Recreational Swimming Water Quality in Northland

Summer 2017-18

Putting Northland first

NORTHLAND REGIONAL COUNCIL

Recreational Swimming Water Quality in Northland

Summer 2017-18

1. Executive Summary

- From December 2017 to March 2018, a total of 14 freshwater and 46 coastal sites were monitored through the Northland Regional Council's Recreational Swimming Water Quality Programme.

- In comparison to the microbiological water quality guidelines (MfE and MoH 2003), 17 coastal sites met the guideline values and were considered suitable for swimming 100 percent of the time, 17 sites were considered suitable for swimming on all but one sampling occasion and 12 sites on all but two occasions.

- In 2017-18, two freshwater sites met the suitable for swimming criteria 100 percent of the time, three sites on all but one occasion and three sites on all but two sampling occasions. Six freshwater sites were considered unsuitable for swimming on three or more occasions during the summer.

- Results from sites recording elevated bacteria levels were cross referenced with rainfall data to indicate whether rainfall related runoff from land was contributing to elevated results. Overall, 37 'Action' level results were recorded for 12 of the 13 freshwater sites, of which 75 percent were likely to have been related to rainfall. At the coast, 42 'Action' level results were recorded for the 46 coastal sites, of which 83 percent were likely to have been related to rainfall.

- Since 2007-08, a total of 34 sites have been studied as part of a Council initiative to investigate water quality issues at problem sites in the region. Results from microbial source tracking analyses indicated that contamination by wildfowl occurred at 28 sites – mostly ducks and/or gulls – 26 sites were contaminated by ruminant and four sites by dog faecal material. Human faecal contamination has been recorded at Ocean Beach, Pahi, and Raumanga. Weak human markers have also been detected at Ruakaka in 2014-15, and Victoria River during the 2012-13 and 2014-15 summer monitoring periods.

- Monitoring and further investigation will continue at sites with consistently elevated bacteria levels where the source(s) of contamination has not yet been identified.

- Four of the 15 permanent monitoring sites for recreational shellfish gathering were within the Ministry for the Environment guidelines during summer 2017-18.

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5. Introduction

The Recreational Swimming Water Quality Programme (RSWQP) is a joint project administered by the Northland Regional Council (the Council), in partnership with the Northland District Health Board (NDHB), the Far North District Council (FNDC), the Whangarei District Council (WDC) and the Kaipara District Council (KDC). The programme design is derived from the Ministry for the Environment (MfE) and Ministry of Health (MoH) Microbiological Water Quality Guidelines (2003). The aim of the programme is to provide information on microbiological contamination at popular freshwater and coastal swimming sites in Northland, to allow the public to make informed decisions about where to swim.

At times sampling has shown some sites, in particular freshwater sites or those with a freshwater influence such as harbours and estuaries, to be unsuitable for swimming, especially after heavy rainfall. Water can occasionally be contaminated by human or animal waste which can contain disease-causing microorganisms. These organisms, also called pathogens, can include bacteria and/or protozoa such as giardia (*Giardia lamblia*) and campylobacter (*Campylobacter jejuni*).

The most common sources of pathogenic contamination in water is animal manure from stock access to water and rural runoff, and human sewage which includes storm overflow, broken sewer pipes and poorly located and maintained septic tank systems (PCE 2012, Jarman 2002). In Northland, microbial source tracking has identified wildfowl (ducks and gulls) and ruminant (including cattle and sheep) as the most common sources of contamination. Human sources of contamination have been identified at five sites.

While contamination from human sewage is relatively easy to identify and mitigate, contamination from storm water, rural run-off, and wildfowl is harder to identify and mitigate. No matter the source, the potential for causing disease remains the same (Jarman, 2002a).

Photo 1: Coopers Beach

6. Programme Procedure

There are currently 46 coastal and 14 freshwater sites monitored each year as part of the RSWQP. The Council is responsible for collecting samples weekly at each site for a total duration of 14 weeks – the programme runs from early December until early March. Every year the list of sites to be monitored is reviewed in consultation with key stakeholders at a pre-season meeting. Sites are selected based on usage and popularity and whether historical bacteria levels are consistently elevated or not.

Samples collected at selected sites are analysed for faecal indicator bacteria (FIB). Sites are graded according to their corresponding bacteria level recorded in 100 millilitres of water, in accordance with the MfE and MoH grading system (see section 8). Results are then distributed to key stakeholders including District Councils and the public. District Councils are responsible for collecting follow-up samples if the initial samples return 'Action' bacteria levels. If results from the follow-up sampling remain at 'Action' level, then the District Councils are responsible for erecting warning signs which remain in place until further testing returns bacteria levels below 'Action' level. Once problem sites have been identified, the Regional and District Councils collectively identify the source of contamination and work towards improving water quality.

This programme, along with other State of the Environment monitoring programmes, contribute to the Council fulfilling its statutory obligations under section 35(2) (a) of the Resource Management Act 1991.

7. Health Risks

Photo 2: Health Notice Sign

Swimming in contaminated water can lead to skin, eye and ear infections; gastrointestinal and respiratory illnesses (Jarman 2002a). Most pathogens can infect individuals when contaminated water is swallowed, but inhalation of contaminated water has also been identified as a route of infection (MfE 2002). Pathogens may also enter the body through the mucus membranes in the nose and mouth and through open wounds.

Pathogenic organisms associated with contaminated water can cause significant ill health. Campylobacteriosis, for example, can cause fever, severe abdominal pain, nausea and diarrhoea, with symptoms lasting up to 10 days (Jarman, 2002b). Depending on the type of disease and the severity of the infection, hospitalisation may be required.

7.1 Acceptable risks

The number of pathogens a person needs to ingest before becoming sick varies from many thousands to a single pathogen and depends on a number of factors. Considering how small bacteria and viruses are and how vast water bodies can be, it makes it impossible to ever guarantee any water body will be suitable for swimming.

Instead, when assessing a water body for its suitability for recreation, it is recommended to consider things in terms of maximum acceptable risk. For example, if only one person in a million became ill after swimming at a site, it is unlikely to be of concern. On the other hand, if every swimmer got sick, the risks become unacceptable. The maximum acceptable risk falls somewhere between the two; some people may get sick from contact with the water but not so many as to become a strain on health resources, or pose a significant risk to human life.

For freshwater recreation in New Zealand, the Ministry for the Environment (MfE) and the Ministry of Health (MoH) have set the maximum acceptable risk at 8 in every 1000 users falling ill as a result of contact with contaminated water (MfE and MoH 2002 and 2003). For marine waters, the maximum acceptable risk is 19 in every 1000 users. These figures are based on both international and New Zealand research.

7.2 When to avoid contact recreation

In order to minimise the risk when using rivers or the coast for contact recreation, the following should be considered:

Clarity

Stagnant and/or murky water contains more pathogens than clear and/or flowing water. The amount of suspended solids in water which reduces water clarity, and agricultural run-off which can contain elevated levels of pathogens, are often related. A simple way of reducing the risk of contamination is to only swim in water in which feet can be seen when standing knee deep.

Discolouration, foams and odour

Water can be unsuitable for swimming if it has an unpleasant smell, if it is discoloured, or if there is foam or scum on the water's surface. Even if the water is relatively clear, foams, discolouration and/or odour are often a sign of contamination.

Rainfall

Rainfall can have a significant impact on water quality, particularly in freshwater. When it rains, some rain flows off the land as runoff which carries contaminants into rivers and lakes, and eventually the sea.

In areas of limited mixing, such as lakes or slow-flowing rivers, this can result in elevated levels of contaminants for several days after heavy rainfall. Areas with greater mixing, for example, open coastal sites where the tide flushes contaminants out to sea, are less susceptible to the effects of rainfall related runoff.

Photo 3: Kapiro Stream

Higher flows in rivers and stormy conditions along the coast can cause re-suspension of contaminants attached to river bank or bed sediment. High intensity rainfall can also affect municipal sewage and septic tank systems, resulting in overflow of human waste into water.

As a rule, it is recommended to wait 48 hours after heavy rainfall before swimming in freshwater or semi-enclosed coastal sites.

8. Recreational Contact Guidelines

National *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas* were released by the Ministry for the Environment and the Ministry of Health in June 2003. Where practicable, the RSWQP for Northland incorporated recommendations in the guidelines, and results from the programme can therefore be assessed against national criteria. This section provides an outline and discussion of the key aspects of the MfE and MoH guidelines, available online at: http://www.mfe.govt.nz/publications/fresh-water/microbiological-water-quality-guidelines-marine-and-freshwater-0.

Sites in the programme are monitored throughout the sampling season, based on single samples collected at weekly intervals. At the end of the season, sites are graded according to their compliance with the guidelines throughout the sampling season.

8.1 Single sample guidelines

The guidelines set a recommended course of action for the treatment of data collected during the survey season. Under the current guidelines, each sample falls into one of three categories depending on levels of faecal indicator bacteria present. At freshwater sites levels of *Escherichia coli* (*E. coli*) bacteria are measured and are graded as follow: Suitable (green), Alert (yellow), or Action (red), as shown in Table 1.

Table 1: Single sample guidelines for freshwater sites (MfE and MoH 2003)

***E. coli* concentration**	**Category**	**Suggested response**
sample≤260/100mL	Suitable	No response necessary – continue weekly sampling
260<sample≤540/100mL	Alert	Collect follow-up sample Undertake catchment assessment and sanitary survey where applicable to isolate source of faecal contamination
sample>540/100mL	Action	Collect follow-up sample Undertake sanitary survey when applicable Erect warning signs Inform public through the media that a public health risk exists

At open coastal sites levels of *Enterococci* (*Ent.*) bacteria are measured. Sites are graded as: Suitable (green), Alert (amber), or Action (red), as shown in Table 2. Where a coastal site is influenced by river input, or is considered to be semi-enclosed, e.g. harbours and estuaries, a combination of *Enterococci* bacteria and faecal coliforms are used to grade each site
Table 3). This approach is particularly useful in places where mangroves are present as levels of the indicator bacteria *Enterococci* can naturally occur in these areas and therefore using *Enterococci* alone could provide misleading results.

