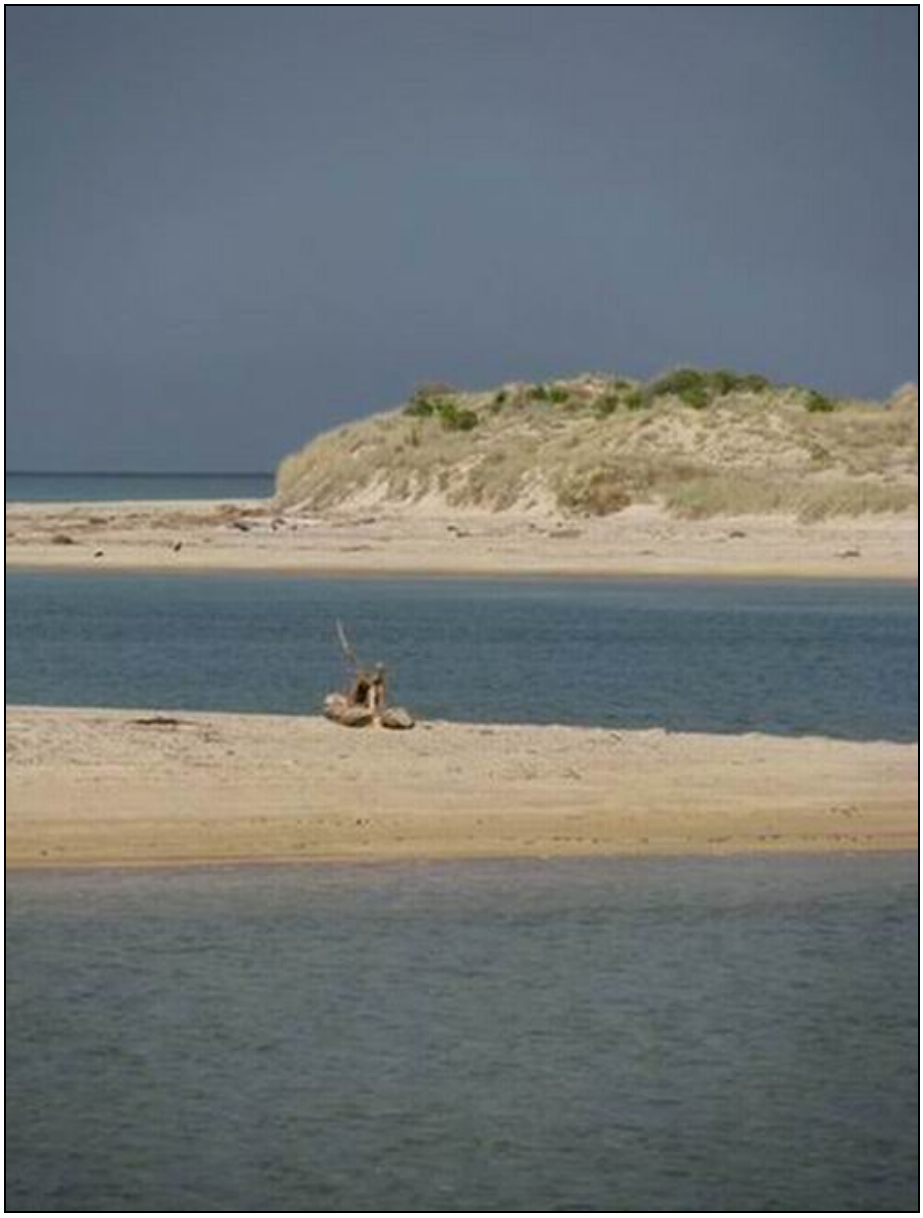
RECREATIONAL SWIMMING WATER QUALITY IN NORTHLAND

SUMMER 2010-11



June 2011
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NORTHLAND REGIONAL COUNCIL

EXECUTIVE SUMMARY

- From November 2010 to February/March 2011, a total of 24 freshwater and 61 coastal sites were monitored through the Recreational Swimming Water Quality Programme

- In comparison with the Ministry for the Environment guidelines (the guidelines) in 2010-11, 22 coastal sites met the 'safe' criteria 100% of the time; 21 met the 'safe' criteria on all but one occasion; 16 met the 'safe' criteria on all but two occasions, and two met the 'safe' criteria <75% of the time.

- In 2010-11, four freshwater sites met the 'safe' criteria 100% of the time; two met the 'safe' criteria on all but one occasion; nine met the 'safe' criteria on all but two occasions, and nine met the 'safe' criteria <75% of the time.

- MfE Grading levels were lower in 2010-11 than in 2009-10, largely due to three major rainfall events during the summer. These three rainfall events accounted for a total of 64 'Action' results.

- The LTCCP target of 95% compliance for the 20 permanent monitoring sites was not achieved in 2010-11. The median compliance for the 20 permanent monitoring sites in 2010-11 was 92%.

- In 2007, all sites with sufficient data were given a Suitability for Recreation Grade. This grading was re-assessed in 2011. Of the coastal sites graded, 11 were given a lower grading in 2011 and 10 were given a higher grading. Of the freshwater sites graded, two were given a lower grading and four were given a higher grading. Re-grading was based on additional data collected since 2007 and new knowledge of water quality issues at each site.

- None of the 15 sites classified for recreational shellfish gathering were within the Ministry for the Environment guidelines (the guidelines) for recreational shellfish gathering during 2010-11.

- A total of 17 sites have now been studied as part of a Council initiative to investigate poor water quality at problem sites in the region.

- Source tracking to isolate the source/s of contamination at these sites has shown that 14 sites are contaminated by wildfowl (ducks and/or gulls). Ten sites are contaminated by ruminant faecal material; five sites with dog faecal material and two sites by a human source of pollution. The two sites that showed a source of contamination to be human are Pahi at stormwater and Ocean Beach stream.

- Microbial data for these sites has been analysed against rainfall, turbidity, temperature and, where applicable, tide and salinity data to build a clearer picture of the environmental conditions that may affect water quality at these sites.

- Sites where investigations have shown the source of contamination to be wildfowl will now be removed from the programme and permanent warning signs erected for public information.

- Sites where water quality is affected by rainfall will still be monitored however signs will be erected to discourage swimming for 48 hours after a rainfall event.

- Investigation work will continue at sites where the source/s of contamination has not yet been identified and these sites will continue to be monitored through the programme.

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1 INTRODUCTION

The Recreational Swimming Water Quality Programme (the programme) is a joint project, administered by the Northland Regional Council (the Council), in partnership with the Northland District Health Board (DHB), and the Far North District Council (FNDC), Whangarei District Council (WDC) and Kaipara District Council (KDC). The aim of the programme is to provide information on water quality at popular freshwater and coastal swimming sites in Northland, to allow the public to make an informed decision about where is safe to swim.

In Northland, swimming sites, particularly freshwater sites or those with a freshwater influence (such as harbours and estuaries), are not always safe for recreational use. Water can sometimes be contaminated with human or animal effluent, which contains large numbers of illness causing organisms. These organisms, called pathogens, can include "bugs" such as giardia (*Giardia lamblia)* and campylobacter *(Campylobacter jejuni)*.

According to research undertaken in 2002, the most common sources of pathogenic contamination in water are human sewage (from sewage spills or leaking septic tanks), storm water and rural run-off (Jarman, 2002). However in Northland, monitoring has shown that the most common cause of contamination is wildfowl (particularly ducks in freshwater and gulls in coastal areas). Contamination from human sources has only been identified at a small number of sites.

Contamination from human sewage is perhaps the easiest to identify and 'fix'. However, the effects of storm water, rural run-off and wildfowl in water are not as easy to identify and mitigate. No matter what the source, the potential for causing illness is the same (Jarman, 2002a).

The objective of the programme is to facilitate 'safer' swimming in Northland by identifying problem sites and informing the public of the implications of recreational contact with contaminated water. Once problem sites have been identified, the Regional and District Councils can also work together to identify the source of contamination and work towards improving water quality at these sites.

Photo: Ocean beach

2 HEALTH RISKS

Swimming in contaminated water can lead to skin, eye and ear infections; gastrointestinal and respiratory illnesses (Jarman, 2002a). Most pathogens are ingested 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 on the body.

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. When you consider how small bacteria and viruses are, and how big water bodies can be (including the sea), it makes it impossible to ever guarantee that any water is safe to swim in. This uncertainty is the reason that health authorities recommend you boil any untreated freshwater before consuming it.

Instead, when determining how safe a body of water is for recreation, it is better to consider things in terms of *maximum acceptable risk*. 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) has set the maximum acceptable risk at 8 in every 1000 users falling ill as a result of contact with contaminated water (MfE, 2002; MfE 2003). For marine waters, the maximum acceptable risk is 19 in every 1000 users. These figures are based on both international and New Zealand studies.

2.2 When to avoid contact recreation

In order to minimise the risk when using our coastal and fresh water sites for contact recreation, a number of simple rules should be followed:

CLARITY

Stagnant and/or murky water contains more pathogens than crystal clear and/or flowing water. Research has shown that there is a link between suspended solids in water (which reduce water clarity) and agricultural run-off (which can contain high levels of pathogens). **A good way to reduce your risk is to only swim[1] in water in which you can see your feet when you are standing knee deep.**

[1] The term 'swimming', when used in this report, refers to all contact recreational uses of a water body, for example, diving, water skiing and swimming.

DISCOLOURATION, FOAMS AND ODOUR

Water can be unsafe for swimming if it has an unpleasant or unusual 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. **Do not swim in water where there is evidence of contamination.**

RAINFALL

Rainfall has a big impact on water quality in Northland, particularly in fresh water bodies. When it rains, some rainfall runs off the land, carrying contaminates from farmland and urban areas, including animal dung, fertiliser and chemicals. This run-off enters rivers, streams 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 contaminates for several days after heavy rainfall. Areas that have greater mixing, for example, open coastal sites where the tide flushes contaminates out to sea, are less susceptible to the effects of rainfall runoff.

In Northland, it is recommended to wait for 48 hours after heavy rainfall before swimming in freshwater or semi-enclosed (harbours and estuaries) coastal sites.

Photo: Wairua Falls in flood after ex-tropical cyclone Wilma.

3 RECREATIONAL CONTACT GUIDELINES

The Ministry for the Environment (MfE) and Ministry of Health (MoH) released national *Microbiological Water Quality Guidelines* (the MfE guidelines) in June 2003. Where practicable, the programme has incorporated recommendations presented in these guidelines, and results from the programme can therefore be assessed against the national criteria. This section provides an outline and discussion of the key aspects of the MfE guidelines, which are 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. Every five years, sites are given a Suitability for Recreation Grade (SFRG), which provides an indication of how suitable a site is for recreational contact outside of the main 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 bacteria present. For freshwater sites, levels of *E. coli* bacteria are measured and sites are graded: Acceptable (green), Alert (yellow), or Action (red), as shown in Table 1.

For open coastal sites, *Enterococci* bacteria are counted. Sites are graded: Surveillance (green), Alert (amber), or Action (red), as shown in Table 2. Where a coastal site is influenced by a freshwater input, or is semi-enclosed (for example, harbours and estuaries), a combination of *Enterococci* bacteria and faecal coliforms are used to grade each site, as shown in Table 3. This is because in certain conditions, for example where mangroves exist, enterococci bacteria can be naturally occurring and therefore using this indicator alone can give a misleading result.

Results are sent to the District Councils and DHB at the end of each sampling week. Any 'alert' or 'action' results are notified to the relevant District Council within 24 hours, so that they can instigate further investigative sampling or erect warning signs. All results are also advertised on the Council website – www.nrc.govt.nz/swimming - at the end of each week.

***E. coli* count**	**Category**	**Suggested response**
Sample < 260 per 100 ml	Surveillance (Safe)	▪ No response necessary – Continue weekly sampling
260 < Sample > 550 per 100 ml	Alert (Caution)	▪ Increase sampling to daily ▪ Undertake sanitary survey to isolate source of faecal contamination
Sample > 550 per 100 ml	Action (Unsafe)	▪ Increase sampling to daily ▪ Undertake sanitary survey ▪ Erect warning signs ▪ Inform public through the media that a public health risk exists

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

Enterococci count	Category	Suggested response
Sample < 140 per 100 ml	Surveillance (Safe)	▪ No response necessary – Continue weekly sampling
140 < Sample > 280 per 100 ml	Alert (Caution)	▪ Increase sampling to daily ▪ Undertake sanitary survey to isolate source of faecal contamination
Sample > 280 per 100 ml	Action (Unsafe)	▪ Increase sampling to daily ▪ Undertake sanitary survey ▪ Erect warning signs ▪ Inform public through the media that a public health risk exists

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

Faecal coliform count	Category	Enterococci count	Category	Grade
Sample < 150 per 100 ml	Surveillance (Safe)	Sample < 140 per 100 ml	Surveillance (Safe)	Safe + Safe = Surveillance
150 < Sample > 600 per 100 ml	Alert (Caution)	140 < Sample > 280 per 100 ml	Alert (Caution)	Any other combination = Alert
Sample > 600 per 100 ml	Action (Unsafe)	Sample > 280 per 100 ml	Action (Unsafe)	Unsafe + Unsafe = Action

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

3.2 End of season grading

At the end of the sampling season, a final spreadsheet of results is prepared. This spreadsheet includes all results for the season plus the season median and percentage of samples at each site that were below 'action' mode. This is the method used by MfE and is based on the number of occasions where an 'unsafe' result (either >550 *E. coli*; >600 faecal coliforms or >280 *Enterococci)* is recorded:

1 (blue) = 100% samples within guidelines (no 'action' results)
2 (green) = 90-99% samples within guidelines
3 (orange) = 75-89% samples within guidelines
4 (red) = <75% samples within guidelines

3.3 Suitability for Recreation Grade (SFRG)

The Suitability for Recreation Grade (SFRG) is calculated by combining the Microbiological Assessment Category (MAC) – a review of the water quality data available for a site – and the Sanitary Inspection Category (SIC) – a review of potential and actual sources of contamination at a site.

