Recreational Swimming Water Quality in Northland

Summer 2012-2013

Putting Northland first

NORTHLAND REGIONAL COUNCIL

Executive Summary

- From November 2012 to February/March 2013, a total of 12 freshwater and 47 coastal sites were monitored through the Northland Regional Council's Recreational Swimming Water Quality Programme.

- In comparison to the relevant guidelines, 29 coastal sites met the suitable for swimming criteria 100 percent of the time in 2012-13. A further 13 were suitable for swimming on all but one occasion, and five were suitable for swimming on all but two occasions.

- In 2012-13, four out of 12 freshwater sites met the suitable for swimming criteria 100 percent of the time, and six sites were suitable for swimming on all but two sampling occasions. The remaining two freshwater sites were considered unsuitable for swimming on more than two occasions recording less than 75 percent of samples below the "Action" level specified in the relevant guidelines.

- The Ministry for the Environment grading levels were higher in 2012-13 than in 2011-12 for both coastal and freshwater sites, most likely due to the drought. Coastal grades were similar to grades in 2009-10 when a drought also occurred. Freshwater grades were the highest recorded since 2007-08.

- Results from sites recording high bacteria levels were cross referenced with rainfall data in order to indicate whether rainfall-runoff from land was contributing to high results. Overall, 21 'Action' levels were recorded for eight of the 12 freshwater sites, of which 48 percent were likely to have been related to rainfall.

- Since 2007-08, a total of 22 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 20 sites – mostly ducks and/or gulls – fourteen sites were contaminated by ruminant and four sites by dog faecal material. Contamination by a human source has been recorded at Ocean Beach Stream, Pahi and Raumanga Stream.

- Monitoring and further investigation will continue at sites where the source(s) of contamination have not been identified yet.

- Seven of the 15 permanent monitoring sites for recreational shellfish gathering were within the Ministry for the Environment guidelines during summer 2012-13.

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1. 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 (DHB), the Far North District Council (FNDC), the Whangarei District Council (WDC) and the Kaipara District Council (KDC). The aim of the programme is to provide information on microbiological contamination at popular freshwater and coastal swimming sites in Northland, to enable 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 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 and Jarman 2002). In Northland, undertaking microbial source tracking has identified wildfowl (ducks and gulls) and ruminants (livestock) as the most common sources of contamination. Human sources of contamination have only been identified at three 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). Once problem sites have been identified, the Regional and District Councils collectively identify the source of contamination and work towards improving water quality at these sites.

Photo 1: Coopers Beach

2. 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 ten days (Jarman, 2002b). Depending on the type of disease and the severity of the infection, hospitalisation may be required.

2.1 Acceptable risks

The amount 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 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.

2.2 When to avoid contact recreation

In order to minimise the risk when using rivers or the coast for contact recreation, the following three simple rules should be followed:

Clarity

Stagnant and/or murky water contains more pathogens than crystal 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 a slick 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.

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.

Photo 3: Kapiro Stream

3. 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 guidelines, available online at: www.mfe.govt.nz/publications/water/microbiological-quality-jun03/

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

3.1 Single sample guidelines

The MfE 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: Surveillance (green), Alert (yellow), or Action (red), as shown in Table 1.

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

***E. coli* concentration**	**Category**	**Suggested response**
sample<260/100mL	Surveillance	No response necessary – Continue weekly sampling
260<sample<550/100mL	Alert	Undertake catchment assessment and sanitary survey to isolate source of faecal contamination
sample>550/100mL	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 follow: Surveillance (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 unclear results.

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

***Ent.* concentration**	**Category**	**Suggested response**
sample<140/100mL	Surveillance	No response necessary – Continue weekly sampling
140<sample<280/100mL	Alert	Undertake catchment assessment and sanitary survey 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	Surveillance	Surveillance+Surveillance =Surveillance
150<sample<600/100mL	140<sample<280/100mL	Alert	Any other combination =Alert
sample>600/100 mL	sample>280/100mL	Action	Action+Action=Action

Results from the weekly sampling are sent to the District Councils and Northland District Health Board, and are published weekly on the Councils website – www.nrc.govt.nz/swimming. Any 'Alert' or 'Action' results are notified to the relevant District Council within 24 hours, so that they can instigate further investigative sampling and/or erect warning signs.

3.2 End of season grading

The end of season grading at each site is determined by the percentage of samples which were below the 'Action' category (either above 550 *E. coli*; 600 faecal coliforms or 280 *Enterococci)*. Grades are presented in Table 4 below:

Table 4: Ministry for the Environment grading system

MfE grades	
1	95-100% samples within guidelines (no 'Action' result)
2	90-94% samples within guidelines
3	75-89% samples within guidelines
4	<75% samples within guidelines

4. Methodology

4.1 Sampling technique

Samples are collected once a week at selected freshwater and coastal sites throughout the summer months. In 2012-13, sampling was carried out from 26 November 2012 to 18 February 2013 at 47 coastal and 12 freshwater sites. It was then continued at 23 coastal and three freshwater sites until 26 March 2013. While some councils in other regions choose not to sample after rainfall, Northland Regional Council tests the water regardless of weather conditions although weather, tide and water temperature are recorded to help provide some context for results.

Each sample is collected following the methods described in the *Microbiological Water Quality Guidelines for Freshwater and Marine Recreational Bathing Areas* (MfE 2003). 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.

Photo 4: Council staff member taking a water quality sample at Lake Waro

4.2 Sample analysis

It is both difficult and expensive to measure the level of faecal pathogens in water. Instead, like other agencies, Northland Regional Council measures the levels of indicator micro-organisms in accordance with the national microbiological water quality guidelines published by the Ministry for the Environment and the Ministry of Health (2003).
For freshwater sites, the indicator bacteria *E. coli* are quantified. This bacterium indicates faecal pollution and epidemiological studies have shown that where *E. coli* is present, we can assume there are pathogens in the water (MfE 2002).

As mentioned above, both *Enterococci* and faecal coliforms are counted for coastal waters. The New Zealand Marine Bathing Study commissioned by MfE and MoH in 1994 showed *Enterococci* was the indicator most closely correlated with health effects in New Zealand marine waters. Faecal coliforms are not as closely related to human health effects; however they are useful in environmental circumstances, such as brackish or estuarine environments, where levels of *Enterococci* may be misleading. For example, naturally occurring *Enterococci* are known to reproduce successfully in organic matter contained within mangrove forests.

All samples are analysed by an independent laboratory using the procedures in the *Standard Methods for the Examination of Water and Wastewater* (APHA *et. al* 2005).

5. Sampling Sites

Due to the large number of coastal and freshwater swimming sites in Northland, it is not practicable or economically viable to monitor them all. Therefore the Council, along with key stakeholders, review the list of sites to be monitored before the start of each season and select sites based on popularity, human health risk, and/or following specific requests from the public.

5.1 Sampling sites 2012-13

In the 2012-13 sampling season, a total of 12 freshwater sites and 47 coastal sites were monitored through the programme (Table 5). Sites highlighted in blue were added this season and those with an asterisk indicate enclosed coastal sites throughout the report.

Table 5: Sites monitored in 2012-13. BOI: Bay of Islands.

Coastal sites	Grid reference		Site No.	Area
Far North District Council				
Ahipara camp ground	1614114	6109386	109871	North-west
Cable Bay	1644302	6127973	105780	North-west
Cooper's Beach	1646729	6127976	101066	North-west
Maitai Bay camp site	1637395	6145952	102326	North-east
Matauri Bay motor camp	1683324	6122702	102425	North-east
Omapere	1634874	6067432	102317	North-east
Opononi	1635376	6070804	106011	North-east
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	BOI
Russell mid-North	1701762	6097524	105710	Far North
Taipa Estuary	1642856	6127391	105777	Far North
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-west
Mangawhai Heads motor camp*	1743147	6005606	101210	South-west
Mangawhai Picnic Bay*	1743636	6005784	110322	South-west
Omamari Beach	1659853	6030465	109875	South-west
Pahi - 150m NW jetty*	1710590	5998103	102198	South-east
Tinopai below creek*	1712122	5987100	101232	South-east
Tinopai below shops*	1712130	5987691	102310	South-east
Whangarei District Council				
Church Bay	1738528	6057429	105448	Whg heads
Lang's Beach mid	1738350	6009900	108318	Whg heads
Matapouri 1st bridge*	1736959	6062631	100711	Whg heads
Matapouri 2nd bridge*	1736535	6063041	100712	Whg heads
Ngunguru motor camp*	1734960	6055124	100073	Tutukaka
Ngunguru toilets	1737070	6056341	108320	Tutukaka
Oakura north bay	1722350	6083581	101345	Tutukaka
Ocean Beach	1742107	6032989	109877	Tutukaka
Ohawini Bay	1722090	6084082	105388	Tutukaka
One Tree Point	1731539	6035180	109266	Tutukaka
Onerahi playground*	1722792	6040203	101600	Tutukaka
Pacific Bay	1738969	6057164	108313	Tutukaka
Pataua South east beach	1738315	6046464	104986	Tutukaka
Ruakaka beach	1731913	6025221	108315	South-east
Ruakaka river	1731414	6025773	108314	South-east
Sandy Bay	1733651	6064285	109879	South-east
Taurikura Bay	1737880	6034149	101262	South-east
Teal Bay	1723703	6077721	101331	South-east