Table 2: Single sample guidelines for open coastal sites (MfE and MoH 2003)

Ent. concentration	Category	Suggested response
sample≤140/100mL	Suitable	No response necessary – continue weekly sampling
140<sample≤280/100mL	Alert	Collect follow-up sample Undertake catchment assessment and sanitary survey where applicable to isolate source of faecal contamination
sample>280/100mL	Action	Collect follow-up sample Undertake sanitary survey when applicable Erect warning signs Inform public through the media that a public health risk exists

Table 3: Single sample guidelines for enclosed coastal sites (harbours and estuaries)

Faecal coliform concentration	*Enterococci* concentration	Category	Status
sample≤150/100mL	sample ≤140/100mL	Suitable	Suitable + Suitable = Suitable
150<sample≤600/100mL	140<sample≤280/100mL	Alert	Any other combination = Alert
sample>600/100 mL	sample>280/100mL	Action	Action + Alert or Action+Action = Action

Results from the weekly sampling are sent to the District Councils and NDHB and are published weekly on the LAWA website – https://www.lawa.org.nz/explore-data/swimming/. Any 'Alert' or 'Action' results are notified to the relevant District Council within 24 hours so that further investigative sampling and/or erecting warning signs can be initiated.

8.2 End of season grading

The end of season grading at each site is determined by the microbiological assessment category (MAC) grading system (MfE/MoH, 2003). Sites are categorised into grades according to 95th percentile faecal indicator bacteria results obtained over the summer period. Grades are presented in Table 4 below:

Table 4: Microbiological Assessment Category (MAC) end of season grading

Grade	Freshwater (95th Percentile)	Coastal and Estuarine (95th Percentile)
A	*E. coli* ≤ 130/100mL	*Ent.* ≤ 40/100mL
B	130/100mL < *E. coli* ≤ 260/100mL	40/100mL < *Ent.* ≤ 200/100mL
C	260/100mL < *E. coli* ≤ 540/100mL	200/100mL < *Ent.* ≤ 500/100mL
D	*E. coli* > 540/100mL	*Ent.* > 500/100mL

9. Methodology

9.1 Sampling technique

Samples are collected weekly at selected freshwater and coastal sites throughout the summer months. In 2017-18, sampling was carried out from 4 December 2017 to 6 March 2018 at 46 coastal and 14 freshwater sites. While some other councils choose not to sample after rainfall, the Council collects water samples regardless of weather conditions although weather, tide and water temperature are recorded to provide some context for interpretation of the results.

Photo 4: Council staff taking water sample at Lake Waro, Hikurangi

Each sample is collected following the methods described in the MfE and MoH (2003) guidelines. Coastal water samples are taken from the shore using a sampling pole at about 0.5 metre depth, from approximately 15 centimetres below the surface. Freshwater samples are taken at approximately 30 centimetres below the surface, at approximately one metre depth. All samples are collected during daylight hours and sites are sampled in the same order each week. This ensures that, where practicable, samples are collected at around the same time each week.

9.2 Sample analysis

It is both difficult and expensive to measure the levels of pathogens in water. Instead, like other councils, the Council measures the levels of faecal indicator micro-organisms contained in 100 millilitres of water, in accordance with the MfE and MoH (2003) guidelines. In freshwater, several epidemiological studies have demonstrated a positive relationship between the presence of *E. coli* and pathogen (MfE 2002).

The New Zealand Marine Bathing Study commissioned by MfE and MoH in 1994 showed *Enterococci* was the indicator most closely associated with health effects in New Zealand marine waters. Faecal coliforms are not as closely related to human health effects; however, they are useful in specific environments, such as brackish or estuarine environments where levels of *Enterococci* may be misleading.

All samples are analysed by an independent laboratory using analytical procedures from the *Standard Methods for the Examination of Water and Wastewater* (APHA online edition).

10. Sampling Sites

Due to the large number of coastal and freshwater swimming sites in Northland, it is not practicable or economical to monitor them all and therefore the most popular sites were prioritised for monitoring. This section provides information on sites which were selected for monitoring in 2017-18 as well as those included in the permanent monitoring sites list. Sites that have been removed from the programme are listed in Appendix 3.

10.1 Sampling sites 2017-18

In the 2017-18 sampling season, a total of 14 freshwater sites and 46 coastal sites were monitored through the programme (Table 5). Sites with an asterisk indicate enclosed coastal sites throughout the report.

Table 5: Sites monitored in 2017-18

Coastal sites	Grid reference		Site No.	Sampling run
Far North District Council				
Ahipara campground	1614114	6109386	109871	Far North
Cable Bay	1644302	6127973	105780	North-east
Maitai Bay camp site	1637395	6145952	102326	Far North
Matauri Bay motor camp	1683324	6122702	102425	North-east
Omapere	1634874	6067432	102317	North-west
Opononi	1635376	6070804	106011	North-west
Paihia beside toilets	1699822	6094837	101194	BOI
Paihia Te Haumi	1700137	6093454	101195	BOI
Paihia Waitangi Bridge	1698267	6096116	101183	BOI
Rawene*	1646026	6083073	100236	North-west
Russell mid-north	1701762	6097524	105710	Far North
Taipa Estuary	1642856	6127391	105777	North-east
Tokerau Beach	1633974	6139217	109872	Far North
Waipapa Kauri	1615249	6122554	109873	Far North
Kaipara District Council				
Baylys Beach	1666750	6021176	109876	South-west
Glinks Gully	1677301	6006503	100798	South-west
Mangawhai Heads Beach	1743817	6006166	109890	South-east
Mangawhai Heads motor camp*	1743147	6005606	101210	South-east
Omamari Beach	1659853	6030465	109875	South-west
Pahi - 150m NW jetty*	1710590	5998103	102198	South-west
Tinopai below creek*	1712122	5987100	101232	South-west
Tinopai below shops	1712130	5987691	102310	South-west
Whangarei District Council				
Church Bay	1738528	6057429	105448	Tutukaka
Lang's Beach	1738350	6009900	108318	South-east
Matapouri southern bridge*	1736959	6062631	100711	Tutukaka
Matapouri northern bridge*	1736535	6063041	100712	Tutukaka
Ngunguru Estuary at Pakapaka Road*	1734960	6055124	100073	Tutukaka
Ngunguru Estuary at school	1737070	6056341	108320	Tutukaka
Oakura Bay	1722350	6083581	101345	BOI
Ocean Beach	1742107	6032989	109877	Whg heads
Ohawini Bay	1722090	6084082	105388	BOI
One Tree Point	1731539	6035180	109266	South-east
Onerahi playground*	1722792	6040203	101600	Whg heads
Otamure Bay	1732610	6071608	311666	Tutukaka
Pacific Bay	1738969	6057164	108313	Tutukaka
McLeod Bay	1735908	6035832	101254	Whg heads

Coastal sites	Grid reference		Site No.	Sampling run
Ruakaka Beach	1731913	6025221	108315	South-east
Ruakaka River	1731414	6025773	108314	South-east
Sandy Bay	1733651	6064285	109879	Tutukaka
Taurikura Bay	1737880	6034149	101262	Whg heads
Teal Bay	1723703	6077721	101331	BOI
Uretiti Beach	1732302	6019720	109888	South-east
Urquharts Bay	1738601	6031879	108311	Whg heads
Waipu Cove	1735915	6011855	108316	South-east
Wellingtons/Whangaumu Bay	1738576	6055370	109880	Tutukaka
Whananaki east beach	1733002	6069592	106938	Tutukaka
TOTAL COASTAL				**46**

Freshwater Sites	Grid Reference		Site No.	Sampling run
Far North District Council				
Kerikeri River Stone Store	1687631	6102447	101530	BOI
Kerikeri at Rainbow Falls	1685773	6102740	308794	BOI
Lake Ngatu	1618033	6122885	100402	Far North
Tirohanga Stream	1699502	6084784	102252	BOI
Victoria River	1639482	6108122	104908	North-east
Waimamaku at Wekaweka Road	1644868	6064405	308844	North-west
Waipapa River at forest pools	1662099	6096027	103248	North-west
Waipoua River at DOC HQ	1650503	6054513	108613	North-west
Waitangi River at Wakelins	1695283	6095847	101752	BOI
Kaipara District Council				
Ahuroa at Piroa Falls	1725149	6007913	317597	South-west
Lake Taharoa pump house	1659736	6037045	105434	South-west
Whangarei District Council				
Lake Waro (Hikurangi)	1716716	6061100	107272	Tutukaka
Raumanga Stream	1717608	6044187	103246	South-east
Whangarei Falls	1720857	6050300	105972	Tutukaka
TOTAL FRESHWATER				**14**

10.2 Permanent monitoring sites

A core group of 20 sites to be monitored every year to constitute a permanent monitoring list was randomly selected in 2007. Having a permanent set of sites enables environmental performance to be assessed over time, irrespective of sites being added or removed. The permanent monitoring sites are listed in Table 6. Results for the permanent monitoring sites are presented in section 11.

Table 6: Permanent monitoring sites

Site name	Site No.
Church Bay	105448
Kerikeri – Stone Store	101530
Lake Waro – Hikurangi	107272
Lang's Beach	108318
Matapouri – northern bridge*	100712
Ocean Beach	109877
Onerahi – playground*	101600
Opononi	106011
Pacific Bay	108313
Pahi – jetty*	102579
Paihia – Waitangi bridge	101183
Raumanga stream	103246
Ruakaka – by motor camp	108314
Taipa	105777
Taurikura	101262
Teal Bay	101331
Tinopai – below shops*	102310
Waipapa River – Puketi	103248
Waipoua River	108613
Waipu Cove	108316

11. Results and Interpretation

The results for all sites sampled in 2017-18 including both coastal and freshwater can be viewed in Appendix 1. Each 'Action' result has been cross-referenced with accumulated rainfall data recorded at the nearest rainfall station 72 hours prior to sampling, giving an indication of the influence of run-off on microbiological contamination. Northland monthly rainfall maps covering the 2017-18 summer period are presented in Appendix 2.

A brief summary of the results for relevant sites is given below. Detailed in section 12 is the investigation programme including sites listed for further analysis to identify the source of contamination. Sites with an asterisk indicate an enclosed coastal monitoring site throughout the report.

11.1 End of season grading – coastal sites

Figure 1: Coastal end of season grading 2017-18

The map above summarises the end of season grading for samples taken from each of the 46 coastal sites monitored in Northland during the 2017-18 sampling season (4 December 2017 to 6 March 2018). The grades indicate the 95th percentile enterococci bacteria results recorded at each site over the summer period.