MICROBIOLOGICAL ASSESSMENT CATEGORY (MAC)

The MAC is calculated by looking at all microbiological water quality data collected for a site through routine sampling. Ideally, each site should have 100 samples or greater collected over a consecutive five year period. However, an interim MAC can be calculated based on 20 or more samples collected over less than five years.
The 95th percentile of the dataset for each site is calculated (I.E 95% of the samples in the dataset fall below this number). The site is then given an MAC based on what the 95th percentile is. The MfE guidelines group the possible range of results for

coastal and freshwater sites into four categories, ranging from A to D, as shown in Tables 4 and 5 below.

A	Sample 95th percentile ≤ 130 *Escherichia coli* per 100 ml
B	Sample 95th percentile 131-260 *Escherichia coli* per 100 ml
C	Sample 95th percentile 261-550 *Escherichia coli* per 100 ml
D	Sample 95th percentile > 550 *Escherichia coli* per 100 ml

Table 4: Microbiological Assessment Category (MAC) definitions for freshwater

A	Sample 95th percentile ≤ 40 *Enterococci* per 100 ml
B	Sample 95th percentile 41-200 *Enterococci* per 100 ml
C	Sample 95th percentile 201-500 *Enterococci* per 100 ml
D	Sample 95th percentile > 500 *Enterococci* per 100 ml

Table 5: Microbiological Assessment Category (MAC) definitions for coastal water

THE SANITARY INSPECTION CATEGORY (SIC)

In order to calculate the SIC, a catchment assessment checklist is completed for each site. This involves identifying potential and actual sources of contamination, both direct and indirect, at a site by establishing adjacent and surrounding land-use and environmental conditions that may affect water quality at the site.

The SIC is based on the principle potential source of microbiological contamination, for example, an adjacent sewage treatment plant, and a category is assigned to the site according to the potential risk from this source. The MfE guidelines have grouped the most commonly occurring sources of contamination into five categories, as shown in Table 6 below.

Sanitary Inspection Category	Examples Of Source
Very Low	No significant source; indirect run-off from native bush or forest.
Low	Indirect run-off from horticulture or low-intensity agriculture/urban/rural catchment; direct run-off from forests.
Moderate	Urban stormwater not contaminated by sewage; receives tertiary treated discharge or sewage overflows; agricultural or rural catchment; significant feral bird/animal population.
High	Tertiary treated wastewater discharged to beach or adjacent area; urban stormwater; marinas or moorings; direct run-off from intensive agriculture or unrestricted access of stock to waterways, significant bird populations.
Very High	Direct discharge of untreated sewage or on-site waste treatment systems (including leaking septic tanks).

Table 6: Sources for Sanitary Inspection Category

THE SUITABILITY FOR RECREATION GRADE (SFRG)

The SFRG is determined by combining the MAC and SIC of a site. There are five grades, ranging from Very Good to Very Poor. Table 7 below shows how the SFRG is calculated.

Suitability for Recreation Grade		Microbiological Assessment Category (MAC)			
		A	B	C	D
Sanitary Inspection Category (SIC)	Very low	**Very good**	**Very good**	**Follow up♠**	**Follow up♠**
	Low	**Very good**	**Good**	**Fair**	**Follow up♠**
	Moderate	**Follow up♣**	**Good♣**	**Fair**	**Poor**
	High	**Follow up♣**	**Follow up♣**	**Poor**	**Very poor**
	Very high	**Follow up♣**	**Follow up♣**	**Follow up♣**	**Very poor**

Table 7: Suitability for Recreation Grade Guidelines (MfE 2003)

SFRG = Very Good

Without any significant sources of faecal contamination, a site with a "Very Good" SFRG may be considered suitable for contact recreation at all times. A site with a "Very Good" SFRG may not require regular sampling in the future.

SFRG = Good

While water quality is generally good at a "Good" site, potential sources of faecal contamination, such as indirect agricultural run-off or non-sewage stormwater, can make the site unsuitable for contact recreation during and after periods of significant rainfall. Regular monitoring of such sites is necessary.

SFRG = Fair

At sites with a "Fair" grade, water is usually suitable for contact recreation but sources of contamination, such as direct discharges from low-intensity agriculture and stormwater drains or indirect discharges from intensive agriculture, may mean that these sites are unsuitable for swimming during or immediately after heavy rainfall. MfE recommends that such sites should be monitored weekly during popular times of the year.

SFRG = Poor

The water at sites with a "Poor" grade tends to breach alert guidelines on a regular basis. Direct discharges from intensive agriculture or tertiary treated sewage, or indirect discharges from leaking septic tanks and other untreated wastes, mean that these sites are generally unsuitable for swimming. Because of the nature of contamination, this grading stands even during dry periods and territorial authorities may choose to erect permanent warning signs, especially if weekly sampling is discontinued at such sites.

SFRG = Very Poor

Sites that receive a grade of "Very Poor" should not be used for recreational activities. Direct discharges of faecal material from sources such as leaking septic tanks or untreated wastewater mean that local authorities should erect permanent warning signs at such sites, advising that the water is categorically unsuitable for use.

Although the SFRG can give an indication of a site's suitability for swimming, it can be misleading as it does not take into account the effects of weather and rainfall on water quality. Northland has a sub-tropical climate and unpredictable rainfall patterns,

♠ Implies non-sewage source of faecal contamination, and this needs to be verified.
♣ Unexpected results, which require further investigation (either SIC or MAC needs to be reassessed).

including frequent high intensity rainfall events. A single rainfall event during the sampling season can elevate the 95th percentile of the dataset for a site, which can unduly influence the MAC. This may lead to a SFRG that does not necessarily reflect actual water quality at a site.

4 METHODOLOGY

4.1 Sampling technique

Sampling is undertaken once a week at selected freshwater and coastal sites throughout the summer months. In 2010-11, sampling ran from 29 November 2010 to the 16 February 2010 at 61 coastal and 24 freshwater sites. Sampling continued at 32 coastal and 7 freshwater sites until 30 March 2011. Sampling is undertaken regardless of weather conditions but weather at the time of sampling is noted and water temperature is also recorded.

Each sample was collected following the methods in the '*Microbiological Water Quality Guidelines for Freshwater and Marine Recreational Bathing Areas'* (MfE, 2003). Coastal samples are taken from the shore using a sampling pole at about 0.5m depth, from approximately 15cm below the surface. Freshwater samples are taken at approximately 30cm below the surface, where the depth of water is approximately 1 metre. All samples are collected during daylight hours and sites are sampled in the same order each week. This ensures that, where practical, samples are collected at around the same time each week.

Photo: NRC staff undertaking water quality sampling

4.2 Sample analysis

It is an expensive and difficult procedure to identify and count pathogens in water. Instead, the Council uses indicator bacteria to grade water quality at each site, as recommended in the MfE guidelines. For freshwater sites, the indicator bacteria *Escherichia coli (E. coli)* are counted. This bacterium indicates faecal pollution and

scientific studies have shown that where *E. coli* is present, we can safely assume there are pathogens in the water (MfE, 2002).

For coastal waters, both *Enterococci* and faecal coliforms are counted. The New Zealand Marine Bathing Study showed that *Enterococci* are 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 in the Council 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 practical or economically viable to monitor every one. The Council, along with key stakeholders, reviews sites to be monitored at the start of each swimming season and selects sites based on popularity, and/or because of a specific request from the public or if there is a suspected human health risk associated with microbiological contamination.

5.1 Sampling sites 2010-11

In the 2010-11 sampling season, a total of 24 freshwater sites and 61 coastal sites were monitored through the programme, as shown in Table 8 (below). Sites highlighted in orange were added for the 2010-11 season.

Freshwater Site	Location	Site No.	District
Lake Waro	Hikurangi	107272	Whangarei
Langs Beach Stream	By car park (*formerly toilets*)	100686	
Ocean Beach Stream	Beach drain	102077	
Otamure Bay Stream	Otamure Bay, Whananaki	108859	
Raumanga Stream	Raumanga reserve	103246	
Waipu Beach Stream	By beach	101207	
Whangarei Falls	Waitaua stream above falls	105972	
Aurere River	SH 10	110324	Far North
Coopers Beach Stream	Kanekane stream, Coopers Beach	101870	
Kapiro Stream	Purerua Road bridge	102838	
Kerikeri River	Stone Store	101530	
Lake Ngatu	South end of lake	100402	
Lake Rotopokaka (Coca Cola)	At public beach	110323	
Mangakahia River	Twin Bridges	105973	
Otaua Stream	Kaikohe	108510	
Tirohanga Stream	Tirohanga Road	102252	
Victoria River	At DOC Reserve	104908	
Waipapa River	Puketi Forest	103248	
Waipapa Stream	Charlie's Rock	110348	
Waipoua River	DOC camping site	108613	
Waitangi River	Lily Pond Reserve	104830	
Kaihu River	Motor camp	102221	Kaipara
Lake Taharoa	Kai Iwi Lakes	105434	
Omamari Beach Stream	Omamari Beach	102305	
Coastal Site	**Location**	**Site No.**	**District**
Bland Bay	Beach	109889	Whangarei
Church Bay	From beach	105448	
Kowharewa Bay	From beach	106444	
Langs Beach	Mid way along beach	108318	
Matapouri	First bridge	100711	
Matapouri	Second bridge	100712	
Matapouri Bay	In centre of beach	110321	
McLeod Bay	By toilets	101254	
Ngunguru	Motor camp	100073	
Ngunguru	By Norfolk Pine	100076	
Ngunguru	By school (*formerly toilets*)	108320	
Oakura	North end of beach	101345	
Ocean Beach	Beach	109877	
Ohawini Bay	From beach	105388	

One Tree Point	By boat ramp	109266	
Onerahi	Foreshore	101600	
Pacific Bay	From beach	108313	Whangarei
Pataua South	Footbridge	102217	
Pataua South	East end of beach	104986	
Pataua South	Frogtown beach	109887	
Ruakaka	Near surf club	108315	
Ruakaka	By motor camp	108314	
Sandy Bay	Beach	109879	
Taurikura	By toilets	101262	
Teal Bay	From beach	101331	
Uretiti Beach	In front of motor camp	109888	
Urquharts Bay	Before rock wall	108311	
Waipu Cove	From beach	108316	
Wellingtons Bay	In front of toilets	109880	
Whananaki	Footbridge	103147	
Whananaki	East end of bay	106938	
Woolleys Bay	Beach	109878	
Coastal Site	**Location**	**Site No.**	**District**
Ahipara	In front of camp ground	109871	Far North
Cable Bay	Beach	105780	
Coopers Beach	Foreshore	101066	
Kerikeri	Skudders beach	100974	
Maitai Bay	In front of camp ground	102326	
Matauri Bay	Beach	102425	
Omapere	Beside jetty	102317	
Opononi	Beach	106011	
Opua	Foreshore	101418	
Paihia	Te Haumi	101195	
Paihia	Beside toilets	101194	
Paihia	Waitangi bridge	101183	
Rawene	Boat ramp	100236	
Russell	Mid-north beach	105710	
Shipwreck Bay	Beach	109870	
Taipa	Beach	105777	
Tokerau Beach	Beach	109872	
Waipapa Kauri	Beach	109873	
Coastal Site	**Location**	**Site No.**	**District**
Baylys Beach	Beach	109876	Kaipara
Glinks Gully	Beach	100798	
Mangawhai Heads Beach	By surf club	109890	
Mangawhai Harbour	Picnic Bay	110322	
Mangawhai Harbour	North end of motor camp	101210	
Mangawhai Harbour	Pontoon (Eveline St)	110320	
Omamari Beach	Beach	109875	
Pahi	Broken rocky groyne	102579	
Pahi	North west of jetty	102198	
Tinopai	Below shops	102310	
Tinopai	Below creek	101232	

Table 8: Sites monitored in 2010-11

5.2 Sites removed

At the end of each sampling season, the Council, along with key stakeholders, meets to discuss results from the season. This stakeholder group may decide to remove certain sites from the programme due to concern over safety at the site; lack of use of the site or because a site is consistently safe or unsafe for recreational use. Sites

with consistently poor water quality have permanent warning signs erected therefore removing the need for regular monitoring.

Table 9 below shows all sites that have been removed from the programme in the last five years. These sites may, however, be monitored on a less frequent basis during the sampling season, depending on resources and need.

Site Name	Site No.	Year Removed	Reason for Removal
Wairoa Stream (Ahipara)	105053	2007-08	Consistently unsafe
Lake Ngatu at launch	100402	2007-08	Consistently safe
Lake Taharoa	100452	2007-08	Consistently safe
Doves Bay	101537	2007-08	Consistently safe
Windsor Landing (Kerikeri)	105707	2007-08	Consistently safe
Opito Bay	101538	2007-08	Consistently safe
Russell mid-south	105711	2007-08	Consistently safe
Matauwhi Bay	102636	2007-08	Consistently safe
English Bay	100802	2007-08	Consistently safe
Kawakawa River	100643	2007-08	Consistently safe
Otiria Stream	105376	2007-08	Consistently unsafe
Ngunguru cable marker	100061	2007-08	Duplicate site
Pataua North	105992	2007-08	Duplicate site
Okiato Point	105712	2008-09	Consistently safe
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 unsafe
Langs Beach north	108317	2010-11	Duplicate site
Rarawa camp site	109874	2010-11	Consistently safe
Taupo Bay	109868	2010-11	Consistently safe
Tauranga Bay	109869	2010-11	Consistently safe

Table 9: Sites removed from the monitoring programme

5.3 Permanent monitoring sites

For the purposes of monitoring the Council's performance, performance targets are laid out in the Long Term Council Community Plan (LTCCP) 2009-2019. For the programme, the performance target is:

Annual Median % compliance of 20 representative bathing sites complies with Ministry of the Environment guidelines.

The baseline for this target is the % compliance in 2007-08, which was 95%.

Due to the large number of sites monitored through the programme, and as some sites may be removed or added each year (which would effect overall % compliance if all sites were used) 20 sites have been randomly selected from the programme to be monitored every year to measure performance. These sites are listed in Table 10 below.

