coli* bacteriological water quality data (nos/100 ml) for all summer surveys in the Waingongoro River at Ohawe Beach to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	88	43	17	34	38	46	31	43	54	31	31	9	31	26	8	43
Maximum	310	650	300	240	850	660	14000	280	940	380	410	5000	870	1000	180	2800
Median	185	130	80	180	170	160	110	110	130	96	100	100	120	96	100	96

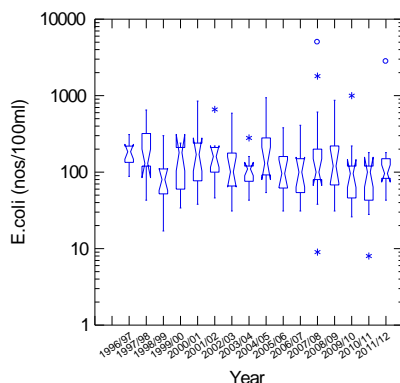
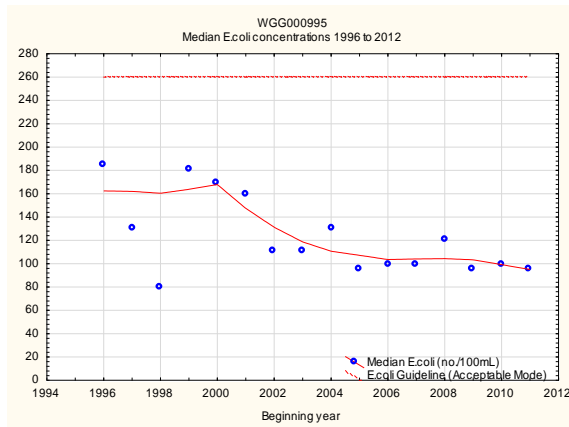


Figure 29 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Waingongoro River at Ohawe Beach

Median *E. coli* bacteria number for the 2011-2012 period was very similar to those found in the previous six seasons, maintaining the general trend of improvement in bacterial water quality recorded over the last ten seasons (Figure 29).

A relatively wide range of *E. coli* numbers was recorded in the recent 2011-2012 period in comparison with all past seasons' ranges to date, as a result of the one high count.

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 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.



N = 16
Kendall tau = - 0.500
p level = 0.007 [$>$ FDR, $p = 0.041$]
Significant at $p < 0.05$,
not significant at $p < 0.01$ after FDR.

Figure 30 LOWESS trend plot of median *E. coli* numbers (per 100ml) for the 1996 to 2012 period at the Waingongoro River Ohawe beach site

A strongly decreasing trend in median *E. coli* number was found over the sixteen seasons of monitoring and the decrease has been particularly apparent over the past ten seasons. The trend was statistically significant at the $p < 0.05$ level, but not significant at $p < 0.01$ after FDR application. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.9 Kaupokonui River at Beach Domain

No usage at this site by bathers was recorded at the time of the sampling surveys but other recreational usage (mainly fishing (whitebaiting was common in early season) and picnicking) was occurring on the majority of survey occasions at this popular site. The site was characterised by the tidal ponded nature of this reach of the river, particularly under very 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. River flow records are provided in Figure 31. Data from this site are presented in Table 43 and illustrated in Figure 32, with a statistical summary provided in Table 44.

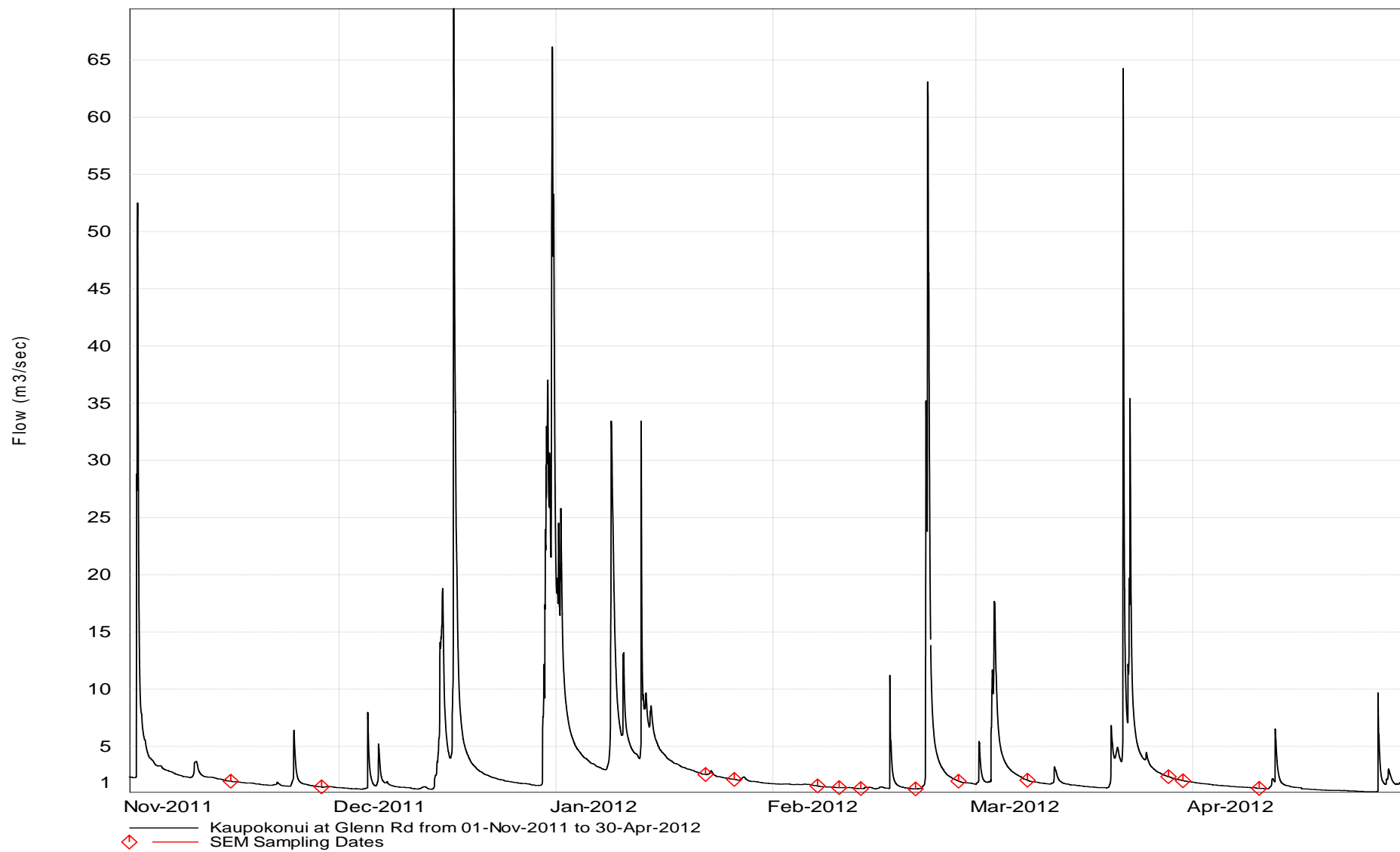
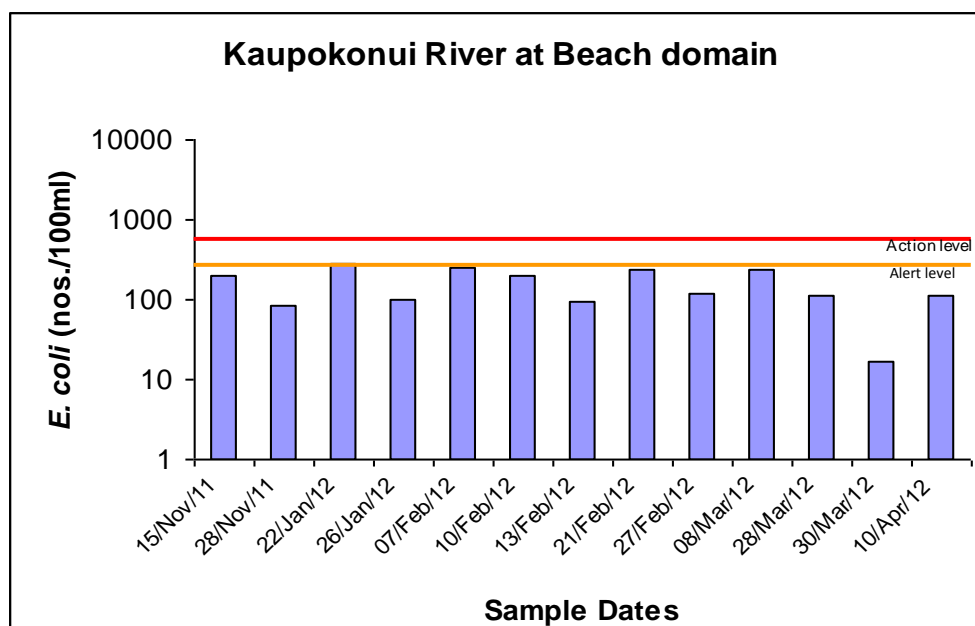


Figure 31 River flow in the Kaupokonui River at Glenn Rd. during the survey period

Table 43 Analytical results for the Kaipokonui River at the beach domain

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1125	16.5	200	21	200	16.5	1.7
28.11.11	1045	16.9	84	15	84	17.4	1.1
22.01.12	0930	17.2	290	240	290	17.3	2.1
26.01.12	1150	38.9	100	88	110	18.0	1.2
7.02.12	1035	17.9	250	370	260	18.1	1.5
10.02.12	1045	18.7	200	860	200	18.6	1.9
13.02.12	1310	17.7	94	200	94	20.5	1.6
21.02.12	0940	17.1	240	280	240	18.7	1.9
27.02.12	1215	14.1	120	150	120	20.2	1.6
8.03.12	0935	15.0	240	500	240	15.4	4.0
28.03.12	1220	14.9	110	95	120	18.5	1.3
30.03.12	1405	15.2	17	52	17	16.8	1.0
10.04.12	1135	16.3	110	70	110	17.3	1.5

**Figure 32** *E. coli* numbers for the Kaipokonui River at the beach domain during the survey season**Table 44** Statistical results summary for the Kaipokonui River at the beach domain

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	14.1	38.9	16.9
<i>E. coli</i>	nos/100ml	13	17	290	120
Enterococci	nos/100ml	13	15	850	150
Faecal coliforms	nos/100ml	13	17	290	120
Temperature	°C	13	15.4	20.5	18.0
Turbidity	NTU	13	1.0	4.0	1.6

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 Fonterra Kapuni Company (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 nine occasions was noted as tidal (incoming surges or ponded) in terms of flow conditions. However, slightly elevated conductivity levels indicating some seawater influence were recorded only on one occasion late in January 2012 at high tide and under low flow conditions (Figure 31). Otherwise these levels were relatively stable (14.1 to 18.7 mS/m at 20°C) and typical of the lower reaches of a Taranaki ring plain river.

Turbidity levels were typical of lower ring plain river reaches throughout the period with minimal impacts of suspended algal matter, unlike in many previous survey periods. Foaming was seldom noticeable in the ponded reach of the river and toward the edges, unlike in previous periods when foaming and suspended algal matter reduced the aesthetic quality of this reach from time to time. Water temperatures varied over a relatively narrow range of 5.1°C with a maximum of 20.5°C recorded in mid February 2012. This temperature was recorded in early afternoon and would be expected to have been exceeded later in the day, particularly as all of the surveys were performed before 1410 hrs at this site.

Bacteriological water quality was relatively good and similar to that recorded in the lower reaches of the nearby Waingongoro River (see section 3.2.8), and better than often found in the lower reaches of a Taranaki ring plain river draining a predominantly agricultural catchment. On-site monitoring of dairy farm wastes disposal systems indicated a generally good standard of compliance during the summer bathing period.

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 in response to 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. It has also been noted that lower faecal coliform to enterococci ratios than usual have been recorded at this (and other) tidal ponded sites, possibly as a result of vegetative enterococcal sources and/or better enterococci survival in tidal pool environments, particularly sites characterised by ebbing and flowing within the ponded river mouth reach. This again was apparent later in summer (Table 43) when enterococci numbers were often in excess of *E. coli* numbers.

One 'Alert' level was recorded, in mid January 2012, but a much lower count was recorded by the following survey four days later. Previously, many flocks of ducks have been recorded in reaches of the river upstream of this 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 2011-2012 season.

3.2.9.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 45.

Table 45 Bacterial guidelines performance at the Kaupokonui River beach domain site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	1 [8]	0 [0]

(Designation: freshwater contact recreational area)

One individual sample was recorded in the 'Alert' mode during the season. Minimal rainfall immediately preceded this count with numbers returning to typical levels by the time of the following scheduled survey four days later.

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 consistent with the generally good compliance standards found by on-site monitoring of dairy wastes disposal systems in the mid and lower reaches of this catchment.

3.2.9.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summer's survey data is presented graphically in Appendix V for all sites. These summer data for the Kaupokonui River site at the Beach Domain are summarised in Table 46 and illustrated in Figure 33.

Table 46 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys in the Kaupokonui River at the Beach Domain

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	26	31	3	7	17	46	46	<8	40	14	26	15	29	20	20	17
Maximum	360	2100	580	780	2000	400	630	200	880	280	2500	850	890	440	340	290
Median	110	360	130	80	120	110	130	77	92	160	140	77	210	100	76	120

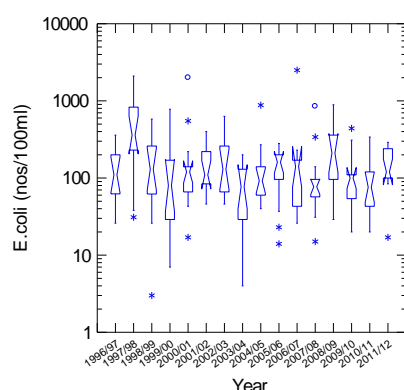


Figure 33 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Kaupokonui River at the Beach Domain

A typical *E. coli* bacterial water quality in terms of median number, but one of the narrowest ranges found by the previous fifteen survey seasons, were recorded over the 2011-2012 season (Figure 33). The median *E. coli* count was in the mid-range of all other season's medians to date (Table 46), whereas the seasonal maximum was the third lowest of the 16 years of record.

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 34) 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.

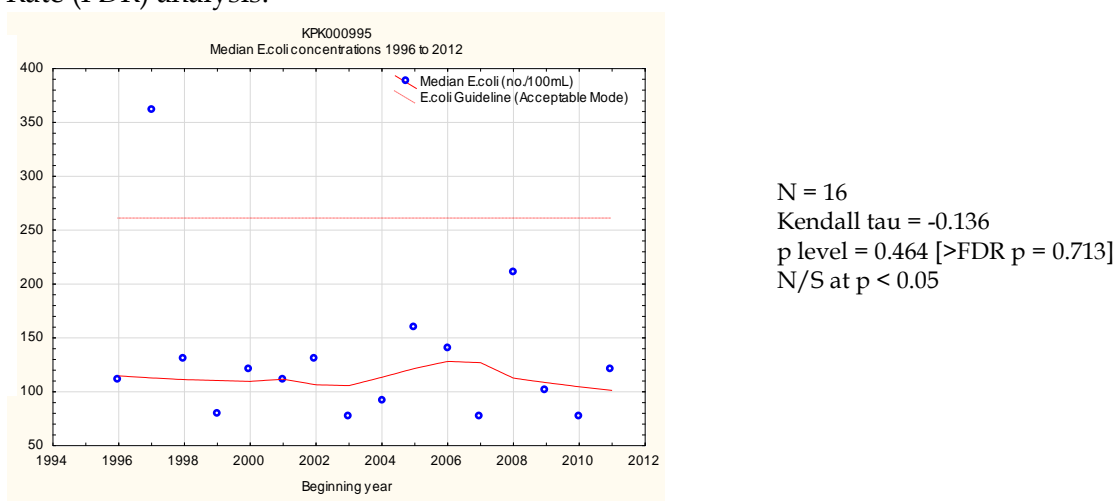


Figure 34 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Kaupokonui River beach domain site for the 1996 to 2012 period

A slight, but statistically insignificant, decreasing trend in median *E. coli* counts was found over the sixteen seasons of monitoring. One of these seasonal medians (1997-1998 season) exceeded the 'Alert' mode but none have exceeded the 'Action' mode, nor have any approached the 'Alert' mode since 1997-1998.

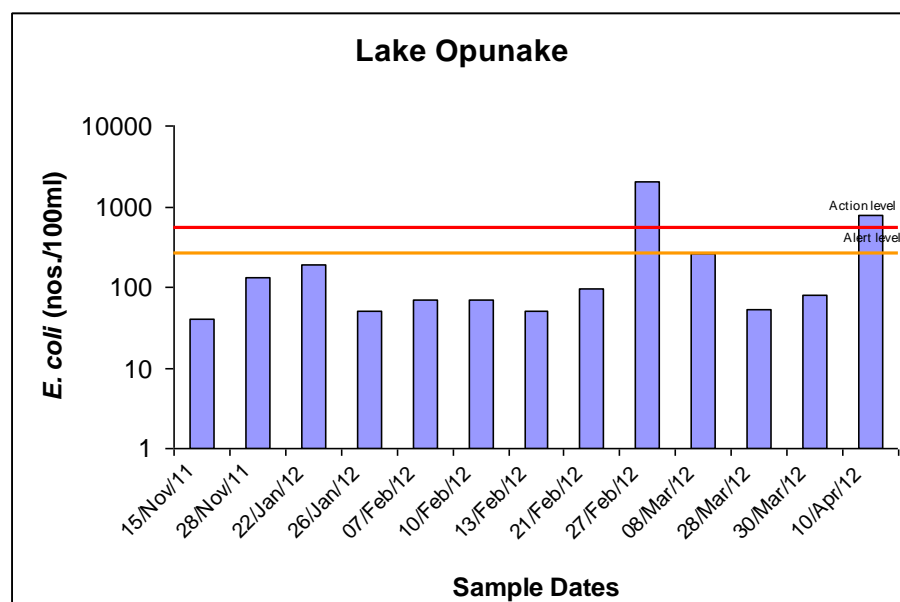
3.2.10 Lake Opunake

No bathing or boating usage of the lake was noted on any occasion, but picnicking, activities were recorded occasionally at the time of sampling surveys. Ducks were also noted regularly on the lake or in the vicinity of the lake edge and numbers were high on most occasions. Large numbers of these wildfowl were present frequently 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 previous season (TRC, 2011b).

Data from this site are presented in Table 47 and illustrated in Figure 35, with a statistical summary provided in Table 48.

Table 47 Analytical results for Lake Opunake

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1200	13.6	40	14	43	16.2	1.1
28.11.11	1115	13.0	130	120	140	15.4	1.3
22.01.12	1000	13.7	190	630	190	18.0	0.9
26.01.12	1220	13.8	51	540	51	19.0	1.1
7.02.12	1100	13.9	69	140	77	18.4	1.0
10.02.12	1120	14.1	68	480	68	20.6	0.9
13.02.12	1340	13.9	51	590	51	20.6	1.2
21.02.12	1010	13.7	96	1400	96	20.9	0.8
27.02.12	1245	12.8	2000	1800	2000	17.3	1.0
8.03.12	1000	13.2	260	440	270	15.9	6.9
28.03.12	1245	13.7	54	120	54	17.0	0.8
30.03.12	1215	14.2	80	240	80	14.6	0.8
10.04.12	1210	14.4	780	690	780	17.6	1.2

**Figure 35** *E. coli* numbers for Lake Opunake during the survey season**Table 48** Statistical results summary for Lake Opunake

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	12.8	14.4	13.7
<i>E. coli</i>	nos/100ml	13	40	2000	80
Enterococci	nos/100ml	13	14	1800	480
Faecal coliforms	nos/100ml	13	43	2000	80
Temperature	°C	13	14.6	20.9	17.6
Turbidity	NTU	13	0.8	6.9	1.0

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 generally relatively good (median turbidity: 1.0 NTU; range of turbidity: 6.1 NTU) as

a result of minimal sediment disturbance or suspended algae in the water column. Generally 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. Water temperatures were moderately high (above 17.5°C) for half of the period with a maximum of 20.9°C (in mid February 2012) and a moderate range of 6.3°C. Conductivity varied over a very narrow range (1.6 mS/m @ 20°C) reflecting river flow conditions.