While there are occasional exceedances of the "Action" level guidelines at sites with significant freshwater inputs (e.g. estuaries), generally coastal water quality in Northland is excellent with the majority of sites suitable for swimming on most sampling occasions.

Coastal areas can occasionally return 'Action' results. However, determining the source of contamination is difficult because 24 hours are required to process a sample and by this time the source of contamination has often been flushed out by the sea.

FAR NORTH

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Ahipara	14	13	1	17
Maitai Bay	14	14	0	n/a
Tokerau Beach	14	12	2	4.5, 49
Waipapakauri	14	14	0	n/a
Total	**56**	**53**	**3**	

NORTH EAST

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Coopers Beach	14	13	1	49
Matauri Bay	14	14	0	n/a
Taipa estuary	14	12	2	80, 49
Total	**42**	**39**	**3**	

NORTH WEST

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Omapere	14	12	2	34.5, 5.5
Opononi	14	14	0	n/a
Rawene*	14	12	2	(no rain), 58
Total	**42**	**38**	**4**	

SOUTH WEST

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Baylys Beach	14	14	0	n/a
Glinks Gully	14	14	0	n/a
Omamari Beach	14	14	0	n/a
Pahi jetty*	14	14	0	n/a
Tinopai at creek	14	14	0	n/a
Tinopai at school	14	14	0	n/a
Total	**98**	**98**	**0**	

SOUTH EAST

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
One Tree Point	14	14	0	n/a
Langs Beach midway	14	13	1	11.5
Mangawhai Heads motor camp*	14	13	1	105.1
Mangawhai Heads	14	14	0	n/a
Ruakaka Beach	14	14	0	n/a
Ruakaka River	14	13	1	64.6
Uretiti Beach	14	13	1	11.5
Waipu Cove Beach	14	13	1	11.5
Total	**112**	**107**	**5**	

BAY OF ISLANDS

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Oakura	14	14	0	n/a
Ohawini Bay	14	14	0	n/a
Paihia Te Haumi	14	12	2	58, (no rain)
Paihia Waitangi Bridge	14	12	2	58, (no rain)
Paihia toilets	14	13	1	58
Russell mid-north	14	14	0	n/a
Teal Bay	14	14	0	n/a
Total	**98**	**93**	**5**	

TUTUKAKA

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Church Bay	14	13	1	69.4
Matapouri Northern Bridge*	14	12	2	11, 69.4
Matapouri Southern Bridge*	14	12	2	8.5, 69.4
Ngunguru at Pakapaka Road*	14	13	1	69.4
Ngunguru at School	14	13	1	69.4
Otamure Bay	14	12	2	69.4, (no rain)
Pacific Bay	14	12	2	(no rain), 69.4
Sandy Bay	14	13	1	69.4
Wellingtons Bay	14	13	1	69.4
Whananaki at east beach	14	12	2	5, 69.4
Total	**140**	**125**	**15**	

WHANGAREI HEADS

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
McLeods Bay	14	13	1	(no rain)
Ocean Beach	14	13	1	63.5
Onerahi	14	13	1	74.6
Taurikura	14	13	1	5
Urquharts Bay	14	11	3	(no rain), 11, 69.4
Total	**70**	**63**	**7**	

11.2 Comparison of coastal results

Coastal results from 2017-18 compared to previous years are presented in Table 7 and Figure 2 below.

Table 7: Annual coastal swimming water quality results compared to previous results

Category	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
95-100% of samples <280 *Ent.* /100mL	27	21	45	22	26	29	29	31	40	45	17
90-95% of samples <280 *Ent.* /100mL	13	8	13	21	16	13	11	13	1	1	17
75-90% of samples <280 *Ent.* /100mL	4	12	5	16	5	5	7	3	3	0	12
<75% of samples <280 *Ent.* /100mL	1	2	0	2	1	0	0	0	0	0	0
Total	**45**	**43**	**63**	**61**	**48**	**47**	**47**	**47**	**44**	**46**	**46**

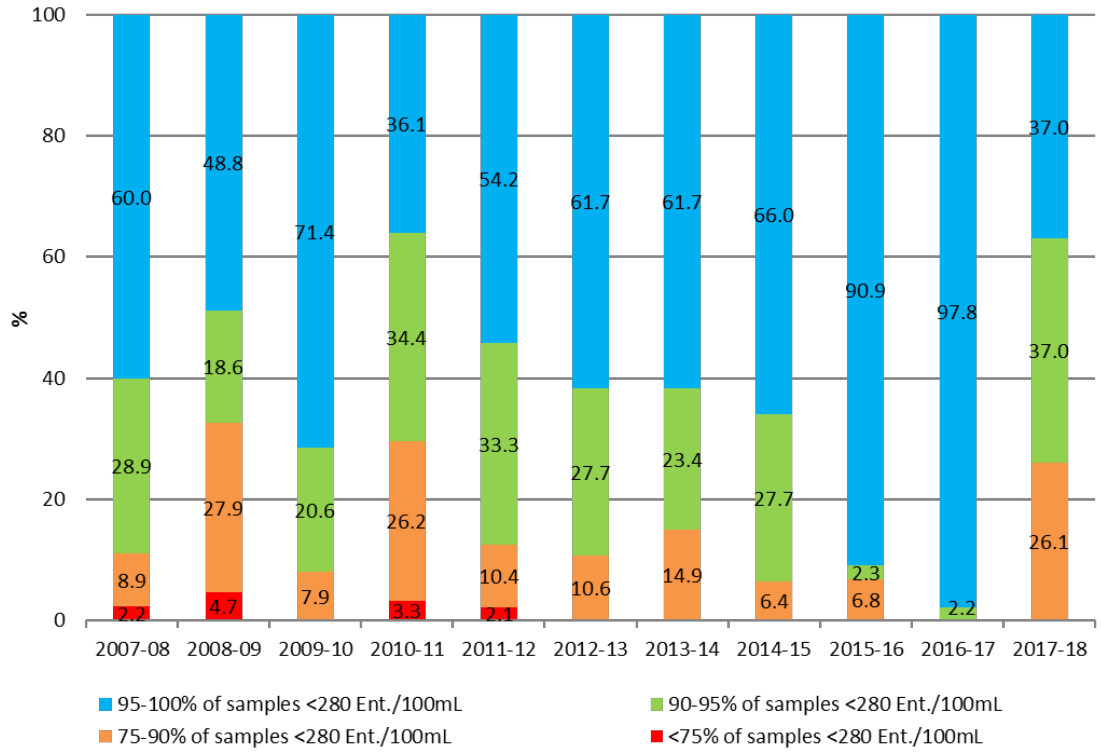

Figure 2: Yearly overall percentage of coastal sites with corresponding percentage of samples within each category from 2007 to 2018

Thirty seven percent of sites monitored in 2017-18 had more than 95 percent of samples fall below the 'Action' level guidelines. No sites had less than 75 percent compliance with the guidelines. Overall, the results from faecal indicator bacteria testing in 2017-18 were worse than 2016-17 which is likely attributed to frequent heavy rainfall during the summer.

11.3 Results for coastal permanent monitoring sites

Results for coastal permanent monitoring sites from 2007-08 to 2017-18 are presented in Table 8 below.

Table 8: Results for coastal permanent monitoring sites 2017-18

Site Name	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Church Bay	100	83	100	94	100	89	88	100	100	100	93
Langs Beach	100	100	100	94	100	94	94	100	100	100	93
Matapouri*	85	83	100	88	100	85	88	100	100	100	86
Onerahi*	100	100	100	89	100	94	100	93	100	100	93
Opononi	100	92	100	92	100	100	92	92	100	100	100
Pacific Bay	100	83	91	82	100	100	88	100	100	100	86
Pahi Jetty*	100	92	100	100	80	91	100	83	100	100	100
Paihia Beach	92	83	100	75	100	92	83	92	100	100	86
Ruakaka River	100	100	91	89	100	94	94	86	100	100	93
Taipa	92	100	100	92	100	100	100	92	100	93	86
Taurikura Bay	92	75	100	89	100	100	100	100	100	100	93
Teal Bay	92	92	100	100	88	100	100	100	100	100	100
Waipu Cove	100	100	100	94	100	100	100	100	100	100	93

Three permanent coastal sites complied with guidelines 100 percent of the time in 2017-18, six sites complied 93 percent of the time and four sites 86 percent of the time.

11.4 End of Season Grading – Freshwater Sites

Compared to the coast, river sites are more susceptible to rainfall related runoff from surrounding land. In summer, Northland is often subject to intense sub-tropical storm events which, combined with soils dominated by clay – which have poor infiltration rates and therefore less capacity to absorb water – the result is rapid runoff. During dry periods contaminants build up on the land and when a storm hits, the result is a 'first flush' of contaminant laden water. For this reason, poorer grades are usually recorded at river sites compared to those located at the coast or in freshwater lakes.

Figure 3: Freshwater end of season grading 2017-18

The map above summarises the end of season grading for samples taken from each of the 14 freshwater sites monitored in Northland during the 2017-18 sampling season (4 December 2017 to the 6 March 2018). The grades indicate the percentage of results below 'Action' level recorded at each site.

FAR NORTH AREA

Site name	No. samples	Suitable/Alert	Action	Rainfall related (mm, 72h accumulated rainfall)
Kerikeri Rainbow Falls	14	8	6	(no rain), (no rain), 12.5, 91.9, 1.5, 52.2
Kerikeri Stone Store	14	9	5	(no rain), 28, 12.5, 91, 51.5
Lake Ngatu	14	14	0	n/a
Tirohanga Stream	14	10	4	(no rain), 10, 113.5, (no rain)
Victoria River	14	13	1	31
Waimamaku River	14	7	7	28.5, 9, 4, 13.5, 7.5, 34.5 69.5
Waipapa River	14	11	3	9.5, 11, 38.5
Waipoua River	14	13	1	22.5
Waitangi River	14	12	2	94.5, 50
Total	**126**	**97**	**29**	

All eight rivers in the Far North recorded 'Action' results in 2017-18, most of which were likely to have been related to rainfall runoff. Kerikeri River and Tirohanga Stream reached 'Action' level on occasions which was unrelated to rainfall.