Site Name	Site Number	% compliance in 2007-08
Opononi	106011	100
Taipa	105777	92
Paihia – Waitangi bridge	101183	92
Pahi – rocky groyne	102579	100

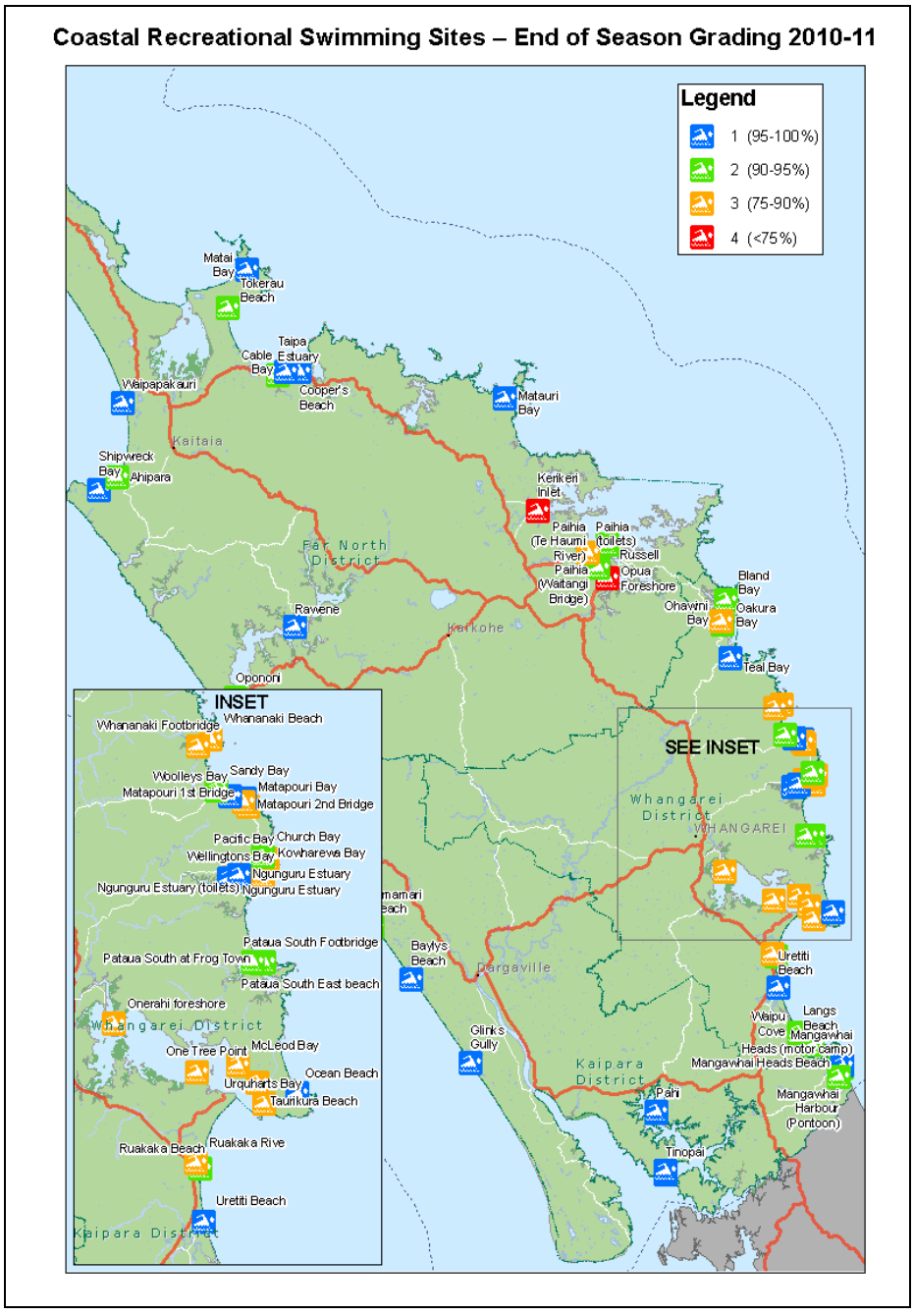
Site Name	Site Number	% compliance in 2007-08
Tinopai – below shops	102310	100
Taurikura	101262	92
Matapouri – second bridge	100712	85
Church Bay	105448	100
Pacific Bay	108313	100
Pataua South – east of beach	104986	92
Onerahi – play ground	101600	100
Ruakaka – by motor camp	108314	100
Lang's Beach – mid beach	108318	100
Teal Bay	101331	92
Waipu Cove	108316	100
Kerikeri – Stone Store	101530	77
Waipoua River	108613	85
Waipapa River – Puketi	103248	92
Lake Waro – Hikurangi	107272	100
Raumanga Stream	103246	54

Table 10: Permanent monitoring sites

6 RESULTS & INTERPRETATION

The results for all sites sampled in 2010-11 can be viewed in Appendix 1.

6.1 End of season grading – coastal sites



Map 1: Coastal Grading 2010-11

The map above summarises the end of season grading for samples taken from each of the 61 coastal sites monitored in Northland during the 2010-11 sampling season (29 November 2010 to the 30 March 2011).

The table below shows coastal results from 2010-11 compared to 2009-10.

Category	2009-10	2010-11
100% samples <280/ml *Enterococci*	45	22
90-95% samples <280/ml *Enterococci*	13	21
75-90% samples <280/ml *Enterococci*	5	16
<75% samples <280/ml *Enterococci*	0	2
Total number of sites:	**63**	**61**

Table 11: A comparison of coastal results over the last two seasons

In 2010-11, there were more 'Action' results recorded for coastal sites than in 2009-10. This is largely due to a number of heavy rainfall events that hit Northland during the summer of 2010-11. In comparison, the summer of 2009-10 was extremely dry with very little rainfall received over the sampling period.

Results for the 2010-11 sampling season are summarised below. Each 'Action' result has been cross-referenced with rainfall data for the 72 hours prior to sampling. This gives an indication of whether or not 'Action' results could be rainfall related.

Rainfall can lead to elevated levels of bacteria in the water for a number of reasons. Rainfall washes contaminates off the land and these enter water through rainfall run-off or stormwater drains. Higher flows in freshwater bodies and stormy conditions along the coast can also cause re-suspension of contaminates attached to bank or bed sediment. High intensity rainfall events can cause municipal sewage and septic tank systems to fail, causing overflow of human waste into water.

FAR NORTH

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Shipwreck Bay	12	12	0	-
Waipapakauri	12	12	0	-
Maitai Bay	12	12	0	-
Tokerau Beach	12	11	1	0
Ahipara	12	11	1	1

The 'Action' result from Tokerau Beach was not related to rainfall. This site has been monitored for the last two years and this is the first 'Action' result. It is not known what caused this result but levels of bacteria in the water had returned to 'safe' levels by the following week.

In coastal areas, it can be difficult to track the source of contamination for random 'Action' results such as this. It takes 24 hours for results from initial sampling to be known, by which time the source of pollution at theses sites has often abated and contamination flushed out to sea.

NORTH EAST

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Cable Bay	12	12	0	-
Coopers Beach	12	12	0	-
Matauri Bay	11	11	0	-
Taipa estuary	12	11	1	1

NORTH WEST

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Omapere	12	12	0	-
Rawene	12	12	0	-
Opononi	12	11	1	0

The site at Opononi, had 90-95% of samples below 'Action'. This result did not correspond to a rainfall event. It is not known what caused the result but levels of bacteria in the water had returned to 'safe' levels by the following week. Historically, Opononi has graded well in comparison to guidelines.

SOUTH WEST

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Baylys Beach	12	12	0	-
Glinks Gully	12	12	0	-
Pahi rocky groyne	12	12	0	-
Pahi NW jetty	12	12	0	-
Tinopai at creek	12	12	0	-
Tinopai at shops	12	12	0	-
Omamari Beach	12	11	1	1

SOUTH EAST

Site Name	No. samples	Surveillance/ Alert	Action	Rainfall Related
Mangawhai Heads	17	17	0	-
Uretiti Beach	17	17	0	-
Mangawhai Harbour pontoon	17	16	1	0
Mangawhai Harbour motor camp	17	16	1	1
Mangawhai Harbour Picnic Bay	17	16	1	1
Langs Beach midway	17	16	1	1
Waipu Cove Beach	17	16	1	0
Ruakaka Beach	17	16	1	1
Ruakaka River	17	15	2	2
One Tree Point	17	15	2	2

The 'Action' results for Waipu Cove and Mangawhai Harbour at pontoon do not correspond to a rainfall event. It is not known what caused these results but levels of bacteria in the water had returned to 'safe' levels by the following week. Historically, Waipu Cove has graded well in comparison to guidelines.

The two 'Action' results for both Ruakaka River and One Tree Point correspond to heavy rainfall events. Historically, both of these sites have graded well, except after rainfall. Ruakaka River in particular is influenced by a freshwater source and after rainfall, contaminants are carried in this freshwater out to sea.

BAY OF ISLANDS

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Teal Bay	12	12	0	-
Bland Bay	12	11	1	0
Oakura	12	11	1	1
Paihia Te Haumi	12	11	1	1
Paihia Toilets	12	11	1	1
Russell mid-north	12	11	1	1
Ohawini Bay	12	9	3	2
Paihia Waitangi Bridge	12	9	3	3
Opua Foreshore	11	7	4	1
Kerikeri Skudders Beach	9	5	4	3

The 'Action' result recorded at Bland Bay in 2010-11 is not rainfall related. It is not known what caused elevated levels of bacteria in this sample but levels of bacteria in the water had returned to 'safe' levels within 24 hours (confirmed by follow-up sampling). Historically, this site has graded well in comparison to guidelines.

Two of the three 'Action' results for Ohawini Bay are rainfall related. Historically, this site has graded reasonably well, with occasional exceedance after rainfall. It is not known what caused elevated levels of bacteria in the non-rainfall related sample.

Three of the four 'Action' results for the Kerikeri site are rainfall related. Water quality at the site is influenced by freshwater input from the Kerikeri River. Historically, water quality at this site can exceed the recommended guidelines after rainfall.

Only one of the four 'Action' results for the Opua Foreshore site is rainfall related. There is a history of water quality issues at the site. This site is discussed in more detail in section 7.

TUTUKAKA

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Matapouri Beach	17	17	0	-
Ngunguru at Norfolk Pine	17	17	0	-
Ngunguru at motor camp	17	17	0	-
Woolleys Bay	17	17	0	-
Sandy Bay	17	16	1	1
Church Bay	17	16	1	-
Matapouri at 2nd bridge	17	15	2	2
Kowharewa Bay	17	15	2	2
Wellingtons Bay	17	15	2	1
Whananaki at east beach	17	15	2	2
Pacific Bay	17	14	3	1

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Matapouri at 1st bridge	17	13	4	3
Ngunguru at School	17	13	4	2
Whananaki at footbridge	17	13	4	2

The 'Action' result from Church Bay is not rainfall related. This site has a history of intermittently poor water quality and is discussed in more detail in section 7.

One of the two 'Action' results for Wellingtons Bay is rainfall related. It is not known what caused elevated levels of bacteria in the second 'Action' sample but levels of bacteria in the water had returned to 'safe' levels by the following week. Historically, this site has graded very high in comparison to guidelines.

'Action' results for Ngunguru at school, Matapouri at 1st bridge, Pacific Bay and Whananaki at footbridge are not consistently related to rainfall. Results for these sites are discussed in more detail in section 7.

WHANGAREI HEADS

Site Name	No. samples	Surveillance/Alert	Action	Rainfall Related
Ocean Beach	17	17	0	-
Pataua South footbridge	17	16	1	1
Pataua South east beach	17	16	1	1
Pataua South Frogtown	17	16	1	1
Taurikura	17	15	2	1
Onerahi playground	17	15	2	2
Urquharts Bay	17	14	3	2
McLeod Bay	17	14	3	3

Historically, the sites at Taurikura and Urquharts Bay have graded reasonably well in comparison to guidelines. However, not all 'Action' results from these sites are rainfall related. These sites are discussed in more detail in section 7.

6.2 End of Season Grading - Freshwater Sites

Map 2: Freshwater Grading 2010-11

The map above provides a summary of end of season grading for samples taken from freshwater sites during 2010-11. As can be seen, freshwater sites in Northland generally recorded a lower grading than coastal sites in 2010-11.

Freshwater sites generally have less 'flush' than open coastal sites, particularly during the summer months when flows are lower and there is less rainfall, and are therefore more sensitive to inputs from surrounding land-use and human activity. When it does rain, rainfall runoff carries contaminates off the land, which also influences water quality in freshwater systems.

The table below shows freshwater results from 2010-11 compared to results from 2009-10.

Category	2009-10	2010-11
100% samples >550/100 ml *E.coli*	6	4
90-95% samples >550/100 ml *E.coli*	2	2
75-90% samples >550/100 ml *E.coli*	6	9
<75% samples >550/100 ml *E.coli*	9	9
Total number of sites:	**23**	**24**

Table 12: A comparison of freshwater grading over the last two seasons

In 2010-11, there were more 'Action' results recorded for freshwater sites than in 2009-10. However, this is largely due to the number of heavy rainfall events that hit Northland during the summer of 2010-11. In comparison, the summer of 2009-10 was extremely dry with very little rainfall received over the sampling period.

Site Name	No. samples	Compliant	Non-compliant	Rainfall Related
Lake Ngatu	12	12	0	-
Lake Coca-cola	12	12	0	-
Lake Taharoa	12	12	0	-
Waipapa River, Puketi	5	5	0	-
Omamari Beach stream	12	11	1	-
Waipoua River	12	11	1	1
Waitangi River	12	10	2	2
Tirohanga Stream	12	10	2	2
Aurere River	12	9	3	2
Kaihu River	12	9	3	3
Lake Waro	17	14	3	1
Raumanga Stream	17	14	3	3
Victoria River	12	9	3	1
Waipapa Stream	12	9	3	2
Waipu Cove stream	17	13	4	4
Kerikeri River	12	8	4	2
Otaua Stream	12	8	4	2
Kapiro Stream	12	8	4	3
Mangakahia at Twin Bridges	12	8	4	3
Langs Beach stream (car park)	17	9	8	5
Coopers Beach stream	12	3	9	2
Whangarei Falls	17	8	9	3
Otamure Bay stream	17	6	11	4
Ocean Beach stream	16	5	11	4

Historically, there have been water quality issues at Omamari Beach stream. 'Action' results from the site are not consistently related to rainfall events. Some investigation work has been undertaken at the site and the results from this investigation are presented in section 7 below.

Two of the three 'Action' results for the Aurere River site are rainfall related. The source of contamination in the non-rainfall related sample is not known. As this site was only introduced in 2010-11, there is not yet enough data to draw any conclusions on this site.