Generally bacteriological quality was moderate, influenced in part by the inflow to the lake originating from the lower reaches of a river draining a developed catchment but more so by the local wildfowl population. Elevated numbers, above 200 *E. coli* per 100 mls, were found in the latter half of the season co-incidental with higher wildfowl numbers in the immediate vicinity of the site. Marked fluctuations in counts were most likely associated with this bird population, particularly in instances where ducks had been attracted to the monitoring site by picnickers feeding the birds.

3.2.10.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 49.

Table 49 Bacterial guidelines performance at Lake Opunake
[% of 13 samples]

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

(Designation: freshwater contact recreational area)

Two single sample exceedances of the 'Action' mode occurred during the period but no single samples were recorded within the 'Alert' mode. Sampling subsequent to the initial 'Action' level in late February 2012 showed a much lower *E. coli* number within ten days of this exceedance. Installation of 'health warning' signage by STDC was performed and publicity was given to the state of the lake by the local newspaper and on both relevant websites. The last exceedance occurred at the time of the final survey, coincident with the presence of a large number of ducks immediately adjacent to the sampling site.

3.2.10.2 Comparison with previous summers' surveys

A statistical comparison of all of the summers' *E. coli* survey data is presented graphically in Appendix V for all sites. The six summers of data collection for the Lake Opunake site are summarised in Table 50 and illustrated in Figure 36.

Table 50 Summary of *E. coli* bacteriological water quality data to date (nos/100 ml) for all summer surveys at Lake Opunake to date

Summer	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	33	26	54	64	8	40
Maximum	720	1300	2800	320	3800	2000
Median	110	130	210	220	80	80

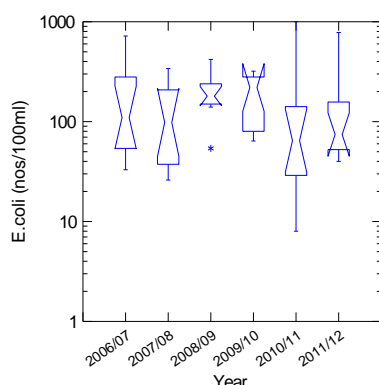


Figure 36 Box and whisker plots for the summer SEM survey of *E. coli* bacteria numbers at Lake Opunake

A lower median *E. coli* number than all but one of the five previous seasons' surveys was found in the latest season but a relatively wide range of counts was found during the latest season (Figure 36).

Trend analysis of median *E. coli* numbers will not be performed for this site until ten seasons' data are available.

3.2.10.3 Cyanobacteria

Microscopic scans of seven samples were performed for the presence and enumeration of cyanobacteria during the season. The results of these analyses are presented in Table 51.

Table 51 Cyanobacteria counts (cells/ml) for Lake Opunake [Health warning:>15,000 cells/ml]

Date	Cyanobacteria total cell count (cells/ml)
21.11.11	nil
06.12.11	nil
20.12.11	nil
05.01.12	nil
18.01.12	nil
31.01.12	nil
16.02.12	nil

No cyanobacteria were detected in any of these samples. No cyanobacteria had been found in this lake during the 2006-2007, 2008-2009, 2009-2010, or 2010-2011 seasons, but their presence (in low numbers) on three occasions in the latter part of the 2007-2008 season followed a lengthy, extremely low flow period. However, these numbers did not reach levels requiring the issue of 'health warnings' during that season. The relatively short lake water residence time (due to hydroelectric power generation usage) may be a controlling factor for these populations.

3.2.11 Timaru Stream at Weld Road (near mouth)

Bathing usage was noted at this site on only one sampling occasion while some picnicking usage was recorded at the times of sampling surveys during the season. The site had been a popular camping area (until the camp was closed by NPDC during early 2005) and access point to the sea coast. The site, to a certain extent tidal, showed varying degrees of saltwater penetration, particularly in the period after New Year under low flow recession conditions.

Data from this site are presented in Table 52 and illustrated in Figure 37, with a statistical summary provided in Table 53.

Table 52 Analytical results for the Timaru Stream at Weld Road

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1015	9.5	48	12	48	14.5	0.4
28.11.11	1050	24.1	160	88	160	14.9	0.5
22.01.12	0800	524	260	290	260	17.0	1.0
26.01.12	0945	22.1	170	180	170	17.8	0.3
7.02.12	0815	402	410	100	410	17.3	0.6
10.02.12	0925	138	310	340	320	18.9	1.5
13.02.12	1430	64.8	34	78	34	21.3	0.6
27.02.12	1105	10.1	120	180	120	17.5	0.7
8.03.12	0820	458	440	310	450	15.4	2.0
21.03.12	0800	1120	220	480	230	16.8	1.0
28.03.12	1140	8.5	96	130	96	15.9	0.4
30.03.12	1250	9.3	96	44	96	16.0	0.5
10.04.12	1020	189	96	240	100	16.2	0.6

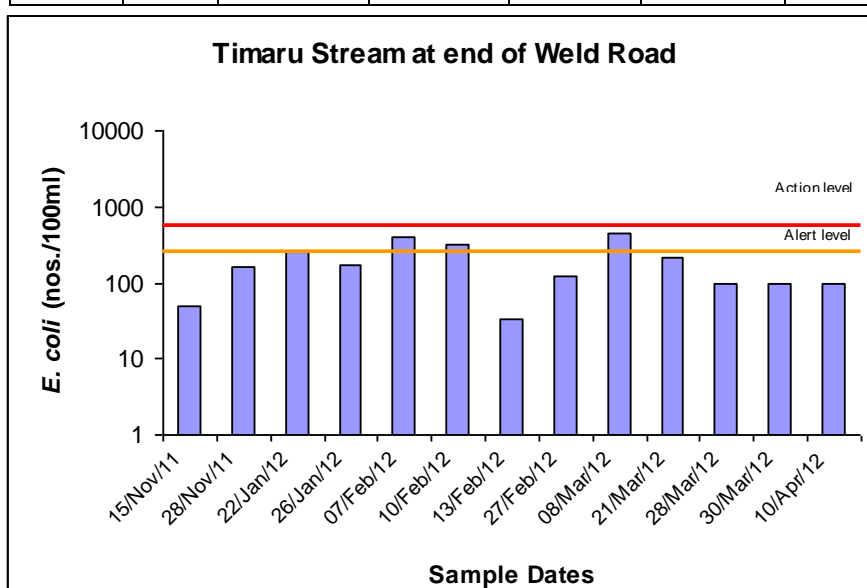


Figure 37 *E. coli* numbers for the Timaru Stream at Weld Road during the survey season

Table 53 Statistical results summary for the Timaru Stream at Weld Road

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	8.5	1120	64.8
<i>E. coli</i>	nos/100ml	13	34	440	160
Enterococci	nos/100ml	13	12	480	180
Faecal coliforms	nos/100ml	13	34	450	160
Temperature	°C	13	14.5	21.3	16.8
Turbidity	NTU	13	0.3	2.0	0.6

This river drains a moderately farmed catchment (five consented dairy farm discharges) receiving point and non-point source discharges from these 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 several occasions during the season and particularly in mid to late summer-autumn under low stream flow conditions. Turbidity levels generally were very low, consistent with the clear appearance of the river. 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 6.8°C with a maximum water temperature of 21.3°C recorded in mid afternoon morning in mid February 2012. This maximum could have been expected to have been exceeded later in the day during summer as all of the sampling was undertaken before 1435 hrs and the majority in the mornings.

Bacteriological water quality at this site was generally below average but more typical of the lower reaches of a smaller Taranaki ring plain stream draining an agricultural catchment. Elevated counts occurred sporadically, more particularly under low flow conditions in the mid to latter part of the sampling period. There was no installation of 'health warning' signage at the site by NPDC as there was no exceedance of the 'Action' level. No problems with wastes disposal practices were recorded by the annual dairy farms inspection round. Stock access to the lower stream (which was crossed to reach adjacent farmland at times) during the prolonged dry period of the 2007-2008 seasons (requiring remedial action after incidents were reported by the general public) was not repeated or recorded in the 2009-2010, 2010-2011, or 2011-2012 seasons. 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). It has also been noted at these tidal river pool sites that lower faecal coliform to enterococci ratios than usual have been recorded possibly due to vegetative sources and/or better enterococci survival in pool environments characterised by the ebb and flow in the ponded river/stream mouth.

3.2.11.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 54.

Table 54 Bacterial guidelines performance at the Timaru Stream, Weld Road site [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	3 [23]	0 [0]

(Designation: freshwater contact recreational area)

Three single samples were recorded in the 'Alert' mode, but none were recorded in the 'Action' mode during the period. Poorer bacteriological water quality coincided with dry weather, low stream flow and moderate seawater intrusion causing ponding at the site. No follow-up surveys were necessary on these occasions as subsequent scheduled sampling found lower numbers within 3 to 7 days of these events. The erection of health warning signage was not required.

In terms of the 2003 contact recreation guidelines, the bacteriological water quality at the site was moderately good, although partly affected by the ponding caused by the site's proximity to the sea coast. Good compliance with dairy sheds' wastes disposal practices was found in monitoring in this catchment during the season.

3.2.11.2 Comparison with previous summers' surveys

A statistical comparison of each of the summers' survey data is presented graphically in Appendix V for all sites. These summer data for the Timaru Stream site at the end of Weld Road (which has been monitored for twelve summers) are summarised in Table 55 and illustrated in Figure 38.

Table 55 Summary of *E. coli* bacteriological water quality data to date (nos/100ml) for all summer surveys in the Timaru Stream at lower Weld Road

Summer	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	40	23	31	77	31	140	77	84	38	43	46	92	46	28	34
Maximum	410	710	1400	540	660	1000	410	1000	460	480	930	440	560	410	440
Median	280	210	160	180	180	260	220	260	220	200	180	230	290	180	160

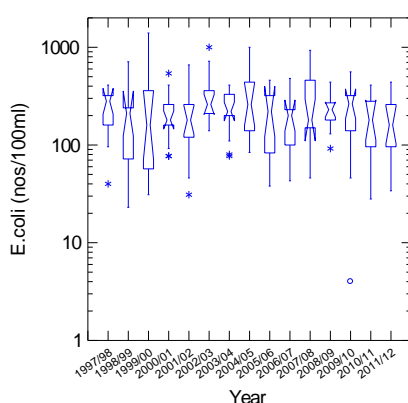
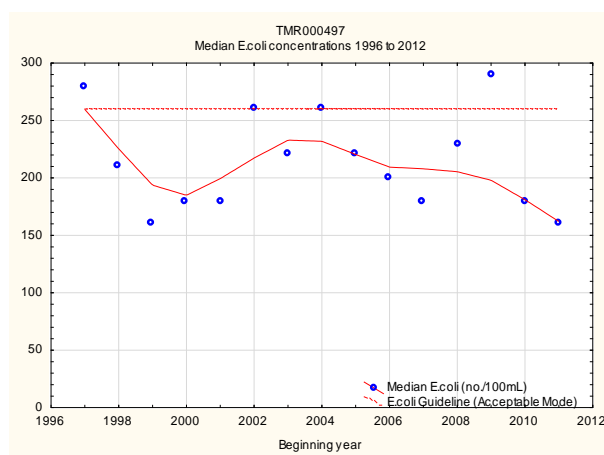


Figure 38

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

The median *E. coli* count for the 2011-2012 season indicated some improvement in bacterial water quality (Table 55) in comparison with recent seasons and was equal lowest with all previous seasons' counts. Counts over the 2011-2012 season had a relatively narrow range (Figure 38), with no counts reaching the 'Action' mode, and the fourth lowest seasonal maximum found over the 16 years of monitoring.

Trend analysis of these median *E. coli* numbers has been performed for the fifteen seasons of data by first applying a LOWESS fit (tension 0.4) to a time scatterplot of the median numbers (Figure 39) 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.



N = 15
 Kendall tau = -0.079
 p level = 0.679 [$>$ FDR, p = 0.815]
 N/S at p < 0.05

Figure 39 LOWESS trend plot of median *E. coli* numbers (per 100ml) at Timaru Stream, lower Weld Road site for the 1997 to 2012 period

An overall very slight decreasing trend in median *E. coli* numbers has been found over the fifteen seasons of monitoring but this trend has not been statistically significant. None of these seasonal medians exceeded the 'Action' mode, although the medians for the initial and 2008-2009 seasons entered the 'Alert' mode and two others have been very close to the 'Alert' mode.

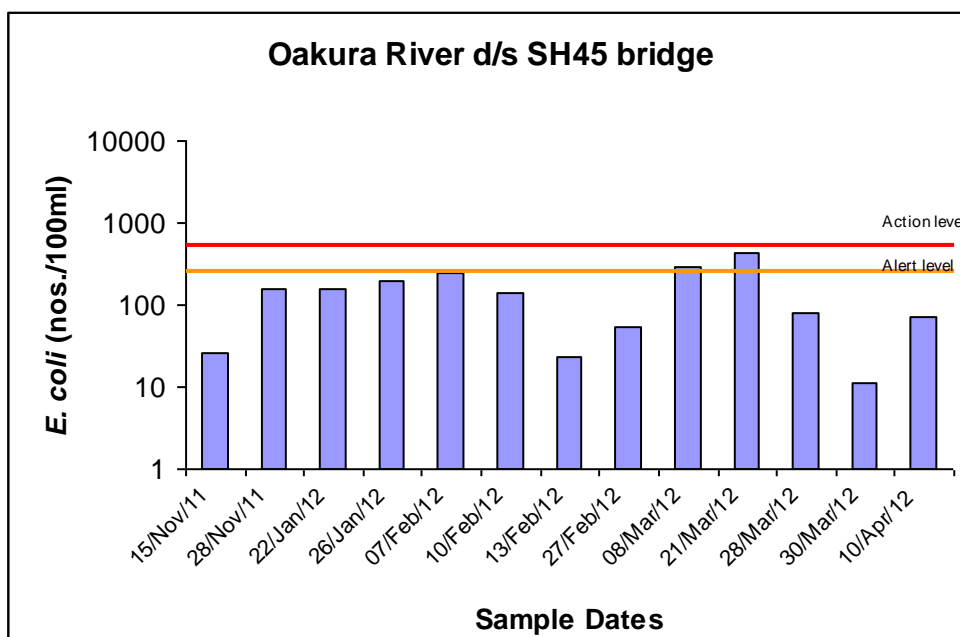
3.2.12 Oakura River below SH45

Minimal bathing usage was recorded at this site and often people were present on the riverbank at this very accessible tidal site where ponding and upstream surging frequently occurred under high tide conditions.

Data from the site are presented in Table 56 and illustrated in Figure 40, with a statistical summary provided in Table 57.

Table 56 Analytical results for the Oakura River below SH45

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1110	8.7	26	13	26	15.1	1.1
28.11.11	1040	7.7	160	41	160	14.9	0.7
22.01.12	0845	8.8	160	200	170	17.5	0.8
26.01.12	1025	9.7	200	140	200	18.0	0.4
7.02.12	0855	7.3	240	350	240	15.6	0.5
10.02.12	1010	28.1	140	140	140	18.4	0.5
13.02.12	1335	8.9	23	74	23	21.5	0.4
27.02.12	1155	6.9	54	160	54	17.8	0.9
8.03.12	0910	8.3	290	370	300	16.9	2.3
21.03.12	0915	151	440	410	440	15.9	0.8
28.03.12	1225	8.5	80	110	80	16.9	1.0
30.03.12	1330	8.4	11	72	11	17.2	0.5
10.04.12	1100	98.2	72	140	100	16.1	0.6

**Figure 40** *E. coli* numbers for the Oakura River below SH45 during the survey season**Table 57** Statistical results summary for the Oakura River below SH45

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	6.9	151	8.7
<i>E. coli</i>	nos/100ml	13	11	440	140
Enterococci	nos/100ml	13	13	410	140
Faecal coliforms	nos/100ml	13	11	440	140
Temperature	°C	13	14.9	21.5	16.9
Turbidity	NTU	13	0.4	2.3	0.7

This river drains a mainly agricultural catchment (three consented dairy farm discharges to surface water) with the survey site established in the short tidal reach

between SH45 and the mouth of the river. The river was noted as tidal with ponding or inflowing surges obvious on seven sampling occasions. Conductivity levels indicated an influence of saltwater intrusion on at least three sampling occasions during the season. The more significant intrusion occurred during low flow conditions in the latter part of this season. On all occasions the river was clear in appearance with no algal substrate cover due to the sandy nature of much of the substrate. Water temperatures varied over a moderate range (6.6°C) during the period reaching a maximum of 21.5°C in early afternoon in mid February 2012, below the maximum water temperature which might be anticipated later in the day as all sampling at this site occurred before 1335 hrs.

Bacteriological water quality was average, with the majority of *E. coli* counts below 200 per 100 mls. Bacteriological water quality was not dissimilar to that found elsewhere in ponded tidal reaches of ringplain 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. Lower faecal coliform to enterococci ratios (than normally found at flowing river sites) were occasionally recorded possibly as a result of vegetative sources of enterococci and/or better survival rates in tidal pool environments; sites which are characterised by ebbing and flowing within the ponded stream mouth reach. An elevated count in mid March 2012 was coincident with the presence of numerous seagulls and significant saltwater intrusion under low flow conditions. Regular sampling seven days after this elevated count, found a much lower *E. coli* count (80 per 100mls). A good standard of compliance with on-site dairy waste disposal practices was recorded during the season.

3.2.12.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 58.

Table 58 Bacterial guidelines performance at the Oakura River SH45 bridge site [% of 13 samples]

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

(Designation: freshwater contact recreational area)

Only two single samples fell within the 'Alert' mode and no samples entered the 'Action' mode. These occurrences coincided with low flow conditions but one followed some localised rainfall. Subsequent sampling showed a return to low levels, well below the 'Alert' mode, seven days after the latter occurrence. No health warning signage was required to be displayed at this site by NPDC following the 'Alert' level exceedance.

However, generally bacteriological water quality was typical for the lower reaches of a Taranaki ringplain stream, and within the acceptable single sample guidelines for contact recreational usage for the majority of the sampling occasions.

3.2.12.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summers' survey data is presented graphically in Appendix V for all sites. These summer data for the Oakura River site below the SH45 bridge are summarised in Table 59 and illustrated in Figure 41.

Table 59 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys in the Oakura River downstream of SH45

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	7	28	42	24	23	31	26	43	11	46	23	31	34	60	19	11
Maximum	260	1100	240	540	310	580	420	1200	820	380	330	2400	450	2500	290	440
Median	34	110	100	77	80	120	120	120	140	160	220	140	180	150	100	140

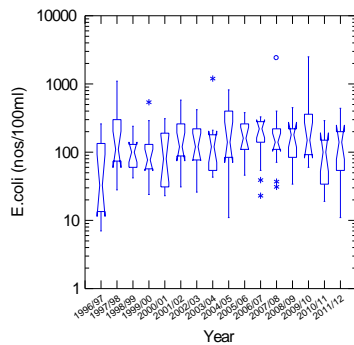


Figure 41 Box and whisker plots for all summer surveys of *E. coli* bacteria numbers in the Oakura River downstream of SH45

The median *E. coli* count was toward the middle of the range of past seasons' results (Figure 41). A narrow range of *E. coli* counts was recorded due to the absence of any very high counts. No median *E. coli* counts have exceeded the 2003 guidelines for contact recreational usage over the sixteen seasons of monitoring.