Kerikeri Rainbow Falls

Four of the six 'Action' results were likely to have been related to rainfall. This site has been monitored since 2013-14 and accounted for nine 'Action' results on 54 sampling occasions within the same time frame. This means the site was considered suitable for swimming 83 percent of the time during the summer season in the last 5 years.

This site has been included in the source tracking investigation programme since 2015-16. Microbial source tracking analyses has identified contamination caused by ruminant and possible wildfowl.

Kerikeri Stone Store

Four of the five 'Action' results were likely to have been related to rainfall. This site has been monitored since 2004-05 and accounted for 46 'Action' results on 175 sampling occasions within the same time frame. This means the site was considered suitable for swimming 74 percent of the time during the summer season in the last 13 years.

The site was part of the source tracking investigation programme from 2010-11 to 2013-14. Microbial source tracking analyses identified contamination caused by wildfowl and ruminant.

Tirohanga Stream

Two of the four 'Action' results were likely to have been related to rainfall. This site has been monitored since 2004-05 and accounted for 25 'Action' results on 171 sampling occasions within the same time frame. This means the site was considered suitable for swimming 85 percent of the time during the summer season in the last 13 years.

The site was part of the source tracking investigation programme in 2013-14 and 2014-15. Microbial source tracking analyses identified contamination caused by ruminant.

Victoria River

The 'Action' result was likely to have been related to rainfall. This site has been monitored since 2007-08 and accounted for 24 'Action' results on 137 sampling occasions within the same time frame. This means the site was considered suitable for swimming 83 percent of the time during the summer season in the last 10 years.

The site has been part of the investigation programme since 2011-12. Microbial source tracking analyses has identified contamination caused by wildfowl, ruminant, plant decay and humans.

Waimamaku River

The seven 'Action' level results were likely to have been related to rainfall. This site has been monitored since 2014-15 and accounted for 11 'Action' results on 54 sampling occasions within the same time frame. This means the site was considered suitable for swimming 80 percent of the time during the summer season in the last four years.

The site was part of the investigation programme in 2017-18. Microbial source tracking analyses has identified contamination caused by ruminant and wildfowl.

Waipapa River

The three 'Action' results were likely to have been related to rainfall. This site has been monitored since 2006-07 and accounted for 12 'Action' results out of 145 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92 percent of the time within the last year.

The site was part of the investigation programme in 2017-18. Microbial source tracking analyses has identified contamination caused by ruminant and wildfowl.

Waipoua River

The 'Action' result was likely to have been related to 5mm of rainfall. This site has been monitored since 2005-06 and accounted for 12 'Action' results on 157 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92 percent of the time during the summer season in the last 12 years.

The site was part of the investigation programme in 2017-18. Microbial source tracking analyses has identified contamination caused by ruminant and wildfowl.

Waitangi River

The two 'Action' results were likely to have been related to rainfall. This site has been monitored since 2012-13 and accounted for nine 'Action' results out of 76 sampling occasions within the same time frame. This means the site was considered suitable for swimming 88 percent of the time within the last five years.

The site was part of the source tracking investigation programme in 2013-14 and 2014-15. Microbial source tracking analyses identified contamination caused by ruminant.

WHANGAREI AREA

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Lake Waro	14	13	1	113
Raumanga Stream	14	12	2	57.8, 57.6
Whangarei Falls	14	9	5	23, 47, 82, (no rain), 25
Total	**42**	**34**	**8**	

Lake Waro
The 'Action' level result was likely to have been related to rainfall. This site has been monitored since 2009-10 and accounted for six 'Action' results out of 140 sampling occasions within the same time frame. This means the site was considered suitable for swimming 96 percent of the time within the last year.

Raumanga Stream
Both 'Action' results were likely to have been related to rainfall. This site has been monitored since 2004-05 and accounted for 30 'Action' results out of 199 sampling occasions within the same time frame. This means the site was considered suitable for swimming 85 percent of the time within the last year.

The site was part of the source tracking investigation programme in 2017-18. Microbial source tracking analyses identified contamination caused by ruminant and wildfowl.

Whangarei Falls
Four of the five 'Action' results were likely to have been related to rainfall. The other 'Action' result was unrelated to rainfall. This site has been monitored since 2004-05 and accounted for 66 'Action' results on 199 sampling occasions within the same time frame. This means the site was considered suitable for swimming 66 percent of the time during summer season in the last 13 years.

The site was part of the investigation programme from 2007-08 to 2010-11, 2015-16, 2016-17 and 2017-18. Microbial source tracking analyses identified contamination caused by wildfowl, ruminant and dog. Results from 2016-17 indicate ruminant and possible wildfowl contamination. Permanent signs are posted to warn the public of health risks from swimming at this site.

KAIPARA AREA

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Ahuroa River at Piroa Falls	14	3	11	9, 5.5, 11.5, 33.5, (no rain), 70.5, 72.5, (no rain), (no rain), (no rain)
Lake Taharoa	14	14	0	n/a
Total	**28**	**17**	**11**	

Ahuroa River at Piroa Falls
Seven of the 11 'Action' results were likely to have been related to rainfall. This site has been monitored since 2017-18 and accounted for 11 'Action' results out of 14 sampling occasions within the same time frame. This means the site was considered suitable for swimming 21 percent of the time within the last year.

The site was part of the source tracking investigation programme in 2017-18. Microbial source tracking analyses identified contamination caused by ruminant and wildfowl.

11.5 Comparison of freshwater results

Freshwater results from 2017-18 compared to previous years are presented in Table 9 below.

Table 9: Annual freshwater grades compared to national guidelines

Category	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
95-100% of samples <550 *E. coli*/100mL	1	2	6	4	2	4	3	4	2	4	2
90-95% of samples <550 *E. coli*/100mL	2	5	2	2	3	0	4	6	6	6	3
75-90% of samples <550 *E. coli*/100mL	6	7	6	9	3	6	4	2	4	3	3
<75% of samples <550 *E. coli*/100mL	12	5	9	9	2	2	1	1	1	0	6
Total	**21**	**19**	**23**	**24**	**10**	**12**	**12**	**13**	**13**	**13**	**14**

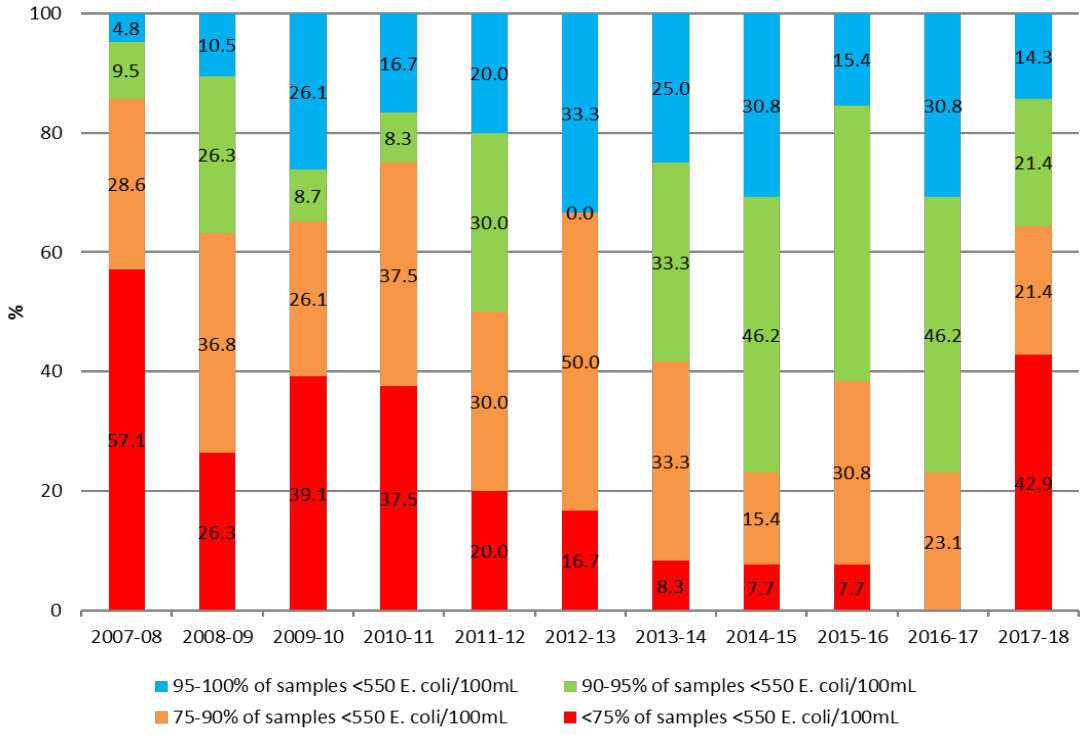

Figure 4: Yearly overall percentage of freshwater sites with corresponding percentage of samples within each category from 2007 to 2018

Around 35 percent of sites in 2017-18 had more than 90 percent of samples fall below 'Action' faecal indicator bacteria levels. This is lower in comparison to 2016-17 which recorded 77 percent of sites. Around 43 percent of sites fell in the less than 75 percent compliance category in 2017-18 which is higher than many previous results.

11.6 Results for freshwater permanent monitoring sites

Results for freshwater permanent monitoring sites from 2007-08 to 2017-18 are presented in Table 10 below.

Table 10: Results for freshwater permanent monitoring sites 2017-2018

Site Name	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Kerikeri River	77	67	72	67	73	55	83	82	69	86	57
Lake Waro			100	82	94	100	100	100	93	100	93
Raumanga Stream	54	92	100	82	81	88	94	93	93	100	86
Waipapa River	92	92	100	100	90	82	92	92	100	93	79
Waipoua River	85	92	83	92	89	100	92	100	93	93	86

It should be noted that even in rivers which originate in pristine forested catchments (such as Waipapa and Waipoua rivers) high counts of the indicator bacteria *E. coli* are recorded after rainfall. The likely source of contamination is plant decay, or possibly wild animals like possums, pigs or goats. As a general rule, the council recommends swimming should be avoided for two to three days after rainfall.

12. Site Investigation

Sites which consistently recorded elevated bacteria levels have been investigated using several techniques to identify the source(s) of contamination. Water quality testing undertaken through this programme has shown that some swimming sites have been considered unsuitable for swimming on a regular basis. These sites have results which regularly fall outside the swimming guidelines. Other sites with generally good water quality, but occasionally record elevated bacteria levels have also been investigated, although in most cases the source of contamination is not immediately obvious. The results from this work help determine suitable management initiatives to improve water quality at these sites.