Only one of the three 'Action' results for Lake Waro in 2010-11 is rainfall related. The source of contamination in the non-rainfall related samples is not known. This site

has had a high grading in comparison to guidelines since 2006 but prior to this, there was an issue with water quality at the site. It is not known what causes levels of bacteria to fluctuate at this site but it may be the incidence and density of birdlife in the lake.

Of the two 'Action' results recorded for the Victoria River site, only one is rainfall related. This site has been monitored since 2007 and has had nine 'Action' results in this time. Of these, only three are rainfall related. As the catchment to this site is largely forest, it would appear that there is another source of contamination affecting the site. Further work needs to be done to isolate the source/s of contamination.

Of the three 'Action' results recorded for the Waipapa stream site in 2010-11, two are rainfall related. The source of contamination for the non-rainfall related sample is not known. The monitoring site in this stream was moved to a new location in 2010-11 and there is therefore insufficient data to draw any conclusions on the site at present.

The site at Otaua Stream has been monitored since 2005 and of 25 non-compliant results recorded during this time, only 13 are rainfall related. The site requires further investigation in order to isolate the source/s of contamination

The sites at Coopers Beach stream, Kapiro Stream, Kerikeri River at Stone Store, Langs Beach stream, Ocean Beach stream, Otamure Bay stream and Whangarei Falls have a history of poor water quality. These sites are included in a site investigation programme, which is administered by the Council. The results to date from this programme are presented in section 7 below.

6.3 Compliance for permanent monitoring sites 2010-11

Site Name	Site Number	% Compliance 2007-08	% Compliance 2010-11
Opononi	106011	100	92
Taipa	105777	92	92
Paihia – Waitangi bridge	101183	92	75
Pahi – rocky groyne	102579	100	100
Tinopai – below shops	102310	100	100
Taurikura	101262	92	88
Matapouri – second bridge	100712	85	88
Church Bay	105448	100	94
Pacific Bay	108313	100	82
Pataua South – east of beach	104986	92	94
Onerahi – play ground	101600	100	88
Ruakaka – by motor camp	108314	100	88
Lang's beach – mid beach	108318	100	94
Teal Bay	101331	92	100
Waipu Cove	108316	100	94
Kerikeri – Stone Store	101530	77	67
Waipoua River	108613	85	92
Waipapa River – Puketi	103248	92	100
Lake Waro – Hikurangi	107272	100	82
Raumanga Stream	103246	54	82

Table 13: Permanent monitoring sites compliance rates 2010-11. The coloured cells represent either an increase (green), a decrease (red), or no change (clear) in compliance rates compared to 2009-10.

As already discussed, the performance target for compliance for the twenty permanent monitoring sites chosen from the programme is the median percentage compliance for 2007-08, which was 95%.

In 2010-11, the median percentage compliance for the permanent monitoring sites was 92%. This means that the performance target for the programme was not met in 2010-11. There were several high-intensity rainfall events during the 2010-11 sampling season that effected results at some sites, for example, Paihia at Waitangi Bridge and Ruakaka by motor camp.

In 2010-11, six of the permanent monitoring sites recorded a higher rate of compliance than in 2007-08 (seen in green in Table 13), 11 recorded a lower level of compliance (seen in red in Table 13) and three recorded the same level of compliance.

6.4 Suitability for Recreation Guide

As discussed in Section 3, the Suitability for Recreation Grade (SFRG) is calculated by combining the Microbiological Assessment Category (MAC) – a review of the water quality data available for a site – and the Sanitary Inspection Category (SIC) – a review of potential and actual sources of contamination at a site.

In 2006/7, all sites in the programme at that time were graded using the MfE Guidelines. As the guidelines recommend that site grades are revised every five years, to incorporate new data collected over this time and changes in land-use, all sites were re-graded in 2011. Sites added to the programme since 2006/7 were also graded, where sufficient data exists.

The results from this grading process for coastal sites can be seen in Table 14 below.

PLEASE NOTE: The SFRG given to all sites in 2011 is only an ‘interim’ grade as none of the sites monitored through the programme have five consecutive years data or over 100 data points, as recommended in the MfE guidelines.

In some instances, the MfE guidelines allow for grades to be adjusted, particularly where the MAC and SIC conflict with each other. This can happen where there is low level of potential for contamination (a ‘low’ SIC) however heavy rainfall events cause a spike in water quality results, affecting the MAC, for example, at Waipoua Forest. As long as the ‘spikes’ in bacteria are rainfall related, and it can be shown that measures are in place to discourage the public from using a site during these ‘spikes’ (such as warning signage), these results can be removed from the dataset and the SFRG re-calculated using the new MAC.

Coastal Sites	Site No.	2007 SIC	2011 SIC	2007 MAC	2011 MAC	2007 SFRG	2011 SFRG
FNDC							
Omapere	102317	Moderate	Moderate	D	D	Poor	Poor
Opononi	106011	Moderate	Moderate	B	C	Good	Fair
Rawene	100236	Moderate	Moderate	D	B	Poor	Good
Cable Bay	105780	Moderate	Very low	A	A	Good	Very Good
Cooper's Beach	101066	High	Moderate	C	C	Poor	Fair
Taipa Estuary	105777	Low	Moderate	B	B	Good	Good
Matauri Bay motor camp	102425	NA	Very Low	NA	A	NA	Very Good
Kerikeri Skudders Beach	100974	Low	Moderate	A	D	Good	Poor
Paihia Te Haumi	101195	High	Low	D	C	Very Poor	Fair
Paihia beside toilets	101194	High	Moderate	B	B	Poor	Good
Paihia Waitangi Bridge	101183	High	Low	C	C	Poor	Fair
Russell mid-North	105710	Very Low	Very Low	A	A	Very Good	Very Good
Opua foreshore	101418	NA	High	NA	D	NA	Very Poor
Shipwreck Bay	109870	NA	Very Low	NA	B	NA	Very Good
Ahipara camp ground	109871	NA	Moderate	NA	C	NA	Fair
Waipapa Kauri	109873	NA	Very Low	NA	A	NA	Very Good
Maitai Bay camp site	102326	NA	Very low	NA	B	NA	Very Good
Tokerau Beach	109872	NA	High	NA	C	NA	Poor
KDC							
Pahi - 150m NW jetty	102198	Low	Moderate	C	B	Fair	Good
Pahi - rocky groyne	102579	Low	Moderate	B	C	Good	Fair
Tinopai below shops	102310	Moderate	Moderate	B	B	Good	Good
Tinopai below creek	101232	Moderate	Very High	D	D	Poor	Very Poor
Omamari Beach	109875	NA	Very Low	NA	B	NA	Very Good
Baylys Beach	109876	NA	Very Low	NA	A	NA	Very Good
Glinks Gully	100798	NA	Very Low	NA	A	NA	Very Good
Mangawhai Harbour pontoon	110320	NA	Moderate	NA	NA	NA	NA
Mangawhai Heads beach	109890	NA	Very low	NA	A	NA	Very Good
Mangawhai motor camp	101210	Moderate	Moderate	B	NA	Good	NA
Mangawhai Picnic Bay	110322	NA	Moderate	NA	NA	NA	NA
WDC							
Ocean Beach	109877	NA	Very Low	NA	B	NA	Very Good
Urquhart's Bay	108311	Low	High	B	B	Good	Poor
Taurikura	101262	Low	High	D	C	Good	Poor
McLeod Bay	101254	Low	Moderate	B	B	Good	Good
Onerahi playground	101600	Low	Moderate	B	B	Good	Good
Pataua South footbridge	102217	Moderate	Moderate	B	B	Good	Good
Pataua South east beach	104986	Moderate	Moderate	B	B	Good	Good
Pataua South Frog Town	109887	NA	Very Low	NA	B	NA	Very Good
Woolleys Bay	109878	NA	Very low	NA	A	NA	Very Good
Sandy Bay	109879	NA	Moderate	NA	B	NA	Good
Matapouri 1st bridge	100711	Moderate	Moderate	C	D	Fair	Poor
Matapouri Beach	110321	NA	Moderate	NA	NA	NA	NA

Coastal Sites	Site No.	2007 SIC	2011 SIC	2007 MAC	2011 MAC	2007 SFRG	2011 SFRG
Matapouri 2nd bridge	100712	Moderate	Moderate	C	D	Fair	Poor
Church Bay	105448	Low	High	D	C	Poor	Poor
Kowharewa Bay	106444	Low	High	D	D	Poor	Very Poor
Pacific Bay	108313	Low	Moderate	C	C	Fair	Fair
Wellingtons/Whangaumu Bay	109880	NA	Low	NA	B	NA	Good
Ngunguru motor camp	100073	Moderate	Moderate	A	B	Good	Good
Ngunguru Norfolk pine	100076	Moderate	Moderate	B	B	Good	Good
Ngunguru by school	108320	Moderate	Very High	D	D	Poor	Very Poor
Uretiti Beach	109888	NA	Very Low	NA	A	NA	Very Good
Ruakaka beach	108315	Low	Very low	B	B	Good	Very Good
Ruakaka river	108314	Moderate	Moderate	D	D	Poor	Poor
Lang's Beach mid	108318	Moderate	Moderate	B	B	Good	Good
Waipu Cove	108316	Low	Moderate	B	B	Good	Good
One Tree Point	109266	NA	Moderate	NA	D	NA	Poor
Whananaki footbridge	103147	Low	Moderate	D	D	Poor	Poor
Whananaki east beach	106938	Low	Moderate	D	D	Poor	Poor
Oakura north bay	101345	Moderate	Very Low	B	B	Good	Very Good
Ohawini Bay	105388	Low	Moderate	C	D	Fair	Poor
Teal Bay	101331	Moderate	Moderate	C	B	Fair	Good
Bland Bay	109889	NA	Very Low	NA	A	NA	Very Good

Table 14: 2011 Suitability for Recreation Grades – Coastal Sites

As can be seen, of the 39 coastal sites graded in 2006, 21 have changed grades. Of these sites, 11 have been down-graded. These sites may have been downgraded due to more 'Action' results over the last five years or because site investigation or environmental incidents have pinpointed a source of contamination at these sites.

In comparison, 10 coastal sites have been upgraded since 2006. These sites may have been upgraded due to fewer levels 'Action' results over the last five years or because site investigation has ruled out potential sources of contamination.

The SFRG results for freshwater sites can be seen in Table 15 below.

Freshwater Sites	Site No.	2007 SIC	2011 SIC	2007 MAC	2011MAC	2007 SFRG	2011 SFRG
FNDC							
Coopers Beach stream	101870	NA	High	NA	D	NA	Very Poor
Waipapa Stream (Basin)	110348	Moderate	Moderate	D	NA	Poor	NA
Waipapa River (Puketi)	103248	Low	Low	D	B	Poor	Good
Kerikeri River (Stone Store)	101530	High	High	D	D	Very Poor	Very Poor
Waitangi River (Lily Pond)	110325	High	Moderate	D	D	Very Poor	Poor
Tirohanga Stream	102252	Moderate	Moderate	D	D	Poor	Poor
Kapiro Stream (Purerua Rd)	102838	Moderate	High	D	D	Poor	Very Poor
Waipoua River	108613	Low	Low	D	C	Poor	Fair
Mangakahia at Twin Bridges	105973	Moderate	Moderate	D	D	Poor	Poor
Otaua Stream	108510	High	High	D	D	Very Poor	Very Poor
Victoria River	104908	Very Low	Very High	D	D	Poor	Very Poor
Lake Coca-cola	110323	NA	Very Low	NA	NA	NA	NA

Freshwater Sites	Site No.	2007 SIC	2011 SIC	2007 MAC	2011MAC	2007 SFRG	2011 SFRG
Aurere River	110324	NA	Moderate	NA	NA	NA	NA
Lake Ngatu south	100402	Low	Very Low	A	A	Very Good	Very Good
KDC							
Kaihu River	102221	High	Moderate	D	C	Very Poor	Fair
Lake Taharoa	105434	Very Low	Very Low	A	A	Very Good	Very Good
Omamari Beach stream	102305	Low	Moderate	D	D	Poor	Poor
WDC							
Ocean Beach Stream	102077	Very High	Very High	D	D	Very Poor	Very Poor
Otamure Bay Stream	108859	High	High	D	D	Very Poor	Very Poor
Lake Waro (Hikurangi)	107272	High	High	D	B	Poor	Poor
Whangarei Falls	105972	High	High	D	D	Very Poor	Very Poor
Raumanga Stream	103246	Moderate	Moderate	D	D	Poor	Poor
Langs Beach Stream (by car park)	100686	Very High	High	D	D	Very Poor	Very Poor
Waipu Cove Stream	101207	NA	High	NA	D	NA	Very Poor

Table 15: 2011 Suitability for Recreation Grades – Freshwater Sites

As can be seen, of the 20 freshwater sites graded in 2007, six have changed grades. Of these sites, two have been down-graded and four have been upgraded.

Of the sites that have been upgraded, results for the Waipapa River, Waipoua River and Kaihu River have been rainfall adjusted as exceedance at these sites is rainfall related. This has led to an improvement in their MAC.

The two sites that have been downgraded, Victoria River and Kapiro Stream, have had their SICs adjusted to take into account the most likely source of contamination at these sites, based on the information currently available.

7 INVESTIGATING 'ACTION' RESULTS

7.1 Site Investigations

Since the programme began, a number of popular swimming sites have been highlighted as having continually poor water quality and permanent warning signs have been erected at some of these sites.

In 2009, MfE published a report summarising the results of the previous two years water quality data for the country. This report showed that Northland had the highest number of non-compliant freshwater sites in the country.

The Council requested that a strategy be drawn up to investigate the problem sites in Northland, in order to identify possible sources of contamination and work towards resolving water quality issues at some of these sites.

Some initial work had already been undertaken in 2007 to try and identify the source of contamination at a number of freshwater sites in the region. In 2009, nine sites sampled through the programme were identified as having poor water quality and were selected for investigation. These were:

- Coopers Beach stream
- Langs Beach stream (mid-way)
- Langs Beach stream (car park)
- Ocean Beach stream
- Otamure Bay stream
- Otaua stream
- Pacific Bay stream
- Tinopai below Creek
- Whangarei Falls

Investigation work included faecal source tracking (identifying the source of faecal contamination), catchment land-use mapping and catchment investigations and land-owner liaison. Two of the chosen sites – Otaua Stream and Tinopai below creek – were not investigated during 2009-10 as water quality was found to have improved during the season. However, three other sites – Kaihu at camp ground, Waipu Cove stream and Pahi below creek - were subject to ad-hoc investigation, in response to water quality issues arising during the sampling season.