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

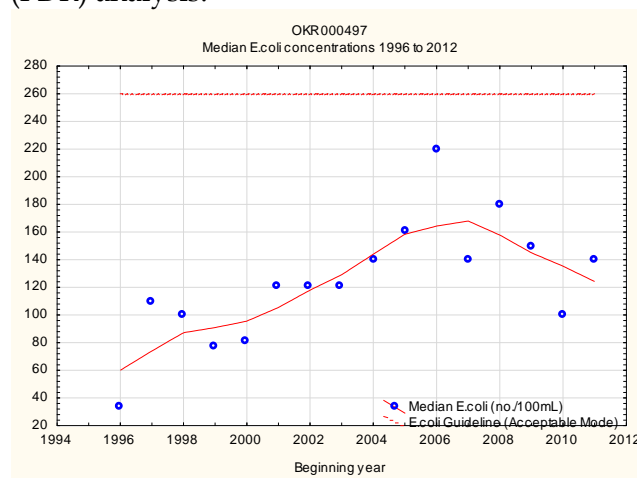


Figure 42 LOWESS trend plot of median *E. coli* numbers (per 100ml) at the Oakura River, SH 45 site for the 1996 to 2012 period

N = 16
 Kendall tau = + 0.541
 p level = 0.0035 [$>$ FDR, p = 0.041]
 Significant at p < 0.05; not significant at p < 0.01 after FDR.

A strong increasing trend in median *E. coli* counts has been found over the sixteen seasons of monitoring. Although statistically significant at the $p < 0.05$ level, it was not significant at $p < 0.01$ after FDR application. However, none of these seasonal medians exceeded the 'Alert' or 'Action' modes. This increasing trend may warrant further investigation if it continues although it should be noted that there has been an improving trend in median *E. coli* counts over the past five year period.

3.2.13 Waitara River at the town wharf, Waitara

Minimal 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 mid-afternoon. Fishing was noted from time-to-time at this site with walking and picnicking as additional activities.

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 (see Section 3.2.10) 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.

Regular sampling data from the site are presented in Table 60 and illustrated in Figure 43 with a statistical summary provided in Table 61. River flow information is illustrated in Figure 44.

Table 60 Analytical results for the Waitara River at the town wharf, Waitara

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1145	352	120	13	120	17.0	5.6
28.11.11	1150	866	550	100	550	16.9	25
22.01.12	1005	567	100	42	100	18.8	2.9
26.01.12	0915	670	210	120	220	19.0	2.4
7.02.12	0940	1100	100	52	100	18.8	1.5
10.02.12	1300	1310	79	42	87	20.8	1.5
13.02.12	1420	973	44	25	44	22.5	1.6
21.02.12	1010	466	230	110	230	20.9	1.4
27.02.12	1305	653	200	72	200	19.2	16
8.03.12	0940	900	260	79	260	15.9	9.6
28.03.12	1205	140	300	51	300	16.3	12
30.03.12	1430	253	150	40	160	17.2	4.4
10.04.12	1330	832	28	5	31	17.2	1.8

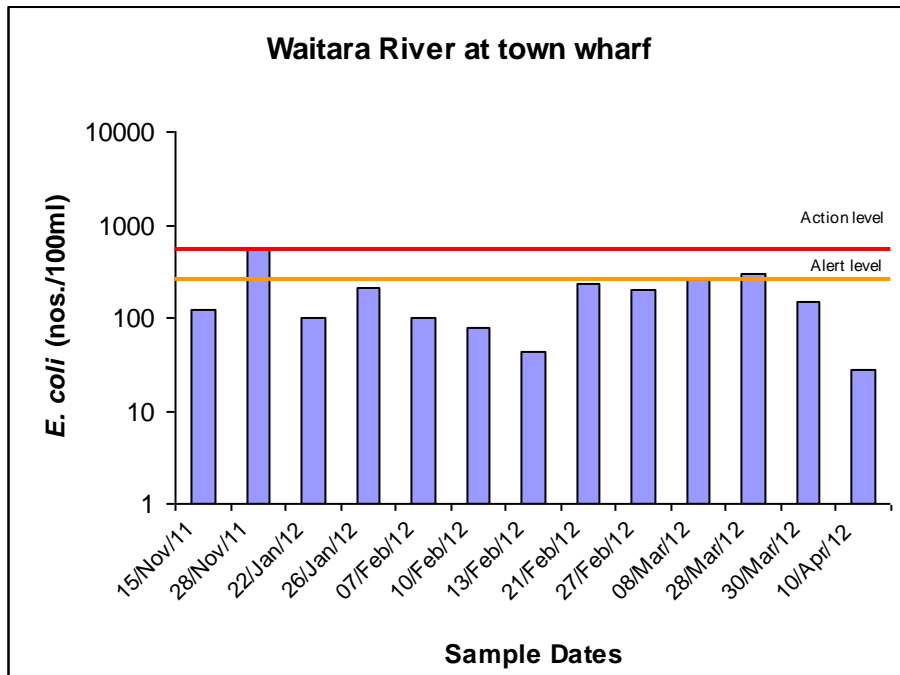


Figure 43 *E. coli* numbers for the Waitara River at the town wharf, Waitara during the survey season

Table 61 Statistical results summary for the Waitara River at the town wharf, Waitara

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20° C	mS/m	13	140	1310	670
<i>E. coli</i>	nos/100ml	13	28	550	150
Enterococci	nos/100ml	13	5	120	51
Faecal coliforms	nos/100ml	13	31	550	160
Temperature	°C	13	15.9	22.5	18.8
Turbidity	NTU	13	1.4	25	2.9

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 2km 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 3.2.14). River water was generally slightly turbid and occasionally turbid in appearance with elevated conductivity levels typical of seawater ingress near high tide on all sampling occasions and often coincidental with ponded or upstream flow conditions.

Water temperatures had a moderate range of 6.6°C partly due to the coastal seawater influence, with a maximum of 22.5°C recorded at 1420 hrs in mid February 2012. All of the samples were collected before 1435 hrs and therefore maximum river temperatures (which tend to occur later in the afternoon) were not sampled.

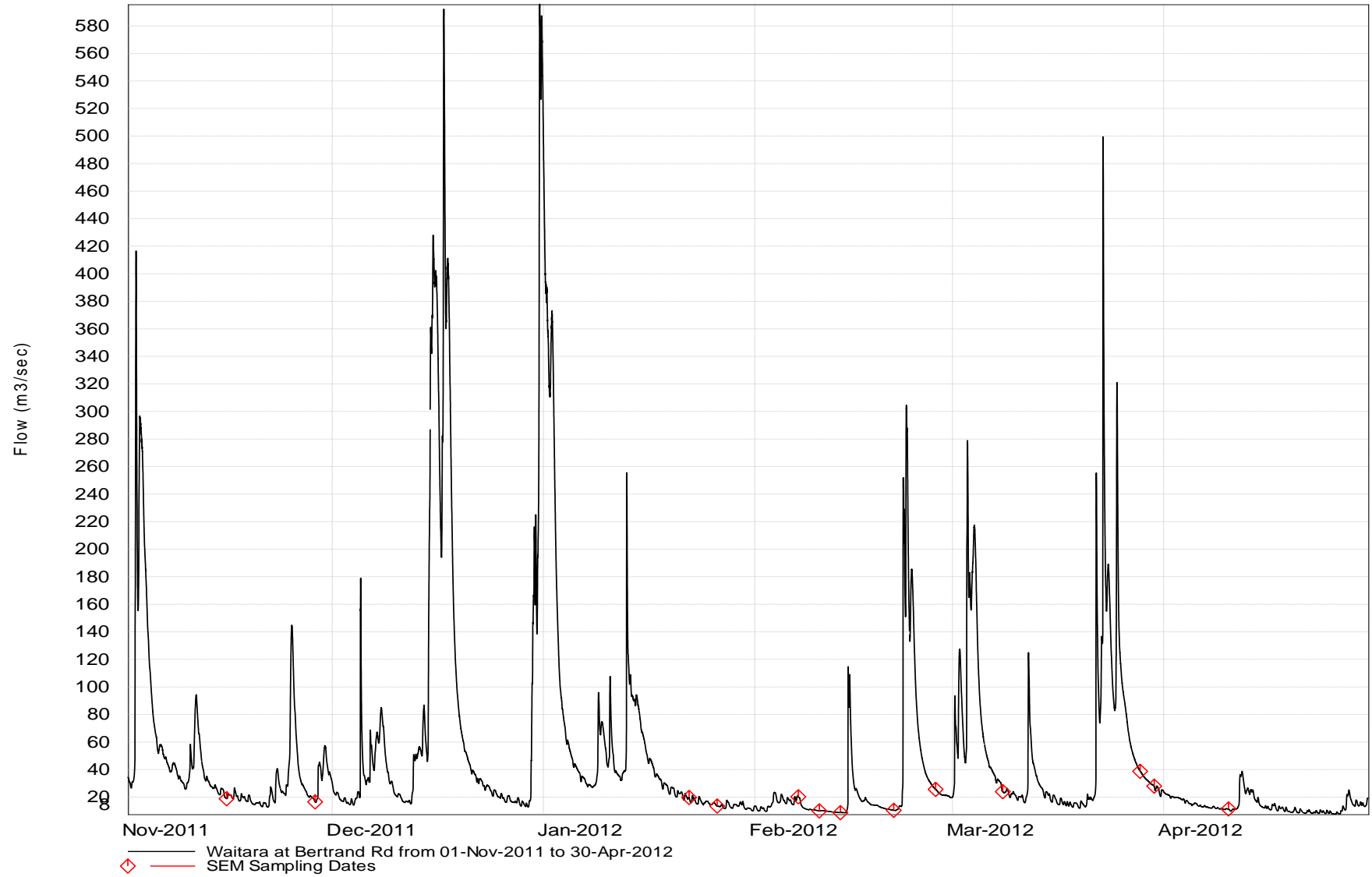


Figure 44 Flow in the Waitara River at Bertrand Road during the survey period

Bacteriological water quality was moderate and typical of the lower reaches of this large Taranaki eastern hill country and ring plain river draining a predominantly agricultural catchment despite some coastal seawater influence under high tide conditions (median 150 *E.coli* per 100mls and 51 enterococci per 100mls). 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 same recreational period and base flow conditions found a lower median *E.coli* bacterial number of 84 per 100mls and a narrower range of *E. coli* numbers (6 to 400 per 100mls).

3.2.13.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 62.

Table 62 Bacterial guidelines performance at the Waitara River at the town wharf, Waitara [% of 13 samples]

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

(Designation: freshwater contact recreational area)

Two single samples fell within the 'Alert' mode but none within the 'Action' mode during the monitoring period. The 'Alert' exceedances occurred about three days following river freshes (Figure 44), coincident with more turbid, brown river appearance indicative of the lag effects of rainfall run-off within this large catchment. The three-day post rainfall sampling protocols followed by the SEM programme for the other (ringplain) catchment sites are therefore not necessarily appropriate for baseline assessments of bacteriological water quality this site near the mouth of this large predominantly eastern hill country catchment river. These issues have been 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. Subsequent sampling indicated that *E.coli* numbers had fallen below the 'Alert' level. Sampling two days after the 'Alert' level incident in late March 2012 found that the *E.coli* number had returned to an acceptable level.

Generally, *E. coli* numbers were moderate (i.e. < 235 per 100mls) for the majority of the sampling period and no exceedances of the guidelines were recorded during lengthier recession flow, dry weather conditions (i.e. 6 days or more after a river fresh).

3.2.13.2 Comparison with previous summers' surveys

Two previous SEM sampling seasons have been monitored at this site. Therefore only a brief statistical comparison can be made with previous data. These data for the

Waitara River at the town wharf, Waitara site are summarised in Table 63 and illustrated in Figure 45 for this, the third season of monitoring.

Table 63 Summary *E. coli* bacteriological water quality data (nos/100ml) for summer surveys in the Waitara River at the town wharf, Waitara

Summer	09/10	10/11	11/12
Minimum	92	19	28
Maximum	1700	570	550
Median	230	76	150

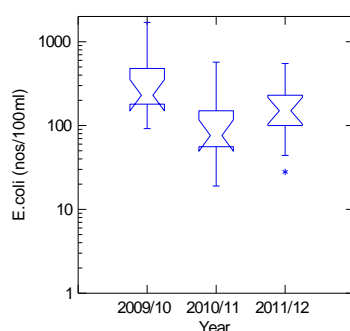


Figure 45 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers for the Waitara River at the town wharf, Waitara

A moderate median *E. coli* number was found by this third season's survey with a slightly narrower range of counts found during the season due to fewer delayed effects of preceding freshes in this large, predominantly hill country catchment. 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.

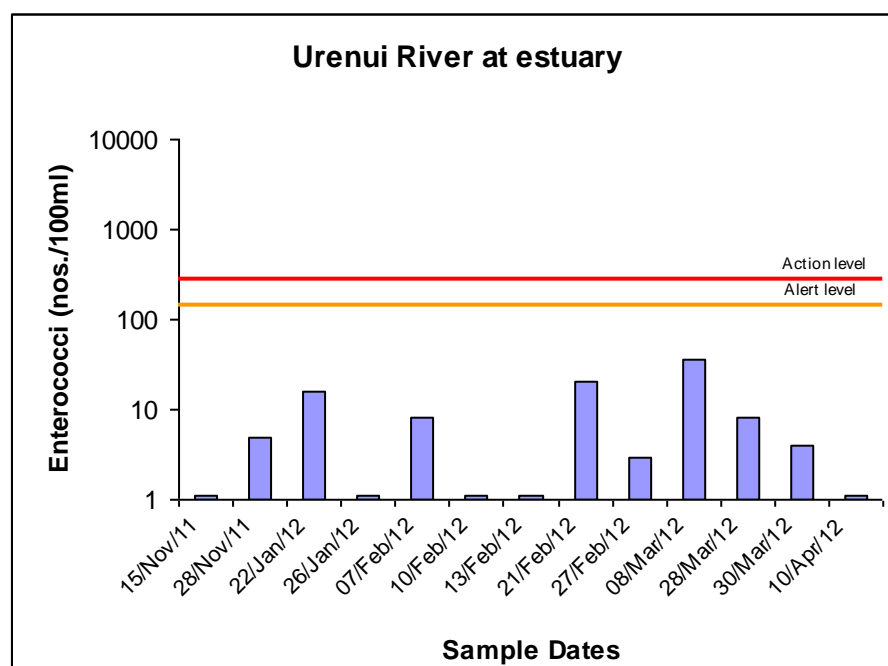
3.2.14 Urenui River at the estuary

Limited bathing usage of this site was noted (on only one of the sampling surveys) with some usage apparent for other activities (e.g boating, fishing, and picnicking) at this tidal site. This is a very popular site during weekends and holiday periods (see TRC, 1999 and TRC, 2008a).

Data from the site are presented in Table 64 and enterococci counts (as the site is predominantly seawater) are illustrated in Figure 46, with a statistical summary provided in Table 65.

Table 64 Analytical results for the Urenui River at the estuary

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	1035	4680	25	<1	25	16.8	9.2
28.11.11	1040	4560	36	5	44	15.5	22
22.01.12	0830	4630	12	16	12	19.5	21
26.01.12	1020	4680	<1	<1	<1	19.4	14
7.02.12	0830	4670	1	8	1	19.1	7.8
10.02.12	1135	4710	7	<1	7	20.1	15
13.02.12	1245	4660	3	<1	3	21.3	4.9
21.02.12	0840	4680	50	20	50	21.1	32
27.02.12	1135	4690	1	3	1	21.0	10
8.03.12	0835	4650	60	36	60	16.8	42
28.03.12	1300	4390	53	8	53	19.9	13
30.03.12	1315	4680	9	4	9	19.6	14
10.04.12	1130	4710	3	<1	3	19.3	22

**Figure 46** Enterococci numbers for the Urenui River at the estuary during the survey season**Table 65** Statistical results summary for the Urenui River at the estuary

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4390	4710	4680
<i>E. coli</i>	nos/100ml	13	<1	60	9
Enterococci	nos/100ml	13	<1	36	4
Faecal coliforms	nos/100ml	13	<1	60	9
Temperature	°C	13	15.5	21.3	19.5
Turbidity	NTU	13	4.9	42	14

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 marked aesthetic improvements within the estuary. Under high tide sampling conditions, the minimum (4.9 NTU) and median turbidity (14 NTU) levels were indicative of slightly to 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 greenish in appearance and relatively clear to slightly turbid. Conductivity levels were characteristic of coastal saltwater on all occasions. Relatively high water temperatures (median of 19.5°C), more typical of coastal seawater temperatures, varied over a relatively narrow range of 5.8°C during the sampling period with a maximum of 21.3°C recorded near midday in mid February 2012. All sampling however, was undertaken prior to 1320 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 (eg medians for *E. coli* [220 per 100 ml] and enterococci [150 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. No high enterococci counts were recorded during the monitoring period.

No problems with dairy sheds' waste disposal practices were found during the season's annual inspection round.

3.2.14.1 Compliance with guidelines

Compliance with the 2003 guidelines for contact usage is summarised in Table 66 using the marine guidelines, which are considered to be more appropriate for this estuarine site.

Table 66 Bacterial guidelines performance at the Urenui River estuary site [% of 13 samples]

Parameter	Number of exceedances of enterococci guidelines	
	ALERT Single sample 141-280/100ml	ACTION 2 consecutive single samples >280/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: coastal contact recreational area)

No single samples fell within the 'Alert' mode or within the 'Action' mode for saline water at any time during the monitoring period. Neither mode was exceeded in terms of the freshwater guidelines (for *E. coli*).

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 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: 4 per 100mls) monitored over six seasons to date.

3.2.14.2 Comparison with previous summers' surveys

A statistical comparison of each of the sixteen summers' survey data is presented graphically in Appendix V for all sites. These summer enterococci data for the Urenui River site at the estuary are summarised in Table 67 and illustrated in Figure 47.

Table 67 Summary of enterococci bacteriological water quality data (nos/100ml) for all summer surveys in the Urenui River estuary to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05-06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	<1	<1	<1	1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1
Maximum	40	69	82	220	160	27	19	72	640	30	9	36	120	190	150	36
Median	5	7	3	8	14	8	4	4	5	4	1	2	11	7	3	4

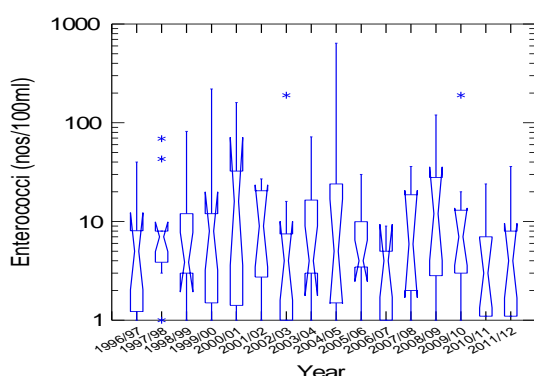


Figure 47 Box and whisker plots for all summer surveys of enterococci bacterial numbers in the Urenui River at the estuary

The high bacteriological water quality of the Urenui River estuary, during high tide conditions, continued during the 2011-2012 season (Figure 47). This was emphasised by all seasonal median enterococci counts being less than 15 enterococci (per 100 mls). The range was very narrow for enterococci during the 2011-2012 season as a result of no single sample counts in excess of 36 enterococci per 100 mls during the period.