More details about the investigation strategy implemented for the 2017-18 summer are available in the *Problem Sites Investigation – Update and On-Going Strategy*, document reviewed and published yearly, and accessible on the Council's website at www.nrc.govt.nz/swimming.

12.1 Methodology

Investigative work includes taking samples for microbial source tracking, catchment profiling and undertaking sanitary surveys where microbial source tracking returned a positive result from human source, or where specific toilets/septic tank systems were suspected to be faulty.

12.1.1 Microbial source Tracking

Several analytic techniques are used to assist in identifying the source of bacterial contamination in water. These include faecal sterol ratio (FSR) analysis, fluorescent whitening agents (FWAs) and polymerase chain reaction (PCR) markers.

Faecal Sterols Ratio Analysis

Sterols are neutral lipids that have important biological functions in plants and animals, such as for cell membrane structure, e.g. cholesterol. The sterol profile in faeces depends on the animal's diet, internally produced sterols and the bacteria in the animal's gut. Consequently, analysis of sterol composition of animal faeces can generate distinctive faecal sterol fingerprints. The ratio of different sterols in a water sample can be used to narrow down the potential source(s) of bacterial contamination to either humans, herbivores (animals whose main diet consists of vegetation, including cattle, sheep, deer and goats), and plant decay and/or run-off from vegetation.

Fluorescent Whitening Agents

Fluorescent whitening agents (FWAs) are common constituents of washing powders and only one is used in New Zealand. In most household's effluent from toilets is mixed with grey water from washing machines and therefore FWAs are usually associated with human faecal contamination in both septic tanks and community wastewater systems.

Polymerase chain reaction Markers

Polymerase chain reaction (PCR) markers show the difference between closely related bacteria using DNA sequencing. In some cases, this bacterium is highly host specific, i.e. only associated with the faecal material of one animal or animal group. Therefore, the type of animal that the bacteria came from can sometimes be identified.

PCR markers for the following host groups have been developed: human, ducks (wildfowl), ruminants (includes sheep, cattle, deer and goats), possums and pigs, as well as a general indicator for faecal contamination.

12.1.2 Catchment Profiling

Catchment profiling involves mapping catchment land-use around problem sites so that potential sources of contamination can be identified, such as pastoral farming or septic tank soakage fields. Therefore, this is carried out only if the first microbial source tracking result returns a contamination source(s) from ruminant or human.

Once catchment land-use has been mapped for each site, water samples are collected from key locations within each catchment to identify where bacterial levels are at their lowest and highest. This information provides an indication of where contamination is originating from, and in some cases, can point to a specific source of pollution.

12.1.3 Sanitary Surveys

A sanitary survey involves inspecting the septic tank and associated soakage field of each property in order to identify any failing or poorly maintained systems, which could be contributing to the water body contamination. Sanitary surveys will only be completed by the relevant District Council if results from microbial source tracking indicate the presence of FWAs or human markers.

12.2 Site investigation results

In order to carry out microbial source tracking analyses, FIB levels need to be above the 'Action' level criteria for swimming, i.e. above 540 *E. coli*/100mL for freshwater and 280 *Enterococci*/100mL for coastal water. Microbial source tracking analytic techniques are a constantly evolving science and markers are now detected with different strengths.

An overview of results from microbial source tracking work undertaken since 2007 is presented in Table 11. Investigations continued in 2017-18 at sites where results had been inconclusive in previous years. Additional sites with recurrent water quality issues were also added to the programme in 2017-18. These sites included:

- Ahuroa at Piroa Falls
- Waimamaku at Wekaweka Road
- Waipapa at Waihou Valley
- Waipoua at Swimming Hole

A total of 14 sites were listed as part of the investigation programme in 2017-18. All 14 sites returned 'Action' level bacterial concentrations (Table 11).

Table 11: Overview of results from microbial source tracking work undertaken since 2007. Sources in bold indicate a strong positive marker. Source in plain designate a positive or a weak positive marker. Site names in bold are permanent monitoring sites and sites with an asterisk indicate an enclosed coastal site. D: Dog, H: Human, R: Ruminant, W: Wildfowl, P: Plant decay.

Site	2007/08	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Ahuroa at Piroa Falls										R/W
Coopers Beach		**D/W**	**R/W**/P							
Hatea at Whangarei Falls	**R/W**	**W**	**D/R/W**					R/W	R/W	R/W
Kaihu River			**R/W**							
Kapiro Stream			**R/W**							
Kerikeri at Rainbow Falls								R	R/W	**R**/W
Kerikeri at Stone Store			**W**	**R**	**R/W**					
Kerikeri at Skudders Beach			R/W							
Langs Beach at Toilets	**R/W**	**W**	**D/R/W**							
Langs Beach (Midway)	**R/W**	**W**								
Mangawhai Motor Camp*			**W**	**W**						
Matapouri Northern Bridge*			**R/W**		R/**W**/P	**R/W/P**	R/**W/P**			
Matapouri Southern Bridge*			**W**				R/**W/P**			**W**
Ngunguru at School			**W**	**W**						
Ocean Beach Stream	**W**		**H**/R/W							
Omamari Beach Stream			**R**							
Omapere at Pioneer Walk Road										R/**W**
Otamure Bay Stream	**R/W**	**R/W**	**R**							
Pacific Bay Stream		**W**								
Pahi at Jetty*		**H**		**W**	**W**/P					
Paihia at Te Haumi River					W/P					

Site	2007/08	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Paihia at Waitangi Bridge					**R**/W	**R/W**	**R**			**R**/W
Raumanga at Park	**W**				H	R/W/P	**R**	W		R/**W**
Rawene Estuary										**R**
Ruakaka Motor Camp					**R**	**R**	**R**/W/H			**R**
Tirohanga						**R**/P	**R**			
Victoria at DOC Reserve				**W**	W/P/H	W/**P**	H	R/W	W	W
Waimamaku at Wekaweka Road										**R**/W
Waipapa at Waihou Valley										R/W
Waipoua at Swimming Hole										R/W
Waipu Cove		**W**	**D/R/W**							
Waitangi at Wakelins						**R**	**R**			
Wellington's Bay										W
Woolley's Bay						**W**/P				

13. Water Quality for Recreational Shellfish Gathering

In addition to assessing sites for their suitability for swimming, results from popular shellfish gathering sites were compared to the MfE and MoH microbiological guidelines for shellfish gathering. The guidelines are based on those used by the shellfish industry and are globally recognised. The guidelines use faecal coliforms in the water as an indicator of the potential presence of pathogens and viruses in shellfish; they do not intend to measure bacteria levels in the shellfish directly.

Although the Council uses these guidelines to grade sites for recreational shellfish gathering, the method used to count the number of faecal coliforms present in a water sample differs from the one recommended in the guidelines. The Council uses colony forming units (CFU) which is a direct measure of bacteria grown on an agar plate used in microbiology. This means results may differ slightly when compared to the most probable number (MPN) method. Despite this, the two methods give results that are close enough for comparing to the guidelines.

13.1 Guideline values

There are two guideline values for assessing water quality for shellfish gathering:

- The median faecal coliform content of samples taken over the entire shellfish gathering season shall not exceed a most probable number (MPN) of 14/100mL;

And

- No more than 10 percent of samples should exceed an MPN of 43/100mL.

13.2 Results 2017-18

The results for 15 permanent shellfish monitoring sites sampled during 2017-18 are presented in Table 12.

Table 12: Results for recreational shellfish gathering permanent monitoring sites 2017-18

		Week																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14					
Permanent shellfish monitoring sites	Site No.	4 Dec 17	11 Dec 17	18 Dec 17	25 Dec 17	1 Jan 18	8 Jan 18	15 Jan 18	22 Jan 18	29 Jan 18	5 Feb 18	12 Feb 18	19 Feb 18	26 Feb 18	5 Mar 18	Samples	Exceedance	Exceedance %	Median	Pass / Fail
Baylys Beach at Sea View Road	109876	10	10	10	10	10	10	10	10	10	10	40	10	10	10	14	0	0%	10	Pass
Mangawhai Heads at Motor Camp	101210	20	10	40	10	20	10	10	20	90	10	1280	20	10	30	14	2	14%	20	Fail
Matauri Bay at Campground	102425	10	10	10	10	10	10	10	10	20	10	20	20	10	50	14	1	7%	10	Pass
Ngunguru Estuary at School	108320	130	10	10	10	30	10	100	10	20	10	2000	10	10	10	14	3	21%	10	Fail
Oakura Bay at North End	101345	10	10	10	10	50	10	10	50	10	10	50	10	10	10	14	3	21%	10	Fail
Ocean Beach at Mid Beach	109877	10	10	10	10	10	10	10	10	10	10	2000	10	10	10	14	1	7%	10	Pass
Ohawini Bay	105388	10	10	20	10	30	10	10	70	10	10	660	10	10	10	14	2	14%	10	Fail
One Tree Point at Intertidal Beach	109266	10	10	10	10	40	30	10	10	20	10	10	10	10	10	14	0	0%	10	Pass
Paihia at Te Haumi	101195	10	10	10	10	90	10	30	10	40	10	480	1790	10	30	14	3	21%	10	Fail
Ruakaka River at Below Motor Camp	108314	20	10	20	30	110	10	90	10	30	60	1480	90	90	40	14	6	43%	35	Fail
Sandy Bay at Mid Beach	109879	1100	10	10	10	20	10	10	10	30	20	2000	10	10	10	15	2	13%	10	Fail
Taipa Estuary at Boat Ramp	105777	10	20	10	40	10	180	10	40	10	10	1080	10	10	370	14	3	21%	10	Fail
Teal Bay	101331	30	10	10	10	130	10	30	130	30	10	100	90	10	70	14	5	36%	30	Fail
Tinopai at Below Shops	102310	10	10	10	10	50	10	30	90	20	10	30	10	10	10	14	2	14%	10	Fail
Urquharts Bay	108311	1920	10	10	10	820	10	10	10	660	10	140	10	10	10	15	4	27%	10	Fail

Results indicated that four out of 15 of the permanent sites monitored were within the MfE and MoH guidelines for shellfish gathering in 2017-18, However, it is important to note that samples were only collected over the summer months rather than for the entire shellfish gathering season, which excluding scallops, is all year round in Northland. Therefore, these results can only be used as an indication of the suitability for shellfish gathering at a site.