Although the results from 2009-10 yielded some valuable results, as the season was particularly dry, it was decided to extend the site investigation programme into 2010-11 so that the effect of rainfall on water quality and source of contamination could be better observed. In addition, some winter sampling was undertaken at Langs Beach stream (midway), Coopers Beach stream and Otamure Bay stream, to measure levels of bacteria in the water during periods of high flow and lower temperature.

Additional sites added to the site investigation programme in 2010-11 included:

- Kaihu River
- Waipu Cove stream
- Mangawhai Harbour motor camp
- Ngunguru estuary (by school)

- Matapouri 1st and 2d bridges
- Omamari Beach stream
- Kerikeri River at Stone Store; and
- Kapiro Stream

The process followed and results (to date) from this investigative work are discussed below.

METHODOLOGY

Additional water samples were taken from the majority of the sites included in the investigative programme, on a number of occasions over 2009-10 and 2010-11, for faecal source tracking. The results of this sampling can be seen in Table 12 below. There are several scientific techniques used to assist in identifying the source of bacterial contamination in water. These include faecal sterol analysis, fluorescent whitening agents (FWAs) and polymerase chain reaction (PCR) markers:

- **Faecal Sterols** - Sterols are lipids that relate to both plants and animals, for example, 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 the sterol composition of animal faeces can generate distinctive faecal sterol fingerprints. Therefore, 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 ingredients of washing powders and only one is used in New Zealand. In most households, the effluent from toilets is mixed with grey water from washing machines and therefore FWAs are usually linked to human faecal contamination in both septic tanks and community wastewater systems.
- **PCR 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.

In addition to taking water samples from the swimming sites, samples were also taken from within the catchment in order to identify where levels of bacteria were at their highest and lowest – 'Catchment Profiling'. Catchment land-use around some of the problem sites was also mapped, so that potential sources of contamination could be identified, such as pastoral farming or septic tank soakage fields.

In cases where septic tanks were identified as being a potential source of contamination, sanitary surveys were also undertaken. Sanitary surveys involve inspecting the septic tank and associated soakage fields of each property in the vicinity of a swimming site, in order to identify any failing or poorly maintained systems that could be contributing contaminants to the water body.

In addition to the above information, rainfall, temperature, wind direction and turbidity data (the amount of material suspended in the water column), and where applicable tide and salinity data, was brought together for each non-compliant result at each site to aid in the investigative process.

RESULTS OF INVESTIGATIVE SAMPLING

An overview of results from faecal source tracking work undertaken since 2007 can be seen in Table 16 below. Green ticks represent results from 2007, red from 2009-10 and blue from 2010-11.

Site	FWA	Human	Ruminant	Dog	Wildfowl
Otamure Bay stream			✓✓✓		✓✓✓
Coopers Beach stream			✓	✓	✓✓
Langs Beach stream (midway)					✓✓
Langs Beach stream (car park)			✓	✓	✓✓
Pacific Bay stream					✓
Whangarei Falls			✓✓	✓	✓✓✓
Waipu Cove stream				✓	✓
Ocean Beach stream		✓	✓	✓	✓✓
Kaihu River			✓		
Kapiro Stream			✓		✓
Kerikeri River			✓		✓
Ngunguru by school					✓
Mangawhai motor camp					✓
Omamari Beach stream			✓		
Matapouri 1st bridge					✓
Matapouri 2nd bridge			✓		✓
Pahi at stormwater	✓	✓			

Table 16: Results from faecal source tracking investigations

Otamure Bay stream

Since November 2008, there have been a total of 34 'Action' results recorded for this site. Only 10 of these results relate to rainfall events. Preliminary analysis of results for the site does not show a relationship between water temperature and levels of

bacteria. A number of 'Action' results relate to high turbidity (material suspended in the water column) however there is not a strong relationship between turbidity and levels of *E. coli* at this site.

'Action' results from this site may, in part, relate to rainfall events or re-suspension of sediment and bacteria in the water column. However, as there is no consistent relationship between rainfall or turbidity and *E. coli,* there must also be a direct source of contamination into the stream.

Results from faecal source tracking at this site over three seasons (including some winter sampling) indicate that the sources of contamination at this site are ruminants and wildfowl. The avian marker identified in these samples is indicative of faecal pollution from ducks.

The ruminant source was identified in five out of nine samples collected from the site. On four of these five occasions, samples were collected after rainfall. The wildfowl source was present in four out of eight samples collected from the site. Only three of these six samples were influenced by rainfall. This indicates that the herbivore source is more prevalent after rainfall but that the wildfowl source is present regardless of rainfall. The two samples which did not contain the avian marker were collected after rainfall events, which may have flushed contamination from this source out of the water body.

Over time, the presence of the herbivore marker seems to have decreased and was only found in one of last four samples taken for faecal source tracking. This may be due to land management work that has been undertaken in the catchment.

Catchment profiling of the site shows that there are two tributaries that flow into the stream before it reaches the beach. Both of these tributaries have been tested for *E. coli* on two separate occasions to determine where levels are at their highest. On both occasions, levels of *E. coli* were high in both tributaries.

Both tributaries run through areas that are heavily stocked with beef cattle however the stream has been fenced to prevent livestock access and the majority landowner has done riparian planting along the stream edge to help reduce the amount of run-off entering the water. This site is noted for its use by the critically endangered species, Brown Teal *Anas chlorotis.*

Work has already been done by the landowner in this catchment to reduce the impact their farm has on water quality. However, there will be a lag time before these activities reduce contamination from the ruminant source. As it is likely that Brown Teal contribute to the avian source of contamination, little can be done to reduce the impact on water quality from this source.

It is therefore recommended that a permanent warning sign be erected at this site, stating the source of contamination, and that monthly monitoring continue at this site as significant land-management work (fencing and revegetation) has taken place in the catchment.

Coopers Beach stream

Since sampling of this site began in December 2008, there have been 33 'Action' results, seven of which are rainfall related. Preliminary analysis of the data indicates that there is no relationship between temperature and levels of bacteria in the stream. Preliminary analysis also suggests that there is no relationship between turbidity and levels of *E. coli* at this site.

'Action' results from this site may, in part, relate to rainfall events or re-suspension of sediment and bacteria in the water column. However, as there is no consistent relationship between rainfall or turbidity and *E. coli,* there must also be a direct source of contamination into the stream.

Faecal source tracking on samples taken from the stream indicates that the two main sources of faecal contamination at this site are farmed ruminant and wildfowl. One sample taken in 2009 indicated a source of contamination to be dog however this source has not been detected in further samples, suggesting it was a one-off event.

Photo: Coopers Beach stream

The Council Land Management team has been working with land-owners in the catchment to discuss options for excluding livestock from the stream. However, the stream is the only source of drinking water for stock in the catchment and a piped water supply would need to be in place before stock could be excluded. This is a long-term project and the Council will continue to work with landowners in this area.

There is little that can be done to control or remove wildfowl, particularly gulls, from the water body and so it is likely that this source of contamination will persist. It is therefore recommended that a permanent warning sign be erected at this site, stating the source of contamination, and that the site be removed from the monitoring programme.

Langs Beach stream - midway

Preliminary analysis of data collected for this site does not indicate a relationship between levels of bacteria and rainfall, temperature or turbidity.

'Action' results from this site may, in part, relate to rainfall events or re-suspension of sediment and bacteria in the water column. However, as there is no consistent relationship between these variables and levels of *E. coli* in the stream, there must also be a direct source of contamination at the site.

Langs Beach stream (middle) was subject to site investigation work in 2009-10. Faecal source tracking work on samples taken from the site indicates that the source of contamination at this site is avian, most likely gulls.

When this site was initially sampled in 2007, a source of contamination could not be pin-pointed and it was suggested that *E. coli* may exist in the environment at the site. Samples were taken by Auckland University in 2010 and will form part of a study into possible bacterial reproduction in stagnant pools.

This site was removed from the monitoring programme in 2010-11 as at this stage, the Council can do little to improve water quality at this site. However, opening the stream annually so that stagnating water can be flushed out by the sea may improve the situation. A permanent warning sign has been erected at the site.

Langs Beach stream – car park

Langs Beach stream (car park) was re-introduced to the sampling and site investigation programme in 2010-11. The site was previously removed from regular monitoring as it had consistently 'unsafe' water quality.

Of 19 'Action' results recorded since 2007, 13 are rainfall related. Preliminary analysis of data for the site does not indicate a relationship between levels of bacteria and temperature.

Of the 19 'Action' results recorded for the site since January 2007, five relate to turbidity >8 (the median for the site is 7.3 NTU). All five of these 'Action' results are rainfall related. Preliminary analysis of the data suggests a weak relationship between turbidity and levels of *E. coli* at the site.

'Action' results from this site may, in part, relate to rainfall events or re-suspension of sediment and bacteria in the water column. However, as there is no consistent relationship between rainfall or turbidity and *E. coli,* there must also be a direct source of contamination into the stream.

Langs Beach stream (by car park) was subject to site investigation work in 2007, 2009-10 and 2010-11. Faecal source tracking work on samples taken from the site in 2007 and 2009-10 indicate a source of contamination at this site is avian, most likely gulls. However, source tracking work undertaken in 2010-11 showed contamination from ruminant and dog sources. No contamination from an avian source was detected.

The catchment of this site is largely bush and plantation forest, with low-density housing and small areas of pasture. It is therefore most likely that contamination at this site is a combination of rainfall run-off carrying contaminates from the catchment, direct contamination from birds in the stream and some re-suspension of bacteria in sediment at the bottom of the stream.

It is recommended that this site continue to be monitored through the programme as water quality does appear to have improved over the last six years. However, It is likely that water quality will continue to occasionally exceed the recommended guidelines at this site and that little can be done to prevent this from occurring.

Pacific Bay stream

This site was included in the site investigation programme not because it is a swimming site but because it was thought that contamination in this stream could be from failing septic tank systems. Faecal source tracking results for this site could therefore be used as a 'control' for human sources of pollution at other sites.

The catchment for this stream is fairly small and comprises a small area of bush and low density housing. At the top of the catchment is a duck pond. Faecal sterol analysis of two samples taken from this site showed the source of contamination to be avian, not human. A sanitary survey was undertaken in the area and no failing septic tank systems were identified. This site was therefore removed from the site investigation programme as no further benefit was seen in continuing to sample here.

Whangarei Falls

This site has been monitored through the programme since 1998. During this time, the season median for *E. coli* has become progressively higher and the number of 'Action' results higher. A detailed site investigation plan was drawn up for this site involving sampling fourteen locations within the upstream catchment, and collecting samples from key points for faecal source analysis in order to isolate possible causes of contamination.

The Waitaua stream originates North of Whangarei where it flows around the edge of an urban area to the east, eventually becoming the Hatea (Hotea) River. The upper catchment contains some mixed beef and sheep farming, however, the majority of the catchment is a mix of lifestyle blocks and urban areas. The reticulated sewage system runs alongside the river in the lower catchment.

Of the four main tributaries flowing into the Waitaua stream above Whangarei Falls, bacteria levels were found to be elevated, and generally above MfE 'Action' guideline values on three. However, the tributary with the highest *E.coli* levels was not found to be having a notable impact on bacteria levels in the Waitaua stream.

Analysis of the data for the swimming site shows that bacterial water quality is consistently poor irrespective of rainfall (25 of 43 non-compliant results since 2003 relate to rainfall). Although some 'Action' results may be related to rainfall and so rainfall runoff, there must also be a more direct source of contamination at this site, for example, stock or wildfowl in the water.

Photo: Whangarei Falls swimming hole in flood

Microbial source tracking at six sites within the catchment indicated faecal contamination from both ruminant and wildfowl sources. A very weak positive marker for dogs was also found in one sample from the swimming site. No human markers were found in any of the samples.

It is likely that contamination at this site is a combination of rainfall runoff, which carries contaminants off the land and into the water, and direct contamination from stock and wildfowl in the water.

Nothing can be done to prevent wildfowl from using the stream. Direct discharges from stock in the water can be prevented by fencing off waterways and providing off-stream watering for stock. However, as long as there is stock on the land, ruminant faecal contamination will occur during or after rainfall events.

It is recommended that this site remain in the monitoring programme but that a permanent warning sign is erected at the site, stating the sources of contamination.

A more detailed report on the investigation work undertaken at this site is available from the Council.

Waipu Cove stream

This site was introduced into the monitoring programme in 2009-10 after a request from the public. Since sampling of this site began, there have been 11 'Action' results, six of which are rainfall related.

Preliminary analysis of the data indicates that there is no relationship between temperature and levels of bacteria in the stream. Preliminary analysis also suggests that there is no relationship between turbidity and levels of *E. coli* at this site, although four 'Action' results do correspond to elevated levels of turbidity (three of which are related to rainfall).

As this site is flushed at each tide, tide data for the 'Action' results was retrieved. Seven of the 11 non-compliant results were recorded on an outgoing tide; two on an incoming tide and one each on a high and low tide.

The preliminary conclusions that can be drawn are that 'Action' results from this site may, in part, relate to rainfall events and rainfall runoff. There may also be some re-suspension of bacteria in sediment from the bottom of the stream. However, there must also be a direct discharge of contaminates into the stream.

Faecal source tracking work undertaken on samples taken from the stream has identified two sources of contamination – wildfowl and a weak positive for dogs, although only one sample in 2009-10 and one in 2010-11 returned any positive results.

It is recommended that this site remain in the monitoring programme so that more data can be collected on water quality at this site.

Ocean Beach stream

Ocean Beach stream was re-introduced to the sampling and site investigation programme in 2009-10. The site was previously removed from regular monitoring as it had consistently 'unsafe' water quality.

Of 16 'Action' results recorded since 2009, five are rainfall related. Preliminary analysis of data for the site does not indicate a relationship between levels of

bacteria and temperature. Of the 16 'Action' results recorded for the site since December 2009, six relate to turbidity >4 (the median for the site is 3.8 NTU). One of these 'Action' results is rainfall related. Preliminary analysis of the data suggests no relationship between turbidity and levels of *E. coli* at the site. Analysis of tide data for 'Action' results shows that 12 of the 'Action' results are at high or incoming tide.