Coastal sites	Grid reference		Site No.	Area
Uretiti Beach	1732302	6019720	109888	South-east
Waipu Cove	1735915	6011855	108316	Tutukaka
Wellingtons/Whangaumu Bay	1738576	6055370	109880	BOI
Whananaki east beach	1733002	6069592	106938	BOI
Woolleys Bay	1735097	6063676	109878	BOI
TOTAL COASTAL				**47**

Freshwater Sites	Grid Reference		Site No.	Area
Far North District Council				
Kerikeri River Stone Store	1687631	6102447	101530	North-east
Lake Ngatu at South end	1618033	6122885	100402	North-west
Punakitere River	1675320	6075378	110927	North-east
Tirohanga Stream	1699502	6084784	102252	Far North
Victoria River	1639482	6108122	104908	BOI
Waipapa River Puketi forest	1662099	6096027	103248	BOI
Waipoua River	1650503	6054513	108613	BOI
Waitangi River at Watea	1695283	6095847	101752	North-west
Kaipara District Council				
Lake Taharoa pump house	1659736	1659736	105434	South-west
Whangarei District Council				
Lake Waro (Hikurangi)	1716716	6061100	107272	Tutukaka
Raumanga stream	1717608	6044187	103246	Tutukaka
Whangarei Falls	1720857	6050300	105972	South-east
TOTAL FRESHWATER				**12**

5.2 Sites removed

Before the start of each season, the Council along with key stakeholders meet to discuss results from the previous season. The stakeholder group then decides whether to remove some sites from the programme due to lack of use, or because a site is consistently suitable/unsuitable for swimming. At sites that are consistently unsuitable for swimming permanent warning signs are erected.

Listed in Table 6 below are all the sites that have been removed from the programme since 2007. Sites that have been removed from the programme for more than five years are reassessed every year under the criteria mentioned above. Following this, some may be re-introduced in the programme for future monitoring. However, these sites may be monitored on a less frequent basis during the sampling season, depending on resources and need.

Table 6: Sites removed from the monitoring programme

Site name	Site No.	Year removed	Reason for removal
Wairoa Stream (Ahipara)	105053	2007-08	Consistently unsuitable
Lake Taharoa	100452	2007-08	Consistently suitable
Doves Bay	101537	2007-08	Consistently suitable
Windsor Landing (Kerikeri)	105707	2007-08	Consistently suitable
Opito Bay	101538	2007-08	Consistently suitable
Russell mid-south	105711	2007-08	Consistently suitable
Matauwhi Bay	102636	2007-08	Consistently suitable
English Bay	100802	2007-08	Consistently suitable

Site name	Site No.	Year removed	Reason for removal
Kawakawa River	100643	2007-08	Consistently suitable
Otiria Stream	105376	2007-08	Consistently unsuitable
Ngunguru cable marker	100061	2007-08	Duplicate site
Pataua North	105992	2007-08	Duplicate site
Okiato Point	105712	2008-09	Consistently suitable
Ngunguru boat ramp	101300	2008-09	Duplicate site
Paihia below junction	101186	2008-09	Duplicate site
Kaikou River	108919	2009-10	Safety concerns
Whakapirau	106100	2009-10	Safety concerns
Langs Beach stream middle	104539	2010-11	Consistently unsuitable
Langs Beach north	108317	2010-11	Duplicate site
Rarawa camp site	109874	2010-11	Consistently suitable
Taupo Bay	109868	2010-11	Consistently suitable
Tauranga Bay	109869	2010-11	Consistently suitable
Coopers Beach stream	101870	2011-12	Consistently unsuitable
Lake Coca Cola	110323	2011-12	Consistently suitable
Aurere River Beach Road	110324	2011-12	Resourcing
Waitangi River Lily Pond	110325	2011-12	Safety concerns
Kapiro Stream Purerua Road	102838	2011-12	Consistently unsuitable
Waipapa Stream Charlies Rock	110348	2011-12	Not popular site
Mangakahia River Twin Bridges	105973	2011-12	Consistently unsuitable
Otaua Stream	108510	2011-12	Consistently unsuitable
Kaihu River at campground	102221	2011-12	Consistently unsuitable
Omamari Beach Stream	102305	2011-12	Resourcing
Ocean Beach Stream	102077	2011-12	Consistently unsuitable
Langs Beach Stream	100686	2011-12	Consistently unsuitable
Waipu Cove Stream	101207	2011-12	Resourcing
Otamure Bay Stream	108859	2011-12	Consistently unsuitable
Kerikeri Skudders Beach	100974	2011-12	Not popular site
Opua foreshore	101418	2011-12	Resourcing
Shipwreck Bay	109870	2011-12	Consistently suitable
Pahi rocky groyne	102579	2011-12	Duplicate site
Mangawhai Harbour pontoon	110320	2011-12	Resourcing
Urquart's Bay	108311	2011-12	Resourcing
McLeod Bay	101254	2011-12	Resourcing
Pataua South footbridge	102217	2011-12	Consistently suitable
Pataua South Frog Town	109887	2011-12	Consistently suitable
Matapouri Beach	110321	2011-12	Consistently suitable
Kowharewa Bay	106444	2011-12	Resourcing
Ngunguru Norfolk pine	100076	2011-12	Consistently suitable
Whananaki footbridge	103147	2011-12	Resourcing
Bland Bay	109889	2011-12	Consistently suitable

5.3 Permanent monitoring sites

As sites are removed or added each year depending on current information needs, a core group of 20 sites was randomly selected to be monitored every year to constitute a permanent monitoring list. This ensures that long term water quality trends can be observed to see if the region's water quality is improving or degrading over time. The permanent monitoring sites are listed in Table 7 and include their results for the 2012-13 season.

Table 7: Permanent monitoring sites

Site name	Site No.	Percentage of samples within guidelines in 2012-13
Church Bay	105448	89.5
Kerikeri – Stone Store	101530	62
Lake Waro – Hikurangi	107272	100
Lang's Beach – mid beach	108318	94.1
Matapouri – second bridge*	100712	85
Onerahi – play ground*	101600	94.4
Opononi	106011	100
Pacific Bay	108313	100
Pahi – jetty*	102579	90.9
Paihia – Waitangi bridge	101183	91.7
Pataua South – east of beach	104986	94.4
Raumanga Stream	103246	84
Ruakaka – by motor camp	108314	94.1
Taipa	105777	100
Taurikura	101262	100
Teal Bay	101331	100
Tinopai – below shops*	102310	100
Waipapa River – Puketi	103248	82
Waipoua River	108613	100
Waipu Cove	108316	100

6. Results and Interpretation

The results for all sites sampled in 2012-13 including both coastal and freshwater can be viewed in Appendix 1. Each 'Action' result has been cross-referenced with accumulated rainfall data recorded 72 hours prior to sampling at the nearest rainfall station, giving an indication of rainfall related run-off influence on microbiological contamination. Northland monthly rainfall maps covering the 2012-13 summer period are presented in Appendix 2.

6.1 End of season grading – coastal sites

Figure 1: Coastal end of season grading 2012-13

The map above summarises the end of season grading for samples taken from each of the 47 coastal sites monitored in Northland during the 2012-13 sampling season (26 November 2012 to the 26 March 2013). The grades indicate the percentage of results below 'Action' level recorded at each site.

While there are occasional exceedances of the guideline at sites with significant freshwater inputs (estuaries), in general coastal water quality in Northland is excellent with the majority of sites suitable for swimming on all sampling occasions.

A brief summary of the results for the relevant sites is given below. Detailed in section 7 is the investigation programme which includes sites which were listed for further analysis in order to identify the source of contamination. Sites with an asterisk indicate a coastal enclosed site and sites in bold designate a permanent monitoring site throughout the report.

In coastal areas there are occasional one off 'Action' results. It is difficult to determine the source of these results because it takes 24 hours to process a sample and by this time the source of contamination has already been flushed out by the sea.

FAR NORTH

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Ahipara	11	11	0	n/a
Maitai Bay	11	11	0	n/a
Tokerau Beach	11	10	1	û (no rain)
Waipapa Kauri	11	11	0	n/a
Total	**44**	**43**	**1**	

The only 'Action' result at Tokerau Beach in 2012-13 was not related to rainfall. This site has been monitored since 2009-10 and accounted for four 'Action' results on 44 sampling occasions within the same time frame. This means the site was considered suitable for swimming 91 percent of the time during the summer season in the last four years. It is not known what caused this result but bacteria levels in the water had returned to 'Surveillance' mode by the following week.