14. Summary and Conclusions

14.1 Coastal sites

The results from 2017-18 indicate that 88.7 percent of the samples collected at coastal sites were considered suitable for recreational use throughout the season. While there are occasional exceedances of the "Action" level guidelines at sites with significant freshwater inputs (e.g. estuaries) and after heavy rainfall, generally coastal water quality in Northland is excellent with the majority of sites suitable for swimming on most sampling occasions.

In comparison to guidelines, 17 coastal sites met the guideline values and were considered suitable for swimming 100 percent of the time, 17 sites were considered suitable for swimming on all but one sampling occasion and 12 sites on all but two occasions.

Many of the 'Action' results recorded for coastal sites can be attributed to frequent and heavy rainfall during the summer.

14.2 Freshwater sites

The results from 2017-18 indicate that 56.6 percent of the samples collected at freshwater sites were considered suitable for recreational use throughout the season.

In comparison to guidelines, two freshwater sites met the suitable for swimming criteria 100 percent of the time, three sites on all but one occasion and three sites on all but two sampling occasions. Six freshwater sites were considered unsuitable for swimming on three or more occasions during the summer.

Overall, 48 'Action' levels were recorded for 12 of the 14 freshwater sites, of which 79 percent were likely to have been related to rainfall.

14.3 Site investigation

Fourteen sites were listed in the investigation programme in 2017-18 and microbial source tracking analyses were carried out for each sample above 'Action' level. Results indicated ruminant and/or wildfowl contamination at all sites.

14.4 Shellfish gathering

The results for the 15 permanent monitoring sites sampled during 2017-18 for their suitability for recreational shellfish gathering indicated that four sites were within the microbiological water quality guidelines.

15. Key Recommendations

- Continue to monitor a key group of sites on a weekly basis through the summer of 2018-19, including the 20 permanent monitoring sites.

- Continue to disseminate water quality information to the Territorial Local Authorities (TLAs) and the District Health Board (DHB), as per the guidelines, and display results from sampling on the Council and national reporting 'LAWA' websites.

- Reassess, in consultation with relevant stakeholders, the sites listed in the monitoring programme, including potential new sites and sites with consistent high and/or low bacteria levels.

- Design the investigation programme for 2018-19 season according to the following:

    - Remove the following sites from the investigation programme due to consistent MST results indicating ruminant and/or wildfowl contamination:
        - Ahuroa at Piroa Falls
        - Hatea at Whangarei Falls
        - Kerikeri at Rainbow Falls

    - Continue investigating water quality at the following sites:
        - Paihia at Waitangi Bridge
        - Raumanga Stream
        - Ruakaka River
        - Victoria River
        - Waitangi River
        - Waimamaku River
        - Omapere at Pioneer Walk Road
        - Rawene Estuary
        - Matapouri Southern Bridge
        - Waipapa at Waihou Valley
        - Waipoua at swimming hole

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17. Abbreviations

FIB: faecal indicator bacteria
FNDC: Far North District Council
KDC: Kaipara District Council
MfE: Ministry for the Environment
MoH: Ministry of Health
NDHB: Northland District Health Board
NIWA: National Institute of Water and Atmospheric research
PCE: Parliamentary Commissioner for the Environment
RSWQP: Recreational Swimming Water Quality Programme
TLAs: Territorial Local Authorities
WDC: Whangarei District Council

18. Appendices

18.1 Appendix 1 – Results 2017-18

Enterococci MPN results for coastal swimming sites in 2017-2018

MfE guidelines 2003	**Single sample**
Alert (orange) mode	**Ent. > 140**
Action (red) mode	Ent. > 280
FU	Follow-up sample

Far North	**Site No#**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**25 Dec 17**	**FU**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**12 Feb 18**	**FU**	**19 Feb 18**	**FU**	**26 Feb 18**	**FU**	**5 Mar 18**	**FU**
Ahipara at Kaka Street	109871	< 10		< 1		20	10		20	10		< 10		12033	2420	< 10		< 10	10		41		74		110	
Waipapakauri Beach	109873	< 10		< 10		< 10	< 10		< 10	< 10		31		< 10		< 10		< 10	10		10		< 10		< 10	

North East (Coopers Beach to Matauri Bay)	**Site No#**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**25 Dec 17**	**FU**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**12 Feb 18**	**FU**	**19 Feb 18**	**FU**	**26 Feb 18**	**FU**	**5 Mar 18**	**FU**
Cooper's Beach Foreshore	101066	< 10		10		228	< 10		10	20		63		228		74		41	160		< 10		< 10		459	305
Maitai Bay at South End	102326	< 10		< 10		< 10	10		52	< 10		< 10		63		31		31	< 10		< 10		< 10		< 10	
Matauri Bay at Campground	102425	31		< 10		< 10	< 10		< 10	< 10		10		20		20		10	10		< 10		< 10		209	10
Taipa Estuary at Boat Ramp	105777	< 10		52		10	62		< 10	203	387	10		63		< 10		10	808		< 10		75		862	31
Tokerau Beach at Melissa Road	109872	41		< 10		< 10	< 10		561	20		10		31		< 10		20	31		10		10		9208	402

North West (Hokianga Harbour)	**Site No#**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**25 Dec 17**	**FU**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**12 Feb 18**	**FU**	**19 Feb 18**	**FU**	**26 Feb 18**	**FU**	**5 Mar 18**	**FU**
Omapere at Pioneer Walk Road	102317	158	326	185	435	62	< 10		< 10	10		< 10		488	648.8	< 10		10	98		627	87	< 10		10	
Opononi at Hokianga Harbour	106011	74		< 10		< 10	< 10		20	< 10		10		< 10		10		< 10	10		62		< 10		< 10	
Rawene at Past Ramp	100236	31		10		31	< 10		10	20	649	1081	> 2419.6	203	579.4	63		30	1112		< 10		20		< 10	

South West (Kaipara District)	**Site No#**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**25 Dec 17**	**FU**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**12 Feb 18**	**FU**	**19 Feb 18**	**FU**	**26 Feb 18**	**FU**	**5 Mar 18**	**FU**
Baylys Beach at Sea View Road	109876	< 10		< 10		< 10	< 10		20	< 10		< 10		< 10		< 10		< 10	62		31		< 10		< 10	
Glinks Gully at Marine Drive	100798	< 10		< 10		< 10	< 10		10	< 10		< 10		< 10		< 10		< 10	< 10		< 10		< 10		< 10	
Omamari Beach	109875	< 10		< 10		< 10	< 10		< 10	< 10		< 10		10		< 10		< 10	< 10		20		< 10		< 10	
Pahi at Jetty	102198	< 10		< 10		41	< 10		< 10	< 10		< 10		< 10		< 10		20	226	119	< 10		10		10	
Tinopai at Below Puapua Creek	101232	10		10		< 10	< 10		51	< 10		10		269		< 10		< 10	20		< 10		171	481	31	
Tinopai at Below Shops	102310	< 10		< 10		< 10	< 10		31	20		52		51		41		< 10	< 10		30		< 10		98	

South East (One Tree Point to Mangawhai Harbour)	**Site No#**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**25 Dec 17**	**FU**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**12 Feb 18**	**FU**	**19 Feb 18**	**FU**	**26 Feb 18**	**FU**	**5 Mar 18**	**FU**
Langs Beach at Mid Beach	108318	10		< 10		< 10	< 10		309	< 10		< 10		10		< 10		10	< 10		< 10		31		< 10	
Mangawhai Heads at Motor Camp	101210	30		< 10		< 10	< 10		20	< 10		10		52		41		85	1414	132	96		< 10		41	
Mangawhai Heads at Open Coast	109890	20		< 10		< 10	< 10		160	< 10		< 10		< 10		< 10		52	< 10		< 10		< 10		< 10	
One Tree Point at Intertidal Beach	109266	< 10		< 10		< 10	< 10		< 10	63		< 10		10		< 10		20	< 10		< 10		< 10		10	
Ruakaka Beach at Surf Club	108315	< 10		< 10		< 10	< 10		< 10	< 10		10		< 10		< 10		< 10	75		< 10		< 10		< 10	
Ruakaka River at Below Motor Camp	108314	20		< 10		10	30		< 10	< 10		41		31		20		52	408		96		86		51	
Uretiti Beach at Tip Road	109888	31		< 10		< 10	< 10		364	< 10		< 10		< 10		10		20	132		< 10		< 10		< 10	
Waipu Cove at Beach	108316	10		< 10		< 10	10		369	< 10		52		< 10		107		10	10		< 10		< 10		20	

Bay of Islands	Site No#	4 Dec 17	FU	11 Dec 17	FU	18 Dec 17	25 Dec 17	FU	1 Jan 18	8 Jan 18	FU	15 Jan 18	FU	22 Jan 18	FU	29 Jan 18	FU	5 Feb 18	12 Feb 18	FU	19 Feb 18	FU	26 Feb 18	FU	5 Mar 18	FU
Oakura Bay at North End	101345	< 10		< 10		< 10	< 10		75	< 10		< 10		10		< 10		20	10		< 10		< 10		< 10	
Ohawini Bay	105388	< 10		< 10		63	121		98	< 10		< 10		20		31		52	98		10		< 10		< 10	
Paihia at Te Haumi	101195	< 10		< 10		< 10	< 10		158	10		31		< 10		31		< 10	301		2723	> 2420	10		171	121
Paihia at Toilets	101194	10		< 10		< 10	< 10		275	110		160	> 2419.6	30		30		< 10	422		20		< 10		119	
Paihia at Waitangi Bridge	101183	< 10		< 10		< 10	< 10		241	52		10		10		52		63	884		1296	> 2420	10		107	
Russell at Mid North Moorings	105710	< 10		< 10		20	< 10		41	< 10		10		< 10		10		10	52		98		< 10		31	
Teal Bay	101331	< 10		10		< 10	< 10		231	< 10		< 10		75		10		< 10	20		31		< 10		62	