Ocean Beach stream was subject to site investigation work in 2007 and 2010-11. Faecal source tracking work on samples taken from the site in 2007 showed a source of contamination to be wildfowl. Results from samples taken in 2010-11 showed two possible sources of contamination – wildfowl (most probably gulls) and humans. Two other weak markers were found in 2010-11 – ruminant and dog.

Photo: Ocean Beach Stream at low tide

Although human sterols were found in two samples taken from this site, no PCR markers for humans were found. This could be because the source of pollution is from a small number of individuals, or that the human source of pollution is partially treated.

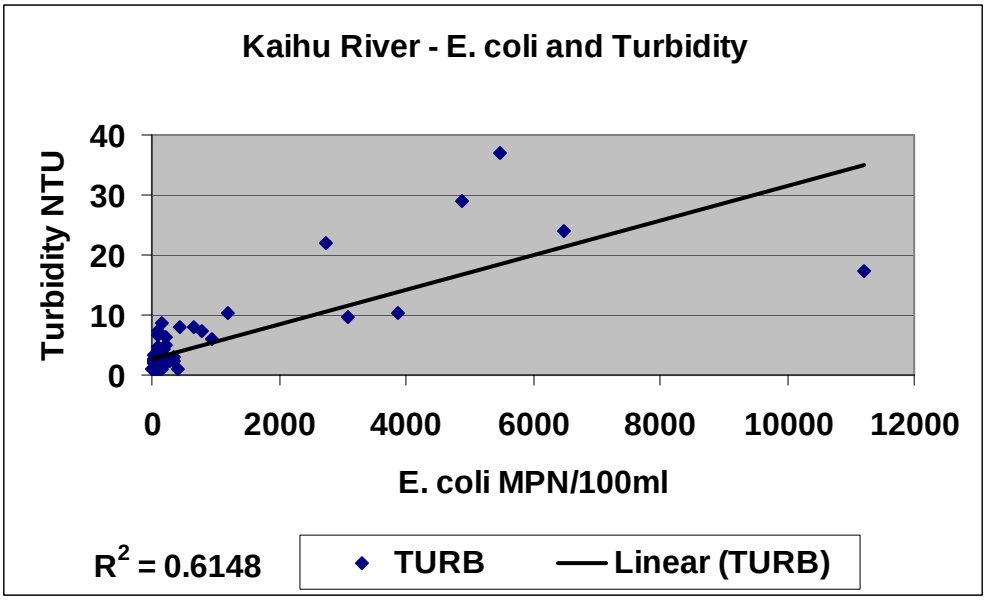
A sanitary survey was undertaken at Ocean Beach settlement in 2010, however, no failing septic tank systems were found. The results of this faecal source analysis have been passed on to Whangarei District Council so that they can decide what further action needs to be taken.

From the site investigation work undertaken at this site, it would appear that there are two sources of contamination. One is human source; the other is wildfowl, most likely gulls. It does not appear that rainfall or turbidity have a bearing on levels of bacteria in the stream. Although work will be done to remove the source of human contamination, nothing can be done to remove the avian source and it is therefore likely that this site will continue to have occasional non-compliant results.

It is recommended that this site continue to be monitored through the programme and warning signs erected, stating the source of contamination, as and when required.

Kaihu River

Since February 2002, there have been a total of 19 'Action' results recorded for this site. All 19 of these results relate to rainfall events. Preliminary analysis of the data shows that there is a relationship between turbidity and *E. coli* at this site, as seen in graph 1 below. All 19 'Action' results correspond to elevated levels of turbidity in the river, which is generally in response to rainfall events.



Graph 1: Turbidity and *E. coli* data for the Kaihu River

Results from faecal source tracking at this site in 2010-11 indicate that the source of contamination at this site is ruminants. The upstream catchment is pastoral with areas of native bush. It is most likely that contamination at this site is the result of rainfall runoff carrying contaminants off farmland into the river, although there have also been incidents of direct discharge of farm dairy effluent into a tributary of the river in the upper catchment.

The Council will continue to monitor this site through the programme. It is recommended that a permanent sign be erected at the site warning people that water quality is not safe for recreational use for 48 hours after rainfall.

Kapiro Stream

Since February 2004, there have been a total of 23 'Action' results recorded for this site. Of these, 13 relate to rainfall events. Preliminary analysis of the data shows that there is no relationship between turbidity and *E. coli* at this site.

The catchment of this site is largely pastoral, with some areas of native bush. Results from faecal source tracking at this site in 2010-11 indicate that the sources of contamination at this site are ruminants and wildfowl.

It is likely that contamination during rainfall events is as a result of rainfall runoff from the land. However, there is also a direct source of contamination at this site that is responsible for non-rainfall related exceedance. This could be direct discharge of untreated livestock effluent into the stream, for example, from livestock in the water body or from wildfowl (ducks) in the stream.

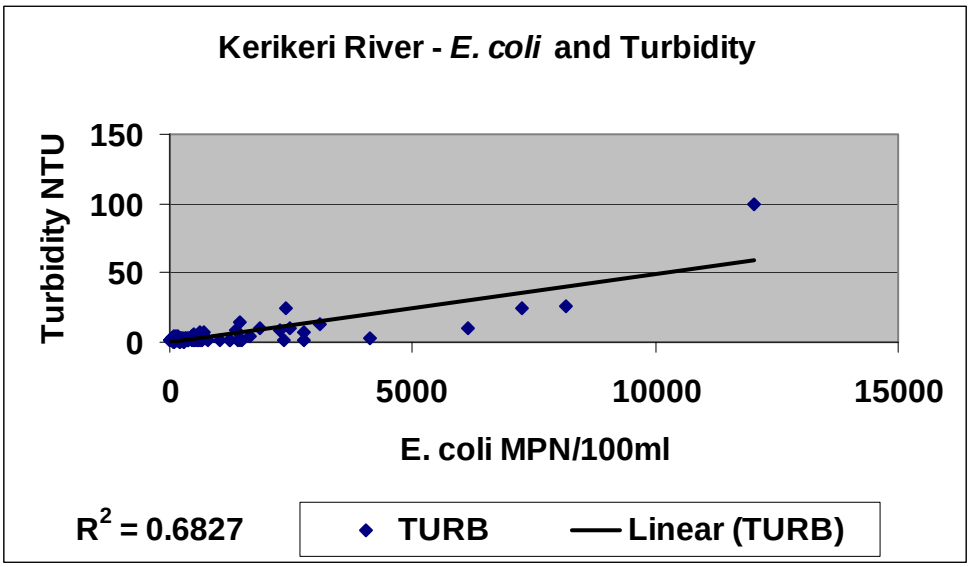
The Council will continue to monitor this site through the programme. It is recommended that a sign be erected at the site warning people that water quality is not safe for recreational use for 48 hours after rainfall. The Council land management team will work with landowners in the catchment to try mitigating the impact of farming on water quality.

Kerikeri River at Stone Store

Since February 2005, there have been a total of 37 'Action' results recorded for this site. Of these, 24 relate to rainfall events. Preliminary analysis of the data shows that there is a relationship between turbidity and *E. coli* at this site, as seen in graph 2.

Results from faecal source tracking at this site in 2010-11 indicate that the sources of contamination at this site are ruminants and wildfowl. The upstream catchment is a mix of pastoral, horticulture, urban and native bush. It is likely that contamination after rainfall is as a result of rainfall runoff from the land. However, there is also a direct source of contamination at the site, as 13 'Action' results are not related to rainfall. This is likely to be contamination from wildfowl in the water.

The Council will continue to monitor this site through the programme. It is recommended that a sign be erected at the site warning people that water quality is not safe for recreational use for 48 hours after rainfall.



Graph 2: Turbidity and *E. coli* data for the Kaihu River

Ngunguru Estuary at School

Since January 2007, there have been 15 'Action' results recorded for this site, four of which are rainfall related. Historically, this site graded well until the 2008-09 survey season.

Preliminary analysis of the data for this site does not indicate a relationship between levels of *Enterococci* and salinity (and therefore freshwater input) or levels of *Enterococci* and turbidity.

Analysis of tide data for the site shows that out of 15 'Action' results, 12 occurred on a high or outgoing tide. One 'Action' result occurred at low tide and this result was not rainfall related. Two results occurred in the latter half of an incoming tide and were

not rainfall related. There does not appear to be a consistent pattern with wind direction and 'Action' results at this site.

Faecal source analysis of three samples taken from the site identified the source of contamination at this site to be wildfowl, most likely gulls. No other source of contamination was identified in these samples.

As the majority of exceedance is not rainfall related, and freshwater input does not appear to influence levels of bacteria at this site, it is unlikely that contamination is occurring as a result of runoff from within the catchment, or stormwater discharge. Faecal source tracking points to a direct discharge of faecal contamination at the site from wildfowl. It is possible that another source of contamination exists however further sampling would need to be undertaken to confirm this.

As this site is used by the local school for swimming and as the site is not consistently 'unsafe' for recreational use, the Council will continue to monitor the site through the programme and take action as and when necessary. It is recommended that further faecal source tracking work be undertaken in the event of non-compliant results in the future.

Mangawhai Motor Camp

From January 2001 to November 2010, a total of five 'Action' results were recorded from the sampling site at the boat ramp close to the motor camp. In 2010-11, the site was moved closer to the motor camp foreshore and a total of 1 'Action' result was recorded for this sampling season. This result was rainfall related.

This site has on average one 'Action' result each sampling season. Faecal source tracking undertaken on two samples taken from the site during 2010-11 indicated the source of contamination to be wildfowl, most probably gulls.

A further sample will be taken in 2011-12 to confirm the source of contamination at this site.

Omamari Beach Stream

Since January 2005, there have been a total of 15 'Action' results recorded for this site. Of these, seven relate to rainfall events.

Results from faecal source tracking undertaken at this site in 2010-11 indicate that the source of contamination at this site is ruminants. The upstream catchment is a mix of pastoral, urban and native bush. It is likely that contamination after rainfall is as a result of rainfall runoff from the land. However, there is also a direct source of contamination.

Only one water sample was sent away for analysis in 2010 as all but one result in 2010-11 complied with the MfE guidelines. Before a conclusion can be drawn on the source/s of contamination at this site, two further samples need to be sent away for analysis in 2011-12.

The Council will continue to monitor this site through the programme. It is recommended that two further samples be sent away for faecal source analysis in 2011-12. Further investigative work should also be undertaken in the catchment of this site to try and isolate the source/s of contamination.

Matapouri Bridges

Since February 2002, Matapouri at 1st bridge has recorded 11 'Action' results of which six are rainfall related. In the same time period, Matapouri at 2nd bridge has recorded nine 'Action' results, of which six are rainfall related.

Preliminary analysis of the data for both sites does not indicate a strong relationship between either salinity (and so freshwater input) or turbidity and *Enterococci* bacteria. However, of the 11 non-compliant results for 1st bridge, nine have a freshwater influence (salinity below 30g/L).

Analysis of tide data for both sites shows that for Matapouri at 1st bridge, seven of the 11 'Action' results occurred on an outgoing tide; two at low tide, one at high tide and one on an incoming tide. For Matapouri at 2nd bridge, six of nine 'Action' results occurred on an outgoing tide; two at high tide and one at low tide. This suggests that some contamination may be travelling past the site from the upstream catchment.

Faecal source analysis of three samples taken from 1st bridge indicates that the source of contamination at this site is wildfowl (most likely gulls). This contamination may be directly deposited at the site by birds in the water or may be transported past the site from within the catchment on an outgoing tide.

Faecal source analysis of two samples taken from 2nd bridge indicates that the sources of contamination at this site are ruminants (weak positive) and wildfowl (most likely gulls). Again, contamination from wildfowl may be direct at the site or carried in an outgoing tide past the site. Ruminant contamination would come from within the catchment.

As these sites are not consistently 'unsafe' for recreational use, the Council will continue to monitor both sites through the programme and take action as and when necessary. Further faecal source tracking work will be undertaken at Matapouri at 2nd bridge to ensure that three representative samples have been collected.

Pahi at stormwater

Faecal source tracking work undertaken on samples taken from the stream in February 2010 returned positive for fluorescent whitening agents (which are indicative of wastewater contamination). PCR analysis was inconclusive; however, faecal sterol ratios were consistent with a human source of faecal contamination.

The Council identified a failing septic tank system in the area as being the source of contamination and worked with the landowner to rectify the failing system.

7.2 Other Non-compliant Results

High bacteria levels in water can be caused by a number of factors. These include:

- Point-source discharges - including failing septic tank systems, sewage spills, farm and industrial discharges, stock, birds and other wild animals in water and dumping of waste from campervans and boats
- Diffuse discharges (rainfall) – a combination of waste products delivered to rivers and streams, and into estuaries and coastal areas, by rainfall runoff.
- Re-suspension of bacteria that live in the sediments (sand/silt/mud) by wave action, or turbulent stream flow, or wind.

Sample contamination during collection could also cause some unexplained 'Action' results. However, the Council has an extensive QA/QC process in place to minimise the risk of this occurring.

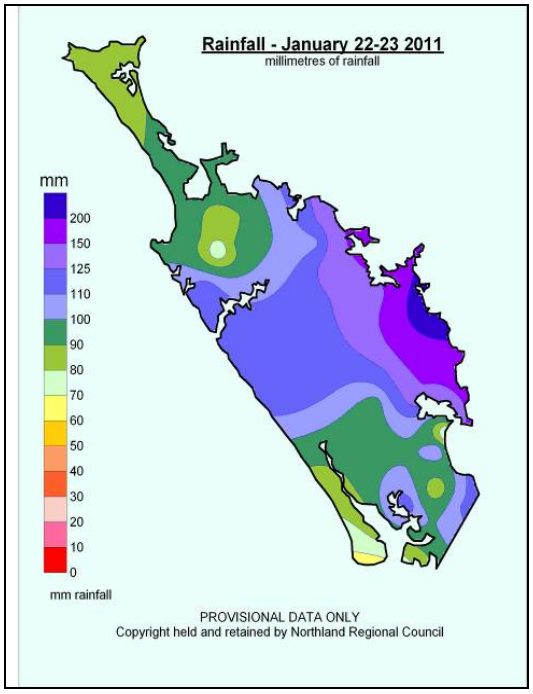
Other than the sites that have been investigated in the above programme, there are a number of popular swimming sites in Northland that are occasionally prone to poor water quality. These sites include:

- Opua Foreshore
- The Tutukaka Coast - Kowharewa, Pacific and Church Bay
- Whananaki
- The Whangarei Harbour – McLeod Bay, Taurikura and Urquharts Bay

Rainfall can have a huge impact on water quality. Northland is subject to high intensity rainfall events throughout the year. Coupled with hilly topography, this means that a large amount of runoff can enter our freshwater and coastal systems for 48 hours after rainfall events. This runoff carries contaminants off agricultural, rural and urban land, and can contain faecal material from wild and domesticated animals, as well as human waste.