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 (ie, higher tide) conditions.

Trend analysis of median enterococci and *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 (Figures 48 and 49) and testing the significance of any trend using the Mann-Kendall test at 5% level followed by Benjamini-Hockberg False Discovery Rate (FDR) analysis.

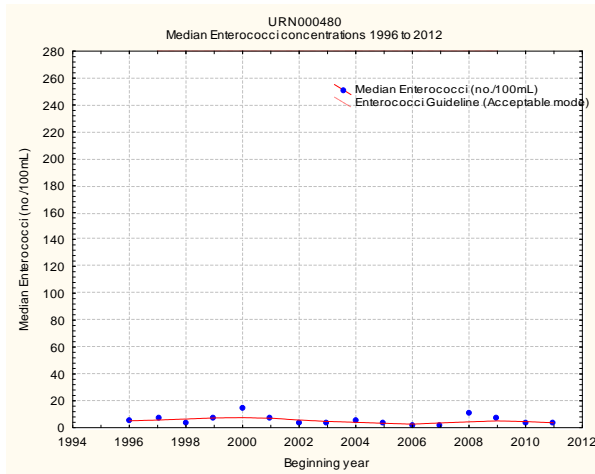


Figure 48 LOWESS trend plot of median enterococci (per 100ml) at the Urenui River, estuary site for the 1996 to 2012 period

N = 16
Kendall tau = - 0.209
p level = 0.259 [>FDR, p = 0.622]
N/S at p < 0.05

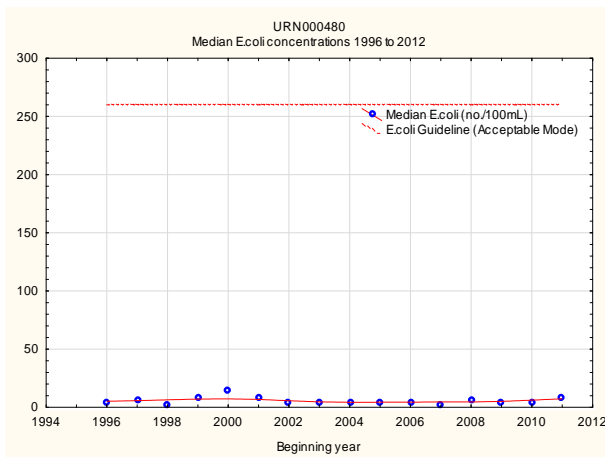


Figure 49 LOWESS trend plot of median *E. coli* (per 100ml) at the Urenui River, estuary site for the 1996 to 2012 period

N = 16
Kendall tau = - 0.090
p level = 0.629 [>FDR, p = 0.815]
N/S at p < 0.05

No statistically significant trend in median enterococci or *E. coli* counts has been found over the sixteen seasons of monitoring. None of these medians exceeded the 'Alert' or 'Action' modes for either marine or freshwater contact recreational usage.

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

No bathing nor 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.

Data from the site are presented in Table 68 and illustrated in Figure 50, with a statistical summary provided in Table 69. River flow records are illustrated in Figure 51.

Table 68 Analytical results for the Manganui River at Everett Park (downstream of the Kurapete Stream)

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	0845	9.6	400	95	400	14.0	1.0
28.11.11	0920	9.7	280	37	280	15.9	0.8
22.01.12	1115	9.7	140	43	140	16.8	1.6
26.01.12	1240	9.1	37	23	37	18.9	0.6
7.02.12	1105	9.4	92	42	92	17.3	0.9
10.02.12	0955	9.6	88	82	88	17.9	0.7
13.02.12	1110	9.4	34	25	34	18.6	0.7
21.02.12	1150	9.6	100	90	100	19.4	1.0
27.02.12	0950	9.4	260	140	260	15.1	1.0
8.03.12	1125	9.8	160	110	160	15.5	0.9
28.03.12	0920	9.7	290	82	290	14.1	1.1
30.03.12	1200	10.0	68	35	71	15.6	0.8
10.04.12	1000	10.1	120	48	130	13.3	0.7

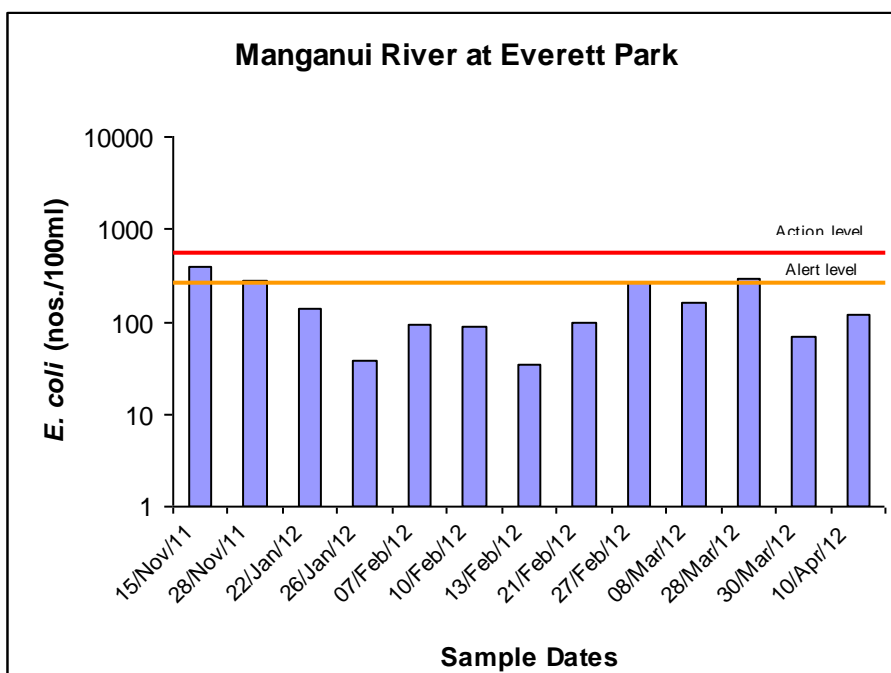


Figure 50 *E. coli* numbers for the Manganui River at Everett Park (downstream of the Kurapete Stream) during the survey season

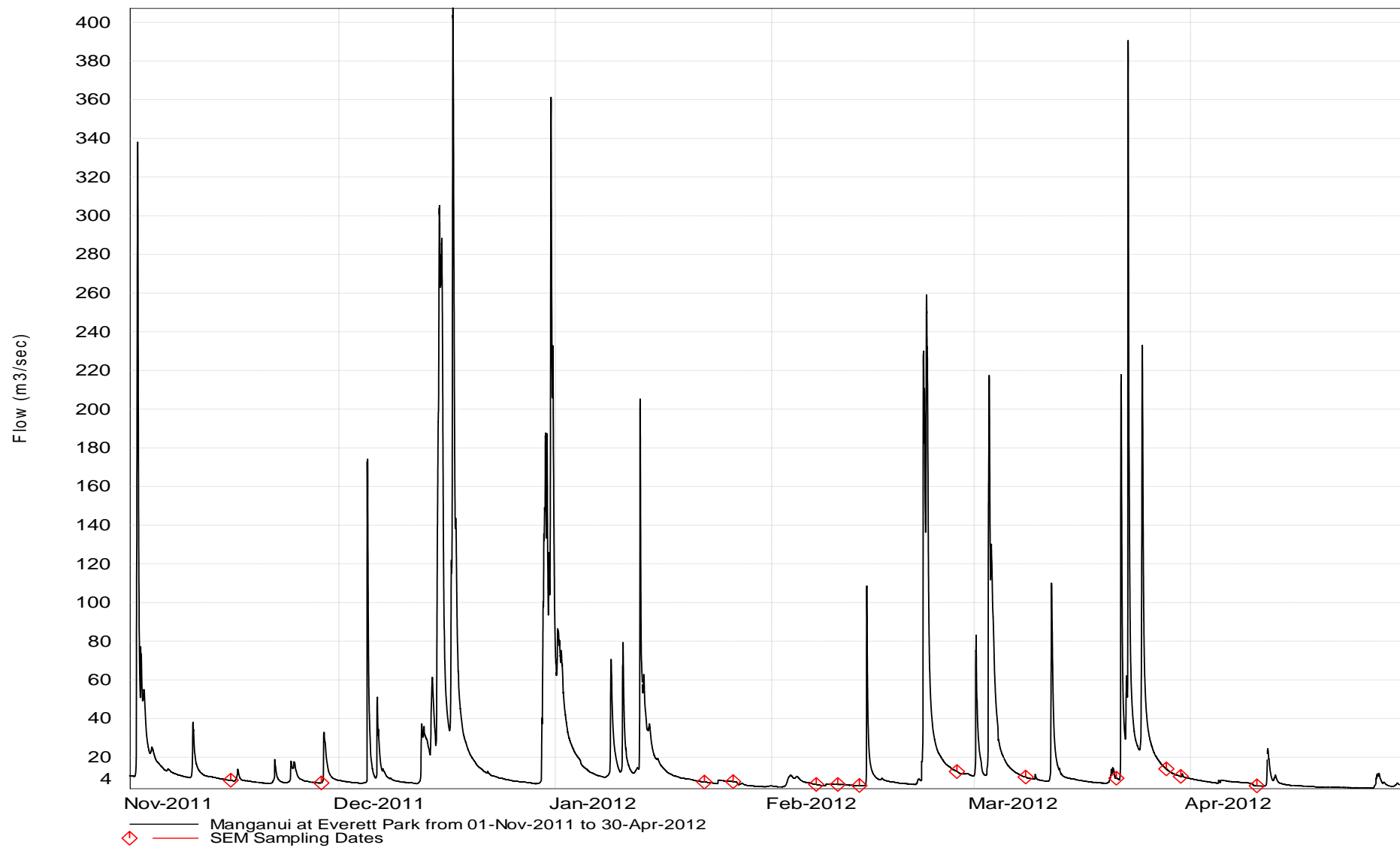


Figure 51 Flow in the Manganui River at Everett Park during the survey period

Table 69 Statistical results summary for the Manganui River at Everett Park (downstream of Kurapete Stream)

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	9.1	10.5	9.6
<i>E. coli</i>	nos/100ml	13	34	400	120
Enterococci	nos/100ml	13	23	140	48
Faecal coliforms	nos/100ml	13	34	400	130
Temperature	°C	13	13.3	19.4	15.9
Turbidity	NTU	13	0.6	1.6	0.9

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 (approximately 8 km upstream of the survey site) have been diverted out of the Kurapete Stream to the New Plymouth wastewater treatment plant.

The river was clear and green/brown at the time of the majority of the sampling surveys, with relatively low conductivity levels. Water temperatures varied over a relatively narrow range of 6.1°C with the maximum temperature (19.4°C) recorded near midday in mid-February 2012. Higher temperatures could be expected later in the day as no sampling surveys were performed after 1240 hrs.

Bacteriological water quality was moderate for this site during the 2011-2012 survey period with all but two of the counts recorded during the period in excess of 65 *E. coli* per 100 mls (Figure 50). The elevated counts in November 2011 and late March 2012 which entered the 'Alert' level, coincided with higher flow conditions for the former, and some localised rainfall for the latter (Figure 51). Levels decreased below the 'Alert' level within two days under low flow conditions following the March, 2012 exceedance.

On-site dairy wastes disposal methods were generally satisfactory in the catchment above the site.

3.2.15.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 70.

Table 70 Bacterial guidelines performance at the Manganui River at Everett Park (upstream of Kurapete Stream) [% of 13 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	3 [22]	0 [0]

(Designation: freshwater contact recreational area)

Three single samples fell in the 'Alert' mode but none reached the 'Action' mode during the season. Two of these elevated counts were coincident with relatively high flows during the very wet spring period.

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 (ie, significant abstraction of upper catchment water for hydroelectric power production purposes).

3.2.15.2 Comparison with previous summers' surveys

A statistical comparison of each of the fifteen summers' survey data is presented graphically in Appendix V for all sites. These summer data for the Manganui River site at Everett Park are summarised in Table 71 and illustrated in Figure 52.

Table 71 Summary of *E. coli* bacteriological water quality summary data (nos/100ml) for all summer surveys in the Manganui River at Everett Park to date

Summer	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	58	85	76	46	26	100	54	66	83	46	11	54	100	92	100	34
Maximum	690	2400	830	350	450	970	460	880	730	240	320	1200	480	370	320	400
Median	150	220	160	110	98	210	140	180	180	120	190	160	170	200	170	120

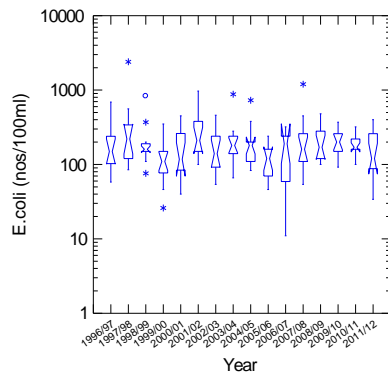
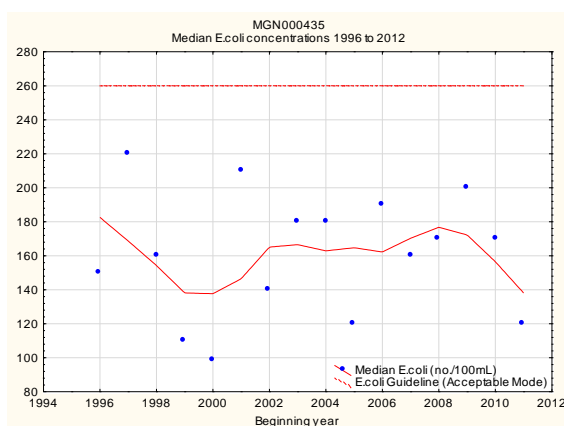


Figure 52 Box and whisker plots for all summer surveys of *E. coli* bacterial numbers in the Manganui River at Everett Park

The median *E. coli* count for the 2011-2012 season was within the range and was the second lowest of the sixteen seasons' medians recorded since the inception of the programme in 1996-97 (Figure 51). The range of *E. coli* numbers was narrower than the majority of those recorded to date mainly due to a moderate maximum count of 400 per 100 mls; the sixth lowest seasonal maximum recorded to date at this site.

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



N = 16
Kendall tau = + 0.034
p level = 0.855 [$>FDR$, $p = 0.932$]
N/S at $p < 0.05$

Figure 53 LOWESS trend plot of median *E. coli* numbers (per 100 ml) at the Manganui River, Everett Road site for the 1996 to 2012 period

A minimal and statistically insignificant increase in median *E. coli* counts has been found over the sixteen seasons of monitoring. None of these seasonal medians exceeded the 'Alert' or 'Action' modes.

3.2.16 Lake Ratapiko

No bathing usage of the lake was noted on any occasion. Jet skiing and picnicking were recorded on separate occasions. No boating, waterskiing, kayaking, or fishing activities were recorded at the time of any of the sampling surveys. However, the lake is commonly used for boating and fishing purposes, particularly at weekends and holidays. Ducks were present in moderate numbers on the lake as occasionally were shags and swan. Stock had access to the lake margins and were recorded on at least one occasion. The lake was drawn down for maintenance purposes toward the end of the season (in early April, 2012) when sampling was unable to be performed.

The data for this site are presented in Table 72 and illustrated in Figure 54 with a statistical summary provided in Table 73.

Table 72 Analytical results for Lake Ratapiko

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
15.11.11	0825	7.9	56	5	56	15.5	1.8
28.11.11	0855	7.9	150	1	150	18.5	1.7
22.01.12	1135	7.8	19	8	20	18.5	1.5
26.01.12	1310	7.8	1	3	1	19.8	1.4
7.02.12	1120	8.0	130	1	140	19.1	2.5
10.02.12	0920	8.5	41	1	41	20.2	1.2
13.02.12	1030	7.9	1	7	1	20.9	1.4
21.02.12	1220	8.2	7	7	7	22.3	1.2
27.02.12	0920	8.4	60	5	60	18.9	1.4
8.03.12	1150	8.4	140	7	140	16.2	1.0
28.03.12	0850	7.9	25	1	25	14.4	0.8
30.03.12	1140	8.4	28	3	32	16.4	1.6
10.04.12	-	-	-	-	-	-	-

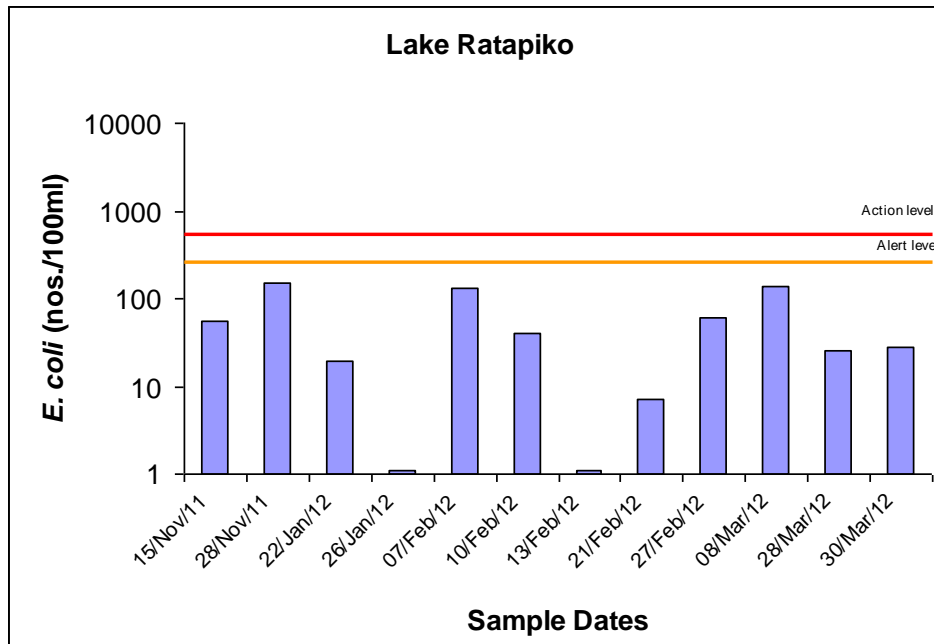


Figure 54 *E. coli* numbers for Lake Ratapiko during the survey season

Table 73 Statistical results summary for Lake Ratapiko

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	12	7.8	8.5	8.0
<i>E. coli</i>	nos/100ml	12	1	150	35
Enterococci	nos/100ml	12	1	8	4
Faecal coliforms	nos/100ml	12	1	150	37
Temperature	°C	12	14.4	22.3	18.7
Turbidity	NTU	12	0.8	2.5	1.4

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: 1.4 NTU; range of turbidity: 1.7 NTU) as a result of low suspended algae populations possibly due to short retention times. Water temperatures were moderate ranging over 7.9°C for the period with a moderately high maximum of 22.3°C (midday in mid February 2012) although all measurements were recorded prior to 1315 hrs. Conductivity showed minimal variation (less than 1 mS/m) during the period.

Generally bacteriological quality was very good considering that the inflow to the lake is from the mid reaches of a river draining a developed farmland catchment. No counts exceeded 150 *E. coli* per 100 mls despite the wet spring-early summer period. No sampling was possible at the very end of the season coincident with the HEP scheme lake lowering for maintenance purposes.

3.2.16.1 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 74.