Tutukaka	Site No#	4 Dec 17	FU	11 Dec 17	FU	18 Dec 17	25 Dec 17	FU	1 Jan 18	8 Jan 18	FU	15 Jan 18	FU	22 Jan 18	FU	29 Jan 18	FU	5 Feb 18	12 Feb 18	FU	19 Feb 18	FU	26 Feb 18	FU	5 Mar 18	FU
Church Bay at Mid Bay	105448	10		< 10		< 10	< 10		160	< 10		< 10		< 10		86		< 10	15531		< 10		< 10		74	
Matapouri Bay at Northern Bridge	100712	20		30		10	187	20	5717	31		31		< 10		110		41	17329		< 10		20		63	
Matapouri Bay at Southern Bridge	100711	41		122		< 10	504	75	197	31		75		< 10		96	833	10	11199		< 10		132	256	10	
Ngunguru Estuary at Motor Camp	100073	73		< 10		< 10	< 10		97	< 10		< 10		< 10		10		< 10	1076		74		< 10		20	
Ngunguru Estuary at School	108320	41		< 10		10	20		20	< 10		63		10		41		< 10	2489		23		< 10		52	
Otamure Bay	311666	41		10		10	75		213	< 10		41		52		20		20	> 24196		10		288	< 10	10	
Pacific Bay	108313	388	31	< 10		< 10	20		146	< 10		< 10		20		52		63	12033		31		< 10		148	
Sandy Bay at Mid Beach	109879	161	< 10	< 10		< 10	< 10		52	20		< 10		< 10		41		10	> 24196		10		97		< 10	
Wellington's Bay	109880	< 10		< 10		< 10	< 10		< 10	< 10		< 10		31		< 10		98	4106		< 10		< 10		146	
Whananaki at East Beach	106938	< 10		< 10		10	173	10	63	< 10		< 10		< 10		657	1515	< 10	> 24196		< 10		< 10		31	

Whangarei Heads including Onerahi and Pataua	Site No#	4 Dec 17	FU	11 Dec 17	FU	18 Dec 17	25 Dec 17	FU	1 Jan 18	8 Jan 18	FU	15 Jan 18	FU	22 Jan 18	FU	29 Jan 18	FU	5 Feb 18	12 Feb 18	FU	19 Feb 18	FU	26 Feb 18	FU	5 Mar 18	FU
McLeod Bay at Toilets	101254	20		10		< 10	75		10	< 10		331	10	20		63		< 10	20		10		< 10		< 10	
Ocean Beach at Mid Beach	109877	31		< 10		< 10	< 10		20	< 10		< 10		< 10		10		< 10	10462		< 10		10		< 10	
Onerahi at Opposite Playground	101600	175	< 10	< 10		31	< 10		10	< 10		169	455	< 10		134	108	41	1354		201		31		20	
Taurikura Bay	101262	< 10		< 10		< 10	< 10		20	10		10		< 10		620	135	< 10	169		52		< 10		< 10	
Urquharts Bay	108311	884	< 10	10		31	< 10		6131	10		< 10		< 10		120		85	336		10		< 10		< 10	

E. coli results for freshwater swimming sites in 2017-2018

MfE guidelines 2003	**Single sample**
Alert (orange) mode	**E.coli > 260**
Action (red) mode	E. coli > 540
FU	Follow-up sample

Whangarei Area	Site No.	4 Dec 17	FU	11 Dec 17	FU	18 Dec 17	FU	25 Dec 17	1 Jan 18	8 Jan 18	FU	15 Jan 18	FU	22 Jan 18	FU	29 Jan 18	FU	5 Feb 18	FU	12 Feb 18	19 Feb 18	FU	26 Feb 18	5 Mar 18	FU
Hatea at Whangarei Falls	105972	269		676		265		359	155	231		216		420		455		5794		9804	581		399	909	
Lake Waro at Launch Site	107272	20		< 10		10		20	10	31		10		10		< 10		30		3255	10		10	41	
Raumanga at Raumanga Valley Park	103246	52		336	3654	233		156	305	175		496	8664	388	595	285	556	1497		609	160		233	282	

Far North Area	Site No.	4 Dec 17	FU	11 Dec 17	FU	18 Dec 17	FU	25 Dec 17	1 Jan 18	8 Jan 18	FU	15 Jan 18	FU	22 Jan 18	FU	29 Jan 18	FU	5 Feb 18	FU	12 Feb 18	19 Feb 18	FU	26 Feb 18	5 Mar 18	FU
Kerikeri at Rainbow Falls	308794	373	160.7	249		820		209	246	336	517.2	160		464	> 2419.6	546	260.3	10462	260.3	932	571	1553.1	231	17329	563
Kerikeri at Stone Store	101530	132		148		959		209	670	148		233		315	> 2419.6	1046	517.2	6867	129.1	884	364	1046.2	122	19863	364
Lake Ngatu at South End	100402	10		< 10		< 10		197	10	20		10		122		10		< 10		< 10	< 10		< 10	< 10	
Tirohanga at Tirohanga Road	102252	211		426	686.7	638		295	292	345	547.5	199		583	> 2419.6	160		253		960	495	1553.1	933	474	373
Victoria at DOC Reserve Crossing	104908	171		226		259		309	323	464	272.3	233		809	185	253		369		185	135		107	355	576
Waimamaku at Wekaweka Road	308844	733	261.3	169		169		563	1850	683	325.5	794	365.4	598	190.4	108		231		581	144		168	218	
Waipapa at Waihou Valley	103248	75		41		161		52	51	650	365.4	144		794	1553.1	228		512	137.6	285	199		31	4611	722
Waipoua at Swimming Hole	108613	464	127.4	98		187		122	< 10	201		189		1565	228.2	218		146		171	84		41	183	
Waitangi at Wakelins	101752	85		148		146		144	75	295	285.1	41		345	> 2419.6	135		108		1081	249		146	7270	480

Kaipara Area	Site No.	4 Dec 17	FU	11 Dec 17	FU	18 Dec 17	FU	25 Dec 17	1 Jan 18	8 Jan 18	FU	15 Jan 18	FU	22 Jan 18	FU	29 Jan 18	FU	5 Feb 18	FU	12 Feb 18	19 Feb 18	FU	26 Feb 18	5 Mar 18	FU
Ahuroa at Piroa Falls	317597	307	228	565	388	262	173	712	959	637	676	408		857		886	1396	2098		934	1515		1616	1119	
Lake Taharoa at Pump House	105434	< 10		< 10		< 10		< 10	31	< 10		< 10		20		< 10		< 10		< 10	< 10		< 10	< 10	

E. coli results for freshwater swimming sites in 2017-2018

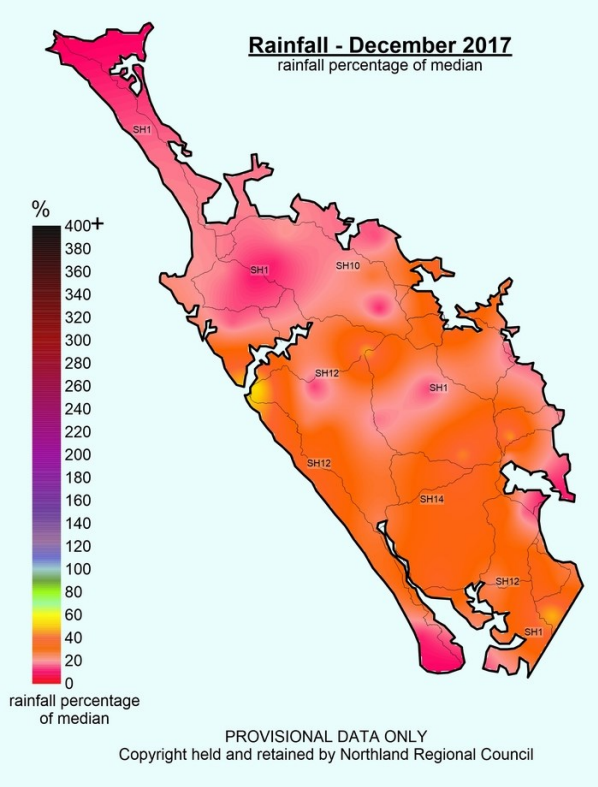
MfE guidelines 2003	**Single sample**
Alert (orange) mode	**E.coli > 260**
Action (red) mode	E. coli > 540
FU	Follow-up sample

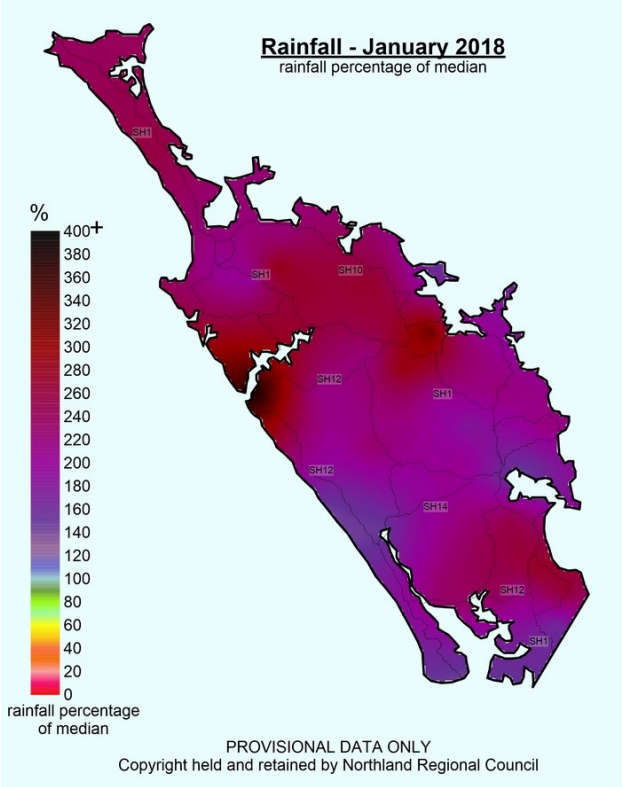
Whangarei Area	**Site No.**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**FU**	**25 Dec 17**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**FU**	**12 Feb 18**	**19 Feb 18**	**FU**	**26 Feb 18**	**5 Mar 18**	**FU**
Hatea at Whangarei Falls	105972	269		676		265		359	155	231		216		420		455		5794		9804	581		399	909	
Lake Waro at Launch Site	107272	20		< 10		10		20	10	31		10		10		< 10		30		3255	10		10	41	
Raumanga at Raumanga Valley Park	103246	52		336	3654	233		156	305	175		496	8664	388	595	285	556	1497		609	160		233	282	