NORTH EAST

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Cable Bay	11	11	0	n/a
Coopers Beach	11	11	0	n/a
Matauri Bay	11	11	0	n/a
Taipa estuary	11	11	0	n/a
Total	**44**	**44**	**0**	

NORTH WEST

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Omapere	11	11	0	n/a
Opononi	11	11	0	n/a
Rawene*	11	10	1	ü (51mm)
Total	**33**	**32**	**1**	

Only one 'Action' result was recorded at Rawene in 2012-13. This was likely to have been related to 51mm of accumulated rainfall. This site has been monitored since 2007-08 and accounted for two 'Action' results on 71 sampling occasions within the same time frame. This means the site was considered suitable for swimming 97 percent of the time during the summer season in the last six years.

It is not known what caused the result but levels of bacteria in the water had returned to 'Surveillance' mode by the following week.

SOUTH WEST

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Baylys Beach	11	11	0	n/a
Glinks Gully	11	11	0	n/a
Omamari Beach	11	11	0	n/a
Pahi jetty*	11	10	1	û (no rain)
Tinopai at shops	11	11	0	n/a
Tinopai at creek	11	11	0	n/a
Total	**66**	**65**	**1**	

Only one 'Action' result was recorded at Pahi jetty in 2012-13 which was not related to rainfall. This site has been monitored since 2007-08 and accounted for five 'Action' results on 77 sampling occasions within the same time frame. This means the site was considered suitable for swimming 93.5 percent of the time during the summer season in the last six years.

The site was part of the investigation programme 2012-13 and therefore samples were also analysed to identify the source of contamination. Microbial source tracking analyses identified contamination caused by wildfowl. Plant decay was also identified as a source of microbiological contamination, likely to be related to its enclosed coastal/estuarine location. Bacteria levels in the water had returned to 'Surveillance' mode by the following week.

SOUTH EAST

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
One Tree Point	17	17	0	n/a
Langs Beach midway	17	16	1	ü (49mm)
Mangawhai Harbour Picnic Bay*	17	17	0	n/a
Mangawhai Heads motor camp*	17	16	1	û (no rain)
Mangawhai Heads	17	17	0	n/a
Ruakaka Beach	17	17	0	n/a
Ruakaka River	17	16	1	ü (25mm)
Uretiti Beach	17	17	0	n/a
Waipu Cove Beach	17	17	0	n/a
Total	**153**	**150**	**3**	

Only one 'Action' result was recorded at Langs Beach, Mangawhai Heads and Ruakaka River sites in 2012-13. The result for Mangawhai Heads was not related to rainfall.

Langs Beach

The result for Langs Beach was likely to have been related to 49mm of accumulated rainfall. This site has been monitored since 2007-08 and accounted for two 'Action' results on 94 sampling occasions within the same time frame. This means the site was considered suitable for swimming 98 percent of the time during the summer season in the last six years.
The site was part of the investigation programme in 2007-08 and 2009-10. Microbial source tracking analyses identified contamination caused by wildfowl and ruminants.

Mangawhai Heads

This site has been monitored since 2010-11 and accounted for three 'Action' results on 50 sampling occasions within the same time frame. This means the site was considered suitable for swimming 94 percent of the time during summer season in the last three years.
The site was part of the investigation programme in 2010-11 and 2011-12. Microbial source tracking analyses identified contamination caused by wildfowl in both occasions.

Ruakaka River

The result for Ruakaka River was likely to have been related to 25mm of accumulated rainfall. This site has been monitored since 2007-08 and accounted for nine 'Action' results on 97 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92 percent of the time during summer season in the last six years.
The site was part of the investigation programme in 2012-13. Microbial source tracking analyses identified contamination caused by ruminant.

BAY OF ISLANDS

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Oakura	11	11	0	n/a
Ohawini Bay	11	11	0	n/a
Paihia Te Haumi	12	11	1	û (no rain)
Paihia Waitangi Bridge	12	11	1	û (no rain)
Paihia Toilets	12	10	2	û (no rain) x 2
Russell mid-north	12	11	1	û (no rain)
Teal Bay	11	11	0	n/a
Total	**81**	**76**	**5**	

The 'Action' results recorded at Russell mid-north and the three Paihia sites were not related to rainfall. These results – occurring on the same sampling day – may have been related to highest perigean-spring tides that week which could have re-suspended bacteria contained in sediment or on the shore line. Bacteria levels in the water had returned to 'Surveillance' mode three days after the event at all sites.

Paihia Te Haumi

This site has been monitored since 2009-10 and accounted for four 'Action' results on 53 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92 percent of the time during summer season in the last four years.
The site was part of the investigation programme in 2012-13. Wildfowl and plant decay were identified as sources of microbiological contamination.

Paihia Waitangi Bridge

This site has been monitored since 2007-08 and accounted for eight 'Action' results on 78 sampling occasions within the same time frame. This means the site was considered suitable for swimming 90 percent of the time during summer season in the last six years.
The site was part of the investigation programme in 2012-13. Microbial source tracking analyses identified contamination caused by ruminant. Wildfowl was also identified as a source of microbiological contamination.

Paihia toilets

This site has been monitored since 2007-08 and accounted for six 'Action' results on 77 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92 percent of the time during summer season in the last six years.

It is not known what caused the results but levels of bacteria in the water had returned to 'Surveillance' mode by the following week on both occasions.

Russell mid-north

This site has been monitored since 2007-08 and accounted for three 'Action' results on 47 sampling occasions within the same time frame. This means the site was considered suitable for swimming 94 percent of the time during the summer season in the last six years. It is not known what caused the results but levels of bacteria in the water had returned to 'Surveillance' mode by the following week.

TUTUKAKA

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Church Bay	19	17	2	û (no rain) x 2
Matapouri at 1st bridge*	19	17	2	û (no rain), ü (49.5mm)
Matapouri at 2nd bridge*	20	17	3	û (no rain) x 2, ü (49.5mm)
Ngunguru at motor camp*	17	17	0	n/a
Ngunguru at School	19	17	2	û (no rain) x 2
Pacific Bay	17	17	0	n/a
Sandy Bay	17	17	0	n/a
Wellingtons Bay	17	16	1	ü (7.5mm)
Whananaki at east beach	18	17	1	ü (49.5mm)
Woolleys Bay	17	17	0	n/a
Total	**180**	**169**	**11**	

Most 'Action' results recorded at Matapouri, Wellingtons Bay and Whananaki sites were likely to have been related to rainfall within 72 hours prior to sampling. Results for Church Bay and Ngunguru were not related to rainfall.

Church Bay

This site has been monitored since 2007-08 and accounted for six 'Action' results on 94 sampling occasions within the same time frame. This means the site was considered suitable for swimming 94 percent of the time during the summer season in the last six years. It is not known what caused these results but bacteria levels in the water had returned to 'Surveillance' mode by the following week on both occasions.

*Matapouri 1st bridge**

The first result was not related to rainfall. The second one was likely to have been related to 49.5mm of accumulated rainfall. This site has been monitored since 2007-08 and accounted for nine 'Action' results on 96 sampling occasions within the same time frame. This means the site was considered suitable for swimming 91 percent of the time during the summer season in the last six years.
The site was part of the investigation programme in 2010-11. Microbial source tracking analyses identified contamination caused by wildfowl.

*Matapouri 2nd bridge**

The first and last results were not related to rainfall. The second was likely to have been related to 49.5mm of accumulated rainfall. This site has been monitored since 2007-08 and accounted for 10 'Action' results on 96 sampling occasions within the same time frame. This means the site was considered suitable for swimming 90 percent of the time during summer season in the last six years.
The site was part of the investigation programme in 2010-11 and 2012-13. Microbial source tracking analyses identified contamination caused by wildfowl and ruminant for both seasons.

Plant decay was also identified as a source of microbiological contamination, likely to be related to its enclosed coastal/estuarine location.

Ngunguru at School

This site has been monitored since 2007-08 and accounted for 15 'Action' results on 95 sampling occasions within the same time frame. This means the site was considered suitable for swimming 84 percent of the time during summer season in the last six years.
The site was part of the investigation programme in 2010-11 and 2011-12. Microbial source tracking analyses identified contamination caused by wildfowl for both seasons.

Wellingtons Bay

The 'Action' result may have been related to 7.5mm of accumulated rainfall. This site has been monitored since 2009-10 and accounted for three 'Action' results on 67 sampling occasions within the same time frame. This means the site was considered suitable for swimming 95 percent of the time during the summer season in the last four years. It is not known what caused this result but bacteria levels in the water had returned to 'Surveillance' mode by the following week.