Table 74 Bacterial guidelines performance at Lake Ratapiko [% of 12 samples]

Parameter	Number of exceedances of <i>E. coli</i> guidelines	
	ALERT Single sample 261-550/100ml	ACTION Single sample >550/100 ml
<i>E. coli</i>	0 [0]	0 [0]

(Designation: Freshwater contact recreational area)

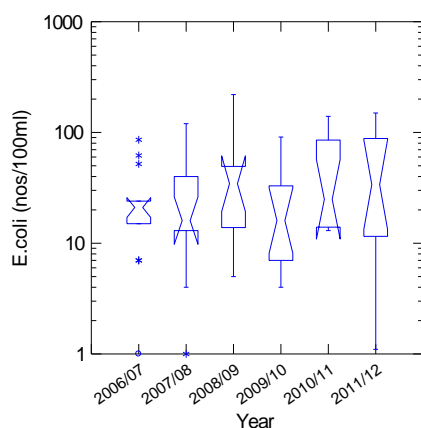
No single sample exceedances of the 'Action' mode occurred and no samples were recorded within the 'Alert' mode during the entire period.

3.2.16.2 Comparison with previous summers' surveys

A statistical comparison of all sites' summers' *E. coli* survey data is presented graphically in Appendix V for all sites. Data from the six summer surveys for the Lake Ratapiko site are summarised in Table 75 and illustrated in Figure 55.

Table 75 Summary of *E. coli* bacteriological water quality data (nos/100ml) for all summer surveys at Lake Ratapiko to date

Summer	06/07	07/08	08/09	09/10	10/11	11/12
Minimum	1	1	5	4	13	1
Maximum	86	120	220	91	140	150
Median	21	16	35	16	25	35

**Figure 55** Box and whisker plots for all summer SEM surveys of *E. coli* bacteria numbers at Lake Ratapiko

A low median *E. coli* number was found by the latest season's survey and a relatively narrow range of counts was recorded. All seasonal medians have been low, however. Trend analysis of median *E. coli* numbers will not be performed for this site until ten seasons' data are available.

3.2.16.3 Cyanobacteria

There was no visual evidence of any nuisance algal blooms during the survey period. Microscopic scans of samples collected on six sampling occasions were performed, with the results of these analyses presented in Table 76.

Table 76 Cyanobacteria counts (cells /ml) for Lake Ratapiko [Health warning: >15,000 cells /ml]

Date	Cyanobacteria total cell count (cells/ml)
21.11.11	nil
6.12.11	nil
20.12.11	nil
5.1.12	nil
18.1.12	nil
16.2.12	nil

No cyanobacteria were detected in any of the samples. None had been found in this lake during the 2006-2007, 2008-2009, 2009-2010, or 2010-2011 seasons, but low numbers of *Anabaena* had been present in the latter part of the 2007-2008 season following a lengthy, extremely low flow period. The relatively short lake water residence time (due to hydroelectric power generation usage) may be a factor in the control of these bacteria populations.

3.2.17 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. 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 2011-2012 season, with the lake visited on nine occasions between mid November 2011 and late March 2012. [Note: bacteriological monitoring is not a component of the SEM programme at this lake].

Usage of the lake included walkers (visitors) and picnicking throughout the season. Jet-skiing was recorded at the time of one of the sampling visits despite the boat ramp remaining unlocked throughout the period from mid December 2011 to the end of March 2012. A few ducks and swans were noted from time to time on the lake which appeared relatively clear to slightly turbid, brownish throughout most of the period.

The bacteriological water quality data for this site are presented in Table 77 with a statistical summary provided in Table 78.

Table 77 Analytical results for Lake Rotokare

Date	Time	Conductivity @ 20°C	Bacteria			Temperature	Turbidity
	(NZST)	(mS/m)	<i>E. coli</i> (nos/100ml)	Enterococci (nos/100ml)	Faecal coliforms (nos/100ml)	(°C)	(NTU)
21.11.11	0900	11.8	37	16	37	2.4	17.5
12.12.11	0820	*	1	5	1	8.8	20.9
05.01.12	1010	10.6	7	9	7	3.4	20.2
18.01.12	1135	10.9	3	<1	3	4.6	20.9
01.02.12	0820	10.8	7	<1	7	4.1	20.4
16.02.12	0920	10.9	28	32	41	3.6	20.6
28.02.12	1010	10.9	3	4	3	1.4	19.4
15.03.12	1020	11.3	220	3	220	0.8	18.4
30.03.12	1120	11.2	130	8	130	1.7	17.6

Table 78 Statistical results summary for Lake Rotokare

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	8	10.6	1.8	11.1
<i>E. coli</i>	nos/100ml	9	1	220	7
Enterococci	nos/100ml	9	<1	32	5
Faecal coliforms	nos/100ml	9	1	220	7
Temperature	°C	9	17.5	20.9	20.2
Turbidity	NTU	9	0.8	8.8	3.4

In general, bacteriological water quality was very good, as might be expected for a small, bush clad lake with only small inflows and relatively low wild fowl numbers. Conductivity levels were very stable (range: 1.2 mS/m) through the period despite variations in inflow during the season particularly during spring-early summer. Water temperatures varied over a relatively narrow range of 3.4°C with a maximum of 20.9°C recorded in mid January 2012. Turbidity was moderate (median: 3.4 NTU) with the range (8.0 NTU) reflecting the variability in abundances of suspended algae in the water column during the season. Maximum turbidity (8.8 NTU) was coincidental with an early peak in cyanobacteria concentration in mid December 2011.

No bacterial counts entered the 'Alert' or 'Action' levels on any occasion during the season although it should be noted that in past seasons the overriding health warnings on both the Regional Council and Area Health Board's websites 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 was noted coincidentally, that as cyanobacteria numbers decreased later in the season, *E.coli* bacterial numbers increased.

3.2.17.1 Cyanobacteria

Microscopic scans of nine samples during the recreational monitoring period found a moderate cyanobacteria population in November 2011 but elevated concentrations present almost throughout the period from mid December 2011 to mid February 2012. However, these elevated concentrations were far lower than maximum numbers found during the 2009-2010 period (by up to 177,000 cells per 100 mls) and during the 2010-2011 period (by up to 20,000 cells per 100 mls). The results of these analyses are presented in Table 79 and illustrated in Figure 56.

Table 79 Cyanobacteria counts (cells/ml) for Lake Rotokare
[Health warning: > 15,000 cells /ml]

Date	Cyanobacteria total cell count (cells/ml)	Principal species
21.11.11	3,200	<i>Anabaena</i>
12.12.11	8,750	<i>Anabaena</i>
05.01.12	3,100	<i>Anabaena</i>
18.01.12	8,300	<i>Anabaena</i>
01.02.12	13,600	<i>Anabaena</i>
16.02.12	9,600	<i>Anabaena</i>
28.02.12	1,200	<i>Anabaena</i>
15.03.12	200	<i>Anabaena</i>
30.03.12	nil	-

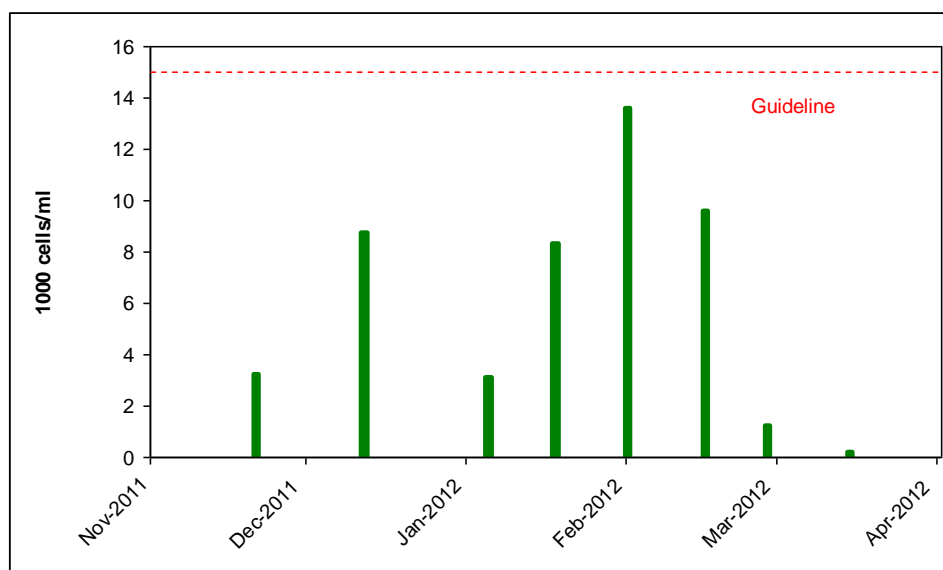


Figure 56 Cyanobacteria counts (cells/ml) at Lake Rotokare [Health warning: >15,000 cells/ml]

Moderate counts of *Anabaena* found initially in the lake in November 2011 did not necessitate installation of a blue-green algal hazard warning sign by the STDC upon advice from the Taranaki Area Health Board. Increasing counts did not exceed the health guideline [15,000 cells/ml] by early February 2012 and therefore there was no requirement for STDC to erect signage at the lake and road access, and the boatramp remained open. *Anabaena* concentrations remained moderately high through summer peaking at about 13,600 cells/ ml in early February 2012 before decreasing rapidly through late February 2012 to very low numbers by the middle to end of March 2012. There was no occurrence of the *Microcystis* bloom which had been found toward the end of the 2007-2008 season, with no instance of *Microcystis* found at all over the 2011-2012 period.

The warning signage displayed adjacent to the boatramp in past seasons was not required and although minimal primary contact recreational usage of the lake was recorded at the time of sampling surveys, recreational use of the lake was possible as the boat ramp remained unlocked.

4. General data summary

A comparative summary of results of the sixteenth summer bacteriological quality freshwater survey involving sixteen contact recreational sites in the Taranaki region is provided in Table 80. Results are also illustrated in Figure 57 for each of the bacteriological species and a comparison of all sites' summer data is presented in Appendix V in the form of statistical 'box and whisker' plots.

Table 80 Statistical summary of results for the sites sampled in the SEM freshwater contact recreational water quality survey, 2011-2012

Site		Temperature (°C)	Conductivity @ 20°C (mS/m)	Faecal coliforms (nos/100 ml)	E. coli (nos/100 ml)	Enterococci (nos/100 ml)	Turbidity (NTU)
Lake Rotomanu	Median	21.6	14.5	120	120	120	7.3
	Minimum	17.7	13.5	6	46	17	4.1
	Maximum	24.2	15.8	2300	2300	1700	12
	No. of samples	13	13	13	13	13	13
Waiwhakaiho River at Merrilands Domain	Median	17.2	11.4	40	40	31	0.5
	Minimum	14.6	9.8	8	8	1	0.3
	Maximum	20.0	13.0	140	120	150	1.5
	No. of samples	13	13	13	13	13	13
Waiwhakaiho River adjacent to L. Rotomanu	Median	17.4	11.8	490	460	340	0.7
	Minimum	15.3	9.9	77	77	85	0.5
	Maximum	22.3	13.9	2400	2000	1400	2.8
	No. of samples	13	13	13	13	13	13
Te Henui Stream at mouth, East End	Median	16.2	165	1100	1100	700	0.8
	Minimum	15.0	10.1	360	350	200	0.5
	Maximum	19.5	1210	14,000	13,000	19,000	1.9
	No. of samples	13	13	13	13	13	13
Patea River at King Edward Park, Stratford	Median	14.3	9.1	160	150	88	0.7
	Minimum	11.0	8.5	66	63	34	0.5
	Maximum	16.9	9.6	440	440	120	2.2
	No. of samples	13	13	13	13	13	13
Patea River at boatramp, Patea	Median	19.1	4620	16	16	8	12
	Minimum	16.4	166	1	1	<1	7.0
	Maximum	19.7	4700	260	260	160	91
	No. of samples	13	13	13	13	13	13
Waingongoro River at Eltham camp	Median	14.5	12.1	150	150	60	1.7
	Minimum	12.2	10.7	74	68	33	1.2
	Maximum	17.3	12.4	330	330	110	2.6
	No. of samples	13	13	13	13	13	13
Waingongoro River at Ohawe Beach	Median	17.0	17.4	100	96	140	2.7
	Minimum	15.5	14.8	46	43	9	2.3
	Maximum	19.0	22.1	2800	2800	1200	5.9
	No. of samples	13	13	13	13	13	13
Kaupokonui River at beach domain	Median	18.0	16.9	120	120	150	1.6
	Minimum	15.4	14.1	17	17	15	1.0
	Maximum	20.5	38.9	290	290	850	4.0
	No. of samples	13	13	13	13	13	13
Lake Opunake adjacent to boat ramp	Median	17.6	13.7	80	80	480	1.0
	Minimum	14.6	12.8	43	40	14	0.8
	Maximum	20.9	14.4	2000	2000	1800	6.9
	No. of samples	13	13	13	13	13	13
Timaru Stream at Weld Road (near mouth)	Median	16.8	64.8	160	160	180	0.6
	Minimum	14.5	8.5	34	34	12	0.3
	Maximum	21.3	1120	450	440	480	2.0
	No. of samples	13	13	13	13	13	13
Oakura River d/s of SH45 bridge	Median	16.9	8.7	140	140	140	0.7
	Minimum	14.9	6.9	11	11	13	0.4
	Maximum	21.5	151	440	440	410	1.0
	No. of samples	13	13	13	13	13	13
Waitara River at town wharf, Waitara	Median	18.8	670	160	150	51	2.9
	Minimum	15.9	140	31	28	5	1.4
	Maximum	22.5	1310	550	550	120	25
	No. of samples	13	13	13	13	13	13
Urenui River at estuary	Median	19.5	4680	9	9	4	14
	Minimum	15.5	4390	<1	<1	<1	4.9
	Maximum	21.3	4710	60	60	36	42
	No. of samples	13	13	13	13	13	13
Manganui River d/s of Kurapete S. (Everett Park)	Median	15.9	9.6	130	120	48	0.9
	Minimum	13.3	9.1	34	34	23	0.6
	Maximum	19.4	10.1	400	400	140	1.6
	No. of samples	13	13	13	13	13	13
Lake Rataipiko at boat ramp	Median	18.7	8.0	37	35	4	1.4
	Minimum	14.4	7.8	1	1	1	0.8
	Maximum	22.3	8.5	150	150	8	2.5
	No. of samples	12	12	12	12	12	12

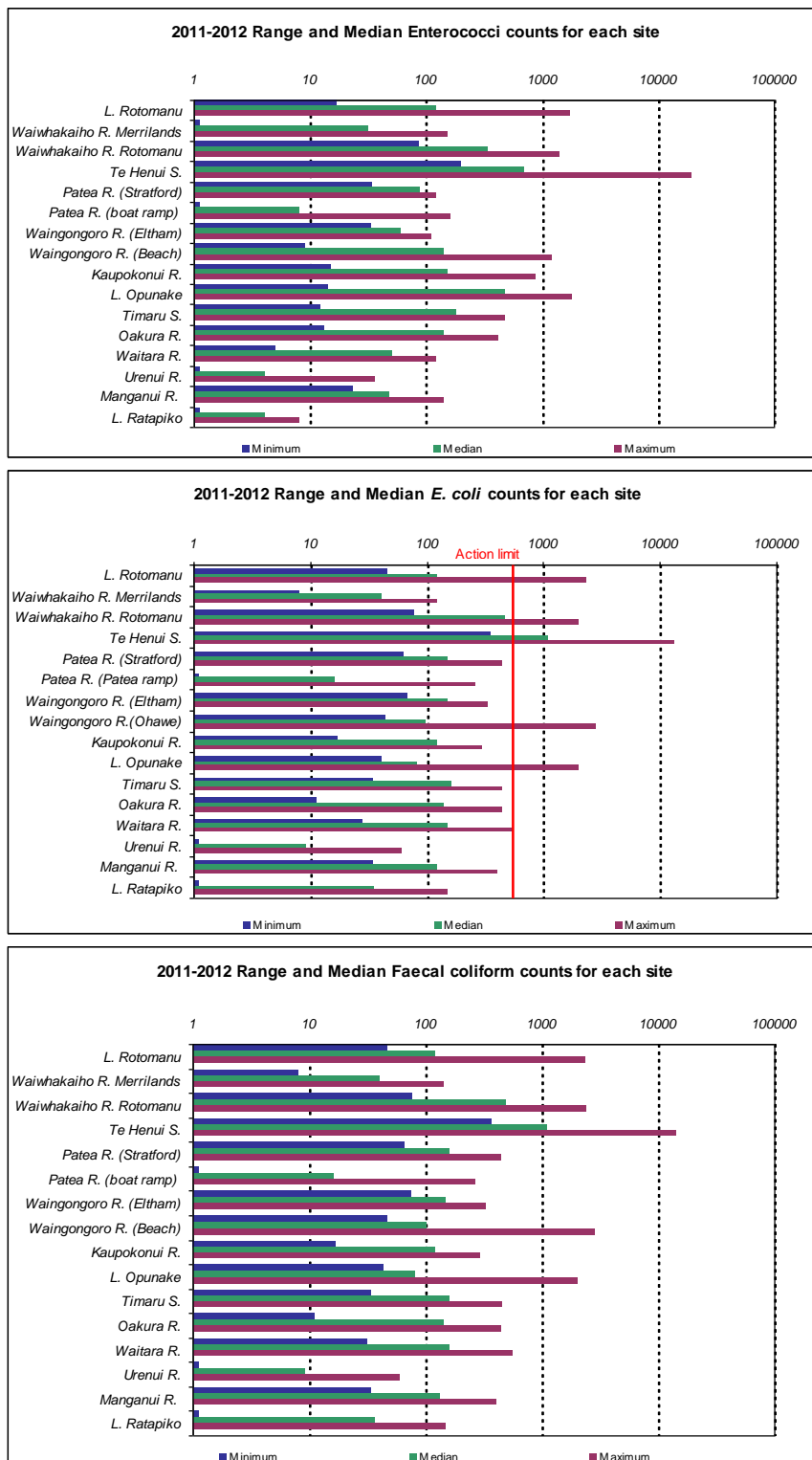


Figure 57 Ranges and medians of bacteria numbers recorded from all sites by the SEM programme over the 2011-2012 survey season

Compliance with the 2003 guidelines has varied at the sixteen freshwater contact recreational sites sampled during the survey period (Figure 57 and Table 81) but not to the same degree as recorded in many of the previous seasons. In relation to the guidelines, only one site (Te Henui at East End beach) regularly failed to meet the *E. coli* 'Action' guideline suitable for contact recreation. In terms of median *E. coli*

counts, this was also the only site with the median count in the 'Action' (>550 *E. coli* per 100mls) mode, whereas only one other site had a median count in the 'Alert' mode (Waiwhakaiho River adjacent to Lake Rotomanu).

Table 81 Number of occasions single sample *E.coli* counts entered the 'Alert' and 'Action' modes and percentage [%] of samples which fell below these modes (ie complied with guidelines). [Note: the latter is consistent with MfE reporting of national compliance with recreational guidelines (www.mfe.govt.nz/environmental-reporting)].

Site	'Alert' mode	'Action' mode
Lake Rotomanu at western beach	0 [62]	5 [62]
Waiwhakaiho River at Merrilands Domain	0 [100]	0 [100]
Waiwhakaiho River adjacent to L Rotomanu	5 [31]	5 [62]
Te Henui Stream at mouth, East End	4 [0]	9 [31]
Patea River at King Edward Park, Stratford	4 [69]	0 [100]
Patea River at boatramp, Patea	0 [100]	0 [100]
Waingongoro River at Eltham Camp	1 [92]	0 [100]
Waingongoro River at Ohawe Beach	0 [92]	1 [92]
Kaupokonui River at beach domain	1 [92]	0 [100]
Lake Opunake at boat ramp	0 [85]	2 [85]
Timaru Stream at Weld Road	3 [77]	0 [100]
Oakura River at SH45	2 [85]	0 [100]
Waitara River at town wharf, Waitara	2 [85]	0 [100]
Urenui River at estuary*	0 [100]	0 [100]
Manganui River at Everett Park	3 [77]	0 [100]
Lake Rataipiko at boat ramp	0 [100]	0 [100]

[Notes: N = 13 samples; * = enterococci count]

Four sites maintained counts below the 'Alert' mode at all times throughout the season (compared with five sites over the 2010-2011 season), while an additional seven other sites maintained counts below the 'Action' mode (Table 81) at all times. In terms of the overall monitoring season, twenty-five 'Alert' levels (12% of counts) and twenty-two 'Action' levels resulted over the period representing an overall 78% compliance with contact recreational guidelines (compared with 68% and 76% in the 2009-2010 and 2010-2011 seasons respectively).