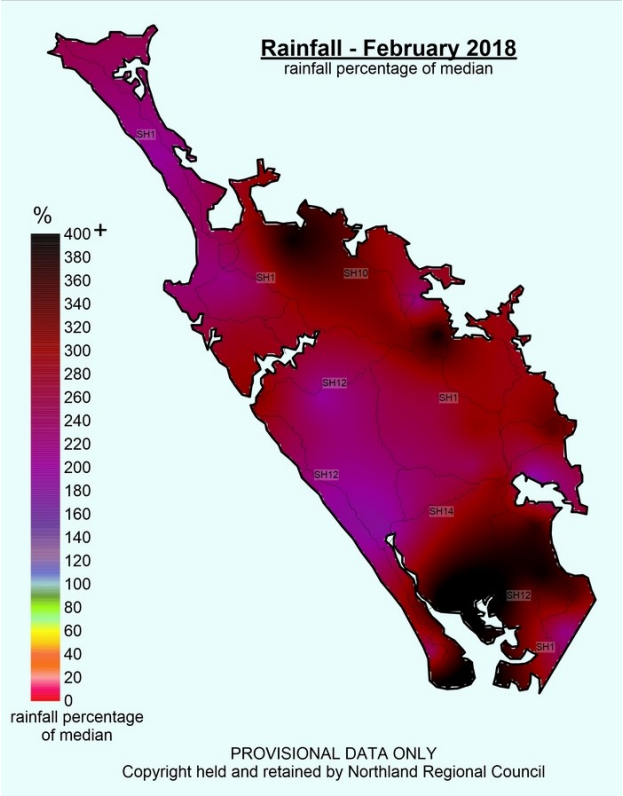
Far North Area	**Site No.**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**FU**	**25 Dec 17**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**FU**	**12 Feb 18**	**19 Feb 18**	**FU**	**26 Feb 18**	**5 Mar 18**	**FU**
Kerikeri at Rainbow Falls	308794	373	161	249		820		209	246	336	517	160		464	> 2419.6	546	260	10462	260.3	932	571	1553	231	17329	563
Kerikeri at Stone Store	101530	132		148		959		209	670	148		233		315	> 2419.6	1046	517	6867	129.1	884	364	1046	122	19863	364
Lake Ngatu at South End	100402	10		< 10		< 10		197	10	20		10		122		10		< 10		< 10	< 10		< 10	< 10	
Tirohanga at Tirohanga Road	102252	211		426	687	638		295	292	345	548	199		583	> 2419.6	160		253		960	495	1553	933	474	373
Victoria at DOC Reserve Crossing	104908	171		226		259		309	323	464	272	233		809	185	253		369		185	135		107	355	576
Waimamaku at Wekaweka Road	308844	733	261	169		169		563	1850	683	326	794	365	598	190.4	108		231		581	144		168	218	
Waipapa at Waihou Valley	103248	75		41		161		52	51	650	365	144		794	1553.1	228		512	137.6	285	199		31	4611	722
Waipoua at Swimming Hole	108613	464	127	98		187		122	< 10	201		189		1565	228.2	218		146		171	84		41	183	
Waitangi at Wakelins	101752	85		148		146		144	75	295	285	41		345	> 2419.6	135		108		1081	249		146	7270	480

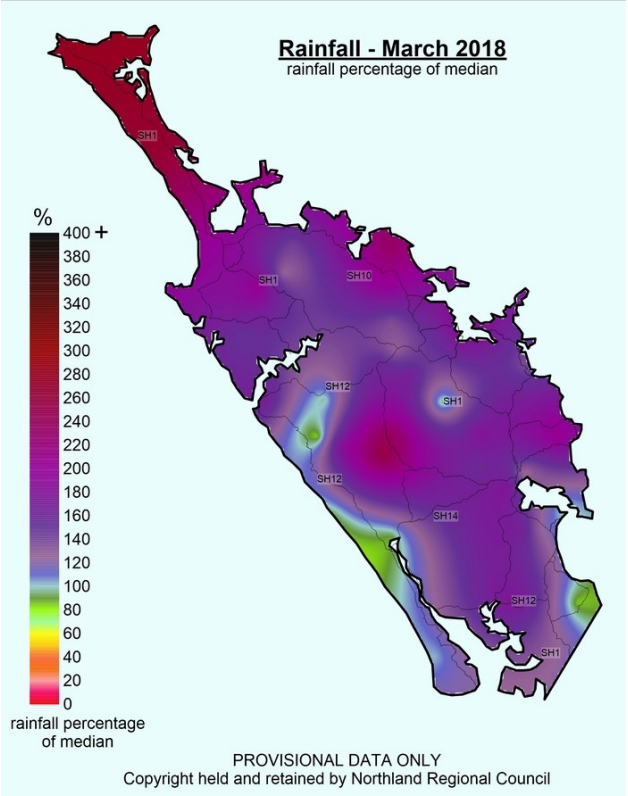
Kaipara Area	**Site No.**	**4 Dec 17**	**FU**	**11 Dec 17**	**FU**	**18 Dec 17**	**FU**	**25 Dec 17**	**1 Jan 18**	**8 Jan 18**	**FU**	**15 Jan 18**	**FU**	**22 Jan 18**	**FU**	**29 Jan 18**	**FU**	**5 Feb 18**	**FU**	**12 Feb 18**	**19 Feb 18**	**FU**	**26 Feb 18**	**5 Mar 18**	**FU**
Ahuroa at Piroa Falls	317597	307	228	565	388	262	173	712	959	637	676	408		857		886	1396	2098		934	1515		1616	1119	
Lake Taharoa at Pump House	105434	< 10		< 10		< 10		< 10	31	< 10		< 10		20		< 10		< 10		< 10	< 10		< 10	< 10	

18.2 Appendix 2 – Rainfall Maps Summer 2017-18









18.3 Appendix 3 – Sites removed from the monitoring programme since 2007

Site name	Site No.	Year removed	Reason for removal
Wairoa Stream (Ahipara)	105053	2007-08	Consistent high bacteria level ●
Lake Taharoa	100452	2007-08	Redundant site
Doves Bay	101537	2007-08	Consistent low bacteria level ●
Windsor Landing (Kerikeri)	105707	2007-08	Consistent low bacteria level ●
Opito Bay	101538	2007-08	Consistent low bacteria level ●
Russell mid-south	105711	2007-08	Consistent low bacteria level ●
Matauwhi Bay	102636	2007-08	Consistent low bacteria level ●
English Bay	100802	2007-08	Consistent low bacteria level ●
Kawakawa River	100643	2007-08	Consistent low bacteria level ●
Otiria Stream	105376	2007-08	Consistent high bacteria level ●
Ngunguru cable marker	100061	2007-08	Redundant site
Pataua North	105992	2007-08	Redundant site
Okiato Point	105712	2008-09	Consistent low bacteria level ●
Ngunguru boat ramp	101300	2008-09	Redundant site
Paihia below junction	101186	2008-09	Redundant site
Kaikou River	108919	2009-10	Staff safety concerns
Whakapirau	106100	2009-10	Staff safety concerns
Langs Beach stream middle	104539	2010-11	Consistent high bacteria level ●
Langs Beach north	108317	2010-11	Redundant site
Rarawa camp site	109874	2010-11	Consistent low bacteria level ●
Taupo Bay	109868	2010-11	Consistent low bacteria level ●
Tauranga Bay	109869	2010-11	Consistent low bacteria level ●
Coopers Beach stream	101870	2011-12	Consistent high bacteria level ●
Lake Coca Cola	110323	2011-12	Consistent low bacteria level ●
Aurere River Beach Road	110324	2011-12	Rationalisation
Waitangi River Lily Pond	110325	2011-12	Staff safety concerns
Kapiro Stream Purerua Road	102838	2011-12	Consistent high bacteria level ●
Waipapa Stream Charlies Rock	110348	2011-12	Not popular site
Mangakahia River Twin Bridges	105973	2011-12	Consistent high bacteria level ●
Otaua Stream	108510	2011-12	Consistent high bacteria level ●
Kaihu River at campground	102221	2011-12	Consistent high bacteria level ●
Omamari Beach Stream	102305	2011-12	Rationalisation
Ocean Beach Stream	102077	2011-12	Consistent high bacteria level ●
Langs Beach Stream	100686	2011-12	Consistent high bacteria level ●
Waipu Cove Stream	101207	2011-12	Rationalisation
Otamure Bay Stream	108859	2011-12	Consistent high bacteria level ●
Kerikeri Skudders Beach	100974	2011-12	Not popular site
Opua foreshore	101418	2011-12	Rationalisation
Shipwreck Bay	109870	2011-12	Consistent low bacteria level ●
Pahi rocky groyne	102579	2011-12	Redundant site
Mangawhai Harbour pontoon	110320	2011-12	Rationalisation
Urquart's Bay	108311	2011-12	Rationalisation

Site name	Site No.	Year removed	Reason for removal
McLeod Bay	101254	2011-12	Rationalisation
Pataua South footbridge	102217	2011-12	Consistent low bacteria level ●
Pataua South Frog Town	109887	2011-12	Consistent low bacteria level ●
Matapouri Beach	110321	2011-12	Consistent low bacteria level ●
Kowharewa Bay	106444	2011-12	Rationalisation
Ngunguru Norfolk pine	100076	2011-12	Consistent low bacteria level ●
Whananaki footbridge	103147	2011-12	Rationalisation
Bland Bay	109889	2011-12	Consistent low bacteria level ●
Pahi at rocky Groyne	102579	2012-13	Redundant site
Cable Bay	105780	2015-16	Consistent low bacteria level ●
Mangawhai Harbour at Picnic Bay	110322	2015-16	Consistent low bacteria level ●
Pataua South	104986	2015-16	Consistent low bacteria level ●
Woolleys Bay	109878	2015-16	Consistent low bacteria level ●

NORTHLAND REGIONAL COUNCIL

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ŌPUA: Unit 10, Industrial Marine Park, Ōpua; Phone 09 402 7516, Fax 09 402 7510.

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Twitter: www.twitter.com/NRCExpress