Whananaki at east beach

The 'Action' result was likely to have been related to 49.5mm of accumulated rainfall. This site has been monitored since 2007-08 and accounted for seven 'Action' results on 88 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92 percent of the time during summer season in the last six years. It is not known what caused these results but bacteria levels in the water had returned to 'Surveillance' mode three days following the event.

WHANGAREI HEADS

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Ocean Beach	17	17	0	n/a
Onerahi playground*	18	17	1	û (no rain)
Pataua South east beach	18	17	1	û (no rain)
Taurikura	17	17	0	n/a
Total	**70**	**68**	**2**	

The 'Action' results recorded at Onerahi and Pataua sites were not related to rainfall.

Onerahi playground

This site has been monitored since 2007-08 and accounted for four 'Action' results on 95 sampling occasions within the same time frame. This means the site was considered suitable for swimming 96 percent of the time during summer season in the last six years.
A sewage spill occurred in the Raumanga area on the same week and caused high bacteria levels at the site which washed into the harbour and may have reached Onerahi. The problem was addressed by the relevant District Council and bacteria levels in the water had returned to 'Surveillance' mode by the following week.

Pataua South east beach

This site has been monitored since 2007-08 and accounted for three 'Action' results on 94 sampling occasions within the same time frame. This means the site was considered suitable for swimming 97 percent of the time during summer season in the last six years. It is not known what caused these results but may have been related to the high perigean-spring tides that week which would have re-suspended bacteria contained in the sediment, or on the shoreline. Bacteria levels in the water had returned to 'Surveillance' mode two days following the event.

6.2 Comparison of coastal results

Coastal results from 2012-13 compared to previous years are presented in Table 8 below.

Table 8: Annual coastal grades compared to national guidelines

Category	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
95-100% samples <280 *Ent.*/100mL	27	21	45	22	26	29
90-95% samples <280 *Ent.*/100mL	13	8	13	21	16	13
75-90% samples <280 *Ent.*/100mL	4	12	5	16	4	5
<75% samples <280 *Ent.*/100mL	1	2	0	2	2	0
Total number of sites	**45**	**43**	**63**	**61**	**48**	**47**

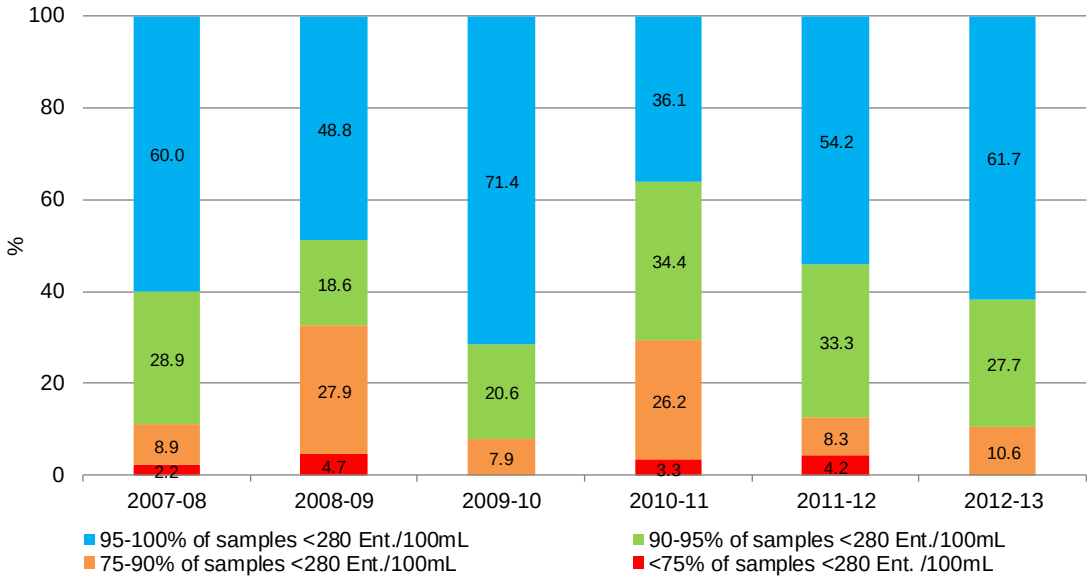

Figure 2: Yearly overall percentage of coastal sites with corresponding percentage of samples within each category from 2007 to 2013

The results from faecal indicator bacteria testing in 2012-13 were slightly improved compared to the 2011-12 season. No site recorded less than 75 percent of samples below the 'Action' level, i.e. 280 *Enterococci* per 100 millilitres. About 62 percent of coastal sites had more than 95 percent of samples below the 'Action level. Similar grades were recorded in summer 2009-10 as shown in Figure 2 above.

One site was removed from the programme in 2012-13 – Pahi at Rocky Groyne – due to its proximity to the Pahi site 150 metres NW of the Jetty. Monitoring was conducted until the end of March for 2012-13 season, unlike in 2011-12 where sampling had been resumed two weeks earlier than usual due to stormy weather. The extended monitoring period this season combined with the drought is likely to have contributed to the slightly better results in 2012-13.

6.3 Results for coastal permanent monitoring sites

Results for coastal permanent monitoring sites from 2007-08 to 2012-13 are presented in Table 9 below.

Table 9: Results for coastal permanent monitoring sites 2007-2013

	Percentage of samples within guidelines					
Site Name	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Church Bay	100	83	100	94	100	89
Langs Beach	100	100	100	94	100	94
Matapouri*	85	83	100	88	100	85
Onerahi*	100	100	100	89	100	94
Opononi	100	92	100	92	100	100
Pacific Bay	100	83	91	82	100	100
Pahi Jetty*	100	92	100	100	80	91
Paihia Beach	92	83	100	75	100	92
Pataua South	92	100	100	94	100	94
Ruakaka River	100	100	91	89	100	94
Taipa	92	100	100	92	100	100
Taurikura Bay	92	75	100	89	100	100
Teal Bay	92	92	100	100	88	100
Tinopai*	100	100	100	100	100	100
Waipu Cove	100	100	100	94	100	100

Overall, the coastal grades have improved since 2010-11 and were close to the grades obtained in 2009-10.

6.4 End of Season Grading – freshwater Sites

Compared to the coast, river sites are more susceptible to rainfall related runoff from surrounding land. This is particularly true in wetter summers when soil moisture levels are higher and soils have less capacity to absorb water. This is reflected in the fact that there are poorer grades in the river sites, compared to the coast and freshwater lakes.

Figure 3: Freshwater end of season grading 2012-13

The map above summarises the end of season grading for samples taken from each of the 12 freshwater sites monitored in Northland during the 2012-13 sampling season (26 November 2012 to the 26 March 2013). The grades indicate the percentage of results below 'Action' level recorded at each site.

A brief summary of the results for the relevant sites is given below. Detailed in section 7 is the investigation programme including sites which were listed for further analysis in order to identify the source of contamination. Sites in bold designate a permanent site.

FAR NORTH AREA

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Kerikeri River	13	8	5	û (no rain) x 3, ü (77mm), ü (40mm)
Lake Ngatu	11	11	0	n/a
Punakitere River	12	10	2	û (no rain), ü (108mm)
Tirohanga Stream	11	9	2	û (no rain), ü (36mm)
Victoria River	11	8	3	û (no rain) x 2, ü (14.5mm)
Waipapa River	11	9	2	ü (111mm), ü (65.5mm)
Waipoua River	11	11	0	n/a
Waitangi River	11	9	2	ü (141.5mm), ü (65.5mm)
Total	**91**	**75**	**16**	

Six out of eight rivers in the far north recorded 'Action' results in 2012-13, in which all had at least two 'Action' results with some related to land runoff.

Kerikeri River

Three of the five 'Action' results were not related to rainfall. The two remainders were likely to have been related to 77 and 40mm of rainfall respectively. This site has been monitored since 2007-08 and

accounted for 25 ‘Action’ results on 80 sampling occasions within the same time frame. This means the site was considered suitable for swimming 69 percent of the time during the summer season in the last six years.
The site has been part of the investigation programme since 2010-11. Microbial source tracking analyses identified contamination caused by wildfowl including ducks, and ruminant including sheep over the three seasons. Plant decay was also identified as a source of microbiological contamination.

Punakitere River

This site was added to the programme in 2012-13 and recorded two ‘Action’ results out of 12 sampling occasions; one of which was likely to have been related to 108mm of rainfall. This means the site was considered suitable for swimming 83 percent of the time.
It is not known what caused the other result but levels of bacteria in the water had returned to ‘Surveillance’ mode two days following the event.