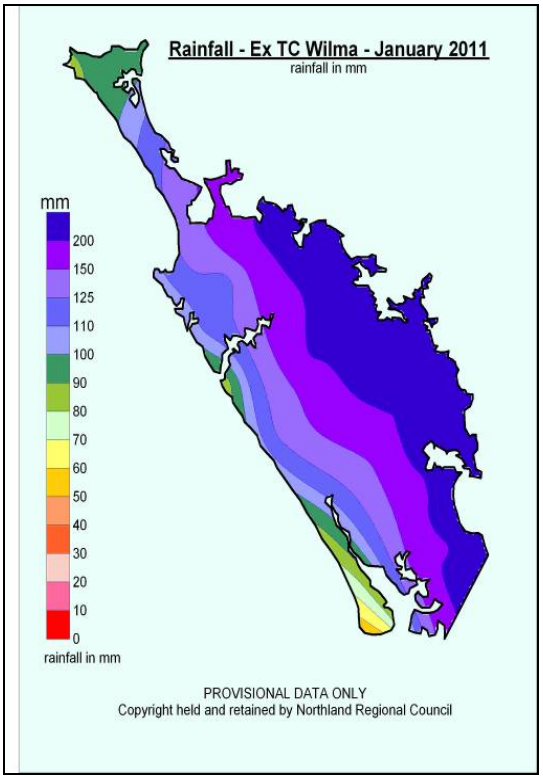
The La Nina weather pattern that prevailed over New Zealand during the summer of 2010-11 brought three extremely heavy rainfall events to Northland. The first event occurred between 16 and 19 December 2010. This rainfall event followed two months of very low rainfall. Sampling undertaken after this event showed that seven coastal and 14 freshwater sites had exceeded the MfE guidelines and water quality at these sites was categorised as 'unsafe' for recreational use.

The second event occurred on 22 - 23 January 2011, with between 60-200mm of rain falling over the majority of Northland (see map 3 below). After this rainfall event, 18 coastal and 14 freshwater sites exceeded the MfE guidelines.



Map 3: Rainfall from the 22-23 January 2011 event

The third event occurred on 28 - 29 January 2011, as ex-tropical cyclone Wilma passed to the east of the north island. Widespread flooding occurred across Northland after extremely heavy rainfall hit the region (see map 4). The Northland District Health Board issued a Public Health Advisory to the regions District Councils following this event and the following week, seven coast and four freshwater sites recorded results above 'Action' level.



Map 4: Rainfall from the 28-29 January 2011 event

These three significant rainfall events accounted for 64 (39%) of the 'Action' results recorded during 2010-11.

Opua Foreshore

Since sampling began at this site in 2007, there have been 13 'Action' results, seven of which are rainfall related.

Preliminary analysis of salinity data for the site shows that only four of the 13 'Action' results were affected by a freshwater input (salinity below 30). Analysis of the data does not indicate a relationship between turbidity and levels of enterococci.

Analysis of tide data for the site does not indicate a relationship between tide and high levels of *Enterococci* bacteria – six 'Action' results occurring on an outgoing tide; five on an incoming tide, one at low tide and one at high tide. In addition, there is no relationship between wind direction and 'Action' (an onshore wind may push boat discharges onshore, for example).

As this site is not a popular bathing site, no further action is proposed at this stage.

Tutukaka Coast – Kowharewa, Church and Pacific Bay

Since sampling began, there have been eight 'Action' results from Church Bay, Kowharewa Bay and Pacific Bay. At each site, three 'Action' results relate to rainfall. The majority of non-compliant results for each site are independent of each other.

Results for Church Bay do not indicate a relationship between tide and 'Action' results, with four 'Action' results occurring on an incoming tide; two on an outgoing tide and two at high tide. Equally, there does not appear to be a relationship between non-compliant results and wind direction or turbidity. The most likely sources of contamination at this site are boats, birds or failing septic tank systems. However, some contamination may be circulating around the bay from the Tutukaka harbour and marina. Further investigative work needs to be done at this site to isolate the source/s of contamination.

Results for Kowharewa Bay do not indicate a relationship between tide and 'Action' results, with three 'Action' results occurring on an incoming tide; four on an outgoing tide and one at high tide. There does not appear to be a relationship between 'Action' results and turbidity or wind direction. Likely sources of contamination for this site are the same as for Church Bay.

Results for Pacific Bay indicate some relationship between tide and 'Action' results, with five 'Action' results occurring on an outgoing tide and two at high tide. One further result occurred on an incoming tide. Again, potential sources at this site are similar to those at Church and Kowharewa Bay, however, the stream that feeds into this site may also have an impact on water quality. Faecal source tracking work undertaken on samples from this stream indicated the source of contamination to be avian.

It may be useful to compare results from this programme with data collected through monitoring of the harbour and marina, in order to see if there is a relationship between water quality in the marina and at these sites, however, there may be insufficient data available to make any comparisons.

Whananaki

Since 2007, Whananaki at footbridge has recorded eight 'Action' results, five of which are rainfall related. Whananaki at east beach has recorded six 'Action' results, five of which are rainfall related. In all but one instance, the results for east beach correspond to the results for the footbridge site.

Analysis of tide data for the footbridge site shows that six of the eight 'Action' results occurred on an outgoing tide and two on an incoming tide. Results for east beach show that four of the six 'Action' results occurred on an outgoing tide and two on an incoming tide.

Analysis of salinity data for the footbridge site shows that five of the eight 'Action' results had a freshwater influence (salinity of less than 30). There is also a weak correlation between levels of enterococci and turbidity at this site.

The most likely source of contamination at these sites is rainfall runoff from the land. However, as high levels of bacteria have been recorded exclusive of rainfall events, there may also be a direct source of contamination at both sites, such as a leaking septic tank or wildfowl.

Whangarei Heads – McLeod Bay, Taurikura and Urquharts Bay

Results for McLeod Bay show four 'Action' results since 2010, all four of which are rainfall related. Results for Taurikura show seven 'Action' results since 2006, five of which are rainfall related. Results for Urquharts Bay show six 'Action' results since 2006, three of which are rainfall related.

All three of these sites are located close to stormwater outlets or streams that drain into the harbour. 'Action' results that relate to rainfall are most likely caused by rainfall runoff entering the harbour via these freshwater outlets. Contaminants from the land will be entrained in this runoff.

Results that are not rainfall related could be caused by discharge from boats, birds or failing septic tank systems in the area. There does not appear to be any relationship between tide or turbidity and 'Action' results at any of the three sites. However, wind direction does appear to relate to 'Action' results at Urquharts Bay, with five out of six 'Action' results recorded during a cross-shore wind.

Further work could be done at these three sites, including faecal source tracking on samples and catchment profiling. However, as grading rates are generally 'Caution' at these sites, these sites are not a priority at this time.

Photo: Taurikura Bay

8 WATER QUALITY FOR RECREATIONAL SHELLFISH GATHERING

In addition to assessing sites for their suitability for contact recreation, results from sites popular for recreational shellfish gathering are analysed against the MfE microbiological guidelines for shellfish gathering. The guidelines are based on those used by the shellfish export sector and are internationally accepted. The guidelines use faecal coliforms as an indicator of the potential presence of pathogens and viruses.

Although the Council uses these guidelines to grade sites for recreational shellfish gathering, the Council uses a different method than that recommended in the guidelines to count the number of faecal coliforms present in a water sample. The Council uses Colony Forming Units (CFU), which is a direct measure of bacteria grown on a plate. This means that the Council's results may not be directly comparable to those achieved by using the MPN method of analysis.

8.1 Guideline values

There are two guidelines 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 14/100 ml;

And

- Not more than 10% of samples should exceed an MPN of 43/100 ml.

Compliance with these guidelines alone does not guarantee that shellfish grown in these waters will be safe for consumption.

8.2 Results 2010-11

The results for 15 coastal sites sampled during 2010-11 are shown in Table 17 below.

Site Name	No. of Samples	% Samples >43/100mL	Median Faecal Coliforms	Pass/Fail
Ngunguru - Norfolk pine	17	**12**	**10**	**Fail**
Whananaki - east end	17	**47**	**34**	**Fail**
Oakura – north end	12	**25**	**6**	**Fail**
McLeod Bay	17	**35**	**6**	**Fail**
Taurikura Bay	17	**18**	**10**	**Fail**
Urquharts Bay	17	**18**	**2**	**Fail**
Pataua – foot bridge	17	**35**	**18**	**Fail**
Ruakaka – motor camp	17	**53**	**72**	**Fail**
Paihia - Waitangi bridge	12	**50**	**47**	**Fail**
Paihia - Te Haumi River	12	**33**	**19**	**Fail**
Taipa	12	**33**	**14**	**Fail**
Coopers Beach	12	**25**	**10**	**Fail**

Site Name	No. of Samples	% Samples >43/100mL	Median Faecal Coliforms	Pass/Fail
Tinopai - below creek	12	**50**	**37**	**Fail**
Mangawhai – above camp	17	**35**	**28**	**Fail**
Pahi – NW of jetty	12	**33**	**14**	**Fail**

Table 17: Results for recreational shellfish gathering sites 2010-11

Results indicate that none of the sites sampled were within the MfE guidelines for shellfish gathering in 2010-11. However, samples were only taken over the summer months, not for the entire shellfish gathering season (which, excluding scallops is all year round in Northland). As such, these results can only be used as an indication of likely suitability.

9 SUMMARY AND CONCLUSIONS

In summary, the results from 2010-11 indicate that most coastal sites sampled are 'safe' for recreational use for the majority of the time. However, after heavy rainfall some sites, particularly those in enclosed coastal locations, do record 'unsafe' (Action) results. The grading of coastal sites was lower in 2010-11 compared to 2009-10 largely due to three major rainfall events that occurred during the summer.

In comparison with MfE guidelines, twenty two coastal sites met the safe criteria 100% of the time; twenty one met the safe criteria on all but one occasion; sixteen met the safe criteria on all but two occasions, and two met the 'safe' criteria <75% of the time.

During 2010-11, the coastal sites at Kerikeri Skudders beach and Opua foreshore recorded the highest rates of 'Action' results. It is not known what caused contamination at either of these sites. Further investigation will be undertaken at Opua foreshore in 2011-12. The site at Kerikeri Skudders beach will be dropped from the programme in 2011-12 as observation has shown that it is not a popular swimming site.

Freshwater sites again recorded lower grades than coastal sites. In comparison to guidelines, nine sites had less than 75% of samples below 'Action' level in 2010-11. These sites were Otamure Bay stream, Lang's Beach stream by car park, Ocean Beach stream, Kerikeri at Stone Store, Kapiro stream, Whangarei Falls, Otaua stream, Mangakahia at Twin Bridges and Cooper's Beach stream.

Seven of these nine recorded similar results in 2009-10 and are part of the Council site investigation programme. However, Otaua stream and Mangakahia River both had poorer water quality this season. Otaua stream has a history of water quality issues and investigation work will be undertaken at this site in 2011-12. Water quality in the Mangakahia River at Twin Bridges appears to be largely affected by rainfall, however, this site will be monitored closely in 2011-12 and investigated if water quality continues to deteriorate.

Of the remaining freshwater sites, four freshwater sites met the safe criteria 100% of the time; two met the safe criteria on all but one occasion; nine sites met the safe criteria on all but two occasions; and nine met the 'safe' criteria <75% of the time.

The results for 15 sites sampled during 2010-11 for their suitability for recreational shellfish gathering indicate that none of these sites were within the microbiological water quality guidelines. However, samples were only taken over the summer months, not for the entire shellfish gathering season (which, excluding scallops, is all year in Northland) and Council records faecal coliforms using the CFU method, not MPN as recommended in the guidelines. As such, these results can only be used as an indicator of likely suitability.

Seventeen sites were subject to investigation into poor water quality during 2010-11. Samples were collected from these sites for faecal source tracking analysis. Results received to date indicate that contamination at most sites is from waterfowl, such as ducks or seagulls. Two sites, Pahi at stormwater outlet and Ocean Beach stream, indicated pollution from a human source. Ten sites show a source to be from herbivores and five sites show a source of contamination to be dog faeces.

Results from this site investigation work will be used to inform land management options in these catchments. Where work has shown the source of contamination to be avian, permanent warning signs will be erected to inform the public of the health risks associated with swimming in contaminated water and these sites will be removed from the monitoring programme. Little can be done to improve water quality at sites where contamination has been shown to come from wild animals and so it is unlikely that these sites will ever be suitable for recreational use.