Overall, a range from average to good bacteriological water quality was measured at the sixteen sites. In terms of results to date, this represented some improvement despite a very wet spring-early summer which resulted in a more concentrated sampling effort in the first three months of 2012. 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, Lake Rataipiko, and at the most estuarine site (Urenui River) which was strongly influenced by seawater penetration during high tide conditions. 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 Urenui River at estuary
- 2 Patea River at boatramp, Patea
- 3 Lake Ratapiko
- 4 Waiwhakaiho River at Merrilands Domain
- 5 Lake Opunake at boat ramp
- 6 Waingongoro River at Ohawe Beach
- 7= Lake Rotomanu
- 7= Manganui River at Everett park (d/s of Kurapete Stream)
- 7= Kaupokonui River at beach domain
- 10 Oakura River d/s of SH 45 bridge
- 11= Waingongoro River at Eltham camp
- 11= Patea River at King Edward Park, Stratford
- 11= Waitara River at town wharf, Waitara
- 14 Timaru Stream at Weld Road (near mouth)
- 15 Waiwhakaiho River adjacent to Lake Rotomanu
- 16 Te Henui Stream at mouth, East End

The biggest improvement in ranking, in comparison with the 2010-2011 season, occurred at the Manganui River, Waingongoro River at Ohawe Beach, and Lake Opunake sites while the two lowest rankings were the two sites introduced into the programme for the 2011-2012 season. The Waitara River at the town wharf slipped furthest down in the rankings (where it was ranked eleventh equal) in terms of seasonal median bacteriological water quality, and there was almost a doubling of the median *E.coli* count between seasons (an increase of 74 *E.coli*/100 mls). More site's median counts increased than decreased reflecting some overall deterioration in bacteriological water quality across the region's sites in 2011 – 2012, although this must be counter-balanced by the fact there was a higher proportion of samples complying with the national guideline, despite two new sites with poor quality being included in the programme for the first time.

4.1 Comparison with fifteen previous summers' surveys

A statistical comparison of each summer's survey *E. coli* data is presented graphically in Appendix V 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 current season.

In general terms, *E. coli* bacteriological water quality was within ranges generally slightly narrower than those recorded over most previous summer bathing seasons due to an absence of very high counts in most cases. There was marked deterioration at three sites and improvement at one site in terms of median counts, in comparison with the previous summer's results. Variability in quality between bathing seasons at each site has related to a variety of reasons including hydrological conditions, stock access, wildlife presence, and dairy farm wastes disposal practices in particular.

All season's results have been summarised in terms of compliance 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 82.

Table 82 Seasonal summaries of single sample *E.coli* counts in 'Surveillance'/'Alert'/'Action' modes for the period 1996 to date (13 samples per season)
[Note:*not included in programme for that 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	Average per season																	
Lake Rotomanu at western beach	0	1	0	1	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	10.5	1	1.5			
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	0	0	0	0	0	1	0	0	0	0	0	0	12.5	<0.5	<0.5	
Waiwhakaiho River adjacent to L. Rotomanu	0	1	*		3	0	*		2	1	*		3	0	*		2	5	*		1	6	*		7	5	*		1	9	5	5	7	2.5	3.5	
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	0.5	3	9.5			
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	8	3.5	1.5	
Patea River at boatramp, Patea	*		*		*		*		*		*		*		*		*		*		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	10.5	2	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	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	11	1	1	
Lake Opunake at boat ramp	*		*		*		*		*		*		*		*		*		*		1	3	2	1	2	2	5	0	0	3	0	2	9.5	1.5	2	
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	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	*	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	11	1.5	0.5	
Waitara River at town wharf, Waitara	*		*		*		*		*		*		*		*		*		*		*		*		*		2	3	1	1	2	0	10	1.5	1.5	
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	13	0	0	
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	10.5	2	0.5	
Lake Rataipiko at boat ramp	*		*		*		*		*		*		*		*		*		*		0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0
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	-			
% overall non-exceedance of 2003 guidelines	82		63		80		82		80		71		67		74		61		71		71		70		67		68		77		78		72			

Allowing for some changes in the numbers of sites included in each season's programme, compliance with the guidelines has occurred on 72% of sampling occasions over the combined sixteen seasons to date with the worst season (2004-2005) showing 61% compliance and best seasons (1996-1997 and 1999-2000), 82% compliance with the guidelines. The two latest seasons have shown above historical average compliance.

A ranking of sites based upon the historical average guidelines compliance (for the period 1996 to date can be summarised as follows:

- 1= Urenui River at estuary
- 1= Patea River at boatramp, Patea
- 1= Lake Ratapiko
- 4 Waiwhakaiho River at Merrilands Domain
- 5= Waingongoro River at Ohawe Beach
- 5= Kaupokonui River at beach domain
- 5= Oakura River at SH45
- 8= Lake Rotomanu
- 8= Waingongoro River at Eltham Camp
- 8= Manganui River at Everett Park
- 11 Waitara River at town wharf, Waitara
- 12 Lake Opunake
- 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
- 16= Waimoku Stream at Oakura Beach.

The two estuarine sites (in the Patea and Urenui Rivers) have never reached the 'Alert' *E.coli* level of the guidelines over the 16 seasons to date. All sites ranked above twelfth have achieved compliance with guidelines on an average of at least 75% of seasonal sampling occasions. The poorest compliance (less than 5% of seasonal sampling occasions) has been recorded at the Te Henui and Waimoku Streams' mouths where resident wildfowl population have been the principal contributors to elevated *E.coli* counts.

Temporal trending of season's median *E.coli* counts at each site, with a minimum of ten years' data, was undertaken statistically for the period 1996 to 2012. Only two sites showed statistically significant ($p < 0.05$) trends in median *E.coli* counts.

- Oakura River below the SH45 bridge had a strong trend of increasing median *E.coli* numbers over the sixteen year period to date which however, was not significant at $p < 0.01$ after FDR application.
- Waingongoro River at Ohawe beach had a strong trend of decreasing median *E.coli* numbers over the sixteen year period to date which was significant at $p < 0.01$ but not after FDR application.

The Oakura River and Waingongoro River site's seasonal median *E.coli* counts did not approach contact recreational 'Alert' (or 'Action') guidelines. A ranking of the order of the significance of the temporal trends at those sites with a minimum of ten seasons' data (eleven sites) is provided in Table 83.

Table 83 Ranking of sites in terms of significant temporal trends in median *E.coli* counts over the period 1996 to 2012 [significant at $p < 0.05$ and $p < 0.01$]

Site	Location	Valid N	p-level	FDR-corrected p value	Trend
Oakura River	d/s SH45 bridge	15	0.004	0.041	↑↑
Waingongoro River	Ohawe Beach	16	0.007	0.041	↓↓
Te Henui Stream	mouth, East End	10	0.052	0.206	↑
Lake Rotomanu	Western beach	16	0.078	0.234	↑
Patea River	King Edward Park	11	0.383	0.713	↓
Kaupokonui River	Beach Domain	16	0.464	0.713	↓
Waingongoro River	Eltham Camp	11	0.475	0.713	↓
Urenui River	Urenui estuary	16	0.629	0.815	↓
Timaru Stream	End of Weld Road	15	0.679	0.815	↓
Manganui River	Everett Park	16	0.855	0.932	↑
Waiwhakaiho River	Merrilands Domain	16	0.964	0.964	↑

In summary, one site has shown a significant increasing temporal trend and one site a significant decreasing temporal trend in seasonal median *E. coli* counts. The other less significant trends indicate gradual improvement (five sites) or deterioration (four sites) in seasonal median *E. coli* counts. With the exception of two seasonal median counts at the Timaru Stream site and one at the Kaupokonui River site (which all entered the 'Alert' mode), none of the other seasonal median counts at the sites with insignificant temporal trends have reached 'Alert' or 'Action' modes at any time.

4.2 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. 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 Regional Council's website. All sites' results were displayed on this website throughout the 2011-2012 survey period and all instances of exceedance of standards were advised to the appropriate authorities. Few follow-up investigations were necessary over the 2011-2012 season and there were few issues with dairy wastes disposal systems contributing to elevated counts in receiving waters. In most cases, mainly at lakes and in the lower reaches of two city streams, wildfowl contamination was responsible for elevation in counts, particularly where public feeding encouraged numbers of birds at recreational sites. Very few isolated instances were related to localised rainfall. On a very few 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 have 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 (20 samples per season) will continue at the two principal freshwater contact recreation usage sites. Cyanobacteria monitoring will also continue at designated sites (at a slightly lesser frequency to the bacteriological monitoring).

Generally, cyanobacteria were not found at the five designated monitoring sites with the exception of Lake Rotokare where numbers were lower than found in the previous four seasons, and for the first time numbers did not exceed public health warning levels between December, 2011 and late March 2012.

5. Recommendations

As a result of the 2011-2012 summer freshwater contact recreation bacteriological survey it is recommended:

1. THAT the 2012-2013 survey be performed at sixteen regular sites (Waimoku S. excluded) continuing with the existing sampling protocols during the season extending from 1 November to 31 March and (into April, if necessary).
2. THAT the 2012-2013 survey includes an additional seven samples collected at the two principal usage sites (Lake Rotomanu and Waiwhakaiho River at the Merrilands Domain) in accordance with MfE, 2003 guidelines.
3. THAT the 2012-2013 summer survey includes cyanobacteria monitoring at the three lake sites, the principal river usage site (Waiwhakaiho River at Merrilands Domain), and an additional lake (Rotokare) site.
4. THAT follow-up sampling be performed as 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.
8. THAT appropriately worded generic signage be displayed on a permanent basis at sites in the lower reaches of the Waiwhakaiho River, Te Henui Stream, Waitara River, and Waimoku Stream warning of frequent exceedances of the recreational guidelines for reasons appropriate to individual sites.

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Appendix I

MAC assessments for all sites

Lake Rotomanu

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Input data

Site Name
Name of site from the MAC file: LRM000002

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedences (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			250 to 550	>550	
2010	13	34.0	0	0	100 %
2009	13	100.1	1	3	76 %
2008	13	220.1	3	3	76 %
2007	13	100.1	4	1	92 %
2006	13	72.0	2	1	92 %
Total	65	120.1	10	8	87 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Results
MAC category: D 95th (100 mL) 3150.0
Interim Result? Interim Data Set (1: 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (1: 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 10. The incidence and density of bedlie

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Assessment of the MAC and/or SIC is required to permit "Recreational Followup" to assign a recreational grade

Recreational Followup

SFRG Assessment Results
Site name: LRM000002
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

OK

Waiwhakaiho River at Merrilands Domain

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Input data

Site Name
Name of site from the MAC file: Waiwhakaiho Merrilands

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedences (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			250 to 550	>550	
2010	13	54.0	0	0	100 %
2009	13	110.1	0	1	92 %
2008	13	46.0	0	0	100 %
2007	13	48.0	0	0	100 %
2006	13	43.0	1	0	100 %
Total	65	54.0	1	1	98 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Results
MAC category: B 95th (100 mL) 207.5
Interim Result? Interim Data Set (1: 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment? Interim Data Set (1: 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Assessment of the MAC and/or SIC is required to permit "Recreational Followup" to assign a recreational grade

Recreational Followup

SFRG Assessment Results
Site name: Waiwhakaiho Merrilands
SFRG Assessment: Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

OK

Patea River at Stratford

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Patea at Stratford

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			250 to 550	>550	
2010	13	160.1	0	1	92 %
2009	13	250.1	4	2	84 %
2008	13	200.1	2	1	92 %
2007	13	290.1	3	4	69 %
2006	13	200.1	3	1	92 %
Total	65	200.1	12	9	86 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: D 95thile (/100 mL) 767.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Assessment of the MAC and SIC is required prior to calculating SFRG to assign a compliance grade.

SFRG Assessment Results
Site name: Patea at Stratford
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

Patea River at boat ramp, Patea

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: PAT000095

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 550/year)
			250 to 550	>550	
2010	13	4.0	0	0	100 %
2009	13	11.0	0	0	100 %
2008	13	9.0	0	0	100 %
2007	13	5.0	0	0	100 %
2006	10	8.0	0	0	100 %
Total	62	8.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: A 95thile (/100 mL) 79.8
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Assessment of the MAC and SIC is required prior to calculating SFRG to assign a compliance grade.

SFRG Assessment Results
Site name: PAT000095
SFRG Assessment: Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

Waingongoro River at Eltham camp

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: WGG000452

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL) 250 to 500	Days in Compliance (Days < 500 / year)
2010	13	140	1	0
2009	13	160	1	0
2008	13	130	1	0
2007	13	160	3	0
2006	13	110	1	0
Total	65	130	7	0

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C 95th (100 mL) 350.0
Interim Result? Interim Data Set (1: 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Interim Data Set (1: 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

SFRG Assessment Results
Site name: WGG000452
SFRG Assessment: Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Waingongoro River at Ohawe beach

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: WGG000895

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL) 250 to 500	Days in Compliance (Days < 500 / year)
2010	13	100	0	0
2009	13	96.0	0	1
2008	13	120	1	1
2007	13	100	0	3
2006	13	100	2	0
Total	65	100	3	5

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: D 95th (100 mL) 902.5
Interim Result? Interim Data Set (1: 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (1: 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

SFRG Assessment Results
Site name: WGG000895
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Kaupokonui River at beach domain

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Input data

Site Name
Name of site from the MAC file: KPR000995

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			250 to 950	>950	
2010	13	76.0	1	0	100 %
2009	13	100.0	2	0	100 %
2008	13	218.0	3	1	92 %
2007	13	77.0	1	1	92 %
2006	13	140.0	0	1	92 %
Total	65	96.0	7	3	95 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Results
MAC category: D 95th (100 mL) 617.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Periphytic SIC Impact: 7: Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Assessment of the MAC and SIC is required to press "Interim Data Follow-up" to assign a compliance grade

Interim Data Follow-up

SFRG Assessment Results
Site name: KPR000995
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

OK

Lake Opunake

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Input data

Site Name
Name of site from the MAC file: LOP000001

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			250 to 950	>950	
2010	13	88.0	0	3	75 %
2009	13	220.0	5	0	100 %
2008	13	210.0	2	2	84 %
2007	13	130.0	2	1	92 %
2006	13	110.0	1	3	75 %
Total	65	190.0	10	9	86 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

Calculate MAC

MAC Results
MAC category: D 95th (100 mL) 1350.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

Save MAC Report

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Periphytic SIC Impact: 10: The incidence and density of bedfils

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Calculate SFRG

Assessment of the MAC and SIC is required to press "Interim Data Follow-up" to assign a compliance grade

Interim Data Follow-up

SFRG Assessment Results
Site name: LOP000001
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save as a Single Entry File

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Save to Database format File

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

OK

Timaru Stream at Weld Road

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: THR000497

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)	Days in Compliance (Days < 550/year)
2010	13	180	4	0
2009	13	250	4	1
2008	13	230	4	0
2007	13	180	3	3
2006	13	200	2	0
Total	65	220	18	4

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: D (95ile /100 mL) 595.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Processing of the MAC and/or SIC is complete. Press "Interim Data Settings" to assign a conservative grade

SFRG Assessment Results
Site name: THR000497
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

Oakura River d/s SH45

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: OKR000497

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)	Days in Compliance (Days < 550/year)
2010	13	100	1	0
2009	13	150	4	1
2008	13	180	1	0
2007	13	140	1	1
2006	13	220	4	0
Total	65	150	11	2

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C (95ile /100 mL) 427.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Processing of the MAC and/or SIC is complete. Press "Interim Data Settings" to assign a conservative grade

SFRG Assessment Results
Site name: OKR000497
SFRG Assessment: Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

Waitara

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: WTR000332

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			260 to 950	>950	
2010	13	76.0	1	1	92 %
2009	13	230.0	2	3	76 %
2008	8	0.0	0	0	0 %
2007	8	0.0	0	0	0 %
2006	8	0.0	0	0	0 %
Total	26	165.0	3	4	84 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: D 95th (100 mL) 1460.0
Interim Result? Interim Data Set (> 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

OK

Urenui River at estuary

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: URN000480

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950/year)
			260 to 950	>950	
2010	13	4.0	0	0	100 %
2009	13	4.0	0	0	100 %
2008	13	7.0	0	0	100 %
2007	13	3.0	0	0	100 %
2006	13	5.0	0	0	100 %
Total	65	4.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: A 95th (100 mL) 30.0
Interim Result? Interim Data Set (> 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment? Interim Data Set (> 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and/or SIC is required for years "Interim Data Set" through a commercial guide

SFRG Assessment Results
Site name: URN000480
SFRG Assessment: Poor

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsFresh.txt"

OK

Manganui River at Everett Park

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: MGN000435

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950 / year)
			250 to 950	>950	
2010	13	170	2	0	100 %
2009	13	200	3	0	100 %
2008	13	170	4	0	100 %
2007	13	160	2	1	92 %
2006	13	190	2	0	100 %
Total	65	170	13	1	98 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: C 95th (100 mL) 390.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment.

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.

SFRG Assessment Results
Site name: MGN000435
SFRG Assessment: Poor

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Lake Ratapiko

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: LRP000050

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 950 / year)
			250 to 950	>950	
2010	12	25.0	0	0	100 %
2009	13	16.0	0	0	100 %
2008	12	34.5	0	0	100 %
2007	13	16.0	0	0	100 %
2006	13	21.0	0	0	100 %
Total	63	21.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: A 95th (100 mL) 120.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save the MAC assessment.

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agricultural use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.

SFRG Assessment Results
Site name: LRP000050
SFRG Assessment: Poor

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file.