Tirohanga Stream

One of the two ‘Action’ results was not related to rainfall. The other was likely to have been related to 36mm of rainfall. This site has been monitored since 2007-08 and accounted for nine ‘Action’ results on 71 sampling occasions within the same time frame. This means the site was considered suitable for swimming 87 percent of the time during the summer season in the last six years.
It is not known what caused the other result but levels of bacteria in the water had returned to ‘Surveillance’ within the two following weeks.

Victoria River

Two of the three ‘Action’ results were not related to rainfall. The other one was likely to have been related to 14.5mm of rainfall. This site has been monitored since 2007-08 and accounted for 15 ‘Action’ results on 71 sampling occasions within the same time frame. This means the site was considered suitable for swimming 79 percent of the time during the summer season in the last six years.
The site has been part of the investigation programme since 2011-12. Microbial source tracking analyses identified contamination caused by wildfowl for both seasons. Plant decay as well as a weak human marker was also identified as source of microbiological contamination. Further investigation was carried out at the site to confirm whether human contamination was occurring. The results from the investigation did not provide sufficient information to confidently identify the source and faecal indicator bacteria levels were all below ‘Action’ level. The site is currently under surveillance and a second investigation may be undertaken prior to the start of the next bathing season in 2013-14. It is not known what caused the other two results but levels of bacteria in the water had returned to ‘Surveillance’ mode within two weeks following the event.

Waipapa River

Both ‘Action’ results were likely to have been related to respectively 111 and 65.5mm rainfall. This site has been monitored since 2007-08 and accounted for five ‘Action’ results on 67 sampling occasions within the same time frame. This means the site was considered suitable for swimming 92.5 percent of the time during the summer season in the last six years.

Waitangi River

This site was added to the programme in 2012-13 and recorded two ‘Action’ results out of 11 sampling occasions; both of which were likely to have been related to 141.5 and 65.5mm of rainfall respectively. This means the site was considered suitable for swimming 82 percent of the time.

WHANGAREI AREA

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Lake Waro	17	17	0	n/a

Raumanga Stream	19	16	3	û (no rain) x 2, ü (10.5mm)
Whangarei Falls	17	15	2	û (no rain) x 2
Total	**53**	**48**	**5**	

Raumanga Stream

Two of the three 'Action' results were not related to rainfall. The other one may have been related to 10.5mm of rainfall. This site has been monitored since 2007-08 and accounted for 15 'Action' results on 96 sampling occasions within the same time frame. This means the site was considered suitable for swimming 84 percent of the time during the summer season in the last six years.

The site was part of the investigation programme in 2007-08 and 2012-13. Microbial source tracking analyses identified contamination caused by wildfowl and human respectively. The strong positive human marker detected was due to a sewage spill which occurred the week prior to sampling and caused very high bacteria levels at the site. The problem was addressed by the District Council and bacteria levels in the water had returned to 'Surveillance' mode by the following week.

Whangarei Falls

Both of the 'Action' results were not related to rainfall. This site has been monitored since 2007-08 and accounted for 38 'Action' results on 99 sampling occasions within the same time frame. This means the site was considered suitable for swimming 62 percent of the time during summer season in the last six years.

The site has been part of the investigation programme in 2007-08, 2009-10 and 2010-11. Microbial source tracking analyses identified contamination caused by wildfowl, ruminant and dog with wildfowl being the main source of contamination for all three seasons.

KAIPARA AREA

Site name	No. samples	Surveillance/Alert	Action	Rainfall related (72h accumulated rainfall)
Lake Taharoa	11	11	0	n/a
Total	**11**	**11**	**0**	

6.5 Comparison of freshwater results

Freshwater results from 2012-13 compared to previous years are presented in Table 10 below.

Table 10: Annual freshwater grades compared to national guidelines

Category	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
95-100% samples <550 *E. coli*/100mL	1	2	6	4	2	4
90-95% samples <550 *E. coli*/100mL	2	5	2	2	3	0
75-90% samples <550 *E. coli*/100mL	6	7	6	9	3	6
<75% samples <550 *E. coli*/100mL	12	5	9	9	2	2
Total number of sites	**21**	**19**	**23**	**24**	**10**	**12**

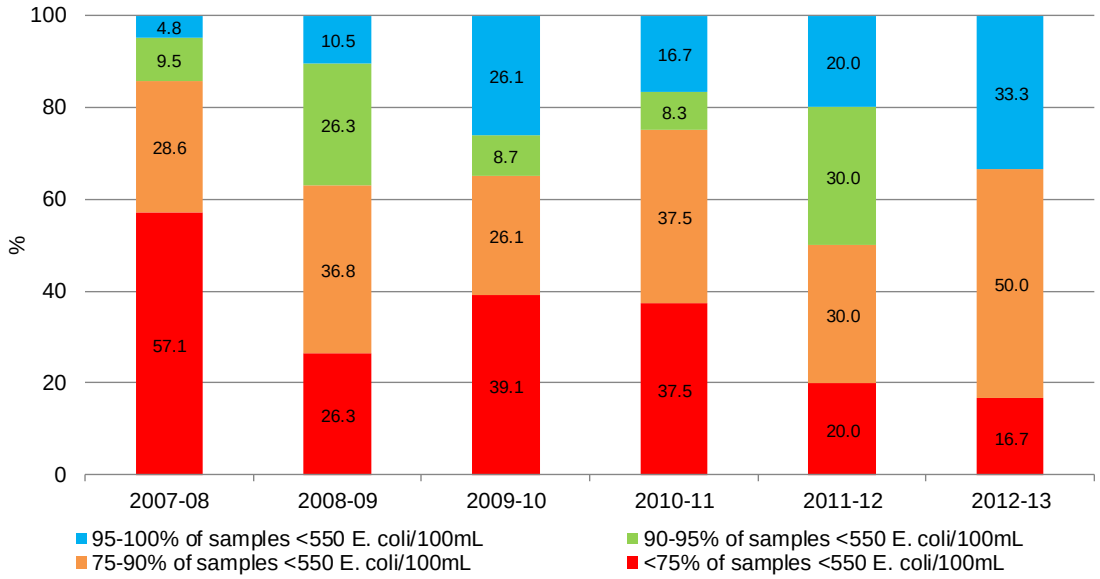

Figure 4: Yearly overall percentage of freshwater sites with corresponding percentage of samples within each category from 2007 to 2013

The results from faecal indicator bacteria testing in 2012-13 were marked by the higher proportion of sites, i.e. 50 percent compared to 30 percent in 2011-12, which recorded between 75 to 90 percent of samples collected below 'Action' level. Also, 33.3 percent of monitored freshwater sites had more than 95 percent of samples below 'Action' level compared to 20 percent in 2011-12. This score was also the highest in the last five years with the drought likely to have contributed to the better results.

6.6 Results for freshwater permanent monitoring sites

Results for freshwater permanent monitoring sites from 2007-08 to 2012-13 are presented in Table 11 below.

Table 11: Results for coastal permanent monitoring sites 2007-2013

Site Name	Percentage of samples within guidelines					
	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Kerikeri River	77	67	72	67	67	62
Lake Waro			100	82	94	100
Raumanga Stream	54	92	100	82	83	84
Waipapa River	92	92	100	100	90	82
Waipoua River	85	92	83	92	89	100

Although the MfE grading for freshwater sites were slightly poorer compared to the 2011-12 season, they were still within the range seen in the last five years.

It should be noted that even in rivers which originate in pristine forested catchments, e.g. Waipapa and Waipoua rivers, high counts of the indicator bacteria *E. coli* have been observed 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 that swimming should be avoided for two to three days after heavy rainfall.

7. Site Investigation

As a result of water quality testing undertaken through this programme, some swimming sites in Northland have been considered unsuitable for swimming. These sites have consistent results outside the guidelines with high bacteria levels recorded on most sampling occasions. Other sites with generally good results but occasional elevated bacteria levels have also been investigated and in most cases the source of bacterial contamination is not immediately obvious. The results from this work inform management decisions when attempting to improve water quality at these sites.

More details about the investigation strategy implemented for the 2012-13 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.

7.1 Methodology

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

7.1.1 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 households 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.

7.1.2 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.

7.1.3 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.

7.2 Site investigation results

In order to carry out microbial source tracking analyses, faecal indicator bacteria levels need to be above the 'Action' level criteria for swimming, i.e. above 550 *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. Therefore, results for 2012-13 include demarcation between weak positive, positive and strong positive markers compared to earlier results.

An overview of results from microbial source tracking work undertaken since 2007 is presented in Table 12 below. In 2012-13 investigations continued at sites where results had been inconclusive. Additional sites with recurrent water quality issues were also added to the programme and included:

- Pahia at Te Haumi River
- Pahia at Waitangi Bridge
- Teal Bay at beach
- Ruakaka River below motor camp

- One Tree Point at intertidal beach
- Raumanga Stream at swimming pool below falls

In the 2012-13 season a total of 11 sites were listed as part of the investigation programme, but only eight of these returned 'Action' level bacterial concentrations. Three sites – Teal Bay, One Tree Point and Lake Waro – did not return any 'Action' results during the season and therefore microbial source tracking analyses were not undertaken.