10 KEY RECOMMENDATIONS

- Continue to monitor a key group of sites on a weekly basis through the summer of 2011-12, including the 20 permanent monitoring sites.
- Disseminate water quality information to the TLAs and DHB, as per the guidelines, and display results from sampling on the Council website.
- Add a blanket statement to the results page of the website stating that water quality in Northland is unsuitable for recreational use for 48 hours after a heavy rainfall event.
- Monitor the top (best) and bottom (worst) 10% of sites on a less regular basis (monthly) and display this information on the Council website. In the interim period, display the site's SFRG and median from 2010-11 on the website, to provide an indication of the site's suitability for recreational use.
- Drop the sites at Waipapa stream and Kerikeri Skudders beach as these are no longer popular recreational swimming sites.
- Continue to collect information on water quality in the Waipoua estuary as a reference point for water quality for recreational shellfish gathering. Work on an alternative method of grading sites for their suitability for recreational shellfish gathering.
- Remove the following problem sites from the monitoring programme:
    - Langs Beach stream (midway and toilets)
    - Coopers Beach stream
    - Pacific Bay stream

  Permanent warning signs will be erected at these sites, stating the source/s of contamination and possible ill health effects from contact with contaminated water.
- Erect signs at Kaihu River, Kerikeri at Stone Store and Kapiro stream to inform the public that water quality is unsuitable for recreational use for 48 hours after rainfall.
- Continue to investigate and monitor water quality at the following sites:
    - Otamure Bay stream
    - Whangarei Falls
    - Ocean Beach stream (further sanitary survey required)
    - Waipu Cove stream
    - Ngunguru at school
    - Matapouri at 1st and 2nd bridges
    - Omamari Beach stream
    - Mangawhai at motor camp
- Add sites at Lake Waro, Opua Foreshore, Victoria River and Otaua Stream to the site investigation programme.
- Monitor water quality in the Whangarei Harbour, Tutukaka Harbour and in the Whananaki inlet and include sites in these areas in the site investigation programme if water quality deteriorates further.

11 REFERENCES

American Public Health Association, American Water Works Association and Water Environment Federation (2005). Standard Methods for the examination of water and wastewater. *American Public Health Association, American Water Works Association and Water Environment Federation, America.*

Jarman, J (2002). Health Impacts of faecally polluted freshwater swimming sites. *Public Health Unit, Northland Health, Whangarei, New Zealand.*

Jarman, J (2002). Freshwater swimming and pathogens. *Public Health Unit, Northland Health, Whangarei, New Zealand.*

Ministry for the Environment (2002). Freshwater Microbiology Research Programme: Pathogen Occurrence and Human Health Risk Assessment Analysis. *Ministry for the Environment and Ministry of Health, Wellington, New Zealand.*

Ministry for the Environment (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. *Ministry for the Environment and Ministry of Health, Wellington, New Zealand.*

NRC (2008). *Recreational Bathing Water Quality at Northland's Freshwater Bathing Sites, Summer 2007-08.* Northland Regional Council report available on the Council's website at the following link: http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/

APPENDIX 1 – RESULTS 2010/11

E.coli results for freshwater swimming spots in the 2010-2011 summer

MfE guidelines 2003

Alert (orange) mode - E. coli >260/100ml (single sample)

Action (red) mode - E. coli >550/100ml (single sample)

FU = Additional followup sample

Site Name	Site No.	1	2	FU	3	4	FU	5	6	7	8	9	FU	10	11	12	13	14	15	16	17	FU
Aurere River at SH10 bridge	110324	73	10		30	9208		457	205	183	337	1153		1565	86	131						
Coopers Beach Stream below SH 10 bridge	101870	249	2602		862	7701		6867	3873	2481	2613	472		650	435	4611						
Kaihu River at swimming hole	102221	98	122		408	173		173	98	63	2282	565		231	712	231						
Kapiro Stream at Pururua Road bridge	102838	160	272		295	820		669	189	419	3654	3255		272	448	496						
Kerikeri River at Stone Store	101530	146	197		158	3076		110	663	259	1198	11199		305	197	121						
Lake Ngatu at south end	100402	5	10		30	20		5	146	10	31	41		86	10	5						
Lake Rotopokaka (Coca-Cola)	110323	5	5		5	41		30	10	309	10	199		345	5	52						
Lake Taharoa at pump house	105434	74	5		5	5		5	5	5	5	5		10	10	5						
Lake Waro at launching area (Hikurangi)	107272	30	20		10	52		31	52	63	2755	882	134	354	63	288	754	30	31	98	20	
Langs Beach Stream at car park (*formerly toilets*)	100686	547	563		132	402		754	1607	933	1860	766		187	441	213	148	161	644	52	5475	
Mangakahia River above Twin Bridges	105973	272	74		906	609		576	41	20	410	906		240	256	134						
Ocean Beach Stream at beach drain	102077	717	1081		6488	1081		2359	8164	134	2359	1313		933	122		2481	5	85	292	4352	
Omamari Beach Stream at beach	102305	110	1333		97	134		135	98	187	285	520		341	109	74						
Otamure Bay Stream at Otamure Bay	108859	2481	1106		2046	860		1259	359	3076	9804	345		402	4352	4106	61	3076	201	4611	496	
Otaua Stream at Otaua Road bridge	108510	677	97		601	697		379	393	119	462	1086		243	282	201						
Raumanga Stream at swimming pool below falls	103246	272	288		221	857	326	487	327	216	185	1421	291	512	314	309	171	134	328	97	3076	517
Tirohanga Stream 50 meters downstream of FNDC take	102252	419	496		213	2359		161	265	262	384	2359		275	185	10						
Victoria River at DOC reserve crossing	104908	160	238		169	1178		624	3255	244	211	259		108	98	122						
Waipapa River Waihou Valley at swimming pool	103248	10	31		52	5		110														
Waipapa Stream at Charlies Rock swimming hole	110348	63	705		74	644		246	233	262	171	2481		5	121	175						
Waipoua River at swimming hole (DOC HQ)	108613	169	364		504	173		399	122	63	2014	350		63	97	243						
Waipu Cove Stream at beach	101207	189	10		441	1019		256	537	85	2282	120		240	86	201	52	146	820	278	3448	
Waitangi River @ Lily Pond Reserve	104830	187	160	364	216	3076		161	74	223	395	6131		488	211	262						
Whangarei Falls (Hatea River above falls)	105972	833	393		657	512		620	512	317	512	644		657	727	1956	717	1860	364	369	437	

Site Name	Site No.	1	2	FU	3	4	FU	5	6	7
Cable Bay at Owhetu Stream	105530	160								
Wairoa Stream (Ahipara) off end of Tui Street	105054	10	52		74	6488		771	379	158

*** Sample number equivalent to week number - Week 1 starts 29 November 2010 to Week 17 that starts 28 March 2011**

MfE guidelines 2003: Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Published by Ministry for the Environment.

Enterococci results for coastal swimming spots in the 2010-2011 summer

MfE guidelines 2003

Alert (orange) mode - Ent >140 (single sample)

Action (red) mode - Ent >280 (single sample)

NR = No Result
FU = Additional followup sample
Xx = Samples measured against guidelines for both faecal coliforms and *Enterococci* (see Section 3.1)

Far North	**Site No.**	***1**	**FU**	**2**	**FU**	**3**	**4**	**FU**	**5**	**6**	**7**	**8**	**9**	**FU**	**10**	**11**	**FU**	**12**
Ahipara	109871	5		5		5	364		5	87	5	5	5		111	5		5
Matai Bay	102326	5		5		10	64		5	99	5	10	5		10	5		5
Shipwreck Bay	109870	5		10		5	42		5	5	5	20	5		10	75		10
Tokerau Beach	109872	20		5		10	10		1	560	5	5	53		10	5		31
Waipapakauri	109873	5		5		5	31		5	5	5	5	10		5	5		5

North East	**Site No.**	***1**	**FU**	**2**	**FU**	**3**	**4**	**FU**	**5**	**6**	**7**	**8**	**9**	**FU**	**10**	**11**	**FU**	**12**
Cable Bay	105780	5		5		5	20		5	10	5	5	5		10	10		5
Cooper's Beach	101066	31		31		5	31		5	31	5	5	5		150	5		5
Matauri Bay	102425	5		10		5	NR		31	10	31	5	10		10	42		5
Taipa estuary	105777	42		5		5	2005		99	5	5	20	5		64	10		75

North West	**Site No.**	***1**	**FU**	**2**	**FU**	**3**	**4**	**FU**	**5**	**6**	**7**	**8**	**9**	**FU**	**10**	**11**	**FU**	**12**
Omapere	102317	10		5		5	124		10	5	5	10	20		20	20		87
Opononi	106011	5		5		5	531		5	5	5	87	5		31	10		10
Rawene	100236	5		5		5	5		31	75	31	42	178		53	10		64

South West	**Site No.**	***1**	**FU**	**2**	**FU**	**3**	**4**	**FU**	**5**	**6**	**7**	**8**	**9**	**FU**	**10**	**11**	**FU**	**12**
Baylys Beach	109876	5		5		5	5		5	10	5	42	5		5	5		5
Glinks Gully	100798	5		5		5	5		5	5	5	10	5		5	5		10
Omamari Beach	109875	5		5		5	5		5	5	5	5	384		5	5		64
Pahi NW of jetty	102198	5		31		20	20		75	20	5	178	254		42	5		5
Pahi at rocky groyne	102579	10		5		5	10		5	5	5	50	31		99	20		5
Tinopai below Creek	101232	5		5		5	5		42	20	5	64	10		5	10		5
Tinopai below shops	102310	5		5		5	31		5	99	5	137	10		137	5		5

South East	Site No.	*1	FU	2	FU	3	4	FU	5	6	7	8	9	FU	10	11	FU	12	13	14	15	16	17	FU
One Tree Point	109266	5		5		5	64		20	10	20	2005	238		5	5		5	42	10	31	5	1091	573
Langs Beach mid-way	108318	5		5		5	53		5	75	5	20	429	20	64	10		5	5	10	31	5	178	
Mangawhai Harbour at Picnic Bay	110322	10		5		20	5		53	192	5	75	75		53	42		5	42	5	10	10	2005	
Mangawhai Harbour at pontoon	110320	5		5		5	10		10	2005	10	5	178					10	5					
Mangawhai Heads at motor camp	101210	5		10		5	31		42	5	5	150	87		137	99		5	5	10	31	10	738	
Mangawhai Heads at open coast	109890	5		5		10	5		5	5	5	10	5		5	5		5	10	5	5	5	10	
Ruakaka Beach	108315	5		5		5	5		5	10	5	31	5		10	5		5	5	5	5	5	324	20
Ruakaka River	108314	5		5		5	150		10	42	5	75	178		659	53		42	87	64	5	42	885	41
Uretiti Beach	109888	5		5		5	20		5	5	5	10	5		10	10		5	5	5	5	5	254	
Waipu Cove	108316	5		5		5	207		5	42	10	238	20		10	271		5	560	5	5	5	192	

Whangarei Heads	Site No.	*1	FU	2	FU	3	4	FU	5	6	7	8	9	FU	10	11	FU	12	13	14	15	16	17	FU
McLeod Bay	101254	5		5		5	10		53	10	10	5	831	63	384	10		5	99	478	5	5	254	
Ocean Beach	109877	5		5		5	178		10	5	5	5	31		5	5		5	20	64	5	5	10	
Onerahi playground	101600	5		5		42	75		53	178	10	178	2005	187	124	87		5	222	20	42	87	429	
Pataua South @ footbridge	102217	10		5		5	64		42	53	10	20	2005	41	124	31		5	31	20	10	20	87	
Pataua South at east beach	104968	5		10		5	53		5	10	20	20	2005	160	64	10		20	99	10	5	5	5	
Pataua South at Frog Town	109887	5		5		5	137		5	87	5	5	306	10	31	10		10	5	10	5	5	5	
Taurikura Beach	101262	5		5		5	5		5	5	10	5	99		20	42		10	###	10	10	10	782	249
Urquharts Bay	108311	5		10		5	10		10	5	5	20	2005	52	453	99		53	453	5	5	10	5	

Tutukaka	Site No.	*1	FU	2	FU	3	4	FU	5	6	7	8	9	FU	10	11	FU	12	13	14	15	16	17
Church Bay	105448	5		5		5	64		99	885	5	20	99		124	20		5	87	20	10	42	42
Kowharewa Bay	106444	10		5		10	697	169	124	207	5	885	42		178	5		5	20	31	20	64	87
Matapouri Bay	110321	5		5		5	10		5	238	5	75	99		31	10		5	5	5	5	20	42
Matapouri first bridge	100711	344	121	5		192	254		1013	10	20	1298	164		222	137		384	5	192	5	271	42
Matapouri second bridge	100712	20		5		5	254		945	75	5	591	111		178	87		31	10	53	42	137	150
Ngunguru Estuary @ norfolk pine	100076	10		5		5	31		75	42	5	5	53		31	10		10	31	5	5	5	53
Ngunguru estuary at motor camp	100073	10		20		5	207	20	5	20	5	20	238		31	5		5	53	5	5	5	42
Ngunguru Estuary at school	108320	5		5		5	238		909	42	64	42	75		87	20		384	42	2005	20	429	75
Pacific Bay	108313	5		5		5	87		271	406	5	384	10		5	31		5	10	429	10	5	10
Sandy Bay	109879	5		5		10	87		531	75	10	5	53		10	5		5	20	5	5	5	10
Wellingtons Bay	109880	5		5		31	124		124	124	10	87	53		87	10		5	64	384	5	5	364
Whananaki at east beach	106938	5		99		10	10		87	5	5	20	1184	41	42	150		5	31	10	20	31	2005
Whananaki at footbridge	103147	31		10		99	53		5	2005	31	111	1091	63	84	478		10	150	20	10	10	2005
Woolleys Bay	109878	5		5		5	31		5	5	5	10	5		5	5		10	10	5	5	5	87

Bay of Islands	Site No.	*1	FU	2	FU	3	4	FU	5	6	7	8	9	FU	10	11	FU	12
Bland Bay	109889	1184	5	5		5	5		5	10	20	5	5		5	5		10
Kerikeri Skudders Beach	100974			429	20		1445			42	31	42	9208		1013	164		150
Oakura Bay	101345	5		5		42	10		20	10	5	42	839	5	31	111		5
Ohawini Bay	105388	10		10		5	591	199	10	885	53	2005	41	187	137	5		10
Opua Foreshore	101418	42		20		5	42			1652	31	192	2247		384	1091		10
Paihia at Te Haumi	101195	5		10		5	20		20	150	10	53	2909		99	5		10
Paihia at Waitangi Bridge	101183	5		5		5	697		64	111	5	5	7701		591	31		99
Paihia at toilets	101194	10		5		5	53		10	10	64	20	1616		42	10		31
Russell mid-north	105710	5		5		5	20		5	5	31	5	1421		192	31		5
Teal Bay	101331	5		5		5	192		5	10	5	5	169		99	5		5

*** Sample number equivalent to week number - Week 1 starts 29 November 2010 to Week 17 that starts 28 March 2011**

MfE guidelines 2003: Microbiological Water Quality Guidelines for Marine and Freshwater Receational Areas. Published by Ministry for the Environment