Lake Rotokare

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: SPR000000

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 550 / year)
			260 to 550	>550	
2010	9	5.0	0	0	100 %
2009	9	3.0	0	0	100 %
2008	9	15.0	0	0	100 %
2007	10	20.5	0	0	100 %
2006	2	5.0	0	0	100 %
Total	39	8.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: A 95th (/ 100 mL) 82.2
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

OK

Waiwhakaiho at Lake Rotomanu

Freshwater MAC Assessment

Input MAC Data
Press "Input Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: WKH000990

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 550 / year)
			260 to 550	>550	
2010	13	300.1	1	9	30 %
2009	0	0.0	0	0	0 %
2008	13	490.1	7	6	53 %
2007	0	0.0	0	0	0 %
2006	13	320.1	1	6	53 %
Total	39	588.1	9	20	49 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: D 95th (/ 100 mL) 2710.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

OK

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agriculture

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and/or SIC is required for sites "Inconclusive Following" to adopt a conservative grade

SFRG Assessment Results
Site name: WKH000990
SFRG Assessment: Very Poor

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

Print the column labels to the file "ColumnLabelsFresh.txt"

OK

Te Henui Stream: mouth

Freshwater MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: TH000499

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (E. coli / 100 mL)		Days in Compliance (Days < 550/year)
			250 to 550	>550	
2010	14	885	1	12	14 %
2009	13	830	2	11	15 %
2008	13	1100	1	12	7 %
2007	13	1100	2	10	23 %
2006	13	1100	2	10	23 %
Total	66	1100	8	55	16 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: D 95thile (/100 mL): 4000.0
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment

Freshwater Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: D
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: High
Primary SIC Impact: 7. Intensive agriculture use

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and/or SIC is required for sites in "Intermittent Following" to adopt a conservative grade

SFRG Assessment Results
Site name: TH000499
SFRG Assessment: Very Poor

Save the SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file

Save SFRG Assessment to a Multiple Summary File
Press "Save to database format file" to save summary data as one row in a comma-delimited file

☐ Print the column labels to the file "ColumnLabelsFresh.txt"

Appendix II

High tide times

High tide times (NZST) at New Plymouth for 2011-2012 sampling dates

Date		Time of HT
Tuesday	15 November 2011	1210
Monday	28 November 2011	1139
Sunday	22 January 2012	0856
Thursday	26 January 2012	1141
Tuesday	7 February 2012	0922
Friday	10 February 2012	1120
Monday	13 February 2012	1335
Tuesday	21 February 2012 *	0925
Monday	27 February 2012	1252
Thursday	8 March 2012	0933
Wednesday	21 March 2012 **	0901
Wednesday	28 March 2012	1259
Friday	30 March 2012	1440
Tuesday	10 April 2012	1214

Notes: * northern and southern runs only

** central run only

Appendix III

**Sampling conditions and public usage
recorded at each site by the SEM programme**

Site Lake Rotomanu (Site Code: LRM000002)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	3/8	N/R	Clear, blue	Ripple	0/1 (jetski)	Few ducks and seagulls	0	0
28 November 2011	Fine, overcast	8/8	None	Blue-brown	Ripple	0/0	Few ducks, seagulls common	0	0
22 January 2012	Fine, overcast	8/8	N/R	Clear, blue	N/R	0/4 (jetski/boating)	Ducks and seagulls common	0	0.5
26 January 2012	Fine, overcast	8/8	N/R	Clear, brown	N/R	0/14 (banks/water skiing)	Ducks common	0	0
7 February 2012	Fine	0/8	None	Clear, brown	Ripple	0/3 (banks)	Ducks common	0	1
10 February 2012	Fine, overcast	8/8	None	Slightly turbid, brown	Ripple	0/5 (banks)	Ducks very common; few gulls and geese	0	0
13 February 2012	Fine	3/8	N/R	Clear, blue	Ripple	0/0	Few ducks	0	8
27 February 2012	Fine	1/8	N/R	Blue-brown	Small waves	0/4 (banks)	Few ducks	0	0.5
8 March 2012	Fine, overcast	7/8	None	Turbid, brown	Waves	0/0	Few ducks	0	0
21 March 2012	Fine	6/8	None	Blue-brown	Small waves	0/0	Few ducks	3.5	5
28 March 2012	Fine	1/8	None	Clear, blue	Calm	0/0	Ducks common	0	3.5
30 March 2012	Fine	3/8	None	Slightly turbid	Small wavelets	0/0	Few ducks	0	0
10 April 2012	Fine	2/8	N/R	Slightly turbid, brown	Flat	0/0	One duck	0	0

Site Waiwhakaiho River at Merrilands (Site Code: WKH000800)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	3/8	Thin	Clear	D/S	0/0		0	0
28 November 2011	Shower, overcast	8/8	Minimal	Green	D/S	0/0	Some foam	0	0
22 January 2012	Light rain, overcast	8/8	Moderate	Clear, green	D/S	0/0		0	0.5
26 January 2012	Fine, overcast	8/8	Thin	Clear, pale brown	D/S	1/0	Two dogs in water	0	0
7 February 2012	Fine	0/8	Thin	Clear	D/S	0/0		0	1
10 February 2012	Fine, overcast	8/8	Moderate	Clear, brown	D/S	0/0		0	0
13 February 2012	Fine	3/8	Moderate	Clear	D/S	0/0		0	8
27 February 2012	Fine	2/8	None	Clear	D/S	0/0		0	0.5
8 March 2012	Fine, overcast	7/8	Thin at edges	Rel. clear	D/S	0/0		0	0
21 March 2012	Fine, overcast	8/8	Thick mats	Clear	D/S	0/0		3.5	5
28 March 2012	Fine	0/8	None	Clear	D/S	0/0		0	0
30 March 2012	Fine	4/8	Thin	Clear	D/S	0/0		0	0
10 April 2012	Fine	5/8	Fil. algae common	Clear, brown	D/S	0/0		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	3/8	N/R	Clear	D/S	0/2 (bank/whitebaiting)	Seagulls (u/s & d/s)	0	0
28 November 2011	Light rain, overcast	8/8	Minimal	Clear	D/S	0/0	Seagulls common	0	0
22 January 2012	Fine, overcast	8/8	N/R	Blue	D/S	0/0		0	0.5
26 January 2012	Fine, overcast	8/8	N/R	Clear, pale brown	Surging	0/0	Few geese	0	0
7 February 2012	Fine	0/8	None	Clear	D/S	0/0	One duck	0	1
10 February 2012	Fine, overcast	7/8	N/R	Clear	Surging	0/0	Few ducks & seagulls common	0	0
13 February 2012	Fine	3/8	None	Clear	Ponded	0/0		0	8
27 February 2012	Fine	2/8	None	Clear	D/S	0/0		0	0.5
8 March 2012	Fine, overcast	7/8	None	Rel. clear	D/S	0/0		0	0
21 March 2012	Fine, overcast	7/8	None	Clear	D/S	0/0		3.5	5
28 March 2012	Fine	2/8	None	Clear	D/S	0/0		0	0
30 March 2012	Fine	2/8	None	Clear	D/S	0/0		0	0
10 April 2012	Fine	3/8	Moderate	Clear	D/S	0/0		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	2/8	Moderate	Clear, green	Surging	0/0	Ducks common	0	0
28 November 2011	Fine, overcast	8/8	N/R	Turbid, green	Surging	0/0	Few ducks	0	0
22 January 2012	Fine, overcast	8/8	N/R	Turbid, green	D/S	0/0	Ducks common	0	0.5
26 January 2012	Fine, overcast	8/8	N/R	Clear, green	Surging	0/1 (fishing)	Ducks common	0	0
7 February 2012	Fine	0/8	None	Clear, green	D/S	0/0	Ducks common, few seagulls	0	1
10 February 2012	Fine, overcast	7/8	N/R	Slightly turbid, green	Surging	0/0	Ducks very common	0	0
13 February 2012	Fine	2/8	Abundant	Slightly turbid	Ponded	0/1 (fishing)	Few ducks	0	8
27 February 2012	Fine	1/8	Abundant	Clear, pale brown	D/S	0/0	Ducks common	0	0.5
8 March 2012	Fine, overcast	7/8	At edges	Turbid, green	D/S	0/0	Ducks common	0	0
21 March 2012	Fine, overcast	8/8	None	Turbid	D/S	0/0	Floating debris, ducks very common	3.5	5
28 March 2012	Fine	1/8	None	Clear	D/S	0/0	Ducks common	0	0
30 March 2012	Fine	0/8	Thin	Clear	Ponded	0/0	Floating debris, ducks common	0	0
10 April 2012	Fine	2/8	N/R	Turbid, green	Surging	0/15 (banks)	Ducks very common (& being fed). Dog	0	0

Site Patea River, King Edward Park, Stratford

(Site Code: PAT000297)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	5/8	Thin mats	Rel. clear, uncoloured	D/S	0/0		0	0.5
28 November 2011	Light rain, overcast	8/8	N/R	Slightly turbid, green	D/S	0/0	One duck	0.5	0.5
22 January 2012	Fine, cloudy	6/8	N/R	Slightly turbid, green	D/S	0/0		0	0
26 January 2012	Fine, overcast	7/8	Widespread	Clear	D/S	0/0		0	0
7 February 2012	Fine	2/8	50%	Clear, brown	D/S	0/0		0	2
10 February 2012	Fine, overcast	8/8	N/R	Slightly turbid, green	D/S	0/3 (fishing)		0	0
13 February 2012	Fine	6/8	Moderate	Slightly turbid, green-brown	D/S	0/6 (fishing)		0	0
21 February 2012	Fine, overcast	7/8	N/R	Slightly turbid, green	D/S	0/0		0	0
27 February 2012	Fine	0/8	N/R	Slightly turbid, green	D/S	0/0		0	11
8 March 2012	Fine, overcast	8/8	N/R	Slightly turbid, pale green	D/S	0/0		0	0
28 March 2012	Fine	1/8	N/R	Clear, uncoloured	D/S	0/0		0	7.5
30 March 2012	Fine	2/8	N/R	Slightly turbid, green	D/S	0/0	Shag	0	0
10 April 2012	Fine	6/8	N/R	Slightly turbid, green	D/S	0/0		0	0

Site Patea River, boatramp, Patea

(Site Code: PAT000995)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	1/8	N/A	Slightly turbid, green-grey	D/S (slow)	0/0		0	1
28 November 2011	Fine, overcast	8/8	N/A	Slightly turbid, pale green	D/S (surging)	0/0		0	0
22 January 2012	Fine	4/8	N/A	Slightly turbid, green	U/S (surging)	1/1 (bank)		0	0
26 January 2012	Fine, overcast	8/8	N/A	Turbid, grey-green	U/S (surging)	0/0		0	0
7 February 2012	Fine	0/8	N/A	Green	U/S (surging)	0/1 (bank)		0	3
10 February 2012	Light drizzle, overcast	8/8	N/A	Slightly turbid, green-brown	U/S (surging)	0/0		0	0
13 February 2012	Fine	6/8	N/A	Slightly turbid, pale green	U/S	0/5 (boating)		0	2.5
21 February 2012	Fine	6/8	N/A	Slightly turbid, pale green	U/S (surging)	0/0		0	0
27 February 2012	Fine	2/8	N/A	Slightly turbid, brown	D/S (surging)	0/0		0	1
8 March 2012	Fine, overcast	8/8	N/A	Slightly turbid, pale brown	U/S	0/0		0	0
28 March 2012	Fine	0/8	N/A	Turbid, brown	D/S (slow)	0/0		0	2.5
30 March 2012	Fine	2/8	N/A	Slightly turbid, brown-green	U/S (surging)	0/1 (boating)		0	0
10 April 2012	Fine, overcast	8/8	N/A	Slightly turbid, pale brown-green	D/S (surging)	0/5 (boating/fishing)		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	5/8	Thin mats	Rel. clear, pale brown	D/S	0/0		0	0.5
28 November 2011	Light rain, overcast	8/8	N/R	Slightly turbid, brown	D/S	0/0	(40 persons in camp)	0.5	0.5
22 January 2012	Fine	4/8	N/R	Slightly turbid, pale brown	D/S	0/0		0	0
26 January 2012	Fine, overcast	8/8	70%	Slightly turbid, brown	D/S	0/0		0	0
7 February 2012	Fine	0/8	Thin mats	Clear, brown	D/S	0/0		0	2
10 February 2012	Fine, overcast	8/8	N/R	Slightly turbid, pale brown	D/S	0/0		0	0
13 February 2012	Fine	5/8	Patchy	Slightly turbid, pale brown	D/S	0/0		0	0
21 February 2012	Fine, overcast	7/8	N/R	Slightly turbid, pale brown	D/S	0/0		0	0
27 February 2012	Fine	0/8	N/R	Rel. clear, colourless	D/S	0/0		0	11
8 March 2012	Fine, overcast	8/8	N/R	Rel. clear, brown	D/S	0/?	(school group in camp)	0	0
28 March 2012	Fine	1/8	N/R	Slightly turbid, uncoloured	D/S	0/0		0	7.5
30 March 2012	Fine	3/8	N/R	Slightly turbid, pale yellow	D/S	0/0		0	0
10 April 2012	Fine	6/8	N/R	Slightly turbid, yellow brown	D/S	0/0		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	0/8	Mod. mats	Rel. clear, pale green-brown	D/S	0/20 (whitebaiting)	No cattle u/s	0	0.5
28 November 2011	Fine, overcast	8/8	N/R	Slightly turbid, brown	D/S	0/5 (whitebaiting)	No cattle u/s	0	0.5
22 January 2012	Fine	6/8	N/R	Slightly turbid, brown	D/S	0/0		0	0.5
26 January 2012	Fine, overcast	7/8	Nil	Clear, brown	D/S (slow)	0/3 (fishing)		0	0
7 February 2012	Fine	0/8	N/R	Clear, brown	D/S (slow)	0/0		0	2
10 February 2012	Light rain, overcast	8/8	N/R	Slightly turbid, brown	D/S (slow & surging)	0/0		0	0
13 February 2012	Fine	2/8	Moderate mats	Slightly turbid, green-brown	D/S	0/0	No cattle u/s	0	0
21 February 2012	Fine, overcast	7/8	N/R	Slightly turbid, green-brown	D/S	0/0	No cattle u/s	0	0
27 February 2012	Fine	1/8	N/R	Slightly turbid, green-brown	D/S	0/3 (banks)	One dog in water	0	2.5
8 March 2012	Fine, overcast	8/8	N/R	Slightly turbid, pale green	D/S (surging)	0/0	Cattle u/s	0	0
28 March 2012	Fine	0/8	N/R	Slightly turbid, uncoloured	D/S	0/0		0	1
30 March 2012	Fine	2/8	N/R	Slightly turbid, green	D/S	0/0		0	0
10 April 2012	Fine	4/8	N/R	Slightly turbid, green-brown	D/S (surging)	0/0		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	1/8	Minimal	Rel. clear, uncoloured	D/S (surging)	0/12 (whitebaiting/fishing)		0	0.5
28 November 2011	Rain, overcast	8/8	N/R	Rel. clear, pale green	D/S	0/6 (whitebaiting)		0	0
22 January 2012	Fine, overcast	8/8	N/R	Slightly turbid, green	D/S (surging)	0/25 (banks/fishing)		0	0.5
26 January 2012	Light drizzle, overcast	8/8	N/R	Clear	U/S (surging)	0/2 (fishing)		0	0
7 February 2012	Fine	0/8	N/R	Clear, green	U/S (surging)	0/8 (banks)		0	2
10 February 2012	Light drizzle, overcast	8/8	N/R	Rel. clear, pale brown	D/S (surging)	0/5 (fishing)	Dogs on bank	0	0
13 February 2012	Fine	5/8	N/R	Slightly turbid, green	D/S (surging)	0/0		0	0
21 February 2012	Fine, overcast	7/8	N/R	Slightly turbid, green-brown	D/S (slow)	0/2 (fishing)		0	0
27 February 2012	Fine	0/8	N/R	Rel. clear, green	D/S (surging)	0/2 (fishing)		0	2.5
8 March 2012	Fine, overcast	7/8	N/R	Slightly turbid, green-brown	D/S (surging)	0/0		0	0
28 March 2012	Fine	3/8	N/R	Rel. clear, pale green	D/S (surging)	0/2 (fishing)		0	1
30 March 2012	Fine	0/8	N/R	Rel. clear, pale brown	D/S	0/0		0	0
10 April 2012	Fine	2/8	N/R	Slightly turbid, brown	D/S (slow & surging)	0/5 (fishing)		0	0

Site Lake Opunake (Site Code: LOP000001)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algae	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	2/8	Minimal	Rel. clear, uncoloured	Calm	0/0	Few ducks; aquatic weed common at edge	0	0.5
28 November 2011	Fine, overcast	8/8	N/A	Rel. clear, brown	Flat	0/2 (banks)	Few ducks	0.5	2
22 January 2012	Fine, overcast	8/8	N/A	Rel clear, brown	Ripple	0.4 (banks)	Ducks very common (public feeding ducks)	0	5
26 January 2012	Fine	6/8	Nil	Rel. clear, brown	Ripple	0/0	Ducks very common	0	0
7 February 2012	Fine	1/8	N/R	Slightly turbid, brown	Ripple	0/0	Ducks very common	0	3
10 February 2012	Fine, overcast	8/8	N/R	Slightly turbid, pale brown	Flat	0/0	Ducks very common	1	1
13 February 2012	Fine, overcast	8/8	N/R	Slightly turbid, pale brown	Flat	0/0	Ducks common	0	2
21 February 2012	Fine	6/8	N/R	Slightly turbid, brown	Flat	0/0	Ducks very common; weed common	0	0
27 February 2012	Fine	0/8	N/R	Slightly turbid, brown	Ripple	0/0	Ducks very common, few geese	0	3
8 March 2012	Fine, overcast	7/8	N/R	Slightly turbid, green-brown	Waves	0/0	Few ducks	6	6
28 March 2012	Fine	5/8	N/R	Slightly turbid, pale brown	Wavelets	0/6 (banks)	Ducks common	0	3
30 March 2012	Fine	2/8	Floating filamentous	Clear, uncoloured	Ripple	0/2 (banks)	Ducks common on lake and on bank	0	0
10 April 2012	Fine	3/8	N/R	Slightly turbid, brown	Flat	0/0	Ducks common, one goose	0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	3/8	Thin	Clear	D/S	0/0		0	2
28 November 2011	Fine, overcast	8/8	Nil	Clear, blue	Surging	0/0	Two dogs	1.5	4
22 January 2012	Fine	6/8	N/R	Clear, blue	Surging	0/2 (bank)	Few seagulls, 1 dog in water	0	3.5
26 January 2012	Fine, overcast	8/8	N/R	Clear	D/S	0/4 (bank)	Seagulls very common	0	0
7 February 2012	Fine	0/8	Nil	Clear	Surging	0/1 (bank)	One dog on bank	0	0.5
10 February 2012	Fine, overcast	7/8	N/R	Clear	Surging	0/0	Few seagulls	0	0
13 February 2012	Fine, overcast	7/8	Nil	Clear	D/S	5/0		0	7
27 February 2012	Fine	3/8	Nil	Clear, blue	D/S	0/0		0.5	2.5
8 March 2012	Fine, overcast	7/8	Nil	Slightly turbid	Surging	0/0		0	0
21 March 2012	Fine	6/8	Nil	Clear	Surging	0/0	Floating debris, few birds	5	8
28 March 2012	Fine	2/8	Widespread	Clear	D/S	0/0		0	3.5
30 March 2012	Fine	0/8	Moderate	Clear	D/S	0/0		0	0
10 April 2012	Fine	2/8	Nil	Clear	D/S	0/2 (banks)		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	2/8	N/A (sandy)	Clear	Ponded	0/0		0	2
28 November 2011	Fine, overcast	8/8	N/A	Clear	Ponded (surging)	0/0		1.5	4
22 January 2012	Fine, overcast	8/8	N/A	Clear, uncoloured	U/S (slow)	0/0	Few seagulls	0	3.5
26 January 2012	Fine, overcast	7/8	N/A	Clear	Surging	2/2 (bank)	Few seagulls	0	0
7 February 2012	Fine	0/8	N/A	Clear	D/S (slow)	0/0	Few seagulls	0	0.5
10 February 2012	Fine, overcast	7/8	N/A	Clear	Surging	0/4 (bank)		0	0
13 February 2012	Fine	3/8	N/A	Clear	Surging	0/2 (bank)	Dog on bank	0	7
27 February 2012	Fine	2/8	N/A	Clear	Surging	0/0		0.5	2.5
8 March 2012	Fine, overcast	7/8	N/A	Clear, blue	D/S	0/0		0	0
21 March 2012	Fine, overcast	8/8	N/A	Slightly turbid	D/S	0/0	Gulls common	5	8
28 March 2012	Fine	3/8	N/A	Clear	D/S	0/6 (bank)		0	3.5
30 March 2012	Fine	0/8	N/A	Clear	D/S	0/1 (bank)		0	0
10 April 2012	Fine	3/8	N/A	Clear	Surging	0/0		0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	S.G. level	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	2/8	1.8	Khaki	D/S (slow)	0/3 (fishing)	Signage removed	0	0.5
28 November 2011	Fine, overcast	8/8	2.4	Turbid, brown	D/S (slow)	0/0	Few ducks	0	0
22 January 2012	Drizzle, overcast	8/8	2.0	Grey-green	D/S	0/0	One duck	0	0.5
26 January 2012	Fine, overcast	8/8	1.4	Turbid, brown-green	Still	0/1 (bank)	Few ducks	0	0
7 February 2012	Fine	0/8	2.2	Green	D/S	0/0	Few seagulls	0	0.5
10 February 2012	Fine, overcast	8/8	N/R	Clear, green	U/S (slow)	0/3 (fishing)		0	0
13 February 2012	Fine	4/8	2.0	Slightly turbid, green	Still	3/1 (fishing)		0	6
21 February 2012	Fine, overcast	7/8	2.1	Turbid, blue-green	U/S	0/1 (fishing)	Some foam	0	0
27 February 2012	Fine	0/8	1.7	Turbid, brown	D/S	0/3 (banks)		0	0
8 March 2012	Fine, overcast	7/8	2.3	Turbid, green-grey	D/S	0/0	Few ducks, seagulls common	0	0
28 March 2012	Fine	1/8	1.5	Turbid, brown	D/S (slow)	0/3 (wharf)	Few ducks, gulls common	0	1.5
30 March 2012	Fine	1/8	N/R	Turbid, brown	D/S	0/0	Gulls common	0	0
10 April 2012	Fine, overcast	7/8	1.8	Turbid, green-grey	D/S	0/3 (fishing)		0	0