Table 12: 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 a coastal enclosed site. D: Dog, H: Human, R: Ruminant, W: Wildfowl, P: Plant decay.

Site	2007-08	2009-10	2010-11	2011-12	2012-13
Coopers Beach stream		**D/W**	**R/W**		
Kaihu River			**R/W**		
Kapiro Stream			**R/W**		
Kerikeri River			**W**	**R**	**R/W**/P
Lake Waro					
Langs Beach stream (car park)	**R/W**	**W**	**D/R/W**		
Langs Beach stream (midway)	**R/W**	**W**			
Mangawhai motor camp*			**W**	**W**	
Matapouri 1st bridge*			**W**		
Matapouri 2nd bridge*			**R/W**		R/**W**/P
Ngunguru by school			**W**	**W**	
Ocean Beach stream	**W**		**H/R/W**		
Omamari Beach stream			**R**		
One Tree Point at intertidal beach					
Otamure Bay stream	**R/W**	**R/W**	**R/W**		
Pacific Bay stream		**W**			
Pahi 150m NW of jetty*		**H**		**W**	**W**/P
Pahia at Te Haumi River					W/P
Pahia at Waitangi Bridge					**R**/W
Teal Bay at beach					
Raumanga Stream	**W**				**H**
Site	**2007-08**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Ruakaka River below motor camp					**R**
Victoria River				**W**	W/P/H
Waipu Cove stream		**W**	**D/R/W**		
Whangarei Falls	**R/W**	**W**	**D/R/W**		

8. Water Quality for Recreational Shellfish Gathering

In addition to assessing sites for their suitability for swimming, results from sites also popular for shellfish gathering are compared to the MfE microbiological guidelines for shellfish gathering. The guidelines are based on those used by the shellfish industry and are globally accepted. 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.

8.1 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.

8.2 Results 2012-13

The results for 15 permanent shellfish monitoring sites sampled during 2012-13 are presented in Table 13 below.

Table 13: Results for recreational shellfish gathering permanent monitoring sites 2012-13

		Week																				
Permanent shellfish monitoring sites	**Site No.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Samples**	**Over Guidelines**	**% Over Guidelines**	**Median**	**Pass/Fail**
Baylys beach @ Sea View Rd	109876	2	2	10	2	2	2	2	2	2	2	2							11	0	0	2	Pass
Intertidal beach @ One Tree Point	109266	2	2	10	42	2	2	78	2	16	102	2	2	2	2	10	2	2	17	2	12	2	Fail
Mangawhai Heads @ motor camp	101210	4	2	10	4	2	8	8	4	266	44	10	2	18	2	10	28	16	17	2	12	8	Fail
Matauri Bay @ camp ground	102425	2	2	10	2	3	2	2	2	2	2	2							11	0	0	2	Pass
Ngunguru Estuary @ school	108320	364	10	340	16	14	396	2	220	2	138	36	2	298	6	10	4	4	17	6	35	14	Fail
Oakura Bay @ beach	101345	2	2	10	14	5	2	2	2	2	2	2							11	0	0	2	Pass
Ocean Beach	109877	2	2	10	2	6	2	2	2	8	2	2	2	2	2	10	2	2	17	0	0	2	Pass
Ohawini Bay @ Parutahi Beach	105388	2	2	10	62	2	40	12	168	32	36	24							11	2	18	24	Fail
Paihia @ Te Haumi River	101195	10	176	10	385	153	2	264	2	4	6	17	58	2					13	5	38	10	Fail
Pataua South @ east end of beach	104986	2	2	10	4	14	2	98	4	36	30	6	8	28	22	10	20	2	17	1	6	10	Pass
Ruakaka River @ motor camp	108314	4	2	10	46	910	34	86	4	8	30	28	2	62	2	10	2	20	17	4	24	10	Fail
Sandy Bay @ beach	109879	2	10	10	2	4	2	8	2	4	6	2	2	2	2	10	2	2	17	0	0	2	Pass
Taipa estuary @ motor camp	105777	2	2	20	2	3	64	2	14	2	58	2							11	2	18	2	Fail
Teal Bay @ beach	101331	2	2	10	28	78	10	114	2	4	130	50							11	4	36	10	Fail
Tinopai @ below shops	102310	2	12	10	2	2	14	46	4	14	10	2							11	1	9	10	Pass

Results indicated that seven out of 15 of the permanent sites monitored were within the MfE guidelines for shellfish gathering in 2012-13, 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.

9. Summary and Conclusions

9.1 Coastal sites

The results from 2012-13 indicated that about 90 percent of the 47 coastal sites sampled were considered suitable for recreational use throughout the season. All sites had generally excellent or very good results with a few returning occasional elevated bacteria levels. In general, those sites were affected by rainfall and tended to be located in estuaries or harbours. The overall grading of coastal sites was higher in 2012-13 than in 2011-12, most likely due to the drought that occurred last summer. These results were similar to those from 2009-10 which was also during drought conditions.

In comparison to guidelines, 29 coastal sites met the suitable for swimming criteria 100 percent of the time in 2012-13. A further 13 were suitable for swimming on all but one occasion, and five were suitable for swimming on all but two occasions. Only one site was suitable for swimming on all but three occasions.

The highest rate of three 'Action' results was recorded for Matapouri at second bridge – an estuarine site. This site was part of the investigation programme and microbial source tracking identified wildfowl, plant decay and a weak maker for ruminant.

Other sites such as Church Bay, Matapouri at first bridge, Ngunguru estuary at school and Paihia foreshore returned two 'Action' results within the summer season. None of which were part of the investigation programme in 2012-13. As an indication, previous investigations at Matapouri first bridge and Ngunguru at school identified wildfowl as the source of contamination. The two 'Action' results for Church Bay and Paihia were not related to rainfall and bacteria levels generally remained low at both sites.

9.2 Freshwater sites

Four out of 12 freshwater sites met the suitable for swimming criteria 100 percent of the time, and six sites were suitable for swimming on all but two sampling occasions. A further two freshwater sites were considered unsuitable for swimming on more than two occasions, recording less than 75 percent of samples collected below 'Action' level.

These two sites – Kerikeri River at Stone Store and Victoria River – recorded five and three 'Action' results during the season respectively. Both sites were part of the investigation programme in 2012-13. The Kerikeri River recorded positive markers for ruminant (including sheep), wildfowl (including ducks), and a weak marker for plant decay. Positive weak markers were recorded for wildfowl and plant decay at the Victoria River as well as a very weak human marker. Further investigation to isolate the human marker was inconclusive.

Whangarei Falls was part of the investigation programme from 2007-08 to 2010-11, and ruminant and wildfowl were identified as the sources of contamination in all three seasons. As the site is prone to recurrent contamination, a permanent sign was erected to inform the public about the risk and stating the source of the contamination.

The Waipapa River site was likely to have been affected by rainfall on both 'Action' results. All 'Action' results at Raumanga Stream were related to a sewage spill that occurred in the area and a human marker was identified accordingly.

Overall, 21 'Action' levels were recorded for eight of the 12 freshwater sites, of which 48 percent were likely to have been related to rainfall.

9.3 Site investigation

Eleven sites were listed in the investigation programme in 2012-13 and microbial source tracking analyses were carried out for each sample above 'Action' level. Results indicated contamination occurring at most sites was coming from wildfowl, such as ducks or seagulls, and also ruminant. Enclosed coastal sites like estuaries and harbours were occasionally contaminated by plant decay. Human contamination was identified with a positive marker for Raumanga Stream site and a very weak marker at the Victoria River site.

9.4 Shellfish gathering

The results for the 15 permanent monitoring sites sampled during 2012-13 for their suitability for recreational shellfish gathering indicated that seven sites were within the microbiological water quality guidelines.