Site Urenui River at estuary (Site Code: URN000480)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	3/8	N/A	Blue-green	U/S	0/0		0	0.5
28 November 2011	Rain, overcast	8/8	N/A	Grey-green	U/S	0/0		0	0
22 January 2012	Fine, overcast	8/8	N/A	Green	U/S (slow)	0/4 (fishing)		0	0.5
26 January 2012	Fine, overcast	8/8	N/A	Slightly turbid, green	U/S	15/20 (banks)		0	0
7 February 2012	Fine	0/8	N/A	Green	U/S (slow)	0/1 (fishing)		0	0.5
10 February 2012	Fine	5/8	N/A	Turbid, grey-green	U/S	0/0		0	0
13 February 2012	Fine	3/8	N/A	Clear, blue-green	U/S	0/0		0	6
21 February 2012	Fine, overcast	0/8	N/A	Clear, green	Surging	0/1 (boating)		0	0
27 February 2012	Fine	0/8	N/A	Green	D/S (slow)	0/0		0	0
8 March 2012	Fine, overcast	8/8	N/A	Grey-green	U/S (slow)	0/0		0	0
28 March 2012	Fine	3/8	N/A	Turbid, green	U/S (slow)	0/0		0	1.5
30 March 2012	Fine	0/8	N/A	Slightly turbid, green	U/S (slow)	0/0		0	0
10 April 2012	Fine	2/8	N/A	Turbid, green	U/S (slow)	0/5 (kayaking)	Few gulls	0	0

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

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
15 November 2011	Fine	3/8	Present	Dark green	D/S	0/0	Some foam	0	0.5
28 November 2011	Fine, overcast	8/8	Thick	Slightly turbid, brown-green	D/S	0/0		1	1
22 January 2012	Fine, overcast	7/8	Present	Green	D/S	0/0		0	1
26 January 2012	Fine, overcast	8/8	Present	Green-brown	D/S	0/0		0	0
7 February 2012	Fine	6/8	Present	Brown-green	D/S	0/0		0	3
10 February 2012	Fine	3/8	Thin	Clear, pale green	D/S	0/0		0	0
13 February 2012	Fine	2/8	Thick	Clear, pale green	D/S	0/0		1	3
21 February 2012	Fine, overcast	8/8	100%	Rel. clear	D/S	0/0		0	0
27 February 2012	Fine	0/8	N/R	Clear, uncoloured	D/S	0/0		0	4
8 March 2012	Fine	4/8	Thin	Clear, green	D/S	0/0		0	0
28 March 2012	Fine	1/8	None	Clear, green-brown	D/S	0/0		0	3.5
30 March 2012	Fine	6/8	Thin	Clear, green-brown	D/S	0/0		0	0
10 April 2012	Fine	5/8	None	Clear, green	D/S	0/0		0	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
15 November 2011	Fine	3/8	N/A	Slightly turbid, green-brown	Sl. chop	0/1 (jetski)	Ducks common	0	0.5
28 November 2011	Light rain, overcast	8/8	N/A	Slightly turbid, brown	Chop	0/0	Few ducks	1	1
22 January 2012	Fine	6/8	N/A	Brown	Ripple	0/10 (banks)	Ducks common; herd (50) of cows on bank!	0	1
26 January 2012	Light drizzle, overcast	8/8	N/A	Brown-green	Chop	0/0		0	0
7 February 2012	Fine	3/8	N/A	Slightly turbid, brown	Ripple	0/0	Shags & ducks common; lake 1.5 m lower than usual	0	3
10 February 2012	Fine	4/8	Nil	Clear, uncoloured	Ripple	0/0	Few ducks & shags	0	0
13 February 2012	Fine	3/8	Nil	Clear, pale brown	Ripple	0/0	Few ducks & shags	1	3
21 February 2012	Fine, overcast	7/8	Nil	Clear, blue	Chop	0/0		0	0
27 February 2012	Fine	0/8	N/A	Clear, pale brown	Ripple	0/0		0	4
8 March 2012	Fine	4/8	N/A	Clear, grey	Ripple	0/0	Few ducks, stock on bank	0	0
28 March 2012	Fine	2/8	N/A	Clear, brown	Flat	0/0	Few swans	0	3.5
30 March 2012	Fine	6/8	N/A	Clear, brown	Slight ripple	0/0	Level lower than normal. Few shags; ducks common	0	0
10 April 2012	Fine	-	N/A	N/A	N/A	-	Lake level very low (maintenance) [No sampling possible]	0	0

Appendix IV

**Sampling conditions and public usage
recorded at two sites by the additional programme**

Dates of additional sampling

Date	Preceding weather
Tuesday 22 November 2011	wet over 72 hours
Tuesday 6 December 2011	very wet over 72 hours
Tuesday 20 December 2011	dry over 48 hours, very wet over 120 hours
Thursday 5 January 2012	dry over 72 hours
Wednesday 18 January 2012	dry over 72 hours
Tuesday 31 January 2012	dry over 72 hours
Thursday 16 February 2012	wet over 72 hours, mainly over 48 to 72 hours

Site Lake Rotomanu (Site Code: LRM000002): additional monitoring (seven samples)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
22 November 2011	Fine	2/8	N/R	Turbid, brown	Ripple	0/1 (bank)	Ducks common (being fed); few gulls	0	0.5
6 December 2011	Fine, overcast	8/8	N/R	Relatively clear, brown	N/R	0/0	Few ducks	23	60
20 December 2011	Fine	0/8	None	Slightly turbid	N/R	0/5 (bank)	Few ducks and seagulls	0	0
5 January 2012	Fine, overcast	8/8	None	Turbid	N/R	0/20 (banks/boating/jet skiing)	Few ducks	0	0
18 January 2012	Fine	0/8	None	Slightly turbid	N/R	0/29 (banks/boating/jet skiing)	Few ducks	0	0
31 January 2012	Fine, overcast	8/8	None	Slightly turbid, brown	Ripple	0/0	Few ducks and seagulls	0	0
16 February 2012	Fine	6/8	None	Slightly turbid, pale brown	N/R	0/0	Few ducks	0.5	37

Site Waiwhakaiho River at Merrilands (Site Code: WKH000800): additional monitoring (seven samples)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Direction of Flow	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
22 November 2011	Fine,	2/8	N/R	Rel. clear, pale brown	D/S	0/0		0	0.5
6 December 2011	Fine, overcast	8/8	N/R	Clear, green	D/S	0/0		23	60
20 December 2011	Fine	0/8	None	Clear	D/S	0/4 (banks)	Dog on bank	0	0
5 January 2012	Fine, overcast	8/8	None	Clear	D/S	0/2 (banks)	1 dog in water	0	0
18 January 2012	Fine	1/8	Thin	Clear, uncoloured	D/S	0/7 (banks/fishing)		0	0
31 January 2012	Fine, overcast	8/8	Medium mats	Clear	D/S	0/0		0	0
16 February 2012	Fine	5/8	N/R	Slightly turbid, green-brown	D/S	0/0		0.5	37

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	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
22 November 2011	Fine	2/8	N/R	Clear, pale brown	Ripple	0/0	Few ducks	1.5	5.5
6 December 2011	Fine	3/8	N/R	Clear	N/R	0/0	Ducks common	20	23
20 December 2011	Fine	0/8	N/R	Clear	N/R	0/0	Ducks common, few swans	0	3
5 January 2012	Fine, overcast	8/8	None	Slightly turbid	N/R	0/2 (boating)	Ducks very common	0	0
18 January 2012	Fine	0/8	None	Clear, colourless	Ripple	0/0	Ducks very common	0	6
31 January 2012	Fine, overcast	8/8	None	Clear	N/R	0/0	Ducks very common, few geese	0	0
16 February 2012	Fine	2/8	None	Slightly turbid, pale brown	Ripple	0/0	Ducks very common	2	20

Site Lake Ratapiko (Site Code: LRP000050)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
22 November 2011	Fine	1/8	N/R	Clear, pale brown	Ripple	0/0	Few ducks	10	18
6 December 2011	Raining, overcast	8/8	N/R	Clear, grey	N/R	0/0		20	33
20 December 2011	Fine	0/8	None	Clear	N/R	0/0	One duck and swan	0	3
5 January 2012	Fine, overcast	8/8	None	Clear	N/R	0/0	Few ducks	0	0
18 January 2012	Fine	4/8	Thin at edges	Slightly turbid	Ripple	0/0	Few ducks	0	0.5
31 January 2012	Light rain, overcast	8/8	Thin at edges	Slightly turbid	N/R	0/2 (fishing)		0	0
16 February 2012	Fine, overcast	8/8	N/R	Slightly turbid, pale brown	Flat	0/0	Few ducks	0	50

Site Lake Rotokare adjacent to boatramp (Site Code: LRK000003)

Sampling Date	Weather		Conditions			Site usage		Rainfall (mm)	
	General	Cloud Cover	Algal cover	Appearance	Surface	Bathers / Users	Miscellaneous	Previous 24 hrs	Previous 72 hrs
21 November 2011	Fine, overcast	8/8	Some fine suspended	Rel. clear, dark green	Ripple	0/1 (bank)	Boat ramp locked	0	1
12 December 2011	Drizzling, overcast	8/8	N/R	Slightly turbid, brown	Ripple	0/0	Few ducks	0.5	0.5
5 January 2012	Fine, overcast	7/8	Minimal suspended	Rel. clear, dark grey-green	Ripple	0/4 (walkers)	Few ducks (scaup) and swan. Boat ramp open	0	0
18 January 2012	Fine	4/8	None visible	Slightly turbid, brown	Ripple	0/5 (boating/picnicking)	Boat ramp open	0	4
1 February 2012	Fine	3/8	N/R	Turbid, brown	Ripple	0/7 (walkers)	Boat ramp open	1	1
16 February 2012	Fine, overcast	7/8	Some suspended	Rel. clear	Ripple	0/3 (walkers)	Few ducks. Boat ramp open	0	35
28 February 2012	Rain, overcast	8/8	N/R	Rel. clear, pale brown	Flat	0/0	Boat ramp open	0	9
15 March 2012	Fine	5/8	Some suspended	Slightly turbid, brown-green	Calm	0/60 (walkers, education class)	Few swan	0	3
30 March 2012	Fine	3/8	None	Clear, pale brown	Calm	1/6 (jet skier, banks)	Boat ramp open	0	0

Appendix VI

**Comparative annual box and whisker plots of SEM data
for *E. coli* for the period 1996 to 2012**

Explanation of box and whisker plots

Box and whisker plots are a useful method of summarising data in a graphical form that allows rapid comparisons of data groups. The data is represented as a box with a whisker from each end.

The median (middle value of the sorted data; half of the data is either side of the median is represented by a single horizontal line. The notch, symmetrically spread around the median represents the 95% confidence interval of the median). It is a feature that allows rapid comparison between groups. If notches overlap, there is no significant difference between groups (at the 95 % confidence interval). If notches do not overlap, a statistical difference is expected.

The top and bottom of the box represent the upper and lower hinges respectively. The median splits the ordered group of data in half and the hinges split the remaining halves in half again. This means that 50% of the data lies within the box.

Hspread, comparable to the interquartile (25% and 75%) range is the difference between the values of the two hinges, ie, Upper hinge - Lower hinge = Hspread. The inner fences are defined as follows:

Lower fence = lower hinge - (1.5 x Hspread)

Upper fence = upper hinge + (1.5 x Hspread)

The outer fences are defined as follows:

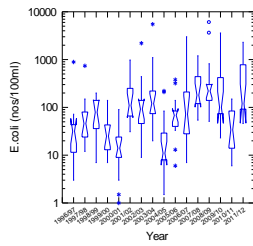
Lower fence = lower hinge - (3 x Hspread)

Upper fence = upper hinge + (3 x Hspread)

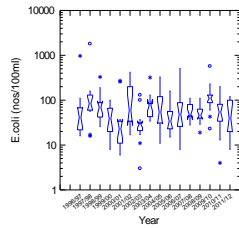
The whiskers show the range of values that lie within the inner fences. Values outside the inner fence (outliers) are plotted as asterisks (*). Values outside the outer fence (extreme outliers) are plotted as °.

E. coli

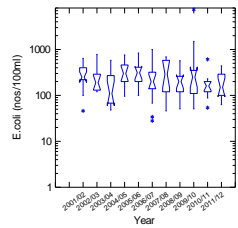
Lake Rotomanu



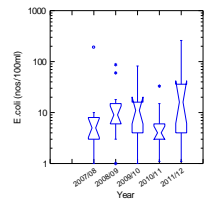
Waiwhakaiho River at
Merrilands Domain



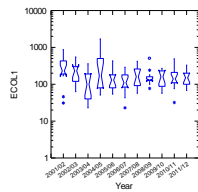
Patea River at Stratford



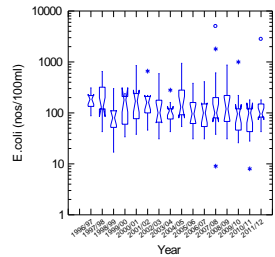
Patea River at Patea boat
ramp



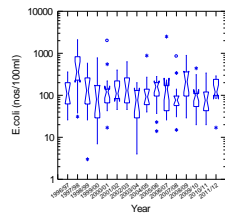
Waingongoro R at Eltham



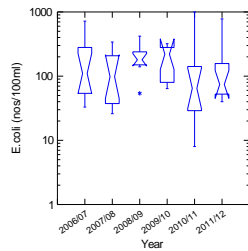
Waingongoro R at Ohawe



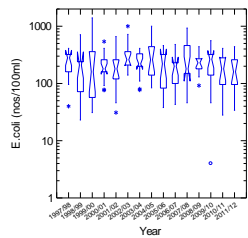
Kaupokonui River



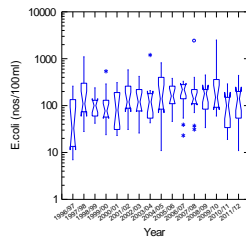
Lake Opunake



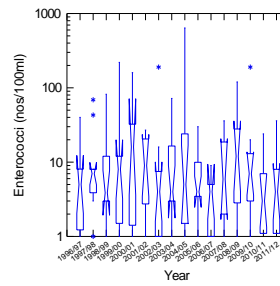
Timaru Stream



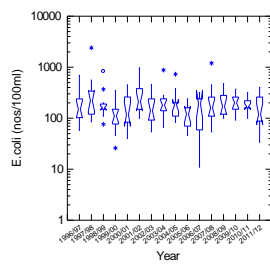
Oakura River



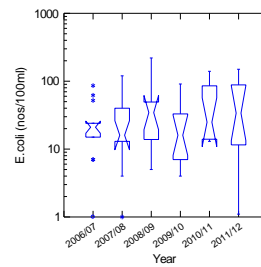
Urenui River



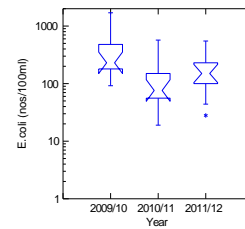
Manganui River



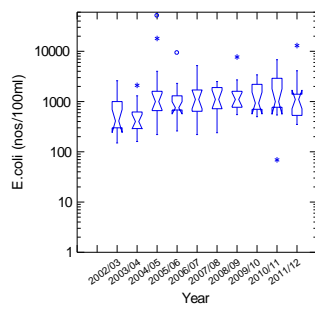
Lake Ratapiko



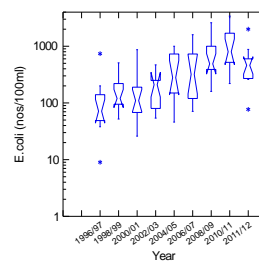
Waitara River at town wharf



Te Henui mouth East End



Waiwhakaiho
adjacent to L. Rotomanu



Appendix VII

Publicity during the 2011-2012 season

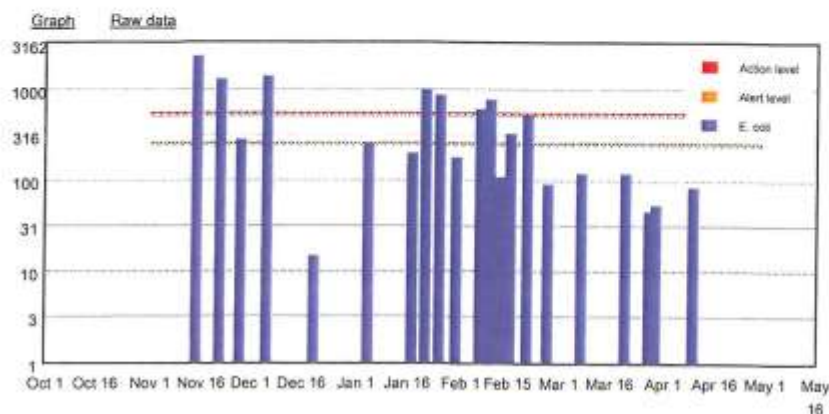
Freshwater quality - Lake Rotomanu

The full monitoring programme runs from November to March or April. When monitoring is being carried out, data on this website is updated each evening at approximately 7:30pm if there are any new results available.

Public health status: Click [here](#) to access Taranaki District Health Board information on the public health status of monitored sites.

The graph and its associated database are set to a minimum count of 1.2 to allow adequate visual presentation. So a reading of 1.2 reflects an actual sample result of 1 or less than 1 bacterium per 100mls.

E. coli (nos/100ml)



[Back to map](#)

Lake Rotomanu

Current values:

- E. coli: 85 nos/100ml (2012-04-10 00:00:00)
- Cyanobacteria: 0 cells/1ml (2012-02-16 00:00:00) (Cyanobacteria risk: Low)



Between 13 and 20 samples will be collected during the annual summer bathing season from November to early April. Purple vertical bars show the bacterial count measured in the water on particular days. These are single sample counts.

Note the logarithmic scale of the bacterial indicator axis. It is not a linear graph where the intervals are unchanged up the scale.

A bathing site is considered safe for swimming unless two consecutive sample counts for marine water are more than the Action Limit of 280 enterococci/100ml at beach sites or when the single sample count for freshwater is more than 550 E. coli /100ml.

Should single sample counts be greater than the Action Limit, this indicates that the maximum recommended value for safe swimming has been exceeded and additional sampling, and investigations may be initiated.

The Medical Officer of Health advises users "that bacterial counts are high after heavy rainfall. Recreational use should be reduced for two-three days after heavy rainfall".

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