10. Key Recommendations

- Continue to monitor a key group of sites on a weekly basis through the summer of 2013-14, including the 20 permanent monitoring sites.
- 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 website.
- 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 2013-14 season according to the following:
  - Remove the following sites from the investigation programme due to consistent low bacteria levels:
    - Lake Waro
    - One Tree Point
    - Teal Bay
  - Remove the following site from the investigation programme due to consistent high bacteria levels and identified source of contamination:
    - Kerikeri River
  - Continue investigating water quality at the following sites:
    - Matapouri at 2nd bridge
    - Paihia at Te Haumi River
    - Paihia at Waitangi Bridge
    - Pahi
    - Raumanga Stream
    - Ruakaka River
    - Victoria River
  - Start investigating water quality at the following sites due to high bacteria levels recorded last season:
    - Tirohanga Stream
    - Waitangi River

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12. Abbreviations

DHB: District Health Board
FNDC: Far North District Council
KDC: Kaipara District Council
MfE: Ministry for the Environment
MoH: Ministry of Health
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

13. Appendices

13.1 Appendix 1 – Results 2012-13

***Enterococci* results for coastal swimming spots in the 2012-2013 summer**

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

Far North	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11
FNDC	Ahipara @ beach off Kaka St (camp ground)	109871	<10		< 10	<10	<10	63	10		10		<10	10	10		20
FNDC	Matai Bay @ Sth end- beach blw toilet blk	102326	<10		< 10	<10	52	<10	<10		20		10	52	<10		<10
FNDC	Tokerau Beach @ Melissa Road	109872	<10		20	<10	20	<10	<10		450		<10	<10	<10		74
FNDC	Waipapa Kauri @ West Coast Rd motor camp	109873	<10		<10	<10	<10	<10	<10		<10		<10	<10	<10		<10

North East (Coopers Beach to Matauri Bay)	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11
FNDC	Cable Bay @ East beach	105780	<10		<10	<10	<10	<10	<10		<10		<10	<10	10		30
FNDC	Cooper's Beach Foreshore @ Kanekane St mouth - east	101066	10		120	10	10	41	73		10		10	10	<10		20
FNDC	Matauri Bay @ Right of camp ground	102425	10		<10	<10	<10	<10	10		<10		<10	<10	<10		<10
FNDC	Taipa estuary @ beside Motor Camp	105777	<10		<10	10	<10	<10	31		<10		10	41	122		<10

North West (Hokianga Harbour)	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11
FNDC	Omapere @ Pioneer Walk Road	102317	<10		10	<10	<10	10	<10		< 10		<10	73	<10		< 10
FNDC	Opononi Shoreline @ Hokianga Harbour (Hok 11) below hotel	106011	<10		10	<10	<10	31	<10		10		<10	10	<10		< 10
FNDC	Rawene @ past ramp*	100236	<10		52	<10	63	359	<10		10		<10	31	<10		63

South West (Kaipara District)	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11
KDC	Baylys beach @ Sea View Rd	109876	<10		<10	<10	<10	<10	<10		< 10		< 10	< 10	< 10		< 10
KDC	Glinks Gully @ Beach off Marine Dv	100798	<10		<10	<10	10	<10	<10		10		10	< 10	< 10		< 10
KDC	Omamari Beach @ beach by stream	109875	<10		<10	<10	<10	<10	<10		< 10		< 10	< 10	< 10		< 10
KDC	Pahi @ 150 mtrs NW of jetty*	102198	279		10	<10	<10	<10	41		959		< 10	31	41		< 10
KDC	Tinopai @ below shops*	102310	10		10	<10	20	<10	<10		63		< 10	10	< 10		< 10
KDC	Tinopai @ Foreshore blw Puapua Creek*	101232	<10		10	<10	<10	10	<10		< 10		< 10	< 10	75		< 10

Enterococci results for coastal swimming spots in the 2012-2013 summer

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

South East (One Tree Point to Mangawhai Harbour)	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11	Week 12	Week 13	Week 14	Week 15	FU	Week 16	Week 17
WDC	One Tree Point east cliffs	109266	<10		10	<10	97	<10	<10		86		<10	10	52		< 10	< 10	< 10	< 10	< 10		10	< 10
WDC	Langs Beach @ Mid-way along beach.	108318	<10		10	<10	20	<10	<10		< 10		<10	20	368		< 10	< 10	< 10	< 10	< 10		< 10	< 10
KDC	Mangawhai Harbour @ Picnic Bay*	110322	<10		<10	<10	41	31	41		< 10		<10	< 10	10		< 10	< 10	< 10	< 10	< 10		< 10	< 10
KDC	Mangawhai Heads @ Motor Camp foreshore*	101210	<10		10	<10	<10	<10	<10		< 10		<10	345	63		10	< 10	41	20	< 10		20	< 10
KDC	Mangawhai Heads @ open coast	109890	<10		10	<10	<10	<10	<10		< 10		<10	< 10	< 10		< 10	< 10	< 10	< 10	< 10		< 10	< 10
WDC	Ruakaka Beach @ Near surf club	108315	<10		20	<10	<10	<10	10		10		<10	< 10	10		20	< 10	20	< 10	< 10		< 10	10
WDC	Ruakaka River @ Below Motor Camp	108314	<10		<10	<10	187	288	10		52		<10	< 10	63		41	< 10	41	< 10	< 10		20	10
WDC	Uretiti Beach @ Tip Road	109888	<10		<10	<10	<10	<10	<10		31		<10	41	41		< 10	< 10	< 10	< 10	< 10		10	< 10
WDC	Waipu Cove @ Beach	108316	20		<10	<10	<10	<10	<10		31		<10	20	10		< 10	20	< 10	< 10	< 10		< 10	< 10

Bay of Islands	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11
WDC	Oakura Bay @ Beach - Nth end of bay	101345	<10		<10	<10	10	10	<10		10		< 10	< 10	< 10		< 10
WDC	Ohawini Bay @ Parutahi Beach Whangaruru	105388	<10		<10	<10	10	<10	41		63		109	31	63		97
FNDC	Paihia @ Te Haumi River	101195	<10		201	<10	168	158	10		1401	10	10	10	63		10
FNDC	Paihia @ Waitangi Bridge (beach)	101183	<10		<10	<10	31	275	<10		288	<10	< 10	108	20		63
FNDC	Paihia @ in front of toilets	101194	<10		<10	10	299	52	10		488	10	< 10	262	98		< 10
FNDC	Russell @ Mid North Moorings	105710	<10		10	<10	119	<10	20		573	10	< 10	31	145		108
WDC	Teal Bay @ Beach	101331	<10		<10	20	10	10	20		75		< 10	< 10	98		52

Tutukaka	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11	Week 12	Week 13	Week 14	Week 15	FU	Week 16	Week 17
WDC	Church Bay @ Mid Bay	105448	<10		<10	<10	<10	97	296	52	292	<10	10	<10	< 10		52	< 10	< 10	< 10	< 10		< 10	< 10
WDC	Matapouri Bay @ First bridge*	100711	31		<10	122	134	20	292	199	119		52	10	556	31	20	31	20	< 10	20		20	173
WDC	Matapouri Bay @ Second bridge*	100712	<10		<10	10	109	31	41		738	<10	10	<10	1296	<10	146	20	84	< 10	754	75	74	52
WDC	Ngunguru Estuary @ Former motor camp ramp*	100073	<10		<10	10	20	<10	<10		122		< 10	<10	< 10		121	< 10	< 10	< 10	10		< 10	< 10
WDC	Ngunguru Estuary @ school	108320	369	<10	<10	228	52	20	6488	<10	< 10		241	<10	10		110	10	110	10	< 10		< 10	< 10
WDC	Pacific Bay @ Beach	108313	<10		75	<10	<10	86	10		52		< 10	10	80		< 10	< 10	< 10	< 10	31		< 10	< 10
WDC	Sandy Bay @ centre of beach	109879	<10		<10	<10	<10	<10	<10		< 10		< 10	10	< 10		< 10	< 10	< 10	< 10	10		< 10	10
WDC	Wellingtons Bay @ beach in front of northern car park	109880	10		<10	41	426	<10	20		< 10		< 10	<10	< 10		63	< 10	20	< 10	20		< 10	< 10
WDC	Whananaki @ east beach	106938	20		<10	10	41	20	10		10		< 10	<10	609	<10	199	31	< 10	20	86		84	< 10
WDC	Woolleys Bay @ centre of beach	109878	<10		<10	<10	<10	<10	<10		122		< 10	20	< 10		< 10	< 10	< 10	< 10	< 10		< 10	< 10

Enterococci results for coastal swimming spots in the 2012-2013 summer

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

Whangarei Heads (including Onerahi and Pataua)	Site Name	Site Number	Week 1	FU	Week 2	Week 3	Week 4	Week 5	Week 6	FU	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11	Week 12	Week 13	Week 14	Week 15	FU	Week 16	Week 17
WDC	Ocean beach @ centre of beach	109877	<10		<10	<10	<10	<10	<10		< 10		<10	<10	< 10		< 10	< 10	< 10	< 10	< 10		< 10	< 10
WDC	Onerahi @ opposite play boat*	101600	<10		20	20	20	<10	<10		345	187	<10	31	10		199	< 10	< 10	< 10	41		< 10	31
WDC	Pataua South @ East end of beach	104986	<10		<10	<10	<10	<10	10		1455	10	<10	10	< 10		243	< 10	< 10	< 10	< 10		10	10
WDC	Taurikura Beach (Whangarei harbour)	101262	<10		<10	<10	160	<10	10		20		<10	10	10		52	< 10	< 10	10	< 10		< 10	<10

*Sites where grades are calculated using a combination of *Enterococci* and Faecal Coliforms as they are usually estuaries and or harbours (considered enclosed marine sites).

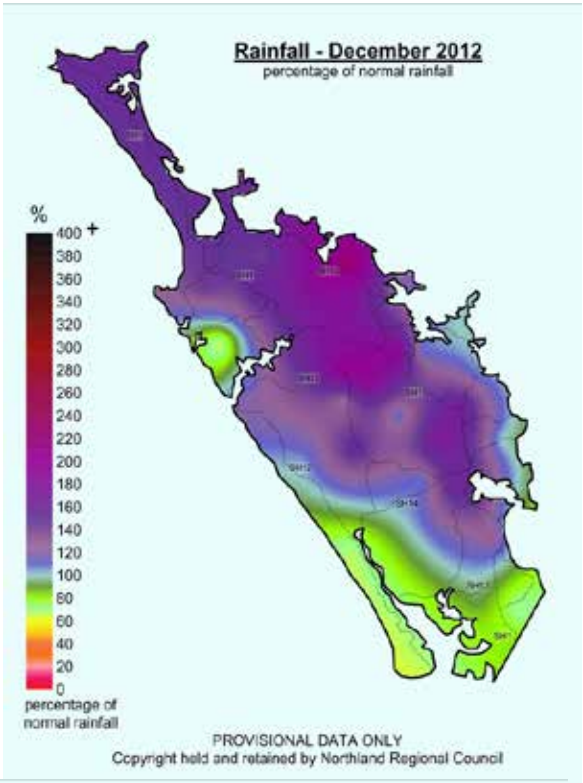
E. coli Results for freshwater swimming sites 2012-2013

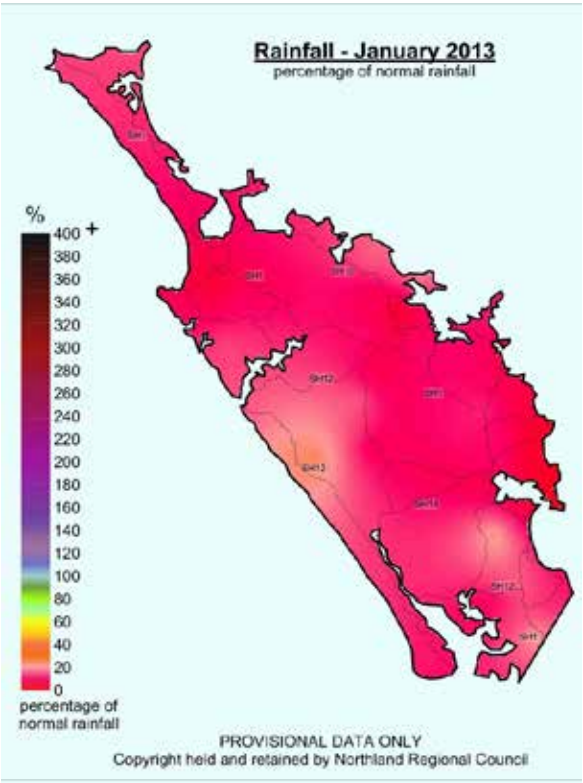
MfE guidelines 2003 — Single sample
Alert (orange) mode — E.coli > 260
Action (red) mode — E.coli > 550
FU — Follow-up sample

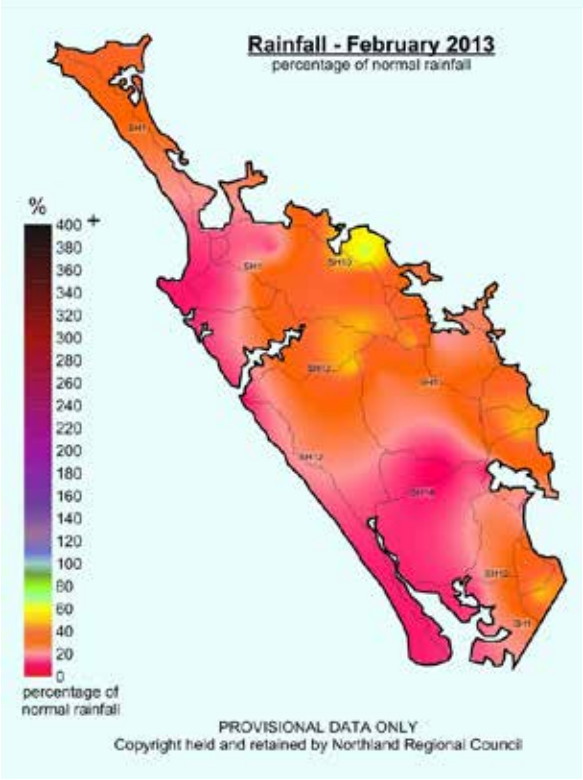
Fresh Water	Site Name	Site Number	Week 1	Week 2	Week 3	FU	Week 4	Week 5	Week 6	Week 7	FU	Week 8	Week 9	Week 10	FU	Week 11	FU	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17
FNDC	Kerikeri River @ Stone Store bridge	101530	75	185	63		780	1314	169	4106	97	97	272	959		5172	43						
FNDC	Lake Ngatu @ South end	100402	10	41	< 10		< 10	10	20	20		< 10	< 10	31		< 10							
KDC	Lake Taharoa @ Pump house	105434	10	10	< 10		< 10	63	< 10	10		< 10	< 10	< 10		< 10							
WDC	Lake Waro @ Launching Area, Hikurangi	107272	<10	< 10	63		10	<10	41	< 10		30	41	20		10		10	<10	<10	41	20	20
FNDC	Punakitere River @ Kaikohe falls swimming hole	110927	63	98	744	167	189	860	121	63		20	< 10	309		74							
WDC	Raumanga Stream @ Swimming pool below Falls	103246	84	173	63		265	175	109	3076	>24196	86	73	771	300	173		144	98	75	20	279	86
FNDC	Tirohanga Stream @ D/S 50 mtrs of FNDC Take	102252	464	226	538		591	408	206	275		223	259	789		135							
FNDC	Victoria River @ DOC Reserve Crossing	104908	148	833	238		8664	292	323	448		272	107	1860		243							
FNDC	Waipapa River Waihou Valley @ Swimming pool	103248	30	86	86		183	573	109	63		63	20	703		121							
FNDC	Waipoua River @ Swimming hole at DOC HQ	108613	10	75	31		134	345	109	41		20	52	52		52							
FNDC	Waitangi River @ Watea (NIWA Wakelins site)	101752	120	62	41		336	1450	265	110		110	85	1935		52							
WDC	Whangarei Falls @ above falls (Hatea River)	105972	404	345	278		1450	521	221	443		305	355	389		554		520	341	292	213	512	359

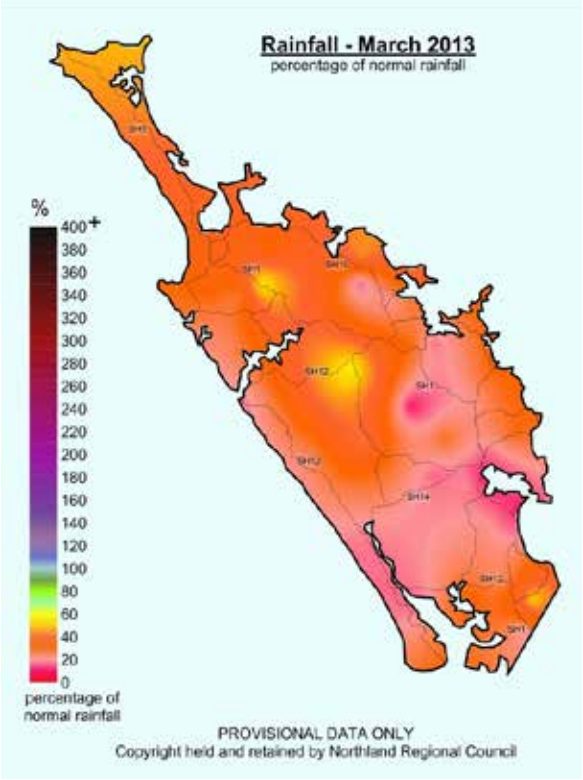
MfE guidelines 2003: Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Published by Ministry for the Environment.
Important note: Following a review of the recreational swimming water quality data in 2006/2007, several sites were removed from the programme because they have had consistently good or poor water quality over the last four summers. These sites are no longer monitored. These sites are listed on the Regional Council website at the following link: http://www.nrc.govt.nz/Living-in-Northland/At-the-beach/Swimming-water-quality/Sites-removed/
FNDC: Far North District Council, WDC: Whangarei District Council, KDC: Kaipara District Council.

13.2 Appendix 2 – Rainfall Maps Summer 2012-13









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